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

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Keywords:	black market, Cape Verde, coastal livelihoods, law enforcement, illegal harvest, loggerhead sea turtle, wildlife trade
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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.

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MAIN ARTICLE

List of plates and figures:

Figure 1. Map of the Cape Verde Archipelago, showing the location of the two studied islands, Santiago and Boavista.



Figure 2. Self-reported past and recent involvement in the sea turtle harvest by fishers and general population (“Others”), and sale by fish sellers in each island.

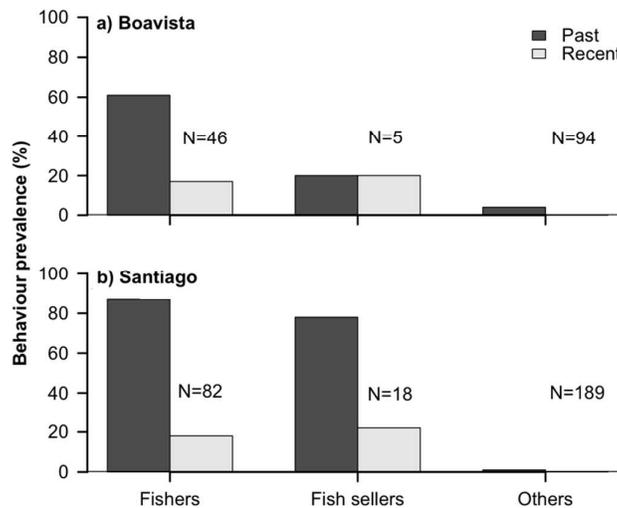


Figure 3. Primary sinks for sea turtles harvested on the two study islands, showing a clear distinction in the selling strategies used by the fishers. The export of sea turtle meat obtained on Boavista to Santiago island is evidenced here, as well as the importance of fish sellers as the main intermediates on the island of Santiago.

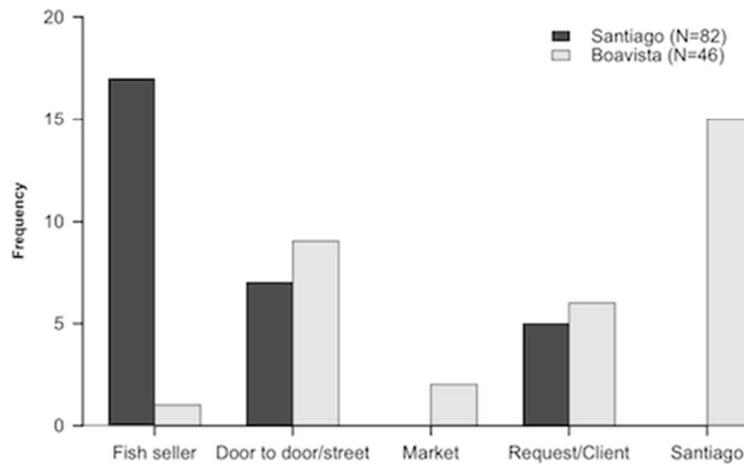


Figure 4. Examples of sea turtle products traded on the island of Cape Verde: (A) whole, alive sea turtles caught at sea or on the nesting beaches; (B) meat and “yellow” eggs are sold by the kilogram, or cooked and served on a small plate; (C) sea turtle penis is either sold whole, or by piece (typically 2 cm long), and is usually served in a shot of the local drink called “grogue” for apparent aphrodisiac qualities.

