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A FISHERY TALE: NAMIBIAN FISHERIES BETWEEN 1950 AND 2010

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ABSTRACT

Namibia's fisheries greatly reflect the ecosystem upon which they depend, the Benguela Current Large Marine Ecosystem, with rich pelagic and demersal resources. The story behind Namibian fisheries reflect that of a fairy tale; foreign fleets exploited these waters heavily, whether legally under the colonial rule or illegally, then after independence the country strived to take full control over its fisheries. At first, Namibians received little to no benefits from their fisheries and had no control over their monitoring and sustainability. Two of the most important stocks in the country, southern African pilchard (*Sardinops ocellatus*) and Cape hakes (*Merluccius capensis*, *M. paradoxus* and *M. pollis*) collapsed, leaving Namibian fisheries with little to build upon. The data supplied to FAO shows landings from the early 1990s to 2010 and do not include catches prior to independence (some were reported as 'South Africa', small-scale sectors, discards and illegal fisheries. The catch reconstruction for Namibia shows a pattern that is far more realistic than that provided by the data reported to the FAO, catches increased from 90,300 t in 1950 to a peak of 3.7 million t in 1968, mostly including Cape hakes and sardines, species caught mostly by South Africa, Russia and Spain, then declined sharply with the collapse of the southern African pilchard and hake fisheries to 445,000 t in 2010, caught by Namibian domestic vessels. Although small-scale fisheries (subsistence and recreational) represented less than 0.1% of total catches, the species that are targeted by these fisheries are already overfished and management plans need to be developed. Overall, today, Namibia performs very well in terms of fisheries reporting, monitoring and stock rebuilding strategies, which does only illustrate a good ending, the only case in West Africa.

INTRODUCTION

Namibia's coastline is located within the Benguela Current Large Marine Ecosystem (Sakko 1998) upon which Namibian fisheries depend (FAO 1995). The Namibian EEZ encompass rich pelagic resources of southern African pilchard (*Sardinops ocellatus*), anchovy (*Engraulis capensis*) and Cape horse mackerel (*Trachurus capensis*), other pelagic fishes, and demersal fish resources dominated by valuable stocks of hakes (*Merluccius capensis*, *M. paradoxus* and *M. pollis*) (Sumaila 2000; Sumaila and Vasconcellos 2000), a wealth created by an intense coastal upwelling (Willemse and Pauly 2004). Although Namibian fisheries are relatively low in diversity, they used to support one of the most productive ecosystems in the world, notably for hakes (Anon. 2004).

One of the particular features of the Namibian coast is its location in an arid desert along its entire length, which beside allowing scattered settlements, limits the development of small-scale fisheries (Figure 1; Anon. 2004). This highly inhospitable Namib Desert is also known as the "Skeleton Coast due to a large number of European explorers and seafarers who perished along this coast in the 1800s" (Anon. 2010). However, historical anecdotes illustrate how fisheries traditionally provided food for the small Khoisan communities in pre-colonial Namibia. These communities fished primarily for subsistence in the coastal lagoons of the Namib Desert (Odada and Godana 2002). Industrial fisheries began in the 18th century by South Africa, primarily by European and North American vessels in search of whales and seals (Odada and Godana 2002).

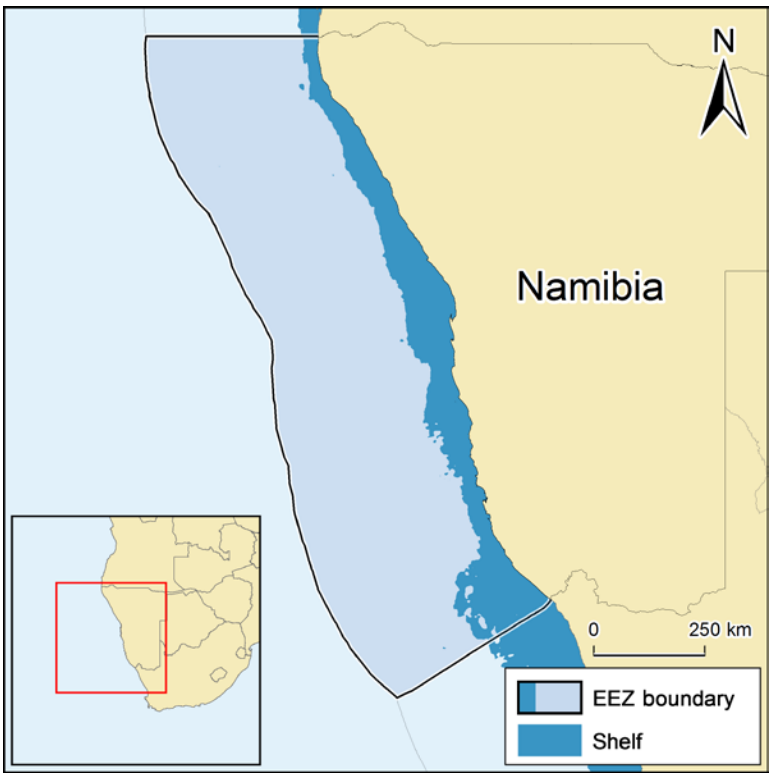

Figure 1: Map of Nambia with its Exclusive Economic Zone (EEZ).

Between 1884 and 1914, Namibia was a German colony. This ended during World War I, when South Africa—itself a former British colony—vanquished the German colonial troops and occupied the country. Namibia remained under South African colonial rule until 1990, and was then known under the name of "South West Africa". During this period, foreign capital held a dominant position in the economy, and European settlers and companies from the Republic of South Africa were largely favored by the colonial administration (Minta 1989). The focus was mainly on developing profitable primary export industries, especially mining and fishing, with low to no benefits to Namibians (Minta 1989).

