Drivers of the illegal consumption and trade of sea turtle products in Cape Verde – What is the right approach?

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<tr>
<td>Manuscript ID:</td>
<td>Oryx-15-A-0248</td>
</tr>
<tr>
<td>Manuscript Type:</td>
<td>Full Article</td>
</tr>
<tr>
<td>Date Submitted by the Author:</td>
<td>01-Sep-2015</td>
</tr>
</tbody>
</table>
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| Keywords: | black market, Cape Verde, coastal livelihoods, law enforcement, illegal harvest, loggerhead sea turtle, wildlife trade |
| Number of Words (all inclusive, except tables): | 5956 |
| Abstract: | Conservation rules aimed at restricting resource use are commonly used to manage and protect natural resources, but their implementation is strongly affected by resource users’ compliance. The design of effective rules should be informed by an understanding of the factors that affect compliance, considering the contextual socio-economic information. Potential changes in the national legislation protecting sea turtles have been recently discussed in the Cape Verde archipelago, where historical and recent records indicate heavy human predation pressure on nesting and foraging sea turtles. The most recent assessment of levels of illegal harvesting and consumption of sea turtle products on two of the islands, Boavista and Santiago, are presented, followed by an analysis of their potential drivers. |

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The perceived impact of main interventions currently employed in Cape Verde to reduce illegal sea turtle harvesting, trade and consumption were investigated by interviewing key stakeholders. Despite an apparent decrease of sea turtle harvest and consumption over recent years, our results suggest a shift from subsistence harvesting to trade in Boavista. The existence of sea turtle protection laws was perceived as a main deterrent to harvesting, while awareness campaigns and a lack of resource availability were perceived as main reasons for decrease in consumption in Boavista and Santiago, respectively. Aiming to inform ongoing discussions, we recommend a multi-targeted approach focusing both on suppliers and consumers in order to magnify conservation effectiveness. Regular impact evaluation focusing both on harvest and consumption is needed to better design regulations and robustly inform policy decisions.
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![Graph showing past and recent use by category]

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<table>
<thead>
<tr>
<th>Drivers</th>
<th>Assumptions</th>
<th>Indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laws And Regulations</td>
<td>Imposition of restrictions and penalties reduces illegal trade</td>
<td>Proportional decrease in trade and consumption due to law imposition</td>
</tr>
<tr>
<td>Awareness</td>
<td>Consumer awareness campaigns reduce the volume of consumption</td>
<td>Level of harvest and consumption</td>
</tr>
<tr>
<td></td>
<td>Increasing harvester/trader awareness reduces illegal trade</td>
<td>Attitude towards sea turtle conservation and protection</td>
</tr>
</tbody>
</table>

Table S2. Characterisation of the groups targeted for this study at Boavista (n = 147) individuals from four villages and one city) and Santiago (n = 291 individuals from six villages and one city).

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Boavista</th>
<th>Santiago</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Male</td>
<td>113 76,9</td>
<td>214 73,8</td>
</tr>
<tr>
<td>Female</td>
<td>34 23,1</td>
<td>76 26,2</td>
</tr>
<tr>
<td>Age</td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>15 - 25</td>
<td>36 24,5</td>
<td>44 15,2</td>
</tr>
<tr>
<td>26 - 35</td>
<td>51 34,7</td>
<td>121 41,7</td>
</tr>
<tr>
<td>36 - 45</td>
<td>33 22,4</td>
<td>50 17,2</td>
</tr>
<tr>
<td>46 - 55</td>
<td>18 12,2</td>
<td>48 16,6</td>
</tr>
<tr>
<td>55 - 65</td>
<td>7  4,8</td>
<td>19  6,6</td>
</tr>
<tr>
<td>65 +</td>
<td>2  1,4</td>
<td>6   2,1</td>
</tr>
<tr>
<td>Origin</td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Boavista</td>
<td>49 33,3</td>
<td>0  0</td>
</tr>
<tr>
<td>Santiago</td>
<td>66 44,9</td>
<td>218 75,2</td>
</tr>
<tr>
<td>Other Island</td>
<td>24 16,3</td>
<td>69 23,8</td>
</tr>
<tr>
<td>Other Country</td>
<td>8 5,4</td>
<td>0   0</td>
</tr>
<tr>
<td>Total (n)</td>
<td>147</td>
<td>291</td>
</tr>
</tbody>
</table>
Table S3. Value comparison of different sea turtle products reported during interviews (*Chi-squared test of significance*).

