

1 **So Excellent a Fische: A global overview of legal marine turtle fisheries.**

2

3 **Short title:** Global overview of legal marine turtle fisheries.

4

5 Humber, Frances <sup>a,b</sup>, Godley, Brendan John<sup>b</sup>, Broderick, Annette Cameron<sup>b,\*</sup>

6

7 <sup>a</sup>Blue Ventures Conservation, Level 2 Annex, Omnibus Business Centre, 39-41 North Road,  
8 London, N7 9DP, UK. Email: [fran@blueventures.org](mailto:fran@blueventures.org)

9 <sup>b</sup>Marine Turtle Research Group, College of Life and Environmental Sciences, University of  
10 Exeter, Cornwall Campus, Penryn, TR10 9EZ, UK. Email: [B.J.Godley@exeter.ac.uk](mailto:B.J.Godley@exeter.ac.uk);  
11 [a.c.broderick@exeter.ac.uk](mailto:a.c.broderick@exeter.ac.uk)

12

13 <sup>\*</sup>Corresponding author. Dr Annette C. Broderick. Email: [a.c.broderick@exeter.ac.uk](mailto:a.c.broderick@exeter.ac.uk)

14

15

16 Number of words in abstract: 270

17

18 Number of words in main body: 4,520

19

20

21 **ABSTRACT**

22 **Aim**

23 We provide a global assessment of the current legal direct take of marine turtles, including  
24 the scale and species breakdown at country level, and investigate the significance of legal  
25 take to marine turtle populations within the wider context of global threats.

26 **Location**

27 World-wide

28 **Methods**

29 We undertook a comprehensive review of literature (>500 publications) and contacted over  
30 150 in-country experts to collate data for countries that permit the legal take of marine turtles  
31 (as of 1<sup>st</sup> January 2013). Current annual take for each country and species was estimated, and  
32 estimates were generated for the 1980s, 1990s and 2000s.

33 **Results**

34 Currently 42 countries and territories permit direct take of turtles and collectively take in  
35 excess of 42,000 turtles per year, the majority of which (>80%) are green turtles *Chelonia*  
36 *mydas* (Linnaeus 1758). Ten countries account for more than 90% of legal take each year  
37 with Papua New Guinea (36.1%) and Nicaragua (22.3%) accounting for more than half of the  
38 total global take. Since 1980 we estimate that more than 2 million turtles have been legally  
39 taken in these countries, with current levels <60% of those in the 1980s.

40 **Main conclusions**

41 Our results provide the most comprehensive global synthesis of the legal take of turtles in  
42 recent years and suggest that legal take has the potential to be a driver of marine turtle  
43 population dynamics, comparable to mortality estimates through recorded bycatch. However,  
44 it is likely that illegal take, along with bycatch, are significantly under-recorded and far

45 greater than the total level of directed legal take. This hampers the ability to assess the  
46 relative impacts of these threats to marine turtles.

47

48 Keywords: direct take, global, legal fisheries, legislation, marine turtle, traditional fisheries

49

## 50 **(A) INTRODUCTION**

51 Widescale commercial exploitation is thought to have contributed significantly to the global  
52 decline in marine turtle populations (Lewis, 1940; Stoddart, 1980; Jackson 1997; National  
53 Marine Fisheries Service & U.S. Fish and Wildlife Service, 1998; Broderick *et al.*, 2006;  
54 Cornelius *et al.*, 2007) leaving many populations at relictual levels (McClenachan *et al.*,  
55 2006; Pritchard, 2003; Bell *et al.*, 2007). However, the direct take of nesting and foraging  
56 marine turtles for meat, shell and other products has taken place for millennia (Groombridge  
57 & Luxmoore, 1989; Frazier, 2003; Daley *et al.*, 2008). Artisanal and subsistence take, as part  
58 of longstanding traditional fisheries, primarily for local consumption, may historically have  
59 been at more sustainable levels (Frazier, 1980), but levels of exploitation increased radically  
60 upon western colonisation of the new world (Babcock, 1938; Wayne King, 1995; Mrosovsky  
61 1996). Quickly, some of this take proved unsustainable, with the first marine turtle harvest  
62 legislation instigated in Bermuda in 1620 to protect “..so eccellente a fishe..”, prohibiting  
63 taking any turtle “under Eighteen inches in the Breadth or Dyiameter” (Babcock, 1938;  
64 Godley *et al.*, 2004).