This is clearly illustrated by fisheries, which despite being among the most productive in the world (Reid *et al.* 2007), were not controlled by Namibia (Boyer and Boyer 2005). These fisheries included mainly distant-waters fleets from Bulgaria, Israel, Japan, Poland, Portugal, South Africa, Spain and the USSR (mainly Russia) (Minta 1989; Nichols 2006). Their uncontrolled activity has led to the collapse of several fish stocks (Fergus *et al.* 2005). For example, catches of southern African pilchard (*Sardinops ocellatus*), which had peaked in the late 1960s, collapsed in the 1980s (Moloney 2010). The blame was directed towards both the colonial ruler for inadequate scientific monitoring of fish stocks (Moorsom 1989), and toward the International Commission for South East Atlantic Fisheries (ICSEAF), which was "misused by many member states to legitimize the plundering of fish stocks in the South-east Atlantic" (Oelofsen 1999). Furthermore, catches were landed and processed in foreign ports without generating benefits to Namibians, nor being accounted for properly in official statistics (Anon. 2004).

Despite the burden of this inheritance, after independence the country implemented a policy of rebuilding stocks to their "full potential" (Anon. 2004), among other things by setting very conservative quotas (Fergus *et al.* 2005). Consequently, today - at least economically - fishing has become the second largest foreign currency earner in the country (Anon. 2004).

In terms of monitoring, any vessel that leaves one of the two fishing ports of Namibia, Walvis Bay and Lüderitz, is legally required to have an observer on board both to ensure compliance and to collect scientific data (Anon. 2009). Beside observer requirement, Namibian government ensures, through sea, air and shore patrols, a complete monitoring of landings. Also, Namibia has implemented a vessel reporting and vessel monitoring systems (VMS), and requires vessels to report any EEZ entry and exit (Anon. 2009). The limited number of landing sites makes it easier to monitor landings as opposed to the scattered nature of landing sites, e.g., in the Gulf of Guinea. This, along with the necessity to deliver landings at processing plants acts as disincentives to uncontrolled landings and thus limits catch mis-reporting. This is particularly true for the recent time periods, however, the uncontrolled nature of the fleet in the past often went along with misreporting of catches (Sumaila *et al.* 2004; Anon. 2009; Kirchner *et al.* 2012). Herein, we look at these catches and reconstruct a realistic baseline of foreign fisheries by flag and by gear type. Also, sectors that were never considered in official statistic, but documented anecdotally, such as artisanal, subsistence and recreational marine fisheries, are herein reconstructed, along with discards.

METHODS

Subsistence

Although some authors allege the absence of artisanal or subsistence fisheries in Namibia, given notably the "harsh environmental conditions prevalent in the Namib dessert" and its "inhospitable" nature, traditional fishing communities existed in the past (Sumaila 2000; Roux and Shannon 2004) which are currently shifting towards commercial fishing, e.g. the Topnaars community (Mavetja Rukoro 2005). The subsistence fisheries, dating back at least 200,000 years (Sowman and Cardoso 2010) consisted of shellfish, seabirds and marine mammals which were the major food for local communities, penguin and fur seal pelts were used for clothing, and whale bones to build shelters (Roux and Shannon 2004). It is clear, however, that despite the loss of such tradition, linked to "colonial and apartheid-rule exclusion" (Sowman and Cardoso 2010), there is still a subsistence fishery in Namibia (Barnes and Alberts 2008) which gets easily confused with the recreational sector. A good way of separating these two sectors is via their aim and regulations: recreational fisheries which occur along a 260 km stretch of the coast (see below), are aimed at mostly leisure, are relatively well regulated, with anglers requiring permits. On the contrary, the mostly informal subsistence fishers catch fish for personal consumption or barter (and limited local trade), operate around Swakopmund, Henties Bay, and Terrace Bay, and are poorly, or not regulated (Fielding *et al.* 2006; Barnes and Alberts 2008).
Although there are very few people involved in the subsistence fishery, its economic importance for poor household requires knowing the extent of its catches to "determine the sustainability and expansion potential of this subsector" (Barnes and Alberts 2008).

Barnes and Alberts (2008) reported for 2006 around 150 subsistence fishers catching silver kob (*Argyrosomus inodorus*), coast steenbras or white fish (*Lithognathus aureti*), galjoen (*Dichistius capensis*) and mullets (Mugilidae), their catch being herein assumed to be equally divided between these taxa. We extracted total population data from the World Bank's database (www.worldbank.org) and coastal population data, i.e., people living 10 km from the coast, for 1990, 2000 and 2010 (CIESIN 2012). Coastal population estimates were then converted to percentages of the total population and extrapolated backwards to 1950. We divided the number of fishers for 2006 by the coastal population estimated for the same year and obtained the percentage of subsistence fishers over the coastal population (0.16%); given that this percentage was likely higher in the past, we assumed it was 50% higher, i.e., 0.23% in 1950. We interpolated linearly between these rates, and multiplied them by the coastal population to estimate the number of subsistence fishers from 1950 to 2010. We assumed the CPUE between 1996 and 2010 was similar to the recreational fisheries CPUE, i.e., declining from 6.06 $kg \cdot fisher^{-1} \cdot day^{-1}$ in 1996 to 3.23

kg·fisher^{-1}·day^{-1} in 2010. We assumed the CPUE was 20% higher in the past, because of over-exploitation. We also assumed the same number of fishing days, i.e., 8.2 days for every 19.7 days (Kirchner and Stage 2005), which is equivalent to a total of 152 days a year, constant between 2005 and 2010. We assumed the latter was 20% higher in 1950, given the gradual shift to commercial fisheries and interpolated linearly. We obtained subsistence catches by multiplying the number of subsistence fishers, by the number of days and the CPUE.

