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1 **The cone snails of Cape Verde: marine endemism at a terrestrial scale**

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10 **Abstract**

11 Cape Verde in the Eastern Atlantic is typical of many island groups in supporting a wealth of endemic  
12 species both terrestrial and marine. Marine gastropod molluscs of the genus *Conus*, commonly  
13 known as cone snails, occur in coastal tropical waters throughout the globe, but in Cape Verde their  
14 endemism reaches its apogee with 53 out of 56 species occurring nowhere else, the majority of  
15 which are restricted to single islands and frequently to single bays. However, Cape Verde is rapidly  
16 moving to a tourism-based economy with a projected boom in infrastructure development often  
17 coincidental with the shallow-water habitat of many range-restricted *Conus*. The conservation  
18 assessment of *Conus* to standards of the International Union for the Conservation of Nature (IUCN)  
19 Red List of Endangered Species, found that 45.3% of 53 species assessed from Cape Verde are  
20 threatened or near-threatened with extinction compared to 7.4% of 579 species in the rest of the  
21 world. The only three *Conus* species globally assessed as Critically Endangered and on the cusp of  
22 extinction are all endemic to Cape Verde. Our analysis of *Conus* species distribution, together with  
23 spatial data of coastal protected areas and tourism development zones, identify important areas for  
24 future research and new marine protection. Our findings show that endemism with its associated  
25 risks for *Conus* in Cape Verde has worldwide parallels with many non-marine taxa, while our  
26 proposed strategy for *Conus* conservation extends beyond the confines of the country and this  
27 taxonomic group.

28 **Keywords:** *Conus*; conservation; Red List; mollusc; threat, tourism

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30

## 31 1. Introduction

32 Small islands and archipelagos, isolated by distance and ocean currents, support centres of  
33 endemism in both terrestrial and marine taxa (Roberts et al., 2002). However, these endemism  
34 'hotspots' are often subject to threats from natural and anthropogenic forces that can have a  
35 disproportionate impact on the biodiversity they support (Fordham & Brook, 2010). Cape Verde in  
36 the tropical Eastern Atlantic is such a 'hotspot' and although it is poorly represented by mammals, it  
37 is rich in endemic invertebrates including 473 species of arthropod and 140 species of beetle  
38 (Triantis et al., 2010), and widely recognised for its endemic plants (Duarte et al., 2008; Romeiras et  
39 al., 2016) and reptiles (Vasconcelos et al., 2013). In the surrounding seas endemic zoanths occur  
40 (Reimer et al., 2010), and it is also here that marine endemism reaches its apogee in the venomous  
41 marine gastropod genus *Conus* (Peters et al., 2013).

42 Cape Verde is an archipelago of ten volcanic islands and several islets (Fig. 1) 570 km west of Senegal  
43 and is the most southerly of the Macaronesian islands. There is also a shallow seamount known as  
44 the João Valente Shoals between the islands of Boa Vista and Maio, with a platform at 14 m that is  
45 probably a guyot (Ramalho, 2011). The Canary Current flowing south-west from Morocco brings  
46 nutrient-rich waters to the region attracting both artisanal and international fishing fleets (Mundt,  
47 2012). With the exception of Santa Luzia, all the islands are inhabited. Service industries account for  
48 73% of the country's economy, with agriculture and fisheries together constituting only 9%  
49 (Nshimyumuremyi & Simpasa, 2015). Cape Verde has few natural resources apart from marine  
50 products and services and the land is generally unsuited to agriculture, such that around 80% of food  
51 is imported (de Carvalho, 2013).

52 Tourism is now considered Cape Verde's primary economic force and including directly associated  
53 sectors, is responsible for 40% of gross domestic product (2014), forecast to increase to 49% by  
54 2025 with visitor numbers expected to reach nearly 701 000 by 2025 (World Travel & Tourism  
55 Council, 2015). In addition to attracting foreign investment tourism also drives the construction  
56 sector (AfDB et al. 2013) including new harbour facilities at Porto Grande, São Vicente, and  
57 international airports on Boa Vista and São Vicente to augment those already on Sal and Santiago.  
58 Plans have also been agreed for the development of a large international casino on the islet of Santa  
59 Maria off the southern coast of Praia, Santiago (Semedo & Gomes, 2015).

60 To support and develop tourism while protecting the natural environment, Integrated Tourism  
61 Development Zones (ZDTI) have been delineated (Cabo Verde, 1994) and selected for geographical  
62 location and landscape suitability (Fig. 2). Tourism Reserve and Protection Zones serving as buffers  
63 to ZDTIs offer some natural protection from development, although incursion from ZDTIs into these  
64 zones has made their value questionable (GEF/UNDP, 2013). Prior to development for each ZDTI a  
65 management plan is required which must then undergo a full environmental impact assessment. No  
66 form of extraction is allowed within a ZDTI (Decree-Law 29/2006). ZDTIs are managed by Cabo Verde  
67 Investimentos (CVI) and the Sociedade de Desenvolvimento Turístico das Ilhas de Boa Vista e Maio  
68 (SDTIBM) on behalf of the government. Currently, there are 25 ZDTIs designated principally around  
69 Santiago, Maio, Boa Vista, Sal and São Vicente, in which large-scale investment in infrastructure is  
70 anticipated (Fig. 2) (SDTIBM, 2010).

71 In 2003, Decree-Law No. 3/2003 (44/2006 amended) nominated 47 protected areas (PA) for Cape  
72 Verde (Tables S1 & S2); however, not all have been gazetted and most are not staffed owing to a  
73 complexity of land ownership and lack of funding (Laurie & Benchimol, 2013). All have suffered  
74 from a general lack of management capability (Laurie & Benchimol, 2013; UNDP, 2009). A large-  
75 scale initiative to consolidate all PAs under a single structural plan was launched in 2009 through a  
76 joint enterprise between the United Nations Development Programme (UNDP), the Global  
77 Environment Facility (GEF), and the Government of Cape Verde (UNDP, 2009). The project's long-

78 term goal was “to conserve globally significant terrestrial and marine biodiversity in priority  
79 ecosystems of Cape Verde through a protected area system’s approach”. Central to the approach  
80 was to be the establishment of a Protected Area Autonomous Authority (PAAA). The project was  
81 scheduled for completion by December 2014, however, the latest report indicates that lack of  
82 financing for the PAAA together with failure of enforcement of environmental legislation threatens  
83 its sustainability (Laurie & Benchimol, 2013).

84 Currently, 27 PAs have been scheduled that encompass coastal elements of which one, Baía da  
85 Murdeira, is exclusively marine (Fig. 2, Table S1). Protection of the shoreline, although typically  
86 planned as a constraint on development in order to preserve the landscape, should coincidentally  
87 reduce disturbance to taxa that dwell in the shallows. Unfortunately however, the PA network was  
88 not created in a scientifically structured way with many areas selected on the basis of features such  
89 as their landscape merit, bird nesting sites or recreational appeal without consideration to an overall  
90 conservation objective (Vasconcelos et al., 2012). Additionally, they are subject to little in the way of  
91 planned wildlife inventories or biodiversity monitoring programmes (Vasconcelos et al., 2012).

92 The Second National Environmental Action Plan, PANA II, (2004), a governmental umbrella  
93 programme for environmental management for the years 2004-2014 currently has no successor  
94 publication. However, echoing concerns expressed through PANA II, the UNDP on Protected Areas  
95 (PAs) in Cape Verde identified key threats to the marine environment quoting: increasing pollution  
96 from the dumping of waste, effluent and oil; a lack of waste collection; no effective regulation to  
97 compel boats to segregate oil from other effluents; increasing discharge of urban wastewater into  
98 the seas; and lack of pollution contingency planning (UNDP, 2009). Development in the interior of  
99 the islands has led to deposition of sediment in coastal areas and widespread excavation of marine  
100 sand for construction (de Carvalho & Araújo, 2006; Höflinger, 2014; UNDP, 2009). From further  
101 afield, oil spills from offshore drilling in Mauritania could be transported by the Canary Current and  
102 carried ashore in Cape Verde, as proven by Mauritanian fish traps finding their way onto Cape Verde  
103 beaches (FAO/UNEP, 2007).