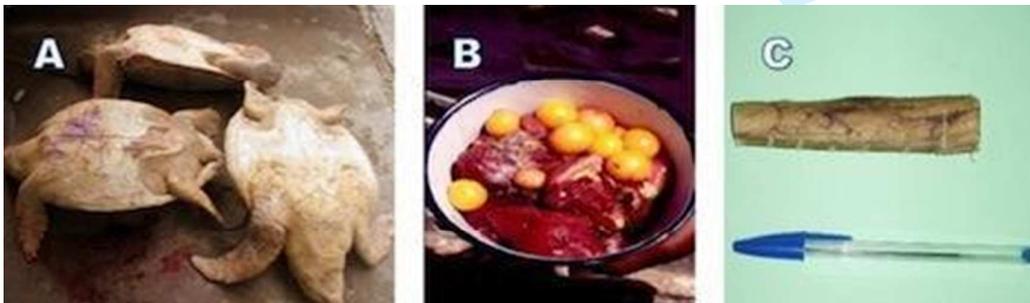


Figure 5. Self-reported past and recent consumption of sea turtle products by fishers, fish sellers and general population (“Others”), in each island.

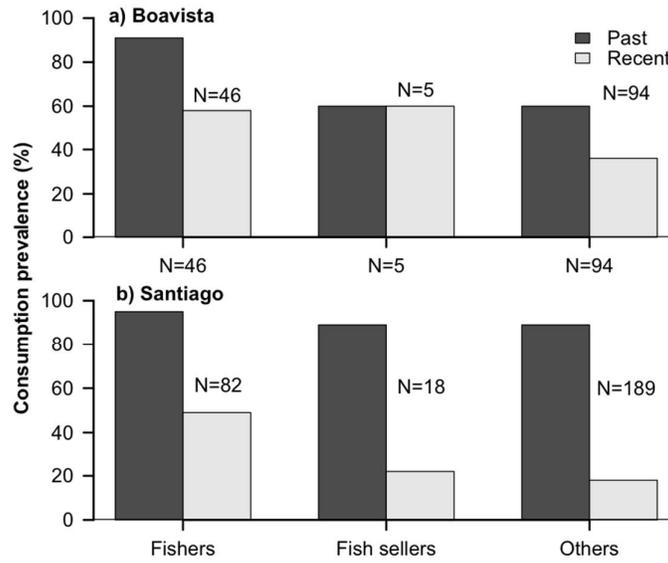


Figure 6. Past and recent sea turtle use by fishers from the islands of Santiago (a) and Boavista (b), showing a shift from consumptive use to commercial use in the island of Boavista.

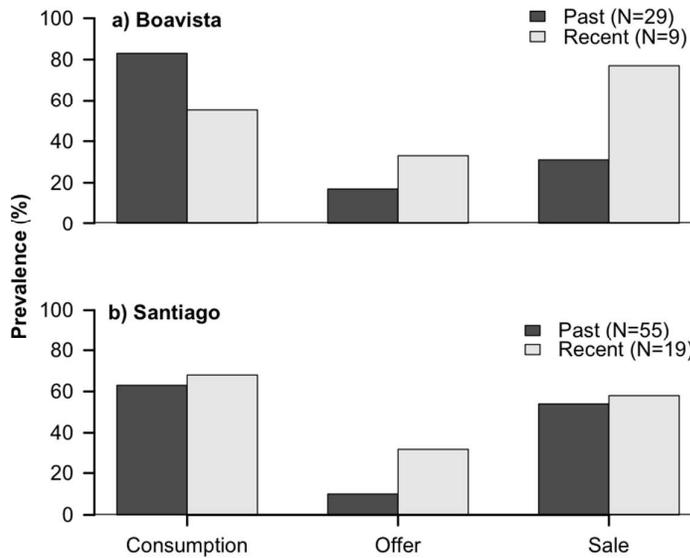
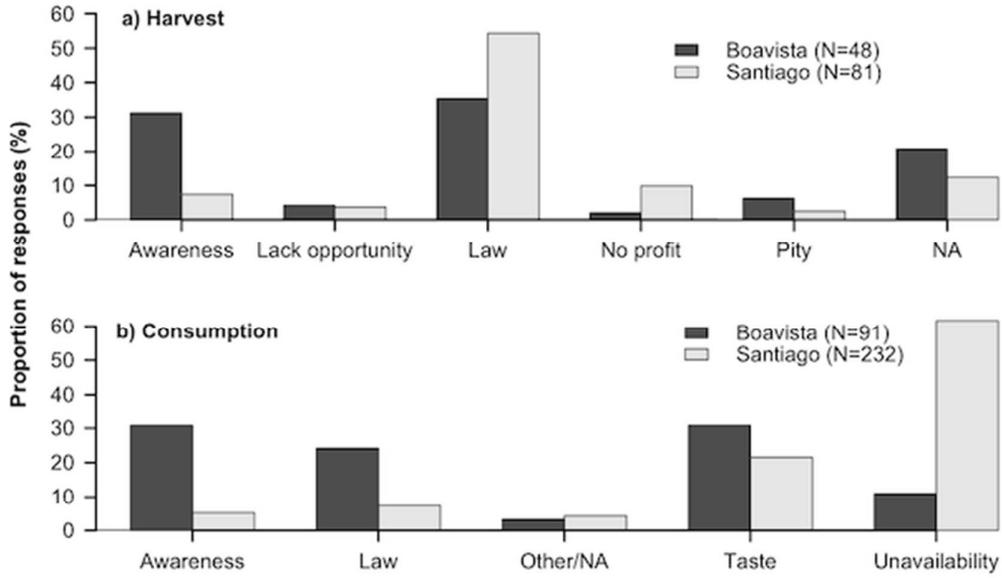