Recreational

Recreational angling is a popular activity in Namibia, also famous for wildlife safaris, sand surfing and shark fishing (Huggins 2011). Angling is practiced by Namibian and foreign anglers (Nghipunya 2012). This activity is important on both the resource use and the tourism development aspects (Barnes and Alberts 2008). Access to the shore angling is limited in Namibia as it encompasses only about 260 km of the Namibian coast comprised between Sandwich Harbour south of Walvis Bay and the Ugab River in the north, where 90% of recreational fishing occurs (Barnes and Alberts 2008). Besides kob and steenbras, recreational fisheries target species include blacktail, also known as dassie (*Diplodus sargus*), galjoen, snoek (*Thyrsites atun*), barbel (*Galeichthys feliceps*), broadnose sevengill shark (*Notorynchus cepedianus*), spotted gullyshark (*Triakis megalopterus*), smooth-hound (*Mustelus mustelus*) and copper shark (*Carcharhinus brachyurus*), along with a limited amount of Cape rock lobster (*Jasus lalandii*) (Mavetja Rukoro 2005; Barnes and Alberts 2008)

Given the decline in species targeted by recreational fisheries, e.g., silver kob or kabeljou and west coast steenbras (Barnes and Alberts 2008), it is important to assess recreational catches (Kirchner and Beyer 1999). The few surveys performed along the Namibian coast estimate catches as the product of total effort and catch rate (Kirchner and Beyer 1999), the method also used here.

Penhrith and Loutit (1982) surveyed recreational fisheries catches over a period of one year along a 30 km stretch of Terrace Bay (Skeleton Park) and estimated total catches at 50 t·year^{-1} for 1980. While 310 km of coast are completely open to recreational shore angling and 85 km under strict regulation with limited access (Kirchner and Beyer 1999), we consider that recreational shore angling is regularly done over a 260 km stretch of coast (Barnes and Alberts 2008). Thus, we extrapolated catches on to the total available coast and estimated a total catch of 436 t·year^{-1} for 1980. Similarly we extrapolated catches for each species documented by Penhrith and Loutit (1982). Using the surveyed catch estimate which accounted for 40 anglers per year on average (Penhrith and Loutit 1982) to extrapolate over the entire coast where recreational fishing occurred is conservative. Indeed, Kirchner and Stage (2005) describe that only “some limited” recreational fishing occurs in Terrace Bay (along the Skeleton Coast Park) in contrast to National West Coast Recreation Area where 90% of recreational shore angling occurs (Barnes and Alberts 2008).
We used the same method for 1990 when Lenssen *et al.* (1991) surveyed recreational shore catches along 20 km stretch of Sandwich Shoreline in the Namib-Naukluft Park and estimated a total catch of around 90 t·year^{-1} for this stretch of coastline. Since this area is very productive, we extrapolated catches for 230 km of coastline, and adjusted downwards the previous catch rate by 50% to account for lower catches in Terrace Bay (30 km). Thus, we estimated total catches at 1,102 t·year^{-1} for 1990. Similarly, the authors provided catches per species, which we extrapolated using the same method.
Kirchner and Beyer (1999) surveyed recreational shore catches along the Namibian coast where most recreational shore fishing occurs and estimated 361 t·year^{-1} of silver kob taken by recreational fishers with an error of 5%. This estimate is conservative as it only takes into account catches from easily accessible areas. To estimate total catches, we added other species assuming the same species composition provided by Nghipunya (2012), where kob represented 36% of total catches, steenbras 27%, galjoen 25% and others including copper shark, spotted gully shark and smooth-hound documented by Barnes and Alberts

(2008) represented 12%, i.e., herein assumed 4% each. Therefore, we estimated total catches at 1,003 t·year^{-1} for 1996.

For 2004, Barnes and Novelli (2007) estimated that around 460,000 fishes were taken annually by recreational anglers. We converted this number to weight using the species disaggregation provided by Nghipunya (2012) and the average weight per fish (Penhrith and Loutit 1982), which translates into a catch of 616 t·year^{-1} for 2004.

Barnes *et al.* (2002) estimated the daily catch per angler at 6.06 kg·angler^{-1}·day^{-1} for 1996 for 8.2 fishing days over a total of 19.7 visiting days per angler (Kirchner and Stage 2005). The latter argue that the CPUE has strongly declined in the latest years. Assuming the trend remained similar over the last few years, i.e., from 2005 onwards, we assumed a decline of 50% between 1996 and 2011, i.e., the CPUE is estimated at 3.23 kg·angler^{-1}·day^{-1} for 2010 after interpolation. Nghipunya (2012) reported the number of recreational fishing permits for 2011 and the annual revenue obtained from fishing permits between 2007 and 2011. We obtained the number of permits per year for 2007, 2008, 2009, 2010 by dividing the number of permits for 2011 by the revenue for 2011, then multiplying the result – assuming the ratio was constant - by the revenue per year for the remaining years. We then multiplied the resulting number of fishing permits by the interpolated CPUE and the number of days (8.2). Thereafter we applied the species disaggregation provided by (Nghipunya 2012).

As there was no clear information documenting the beginning of recreational fishing in Namibia or in South West Africa, we assumed the beginning was in the early-1960s given that the first description of Sandwich harbor, where significant recreational fishing occurs, was available in 1963 (Lenssen *et al.* 1991). We thus interpolated linearly between zero in 1960 and the estimated catches for the subsequent years to fill in the gaps.

