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ABSTRACT

Total marine fishery removals in Georgia (including the region of Abkhazia) were estimated for the time period 1950-2010 using a reconstruction approach and were composed of industrial landings, their discards, and small-scale catch in the artisanal, recreational and subsistence sectors. We added the unreported components of these estimates to the 'official' data, which have been reported on Georgia's behalf by the United Nations' Food and Agriculture Organization (FAO) from 1988 to 2010. We allocated a component of former USSR catch to Georgia for 1950-1987 (which was determined through national sources). The reconstructed total domestic catch for the 1950-2010 time period (inclusive of the reported data) is approximately 3.02 million t, or 41% more than the 2.15 million t of reported data. The main unreported taxon by tonnage was European anchovy (*Engraulis encrasicolus*) due to its sheer high proportion of catch. Unreported catches consisted of 32% industrial discards, 23% industrial landings, 20% subsistence landings, 15% artisanal landings, and 10% recreational landings. Total catches increased from 9,500 t in 1950, to a peak of 133,000 t in 1980 before rapidly declining with the collapse of the Soviet Union, as well as a local fisheries crisis stemming from a local ctenophore population explosion, to about 12,000 t in 1991, and since then increased to reach 92,000 t in 2010. In the 2000s, reconstructed catch for Georgia was nearly five times the total reported marine landings. Furthermore, catch of the foreign fleets operating inside Georgia's EEZ was estimated for Turkey, Ukraine, and Russia, who caught 443,000 t, 198,000, and 106,000 t for the years 1991-2010, respectively, most of which was unreported and taken from Abkhazia after its dispute with Georgia in 1992.

INTRODUCTION

Georgia is situated along the eastern Black Sea, and is surrounded by Russia to the north and Turkey to the south (Figure 1). The Black Sea is an almost entirely enclosed body of water which connects to the Aegean Sea and then the Mediterranean Sea via the narrow Bosphorus Strait in Turkey. More saline, denser water from the Mediterranean Sea is transported to the Black Sea via a bottom current in the Bosphorus Strait, while lighter, less saline water flows out of the Black Sea through a surface current in the Bosphorus Strait. This marked density difference has left the entire Black Sea at depths greater than 100-150 m anoxic and practically devoid of life, which also contributes to the relatively narrow fishable area on ice coastal continental shelf.

Georgia declared its independence from the U.S.S.R. on April 9, 1991 and claims a 12 nm territorial sea and a 200 nm Exclusive Economic Zone (EEZ), which is roughly 23,000 km^2 (www.seaaroundus.org); Figure 1. The most important ports are in Poti, Sukhimi and Batumi, respectively (Figure 1). In 2008, Georgia sold 51% of its port in Poti to the United Arab Emirates to develop a free economic zone and new terminal.[1] Batumi, also sold its two harbours to private owners and serves only recreational yachts, leaving the fishing fleet without landing facilities or a commercial harbour, although exceptions are made in the off-season (Khavtasi *et al.* 2010). The population trajectory of Georgia had two distinct and diverse

[1] http://www.worldportsource.com/ports/GEO_Port_of_Poti_2227.php

phases, from 1950 to 1990, the population grew from 3.5 million to 5.4 million people, after which its population rapidly declined to 4.3 million people by 2010 (Rukhadze 2010).

Abkhazia, also outlined in Figure 1, lies in the north-western part of Georgia and is a disputed territory plagued with violence, organized crime and smuggling networks since the 1990s (Kukhianidze *et al.* 2004). Abkhazia has been closed to international trade since 1993, but since Abkhazia declared itself a Republic, the 'Abkhazian Autonomous Republic', they still trade with Turkey by sea and Russia by land, but international consensus is that it is an integral part of Georgia, and thus are treated here as one entity (http://government.gov.ge). The population of Abkhazia was approximately 526,000 in 1989, 216,000 in 2003, and 240,000 in 2010,[2] with an additional 600,000 Abkhaz people living in Turkey.[3] The majority of Abkhazians have recently been granted Russian citizenship, escalating the polarity between Abkhazia and Georgia (Punsman 2009). The structure of Abkhazia's foreign trade seems unfavourable for them as exports are mainly citrus fruits, hazelnuts and fish, and imports are mainly manufactured goods, gasoline and tobacco products.[4]

This project aims to first determine Georgia's reported (with respect to FAO reported data for the former-USSR and Georgia) marine catches taken exclusively from Georgian waters from 1950-2010 and use those as the 'reported' baseline, and then estimate all unreported landings and discards from the Georgian EEZ from 1950-2010 using the best available data. The unreported components include: industrial landings, artisanal landings, recreational and subsistence landings, and discards. In addition, the amount of foreign catch taken from Georgian waters was estimated.

Fishing history

The ancient Greek historian, Herodotus (484-425 B.C.) noted that fishing was the main activity of Georgian tribes living adjacent to the Black Sea (van Anrooy *et al.* 2006). In the late 19th century, documents stated that sturgeon (Acipenseridae) and mullets (Mugilidae) were the most abundant species. Based on expert data from 1901-1913, annual Georgian marine catches were about 5,700 t·year^{-1} (van Anrooy *et al.* 2006), which did not include local consumption.

The Georgian fishing sector took shape in 1930, when the company *Saktevski* was established. By 1945, commercial fishing switched to purse seining to target European anchovy. Passive fishing gear-types common at this time included drag seines, seines, fixed and fyke nets, baited hooks, and gillnets for turbot (*Scopthalmus maximus*). That same decade, fish processing plants were constructed, and in 1960, the Ocean Fishing Department was founded (van Anrooy *et al.* 2006). At this time it was mainly just the inshore area was fished and engine power was about 25-30 HP.

When Georgia was under Soviet rule, fishing often took place by semi-military organizations which helped protect the nation's security and also controlled illegal fishing. Places with high fish abundances were allocated as marine reserves. The Soviet portion of the Black Sea was openly shared by the Soviet states.

From 1980-1990, the Georgian industrial fishing fleet had 48 vessels, ten of which were trawlers with up to 3,000 hp, capable of distant water fishing (FAO 2005); each distant-water vessel caught and processed about 4,000 t·fish·year^{-1}. The marine fisheries employed about 3,400 people in the 1980s, which rapidly decreased to less than 1,800 by the early 1990s. After gaining independence, economic and social hardship were felt in Georgia; the industrial fishing fleet practically disappeared and fisheries catches

[2] http://taklama.com/2011/12/29/a-first-look-at-abkhazias-census-results/
[3] http://abkhazworld.com/news/diaspora/95-turkish-abkhazians-enjoying-independence-of-their-far-away-country-.html
[4] http://abkhazworld.com/aw/analysis/760-socio-economic-system-of-abkhazia-and-problems-of-its-development#sthash.6LXLtV0H.dpuf

dramatically declined (Khavtasi *et al.* 2010). The country was no longer able to reap the rewards of their marine resources as the local economy, and consequently infrastructure, largely dissipated.

By 2005, Georgia's industrial fishing fleet consisted of 36 medium-sized seiners which used a combination of purse-seine and bottom trawls to target anchovy (Khavtasi *et al.* 2010); 80% of the fleet operated out of Poti (Figure 1) and used pelagic trawls, whereas the remainder operated out of Batumi and used bottom trawls, illegal in the eastern Black Sea (Khavtasi *et al.* 2010). Purse seines are much more practical for targeting anchovy, but require more capital.

After 1982, with the adoption of the United Nation's Convention on the Law of the Sea (UNCLOS), which notably established resource control within each maritime country's Exclusive Economic Zone (EEZ, if declared), the former USSR relocated a large part of their distant water fleet into their EEZ in the Black Sea, thus at one point, Georgia had 220 seiners targeting anchovy in the Black Sea (van Anrooy *et al.* 2006), whereas before they were free to roam internationally. Georgia lost free and ready access to about two-thirds of its EEZ to the ongoing Abkhaz dispute, with the Abkhaz coastline being almost twice that of the rest of Georgia.

In 2004, the catch rate for the local 35 purses-seiners was between 10-12 $t \cdot vessel^{-1} \cdot day^{-1}$, with an average of 55-60 fishing $days \cdot season^{-1}$ (van Anrooy *et al.* 2006), resulting in an annual catch potential of 20,000-26,000 $t \cdot year^{-1}$. Thus, the Georgian vessels have the capacity to catch almost half the annual quota, but the bidding system clearly prefers foreign income.

Commercial species

In the 1950s, the main commercially targeted species (van Anrooy et al. 2006) were anchovy, Atlantic horse mackerel (*Trachurus trachurus*), turbot, grey mullets (*Mugil* spp.), Pontic shad (*Alosa immaculata*), Black Sea shads (*Alosa maeotica and A. tanaica*), five sturgeon species, Black Sea salmon (*Salmo labrax*) and picked dogfish (*Squalus acanthias*). In 1950, anchovy comprised 83% (5,200 t) of Georgia's marine coastal catch, which increased to 99% by 1980 (110,000 t). Throughout the 1960s, the use of passive gears decreased while active gears and gillnets increased (van Anrooy *et al.* 2006).