<table>
<thead>
<tr>
<th>Sea Turtle Product</th>
<th>Island</th>
<th>Product Value (Local Currency CVE)</th>
<th>Mean ± SD</th>
<th>Range</th>
<th>Mode</th>
<th>Sign.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Turtle¹</td>
<td>Boavista (n=17)</td>
<td>10,000 ± 4,000</td>
<td>5,000 - 20,000</td>
<td>10,000</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Santiago (n=96)</td>
<td>12,000 ± 4,000</td>
<td>4,000 - 20,000</td>
<td>10,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Juvenile Turtle (Whole)²</td>
<td>Santiago (n=3)</td>
<td>5,000 ± 4,500</td>
<td>1,500 - 10,000</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raw Meat (Kg)²</td>
<td>Boavista (n=10)</td>
<td>400 ± 100</td>
<td>250 - 600</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Santiago (n=11)</td>
<td></td>
<td>200 - 600</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penis (Whole)¹</td>
<td>Santiago (n=6)</td>
<td>8,000 ± 4,000</td>
<td>3,500 - 15,000</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penis (Drink)¹</td>
<td></td>
<td>1,000 ± 500</td>
<td>500 - 2,000</td>
<td>1,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serving (Cooked)²</td>
<td>Boavista (n=5)</td>
<td>150 ± 50</td>
<td>100 - 200</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Santiago (n=70)</td>
<td></td>
<td>50 - 300</td>
<td>200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Values rounded to the nearest 1000 CVE
² Values rounded to the nearest 100 CVE

1€ = 110 CVE
Table S4. Responses received during the interview to questions regarding (a) general perceived importance of sea turtles at an ecological and cultural level; (b) the use of sea turtles as an economic resource, and (c) the general opinion about the measures that have been taking place to protect and conserve sea turtles on each island.

<table>
<thead>
<tr>
<th>Importance of Sea Turtles</th>
<th>Boavista (%)</th>
<th>Santiago (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Yes</td>
</tr>
<tr>
<td>a) Sea turtles play an important role in nature</td>
<td>143</td>
<td>97,2</td>
</tr>
<tr>
<td>b) Sea turtles are important in the culture of this island</td>
<td>142</td>
<td>93,7</td>
</tr>
<tr>
<td>c) It is important for you that sea turtles do not go extinct</td>
<td>142</td>
<td>99,3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Use of Sea Turtles as Economic Resource</th>
<th>Boavista (%)</th>
<th>Santiago (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Yes</td>
</tr>
<tr>
<td>a) Sea turtles are a good tourist attraction</td>
<td>144</td>
<td>75,0</td>
</tr>
<tr>
<td>b) The consumption of sea turtle meat should be allowed</td>
<td>137</td>
<td>13,9</td>
</tr>
<tr>
<td>c) If population is not declining, or stable, sustainable harvesting should be permitted</td>
<td>140</td>
<td>12,9</td>
</tr>
<tr>
<td>d) Low income residents should be allowed to sell sea turtle products as an alternative source of income</td>
<td>141</td>
<td>7,9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sea Turtle Protection and Conservation</th>
<th>Boavista (%)</th>
<th>Santiago (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Yes</td>
</tr>
<tr>
<td>a) Sea turtles must be protected</td>
<td>147</td>
<td>91,8</td>
</tr>
<tr>
<td>b) The government should be more active in sea turtle protection</td>
<td>139</td>
<td>94,2</td>
</tr>
<tr>
<td>c) The current laws are effective in protecting the turtles</td>
<td>114</td>
<td>49,1</td>
</tr>
<tr>
<td>d) People are well informed about the sea turtle protection laws</td>
<td>132</td>
<td>68,2</td>
</tr>
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</table>
APPENDIX I.

MAIN SURVEY QUESTIONS

Drivers of the illegal consumption and trade of sea turtle products in Cape Verde, West Africa

Text in Italics denotes expected answers or options given to select

Section 1 – DEMOGRAPHIC INFORMATION

Target: All interviewees

1.1. Gender
1.2. Age
1.3. Origin - Country, and Island (if natural of Cape Verde)
1.4. Level of Education (None/ Primary/ Secondary/ University)

Section 2 – ECONOMIC BACKGROUND

Target: All interviewees

2.1. Occupation
2.2. Level of monthly income (Low (<50,000 CVE)/ Medium (51,000 – 150,000 CVE)/ High (>150,000 CVE)

Section 3 – HARVESTING – Direct and Intentional Captures

Target: Fishermen/Potential Poachers

3.1. Has ever harvested sea turtles (Yes/ No)?

If not, or if activity has stopped:

3.1.1. What are the main reasons for not harvesting? (Awareness of conservation need/ Law/ Pity for the animal/ Religious beliefs/ Other)

If yes:

3.1.2. Still does? (Yes/ No)
3.1.3. What are/were the main uses of the harvested sea turtles? (*Eat/ Sell/ Offer in the community*)

3.1.3. How do you rank the importance of sea turtles as a source of income to the family (Very (1) – Little (4))? 

3.1.4. Where are/were turtles captured? (*Sea/ Beach/ Both*)

3.1.5. In which island(s) are/were turtles captured?

3.1.5. In which months are/were sea turtles captured? Which species?

3.1.6. How are/were sea turtles captured? (*Opportunistically/ Intentionally/ Both*)?

3.1.7. What is the level of harvesting (*Low (<3 turtles/year)/ Medium (3-10 turtles/year)/ High (>10 turtles/year]*)

Section 4 – SALE AND TRADE I

**Target: Poachers, Fishermen, fish sellers**

4.1. Has ever sold the turtle captured, either as whole, or parts? (*Yes/ No*)

*If yes:*

4.1.1. If yes, what was the product sold?

4.1.2. Where and to whom do you sell the whole turtle?

4.1.3. Where and to whom do you sell the meat and other parts?

4.2. What are prices of the different sea turtle products? (*Average price in CVE per unit*)

4.3. What are the factors that affect the price?

Section 5 - SALE AND TRADE II

**Target: Merchants, workers at places that can be used for entry points, or selling points (e.g. fish markets, docks or landing sites)**

5.1. Is turtle meat currently available for sale in this establishment/ area/ neighbourhood? (*Yes/ No*)

*If yes:*

5.2.1. Is the sale of turtle meat done openly? (*Yes/ No*)

5.2.2. Is there any control of the sale of turtle meat by the authorities? (*Yes/ No*)
5.2.3. What species of sea turtle are sold here, and from which island do they come from?

5.2.4. How is the price of the turtle meat determined?

**Section 6 – CONSUMPTION**

**Target: All interviewees**

6.1. Have you ever consumed turtle meat? (Yes/ No)

6.2.1. If you have never done it, why have you chosen so? (Awareness of conservation need/ Law/ Pity for the animal/ Religious beliefs/ Lack of Opportunity/ Taste/ Other)

6.2.2. If you still do, what is the main reason? (Culture/ Taste/ Medicinal Properties/ Tradition/ Infinite Resource/ Other)

6.3. How can you get turtle meat in the village where you live?

6.4. Please give details of what you can buy and for how much (average price in CVE per unit)

6.5. From which island does the meat come from?

6.6. Can you see any difference in the offer of sea turtle meat in the last 7 years? (Increase/ Decrease/ None/ Don’t Know)

6.6.1. What are the main reasons for this change?

6.7. Can you see any difference in the demand of sea turtles in the last 7 years? (Increase/ Decrease/ None/ Don’t Know)

6.7.1. What are the main reasons for this change?

6.8. What are the current laws (if any) that protect sea turtles in Cape Verde?

6.8.1. Who breaks these laws, fishermen or consumers?

6.9. Do you agree with the following statements? (Yes/ No)

   a) Sea turtles must be protected
   b) Sea turtles should be used as tourist attractions
   c) The existing laws are being properly enforced
   d) Some of the money generated by turtle tourist should go back to turtle conservation
   e) Sea turtles should be used not only as tourist attractions, but also as source of food
   f) Sea turtles have an important ecological role
g) Government should have a more active role in the protection of sea turtles

h) Local residents should be allowed to capture and consume sea turtles, if this does not affect the sea turtle populations

i) It is important to preserve the sea turtles for the future generations
Title: Drivers of the illegal consumption and trade of sea turtle products in Cape Verde – What is the right approach?