Industrial

"Photographs from the late 1950s show trawlers loaded from gunwale to gunwale, with only the steering-house not covered in fish. A retired pilchard trawler captain, Peter Sylvester Sr., recalled how he had sunk four trawlers during the 1950s and 1960s by over-loading – but was given bigger and better boats every time in recognition of his efforts" (Grobler 2008). This illustrates the overcapitalization of the industrial fisheries during the colonial periods, which led to overexploitation (Grobler 2008). The profile of industrial fisheries in Namibia was described by many authors, most of them providing the same set of landing data (Cram 1976; Anon. 1994; Bonfil *et al.* 1998; Oelofsen 1999; Sumaila and Vasconcellos 2000; de Astrola 2002; Roux and Shannon 2004; Crawford 2007; Huggins 2011; Japp 2011; Kirchner *et al.* 2012; Midgley 2012; Akawa and Nashima 2013), as well as the profile of the fleet and the number of fishing vessels (Anon. 1965; Lees 1969; Beaudry *et al.* 1993; Anon. 1994; Bonfil *et al.* 1998; Goodisan 2000; Sumaila 2000; Nichols 2006; Anon. 2009; DEEPFISHMAN 2010; Midgley 2012; Akawa and Nashima 2013; Esau 2013; Paterson *et al.* 2013). Although these data are taken as a unbiased baseline for assessment, it appears that prior to Namibian independence, there was a major bias in the assessment, notably those of the FAO as catches of some species that are landed in Namibia are presented to be higher than those of species that are caught in important amounts but landed in e.g. South Africa (Thomesen 1978). Another kind of bias was related to the fact that landing statistics of some species, e.g. west coast sole, were recorded only in South Africa prior to 1987 (de Astrola 2002), along with other species (Binet 2012). Under-reporting was also common as "there was little to no surveillance of most fishing operations in Namibian waters" which resulted in massive uncontrolled extractions (Anon. 1994). This reporting bias of catches and effort "are suspected to have played a major role in the decline in Cape hake stocks" (Oelofsen 1999; Roux and Shannon 2004) as foreign fishing effort in the southeast Atlantic was mostly

unregulated prior to 1972 (Paterson *et al.* 2013). Further evidence related to the sudden collapse of some stocks e.g., the horse mackerel stocks highlight that the chartered vessels might have been exceeding their quotas (Grobler 2008). Moreover, "anecdotal evidence suggests that during the 1960-1980 period, just about every pilchard fishing company was exceeding quota, some by several times over; by some estimates, recorded landed catches is thought to amount to less than half of what was really being caught" (Grobler 2008). Furthermore, after the introduction of ICSEAF in 1971, the hake foreign fleet fishery intensified even more (Binet 2012) and led to a "virtually uncontrolled fishing activity by the fleets of Europeans, South Africans and Eastern Bloc countries" (Binet 2012) and quotas were not allocated on a scientific basis (Cram 1976).

Therefore, although the evidence at hand suggests that under-reporting was common, we remained conservative by considering that it applied only the hake and pilchard fisheries. We assumed pilchard catches between 1950 and 1980 were conservatively 50% higher than the reported landings - although (Grobler 2008) reported in some cases they were twice higher, - and that under-reporting declined to zero after Namibia regained full control of its fisheries in 1994 (Anon. 1994). We applied the same under-reporting rates for the hake fishery, as quota abuses were common. To be conservative, we kept the landing data for other species as a reasonable baseline.
For snoek, Lees (1969) reported that a fleet of around 20 boats were catching "more than a million snoek" every year during the 1950. Using an average weight of 3 $kg \cdot fish^{-1}$, we estimated 3,000 $t \cdot year^{-1}$ during the 1950s, then interpolated to zero unreported catches in 1987, when reporting for this species began.

Namibian ownership is defined as 90% of the shares being held by Namibian citizens. To encourage nationalization of boats, quota levis are offered to vessels (Oelofsen 1999). This has triggered a large campaign of 'Namibianization', which increased the percentage of "Namibian" vessels from 50.5% in 1991 to 83.8% in 1998 (Anon. 2004). In the small pelagic and rock lobster fisheries, quotas are controlled by Namibian companies. Similarly, Namibian control over the horse mackerel quotas has increased from 14 % to 80% (Anon. 2004) and that of hake increased to 80% in 2003 in contrast to 17% at independence (Anon. 2004). This Namibianization of the fisheries were not only limited to the fleet, but led to access agreements being cancelled, notably with the EU (Mavetja Rukoro 2005). Therefore, we assumed after 1994, all catches reported by Namibia were domestic.

FAO data shows landing data starting from the late 1980s, which fails to capture most of what was taken prior to independence. It is known, however, that there was a heavy presence of foreign fishing fleets e.g. South Africa caught between 10-12% of the fish off the Namibian coast while the former Soviet Union, mainly Russia (Beaudry *et al.* 1993) and Spain took almost all the remaining catch (du Pisani 1991). Right before Namibia regained control of its fisheries in the early 1990s, demersal fleets were 44% foreign, and demersal longliners, mid-water trawlers, tuna boats, liners, and pelagic vessels were all foreign (Beaudry *et al.* 1993)

Anon. (1994) documented the beginning of the operations by each fleet targeting different species, i.e., Spain and the former Soviet Union for Cape hake (1963). The Soviet Union shifted its interest to Cape horse mackerel after the decline of Cape hake fisheries, Bulgaria (1965) targeted Cape hake, monkfish (*Lophius* spp.), and Cape horse mackerel, Israel (1965) monkfish, west coast sole (*Austroglossus microlepis*) and Cape hake and Japan (1965) Cape hake, west African geryon (*Geryon maritae*) and Cape horse mackerel (Kasahara 1972). Although evidence highlights the presence of Japanese and Taiwanese longliners (starting from 1987 for the latter) in the waters of Namibia prior to independence, (Anon. 1994; Stop Illegal Fishing 2008), their catches are difficult to assess and it is even more difficult to conclude these are not reported given that, e.g., Japan started reporting tuna catches to the FAO from FAO area 47 the same year Japan that started fishing off Namibia. (West) Germany operated in Namibia since 1965 and fished for Cape hake, monkfish, southern African pilchard and cape horse mackerel; France started