Figure 7. The perceived main deterrents against (a) harvesting or selling sea turtles or their products (fishers and fish sellers) and (b) consuming sea turtle products (population in general) on each surveyed island. (*Question allowed for multiple answers*).



## SUPPLEMENTARY INFORMATION

### List of Tables

Table S1. Drivers and assumptions underlying wildlife trade interventions (TRAFFIC, 2008) and indicators used in this study to assess their success.

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

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).

Demographics	Boavista		Santiago	
	n	%	n	%
<b>Gender</b>				
Male	113	76,9	214	73,8
Female	34	23,1	76	26,2
<b>Age</b>				
15 - 25	36	24,5	44	15,2
26 - 35	51	34,7	121	41,7
36 - 45	33	22,4	50	17,2
46 - 55	18	12,2	48	16,6
55 - 65	7	4,8	19	6,6
65 +	2	1,4	6	2,1
<b>Origin</b>				
Boavista	49	33,3	0	0
Santiago	66	44,9	218	75,2
Other Island	24	16,3	69	23,8
Other Country	8	5,4	0	0
<b>Total (n)</b>	<b>147</b>		<b>291</b>	

Table S3. Value comparison of different sea turtle products reported during interviews (*Chi-squared test of significance*).

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

<sup>1</sup> Values rounded to the nearest 1000 CVE 1€ = 110 CVE

<sup>2</sup> Values rounded to the nearest 100 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.

Importance of Sea Turtles								
	Boavista (%)				Santiago (%)			
	<i>n</i>	Yes	No	No opinion	<i>n</i>	Yes	No	No opinion
a) Sea turtles play an important role in nature	143	97,2	2,8	na	103	92,2	4,9	2,9
b) Sea turtles are important in the culture of this island	142	93,7	6,3	na	102	80,4	12,7	6,9
c) It is important for you that sea turtles do not go extinct	142	99,3	0,7	na	103	89,3	7,8	2,9

Use of Sea Turtles as Economic Resource								
	Boavista (%)				Santiago (%)			
	<i>n</i>	Yes	No	No opinion	<i>n</i>	Yes	No	No opinion
a) Sea turtles are a good tourist attraction	144	75,0	25,0	na	284	57,4	39,4	3,2
b) The consumption of sea turtle meat should be allowed	137	13,9	86,1	na	207	10,6	88,4	1,0
c) If population is not declining, or stable, sustainable harvesting should be permitted	140	12,9	87,1	na	280	11,1	87,9	1,1
d) Low income residents should be allowed to sell sea turtle products as an alternative source of income	141	7,9	92,2	na	104	19,2	78,8	1,9