Running title: Illegal consumption and trade of sea turtle products in Cape Verde

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Word Count: 5956
Abstract

Conservation rules aimed at restricting resource use are commonly used to manage and protect natural resources, but their implementation is strongly affected by resource users' compliance. The design of effective rules should be informed by an understanding of the factors that affect compliance, considering the contextual socio-economic information. Potential changes in the national legislation protecting sea turtles have been recently discussed in the Cape Verde archipelago, where historical and recent records indicate heavy human predation pressure on nesting and foraging sea turtles. The most recent assessment of levels of illegal harvesting and consumption of sea turtle products on two of the islands, Boavista and Santiago, are presented, followed by an analysis of their potential drivers. The perceived impact of main interventions currently employed in Cape Verde to reduce illegal sea turtle harvesting, trade and consumption were investigated by interviewing key stakeholders. Despite an apparent decrease of sea turtle harvest and consumption over recent years, our results suggest a shift from subsistence harvesting to trade in Boavista. The existence of sea turtle protection laws was perceived as a main deterrent to harvesting, while awareness campaigns and a lack of resource availability were perceived as main reasons for decrease in consumption in Boavista and Santiago, respectively. Aiming to inform ongoing discussions, we recommend a multi-targeted approach focusing both on suppliers and consumers in order to magnify conservation effectiveness. Regular impact evaluation focusing both on harvest and consumption is needed to better design regulations and robustly inform policy decisions.
Keywords: black market, Cape Verde, coastal livelihoods, law enforcement, illegal harvest, loggerhead sea turtle, wildlife trade

Introduction

For millennia, humans have preyed upon marine megafauna and have benefited from their use, incorporating them into their livelihoods and cultures (Witherington & Fraser, 2003; Jackson et al., 2001). However, there has been a clear modern tendency for humans to overexploit such resources (Parsons, 1962; Nietschmann, 1995; Springer et al., 2003), as shifts from subsistence use to the commercial exploitation of marine wildlife stocks have led to the local and/or global extinction of many species, or severe declines of others (Polidoro et al., 2008; Baum et al., 2003).

Challenges in conservation implementation are diverse and often related to the social-ecological nature of the systems in which interventions occur (Pollnac et al., 2010; Nuno et al., 2014). For example, conservation agreements and legislation aimed at restricting resource use (e.g. harvest quotas, protected areas, and harvest seasons) are commonly used to manage and protect natural resources but their implementation is strongly affected by resource users’ compliance (Keane et al., 2008). Conservation programmes often lack a robust understanding of the socio-economic context and decision-making processes affecting resource use, which is essential for assessing feasibility of potential management strategies and implementing effective interventions (Roe & Mulliken, 2002; St John et al., 2013; Raymond & Knight 2013), such as through law enforcement (Rowcliffe et al., 2004). In addition, this knowledge...
should be coupled with regular scientific assessment and potential adjustments (Pullin et al., 2004; Sutherland, 2004; Garnet et al., 2007) in order to inform policy-makers about the effectiveness of on-going interventions and aid identifying alternatives.

At the Cape Verde Islands in the Atlantic Ocean, historical records and recent studies suggest heavy human predation pressure on nesting and foraging turtles on most islands (López-Jurado, 2007; Loureiro & Torrão, 2008; Marco et al., 2012; C. Roder, Program Director, Turtle Foundation, pers. comm., July 15th, 2015). This occurs despite several conservation interventions, such as: the implementation of national legal frameworks that penalize the killing and consumption of sea turtles (Decree-Laws 7/2002; 53/2005); military enforcement of sea turtle protection on the main nesting beaches; and public awareness activities led by local and international non-governmental organizations. Recently, environmental authorities have been discussing a new decree to reinforce the existing law such that charges for sea turtle harvesting changes from being a matter of the civil procedure code to the criminal procedure code, which allows authorities to set jail convictions for the killing of sea turtles. Lack of socio-economic data and limited sea turtle harvest and consumption prevalence information may, however, undermine the robustness of policy decisions and challenge the implementation of effective regulations in the study area.

This study aimed to explore the dynamics of the harvesting, consumption and trade of sea turtle products in Cape Verde, and potential changes due to a change in conservation efforts and legal protection of sea turtles. First, we assessed levels of harvesting and consumption of sea turtle products, and explored what socio-demographic and economic factors potentially affected their trade and consumption.
Secondly, we investigated the perceived effectiveness of two broad categories of interventions that have been commonly employed, individually or in combination, in Cape Verde to reduce sea turtle harvesting, trade and consumption: (1) establishment of regulations and law enforcement, and (2) campaigns to increase awareness (Table S1). Ultimately, we aimed to inform ongoing discussions about sea turtle protection in the study area and suggest the need for a better understanding of contextual factors for the design of effective conservation rules.