fishing in Namibia in 1966, Cuba in 1968, Romania and Portugal in 1969, Poland in 1971, Italy in 1973 and Iraq in 1978 (Anon. 1994). We cross-matched these fleets with the data extracted from FishStatJ for hake and then converted the latter's catch to percentages, which we applied later onto the data from 1963 when hake fishing in Namibia began to 1990 when Namibia obtained independence. We followed the same approach for West coast sole (Namibia, Spain, Israel), for which catches of west coast sole in area 47 of FAO, under Israel, Spain and Namibia may refer to the northern stock, i.e., Namibia (de Astrola 2002), Cape rock lobster and southern anchovies which were caught by South Africa, and then South Africa and Namibia. We also applied the same previous method for monkfish, which was a by-catch of the hake fishery at the beginning, was caught by Bulgaria, Cuba, France, Germany, Israel, Namibia, Portugal, Spain, the former Soviet Union (mainly Russia). Similarly, west African geryon was caught by Japan, Namibia, Portugal, South Africa and Spain, and therefore, after converting the data in FishstatJ combined with the best evidence (Anon. 1965, 1994; Paterson *et al.* 2013), we could allocate unreported catches (those reported at a national level but not submitted to FAO) per country, while reported catches were all allocated to Namibia.

For Cape horse mackerel catches, almost all of the fleet "originate from Russia and sail under so-called Flags of Convenience (FoCs), and are registered to Ports of Convenience such as St Vincent & the Grenadines, Mauritius and Belize" (Grobler 2008). Therefore, although the catch is reported to FAO as Namibian, it is highly likely that Namibia has only but a small share of it, and most of it, herein 64% (percentage obtained from FishStaj) for the year prior to independence) was assumed to have been caught by Russian vessels flagged to a FoC country.

The tuna catches were all allocated to South Africa as the entire tuna fleet is based in South Africa; this applies to bigeye tuna, albacore, skipjack, and southern bluefin that are reported by Namibia as 'domestic', although caught by the South African fleet (Bonfil *et al.* 1998).

We compared the national data to the data supplied to FAO for orange roughy (*Hoplostethus atlanticus*), whose fishery began after independence (Oelofsen and Staby 2004) and for blue sharks (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*), and found some inconsistencies. However, they were small enough to consider FAO data as a complete baseline, as these species began to be reported only after independence.

Discards

Discarding in Namibia is prohibited by the present regulations, and a discard levy has been implemented (Mavetja Rukoro 2005). Although this is believed to have reduced discard rates to as low as 2% (Pramod and Pitcher 2006), there is but scarce information on discarding practices and discard rates on Namibian fisheries.

Before the implementation of the ban, discards, particularly those of the hake fishery were estimated at about 35% of Cape hake catches consisting of monkfish in the 1960s (Binet 2012); this declined after the ban to be between 5% and 15% of hake and monkfish catches in the 2000s, i.e. to a mean of 10% (Pramod and Pitcher 2006). We assumed the discard rate was constant between 1950 and the mid-1960s at 35% of catches then declined linearly to 10% in 2006, which we kept constant from then on.

Companies in the 1970s evaded southern African pilchard quotas by "carrying out large scale dumping of catches at sea" (Midgley 2012). Prior to the decline in southern African pilchard catches, discards were believed to be around 15%, consisting mostly of anchovies caught as bycatch (Midgley 2012), which then started to be landed in the early 1980s . Therefore, we kept the discard rate constant between 1950 and 1980, then interpolated to 2% since 2006 (Pramod and Pitcher 2006).

The horse mackerel fishery has a discard rate of around 2% (Pramod and Pitcher 2006), which we kept constant between 1950 and 2010.

We applied the previous discard rates to each fishery to obtain total discards.

Illegal fishing

There is significant concern related to the presence of unlicensed vessels fishing illegally in Namibia waters (Mavetja Rukoro 2005), which is the most serious offence in Namibia along with catch misreporting and exceeding by-catch allowances (Stop Illegal Fishing 2008). For example, 11 large trawlers were arrested between 1990 and 1991 (Anon. 2004). Later on, Chinese vessels targeting mussels and limpets in inshore waters in 2004-2005 were arrested (Pramod and Pitcher 2006). The monitoring efforts since independence have proved efficient in at least "deterring other foreign vessels from poaching" (Anon. 2004). Furthermore, due to the limited fishing rights, fishers themselves monitor and enforce fishing rights, any observed attempt to fish illegally within Namibian waters is reported, e.g. "fishers paid for a helicopter to nab intruders" (Huggins 2011).

Nichols (2006) estimated that around 100 vessels were fishing illegally in Namibian waters in 1990. World Wildlife Fund (1998) reported that this number dropped by 90% between 1990 and 1991, as 12 vessels were arrested in 1991, of which 11 were Spanish - the most recurrent offenders (Freeman 1992) - and 1 from the Congo (Mavetja Rukoro 2005). In 2004, 6 out of 16 inspected vessels were arrested (Stop Illegal Fishing 2008). Assuming only 10% (in 2004) to 5% (2010) of these were fishing without a license, and expanding this to the entire fleet operating in Namibia between 2004 and 2010, the number of vessels fishing illegally is estimated at 8 in 2004, 10 in 2005, 8 in 2006 and 2007, 7 in 2008 and 5 in 2009 and 2010. We then multiplied the number of vessels (2004-2010) by the average CPUE (1,573 $t \cdot vessel^{-1} \cdot year^{-1}$), i.e., the total legal catch divided by the number of legal vessels, averaged between 2004 and 2010. Similarly, we conservatively used this CPUE for the previous years, and multiplied it by the effort for 1990 and 1991. We then interpolated from zero at the introduction of ICSEAF in 1971, set as the beginning of unregulated (then illegal) fisheries in Namibia.

RESULTS

Subsistence catches

Subsistence catches were estimated at around 60 t in 1950, increased to a peak of 120 $t \cdot year^{-1}$ by the mid-1990s and then decreased to around 80 t in 2010 (Figure 2). Catches consisted of kob, steenbras, galjeon and mullets.