104 Cone snails of the genus *Conus* occur within tropical and subtropical coastal waters throughout the  
105 world where they have evolved into more than 630 species (Kohn, 1990). Cone snails are  
106 carnivorous gastropods that with few exceptions feed exclusively on either fish, molluscs or worms  
107 (Duda et al., 2001). They in turn are preyed upon by other carnivorous taxa most notably crabs  
108 (Dietl & Hendricks, 2006) and are therefore important components in the marine food web. To  
109 immobilize their prey, all cone snails utilise venom known as ‘conotoxins’ that comprise a complex  
110 cocktail of peptides delivered via radulae that have been adapted through evolution into harpoons  
111 (Olivera, 1997). Biomedical research of conotoxins (Bingham et al., 2010) has gained traction during  
112 the past 25 years, but today less than two per cent of toxins has so far been characterised (Kaas et  
113 al., 2010). Nevertheless, with each species of cone snail developing up to 100 discrete toxins  
114 targeted at a broad range of highly-specific cellular receptor sites, and with little replication between  
115 species, a considerable reservoir of potential pharmacological agents remains to be explored for use  
116 in a wide range of medical therapies (Terlau & Olivera, 2004). Furthermore, outside their ecological  
117 and pharmacological utility, cone snails help support a global industry in the trade for specimen  
118 shells and shellcraft (Dance, 1966; Floren, 2003; Rice, 2007).

119 An analysis of the findings by Peters et al. (2013) from their global assessment of 632 species of  
120 *Conus* for the International Union for Conservation of Nature (IUCN) Red List of Threatened Species  
121 revealed that those endemic to the Eastern Atlantic and to Cape Verde in particular represent a  
122 disproportionate number of globally threatened species (Fig. S1) (IUCN, 2013; Peters et al., 2013;  
123 Tenorio, 2012). Fifty-three of the 56 *Conus* assessed for the Red List for Cape Verde are endemic  
124 (Monteiro et al, 2004; Peters et al., 2013). This includes 24 species, representing over one-third

125 (36%) of the 67 *Conus* species assessed as 'threatened' or 'near threatened' globally, and 45% of the  
126 53 Cape Verde endemic species, compared to 18% of 231 remaining endemic species across the rest  
127 of the world. Such a high concentration of endemic marine species of the same genus is exceptional  
128 and may be unsurpassed (Duda & Rolán 2005). Across Macaronesia, other areas are largely devoid  
129 of *Conus* (Monteiro et al., 2004).

130 Unlike many cone snails, all endemic Cape Verde *Conus* larvae are lecithotrophic, and obtain  
131 nourishment through an egg sac during their pre-metamorphic dispersal phase (Kohn & Perron,  
132 1994; Perron, 1981). This has resulted in low larval production with limited dispersal ability but  
133 accelerated speciation and probably accounts for an unusual diversity of species with the majority  
134 restricted to single islands or even single bays (Cunha et al., 2005). Main cladogenetic events of  
135 *Conus* in the archipelago are associated with episodes of low sea level that caused an increase in  
136 available shallow-water habitat. The increase in the habitat area combined with the reduced  
137 dispersal abilities of *Conus* larvae and the irregular shape of the Cape Verde coastline, created  
138 conditions for genetic differentiation to occur (Cunha et al. 2005; Cunha et al. 2008). A recent study  
139 also showed that sea surface temperature is an equally important predictor of *Conus* diversity in  
140 Cape Verde, as demonstrated by ecological models (Cunha et al., 2014). This high degree of  
141 endemism among Cape Verde *Conus* with a hereditary loss of functionality to freely disperse, low  
142 larval production, sensitivity to sea-surface temperatures and highly restricted range, has set the  
143 scene for an elevated threat of extinction.

144 With the exception of *C. atlanticoselvagem*, all Cape Verde endemic *Conus* occur within snorkel  
145 depth and only seven descend deeper than 5 m, with none below 15 m (Peters et al., 2013).  
146 Although small in size, they generally display an attractive pattern and may easily be gathered by  
147 tourists or by international shell traders for direct sale (e.g. [www.caboverdeshells.com](http://www.caboverdeshells.com),  
148 [www.shellauction.net](http://www.shellauction.net)) where only live animals offer the quality of shell demanded by serious  
149 collectors.

150 To understand why an exceptionally high ratio of threatened cone snail species occurs on Cape  
151 Verde compared to other regions with high species richness of *Conus* (Peters et al., 2013; Peters et  
152 al., 2015) we analysed the threats to all Cape Verde's 53 endemic species. Building on threat data,  
153 species' distribution and bathymetry, we explored the proximity of threatened species across their  
154 combined occupancy against areas zoned for tourism development and sites designated for marine  
155 and coastal protection, to consider effectiveness of current conservation planning. We identified  
156 areas of high value to *Conus* that we consider a priority for future research and conservation, also  
157 highlighting where threats to the marine environment generally may be greatest. These areas are  
158 likely to require environmental impact assessments in future planning of shoreline development.  
159 More broadly our study offers guidance not only for the protection of endemic *Conus* of Cape Verde  
160 but helps to inform future strategy on marine management that can be applied equally to other  
161 regions of high endemism worldwide, whether marine or terrestrial.

162

## 163 **2. Methods**

### 164 2.1. IUCN Red List assessment

165 We analysed extinction threats to the 53 *Conus* species endemic to Cape Verde within a global Red  
166 List assessment, prepared to IUCN standards (IUCN Standards and Petitions Subcommittee 2010) as  
167 described in Peters et al. (2013). A recent revision of *Conus* systematics resulting in reclassification  
168 to 82 genera (Tucker & Tenorio, 2009; Bouchet et al., 2011) is gaining broad acceptance (Petuch  
169 pers. comm. 2014). However, with the new taxonomy not yet universally adopted (Kohn 2014), and

170 to facilitate cross-referencing, all species in our study are referred to by their original Linnaean  
171 genus, *Conus*, as presented in the Red List. Furthermore, 19 recently described species endemic to  
172 Cape Verde from sites in Boa Vista, Maio and Sal (Afonso & Tenorio, 2014; Cossignani & Fiadeiro,  
173 2014; Cossignani, 2014; Tenorio et al., 2014) have been excluded from this analysis as they have not  
174 yet been assessed for the Red List and their range is unknown except for the type locality which  
175 provides no measurable distribution.

176 Three Red List ‘threatened’ categories define the highest levels of threat to a species, namely:  
177 Critically Endangered (CR), Endangered (EN) and Vulnerable (VU), broadly representing ‘extremely  
178 high’, ‘very high’, and ‘high’ risk of extinction. Species assessed for likely elevation to a ‘threatened’  
179 category are categorized as Near Threatened (NT); those with insufficient data for categorization are  
180 classed as Data Deficient (DD) and species not considered to be at current or imminent threat are  
181 categorized as Least Concern (LC). Note that although Data Deficient species are not classified as  
182 threatened, research suggests that a high proportion of species assessed for this category are also at  
183 risk (Howard & Bickford, 2014; Morais et al., 2013). Of 632 *Conus* species assessed world-wide, all 3  
184 CR, 4 of 11 EN, and 5 of 27 VU are endemic to Cape Verde. A further 12 species within Cape Verde  
185 from the global total of 26 are categorised as NT, and there is a single DD species from the global  
186 total of 87 (Peters et al., 2013).

187 For our analysis, we extracted data held on the IUCN Red List for each species including associated  
188 spatial data. We examined each species’ distribution and bathymetric profile with evidence of  
189 abundance, sub-populations and habitat preference. For enhanced accuracy in mapping species  
190 richness, we used species distribution trimmed to only include the area within each species’  
191 reported bathymetric range using data from General Bathymetric Chart of the Ocean (GEBCO, 2013).  
192 ArcGIS version 10.1 with Python version 2.7 (Environmental Systems Research Institute) were used  
193 to analyse the data. All data were standardised onto 1 km<sup>2</sup> grid cells and projected to Lambert  
194 Conformal Conic. With the exception of two species (*C. atlanticoselvagem* and *C. luquei*), all endemic  
195 *Conus* in Cape Verde are found in the shallow littoral zone in waters up to two metres or less. At  
196 these depths precision is found wanting in most published bathymetric chart data, giving rise to  
197 small mapping discrepancies in the areas of occurrence of taxa living there. Consequently a few  
198 species appear to lie further offshore than would be expected. Nevertheless, their locations still  
199 remain relevant to their proximity to neighbouring regions zoned for development, as well as those  
200 subject to protection.