65

66 Notwithstanding, large-scale commercial take in areas with remaining abundance continued,  
67 with global capture peaking at over 17,000 tonnes in the late 1960s (FAO, 2011), principally  
68 fuelled by commercial-scale exploitation and international trade (Fleming, 2001; van Dijk &  
69 Shepherd, 2004). For example, during the peak of Mexico’s sea turtle exploitation in 1968, it

70 is estimated that the national take was over 380,000 turtles (Cantú & Sanchez, 1999). The  
71 continued international trade of turtle products in the latter half of the 20<sup>th</sup> century meant that  
72 over 2 million turtles (hawksbill *Eretmochelys imbricata*, Linnaeus 1766; green *Chelonia*  
73 *mydas* and olive ridleys *Lepidochelys olivacea*, Eschscholtz, 1829) would have been needed  
74 to produce the volume of marine turtle products imported into Japan between 1970 and 1986  
75 (Milliken & Tokunaga, 1987). Against the backdrop of widespread commercial exploitation,  
76 a decline in traditional and small-scale turtle fisheries also occurred (Frazier, 1980; Allen,  
77 2007; Bell *et al.*, 2010), resulting from increased pressures from human populations and more  
78 efficient capture methods (Brikke 2009), often with a corresponding breakdown of associated  
79 cultural rituals that would have once promoted more sustainable take levels (Hickey, 2003;  
80 Allen, 2007).

81

82 Increased conservation awareness at the international scale has led to greater protection of  
83 marine turtles and a series of multilateral agreements with associated enabling local  
84 legislation coming into force to restrict the trade of turtle products, such as the Convention on  
85 International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1975, which  
86 helped to reduce demand and promote regional cooperation in increasing turtle populations.  
87 By 1980, 59 countries were signatories to CITES rising to 178 in 2013; and, although subject  
88 to considerable debate, marine turtle species have been listed on the IUCN Red List of  
89 threatened Species since 1982 (Mrosovsky, 2003; IUCN, 2013).

90

91 Despite increasing levels of protection, the direct take of turtles has continued legally in  
92 many regions and countries (Bräutigam & Eckert, 2006; Maison *et al.*, 2010). Permitted take  
93 now tends to be characterised by subsistence use by traditional coastal groups, or small-scale  
94 fisheries supplying local markets with meat, and sometimes shell (Bräutigam & Eckert, 2006;

95 Limpus, 2008, Maison *et al.*, 2010). The fisheries continue to be an important source of  
96 finance, protein and cultural identity in these parts of the world (Hamann *et al.*, 2006; Vander  
97 Velde, 2008). Although the nature of these permitted fisheries vary greatly among countries  
98 and regions, many have been subject to increasing regulations over the past 30 years, with  
99 specific legislation put in place to help manage direct take, often limiting species, number,  
100 timing or size of turtles targeted (Bräutigam & Eckert, 2006). There is, however, a paucity of  
101 information on the direct take from these fisheries at present, despite often being listed as one  
102 of the major threats to marine turtle populations (Wallace *et al.*, 2010; IUCN, 2013). Here we  
103 set out to assess the current legal direct take (hereafter referred to as legal take) of marine  
104 turtles globally; as well as recent trends within those countries.

105

## 106 **(A) METHODS**

### 107 **(B) Focal countries**

108 In this study we focussed on coastal countries or territories, hereafter referred to as countries,  
109 which currently (as of 1<sup>st</sup> January 2013) permit the legal take of marine turtles and are  
110 geographically between 40°N and 40°S. This region covers the majority of the known range  
111 of hard-shelled marine turtle species (IUCN 2013). Although some marine turtle species can  
112 occur outside this range, there is no significant direct turtle take documented outside these  
113 latitudes. Legalised egg harvest was not included in this study.