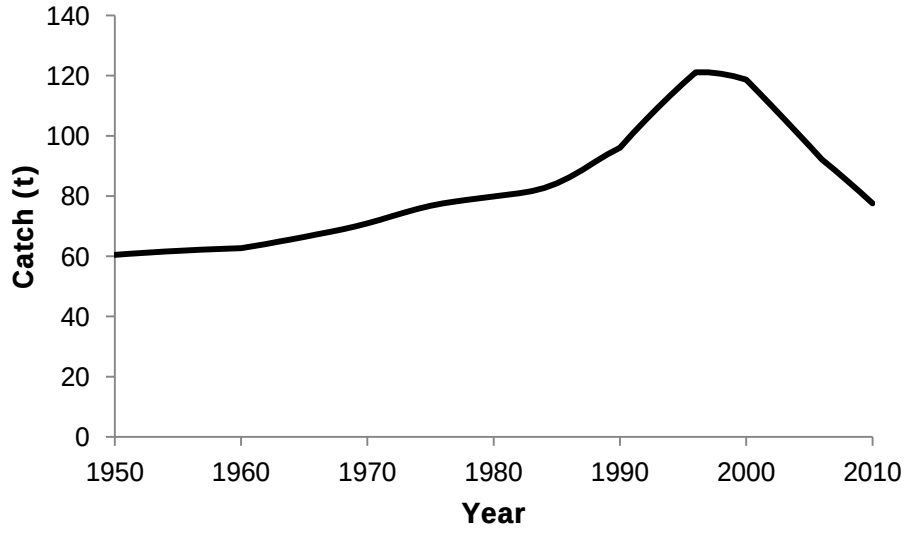

Figure 2. Reconstructed subsistence catches for Namibia, 1950-2010.

Recreational

Recreational catches were estimated at around 20 t in 1961 when recreational fishing began, increased to a first peak of 307 t in 1990, decreased to around 450 tin 2004, and then increased to a peak of 900 t·year^{-1} before decreasing to around 200 t in 2010 mainly due to the decrease in the number of visitors (Figure 3). Catches consisted mainly of galjoen in the past, kob, steenbras and blacktail today (Figure 3).

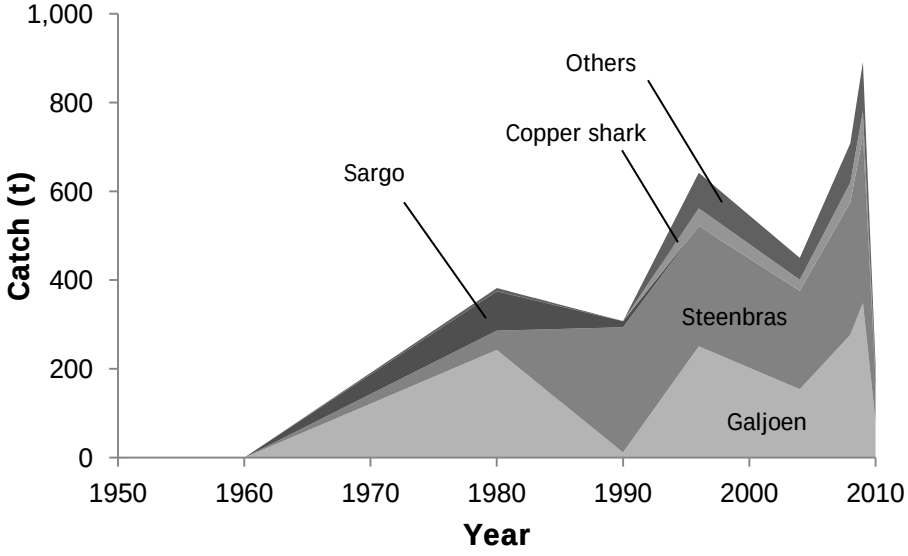

Figure 3. Reconstructed recreational catches for Namibia, 1950-2010.

Industrial

Industrial fisheries, the only segment reported to FAO, landed catches estimated at 90,200 t in 1950 compared to zero tonnes reported to FAO on behalf of Namibia. Catches increased rapidly to a peak of 3.7 million t in 1968 compared to 5,000 reported to FAO, and then decreased gradually to 445,000 t in 2010 compared to 367,200 t·year^{-1} in reported to FAO. Catches were dominated by South Africa with 47% of total catches, the Russian Federation with 25% of catches, and Spain with 13%, the remaining caught by Bulgaria, Cuba, France, Germany, Iraq, Israel, Italy, Japan, Poland, Portugal and Romania (Figure 4). After independence, with the Namibianization of the fleet, catches remained mostly Namibian (Figure 4), except for tuna, which were also caught by a fleet based in South Africa.

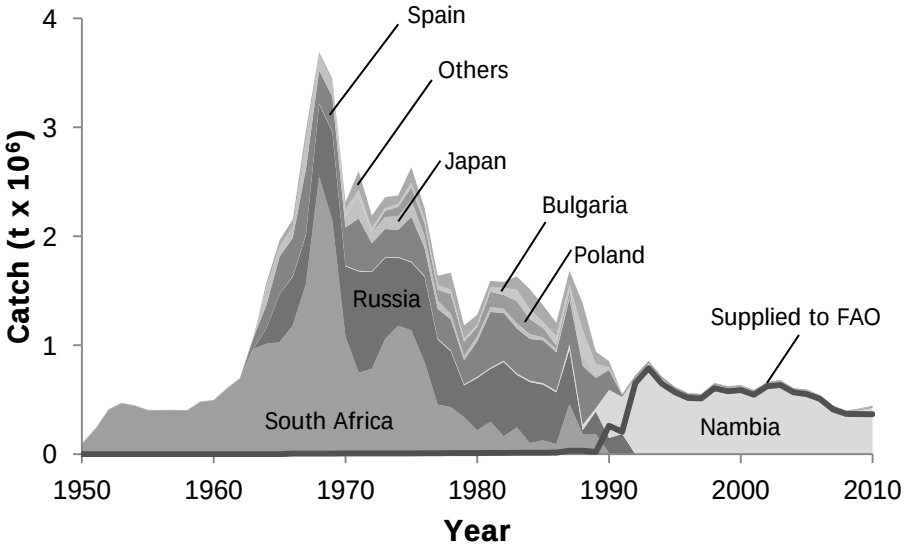

Figure 4. Reconstructed industrial landed catches from Namibia, 1950-2010.