Demersal fish are less common in Georgia's catches due to the narrow continental shelf and also the anoxic nature of the Black Sea basin, which inhibits fish survival below the 150 m thermocline. At first, increase in effort, and the geographical and taxonomic expansion of the fisheries, masked the declining trend in local catches (Eremeev and Zuyev 2007; Pauly 2009), and thus the disappearance of the large predators went almost unnoticed in the Black Sea from 1950-1980. Subsequently, no management system was enacted to reverse the losses, a typical case of 'Fishing Down Marine Food Webs' (Pauly *et al.* 1998), which triggered a trophic cascade (Daskalov 2002). After the near-complete removal of large predators, their former prey, the small pelagics, e.g., anchovy, European sprat (*Sprattus sprattus*), Mediterranean horse mackerel (*Trachurus mediterraneus*) and whiting (*Merlangius merlangus*), increased their biomass of total Black Sea landings from 70% in the 1960s-1970s to 93% in 1988 (Eremeev and Zuyev 2007).

The number of commercially targeted species has decreased over the years from 17 species in the 1930s, 14 species in the 1960s, 6 species in the 1980s, e.g. anchovy, sprat, whiting, picked dogfish, red mullet (*Mullus barbatus barbatus*) and Mediterranean horse mackerel (Komakhidze *et al.* 2007)], and to four by the 1990s (Mazmanidi and Komakhidze 1996). While other species still have commercial value, they are sold as retained by-catch, since their contributions to the catch do not warrant a targeted fishery. Prior to independence, most fisheries catches were exported to the USSR, leaving most Georgians devoid of fish culture, folklore and fish protein (apart from some seaside towns).[3] Anchovy catches alone were in the 200,000 to 300,ooo $t \cdot year^{-1}$ range, landed from both the Sea of Azov and Black Sea (Komakhidze *et al.*

2007). Sea snails (*Rapana* spp.) and Mediterranean mussel (*Mytilus galloprovincialis*) were also commercially caught.

Thus, the Georgian commercial fishery can be classified as having three distinct stages:

1) From the 1930s to the early 1960s, annual catches were small yet stable and ranged from approximately 3,000 to 8,000 $t \cdot year^{-1}$ (except during WWII when they decreased to under 2,000 $t \cdot year^{-1}$);
2) From the mid-1960s to 1990, the commercial fisheries appeared to improve remarkably due to a massive increase in anchovy and sprat populations (likely due to the overfishing of their larger predators), and reported catches peaked in 1985 at almost 94,000 $t \cdot year^{-1}$;
3) A fisheries collapse circa 1990, due to an alien ctenophore invasion which consumed most fish larvae of the small pelagics (Komakhidze *et al.* 2007), along with the transfer from a state-led to a market economy which also negatively impacted the livelihood of the fleet.

Most locally consumed fish is imported from Turkey, since Georgians prefer larger-size fish such as mackerel, hake (*Merluccius merluccius*), salmon and sturgeon, currently unavailable in local markets[5]. The Georgian fishery is not accredited to export fish to the European Union, leaving only non-EU countries able to import their products, such as Turkey. In light of the scarcity of fresh fish, the national seafood consumption rate diminished from 19 $kg \cdot person^{-1} \cdot year^{-1}$ pre-independence to under 4 $kg \cdot person^{-1} \cdot year^{-1}$ by 2010 (Khavtasi *et al.* 2010).

METHODS

Here, we present a reconstruction of Georgia's fisheries catches for the years 1950-2010, using the methodology described in Zeller *et al.* (2007).

Baseline data

The Food and Agriculture Organization of the United Nations (FAO) asks its member countries to submit their national fisheries catch statistics since 1950, which is made publicly accessible in the Fishstat database. The FAO began reporting for Georgia in 1988, whereas prior to 1988 (1950-1987), Georgia's marine fisheries catches for the Black Sea region were combined with the catches of the other Black Sea Soviet States (Ukraine and Russia). An earlier attempt was made to disaggregate the former USSR catches to individual Soviet States from 1950 until Georgia began reporting independently in 1988 based on each taxa's first five-year reported average (Zeller and Rizzo 2007), which was improved upon here after locating local national data from the early period. Post-independence, Georgia's reporting habits and quality greatly deteriorated (Raykov 2010). For example, in 2001 and 2002, Georgia reported for about 20 species, but in 2003, Georgia only reported for one species, anchovy. From 2004-2006, no catches were reported, and in 2007, only three species were reported, and none since then. The Black Sea Commission refused to accept Georgia's 2007 anchovy catch data due to incompleteness and lack of credibility (Mathews 2007); the FAO also noted that anchovy landings may have been mis-reported. Data were collected both from licensed landing vessels and/or from market research, but only for the handful of species indicated on the license.

Abkhaz fisheries catches prior to the civil war, beginning in 1992, were assumed to have been included in the catches reported on behalf of Georgia to the FAO. It appears that post-conflict, Abkhaz marine catches have been omitted from the data sent on behalf of Georgia to the FAO. Furthermore, since most small-

[5] http://www.finchannel.com/Main_News/Geo/107053_Investment_Opportunities_in_Georgia%E2%80%99s_Fishing_Industry/

scale fishers are unlicensed, their catches have largely been omitted from the statistics (van Anrooy *et al.* 2006). Catches were generally only reported for species which had a specific quota and license requirement.

Improvements were to be made in data collection and analysis by the Department of Fisheries (van Anrooy *et al.* 2006), but this has not occurred. Prior to 2005, the Department of Fisheries (DoF) was severely understaffed with only 8 staff, each with an annual budget of US $6,000. In 2005, the number of staff was increased to about 20, along with their salaries. Despite the increased funding, the department was still lacking basic technical resources. The Biodiversity Protection Service (BPS) of the Ministry of Environment Protection and Natural Resources of Georgia (MEPNR) is supposed to protect, develop and optimize the natural resources. However, the BPS operates without technical staff (Mathews 2007), resulting in inconclusive data.

Georgia's reported marine fisheries catches from the Black Sea were accounted for using a combination of catch data and species allocations found in van Anrooy *et al.* (2006). Table 1 from van Anrooy *et al.* (2006) was used to determine the 1950 and 1980 species allocations and total catches, and Table 3 in van Anrooy *et al.* (2006) was used to determine 1960 and 1965 total marine catches for Georgia. Each reported taxon was assigned a percentage contribution to the total catch which was interpolated from 1951-1979, and again from 1981 to the FAO 1988 reported data. Some species were only reported for the early period (1950 to the early 1960s), as they were overfished and not present from later data, such as Atlantic horse mackerel, sturgeon, turbot and garfish (*Belone belone*), hence local expert knowledge of the temporal taxonomic disappearances were used to estimate their disappearance from the data. Sprat was initially reported in the 1988 FAO data, but we interpolated its percentage of annual growth from the first three years of reporting backwards, which resulted in it initially likely being caught in 1980. From 1988 onwards, the FAO data were used as the baseline of reported marine catches for Georgia.

Commercial fishing

Industrial sector

For the purposes of this report, industrial (i.e., large-scale commercial) catches are those taken by active fishing gear (trawl, purse seines, etc.), whereas artisanal catches (i.e., small-scale commercial) are those taken by passive types of fishing gear (i.e., rod, set nets, traps, longlines, etc.) as also described by the European Parliament (Martín 2012).

For the reported catch data, in Table 3 in van Anrooy *et al.* (2006), the composition of reported catches caught by either active or passive gear-type were used to separate industrial catches from artisanal catches, and the categorizations were available for every fifth year between 1950 and 1970. The years which were not specified during 1950-1970, were interpolated from previous years. It should be noted that from 1950 to 1960, catches caught by active gear-types increased at an astonishing rate of 6% per annum from 34% in 1950 to 92% in 1960. From 1970 onwards, the same annual percentage rate of increase in industrial fishing as the 1965-1970 period was used, which by 1979 equated to 100% of reported catches being industrial. It is assumed that in the last few decades, only industrial catches were reported, as mixed local species typical of artisanal catches seem largely unaccounted for.

Unreported industrial fishing operations were reconstructed within the EEZ of Georgia for both the domestic fleet (including Abkhazia) and foreign fleets. While Georgia was under Soviet jurisdiction (1950-1990), industrial catch statistics were assumed to have been relatively well reported. Hence, the following section deals mostly with unreported catch in the last two decades of the time period in question, 1990-2010. The methodology is presented separately for the anchovy fishery, which is by far the most prominent fishery in these waters, followed by fisheries targeting high valued species.

Anchovy

Catch for the anchovy fishery was calculated separately for the Abkhazia fisheries from the rest of Georgia, yet both regions had catch by domestic and foreign fleets.