114

115 The national legislation within these countries was further classified as allowing marine turtle  
116 take if protection was absent, unverifiable, incomplete or temporary. National legislation was  
117 classified into one of five categories: protection absent (N), legislation allows for a level of  
118 directed take of one or more species of turtles (L), full protection but traditional hunting  
119 exemptions exist (T), moratorium in place at present (M) and unable to verify legislation (U).

120

121 **(B) Data compilation**

122 We searched relevant databases (eg. Web of Knowledge, Google Scholar, seaturtle.org, Sea  
123 Turtle Bibliography at the Archie Carr Center for Sea Turtle Research, SPC Coastal Fisheries  
124 Programme) and the broader internet using combinations of relevant keywords ('turtle' with  
125 'take', 'harvest' or 'fishery'). Over 500 reports and papers were collated and reviewed to  
126 compile data on legal take, with bycatch or incidental take data removed where possible. In  
127 the first instance data from actual studies were prioritised, but in the absence of such data  
128 estimates by experts found in literature or via personal communications were used. Where  
129 data presented in the literature were unclear or incomplete, efforts were made to consult  
130 relevant authors. Further consultation with expert individuals living in or known to work in  
131 target nations (>150 contacted by email; 106 responded with information) was undertaken to  
132 locate further reports and papers and ascertain best estimates of legal take since 1<sup>st</sup> January  
133 2010.

134

135 Data for all seven species of marine turtles (green; hawksbill; loggerhead *Caretta caretta*,  
136 Linnaeus 1758; olive ridley; leatherback *Dermochelys coriacea*, Vandelli 1761; Kemp's  
137 ridley *Lepidochelys kempii*, Garman 1880; flatback turtle *Natator depressus*, Garman 1880),  
138 were collated by country (see Table S1 in Supporting Information; see Appendix S1).

139

140 A median was calculated for any estimates given as ranges. Where a single estimate was  
141 provided as an annual estimate for a number of years, the same value was used for each year  
142 in the range. Estimates given as a total figure for a number of years were divided equally  
143 among those years. Multiple estimates by different authors for the same year were averaged.  
144 No attempt was made to extrapolate data where estimates were given for periods less than a

145 year, or when they were not countrywide estimates. In these cases, values were included as  
146 minimum values.

147

148 In a small number of highlighted cases (see Table S1; n=8), international trade statistics in  
149 bekko (hawksbill turtle shell) were used to calculate estimates for hawksbills, only where no  
150 other data could be located. Conversion rates of bekko (kg) to number of turtles were  
151 normally given by authors (eg. Fiji 0.7 – 1.1 kg bekko/turtle, Milliken & Tokunaga, 1987).

152

### 153 **(B) Creating annual estimates for each decade**

154 We calculated the median annual take for each decade (1980s, 1990s, 2000s) for each species  
155 by country and for our current estimate the median annual take for the years 2010 -2012.

156

157 Data that had not been identified by species were only included in circumstances where we  
158 were confident that the data were not duplicated within other studies. Data were then broken  
159 down into species using the best available species composition information from additional  
160 studies and reports from that country.

161

162 Where data were missing for a decade we used the temporally closest data to extrapolate. For  
163 example where we only had data for the 1990s and 2000s we used the 1990's estimate for the  
164 1980s. Where decadal data were only available for the 1980s and 2000s (n=4 countries), we  
165 used what we considered would be the most similar estimate for the 1990s, in relation to any  
166 changes in legislation or reports of increases/decreases in legal take. Where data for only one  
167 decade existed (n = 8 countries), this was used for all other decades. To allow confidence to  
168 be assigned to overall estimates, any "estimated" data are highlighted.

169

170 (C) *Current take*

171 Relevant expert individuals contacted between 2011 and 2013 were also asked for comments  
172 on present day harvest compared to the last known study or report on take within a country. If  
173 the expert was unable to answer or unable to confirm, then take was assumed to have been  
174 unchanged from the most recent known estimate.