Discards

Discards were estimated at 10,600 t in 1950, increased to 571,000 t in 1968 at the peak of industrial fisheries and then decreased to around 19,000 t in 2010 (Figure 5). Discards consisted mostly of monkfish and anchovy in the past, and undersized monkfish today (Figure 5).

Illegal and unregulated catches

Illegal catches increased from around 8,000 t in 1971 to a peak of 157,000 t in 1990, and then decreased after independence to around 7,500 t in 2010 (Figure 6).

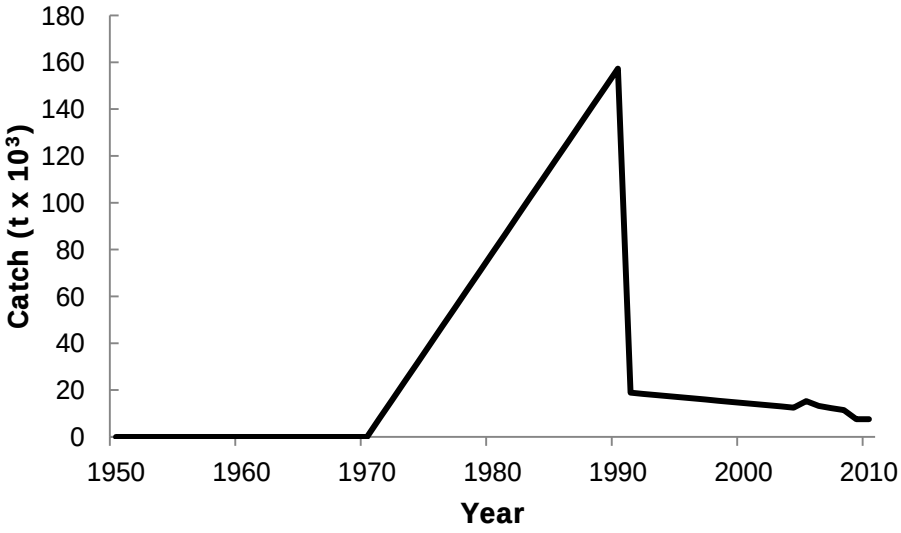

Figure 6. Reconstructed illegal catches from the Namibian EEZ, 1950-2010.

Total catches

Total catches were estimated at around 90,300 t in 1950, increased to a peak of 3.7 million t in 1968 and then declined sharply at the collapse of the southern African pilchard fishery to 445,300 t in 2010 (Figure 7a). Less than 0.1% of the catch was domestic before the late 1980s, in contrast to almost 100% today. Domestic catches increased from 60 t in 1950, all of which were for subsistence purposes, compared to zero reported to FAO on behalf of Namibia, to a first peak of around 443,000 t in 1990 compared to 261,000 t reported to FAO, declined slightly before increasing to a second peak of 834,000 t in 1993 compared to 786,000 t reported to FAO. Domestic catches declined later on to 425,000 t in 2010 compared to 366,000 t reported to the FAO (Figure 7a).

Since catches were mostly foreign in the past, the bulk of these were unreported until Namibia gained independence and took control of its fisheries, which resulted in only 9% of catches being unreported.

Taxonomically, catches were composed mostly of southern African pilchards and Cape hakes in the past; their catches declined drastically in the 1980s and were slowly replaced by Cape horse mackerel, which today contributes most of the catch (Figure 7b). This contrasts with official data reported for Namibia, which show a decrease in Cape horse mackerel catches since the 1990s and roughly constant catches of Cape hakes.