**Study site**

Cape Verde is a small insular country located in the Atlantic Ocean about 500 km from the west coast of Africa with a population of ca. 491,000 inhabitants and a mean GDP of 1,865 US dollars per capita in 2011 (World Bank, 2011). The country is characterised by a young human population, distributed unequally among the nine inhabited islands, with approximately half of the population inhabiting the main island, Santiago; over the last two decades, the country’s population has increased by 82%, particularly in urban centres, such as Praia. In the island of Boavista, the main tourism destination, the population has tripled over the last decade (INE, 2010).

Cape Verde is perceived as the third most important known nesting sites for the loggerhead sea turtle (*Caretta caretta*) in the world and it is estimated that 85-90% of turtle nesting is located on the beaches of Boavista (Marco *et al.*, 2011). This island, as well as Santiago (the most populated island in the archipelago and where the nation’s capital, Praia, is located), were the focus of this study (Fig. 1).
Methods

During May and June, 2011, 147 and 291 individual interviews in total were conducted in main coastal communities of Boavista and Santiago, respectively. The specific study locations were selected based on preliminary information obtained from fishers who were formerly involved in sea turtle harvesting; this information was used to identify areas of high sea turtle consumption and/or where turtle harvesters and sellers were known to be present. The sample size of each target group was defined using a power analysis for a binomial proportion test, based on the number of registered fishers and fish sellers, as well as adult population, on both islands (95% confidence level, with 5% confidence interval). Past and current sea turtle harvesters and sellers were selected through snowball sampling to assess the dynamics of the harvesting and trade due to potential involvement in sea turtle trade; artisanal fishers (n=128) and fish sellers (n=23) from both islands were interviewed at landing docks, beaches and markets or sought after from names lists provided by the local fishers associations. Members of the general public were randomly selected for interviews on the streets of the main urban centres on each island (n=95 in Boavista; n=190 in Santiago) (the characterization of the main target groups is summarized in Table S2).

The surveys included both open and closed questions about (a) socio-economic and demographic characteristics; (b) present and past participation in sea turtle harvesting, sale or and consumption, and their potential drivers; and (c) perceptions and awareness of sea turtle conservation. Questions allowed assessment of respondents’ perceptions of how harvesting, sale and consumption had evolved since sea turtles
received legal protection in 2002. The survey also involved mapping trade dynamics, such as identification of main trade chain parameters, particularly sources and sinks of sea turtle meat, selling locations, species traded and product prices. A shorter version of the survey, including only subsections related to consumption patterns and perceptions, was used for the general public (questionnaires presented in Supplemental Methods).

Data management and statistical tests were conducted using R v.2.9.1 (R Development Core Team, 2009). Chi-squared tests were used to test for significant associations between different variables.

Results

Sea turtle harvesting and trade at Cape Verde

Our results indicate that sea turtle harvesting in Cape Verde was generally carried out by fishers but a few other members of the public also reported taking part in this activity, while trade of sea turtle products was mostly done by fish sellers (which is a job predominantly done by women). During the study, we identified 28 fishers who were active harvesters and five fish sellers who were actively engaged in the sale of sea turtle meat. Based on self-reported information, which potentially underestimated involvement in these target behaviours, the estimated number of fishermen harvesting sea turtles decreased from 61% to 17% in Santiago, and 87% to 18% in Boavista since the implementation of the protection law (Fig. 2). Meanwhile, the percentage of fish sellers involved in the sale of sea turtle products remained stable in Boavista.
(only one of the interviewed fish sellers ever engaged in sale of sea turtle products, but remained active) and decreased from 78% to 22% in Santiago.

Despite this apparent decrease in the number of active harvesters and sellers, annual capture rates, as reported by 19 of the active harvesters, varied from low (1 to 3 turtles per annum) by 11 fishers (48%), medium (3-10 turtles per annum) by 7 of the fishers (30%) and high (10 turtles or more) by only one fisherman (4%), the remaining not providing an answer. Based on the above ranges of figures, this represents a conservative, overall estimation of 50-114 turtles harvested by the 19 interviewed fishers alone (20-52 by fishers from Boa Vista; 30-62 by fishers from Santiago) per year.

According to the information provided by the active harvesters, the majority of the turtles were caught at sea (74% of the respondents; 7 at Boa Vista and 15 at Santiago), while some were caught on the nesting beaches (29% of the respondents; 1 at Boa Vista and 8 at Santiago; question allowed both options). Marine captures by Boavista fishers were all in local, insular waters; however, fishers living on Santiago undertook captures in the waters surrounding a variety of islands, mainly Boavista, Maio and Santiago itself. The beaches where captures took place were not identified in this study, but all were local to the fishers’ island of origin.