175

176 **(A) RESULTS**

177 **(B) Legislation**

178 As of 1<sup>st</sup> January 2013, a total of 42 countries permitted the direct take of marine turtles, four  
179 countries had a moratorium on take (Anguilla, Chile, Fiji and the Maldives), although permits  
180 for traditional purposes can be granted in Fiji; and four countries had legislation that could  
181 not be verified (Algeria, North Korea, Panama and Somalia) (Fig. 1) (see Table S1 for  
182 information on type or absence of legislation). A change of legislation to prohibit direct turtle  
183 take occurred in three countries (Republic of Congo, South Korea and Trinidad and Tobago)  
184 between 1<sup>st</sup> January 2010 and 1<sup>st</sup> January 2013. Data from these countries, and also those that  
185 prohibited turtle take between 1980 and 2010, are not included in this study.

186

187 **(B) Take by species**

188 We estimate that currently, more than 42,000 marine turtles are caught each year as legal take  
189 (n = 42 countries). Over 80% of these are green turtles (37,339; 88.5% of catch), with an  
190 estimated 3,456 hawksbill turtles taken each year (8.2%) (Fig. 2). Fewer than 1500  
191 loggerhead (1051; 2.5%), leatherback (62; 0.1%) and olive ridley (263; 0.6%) turtles are  
192 estimated to be among those legally captured each year. Data on take of flatback turtles were  
193 scarce with only a small amount recorded from Papua New Guinea and Australia,



194 approximately 18 turtles.yr<sup>-1</sup> (Kare, 1995; Kennett *et al.*, 1998). No data were found on legal  
195 take of Kemp ridley's from 1980 to present day.

196

197 Green turtles were the only species permitted to be taken from all countries within this study,  
198 with the exception of countries with a moratorium (although not including Fiji). Leatherbacks  
199 had the highest degree of protection and were prohibited from take in 13 of the 42 focal  
200 countries examined (31.0%).

201

## 202 **(B) Global distribution of take**

203 Current permitted take is concentrated in two regions: the wider Caribbean region accounts  
204 for 34.6% (14,640 turtles.yr<sup>-1</sup>) of estimated take from 16 countries (see inset Fig. 3; Fig. 4a)  
205 and the Indo-Pacific region accounts for 63.3% (26,675 turtles.yr<sup>-1</sup>) from 17 countries (Fig. 3;  
206 Fig. 4b). No take was known to occur in four of the countries where it was legal (Bosnia and  
207 Herzegovina, Niue, Pitcairn Islands and Wallis and Futuna). In 12 countries take was  
208 unquantified: in three of these countries take was known to occur but no estimate was  
209 available (Kiribati, Nauru, Syria), and nine of these countries only illegal take data were  
210 found (Belize, Cayman Islands, Dominica, Indonesia, Atlantic coast of Mexico), including  
211 four countries where a moratorium exists (Anguilla, Chile, Fiji, Maldives). Take from the  
212 four countries where legislation could not be verified (Algeria, North Korea, Panama and  
213 Somalia) is estimated to be 6600 green turtles.yr<sup>-1</sup> and is not included in the 42,000 estimate  
214 (Table S1). A breakdown of take by species for each country is available in Figs S2, S3 and  
215 Table S1.

216

## 217 **(B) Take by country**

218 The top ten countries with permitted take account for 94.2% (39,716) of marine turtle take  
219 per year (Fig. 5). Papua New Guinea (15,217 turtles.yr<sup>-1</sup>; 36.1%), Nicaragua (9,413 turtles.yr<sup>-1</sup>;  
220 22.3%) and Australia (6,638 turtles.yr<sup>-1</sup>; 15.7%) together account for almost three quarters  
221 of current permitted take (74.1%; 31,268). Given the preponderance of green turtles, the top  
222 ten countries for this species are similar to those for overall take. Papua New Guinea,  
223 Australia and Nicaragua do not feature in the top ten for the other four species, apart from a  
224 small annual take of hawksbills from Papua New Guinea and Australia and a small annual  
225 take of loggerheads from Australia (see Fig. S4).

