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ABSTRACT

Accurately recording marine fisheries catches is difficult and costly and thus under-reporting of fisheries catches occurs worldwide. This report presents the reconstruction of total marine fisheries catches for the US Virgin Islands (USVI) for the period 1950-2010, which includes estimates of under-reported artisanal and subsistence catches and unreported recreational catches. Total small-scale catches were estimated at slightly over 77,000 t for the period 1950-2010, which is approximately 1.8 times the official landings of 43,626 t reported by the FAO on behalf of the USVI. This estimate better reflects the importance of small-scale fisheries in providing seafood and recreation to locals and visitors, and livelihoods to fishers, than official statistics.

INTRODUCTION

The US Virgin Islands (USVI) is an overseas territory of the United States that is located between 18˚21 N and 64˚56 W in the northeast Caribbean next to Puerto Rico (see Figure 1). It consists of three major islands: St. Thomas, St. John and St. Croix and about 50 cays. St. Thomas and St. John lie on the Puerto Rico Bank, whilst St. Croix is separated from the Puerto Rico Bank by a deep trench (Kojis 2004). Collectively the islands share an Exclusive Economic Zone of approximately 33,750 km^2 (<www.seaaroundus.org>).

Originally inhabited by Ciboney Indians, Caribs and Arawaks (native Indians originating in South America), the islands were claimed for Spain by Christopher Columbus in 1493. For the next 400 years, the islands were ruled by the Spanish, British, French and Dutch. The islands were known as the Dutch West Indies until they were sold to the United States by Denmark in 1916. Now the islands are comprised mainly of descendants of African slaves who arrived in the sugar era, though a distinct Danish heritage persists in the form of street names (Ockerstrom 2000).

Each year the islands host over a million tourists, mostly from the United States. Tourism is the main economic earner, generating 80% of GDP and employment (Ockerstrom 2000). However tourists put an additional strain on the islands marine resources both in terms of seafood consumption as well as recreational fishing activities which are popular among visitors, as the waters to the north of the islands teem with billfish (Mateo 2004). It has been estimated that the billfish fishery of St. Thomas contributes around $5.5 M to the local economy (Tobias 1987).

The fisheries of the USVI can be divided into three sectors: artisanal, subsistence and recreational and sport. The sport fishery for billfishes in the USVI began in the 1950s (Erdman 1968). Annually 40-70 fishing boats from southeast USA and a number of Caribbean countries travel to St. Thomas to participate

in the fishery for blue marlin and other billfishes (Brandon 1989). Three internationally recognised billfish tournaments are held annually in the USVI, along with several local tournaments. Most of the fishing takes place from June to October (Olsen and Wood 1983) on the 'North Drop', located about 30 km north of St. Thomas (Friedlander 1995).

The artisanal fishery is primarily based on the use of fish traps known locally as 'nass'. Seine nets, hook & line and troll lines are commonly used to exploit marine species. 'Fundering' is a unique fishing technique employed in these islands. It consists of lowering a heavily baited fish pot to depths of 600 feet or more, inducing a feeding frenzy, then after some time has passed, the pot is hauled and the catch is removed (Swingle *et al.* 1970). Fishers operate from motorised open boats, typically 4-6 m in length. Artisanal fishing in St. Thomas and St. John takes place all around the shores of the island, but fishing around St. Croix (the largest of the 3 main islands) is restricted to the eastern shores, since the bottom drops sharply just half a mile from the western shore (Fiedler *et al.* 1943). Despite the fact that fishers operate year-round, the fishery is still considered small-scale due to low fisher participation and capital investment. As such, annual landings are not enough to satisfy local demand and large quantities of seafood products are imported each year mainly from Puerto Rico and the United States. In the year 1967, 838 t of fish were landed locally, while an additional 812 t of seafood products were imported (Swingle *et al.* 1970). In the past, boats from Tortola (in the British Virgin Islands) would land catches directly in St. Croix (Fiedler *et al.* 1943).

In the 1950s and 1960s, the absence of any organised distribution system for the fishery combined with the lack of a licensing system made the procurement of accurate catch statistics impossible (Swingle *et al.* 1970). By the early 1980s, the fisheries and wildlife office began administering the fisheries of the USVI with federal funding from NOAA. Fishers recorded catches by species on monthly log books which are returned to the Fisheries Department; however, in 2010, the department collected data by trip-tickets. Unfortunately no data is collected for the sizeable recreational sector, although records exist for tournament catches (Stephen Hale, Conservation and Fisheries Department, pers. Comm., 13 September, 2012).