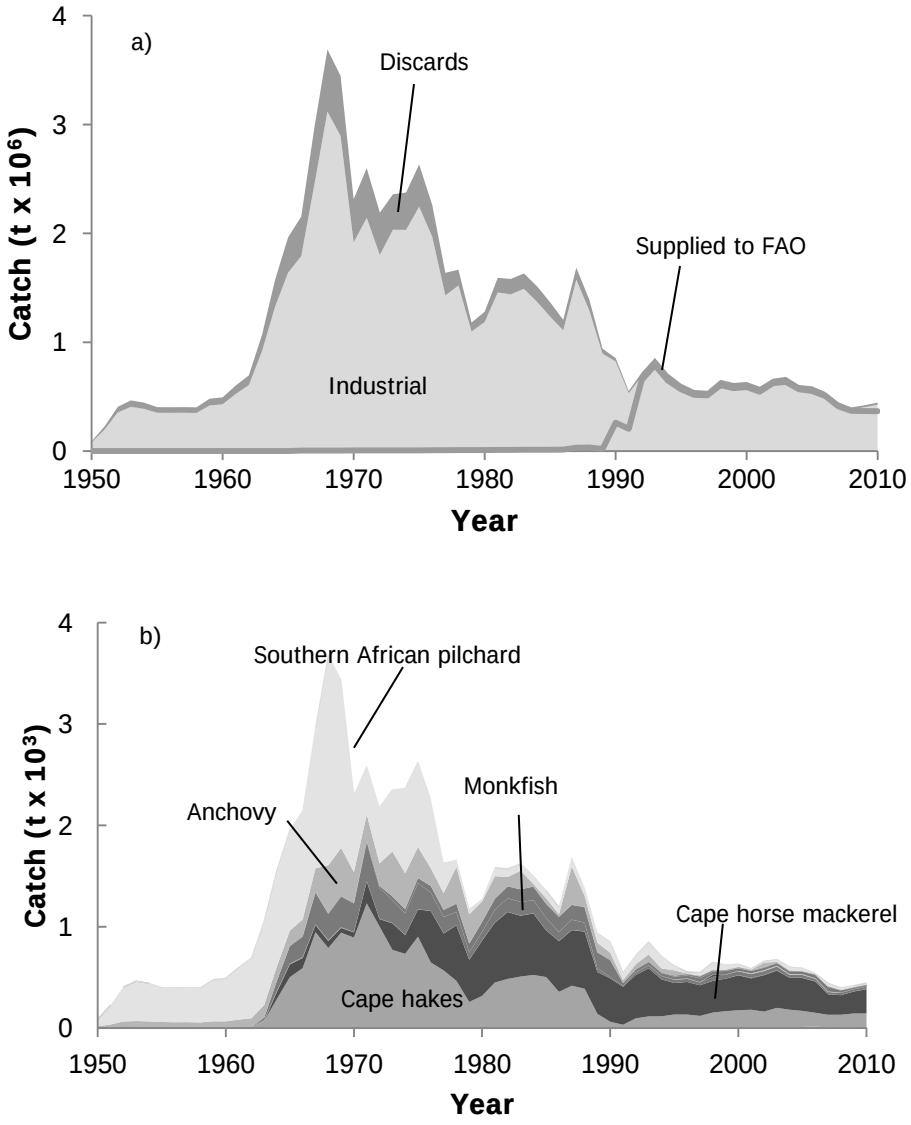

Figure 7. Reconstructed total catch for Namibia, 1950-2010, by a) sector, with official reported data overlaid as a line graph. Note recreational and subsistence catches are plotted but too small to be visible on graph; and b) taxon.

DISCUSSION

We reconstructed total catches from the Namibian waters, including all sectors documented in the literature. Total catches were estimated to be over 6 times as high as the data supplied to the FAO, most of which taken by foreign fleets. The tremendous improvements made by Namibia in terms of reporting and monitoring fisheries is illustrated here through declining under-reporting of catches and declining illegal fishing practices. Thus the story of Namibian fisheries, which struggled through overcapacity and unmonitored foreign fleets plundering the Namibian EEZ, has a good ending, with at least what appears to be full control of its fisheries, the only case in West Africa.

However, the situation is not as positive as it appears to be, notably regarding the Namibianization of the fleet, a deceptive move that is motivated by the "EU subsidies and receiving funds for keeping boats out of the EU waters" (Grobler 2008). Still, the returns are at least controlled by Namibians as catches are landed and processed in Namibia.

Along with strict control on catch landings, Namibia enforced strict rules upon illegal fishing fleets, for example, in the report published by (Grobler 2008), the government restricted the operations of an entire fleet based on unregulated fishing by a few vessels as "they can't catch the bad guys, so they punish everyone", which drastically limits the likelihood of illegal fishing within the EEZ.

The year 2002 appears to be the "worst year for Namibian pilchard catches" (Anon. 2004) as the Ministry of Fisheries and Marine Resources set the total allowable catch (TAC) at zero. Indeed, the collapse of the early 1970s represented the beginning of the end for the southern African pilchard fishery. The stock has not recovered, and may not do so, if only because of increasing water temperatures due to global warming (Anon. 2002). Similarly, the hake fisheries appear to be performing poorly, and at least one author (Sumaila (2000) suggested upported that freezer trawlers exploiting hake should be banned from Namibian waters.

Along with the decrease of both southern African pilchard and Cape hake fisheries, another major sign of collapse is the increase in both biomass and jellyfish catches since the 1970s (Roux and Shannon 2004; Moloney 2010) and declining sizes of fishes (Kreiner *et al.* 2011).

Namibian policy has been quoted as "one of the most successful in the world" (Esau 2013) with reference to the way it tackled the issues inherited from it colonial economy (Boyer and Boyer 2005), which was described as "theft" (Green 1981). For example, fisheries are subjected to some of the highest taxes in the country, while they appear to remain profitable and are taxed to the country's benefit (Reid *et al.* 2007). However, the fact that fisheries management is not socially driven mean that "the ecological, economic, and social realities around Namibia's fisheries management are not sustainable" (Paterson *et al.* 2013). This is illustrated by the lack of transparency in terms of employment potential as the numbers claimed by industry to be employed onboard vessels (Anon. 2009) are exaggerated by around 30% for political reasons (Grobler 2008).

Our reconstruction shows an important potential for the development of the recreational fishery, as recreational anglers are often coming from South Africa where the recreational fishery resources have been severely depleted (Barnes *et al.* 2002). Plans should be developed with extreme care, however, as authors already report that these resources are being "over-utilized" in Namibia (Barnes and Novelli 2007).

Overall, the case of Namibian fisheries provides a good example of how to escape neo-colonial pressure on fishery resources, and rebuilding fisheries after major collapses. The country has refused to conclude fishing agreement deals with the EU, set quotas to zero, banned several fisheries, domesticated vessels and disallowed others from fishing. For example, despite political pressure[1], Spain which used to get two-thirds of its entire 'white fish' overseas catch from from Namibia (Cram 1976) saw its fleet in Namibia reduced by 200 vessels (Freeman 1992). Namibia is also a good example of how industry takes full part in both the monitoring of fisheries and their cautious management. An example of this is the horse mackerel fishery whose low catches by the purse-seine fleet were attributed to the industry not willing to risk the pilchard stock as horse mackerel and pilchard stocks are mixed because of increasing temperatures (Tallaksen 2014).

[1] http://www.publicintegrity.org/2011/10/04/6769/spain-s-hake-appetite-threatens-namibia-s-most-valuable-fish [Accessed on 19/03/2003]

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