Sea Turtle Protection and Conservation								
	Boavista (%)				Santiago (%)			
	<i>n</i>	Yes	No	No opinion	<i>n</i>	Yes	No	No opinion
a) Sea turtles must be protected	147	91,8	7,5	0,7	220	95,9	3,2	0,9
b) The government should be more active in sea turtle protection	139	94,2	5,8	na	280	50,0	48,9	1,1
c) The current laws are effective in protecting the turtles	114	49,1	50,9	na	102	68,6	26,5	4,9
d) People are well informed about the sea turtle protection laws	132	68,2	31,8	na	282	69,9	28,7	1,4

**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*)
- Sea turtles must be protected
  - Sea turtles should be used as tourist attractions
  - The existing laws are being properly enforced
  - Some of the money generated by turtle tourist should go back to turtle conservation
  - Sea turtles should be used not only as tourist attractions, but also as source of food
  - 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

For Peer Review

1 **Title:** Drivers of the illegal consumption and trade of sea turtle products in Cape  
2 Verde – What is the right approach?

3

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

5

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24

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26

27 **Abstract**

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

50 **Keywords:** black market, Cape Verde, coastal livelihoods, law enforcement, illegal  
51 harvest, loggerhead sea turtle, wildlife trade

52

### 53 **Introduction**

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

61 Challenges in conservation implementation are diverse and often related to the social-  
62 ecological nature of the systems in which interventions occur (Pollnac *et al.*, 2010;  
63 Nuno *et al.*, 2014). For example, conservation agreements and legislation aimed at  
64 restricting resource use (e.g. harvest quotas, protected areas, and harvest seasons) are  
65 commonly used to manage and protect natural resources but their implementation is  
66 strongly affected by resource users' compliance (Keane *et al.*, 2008). Conservation  
67 programmes often lack a robust understanding of the socio-economic context and  
68 decision-making processes affecting resource use, which is essential for assessing  
69 feasibility of potential management strategies and implementing effective  
70 interventions (Roe & Mulliken, 2002; St John *et al.*, 2013; Raymond & Knight 2013),  
71 such as through law enforcement (Rowcliffe *et al.*, 2004). In addition, this knowledge

72 should be coupled with regular scientific assessment and potential adjustments (Pullin  
73 *et al.*, 2004; Sutherland, 2004; Garnet *et al.*, 2007) in order to inform policy-makers  
74 about the effectiveness of on-going interventions and aid identifying alternatives.

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

90

91 This study aimed to explore the dynamics of the harvesting, consumption and trade of  
92 sea turtle products in Cape Verde, and potential changes due to a change in  
93 conservation efforts and legal protection of sea turtles. First, we assessed levels of  
94 harvesting and consumption of sea turtle products, and explored what socio-  
95 demographic and economic factors potentially affected their trade and consumption.

3

96 Secondly, we investigated the perceived effectiveness of two broad categories of  
97 interventions that have been commonly employed, individually or in combination, in  
98 Cape Verde to reduce sea turtle harvesting, trade and consumption: (1) establishment  
99 of regulations and law enforcement, and (2) campaigns to increase awareness (Table  
100 S1). Ultimately, we aimed to inform ongoing discussions about sea turtle protection in  
101 the study area and suggest the need for a better understanding of contextual factors for  
102 the design of effective conservation rules.

103

#### 104 **Study site**

105 Cape Verde is a small insular country located in the Atlantic Ocean about 500 km  
106 from the west coast of Africa with a population of ca. 491,000 inhabitants and a mean  
107 GDP of 1,865 US dollars per capita in 2011 (World Bank, 2011). The country is  
108 characterised by a young human population, distributed unequally among the nine  
109 inhabited islands, with approximately half of the population inhabiting the main  
110 island, Santiago; over the last two decades, the country's population has increased by  
111 82%, particularly in urban centres, such as Praia. In the island of Boavista, the main  
112 tourism destination, the population has tripled over the last decade (INE, 2010).