## 201 2.2 Tourism in Cape Verde

202 Islands earmarked for major development include Boa Vista, Maio, Sal, São Vicente and Santiago.  
203 The scope of the development for Boa Vista and Maio are described in reports by SDTIBM (SDTIBM,  
204 2013a, 2013b). The most detailed descriptions for Sal and São Vicente ZDTIs descriptions have been  
205 published by the Millennium Challenge Account – Cabo Verde II (Millennium Challenge Account,  
206 2012a, 2012b). ZDTIs have also been described for Santiago in Cape Verde government bulletin No.  
207 20 of 23 May 1994.

208 To explore trends in tourism, we analysed statistical data using descriptive statistics published by  
209 Cape Verde National Institute of Statistics (INE, 2015) on annual visitor numbers for each island,  
210 including hotel occupancy for the ten years from 2005 to 2014 inclusive (INE, 2015).

## 211 2.3. Protected Areas

212 By reference to PANA II, (2004) together with UNDP project 4176 (Laurie & Benchimol, 2013; UNDP,  
213 2009) and local development plans, and through exploring the effectiveness of current marine  
214 protection strategies, we considered the location of all scheduled marine and coastal protected

215 areas in relation to *Conus* species' distribution. The exposure of *Conus* to possible disturbance from  
216 ZDTI development on the islands of Boa Vista, Maio, Sal, São Vicente and Santiago were analysed  
217 through a review of existing ZDTI plans and their spatial proximity.

#### 218 2.4. Proposed priority areas for research and conservation

219 We adopted four progressively expanding 'scenarios' to provide a context from which the most  
220 appropriate priority marine areas for future *Conus* research and conservation could be selected.  
221 Each 'scenario' or Proposed Priority Areas for Conservation (PPAC) used the consolidated ranges of  
222 all species categorized as: (1) CR; (2) CR and EN; (3) CR, EN and VU; and (4) CR, EN, VU and NT. These  
223 PPACs were selected to ensure priority for biogeographical areas containing the most highly  
224 threatened species. Incidental species' representation was also considered to identify the added  
225 value of each PPAC. We considered the use of a fifth scenario including the distribution of the single  
226 DD species, however this was found to be unnecessary as the range of this species was fully  
227 represented in scenario 3. We believe this approach is effective in identifying areas with the widest  
228 range of threatened *Conus* that may be managed economically.

229

### 230 3. Results

#### 231 3.1. *Conus* species richness and distribution

232 Table 1 describes the 53 species of *Conus* assessed, of which 81% (43) are restricted to a single island  
233 and mostly within a small area (including *C. atlanticoselvagem* from the João Valente Shoals  
234 between Boa Vista and Maio). Distribution is weighted towards the east with the Leeward group in  
235 the south having disproportionately fewer species than the Windward group in the north (Figs. 2 and  
236 3). Species richness is greatest on the islands of Sal, Boa Vista and Maio which together account for  
237 41 species (Fig. 3). Together with the distribution of endemic *Conus* species richness, Figure 2 also  
238 describes PAs with a marine element, and ZDTIs.

#### 239 3.2. Tourism

240 Statistics from hoteliers for the decade from 2005 to 2014 show registered establishments increased  
241 by 73%, hotel arrivals by 131%, and total number of nights spent by 265% (Figs. S2 and S3). Visitors  
242 are concentrated on Sal and Boa Vista which together account for nearly 90% of total nights spent in  
243 Cape Verde (Fig S3).

#### 244 3.3. *Conus* Status by island

245 Table 1 summarises the assessment category of all endemic species by island (Fig. 1) with the  
246 rationale to support this and an outline of the development status of each island. Threatened (CR,  
247 EN, VU), Near Threatened (NT) and Data Deficient (DD) species are described in greater detail below:

##### 248 3.3.1. Santo Antão

249 Santo Antão hosts a single species of *Conus*, namely *C. fernandesii* (EN), a recently described and  
250 scarce species that occurs along just one kilometre of coast, off Porto Novo and close to the small  
251 but busy ferry port, where it is at risk from accidental discharge of oil and other pollutants.

##### 252 3.3.2. São Vicente and Santa Luzia

253 Eight species of *Conus* are endemic to these two islands, five of which occur on both. *C. curralensis*  
254 (NT) is restricted to Santa Luzia with *C. denizi* (NT) and *C. lugubris* (CR) restricted to São Vicente.



255 With the exception of *C. lugubris* all São Vicente *Conus* occur off the island's east coast. *C. lugubris*,  
256 however, is limited to the north shore of the island with its centre of population in the Baía de  
257 Salamansa. Most of the shallow water, rocky habitats occupied by this species have been disturbed,  
258 and most, if not all of their populations are thought to have been extirpated. No specimens of *C.*  
259 *lugubris* have been collected since the 1980s. *C. decorates* (VU), occurs along the southeast coast of  
260 São Vicente where it is subject to disturbance from beach tourism, fishers and shell collectors. It is  
261 also found along three kilometres in the southwest of Santa Luzia where populations are considered  
262 scarce. A further population at Salamansa in the north of São Vicente has been lost. *C. bellulus* (DD)  
263 has not been recorded for several years and has probably always been scarce. There are two other  
264 NT species, namely *C. navarroi* and *C. saragasae*. As with *C. curralensis* and *C. denizi* both occupy  
265 highly restricted ranges in shallow water where they are at risk from pollution, over-gathering and  
266 habitat loss, although not yet at a level where they are at immediate risk.

### 267 3.3.3. São Nicolau

268 The island only hosts *C. kersteni*, which is restricted to the southwest. This species has been  
269 assessed as NT on a precautionary basis owing to its highly restricted range.

### 270 3.3.4. Sal

271 Twelve species of *Conus* are endemic to Sal. These include one CR, *C. mordeirae*; two EN, *C.*  
272 *ateralbus* and *C. cuneolus*; and three VU, *C. felitae*, *C. fontonae* and *C. regonae*. All six threatened  
273 species occur within snorkel reach at depths from approximately one to five metres along the  
274 western coast of the island, and except *C. fontonae* and *C. regonae* are principally located along Baía  
275 da Murdeira. The ranges of *C. ateralbus* and *C. cuneolus* also extend two kilometres to the south into  
276 Baía do Algodoeiro, while *C. cuneolus* also occurs along the southern bay of Santa Maria. North of  
277 Baía da Murdeira, *C. fontonae* occurs in Baía da Fontona to the south of the port of Palmeira, and *C.*  
278 *regonae* has its habitat extending to the north and south of the port. Both of these range-restricted  
279 shallow water species are threatened because of risk to their habitat from marine pollution, in  
280 particular the accidental discharge of oil from boat traffic including tankers and other commercial  
281 vessels using the port of Palmeira.

282 *C. mordeirae*, with its population restricted to the bay that bears its name, has been observed to be  
283 in decline, with the highest density of taxa occurring adjacent to resort developments. Similarly, *C.*  
284 *felitae* occurs solely in the north of the bay where plans have been mooted to extend development.  
285 Under such eventuality and in the absence of special conservation measures, this species may  
286 require re-categorisation from VU to CR.

### 287 3.3.5. Boa Vista

288 Boa Vista has the greatest diversity of *Conus* with 21 species of which 15 are endemic to the island.  
289 All three threatened species occur off the west coast of which *C. salreiensis* (CR) is only found in the  
290 northwest of Boa Vista in the bay at Sal Rei and its adjacent islet. Harbour construction in the early  
291 1990s impacted abundance and this species is now mainly found off the islet where it is at risk from  
292 pollution and human disturbance. *C. crotchii* (EN) occurs from Morro de Areia south to Santa  
293 Mónica in the centre of the new tourism zone where paved roads and resort hotels are under  
294 construction. This places it at high risk from damage to habitat during the construction phase and of  
295 continuing disturbance thereafter from holidaymakers. *C. teodora* (VU) also occurs around Sal Rei  
296 continuing north to Baía Teodora for 4.5 km. Around the southern half of its range it is subject to  
297 the same pressures as *C. salreiensis*.