The information gathered from the interviews suggests that the typical trade chain was different between islands. In Santiago, the majority of the fishers active in sea turtle harvesting chose to have fish sellers as intermediaries between them and the
end-consumers \( (n = 18) \), thus creating a trade, although some stated that they had a
well-established list of regular end-clients \( (n = 5) \). In Boavista, only one of the five
known fish sellers was still actively involved in the sale of turtle meat (Fig. 3; more
details about the trade in Figure S1).

Typical products traded in Cape Verde that were recorded in this study included
whole sea turtles, sea turtle meat, eggs, and the penis (Fig. 4). Only the price of live
adult turtles was significantly higher in Santiago, while the value of other sea turtle
products was found to be similar on each study island (Table S3). According to the
fish sellers interviewed, product prices were regulated by turtle size, rather than
seasonal availability, species, or risk associated with the sale.

Consumption of sea turtles

Based on all interviews (including the general public), consumption prevalence was
found to be significantly different between islands \( (\chi^2 = 69.86, \text{df} = 5, P < 0.001) \), with
a higher proportion of the population in Boavista consuming turtle than that in
Santiago. The consumption of sea turtle products had, however, apparently decreased
over time, being this more noticeable on the island of Santiago, where a reduction of
62% was estimated, versus just 28% on Boavista (Fig. 5). Consumption was found to
be unrelated to age, income or occupation \( (P > 0.05) \), but those with lower educational
levels were more likely to consume turtle products \( (\chi^2 = 10.74, \text{df} = 4, P = 0.03) \).

Self-reported drivers of trade and consumption
Harvesting and Trade

The results suggest that there was a shift from subsistence use in Boavista to harvesting conducted primarily for trade purposes with the island of Santiago (Fig. 6), conducted mainly by natives of Santiago Island (5 of the 9 active turtle fishers identified).

Traditionally, in neither island was turtle harvesting considered a primary source of income (P > 0.05), but the supplementary income originated from the sale of turtles was considered more important on Santiago than Boavista (χ² = 12.98, df = 4, P = 0.01), where the average monthly income was found to be considerably lower (χ² = 10.63, df = 4, P = 0.003). Turtles were, and have been in general, harvested mostly opportunistically (85% of the all fishers surveyed, regardless of the islands (P > 0.05), generally to meet extra expenses related to the use of boat fuel or food when fish supplies or associated income were low (especially on the island of Santiago). Fishers and fish sellers who have never been, or ceased to be, engaged in sea turtle harvesting and sale indicated that the existence of legislation is the main deterrent (Fig. 7).

Consumption

The main self-reported drivers for respondents to stop or avoid the consumption of sea turtle meat varied between the two islands, with environmental awareness playing an important role in Boavista, where several NGO’s have been actively carrying out environmental education and public outreach. The low availability of sea turtle meat for sale on both islands, and the elimination of the main selling points in the capital city of Praia, have apparently driven the decrease in the level of consumption (Fig. 7).
Law enforcement and legislation

The self-reported level of awareness about conservation needs and the importance of sea turtles was very high on both islands, suggesting that, in general, the population seemed to have a positive attitude towards sea turtles and agreed with their full protection (Table S4). The effectiveness of the existing laws was more likely to be regarded positively by those on Santiago (68%), than by those on Boavista (50%). However, respondents pointed out a perceived lack of law enforcement (90%) and insufficient protection at the beaches and docks (92%) as the main reasons why sea turtle trade continues to take place. Increased awareness about turtle conservation has not necessarily resulted in a successful change in consumptive behaviour, as respondents often contradicted themselves by also openly admitting to participate and support the consumption of turtle meat ignoring the fact that this is also prohibited by law (only 9% of the respondents knew that consuming sea turtle meat was prohibited).

Discussion

Illegal harvest and consumption

Despite a decade of targeted interventions, our results demonstrate that, at the time of the study, illegal direct take of sea turtles persisted on beaches on the islands where nesting occurs, as well as in the waters surrounding both islands. This confirms suggestions from anecdotal evidence and previous studies in the area (Marco et al. 2012, Cozens et al., 2012). Nevertheless, this study suggests that there had been a clear reduction in both the level of sea turtle harvest and consumption since the implementation of the protective law in 2002, although the magnitude of this
reduction must be regarded with care, as respondents may have been more inclined

towards reporting a positive change due to the illegal nature of this behaviour. Our
study also points to Santiago Island as the main sink of sea turtle meat derived from
sea turtles caught on Boavista Island; this was evidenced by the shift from subsistence
to commercial harvesting on Boavista, possibly driven by the increasing demand for
sea turtle meat in the growing urban area of Sal Rei (Boavista), and the city of Praia
(Santiago), as suggested by some respondents, and a pattern also suggested in
previous studies (Araújo, 2008; Merino et al., 2008).