Without a knowledge of historical fish landings, there is no baseline for comparing present landings. The commercial fisheries of the USVI have been reported by Fiedler and Jarvis (1932), Idyll and Randall (1959) andWilliams (1976). Swingle *et al.* (1970) conducted a survey of the commercial fishery in 1968, and Kojis (2004) carried out a census of marine life in 2004. Meanwhile, the recreational fishing sector has been well documented by Olsen and Wood (1983), Tobias (1987), Friedlander and Contillo (1994), Friedlander (1995), García-Moliner *et al.* (2002), andMateo (2004). The aim of the present study is to provide a reconstruction of total marine catches landed in the USVI from 1950 to 2010. Using anchor points established from published and unpublished fisheries literature, together with some assumptions, we filled in the gaps in the official catch data submitted to the FAO, thereby improving the catch statistics for the USVI.

METHODS

Using information on the number of fishers from various sources together with catch per unit (CPUE) effort information fromFiedler and Jarvis (1932), Swingle *et al.* (1970) andWilliams (1976), we reconstructed the small-scale catches made in the US Virgin Islands from 1950-2010. Using effort information from a 2004 survey of resident participation in recreational fisheries (Mateo 2004), we estimated the recreational catches made by locals. Combined with effort information from García-Moliner *et al.* (2002) on recreational chartered fishing activity in the U.S. Caribbean we reconstructed the tourist recreational catches.

Tourist population and fisher population

Data on the number of stop-over tourists (i.e., travelers who stay on the islands for more than a day) were available for 1954 from Ockerstrom (2000) and from the Caribbean Tourism Organisation[1] for 2005-2010. It was assumed that tourism existed in 1950. Using linear interpolation we derived an entire time series of the number of stop-over tourists visiting the USVI from 1950-2010 (Figure 2a).

Using linear interpolation between anchor points: 1930, 1967 and 2003, we estimate the population of fishers operating on the island from 1950-2010. The population of fishers operating in USVI has remained relatively stable over time (Figure 2b).

Table 1. Data and sources used to derive a time series of the number of fishers in the US Virgin Islands.

Year	No. artisanal fishers	Source
1930	405	Fiedler and Jarvis (1932)
1967	400	Swingle *et al.* (1970)
2003	323	Kojis (2004)

Small-scale catches

Fiedler and Jarvis (1932) estimated 280 tonnes total landings for the USVI in 1932, and Swingle *et al.* (1970) estimated 838 tonnes for the year 1968. Dividing these catches by the number of fishers surveyed in those years, we derived two CPUE anchor points. Finally, Williams (1976) suggested that USVI fishers fish 42-48 weeks each year, 4.5 days a week and haul about 15 traps per day. We assumed the average catch per trap to be 5 lbs (i.e., 2.27 kg); the same as calculated by Klausing (1978) for the neighbouring British Virgin Islands (BVI). We conservatively took this trap fishing CPUE to be representative for total small-scale CPUE, since information on other gear types was not available for this year. Interpolating between these three anchor points we derived a CPUE series for 1950-2010. Combining CPUE rates with the times series of local fishers, we reconstructed total small-scale catches taken in the USVI from 1950-2010.

Since it is known that fishers take home a portion of their catch, we assumed some proportion of our reconstructed catches to be part of subsistence catches. To assign small-scale catches to artisanal and subsistence sectors, it was assumed that in 1950, 70% of near-shore catches were from the subsistence sector and 30% were from the artisanal sector. In 2010, it was assumed that 30% of catches were attributed to the subsistence sector and 70% to the artisanal sector. A linear interpolation was done between these two years to derive an assignment by sector for the entire 1950-2010 time-period.

Recreational fishery

The USVI Division of Fish and Wildlife's recreational fisheries assessment program conducted a telephone survey from December 1998 to July 1999. Based on this survey, 11% households in St. Croix and 13.5% households in St. Thomas/St. John had at least one recreational angler. The study estimated a total recreational catch of 78 tonnes in the USVI in the year 1999. Thus taking the average of 12% resident participation in recreational fishing, and a typical household size of 4 persons, we reconstructed a time series of local recreational anglers in the USVI from 1950-2010. Taking this together with a CPUE of

[1]Caribbean Tourism organisation website (<http://www.onecaribbean.org/>) [Accessed September 2012]

0.024 t·fisher^{-1}·year^{-1} (the 1999 rate) we reconstructed the recreational catches made by local anglers from 1950-2010.