298 There are seven NT species found off Boa Vista of which five are endemic to the island: *C. derrubado*  
299 restricted to just five kilometres of coast in the north; *C. diminutus* which is found along two 2  
300 kilometre sites in the west; *C. evorai* and *C. luquei* which occur off Baía das Gatas in the northeast  
301 with another population of *C. evorai* at the islet off Sal Rei; and *C. trochulus* which with *C. josephinae*  
302 occurs along the western shores of Boa Vista adjacent to part of the development zone and  
303 continuing north to Sal Rei. There is a sub-population of *C. josephinae* also on Maio. With the  
304 exception of *C. trochulus* and *C. josephinae*, all these NT species have highly restricted ranges, and  
305 although not at immediate risk as they are sufficiently remote from main centres of tourism, they  
306 may become threatened in the future. *C. atlanticoselvagem* (NT) occurs on the João Valente Shoals  
307 which are only visited by lobster fishers, and although within SCUBA depths the shoals do not at  
308 present attract divers. However, its solitary site and the potential for over-gathering or habitat  
309 degradation have placed this species as a candidate for future review.

### 310 3.3.6. Maio, Santiago, Fogo and Brava

311 There are no Threatened or Near Threatened *Conus* species on these islands except where they also  
312 occur on other islands (Table 1). However, in the light of recent tourism resort and casino  
313 development plans it may be necessary to review their assessments over the short term.

### 314 3.6. Proposed Priority Areas for Conservation (PPAC)

315 Proposed priority areas for future research (e.g. ground truthing surveys) and conservation (PPACs)  
316 occur mostly around Sal, particularly to the southwest, and in the west of Boa Vista (Fig. 4). Other  
317 smaller pockets occur around Santo Antão, São Vicente and Santa Luzia. The combined areas range  
318 from 35 km<sup>2</sup> to 311 km<sup>2</sup>, depending on which level of PPAC is adopted, representing between 4%  
319 and 33% of the entire range of *Conus* across Cape Verde (Table S3) and between approximately  
320 0.12% and 1.11% of Cape Verde's territorial waters. Subject to physical survey, between 36% and  
321 93% of species would be represented in any conservation initiative (Table S3). Under the most  
322 protective PPAC, i.e. number 4 (CR, EN, VU and NT), only four species, all of Least Concern, would be  
323 unrepresented: *C. antoniomonteiroi*, *C. furnae*, *C. melissae* and *C. verdensis*

### 324 3.7. Tourism Development Zones (ZDTIs) with proximity to Proposed Priority Areas for Conservation 325 (PPACs)

326 Table 1 describes the ZDTIs designated on each island and Figure 4 shows the position of the ZDTIs in  
327 relation to PAs and PPACs. ZDTIs in close proximity to PPACs include:

- 328 1. Boa Vista: Chave (PPACs 1-4), Morro de Areia (PPACs 2-4) and Santa Mónica (PPAC 2).
- 329 2. Sal: Morrinho Branco (PPACs 2-4) and Murdeira e Algodoeiro (PPACs 1-4).
- 330 3. São Vicente: Salamansa (PPAC 2), Sul da Baía, Ponta de Saragaça and Vale Palha Carga, and  
331 Calheta (PPACs 3-4).

332  
333 Areas requiring the most urgent research and potential protection (PPAC 1) are located around the  
334 islands of Boa Vista, Sal and São Vicente (Fig. 4 and Table S4). Currently, only Sal has PA conservation  
335 support for PPAC 1 (CR) and 2 (CR & EN) areas through the Baía da Murdeira Nature Reserve and the  
336 Costa da Fragata Nature Reserve. Only under PPAC 4 do other islands offer any existing protection to  
337 PPACs. No PPACs are located around the islands of Brava, Fogo, Santiago, Branco or Raso.

338

## 339 4. Discussion

340 Cape Verde is a centre of endemism for both terrestrial and marine organisms (Freitas, 2014;  
341 Romeiras et al., 2016; Vasconcelos et al., 2012). Twelve Cape Verde *Conus* species are classified as  
342 threatened on the Red List of which three attain the highest risk category of Critically Endangered. A  
343 further 12 species have been assessed as Near Threatened. All these species have highly restricted  
344 ranges, low population sizes and an inability to freely disperse which exposes them to an elevated  
345 risk of extinction from a range of pressures. As numbers decline, low-density populations fall subject  
346 to the 'Allee Effect' and become unable to locate a mate (Berec et al. 2007), exacerbated by  
347 inadequate genetic diversity to ensure a healthy population (Briggs, 1966).

348 There are many who consider marine taxa to be less susceptible to extinction risk than terrestrial  
349 species (Roberts & Hawkins, 1999; Webb & Mindel, 2015). However, our assessment of Cape Verde  
350 *Conus* suggests that threats to its marine endemic species may be comparable to its non-marine  
351 endemics. For example, in a Red List assessment of Cape Verde reptiles, only three were non-  
352 endemic from the 37 extant species recorded of which approximately 35% are within a threatened  
353 category (CR/EN/VU) with none listed as near threatened (NT) (Vasconcelos et al., 2013). This  
354 compares similarly to three non-endemic *Conus* from 56 species occurring in the archipelago, of  
355 which 43% are either threatened or near-threatened. Vasconcelos et al. (2013) state natural  
356 disasters as representing one of the principle threats to Cape Verde reptiles, but as with *Conus*,  
357 threats to reptiles are exacerbated by their highly restricted range further aggravated by specimen  
358 collection. A similar picture emerges elsewhere when comparing Cape Verde cone snails with other  
359 endemic non-marine taxa at risk: for example, the global threat attributed to island endemic birds  
360 (De Lima et al., 2011; Johnson & Stattersfield, 1990; Stattersfield et al., 1998) equates with the 23%  
361 of endemic *Conus* in Cape Verde threatened with extinction (CR/EN/VU).

362 To-date most tourism in Cape Verde has been concentrated on Sal and Boa Vista, but there is intent  
363 to expand to other islands, in particular low-tourism areas of Maio (SDTIBM, 2013b), São Vicente  
364 (Laurie & Benchimol, 2013), and Santiago (Nshimyumuremyi & Simpasa, 2015). It has been reported  
365 that the government would like to see one million visitors by 2020 although many believe this would  
366 be unsustainable (Baker, 2009). In common with many developing countries, Cape Verde suffers  
367 from inadequate management of its natural resources with damaging practices such as sand  
368 extraction. New harbour construction has already resulted in the decline of *C. salreiensis* leading to  
369 its Critically Endangered status. Disturbance to habitats from tourism infrastructure projects has had  
370 similar impacts on the viability of Cape Verde's two other Critically Endangered species, namely *C.*  
371 *lugubris* and *C. mordeirae*. With multi-million dollar investments also driving an emerging  
372 international resort and casino sector, exemplified by large-scale construction that will cover the  
373 islet of Santa Maria off Santiago (Semedo & Gomes, 2015), this can be expected to continue.

374 Our analysis has shown that Cape Verde endemic *Conus* with their narrow bathymetric range biased  
375 towards coastal shallows combined with a restricted geographical distribution places all species at  
376 risk especially in areas of development for tourism. Although some species are targeted by  
377 specimen shell collectors this is not yet believed to have had a major impact on the viability of most  
378 (Tenorio pers. comm. 2013). However, rare species already facing pressures from other factors may  
379 be pushed further towards extinction by irresponsible gathering for shells.

380 A recent study revealed there to be scant awareness among citizens of the islands' vulnerability to  
381 climate change and its likely impacts (de Carvalho, 2013). It is currently unknown what effect, if any,  
382 the hurricane on September 1, 2015 will have had on shallow water marine organisms. This  
383 hurricane, the most easterly ever recorded in the tropical Atlantic (NOAA, 2015) is possibly the  
384 harbinger of future extreme weather events caused by climate change. Certainly, elevated sea-  
385 surface temperatures combined with increasing acidification of the oceans create an uncertain

386 future for all marine calcifying taxa (Doney et al., 2009). This includes cone snails (Peters et al., 2015)  
387 and other molluscs whose larvae are at particular risk (Gazeau et al., 2013).

388 Recognising this lack of environmental awareness, PANA II incorporated programmes of popular  
389 education and environmental awareness including marine protection into its strategic plans.  
390 Furthermore, the use of ZDTIs to control development with enforceable environmental impact  
391 assessments and designation of 47 protected areas, further underscore the government's  
392 commitment. This is to be applauded, however, this could be put at risk through a shortage of  
393 political will and lack of funding (UNDP, 2009).