Abkhazia

Since the turmoil for Abkhazia began in the early 1990s, the maritime area has been plagued with escalated levels of illegal activities, resulting from a lack of rules, regulations and control of their resources. The following describe some of the issues related to fisheries catches in the Abkhaz state:

- Thomas Moth-Poulson from the FAO stated that the level of IUU fishing in Abkhazian waters is possibly of an unrecognized magnitude which may seriously affect sustainable measures being applied elsewhere, creating unfairness in shared resource use (GFCM 2013);
- Much of the catches taken in Abkhazia stem from illegal and/or informal deals, neither of which can be reported;
- Abkhazia leases (some) of their continental shelf to Turkey for fishing, which equates to 15% of Abkhazia's export revenue, and locals say the Turks have largely thinned the fish population in the shallow coastal waters (Delyagin 2009);
- Two Turkish companies (*Konevy Ltd.* and *Kiyak Kardes Liyar*) had 'official' contracts with the Ministry of Economy of Abkhazia and export their catches to Turkey (Kukhianidze *et al.* 2004);
- In recent years, Turkish-Abkhaz relations increased both politically and economically, and many Turkish fishing vessels are typically seen anchored in Sukhumi harbour;[6]
- About 30 Turkish fishing vessels operate in Abkhazia where no fisheries control exists;[7]
- Two-thirds of Abkhazia's exports to Turkey are shipments of fish, fish meal and fish oil;[8]
- In addition to Turkish fishers, there are also Russian and Ukrainian fishers operating in Abkhazia, targeting anchovy but also turbot, whiting, red mullet and prohibited sturgeon (Zengin *et al.* 2012).

In Abkhazia, in 2011, anchovy was fished by two Turkish, one Ukrainian and a few local companies for local processing and then export, but was not made available to locals. Instead, Abkhazians find frozen mullet and salted herring at their fish markets.[9] The Abkhaz anchovy quota was recently increased from 17,000 t·year^{-1} in 2010 to 27,000 t·year^{-1} in 2011, all which was used.

It was estimated that the combined Russian, Ukrainian and Turkish catch from Abkhaz waters in early 2011 was about 50,000 t of small-sized anchovy (Oztürk *et al.* 2011). Since foreign fishing began in Abkhazia in 1996, anchovy catches were estimated at a conservative 13,000 t·year^{-1} in 1996, which was linearly increased to our 2011 published estimated catch amount of 50,000 t·year$^{-1,}$ which was applied to 2010. Of these annual totals, 60% was assumed to be caught by Turkish fishers and 20% each by Ukrainian and Russian fishers. Domestic unreported Abkhaz catches were thought to begin in 1992 at 2,000 t·year^{-1}, which was linearly increased to 4,000 t in 2006, the year prior to the opening of the domestic plant processing anchovy (Gaerke and MothPoulson 2011); thereafter, catches were linearly interpolated to the 2010 domestic catch amount of 17,000 t. Both domestic anchovy catch and foreign fishing in Abkhaz waters were assumed to be unreported, as in (Oztürk *et al.* 2011) it was stated that Georgian and Turkish catches were definitely unreported, while data on other countries does not exist.

[6] http://www.abkhazworld.com/Pdf/Reflections_on_Abkhazia.pdf
[7] http://hamsi.ims.metu.edu.tr/sunumlar/4-IUU-GFCM[ACG].pdf
[8] http://apsnypress.info/en/news/417.html
[9] http://www.bakutoday.net/abkhaz-president-instructed-to-provide-the-population-of-black-sea-fish-which-nearly-wiped-out.html

Georgia (excluding Abkhazia)

Domestic catch

While FAO catch for Georgia was used as the reported landings baseline, one significant omission from reported catch data is that processed anchovy (into fish meal, oil and flour) are not reported as fish catches (Oztürk *et al.* 2011), but the processed fish meal and oil are reported as exports from Georgia, and likely reported as fishmeal/oil imports to Turkey, but not as fresh fish. Most Georgian caught anchovy (85-90%) is processed in fish meal factories (Gaerke and MothPoulson 2011), and three new fish processing plants opened in 2005 in Georgia (Kapadokia Ltd., Laguna Ltd. and Tedoradze Ltd.) with the capacity to process 250, 300 and 50 $t \cdot shift^{-1,}$ respectively, under joint Georgian-Turkish ventures. Technically, these ventures are supposed to have 2/3 of their catches processed in Georgia while 1/3 is allowed to be exported unprocessed (Khavtasi *et al.* 2010); however freezing the catch technically classifies as processing so the frozen fish can easily be exported. Since processing capabilities in Georgia are limited, most exports are either chilled or frozen and then sent to Turkey.

According to the Abkhazian website for their chamber of commerce, Abkhazia claims to export over 8 t of fish meal and fish oil per year[10] which was understood to be highly inaccurate. Abkhaz anchovy processing plants began in 2007 with *Ooo Hamsa* under Turkey's largest fish oil and fish meal manufacturer, *the Kobyalar Group*. A trusted source stated that in early 2011, Abkhaz factories processed 17,000 t of fish and exported another 25,000 t to Turkey, some of which was reported (Oztürk *et al.* 2011). The first half of 2012 of the Abkhaz foreign trade showed a much more trusted amount of US $11 million in exports to Turkey in fish, fish meal and fish oil products.[11] We assumed these amounts were already considered in our previous estimates of local and foreign Abkhaz catch in order to avoid double counting.

As of 2009, two freezing plants, one fishmeal plant and one smoking plant were operational in Poti, the major landing port in Georgia (Khavtasi *et al.* 2010). To account for the catches processed into fishmeal and fishoil, FAO's Fishstat software was used to determine Georgian fishmeal and fishoil exports, which were available from 2004-2009, and Eurofish data (http://georgia.eurofish.dk/Countries/Georgia.pdf) was used to determine 2010 Georgian marine fish exports, which were considerable. In 2010, Georgia exported 2,870 t of fishmeal and 1,125 t of fish oil. The annual totals were applied the appropriate conversion ratio of 6.5:1 for fishmeal and 13:1 for fish oil (Gaerke and MothPoulson 2011) to convert to whole fish weight. Since export data for 2006 was missing, the values were interpolated (see Table 2) and the time series from 2004-2010 was used to estimate unreported domestic anchovy catch. Since exports were small yet still present in the 2000s (Gaerke and MothPoulson 2011), we interpolated from 0 t of unreported catch in 1999 to the 2004 amount of unreported catch (2,593 t).

Foreign catch

In Georgia, as in the Mediterranean, Turkey is the main fisher of European anchovy and captured about 36% of the world's catch in 2008 (Gaerke and MothPoulson 2011). Turkish fishers have a history of fishing illegally in waters other than their own without permission, or for defying other rules such as minimum size or minimum depth limits (see also Ulman *et al.* 2013). Being aware of this, Georgian authorities have imposed the following regulations on Turkish anchovy fishers: protected 'no-take' areas, spatial restrictions >300 m from the coast, a minimum landing size of 7 cm (anchovy), total allowable catch, and to process most of the landings in Georgia. From 2009-2010, there were 32 Turkish fishers arrested for disobeying these laws,[12] suggesting low compliance, including with reporting of catches.

[10] http://www.tppra.org/en/livestock-sector-and-fisheries
[11] http://www.abkhazworld.com/news/misc/900-russia-and-turkey-remain-abkhazias-main-trade-partners.html
[12] http://hamsi.ims.metu.edu.tr/sunumlar/4-IUU-GFCM[ACG].pdf

Turkish fishers began targeting anchovy in Georgian waters in 1996, after purchasing permission from the Georgian government (Oztürk *et al.* 2011). The Turkish Ministry of Agriculture and Rural Affairs (MARA) published the number of Turkish vessels from 2002-2009 licensed to fish in Georgia; the number of vessels averaged 46 per year and the number of transport vessels averaged 14 per year, or roughly one transport vessel working per three purse seiners. Obviously, these numbers only include the 'legal' vessels. In 2009, Turkey had 5,973 licensed vessels operating in the Black Sea, 12% of which were of industrial class (12-50+ m long), signifying a massive presence and extraction potential (TÜİK 2010).

Although it cannot be shown with certainty that the Turkish fleet has exceeded the Georgian allowable catch for anchovy, the following sources support the notion:

1) A Turkish-hired seiner catches between 300-500 and sometimes 1,000 $t \cdot day^{-1}$ of anchovy (Khavtasi *et al.* 2010), thus, one Turkish seiner can catch somewhere between 30,000-100,000 $t \cdot year^{-1}$ assuming an actual fishing season of 30-100 days;

2) In private interviews with the first author in July 2013, two Turkish seine fishers explained that one Turkish vessel fishing in Georgia/Abkhazian waters catches between 10,000-20,000 $t \cdot season^{-1}$;

3) A captain of a Turkish carrier vessel working for one of two Turkish purse seiners which fished in Abkhazian waters, explained to a contact that in a 3 month period, he made 23 shipments of anchovy to the middle of the Turkish Black Sea coast[13] (not the official landings port in the town of Hopa bordering Georgia where foreign anchovy are to be landed and hence reported), the smallest of which was 60 t but the average load being 100 t (Ulman *et al.* 2013);

4) Along with the transshipment of turbot from domestic Georgian vessels to Turkish vessels, mussel, rapa whelk and turbot as well as anchovy and sprat are illegally fished (Oztürk *et al.* 2011);

5) In 2007, Georgia signed a Free Trade Agreement with Turkey which came into effect in 2008. In 2009, Georgian exports to Turkey accounted for 20% of total Georgian exports; and

6) It is understood that anchovy sent for processing into fish meal and fish oil are not reported by either Turkey or Georgia, also the fresh and the processed anchovy products taken in Abkhazia waters are not thought to be recorded in either Georgian or Turkish catch data, and were estimated to total 50,000 $t \cdot year^{-1}$ in 2011 (Oztürk *et al.* 2011).