Taking the average *per capita* recreational catch rate of 0.001 t·tourist^{-1}·year^{-1} (Klausing 1978), we conservatively estimated catches from USVI's recreational sector for the period 1950-2010.

Taxonomic breakdown

Using information on catch composition on St. Croix and St. Thomas, we derived an average catch composition for small-scale catches of the USVI. However only a breakdown of fish species was provided, thus in order to estimate catches of invertebrates in the USVI we used information on proportion of conch and lobster in USVI catches fromSwingle *et al.* (1970). Recreational catches by locals and tourists were divided equally into 4 categories: wahoo, tuna, dolphinfish and marlin.

RESULTS

Reconstructed catches from the USVI for the time period 1950-2010 were composed of artisanal catches of 40,100 t, subsistence catches of 34,100 t and recreational catches of 3,100 t (Figure 3a). Total unreported catches from 1950-2010 were around 33,700 t, being on average nearly 550 t·year^{-1} for the time period 1950-2010.

Overall, reconstructed total catches were 1.8 times the data reported by the FAO on behalf of the USVI (Figure 3a). Total catches increased from around 630 t·year^{-1} in the early 1950s to just under 2000 t·year^{-1} by the late 2000s (Figure 3a). Officially reported data more or less capture the extent of commercial (i.e., artisanal) fishing, although trends for the last 5 year appear to differ substantially (Figure 3a).

Parrotfish (Scaridae; 23%), snappers (Lutjanidae; 14%) and triggerfish (Balistidae; 10%) were dominant in USVI catches (Figure 3b). Shallow reef species such as surgeon fish (*Acanthurus* spp.; 8%) and grunts (Haemulidae; 8%) were common. Groupers (*Epinephelus* spp.; 9%), lobsters (*Panulirus argus*; 8%) and queen conch (*Stombus gigas*; 6%) were also important.

DISCUSSION

Caribbean fisheries are typically small-scale operations, of a labour-intensive and dispersed nature, which make them especially difficult to monitor. This task becomes even more difficult in multi-island entities such as the US Virgin Islands. This catch reconstruction shows a substantial level of under reporting in St. John, St. Croix and St. Thomas.

USVI fisheries are considered small-scale, but sport fishing has developed into a lucrative sector of the islands' economy. Unfortunately, no data are collected for the sizeable recreational sector, although records exist for tournament catches (Stephen Hale, Conservation and Fisheries Department, pers. comm., 13 September, 2012).

Reconstructed recreational catches amounted to around 3,000 t for the period 1950-2010, but are likely higher since our estimate was rather conservative. Overall, unreported catches from the three islands during 1950-2010 amounted to over 33,700 t, being on average nearly 550 t·year^{-1} for the time period 1950-2010. Unfortunately, under-reported catches can lead to erroneous interpretations on fisheries trends and substantially under-value the socio-economic importance of small-scale fisheries.

In view of the recognized importance of catch statistics for management and the state of data monitoring in the Caribbean, alternative methods must be sought to provide better estimates. This is what the catch reconstruction method can accomplish. Whilst assumptions may be necessary to achieve our reconstructions, we maintain a conservative approach.