394 Biodiversity hotspots and centres of endemism such as Cape Verde benefit from integrated  
395 conservation strategies incorporating both marine and terrestrial ecosystems to the benefit of all  
396 taxa within boundaries (Roberts et al., 2002). In its current form, the protected area network in Cape  
397 Verde is primarily an ad-hoc collection of zones selected as much for their landscape appeal as for  
398 any planned ecological purpose, and generally lack management and scientific monitoring  
399 (Vasconcelos et al., 2012). Our proposed priority area approach for *Conus* will enhance Cape Verde's  
400 conservation initiative and coincidentally help conserve other shallow water taxa, in particular  
401 sessile and semi-sessile marine invertebrates and the habitats in which they occur (Dumas et al.,  
402 2013; Edgar & Barrett, 1999; Linares et al., 2011). This can be particularly effective where terrestrial  
403 and marine reserves are treated as a combined entity (Roberts et al., 2002). However, to be  
404 effective, such areas need to be fully-enforced, permanent no-take zones (Edgar et al., 2014).

405 To secure the future of Cape Verde *Conus*, further direct and enforceable action is needed before  
406 projected increases in tourism are realised. With customs control of threatened species unrealistic,  
407 we recommend an export ban on all Cape Verde *Conus* either animals or shells, with exception only  
408 through special licence for scientific research. Population assessments with ongoing monitoring of all  
409 *Conus* species should be initiated using PPACs as a guide. We have identified 311 km<sup>2</sup> of *Conus*  
410 habitat as PPACs, 11% of which, i.e. those identified under PPAC 1 (Figure 4) should be considered  
411 for immediate protection under the precautionary principle although Sal protected areas in  
412 particular already offer protection to some of the PPACs.

413 In pursuit of effective *Conus* conservation, we recommend further species' habitat and bathymetric  
414 assessments via mapping and ground survey techniques, to strengthen knowledge and ensure  
415 current and future marine reserves provide adequate protection. With many ZDTIs adjacent to  
416 PPACs, further marine protection may be needed. ZDTIs planned for other islands should be  
417 considered in line with PPACs. To meet its international commitments under the Convention on  
418 Biological Diversity (ratified March 1995), Cape Verde needs to not only legally define protected  
419 areas but to also develop effective and transparent management, monitoring and enforcement  
420 strategies. To achieve this we strongly support the establishment of a Protected Area Autonomous  
421 Authority (PAAA). We recognise that marine protection can only be effective if it is supported by the  
422 populace and in particular by those who are likely to feel disadvantaged by its implementation such  
423 as fishers. Consideration therefore needs to be given to the impact on current activity within the  
424 proposed areas and how regional authorities, whose responsibility will be to manage and enforce  
425 the designated areas, can play a central role supported by international organisations.

426 Through this study, we have identified shortfalls in current conservation strategy in an attempt to  
427 propose solutions against further declines in Cape Verde's *Conus* populations, and to protect the  
428 country's shallow water habitat to the benefit of many taxonomic groups, including anthozoa such  
429 as sea anemones (Monteiro et al., 1997), corals, crustaceans such as lobsters *Panulirus regius* and *P.*  
430 *charlestoni*, already severely over-fished, as well as many species of fish and other molluscs (Duarte  
431 & Romeiras, 2009), and organisms such as amphipods and isopods (Stock & Vonk, 1992).  
432 Worldwide, our methodology is applicable to other regions of high endemism to help inform their

433 marine management strategies. Our findings clearly illustrate that marine organisms can face similar  
434 levels of extinction risk to non-marine taxa (McKinney, 1998; Roberts & Hawkins, 1999; Webb &  
435 Mindel, 2015) and that many of the management issues raised through our analysis apply to  
436 conservation planning in general, thereby supporting the high value of systematic and integrated  
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438

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668

669 **Tables**

670 **Table 1.** Assessed Cape Verde endemic *Conus* (N=53) by island with rationale on threatened and near threatened species and proximity to areas zoned for tourism  
 671 development (ZDTIs). Abbreviations for IUCN Red List species status - CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, LC Least Concern, DD  
 672 Data Deficient.

Island	Species names and Red List category of endemic <i>Conus</i>	Species' distribution (except Least Concern)	PAs with marine element	Threats	Tourism Development Zones (ZDTI)
<b>Santo Antão</b>	(a) <i>C. fernandesi</i> (EN)	Recently described (2008); Porto Novo for 1 km to S of island.	None	Accidental discharge of oil and other pollutants from small but busy ferry port. Scarce	None
<b>São Vicente</b>	(a) <i>C. bellulus</i> (DD)* (b) <i>C. decorates</i> (VU)* (c) <i>C. denizi</i> (NT) (d) <i>C. grahami</i> (LC)* (e) <i>C. navarroi</i> (NT)* (f) <i>C. lugubris</i> (CR) (g) <i>C. saragasae</i> (NT)*  * also on Santa Luzia	All except (f) restricted to E of island. (a) Not recorded for several years. (b) Calhau S to Saragaça. (c) Praia Grande in NE of island. (e) Calhau (f) Restricted to N where centred at Baía de Salamansa. (g) Calhau to Baía de Saragaça	None	(a) Probably always scarce. (b) Population in N lost from development, other scarce and suffering disturbance. (c,e) Pollution, over-gathering & habitat loss. (f) Most of the shallow water, rocky habitats disturbed; probably now extirpated. None collected since 1980s. (g) as (c,e).	N: Salamansa (5/2008) SW: São Pedro (7/2008) SW: Vale de Flamengos (12/2007) SE: Saragaça e Topinho (6/2008) S: Palha Carga (7/94) S: Praia Grande (7/94) NE: Norte e Sul da Baia das Gatas (5/2011)
<b>Santa Luzia</b>	(a) <i>C. curralensis</i> (NT)	(a) Restricted to SW of island. See also São Vicente (*): <i>C. decorates</i> : Curral for approx 3 km in SW of island <i>C. navarroi</i> : Praia Francisca for 2 km. <i>C. saragasae</i> : Água Doce and Curral for 2 km.	Santa Luzia	(a) Pollution, over-gathering & habitat loss. See also São Vicente (*): <i>C. decorates</i> , <i>C. navarroi</i> and <i>C. saragasae</i> are all of highly restricted range on Santa Luzia and at risk from pollution and gathering.	None
<b>São Nicolau</b>	(a) <i>C. kersteni</i> (NT)	Tarrafal in SW and other reported sightings.	None	Highly restricted range with few locations. Pollution.	None

Island	Species names and Red List category of endemic <i>Conus</i>	Species' distribution (except Least Concern)	PAs with marine element	Threats	Tourism Development Zones (ZDTI)
Sal	(a) <i>C. antoniomonteiroi</i> (LC) (b) <i>C. ateralbus</i> (EN) (c) <i>C. cuneolus</i> (EN) (d) <i>C. felitae</i> (VU) (e) <i>C. fontonae</i> (VU) (f) <i>C. longilineus</i> (LC) (g) <i>C. melissae</i> (LC) (h) <i>C. miruchae</i> (LC) (i) <i>C. mordeirae</i> (CR) (j) <i>C. pseudocuneolus</i> (LC) (k) <i>C. regonae</i> (VU) (l) <i>C. serranegrae</i> (LC)	All except (e,k) restricted to W of island. (b) Baía da Murdeira then 2 km to S into Baía do Algodoeiro. (c) As (b), continuing further S to Baía da Santa Maria. (d) N of Baía da Murdeira. (e) Regona in N to Petinha in S, incl. Fontona Bay. (i) Baía da Murdeira . (k) Pedro Lume to Ponta de Rabo de Junco in N of island.	Salinas Pedra Lume e Cagarral; Costa da Fragata; Ponta do Sinó; Rabo de Junco; Serra Negra.	(b,c,d,i) Tourism development. (e,k) Marine pollution especially accidental discharge of oil from tankers and other vessels using port of Palmeira.	W: Murdeira e Algodoeiro (12/2005) S: Santa Maria Este e Oeste (14/2009) SE: Morrinho Branco (15/2007) NE: Pedra de Lume (11/2005)
Boa Vista	(a) <i>C. atlanticoselvagem</i> (NT) (b) <i>C. boavistensis</i> (LC) (c) <i>C. borgesii</i> (LC) (d) <i>C. crotchii</i> (EN) (e) <i>C. damottai</i> (LC)*** (f) <i>C. delanoyae</i> (LC) (g) <i>C. derrubado</i> (NT) (h) <i>C. diminutus</i> (NT) (i) <i>C. evorai</i> (NT) (j) <i>C. fuscoflavus</i> (LC) (k) <i>C. irregularis</i> (LC)*** (l) <i>C. josephinae</i> (NT)*** (m) <i>C. luquei</i> (NT) (n) <i>C. messiasi</i> (LC) (o) <i>C. pseudonivifer</i> (LC)** (p) <i>C. roeckeli</i> (LC) (q) <i>C. salreiensis</i> (CR) (r) <i>C. teodorae</i> (VU) (s) <i>C. trochulus</i> (NT) (t) <i>C. venulatus</i> (LC)* (u) <i>C. vulcanus</i> (LC)	All except (a,g,l,m) restricted to W of island. (a) João Valente Shoals. (d) Morro de Areia S. to Santa Mónica, in centre of Morro de Areia ZDTI and near Chave ZDTI. (g) Derrubado for 5 km in N. (h) Two 2 km sites: Baía de Sal Rei and Morro da Areia. (i) Three sites: Praia Zebraca, Baía das Gatas in NE and the islet off Sal Rei in W of island. (l) Ponto do Rincão in N to Sal-Rei and S to Morro de Areia . Also on Maio. (m) Baía das Gatas in NE for 4 km. (q) Baía Teodora and Sal Rei with islet. (r) As (q), also possibly further to N.	l. de Baluarte; l. dos Pássaros; l. de Curral Velho; Ponta do Sol; Boa Esperança; Morro de Areia; Tartaruga; Parque do Norte; l. de Sal-Rei.	(a) Only visited by lobster fishers, and does not at present attract divers. Potential for over-gathering and/or habitat degradation. (d) Damage to habitat during resort construction and then tourism. (g,h,i,l,m) All NT with highly restricted ranges at risk from increased tourism although not currently threatened. (q) Impact from harbour construction in early 1990s; now mainly found off the islet where at risk from pollution and human disturbance. Very scarce. (r) As (q) although less scarce.	NW: Chave (2/2007) W: Morro de Areia (1/2009) SW: Santa Mónica (21/2009)