The Turkish fleet generally fishes for anchovy from January to March of each year (Zengin *et al.* 2012). Catches caught in Georgia but landed in the Turkish town of Hopa were registered from 2003-2009 (Table 1)(Oztürk *et al.* 2011). These catches were tagged as Turkish catches from Georgian waters in the present data since in the Turkish catch statistics, there were no catches originating from foreign waters. For 2010, we assumed the same values were caught as in 2009, as it is known the quota was reached.

In 2006, there was a Total Allowable Catch (TAC) of 60,000 t set for the industrial anchovy fishery (Komakhidze *et al.* 2007), 10% of which is reserved for small-scale Georgian companies, and the remainder to the highest bidder. For the purposes of this reconstruction, these 'small-scale' catches are actually industrial because the vessels employed are trawlers, albeit many are outdated and cannot compete with the new Turkish chartered vessels (Gaerke and MothPoulson 2011). Winning bidders own their portion of the quota for 10 years and the annual TAC varies each year based on scientific advice

[13] Hopa is the 'official' import port from Abkhazia, which suggests that catches being landed outside of Hopa may have gone unreported.

(Mathews 2007), i.e., increased to 70,000 t for the 2010/2011 season, and to 80,000 t for the 2011/2012 season. There are now six main Georgian companies as license holders who charter about 20 Turkish vessels to catch the majority of the quota (Gaerke and MothPoulson 2011). In 2011, of these 6 Georgian companies, three owned fish meal factories, another was under construction and one was in the planning stages. Two-thirds of this catch is to be processed in Georgia, either by freezing the catch or by processing into fish meal/oil. Once allotted a quota, each vessel pays 15 GEL (i.e., $8.70 USD) per allotted tonnage as a regulation fee and an additional 25 GEL per tonne as a natural resource fee (Mathews 2007), independent of their actual catch amount.

The fish processing industry of the Ukraine was more prominent in the past since the Soviet Union was the main consumer of processed fish products, and according to van Anrooy *et al.* (2006) both Ukraine and Turkey began fishing in the 1990s in Georgia. Furthermore, van Anrooy *et al.* (2006) provided data on the total catch of anchovy in Georgian waters by national and foreign fleets from 1970-2003 for select years. We compared this data to FAO reported Georgian catch, assuming the difference between total catch and Georgian FAO catch to be foreign. We only considered catch from the years 1992 onward, as prior to this Georgia was part of the USSR and most likely Soviet catches predominated in their waters.

Any foreign catch from 1992-1995 was assigned to Ukraine, as Turkey only established an agreement to fish in Georgian waters in 1996. Thus in 1995, 0% of foreign catch was caught by Turkey and 100% by Ukraine. Starting in 2003, Turkish catch of anchovy in Georgia was available (Table 1), as was total catch data in van Anrooy *et al.* (2006), thus allowing a straightforward subtraction to yield Ukrainian catch. As a result, in 2003, 66% of foreign catch was caught by Turkey, and the remaining 34% by Ukraine. We interpolated the relative proportions of both Turkey and Ukraine to total foreign catch from 1995 to 2003, and therefore derived the estimated removals of each country's catch for the years in between.

From 2003 onward, data on Turkish catch was available but estimates of total catch or Ukrainian catch is limited. Given the knowledge that there has been a seasonal quota of 60,000 t of anchovy since 2006 (although there is limited data on whether it was met) we assumed total catch in 2009 and 2010 was 60,000. It is more reasonable to assume that the quota was fully met in 2009 than in previous years because Georgian domestic catch of anchovy was reported at 24,500 t while Turkish catch was about 22,200 t (Oztürk *et al.* 2011), which are markedly higher than in previous years. This leaves the remainder of catch, assumedly, to be caught by Ukraine. To estimate Ukrainian catch from 2004-2008, we used the 2003 and 2009 anchor points to derive a ratio of Ukrainian catch in Georgia to all other catch (Georgian and Turkish) and interpolated this ratio between the two years. This was then applied to the total estimated landings of Georgian and Turkish catch. Since FAO catch data for 2010 was the same as in 2009, and we assumed that Turkish catch was comparable and the quota was comparable, catch for Ukrainian catch was also the same in 2010 as in 2009.

Other species

High-valued species caught in Georgian waters go unreported because there is no mandate requiring landed species which do not have specific catch quotas to be reported. From Komakhidze *et al.* (2007), several unreported species were monitored from 1990-2001, and their catches ranged from 288-355 $t \cdot year^{-1}$, but the trend showed that catches slightly increased throughout the period due to improved monitoring. From 2002-2010, the same values for the select unreported species as in the last year (2001) of their unreported estimations were applied as unreported catches. The data from the Komakhidze *et al.* (2007) graph were not 100% clear, so the values were estimated to our best ability, with a taxonomic group created for miscellaneous marine fish to equate to the same published totals from Komakhidze *et al.* (2007).

To include unreported catches for high-valued species in the Abkhaz region, these values were multiplied by 1.75 to attain estimates for the entire coast (based on the relative size of Abkhazia's coast). Once each taxon's values were estimated from 1990-2010, 50% of these catches were applied to the industrial sector, and the remainder, which were artisanal, were not used here, since artisanal catches were estimated using other methods, thus avoiding double-counting. Of the industrial unreported high-valued commercial catches, beginning in 1996, 90% of the catches were assumed to have been caught by Turkish fishers in Georgia, the remaining 10%, thought to have been caught by domestic fishers.

Artisanal sector

In Georgia, the artisanal fishery (locally referred to as the 'traditional fishery' or small-scale commercial) is defined as the commercial collection of fish and other living marine resources by traditional passive gear types. This sector is only permitted to operate within 300 m of the shoreline (Mathews 2007) and a licensing system for the coastal fisheries was not introduced until 2007.

Under Soviet rule, small-scale fishing with passive gear, such as trammel nets, gillnets, longlines, rod and line, etc., was conducted by semi-military organizations (van Anrooy *et al.* 2006), which consequently contributed to the security of the country. The small-scale sector played a significant role in the economy up until 1990, when it rapidly shrunk by almost half, the total number of people employed in (both large- and small-scale) marine fisheries was 3,400 in 1980, which decreased to 1,800 by 1990 (van Anrooy *et al.* 2006). This sector is technically supposed to be licensed, but in general, is not.

Seemingly, since 1988, when Georgia began reporting to the FAO independently, only a handful of commercial species (both pelagic and benthic, likely caught by bottom-, mid-water trawlers or seiners) were reported on. Since quotas are only placed on the industrial sector, is was assumed that the artisanal sector had not reported any catches during this period (1988-2010). If the artisanal sector had reported, there would then be some data on mixed coastal fish species. The FAO species list for marine fishes and invertebrates of Georgia only lists 19 taxa, only 8 of which had catch amounts in the first year of reporting in 1988. In the 1950-1987 data, using the same percentage of increase of the large-scale sector in comparison with the small-scale sector which had occurred from 1960-1970 (van Anrooy *et al.* 2006), it was assumed that catches of the small-scale sector were absent from the reported data as of 1979.

While one source stated that in the late 1980s that the small-scale fleet had an estimated 325 small-scale fishing boats, on closer inspection, this amount in some sources represented small-capacity bottom trawlers, which we considered to be part of the large-scale or industrial sector as that involves an active type of fishing, i.e., was towed from a boat such as a trawler or a seiner (Martín 2012). Thus, a type of fishing gear was considered to be used by the artisanal sector (i.e., small-scale) if only passive fishing methods were used, e.g., small nets, traps etc. (van Anrooy *et al.* 2006), hence the amount of small-scale vessels was not used as an anchor point. Another area in the same document suggested that there may have been about 1,000 small-scale small fishing units (vessels?) operating in the country, as there were about 300 in the Achara province alone.