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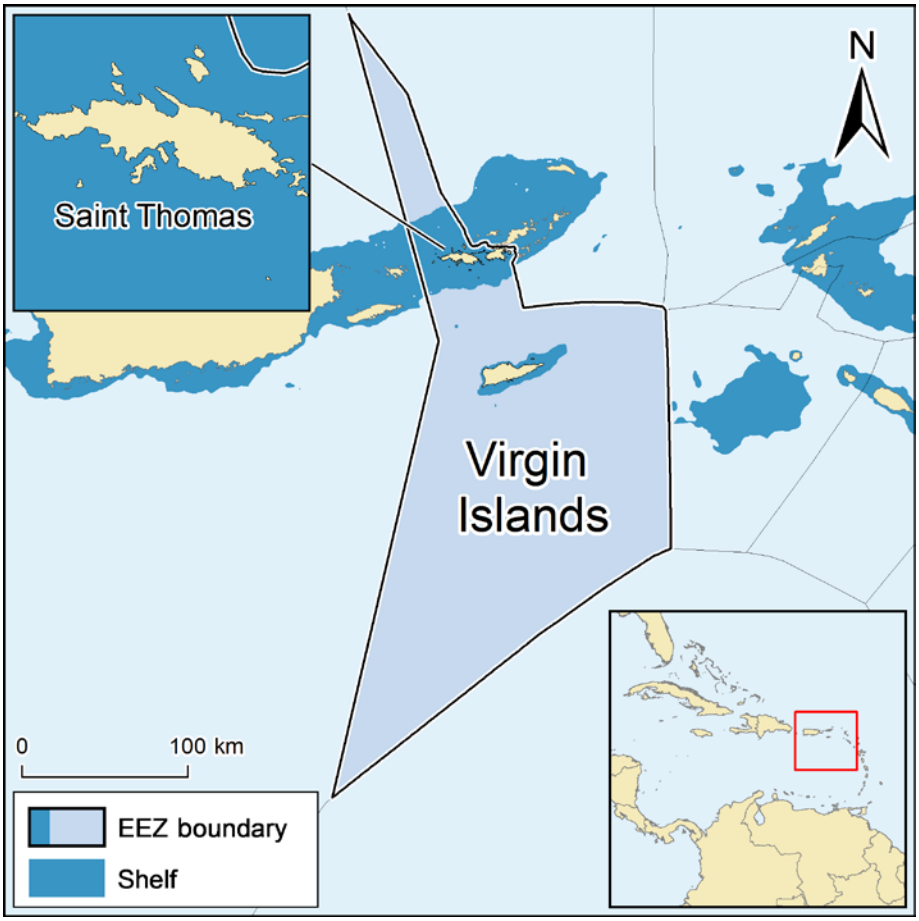

Figure 1: Map of Turks and Caicos with its Exclusive Economic Zone (EEZ).