226

### 227 **(B) Past take**

228 The estimated change in annual permitted take of marine turtles in 46 countries that currently  
229 allow take of turtles (including the four with current moratoria) over the past 3 decades is  
230 illustrated in Fig. 6 and by species in Fig. S1. We estimate more than 2 million turtles have  
231 been taken by these countries since 1980. Take has decreased by more than 60% over the  
232 past three decades, from an estimated take of 116,420 turtles.yr<sup>-1</sup> in the 1980s, 68,844  
233 turtles.yr<sup>-1</sup> in the 1990s and 45,172 in the 2000s with this downward trajectory apparently  
234 continuing.

235

236 One of the major changes in species taken over the past three decades has been in the  
237 cessation of the olive ridley take on the Pacific coast of Colombia from nearly 40,000  
238 turtles.yr<sup>-1</sup> in the early 1980s to fewer than ten per year in the 1990s and 2000s (see Fig. S1c).  
239 There have also been declines in the other four prevalent species since the 1980s within these  
240 countries. There has been a >40% decline in green take since the 1980s, a >60% decline in  
241 hawksbill and leatherback take and a >30% decline in loggerhead take.

242

243 Although it has not been possible to fully separate all legal and illegal take from data from  
244 these countries, there is also some illegal take recorded (see Table S1; see Appendix S1). It is  
245 estimated that currently some additional 13,150 turtles are illegally taken in these 46  
246 countries each year. Within this study, the Pacific coast of Mexico accounts for the greatest  
247 proportion of recorded illegal take with 47.8% (6,644 turtles.yr<sup>-1</sup>), followed by Indonesia  
248 (23.6%; 3,279 turtles.yr<sup>-1</sup>) and Fiji (23.4%; 3,261 turtles.yr<sup>-1</sup>) (see Table S1).

249

## 250 **(A) DISCUSSION**

251 This study provides the first global synthesis of the reported legal direct take of marine  
252 turtles. Our estimate of current legal take, in excess of 42,000 turtles.yr<sup>-1</sup>, highlights this as a  
253 potential threat to at least some marine turtle populations, but also places this threat in the  
254 context of others such as bycatch, that is likely to have a greater impact on global stocks. Our  
255 study also shows that there has been a 60% decrease in take from the countries within this  
256 study since the 1980s, with further decreases in the global take likely as many countries  
257 prohibited take during the period 1980 to 2010 (eg. Cuba, Bahamas, Barbados) (Bräutigam &  
258 Eckert, 2006). Many green turtle populations, the most heavily targeted species, have also  
259 shown large increases in nesting populations in recent decades (Broderick *et al.*, 2006;  
260 Chaloupka *et al.*, 2008), potentially facilitated through the reduction or cessation in global  
261 take at these sites.

262 Bycatch estimates for marine turtles have been the focus of a number of relatively  
263 comprehensive studies in recent years. Wallace *et al.* (2010) estimated a minimum global  
264 bycatch of 85,000 turtles between 1990 and 2008 but suggest that this likely underestimates  
265 the true total by at least two orders of magnitude (due to <1% fishing effort observed and  
266 recorded and underrepresentation of small-scale fisheries in bycatch data). For instance, more  
267 recent work by Casale (2011) estimated that there were 44,000 incidental sea turtles

268 deaths.yr<sup>-1</sup> alone in the Mediterranean whilst Mancini *et al.* (2011) estimated that there were  
269 >1000 deaths.yr<sup>-1</sup> within one fishery in a lagoon in NW Mexico. Small-scale fisheries in Peru  
270 capture tens of thousands of turtles as bycatch annually (Alfaro-Shigueto *et al.*, 2011). These  
271 few estimates alone strongly suggest that global mortality from bycatch greatly exceeds that  
272 of legal take and likely extends into hundreds of thousands per annum. Improvements have  
273 been made in some areas however, with comparative declines (~60%) in bycatch reported  
274 since 1990 in US fisheries (Finkbeiner *et al.*, 2011).