In addition to the above, it was stated that the coastal fishery had approximately 1,500 full-time, and 300 part-time fishers in 2004 (excluding about 300 industrial fishers), and likely also hundreds of illegal fishers (van Anrooy *et al.* 2006). Thus, we assumed there to be 1,800 full-time fishers in 2004, which thus included the illegal as full-time fishers but excluded the part-time to remain conservative. We also used the above loose estimate of 1,000 small-scale vessels as an anchor point to determine the number of fishers per vessel (1,800 fishers divided by 1,000 vessels equated to 1.8 fishers per vessel). In 1980, we know there were roughly 88% more fishers in the total marine fisheries (i.e., 3,100 compared to 1,500 in 1990) and both the 1980 and 1990 amounts each had the industrial fishers subtracted to complete our time-series of artisanal fishers. The number of small-scale fishers was kept constant from 1950-1980. A

catch rate of 2 t·vessel^{-1}·year^{-1} was applied from 1950-1985 per vessel, after which it was linearly decreased to 1 t·vessel^{-1}·year^{-1} by 1990 and held constant to 2010 to acknowledge the tropic cascade in the Black Sea which resulted in smaller, lower quality fish, which mostly negatively affected the industrial sector more than the artisanal. Thus the number of boats was then multiplied by the annual catch rate to determine annual small-scale catches per vessel. Since it was assumed that the artisanal sector was accounted for in the early period, but unreported from about 1980, the annual calculated artisanal catch amounts had the reported artisanal amounts subtracted from them to determine the unreported artisanal portion from 1950-1979.

Since the number of small-scale fishers dramatically decreased from 1980-1990, around the time the turmoil began between Georgia and Abkhazia, this decrease in the number of fishers was understood to somewhat represent the separation of state by excluding the fishers from much of its coastline, hence, it was assumed that total small-scale catches did not actually decline much with the inclusion of Abkhazian catches. Although Abkhazia has claimed its independence from Georgia, this has not been recognized by most of the world, except for Russia and a few other countries. Despite the ongoing dispute, it is assumed here to be a part of the Georgian territory, a *de facto* sate, and its fisheries catches were here estimated for the first time for inclusion purposes, as we aim to include all unreported catches of the country. To include the catches of the Abkhaz region, the above estimated artisanal catches for Georgia from 1995 to 2010 were multiplied by 1.75 to determine amounts for the entire country, whereas from 1992 (the start of the Abkhaz war) to 1995, Abkhazia's small-scale catches were linearly increased from 0 to 175%.

The species allocated to these catches varied annually reflecting the natural changes in the Black Sea ecosystem and were derived using a combination of expert advice from the Ukrainian fisheries (Vladyslav Shlyakhov, pers. comm.), Turkish Black Sea fisheries statistics, and the recreational catch composition. The taxonomic allocation for 1954 (what we deemed the first year of small-scale unreporting) and 2010 are provided in Table 3, and the amounts were interpolated in between.

Industrial discards

Discards are defined as the portion of the catch that is "thrown away, or dumped at sea" (Kelleher 2005), and may include both commercial and non-commercial species. Reasons for discarding include damaged or spoiled catches, target-species smaller than the legal landing size, or having little or no market or commercial value (Rousou 2009).

Since very little publicly available data exist on the earlier composition of the fishing fleet (prior to 1980), besides a fleet of Black Sea seiners beginning in 1945,[14] the Georgian fleet was assumed to have similar development to the Ukrainian fishing fleet, both ex-Soviet Union States. Thus from 1950-2010, 60% of landings of the industrial fleet (except sea snail which is calculated separately) were assumed to have been fished by purse seine, 20% by bottom trawl, and 20% by mid-water trawl. From 1980-1990, 20% of the fleet was known to be bottom trawlers (FAO 2005), and bottom trawling was noted to be a leading cause of fish biodiversity and biomass decline. In the 2000s, in Abkhazia, vessels fishing for the joint Turkish-Abkhaz company *Amalgur* were known to use bottom trawls, and also 20% of the 'seiners', which operated out of Poti, actually fished via bottom trawl (Khavtasi *et al.* 2010). One published Black Sea bottom trawl discard rate was 42% (Ceylan *et al.* 2014), but to be conservative, this rate was reduced to 30%. Of this 30% bottom trawl discard rate, 10% was allocated as damaged, juvenile, or otherwise unmarketable sprat, 5% as damaged or juvenile anchovy, the remaining 15% were allocated as non-target (i.e., non-commercial fish, Table 5) and invertebrates. Other commonly occurring benthic species had commercial value and thus would be retained by-catch, and not 'discarded'.

[14] http://georgia.eurofish.dk/Countries/Georgia.pdf

It has been suggested that the Black Sea anchovy purse seine fleet has a zero discard rate (Kelleher 2005), but it is understood that in the winter months of December and January, sprat is often caught as by-catch in the anchovy fishery (Shlyakhov, unpubl. data), and sprat can make-up 10-60% of total anchovy catch when anchovy is the target (C. Keskin, pers. comm.). Since some fish processing plants only accept anchovy, much of the incidentally-caught sprat is discarded. In the Black Sea, sprat and anchovy biomasses increased together in the 1970s, and since anchovy was of higher value, many fishers switched their target species to anchovy. A sprat fishery only became commercially viable post-1990, after the Black Sea fisheries crisis, and was largely discarded prior to that. The sprat composition in anchovy fisheries can range from 10-60% (known to be higher in the western Black Sea), since they temporally occur together for about a third of the anchovy season. Thus, from 1950-2010, for the purse seine catches, a 10% sprat discard rate was initially allocated, but since the two species are only closely associated for 1/3 of the anchovy season, the 10% was divided by three to temporally represent their co-occurrence which resulted in a 3.3% annual discard rate (applied to sprat) for the anchovy fisheries. Sprat are occasionally landed for processing, but are still often discarded if the associated fishmeal factory is selective. An additional 1% discard rate was calculated to represent non-marketable fish species, thus, a total discard rate of 4.3% was applied to purse seine catches.

The published discard rate for mid-water trawlers is 5.1% (Kelleher 2005). To be conservative, mid-water trawlers were also assumed to have the same 4.3% discard rate as the seiners, as they share similar fishing behaviour. The discard rates for purse seine, bottom trawl and mid-water seine were applied to the reported and unreported industrial catches. Foreign discards were allocated to the specific country fishing them.

Sea snails in Georgia are fished by the 'cage trawl' method (Mathews 2007), a mixture between a dredge and a bottom trawler. We applied a sea snail discard rate of 11.5% (Kelleher 2005), which was assumed to consist of equal amounts of miscellaneous marine fish and miscellaneous marine crustaceans.

Recreational fishing

We realized that recreational, subsistence and some aspects of small-scale commercial fisheries form a continuum, and may be hard to separate, however, here recreational and subsistence fisheries are defined and estimated separately.

We are defining the recreational fishery here as fishing primarily for pleasure, and generally neither for commercial sale, nor for the primary purpose of feeding one's self or one's family. The recreational fishery in Georgia is locally referred to as either the 'amateur' or 'sports' fishery and is defined as fishing with any kind of fishing rod, spinning net, throw net, racket net, draught net or the hunting and collection of marine life without the use of scuba gear (Mathews 2007).

Recreational fishing is widespread in Georgia, and the fishers are well-equipped (Khavtasi *et al.* 2010). Khavtasi *et al.* (2010) suggested that the number of recreational fishers is high, and their annual catch may be around several hundred tonnes.

To assemble a time-series of Georgian population statistics, the time-series of Tsiklauri and Sulaberidze (2013) was used, which addressed many inconsistencies in the national data, which also included the Abkhaz population.

Given that Georgia has the highest percentage (38.6%)[15] of people living coastally among Black Sea countries, it was assumed that the number of recreational fishers was fixed at a low rate of 0.25% of the

[15] http://www.wetlands.org/Portals/0/publications/BSO%20publications/vision_fin.pdf

total population from 1950-1975 (due to a strong military presence which would have deterred many leisure fishers), after which it was linearly increased to 1% of the population by 1990, and a catch rate of 49 kg·fisher^{-1}·year^{-1} (verified by local experts for use for the Ukrainian catch reconstruction) was used from 1992-2010, this catch rate was linearly increased by 50% to 73.5 kg·fisher^{-1}·year^{-1} for the 1950-1975 period (to represent larger and more abundant fish in the earlier Black Sea ecosystem), and then the two catch rates were interpolated between 1976 and 1991. The values from 1989-1992 were reduced by 50% to account for the 'Black Sea fishery crisis' which negatively affected mainly small pelagic catches.

The taxa allocated to the recreational and subsistence sectors were varied to reflect the natural changes in the Black Sea ecosystem, and were derived using a combination of expert (Ukrainian) advice, Turkish fisheries statistics and recreational catch knowledge. In Table 4, each taxon's contribution to the total sum was presented as a percentage for both 1950 and 2010, and were largely interpolated in between following expert advice.

Subsistence fishing

Subsistence fishing is generally defined as fishing for the primary purpose of feeding one's self or family, and thus generally not for commercial sale. Due to Georgia's recent increase in economic hardship and the associated decrease in social welfare, it is understood here that the subsistence sector primarily fishes to provide fresh protein for one's self or one's family, but also may sell some catches if they were substantial or if the landed species were of high-value.