Island	Species names and Red List category of endemic <i>Conus</i>	Species' distribution (except Least Concern)	PAs with marine element	Threats	Tourism Development Zones (ZDTI)
	* also on Maio, Sal, Santiago. ** also on Sal, Santiago *** also on Maio.	(s) Baía Teodora and Baía de Sal-Rei to Curral Velho; adjacent to part of ZDTI.		(s) As (g,h,i,l,m)	
<b>Maio</b>	(a) <i>C. calhetae</i> (LC) (b) <i>C. claudiae</i> (LC) (c) <i>C. crioulus</i> (LC) (d) <i>C. fantasmalis</i> (LC) (e) <i>C. infinitus</i> (LC) (f) <i>C. isabelarum</i> (LC) (g) <i>C. maioensis</i> (LC) (h) <i>C. raulsilvai</i> (LC)	All spp. LC.	Casas Velhas; Terras Salgadas; Lagoa de Cimidor; Praia do Morro; Barreiro Figueira; Salinas de Porto Inglês.	None immediate	S: Sul da Vila do Maio (4/2008) SE: Ribeira D. João (4/2008) NW: Pau Seco (18/97)
<b>Santiago</b>	(a) <i>C. verdensis</i> (LC)	All spp. LC.	None	None immediate	SE: Norte da cidade da Praia (7/94) SE: Sudoeste da Praia E: Achada Baleia (7/94); E: Mangue Monte Negro (7/94); E: Porto Coqueiro (7/94); E: Achada Lage (7/94);
<b>Brava</b>	(a) <i>C. furnae</i> (LC)	All spp. LC.	None	None immediate	

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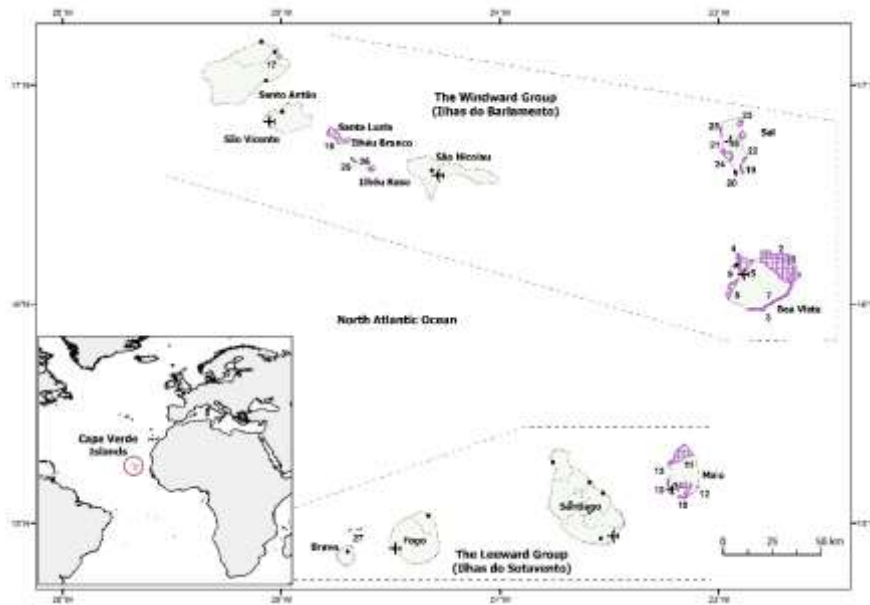
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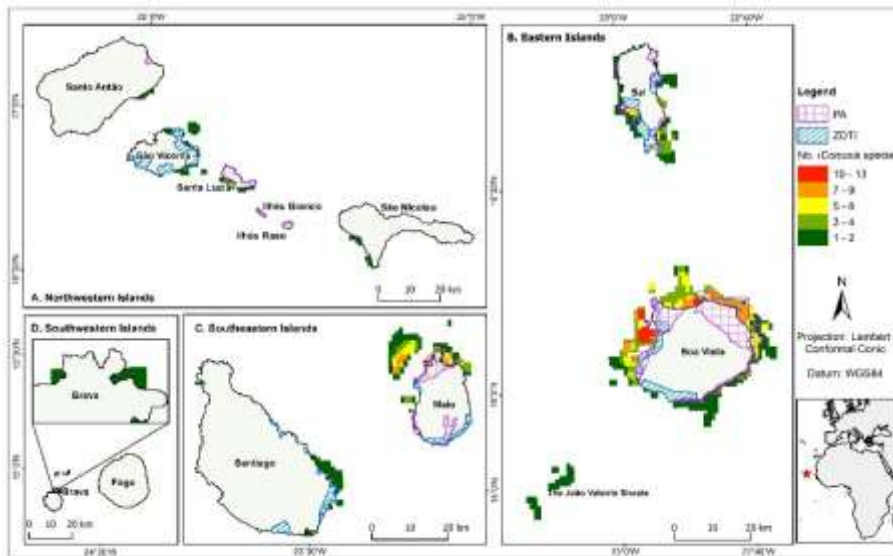
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678 **Figures**



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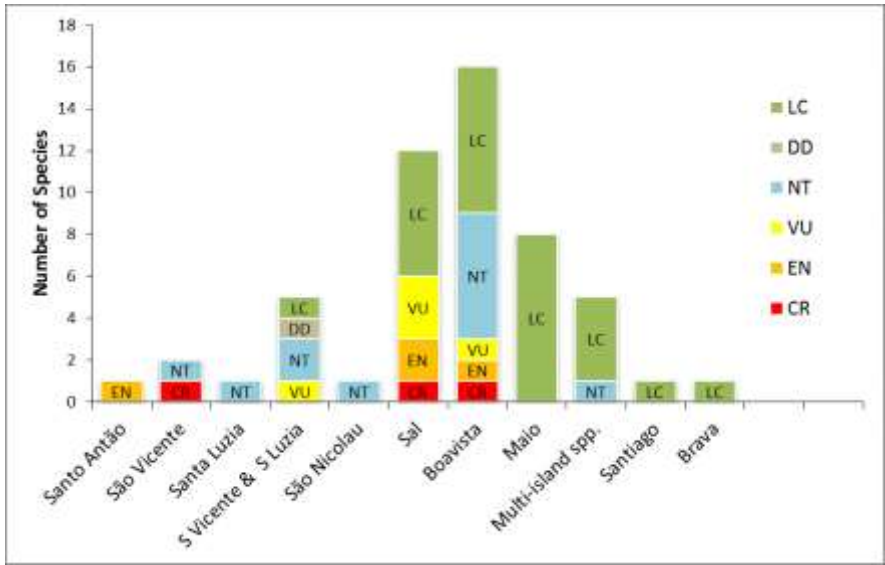
680 **Figure 1.** Map of Cape Verde with protected areas with a marine or coastal element shown in green, major  
 681 towns as black circles and airports with a plane symbol. Protected Area names and sizes may be cross-  
 682 referenced to the key in this map from Table S1.