The biological impact of this trade was, until now, underestimated, as mortality data
have been limited to reproductive females harvested on the main nesting beaches; the
most recent estimates indicate a poaching rate of 5% of the 8900 reproductive females
estimated to have nested on Boavista beaches in 2009 alone (Marco et al., 2012). Our
study recognizes the impact of the captures on the nesting beaches of Boavista, but
suggests that added pressure from opportunistic captures at sea needs to be
considered. The potential impact on population demography is difficult to ascertain,
as an unknown numbers of males and juveniles are targeted at sea. The estimated
magnitude of take obtained in this study should be regarded as conservative as some
respondents could be reluctant in sharing information about illegal activities, and the
snowball sampling technique used may have allowed to identify only a small and
possibly non-representative number of harvesters and sellers. The illegal harvesting
and trade, in conjunction with the impact of incidental captures at sea (see Melo &
Melo, 2013; Martins et al., 2008), demands further quantitative investigation. Barriers
to this include the lack of adequate law enforcement and surveillance at sea and on
land, making trade relatively easy and generally unnoticed, thus difficult to assess. Knowledge of the specifics of wildlife trade dynamics, such as transport mechanisms and routes within and among islands, is essential to develop practical, policy-relevant measures (TRAFFIC, 2008). The use of other types of data and specialized questioning techniques could be used to further explore these dynamics (Nuno et al., 2013). Nevertheless, this study contributed to identifying key factors and potential processes that should now be further explored, for example, by focusing on understanding causation between outcomes and potential predictor variables.

## Exploratory assessment of conservation interventions

Broadly, the actions taken by the Cape Verde government and NGOs to discourage sea turtle harvest and consumption have focused on two lines of action: (1) providing a legal framework for sea turtle protection in parallel to enforcing deterrents at the nesting beaches; and (2) raising awareness campaigns to motivate consumers to change their behaviours towards the consumption of sea turtle products (Araújo, 2008). Many of these interventions are believed to have been at least partially successful (this study), but our results also draw attention to several limitations or gaps in some of the intervention areas, and provide an opportunity to develop new opportunities and strategies and inform current discussions about potential changes in national sea turtle protection regulations.

### Laws and Regulations

The current study shows that legal and regulatory measures exert an important influence on people’s participation in sea turtle harvesting and trade; therefore, the development of the laws and regulations on Cape Verde seem to
be an effective mechanism for reducing illegal trade. However, the effectiveness of
the enforcement of deterents appears to be undermined by gaps and weaknesses in
specific parts of the enforcement process, as experienced elsewhere around the world
(e.g. Brautigam & Eckert, 2006; Keane et al., 2008; TRAFFIC, 2008). This is
evidenced by the recently reported increase in sea turtle harvesting on protected
beaches after military presence was withdrawn in 2014 due to conflicts with the local
communities in Boavista in the previous two years (Fonseca, 2014), suggesting that
without enforcement, people will continue harvesting sea turtles. Severe limitations
on means and resources, both financial and human, the lack of information and
difficulties in interpreting the law, and limitations of specialized training especially in
conflict mediation may be at the root of this problem (Merino et al., 2008; Araújo,
2008). It is thus essential that law enforcement mechanisms/resources are improved,
and that policies and controls are targeted at points in the trade chain that are likely to
have the greatest impact. While some efforts were developed in Santiago to tackle this
problem (Araújo, 2008), better results could be achieved by strengthening the judicial
sector’s understanding of the significance of illegal and unsustainable wildlife trade,
and focusing on the development of multi-agency law enforcement capacity (Akella
& Canon, 2004; TRAFFIC, 2008). In fact, most contribution towards law
enforcement and beach protection in the study area has been provided by non-
governmental organizations (to date, all led by foreigners), including community-
based organizations; however, while this non-governmental investment is generally
viewed as positive, there is a need to recognize the essential, fundamental role of
government and, thus, the need for governments to engage politically, logistically and
financially for sustaining initiatives at the long-term (Bräutigam & Eckert, 2006).
To evaluate the impact of awareness campaigns, the key questions are whether such messaging reaches its target audiences, whether it affects their attitudes and ultimately whether it influences their consumptive behaviour. The results of this study show that the awareness efforts developed on both islands have had a relatively high level of success towards raising awareness about the illegality of sea turtle trade; however, there remained a severe lack of knowledge regarding the negative impacts of the consumption of sea turtle products; the majority of consumers did not fully understand the connection between their consumptive habits and the illegal trade of sea turtles. While sea turtle meat suppliers admitted that there had been some decrease in demand, a high percentage of the respondents, however, admitted that the level of consumption is related to the availability of turtle meat. Therefore, this study indicates a serious gap in developing awareness campaigns directed at consumers, and a lack of understanding of the links between raising awareness and changes in the attitudes and behaviour of participants in the wildlife trade. Thus, possibly the biggest challenge of all is to develop a well-targeted awareness campaign, aimed primarily at the consumers. Nevertheless, some positive results have been observed in Boavista, where improved awareness has been one of the reported drivers for the reduction of sea turtle consumption on this island. For the best results, awareness campaigns should incorporate a monitoring and evaluation component, promoting at all times science-based management (Pullin, 2004; Sutherland, 2004).