While a subsistence fishery certainly exists in Georgia, no studies have ever been conducted on this sector. An analysis of all peer-reviewed and grey literature uncovered the following on this sector:

- There are too many fishers sharing reduced revenues. When asked why they continued to fish, the fishers said it was because they needed to eat, even if profits were zero signifying that subsistence fishing is as important as fishing for profit (Mathews 2007); and

- Post-independence, Georgians have been trying to survive under poor socio-economic conditions which have led to increased unemployment and also increased impoverishment. Subsequently, fish poaching (as in the taking of protected fish) has recently increased (Komakhidze *et al.* 2007), which for many, is a main means for survival. Both poaching and illegal fishing happen year-round, but are more significant during certain spawning periods, when the fish are more vulnerable, as with sturgeons.

From the above, we assumed that 1.0% of the total population fished for subsistence purposes from 1950 to 1989, which was linearly increased to 1.5% of the population by 1991, when the state-authoritative control was significantly reduced. This rate was held constant from 1991-2010. We suspect this may have been an underestimate for recent times.

We assumed a catch-rate which was one-third less than the recreational fishery which equated to 32.6 kg·fisher^{-1}·year^{-1}, which was held constant from 1992-2010. The catch rate was doubled from 1950-1985 to 65 kg·fisher^{-1}·year^{-1} due to the former presence of larger predatory fish, and then the rate was linearly decreased from 1986 to the 1992 value. The catches from 1989-1992 were additionally reduced by 50% to account for the fishery crisis which affected the entire Black Sea, mostly brought on by overfishing, a trophic cascade and then a ctenophore invasion which consumed much of the eggs of the small pelagics.

RESULTS

Georgia as a whole

Our reconstruction of Georgia's total catch from 1950 to 2010 established an independent reported baseline for Georgia, as none was previously available. The total reconstructed catch used this newly derived reported baseline, along with our best estimates of unreported industrial, artisanal, recreational, and subsistence landings, as well as major discards (Figure 2a, Appendix Table A1), and the separate estimation of foreign fishing in Georgia (Figure 3).

The total reconstructed catch for the Georgia averaged just under 10,000 t·year^{-1} in the early 1950s, after which it gradually increased to 45,600 t in 1970, increased rapidly to peak in 1980 with 133,000 t and sustained these levels until 1988. After this point, the fisheries rapidly crashed to 12,200 t by 1991 due to the Black Sea fisheries crisis, the collapse of the Soviet Union, and the associated cessation of funding to the industrial fisheries, only beginning to recover in the 2000s as catch reached 92,000 t in 2010 (Figure 2a, Appendix Table A1). For the entire time period, total reconstructed catch was 41% higher than the derived baseline of reported catches from 1950-2010.

From the total reconstructed catches (inclusive of the reported data) for the 1950-2010 period (Figure 2b, Appendix Table A2), the major taxonomic contributors to the catches were European anchovy (74%) and European sprat (4%), and the minor contributors were picked dogfish (3%), gobies (Gobiidae) (2%), and Mediterranean horse mackerel (2%) with 45 additional taxa contributing to the remaining 17% of the catches (Figure 2; Appendix Table A2).

Industrial landings

Reported industrial landings for Georgia averaged 2,700 t·year^{-1} in the early 1950s, peaked in 1980 with 111,000 t, declined substantially after 1988, with catch averaging only 2,000 t·year^{-1} from 1993-2002, thereafter increasing to reach 25,500 t·year^{-1} in the late 2000s. Unreported catches in the industrial fisheries only began in 1991 after the collapse of the Soviet Union, and increased dramatically from 93 t of catch in 1991 to over 50,000 t in 2010, due to undocumented catch in Abkhazia and in domestic fishmeal/oil operations (Figure 2a, Appendix Table A1).

The major species landed by the industrial sector from 1950-2010 were European anchovy (94.8%), European sprat (2.4%), and smaller amounts of picked dogfish, horse mackerel, grey mullets, bonito, and an additional 25 taxa each contributing less than 1% each to catch.

Artisanal landings

Reported artisanal landings were 4,170 t in 1950, and then were assumed to gradually decrease to a reported contribution of 20 t in 1979. Unreported artisanal landings were assumed to have begun in 1954 at 1,050 t, gradually increased to peak in 1978 at 3,440 t, after which they decreased to average just over 800 t·year^{-1} during 1989-1991, and then increased to 2,750 t·year^{-1} in the late 2000s (Figure 2a, Appendix Table A1).

The major taxa landed by the artisanal sector from 1950-2010 were European anchovy (26.5%), mullets (Mugilidae) (8.6%), whiting (7.7%), gobies (7.5%), bluefish (*Pomatomus saltatrix*) (6.4%), picked dogfish (5.8%), sturgeons (5.2%), Mediterranean mussel (4.5%), and Mediterranean horse mackerel (4.5%), with 17 other taxa making up the remaining 23.3% of catches.

Recreational fisheries

Recreational landings (all unreported) averaged 650 t·year^{-1} in the early 1950s, peaked in 1988 with 2,400 t, crashed to 1,200 t·year^{-1} from 1990-1992, and have since increased to 1,900 t·year^{-1} in the late 2000s, but have slowly been declining since 1993 (Figure 2a, Appendix Table A1).

The major taxa which we assumed were caught by the recreational sector from 1950-2010 were Mediterranean horse mackerel (14.4%), Mediterranean mussel (11.6%), bluefish (11.0%), gobies (10.4%), whiting (10.0%), So-iuy mullet (*Liza haematocheila*, 7.6%), sea snails (5.1%), with 14 other taxa accounting for the remaining 30% of catch.

Subsistence fisheries

Subsistence landings (all unreported) gradually grew from 2,300 t in 1950 to 3,200 tons in 1985, declined to a low of 1,500 t in 1989, increased to 3,500 t·year^{-1} just after independence and have since declined to average 2,800 t·year^{-1} in the late 2000s (Figure 2a, Appendix Table A1).

The major species we assume were caught for subsistence purposes were Mediterranean horse mackerel (14.5%), Mediterranean mussel (12.2%), bluefish (11.6%), whiting (10.0%), gobies (8.9%), and So-iuy mullet (5.6%), and grey mullets (5.0%) with 14 other taxa accounting for the remaining 32.1%.

Discards

Discards were applied to industrial catches and hence followed their trend. Discards averaged 300 t·year^{-1} in the early 1950s, gradually increased to peak from 1980-1988, averaging 13,000 t·year^{-1}, after which they dipped to 600 t·year^{-1} from 1993 – 2000 before rebounding to reach over 9,000 t by 2010. Discards were composed of mostly sprat (22%), picked dogfish (18%), skates (Rajidae; 14%) and whiptail stingrays (Dasyatidae; 14%).

Foreign fishing

Foreign fishing grew from 190 t in 1991 to 85,700 t in 2010, while discards grew from 20 t to 10,300 t, with Turkey accounting for 59% of catch, Ukraine for 27%, and Russia for 14% (Figure 3).

DISCUSSION

This reconstruction of fishery catches for Georgia in Georgian waters from 1950-2010 is a first attempt at comprehensively correcting omissions and improving on the taxonomic detail of locally caught species for the complete 1950-2010 time period. There is a serious lack of taxonomic knowledge transfer in the country which needs to be addressed so that the state of its resources can be tracked and managed.

The fisheries catches of Abkhazia from separation up until 2012 (when they began reporting exports) is completely unreported and the amount of catch is certain to be high, as is illustrated by the estimates presented here. There appear to be several formal foreign fishing agreements (none of which could be located for our purposes) as well as informal foreign fishing agreements, the latter of which are likely not reported in either the country fishing or in Abkhazia. The Abkhaz marine catches are understood here to be completely omitted from the data reported on behalf of Georgia to the FAO after 1992 and were reconstructed here using conservative best estimates which utilized the available published data and grey literature but catches may be much higher. These estimates are a first attempt at putting numbers to the unknown, and to present the issue using all available information.

The credibility of Georgia's fisheries statistics deteriorated rapidly after the collapse of the Soviet Union due to major reductions to the formerly state-funded industrial fisheries, and severely reduced Monitoring, Control and Surveillance (MSC) capabilities. Statistics were not reported by Georgia to the FAO after 2004, with the exception of 2007, and the 'reported' totals were instead interpolated from previous years. This was still used as our baseline, with efforts made to improve upon this.

While it is understood that domestic enforcement ramped up in 2006, leading to arrests and hence influenced many to obey laws (Mathews 2007), the scale of foreign fishing is still known to be high, plus the other domestic sectors which are not reported for at all.

According to a 2012 GFCM *ad hoc* Working Group meeting on the Black Sea's fisheries, future goals of the group will incorporate improving scientific information, develop regional databases, identify data required to develop an Ecosystem Approach for Fisheries (EAF), better understand the role of the artisanal sector, and to assess unreported fishing.[16] It remains to be seen if this can be achieved.