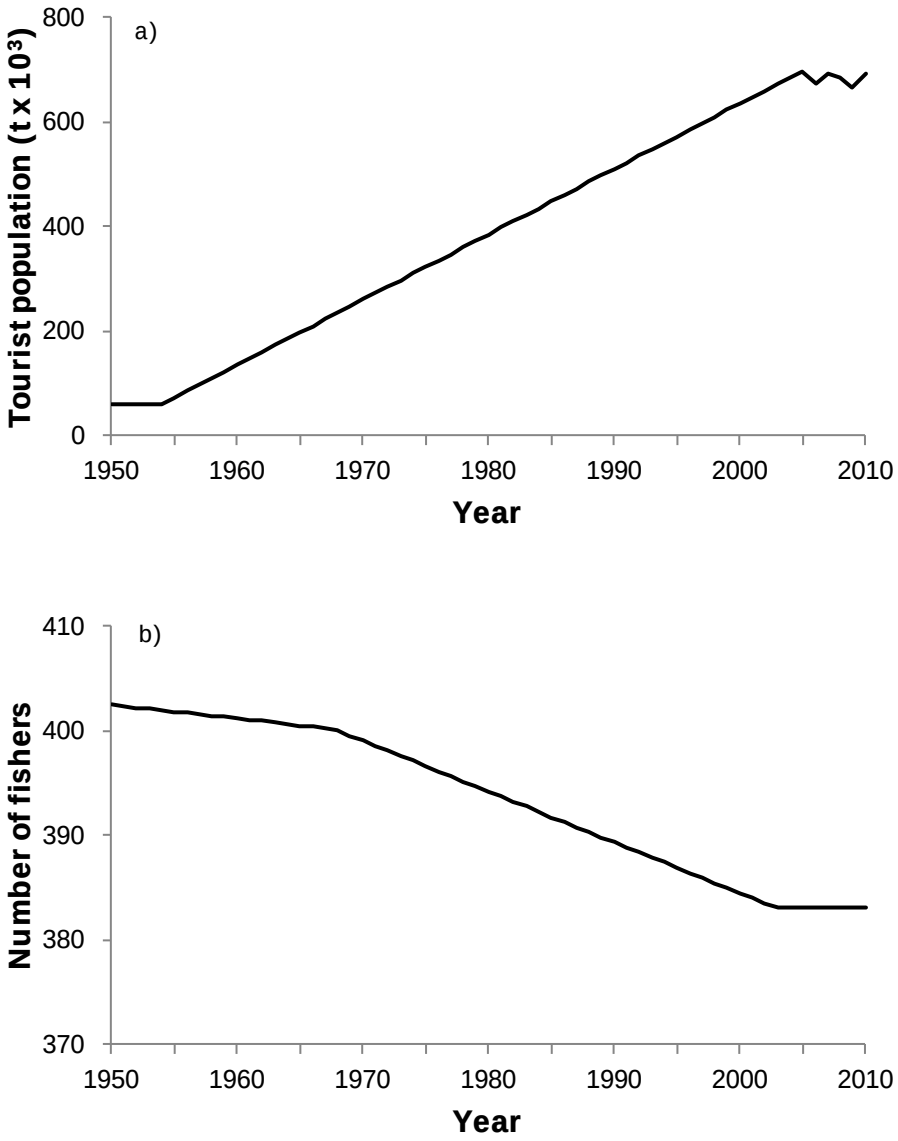

Figure 2. Population data for the US Virgin Islands including, a) stop-over tourist population, and b) number of fishers.

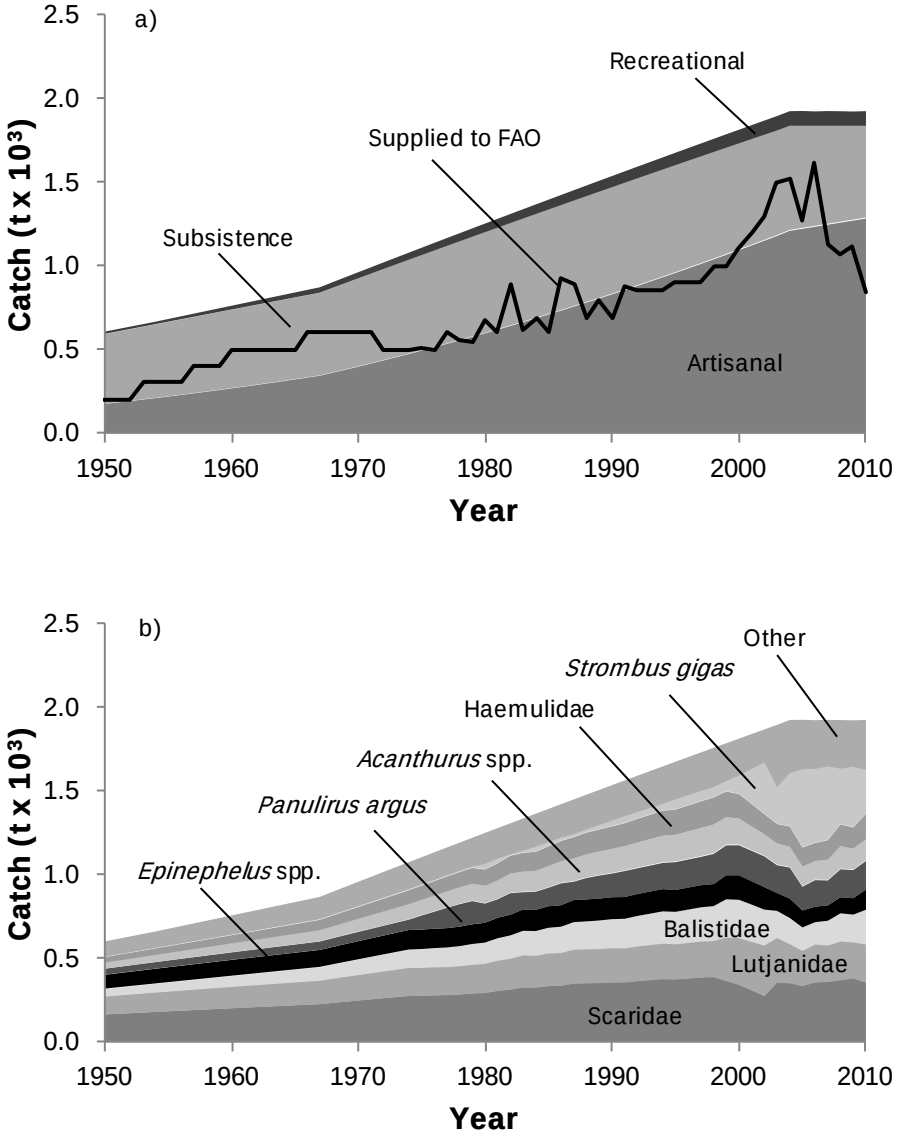

Figure 3. Total reconstructed catches for USVI by a) fishing sector, with data as reported by FAO on behalf of USVI overlaid as line graph; and b) taxa. 'Other' includes 15 additional taxonomic categories.