113

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

119

**120 Methods**

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

138

139 The surveys included both open and closed questions about (a) socio-economic and  
140 demographic characteristics; (b) present and past participation in sea turtle harvesting,  
141 sale or/and consumption, and their potential drivers; and (c) perceptions and  
142 awareness of sea turtle conservation. Questions allowed assessment of respondents'  
143 perceptions of how harvesting, sale and consumption had evolved since sea turtles

5

144 received legal protection in 2002. The survey also involved mapping trade dynamics,  
145 such as identification of main trade chain parameters, particularly sources and sinks of  
146 sea turtle meat, selling locations, species traded and product prices. A shorter version  
147 of the survey, including only subsections related to consumption patterns and  
148 perceptions, was used for the general public (questionnaires presented in  
149 Supplemental Methods).

150

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

154

## 155 **Results**

156

### 157 **Sea turtle harvesting and trade at Cape Verde**

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

6

168 (only one of the interviewed fish sellers ever engaged in sale of sea turtle products,  
169 but remained active) and decreased from 78% to 22% in Santiago.

170

171 Despite this apparent decrease in the number of active harvesters and sellers, annual  
172 capture rates, as reported by 19 of the active harvesters, varied from *low* (1 to 3 turtles  
173 *per annum*) by 11 fishers (48%), *medium* (3-10 turtles *per annum*) by 7 of the fishers  
174 (30%) and *high* (10 turtles or more) by only one fisherman (4%), the remaining not  
175 providing an answer. Based on the above ranges of figures, this represents a  
176 conservative, overall estimation of 50-114 turtles harvested by the 19 interviewed  
177 fishers alone (20-52 by fishers from Boa Vista; 30-62 by fishers from Santiago) per  
178 year.

179

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

188

189 The information gathered from the interviews suggests that the typical trade chain  
190 was different between islands. In Santiago, the majority of the fishers active in sea  
191 turtle harvesting chose to have fish sellers as intermediaries between them and the

7

192 end-consumers (n = 18), thus creating a trade, although some stated that they had a  
193 well-established list of regular end-clients (n = 5). In Boavista, only one of the five  
194 known fish sellers was still actively involved in the sale of turtle meat (Fig. 3; more  
195 details about the trade in Figure S1).

196

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

203

#### 204 **Consumption of sea turtles**

205 Based on all interviews (including the general public), consumption prevalence was  
206 found to be significantly different between islands ( $\chi^2 = 69.86$ ,  $df = 5$ ,  $P < 0.001$ ), with  
207 a higher proportion of the population in Boavista consuming turtle than that in  
208 Santiago. The consumption of sea turtle products had, however, apparently decreased  
209 over time, being this more noticeable on the island of Santiago, where a reduction of  
210 62% was estimated, versus just 28% on Boavista (Fig. 5). Consumption was found to  
211 be unrelated to age, income or occupation ( $P > 0.05$ ), but those with lower educational  
212 levels were more likely to consume turtle products ( $\chi^2 = 10.74$ ,  $df = 4$ ,  $P = 0.03$ ).

213

#### 214 **Self-reported drivers of trade and consumption**

215

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

220

221 Traditionally, in neither island was turtle harvesting considered a primary source of  
222 income ( $P > 0.05$ ), but the supplementary income originated from the sale of turtles  
223 was considered more important on Santiago than Boavista ( $\chi^2 = 12.98$ ,  $df = 4$ ,  $P =$   
224  $0.01$ ), where the average monthly income was found to be considerably lower ( $\chi^2 =$   
225  $10.63$ ,  $df = 4$ ,  $P = 0.003$ ). Turtles were, and have been in general, harvested mostly  
226 opportunistically (85% of the all fishers surveyed, regardless of the islands ( $P > 0.05$ ),  
227 generally to meet extra expenses related to the use of boat fuel or food when fish  
228 supplies or associated income were low (especially on the island of Santiago). Fishers  
229 and fish sellers who have never been, or ceased to be, engaged in sea turtle harvesting  
230 and sale indicated that the existence of legislation is the main deterrent (Fig. 7).