A small stock assessment team and fishery management unit is urgently needed to assess, monitor and collect data on stocks and catches (Mathews 2007). The Center for Statistics, Monitoring and Prognostication (CSMP) lacks enough skilled technical staff, equipment and operation funds to carry out their mandate.

Georgia's present quota for anchovy of 70,000 $t \cdot year^{-1}$ is not based on scientific advice, such as stock assessments, but rather based on the necessity of economic aid (Mathews 2007). Stock assessments of the most important and valuable commercial fishery stocks are urgently needed in Georgia, so that the remaining abundant anchovy fishery does not run out as anchovy seems to be the last existing commercially viable stock; sprat is also abundant but does not seem to be a prime commercial target since many fish meal/oil plants do not accept sprat for processing, nor is it used for human consumption. The future and sustainability of the resources are in question and should be made the primary goal to at least provide some fresh fish to locals, considering the fishing contribution to GDP has undoubtedly diminished over time.

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[16] http://151.1.154.86/GfcmWebSite/SAC/SubCommittees_2012/Farrugio-Blacksea.pdf

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Figure 1. Map of Georgia, its ports of interest, continental shelf, and Exclusive Economic Zone (EEZ). The depth limit of the continental shelf here is shown to 100m, since there is very little life beyond that depth due to the anoxic layer.

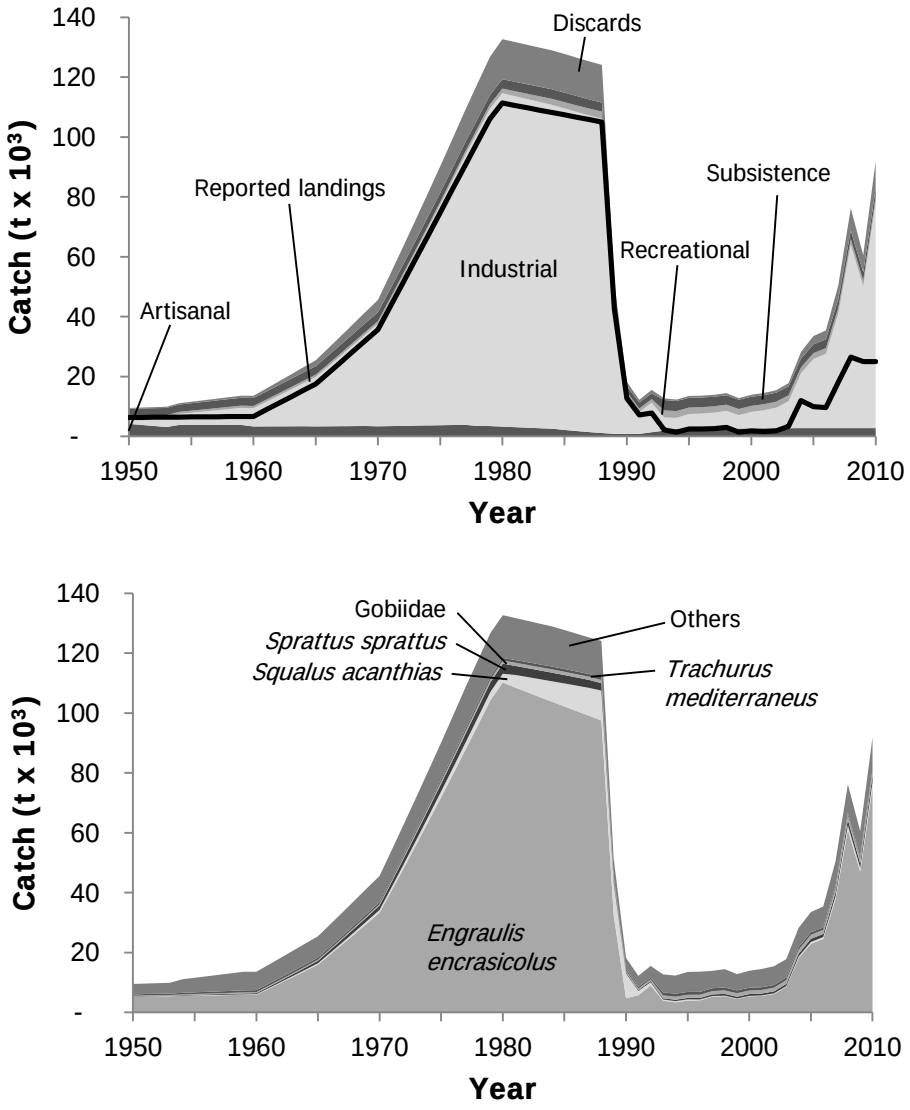

Figure 2. Time-series of marine catches for Georgia from 1950-2010 by **a)** sector (plus discards) with reported data overlaid as a solid black line and **b)** by major caught taxa, with 'Others' grouping including 45 additional taxa.

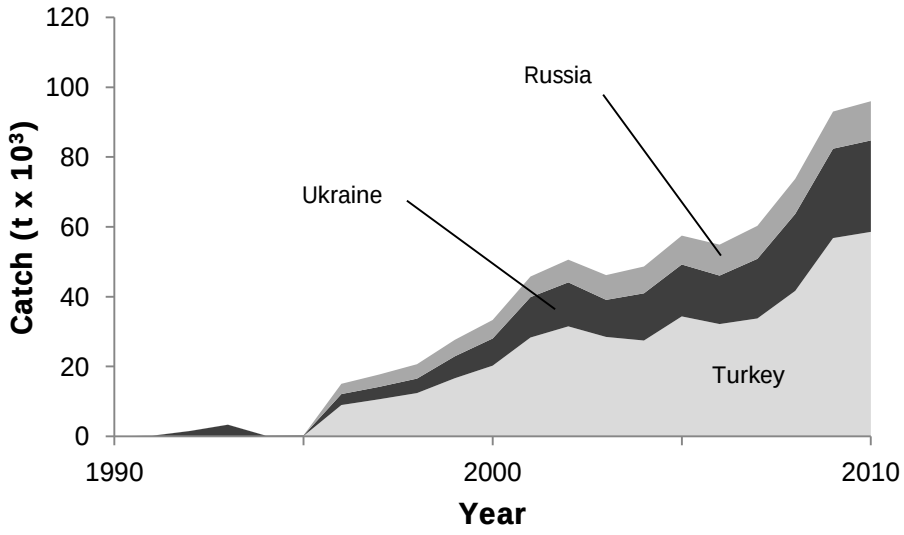

Figure 3. Foreign fishing catches of Turkey, Ukraine, and Russia in Georgia, including Abkhazia, from 1990-2010.

Table 1. Turkish catch of anchovy in Georgian waters from 2003-2009; data from (Oztürk et al. 2011).

Year	Catch (t)
2003	6,408
2004	3,906
2005	8,485
2006	4,944
2007	4,793
2008	10,259
2009	22,173

Table 2. Fish meal/oil statistics discrepancies from Georgia excluding Abkhazia.

Year	Catch equivalent (t)
2004	2,593
2005	9,243
2006	11,063
2007	12,883
2008	24,258
2009	8,560
2010	33,280

Table 3. Catch allocation proportions applied to artisanal catches for 1950 and 2010 in Georgia, with year in between interpolated.

Taxa	1950	2010
Pomatomus saltatrix	0.10	0.08
Acipenseridae	0.10	0.00
Merlangius merlangus	0.10	0.10
Trachurus mediterraneus	0.06	0.06
Xiphias gladius	0.06	0.00
Mytilus galloprovincialis	0.06	0.06
Shrimps and prawns	0.06	0.00
Platichthys flesus	0.06	0.00
Mugilidae	0.06	0.02
Mullus barbatus barbatus	0.06	0.01
Gobiidae	0.05	0.15
Serranidae	0.05	0.00
Umbrina cirrosa	0.04	0.00
Engraulis encrasicolus	0.03	0.08
Sarda sarda	0.03	0.02
Belone belone	0.03	0.00
Squalus acanthias	0.01	0.15
Rajiformes	0.01	0.05
Scophthalmus maximus	0.01	0.01
Decapoda	0.01	0.01
Scomber scombrus	0.01	0.00
Atherinidae	0.00	0.04
Mugil soiuy	0.00	0.16

Table 4. Recreational and subsistence catch allocation proportions for Georgia, 1950-2010.