683

684 **Figure 2.** *Conus* Species richness around Cape Verde with Tourism Development Zones (ZDTIs, Boa Vista, Maio,  
 685 Sal, São Vicente and Santiago only) and Protected Areas (PAs) with a marine or coastal element.

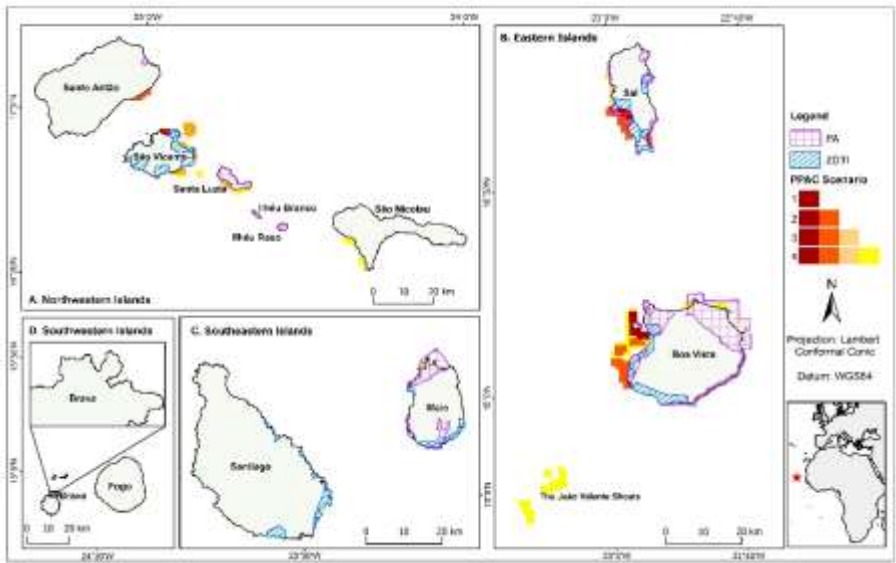
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688 **Figure 3.** Number of *Conus* species occurring on each Cape Verde island by category of threat. The four  
 689 eastern islands of Sal, Boa Vista, Maio and Santiago that together host five species that occur across more than  
 690 one of the islands are shown consolidated under ‘Multi-island spp’. Only one species (*C. atlanticoselvagem*,  
 691 classified as NT) occurs between two islands (Boa Vista and Maio) and this has been allocated to Boa Vista.  
 692 Key: CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, LC Least Concern, DD Data  
 693 Deficient

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695

696 **Figure 4.** Proposed Priority Areas for *Conus* research and conservation (PPACs) in Cape Verde according to four  
 697 progressively expanding scenarios: PPAC 1 represents the range of all Critically Endangered (CR) species (N=3);  
 698 PPAC 2, all CR and Endangered (EN) species (N=7); PPAC 3, all CR, EN and Vulnerable (VU) species (N=12); and  
 699 PPAC 4, all CR, EN, VU and Near Threatened (NT) species (N=24). Additional information on each PPAC is  
 700 provided in Table S4.

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703 **Supplementary Material - Tables**

704 **Table S1.** Legally defined Protected Areas (PAs) of Cape Verde (UNDP, 2009). PL Protected Landscape; INR  
 705 Integrated Natural Reserve; NR Nature Reserve; NP Natural Park; NM Natural Monument. These definitions  
 706 are presented in Table S2.

Marine Coast	Name of PA	Designation	Terr-estrial	Marine Coast	Land (ha)	Sea (ha)	TOTAL (ha)
Nr			PA	PA	PA	PA	
<b>BOA VISTA</b>							
	Monte Caçador e Pico Forcado	PL	x		3 365.02		3 365.02
01	Ilhéu de Baluarte	INR		x	7.65		7.65
02	Ilhéu dos Passaros	INR		x	0.68		0.68
03	Ilhéu de Curral Velho	INR		x	0.51		0.51
04	Ponta do Sol	NR		x	456.79		456.79
05	Boa Esperança	NR		x	3 130.29		3 130.29
06	Morro de Areia	NR		x	2 100.24		2 100.24
07	Tartaruga	NR		x	1 766.42		1 766.42
08	Parque do Norte	NP		x	8 964.64	7 524.45	16 489.09
09	Ilhéu de Sal-Rei	NM		x	89.98		89.98
	Monte Santo António	NM	x		457.91		457.91
	Monte Estancia	NM	x		763.3		763.3
	Curral Velho	PL	x		1 636.87		1 636.87
	Rocha Estancia	NM	x		253.44		253.44
<b>MAIO</b>							
10	Casas Velhas	NR		x	137.95		137.95
11	Terras Salgadas	NR		x	1 980.40	3 868.47	5 849.87
12	Lagoa de Cimidor	NR		x	50.63		50.63
13	Praia do Morro	NR		x	21.85		21.85
14	Barreiro e Figueira	NP		x	1 079.00		1 079.00
15	Salinas de Porto Inglês	PL		x	337		337
	Monte Penoso e Monte Branco	PL	x		1 117.80		1 117.80
	Monte Santo António	PL	x		881.73		881.73
<b>SANTA LUZIA</b>							
16	Santa Luzia	NR		x	3 500.00		3 500.00
<b>SANTIAGO</b>							
	Serra Malagueta	NP	x		1 200.00		1 200.00
	Serra do Pico de Antónia	NP	x		0		0



<b>SANTO ANTÃO</b>					
	Morroços	NP	X	671	671
17	Pombas	PL		x	0
	Topo da Coroa	NP	X	3 500.00	0
	Cova/Paúl/RªTorre	NP	X	3 217.00	3 217.00
	Cruzinha	NR	X	1 117.80	1 117.80
<b>SÃO NICOLAO</b>					
	Monte do Alto das Cabaças	NR	X	0	0
	Monte Gordo	NP	X	2,500.00	2,500.00
<b>SÃO VICENTE</b>					
	Monte Verde	NP	X	800	800
<b>FOGO</b>					
	Fogo	NP	X	8 468.51	8 468.51
<b>SAL</b>					
18	Salinas Pedra Lume e Cagaral	PL		x	806.96
19	Costa da Fragata	NR		x	351.68
20	Ponta do Sinó	NR		x	89.28
21	Rabo de Junco	NR		x	151.21
22	Serra Negra	NR		x	335.9
	Morrinho do Açúcar	NM	X	5.87	5.87
	Morrinho do Filho	NM	X	13	13
23	Monte Grande	PL		x	1 320.76
	Salinas de Santa Maria	PL	X	78.44	78.44
24	Marinha Baía da Murdeira	NR		x	2 066.63
25	Buracona-Ragona	PL		x	518.71
<b>ILHÉUS</b>					
26	Ilhéus de Branco e Raso	INR		x	1 000.00
27	Ilhéu do Rombo	INR		x	450

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710 **Table S2.** Protected Area definitions. Source: Decree-Law 3/2003.

Designation and number designated	Definition and management
<b>Nature Reserve</b> (15 Nature Reserves designated but no Partial Natural Reserves or Temporal Natural Reserves)	Areas of special ecological and scientific interest. There are two further subsets Partial Natural Reserves and Temporal Natural Reserves. Partial Nature Reserves offer protection to a specific natural resource, whether a single species, group of species or a particular habitat. Uses are permitted that are compatible with the purpose of protection. Temporal nature reserves are small areas established for a limited period of time to allow recovery of the resource or of specific ecological systems.
<b>Integrated Natural Reserve</b> (5 designated)	Areas of special ecological and scientific interest. Integral Natural Reserves offer protection to the entire ecosystem. They restrict further development and human use.
<b>National Park</b> (None designated)	Areas unaffected by human exploitation and occupation which have a special scientific, socio-economic, educational, recreational or landscape aesthetic interest. Exploitation and human occupation are prohibited beyond visits for recreational or cultural purposes.
<b>Natural Park</b> (11 designated)	Large areas containing predominantly natural habitats, species or representative samples of the country's biodiversity. Within these there may be a traditional local population. Natural Parks aim to conserve, protect and/or restore natural environments and cultural resources: they promote socio-economic development compatible with nature conservation to improve the quality of life for local communities; educational, recreational and scientific use is encouraged.
<b>Natural Monument</b> (6 designated)	Moderate sized areas which contain at least one natural or cultural element of exceptional value (e.g. rarity, uniqueness, scientific interest, ecological or cultural function). They are protected to safeguard the feature(s) of interest and prohibit activities which changes them.
<b>Protected Landscape</b> (10 designated)	Terrestrial or coastal areas modified by human activity with a particular aesthetic quality or cultural value. Protection focuses on preserving and restoring the characteristics that define them.
<b>Site of Scientific Interest</b> (None designated)	Areas, usually of a small size, which contain natural elements of scientific interest or animal or plant populations threatened with extinction.