231

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

239

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

253

## 254 **Discussion**

255

### 256 **Illegal harvest and consumption**

257 Despite a decade of targeted interventions, our results demonstrate that, at the time of  
258 the study, illegal direct take of sea turtles persisted on beaches on the islands where  
259 nesting occurs, as well as in the waters surrounding both islands. This confirms  
260 suggestions from anecdotal evidence and previous studies in the area (Marco *et al.*  
261 2012, Cozens *et al.*, 2012). Nevertheless, this study suggests that there had been a  
262 clear reduction in both the level of sea turtle harvest and consumption since the  
263 implementation of the protective law in 2002, although the magnitude of this

264 reduction must be regarded with care, as respondents may have been more inclined  
265 towards reporting a positive change due to the illegal nature of this behaviour. Our  
266 study also points to Santiago Island as the main sink of sea turtle meat derived from  
267 sea turtles caught on Boavista Island; this was evidenced by the shift from subsistence  
268 to commercial harvesting on Boavista, possibly driven by the increasing demand for  
269 sea turtle meat in the growing urban area of Sal Rei (Boavista), and the city of Praia  
270 (Santiago), as suggested by some respondents, and a pattern also suggested in  
271 previous studies (Araújo, 2008; Merino *et al.*, 2008).

272

273 The biological impact of this trade was, until now, underestimated, as mortality data  
274 have been limited to reproductive females harvested on the main nesting beaches; the  
275 most recent estimates indicate a poaching rate of 5% of the 8900 reproductive females  
276 estimated to have nested on Boavista beaches in 2009 alone (Marco *et al.*, 2012). Our  
277 study recognizes the impact of the captures on the nesting beaches of Boavista, but  
278 suggests that added pressure from opportunistic captures at sea needs to be  
279 considered. The potential impact on population demography is difficult to ascertain,  
280 as an unknown numbers of males and juveniles are targeted at sea. The estimated  
281 magnitude of take obtained in this study should be regarded as conservative as some  
282 respondents could be reluctant in sharing information about illegal activities, and the  
283 snowball sampling technique used may have allowed to identify only a small and  
284 possibly non-representative number of harvesters and sellers. The illegal harvesting  
285 and trade, in conjunction with the impact of incidental captures at sea (see Melo &  
286 Melo, 2013; Martins *et al.*, 2008), demands further quantitative investigation. Barriers  
287 to this include the lack of adequate law enforcement and surveillance at sea and on

288 land, making trade relatively easy and generally unnoticed, thus difficult to assess.  
289 Knowledge of the specifics of wildlife trade dynamics, such as transport mechanisms  
290 and routes within and among islands, is essential to develop practical, policy-relevant  
291 measures (TRAFFIC, 2008). The use of other types of data and specialized  
292 questioning techniques could be used to further explore these dynamics (Nuno *et al.*,  
293 2013). Nevertheless, this study contributed to identifying key factors and potential  
294 processes that should now be further explored, for example, by focusing on  
295 understanding causation between outcomes and potential predictor variables.

296

### 297 **Exploratory assessment of conservation interventions**

298 Broadly, the actions taken by the Cape Verde government and NGOs to discourage  
299 sea turtle harvest and consumption have focused on two lines of action: (1) providing  
300 a legal framework for sea turtle protection in parallel to enforcing deterrents at the  
301 nesting beaches; and (2) raising awareness campaigns to motivate consumers to  
302 change their behaviours towards the consumption of sea turtle products (Araújo,  
303 2008). Many of these interventions are believed to have been at least partially  
304 successful (this study), but our results also draw attention to several limitations or  
305 gaps in some of the intervention areas, and provide an opportunity to develop new  
306 opportunities and strategies and inform current discussions about potential changes in  
307 national sea turtle protection regulations.