Harvesting and sale of sea turtles contribute, as on other islands (Merino et al., 2008), to generating alternative income for families of fishers, especially on Santiago. A key
issue to be studied in the future is the ramifications of any further deterrence of the
harvest of female turtles on these islands. This resource may be more profitably used
in a non-consumptive way such as tourism (Tisdell & Wilson, 2001a; Troeng &
Drews, 2004), an especially important and developing sector for Cape Verde (Merino
& Berrow, 2006). But the low number of nesting turtles on Santiago, and the low
likelihood of observing turtles regularly at sea render this an unviable option on
Santiago Island. In fact, this may promote the opportunistic harvesting of sea turtles
by Santiago fishers on other islands. The sale of a single turtle generated, during the
study period, up to 20,000 CVE, which is the equivalent of a month’s salary for at
least 25% of the fishers interviewed in Santiago. The challenge on Santiago,
therefore, lies in the fact that the sale of sea turtles can generate high returns, and as
the meat is easy to store and transport, it is too tempting for the fishers to harvest the
turtles to gain extra income, as recorded elsewhere (Fa et al., 1995). This illegal trade
is further exacerbated if no financial aid is offered to fishers in times of socio-
economic decline; therefore, participatory research of alternative sources of income
may be important, while efforts towards mobilising improved living and working
conditions should be developed, as has been shown for other islands in the
archipelago (Merino et al., 2008) and benefits documented elsewhere (Brown, 1998;
Campbell & Vainio-Mattila, 2003).

Conclusion

The results presented in this study can be seen as an eye-opener to the gaps in
addressing the problem of illegal trade of sea turtles in Cape Verde, and also future
challenges that may arise. There is clear evidence that the harvesting and consumption
of sea turtles are still taking place, and thus conservation interventions still need refinement and reassessment.

The trade and consumption of sea turtles in Cape Verde not only threatens the species in question, but also the health of the ecosystems in which they occur, as well as reducing the availability of sea turtles for the development of alternative, non-consumptive uses such as turtle-watching. It is clear that conservation research needs to be integrated with social and economic disciplines to have a full understanding of the spatial, temporal and social realms of sea turtle consumption in Cape Verde.

Acknowledgements

This research project was undertaken for Turtle Foundation in collaboration with the INDP (National Fisheries Development Institute), and received financial support from the Turtle Foundation as well as the University of Exeter. JMH would like to thank in Cape Verde, her colleagues of Turtle Foundation in Sal Rei, Christian Roder and Julio Rocha; Bernardo Gonçalves for conducting a great part of the interviews in often difficult conditions and places; the INDP staff provided great logistical support: Dr. Carlos Santos, Dr. Vera Gominho, Dr. Alcides Varela, Victor Tavares, Paulo Varela, Avelino Tavares, Anselmo Rocha, Osvaldinha Rosa and Melicia Cardoso; Jelena Adeli and Indira for making life in Santiago so much easier. Also, Dr. Christophe Eizaguirre and Dr. Gail Schofield for help provided with analysis, review and editing of a previous version of the manuscript; Peter Richardson and Amdeep Sanghera from MCS for valuable input on the initial questionnaire, and sharing their experiences in TCOT/UK. BJG and AN acknowledge the support of the Darwin Initiative.
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