Common name of species	1950	2010
Bluefish	0.13	0.04
Atlantic mackerel	0.01	0.00
Mediterranean horse mackerel	0.15	0.10
Mediterranean mussel	0.14	0.10
Shrimps	0.05	0.05
European flounder	0.05	0.00
Grey mullets	0.05	0.05
Red mullets	0.05	0.02
Gobies	0.05	0.20
Whiting	0.10	0.10
Groupers and seabream	0.04	0.00
Shi drum	0.04	0.00
Bonito	0.03	0.01
Garfish	0.03	0.00
Dogfish	0.02	0.02
Rays/skates	0.02	0.02
Turbot	0.02	0.02
Sturgeons	0.01	0.00
Crabs/lobsters	0.01	0.00
Sea snail	0.00	0.07
Pacific mullet	0.00	0.20

Table 5. Bottom trawl discards (%)

Squalus acanthias	25.0
Rajidae	20.0
Dasyatidae	20.0
Misc. marine crustaceans	10.0
Scorpaenidae	5.0
Gobiidae	5.0
Echinoderms	5.0
Misc. marine molluscs	5.0
Congridae	2.5
Muraenidae	2.5

Appendix Table A1. Time series of domestic reported marine fisheries landings (t) in Georgia and its reconstructed total catch by sector, e.g., industrial, artisanal, recreational, and subsistence landings and discards, from 1950-2010.

Year	Reported landings	Total reconstructed catch	Industrial	Artisanal	Recreational	Subsistence	Discards
1950	6,320	9,490	2,150	4,170	643	2,280	258
1951	6,350	9,620	2,530	3,820	655	2,320	304
1952	6,380	9,750	2,910	3,470	666	2,360	349
1953	6,410	9,880	3,300	3,120	678	2,400	396
1954	6,440	11,100	3,690	3,810	689	2,440	443
1955	6,470	11,600	4,080	3,810	701	2,480	490
1956	6,510	12,100	4,480	3,810	712	2,520	538
1957	6,540	12,600	4,880	3,820	724	2,560	586
1958	6,570	13,100	5,280	3,820	735	2,600	634
1959	6,600	13,600	5,690	3,820	744	2,630	683
1960	6,630	13,600	6,100	3,310	753	2,670	733
1961	8,810	15,900	8,140	3,320	763	2,700	978
1962	11,000	18,300	10,200	3,340	772	2,730	1,230
1963	13,200	20,700	12,300	3,360	781	2,760	1,480
1964	15,400	23,100	14,400	3,370	790	2,800	1,730
1965	17,500	25,400	16,500	3,320	799	2,830	1,980
1966	21,200	29,400	20,000	3,360	809	2,860	2,400
1967	24,800	33,400	23,500	3,390	818	2,890	2,820
1968	28,400	37,500	27,100	3,420	827	2,930	3,250
1969	32,000	41,600	30,700	3,460	832	2,940	3,680
1970	35,600	45,600	34,300	3,350	837	2,960	4,120
1971	43,400	54,300	42,000	3,430	841	2,980	5,050
1972	51,300	63,200	49,800	3,500	846	2,990	5,990
1973	59,100	72,100	57,700	3,570	851	3,010	6,930
1974	66,900	81,100	65,700	3,640	856	3,030	7,890
1975	74,700	90,200	73,700	3,710	861	3,040	8,850
1976	82,600	99,500	81,800	3,790	1,010	3,060	9,830
1977	90,400	109,000	90,000	3,860	1,150	3,080	10,800
1978	98,200	118,000	98,200	3,460	1,290	3,100	11,800
1979	106,000	127,000	106,000	3,440	1,420	3,110	12,700
1980	111,000	133,000	111,000	3,260	1,550	3,130	13,400
1981	111,000	132,000	111,000	3,080	1,670	3,150	13,300
1982	110,000	131,000	110,000	2,900	1,790	3,160	13,200
1983	109,000	130,000	109,000	2,710	1,900	3,180	13,100
1984	108,000	129,000	108,000	2,560	2,000	3,200	13,000
1985	107,000	128,000	107,000	2,140	2,100	3,220	12,900
1986	107,000	126,000	107,000	1,760	2,200	3,130	12,800
1987	106,000	125,000	106,000	1,420	2,280	3,050	12,700
1988	105,000	124,000	105,000	1,110	2,390	3,000	12,600
1989	42,600	51,300	42,600	833	1,250	1,470	5,120
1990	12,700	18,200	12,700	845	1,290	1,800	1,530
1991	7,120	12,200	7,210	836	1,280	2,020	866
1992	7,790	15,500	9,870	1,380	1,200	1,880	1,190
1993	2,190	12,700	4,410	1,900	2,330	3,500	530
1994	1,400	12,300	3,760	2,430	2,260	3,390	452
1995	2,470	13,500	4,980	2,470	2,180	3,270	605
1996	2,450	13,600	5,100	2,500	2,150	3,230	620
1997	2,580	13,900	5,380	2,530	2,120	3,180	647
1998	3,000	14,400	5,930	2,570	2,090	3,140	713
1999	1,400	12,800	4,480	2,600	2,060	3,090	538
2000	1,770	13,900	5,510	2,630	2,030	3,050	664
2001	1,630	14,500	6,040	2,660	2,020	3,020	731
2002	1,800	15,400	6,880	2,700	2,000	3,000	831
2003	3,270	17,800	9,010	2,730	1,980	2,970	1,080
2004	11,900	28,200	18,300	2,750	1,960	2,950	2,200
2005	9,920	33,500	23,100	2,750	1,950	2,920	2,780
2006	9,660	35,400	24,800	2,750	1,930	2,900	2,980
2007	18,100	50,500	38,400	2,750	1,910	2,870	4,620
2008	26,500	76,200	61,300	2,750	1,900	2,840	7,370
2009	25,000	60,600	47,400	2,750	1,880	2,820	5,700
2010	25,000	91,800	75,400	2,750	1,860	2,790	9,060

Appendix Table A2: Domestic reconstructed catch (t) by major taxa in Georgia from 1950-2010. 'Others' grouping includes 45 additional taxa.

Year	*Engraulis encrasicolus*	*Sprattus sprattus*	*Squalus acanthias*	Gobiidae	*Trachurus mediterraneus*	Others
1950	5,220	57	104	155	438	3,520
1951	5,280	67	180	159	446	3,490
1952	5,340	77	162	164	453	3,560
1953	5,400	87	136	168	461	3,630
1954	5,490	97	176	225	532	4,540
1955	5,560	108	209	247	562	4,870
1956	5,640	118	235	270	592	5,210
1957	5,710	129	261	293	622	5,550
1958	5,780	139	287	316	652	5,890
1959	5,860	150	314	339	681	6,230
1960	5,920	161	335	336	679	6,130
1961	7,880	215	425	341	678	6,370
1962	9,870	269	519	346	678	6,590
1963	11,900	324	617	353	679	6,810
1964	13,900	380	718	360	681	7,010
1965	16,000	435	823	366	680	7,150
1966	19,400	528	980	378	681	7,490
1967	22,800	621	1,130	393	685	7,830
1968	26,200	715	1,240	409	690	8,190
1969	29,800	810	1,350	426	694	8,540
1970	33,300	905	1,460	459	692	8,730
1971	40,900	1,110	1,720	492	694	9,450
1972	48,500	1,320	1,960	565	700	10,100
1973	56,200	1,520	2,180	616	711	10,800
1974	64,000	1,730	2,390	670	726	11,600
1975	71,900	1,950	2,590	725	746	12,300
1976	79,900	2,160	2,760	795	791	13,100
1977	88,000	2,380	2,910	871	840	13,900
1978	96,100	2,590	3,070	916	864	14,300
1979	104,000	2,800	3,150	991	887	14,600
1980	110,000	2,940	3,360	1,030	898	14,300
1981	109,000	4,210	3,030	1,050	908	14,000
1982	107,000	5,100	2,980	1,060	917	13,800
1983	105,000	5,970	2,930	1,070	926	13,600
1984	104,000	6,830	2,880	1,110	933	13,400
1985	102,000	7,680	2,810	1,090	926	13,000
1986	101,000	8,520	2,730	1,080	905	12,600
1987	99,100	9,340	2,660	1,080	885	12,200
1988	97,500	9,980	2,460	1,070	906	12,200
1989	32,500	10,800	1,040	541	476	5,920
1990	4,720	8,250	416	474	539	3,810
1991	5,710	1,460	304	486	545	3,710
1992	8,980	1,090	416	561	545	3,920
1993	3,950	348	417	956	989	6,020
1994	3,340	407	466	1,030	992	6,060
1995	3,930	405	487	1,040	966	6,680
1996	4,000	301	502	1,090	957	6,750
1997	5,200	224	564	1,100	966	5,800
1998	5,410	181	592	1,150	952	6,160
1999	4,470	163	574	1,190	929	5,440
2000	5,360	141	606	1,180	955	5,650
2001	5,480	176	626	1,190	898	6,110
2002	6,130	211	661	1,250	881	6,280
2003	8,530	232	732	1,250	903	6,130
2004	18,100	486	942	1,330	860	6,460
2005	22,900	607	1,050	1,340	829	6,780
2006	24,500	647	1,030	1,390	799	7,000
2007	37,800	998	1,320	1,460	768	8,180
2008	60,900	1,610	1,810	1,570	694	9,570
2009	47,000	1,240	1,510	1,530	666	8,570
2010	75,000	1,980	2,110	1,660	639	10,400