308

309 *Laws and Regulations* The current study shows that legal and regulatory measures  
310 exert an important influence on people's participation in sea turtle harvesting and  
311 trade; therefore, the development of the laws and regulations on Cape Verde seem to

312 be an effective mechanism for reducing illegal trade. However, the effectiveness of  
313 the enforcement of deterrents appears to be undermined by gaps and weaknesses in  
314 specific parts of the enforcement process, as experienced elsewhere around the world  
315 (e.g. Brautigam & Eckert, 2006; Keane *et al.*, 2008; TRAFFIC, 2008). This is  
316 evidenced by the recently reported increase in sea turtle harvesting on protected  
317 beaches after military presence was withdrawn in 2014 due to conflicts with the local  
318 communities in Boavista in the previous two years (Fonseca, 2014), suggesting that  
319 without enforcement, people will continue harvesting sea turtles. Severe limitations  
320 on means and resources, both financial and human, the lack of information and  
321 difficulties in interpreting the law, and limitations of specialized training especially in  
322 conflict mediation may be at the root of this problem (Merino *et al.*, 2008; Araújo,  
323 2008). It is thus essential that law enforcement mechanisms/resources are improved,  
324 and that policies and controls are targeted at points in the trade chain that are likely to  
325 have the greatest impact. While some efforts were developed in Santiago to tackle this  
326 problem (Araújo, 2008), better results could be achieved by strengthening the judicial  
327 sector's understanding of the significance of illegal and unsustainable wildlife trade,  
328 and focusing on the development of multi-agency law enforcement capacity (Akella  
329 & Canon, 2004; TRAFFIC, 2008). In fact, most contribution towards law  
330 enforcement and beach protection in the study area has been provided by non-  
331 governmental organizations (to date, all led by foreigners), including community-  
332 based organizations; however, while this non-governmental investment is generally  
333 viewed as positive, there is a need to recognize the essential, fundamental role of  
334 government and, thus, the need for governments to engage politically, logistically and  
335 financially for sustaining initiatives at the long-term (Bräutigam & Eckert, 2006).

336

337 *Awareness* To evaluate the impact of awareness campaigns, the key questions  
338 are whether such messaging reaches its target audiences, whether it affects their  
339 attitudes and ultimately whether it influences their consumptive behaviour. The  
340 results of this study show that the awareness efforts developed on both islands have  
341 had a relatively high level of success towards raising awareness about the illegality of  
342 sea turtle trade; however, there remained a severe lack of knowledge regarding the  
343 negative impacts of the consumption of sea turtle products; the majority of consumers  
344 did not fully understand the connection between their consumptive habits and the  
345 illegal trade of sea turtles. While sea turtle meat suppliers admitted that there had been  
346 some decrease in demand, a high percentage of the respondents, however, admitted  
347 that the level of consumption is related to the availability of turtle meat. Therefore,  
348 this study indicates a serious gap in developing awareness campaigns directed at  
349 consumers, and a lack of understanding of the links between raising awareness and  
350 changes in the attitudes and behaviour of participants in the wildlife trade. Thus,  
351 possibly the biggest challenge of all is to develop a well-targeted awareness  
352 campaign, aimed primarily at the consumers. Nevertheless, some positive results have  
353 been observed in Boavista, where improved awareness has been one of the reported  
354 drivers for the reduction of sea turtle consumption on this island. For the best results,  
355 awareness campaigns should incorporate a monitoring and evaluation component,  
356 promoting at all times science-based management (Pullin, 2004; Sutherland, 2004).

357

358 Harvesting and sale of sea turtles contribute, as on other islands (Merino *et al.*, 2008),  
359 to generating alternative income for families of fishers, especially on Santiago. A key

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

379

### 380 **Conclusion**

381 The results presented in this study can be seen as an eye-opener to the gaps in  
382 addressing the problem of illegal trade of sea turtles in Cape Verde, and also future  
383 challenges that may arise. There is clear evidence that the harvesting and consumption

15

384 of sea turtles are still taking place, and thus conservation interventions still need  
385 refinement and reassessment.

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

392

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407

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536

537

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