711 **Table S3:** Proposed Priority Areas for Conservation (PPACs). Note: Total area occupied by *Conus* is 945 km<sup>2</sup>  
 712 Key: CR Critically Endangered, EN Endangered, VU Vulnerable, NT Near Threatened, LC Least Concern, DD Data  
 713 Deficient.

PPAC	Area represented (km <sup>2</sup> )	% of <i>Conus</i> range	Total targeted <i>Conus</i> spp.	Total Incidental, i.e. non-target, spp	Total target and non-target <i>Conus</i> spp.	% spp. represented in each assessment category	Total spp. represented as % of all <i>Conus</i> spp.	Total Nr. <i>Conus</i> spp. not represented in each assessment category	Total <i>Conus</i> spp. not represented
<b>1. CR spp</b>	35	3.7	CR: 3	EN: 2 VU: 3 NT: 4 LC: 7 DD: 0	19	CR: 100 EN: 50 VU: 60 NT: 33 LC: 25 DD: 0	35.9	CR: 0 EN: 2 VU: 2 NT: 8 LC: 21 DD: 1	34
<b>2. CR, EN spp</b>	119	12.6	CR: 3 EN: 4	VU: 3 NT: 4 LC: 9 DD: 0	23	CR: 100 EN: 100 VU: 60 NT: 33 LC: 32	43.4	CR: 0 EN: 0 VU: 2 NT: 8 LC: 19	30

						DD: 0		DD: 1	
<b>3. CR, EN, VU spp</b>	175	18.5	CR: 3 EN: 4 VU: 5	NT: 8 LC: 11 DD: 1	32	CR: 100 EN: 100 VU: 100 NT 67 LC: 39 DD: 100	60.4	CR: 0 EN: 0 VU: 0 NT 4 LC: 17 DD: 0	21
<b>4. CR, EN, VU, NT spp</b>	311	32.9	CR: 3 EN: 4 VU: 5 NT: 12	LC: 24 DD: 1	49	CR: 100 EN: 100 VU: 100 NT 100 LC: 86 DD: 100	92.5	CR: 0 EN: 0 VU: 0 NT 0 LC: 4 DD: 0	4

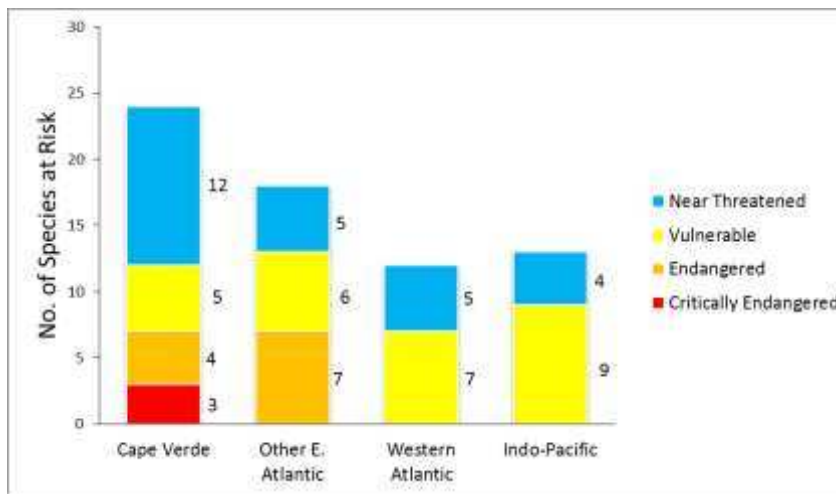
714 **Table S4:** Proportion of PPACs located within existing PAs. Results are only reported for islands where *Conus*  
715 are found and where priority areas have been identified. Cells are counted as being protected if the existing PA  
716 designation covers at least part of the cell. Key: CR Critically Endangered, EN Endangered, VU Vulnerable, NT  
717 Near Threatened.

718

PPAC Scenario	Island	Per PPAC			Cumulative		
		Total No. <i>Conus</i> cells	No. <i>Conus</i> cells in PAs	% protected	Total No. <i>Conus</i> cells	No. <i>Conus</i> cells in PAs	% protected
<b>1 CR only</b>	Boa Vista	19	0	0	19	0	0
	Sal	10	10	100	10	10	100
	Sao Vicente	6	0	0	6	0	0
<b>2 CR/EN</b>	Boa Vista	39	0	0	58	0	0
	Sal	29	19	66	39	29	74
	Sao Vicente	0	0	0	6	0	0
	Santo Antão	12	0	0	12	0	0
<b>3 CR/EN/VU</b>	Boa Vista	0	0	0	58	0	0
	Sal	17	1	6	56	30	54
	Sao Vicente	34	0	0	40	0	0
	Santo Antão	0	0	0	12	0	0
	Santa Luzia	4	0	0	4	0	0
<b>4 CR/EN/VU/NT</b>	Boa Vista	47	11	23	105	11	10
	Sal	0	0	0	56	30	54
	Sao Vicente	9	0	0	49	0	0
	Santo Antão	0	0	0	12	0	0
	Santa Luzia	11	0	0	15	0	0
	Maio	2	2	100	2	2	100
	Sao Nicolau	15	0	0	15	0	0
	João Valente Shoals	46	0	0	46	0	0

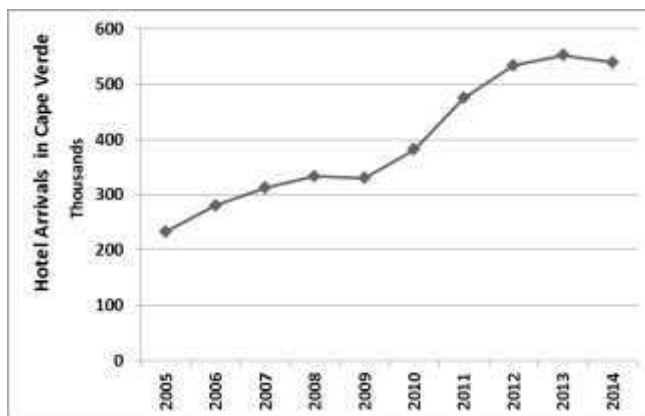
719

720 **Supplementary Material – Figures**



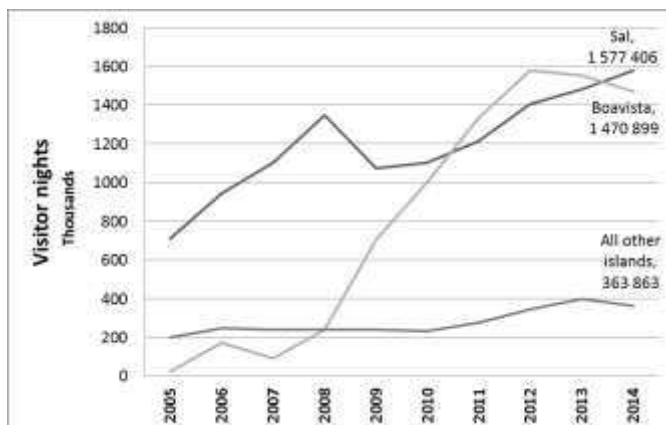
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722 **Figure S1.** Number of threatened and near threatened *Conus* species that occur in each ocean basin with the  
 723 Eastern Atlantic separated for *Conus* that occur around Cape Verde and those in the rest of the region.



724

725 **Figure S2.** Hotel arrivals in Cape Verde 2005-2014. Source: Instituto Nacional de Estatística Cabo Verde.



726

727 **Figure S3.** Nights spent by visitors to Cape Verde 2005-2014. Source: Instituto Nacional de Estatística  
 728 Cabo Verde.