275

276 Illegal fishing for turtles also continues to be a major cause of mortality, both in countries  
277 within this study and those where take is illegal (Bräutigam & Eckert, 2006; Maison *et al.*,  
278 2010; Lam *et al.* 2011). We estimate that a minimum of 65,000 turtles have been taken  
279 illegally from Mexico since 2000 (Koch *et al.*, 2006; Peckham *et al.*, 2008; Mancini *et al.*,  
280 2011) and in Nicaragua there is documented take of species other than the permitted green  
281 turtles (Lagueux *et al.*, 2003). The scale of global illegal take is likely to be severely  
282 underreported due to the inherent difficulty in collecting data on such activity. However, a  
283 number of reports highlight widespread artisanal fisheries taking thousands of turtles.yr<sup>-1</sup>  
284 across Africa (WWF, 2005; Peñate *et al.*, 2007; Catry *et al.*, 2009; Marco *et al.*, 2010;  
285 Humber *et al.*, 2011). Elsewhere, several medium-sized illegal turtle fisheries are found in the  
286 Caribbean (1000 to 2500 individuals.yr<sup>-1</sup>), in Venezuela (Bräutigam & Eckert, 2006),  
287 Dominican Republic (Fleming, 2001) and Puerto Rico (Moore *et al.*, 2003); whilst a black  
288 market still exists within the Mediterranean for turtle meat (Nada & Casale, 2008).

289

290 The majority of current legal take is of green turtles, although past take of olive ridley turtles  
291 was significant, there has been a substantial decline in the legal take of both species since the  
292 1980s. There has also been a corresponding increase in national legislation during this time

293 that focuses on protecting turtles during breeding seasons whilst allowing customary and  
294 traditional users to continue fishing, and is likely a reason for the decline in take over the past  
295 30 years.

296

297 The majority of countries with legal turtle take are located in small island states in the  
298 Caribbean and Pacific (Melanesia, Polynesia, Micronesia). Turtle take in the Caribbean tends  
299 to be legislated through closed seasons, size restrictions by species, permits and gear  
300 restrictions (Richardson *et al.*, 2006); whereas turtle take in the Pacific is characterised by  
301 high cultural significance with associated customs (Rudrud, 2007, 2010; Bell *et al.*, 2010).  
302 Both regions report declines in take over the last 30 years (Eckert *et al.*, 1992; Fleming  
303 2001), in some cases due to a lack of interest from younger generations (eg. Belize:  
304 Bräutigam & Eckert 2006; British Virgin Islands: Sam Davies pers. comm.; Cook Islands:  
305 Michael White pers. comm.; Samoa: Juney Ward pers. comm.; Tokelau: Feleti Tulafono pers.  
306 comm.).

307

308 However, the three largest legal fisheries persist in Papua New Guinea, in the waters of  
309 Australia, and on the Atlantic coast of Nicaragua. Estimates used in this study for Nicaragua  
310 are, however, based on data from the 1990s, although current levels of take have decreased  
311 since last published estimates (C. Lagueux pers. comm.). There are also complications when  
312 estimating take for Papua New Guinea and Australia because the majority of turtle take is  
313 centred in remote areas of both countries. Furthermore, turtles are taken across the  
314 jurisdictions of Australia and Papua New Guinea by Australian Aboriginal and Torres Strait  
315 Islanders, as well as the coastal communities in Papua New Guinea and Indonesia. Estimates  
316 for the Torres Strait region (includes Torres Strait Islanders and neighbouring Papua New  
317 Guinea communities) in the past have been highly variable, from 5,100 - 6,700 (Kwan, 1991)

318 to 10,000 per year (Limpus, 1980). This study estimates that the take from the whole of  
319 Papua New Guinea and Australia is in the order of 20,000 turtles per annum. However, there  
320 are limitations to these data from Australia due to the fact that they have been extrapolated  
321 from small data sets with restricted spatial and temporal limitations, and there are known  
322 large variations in numbers of nesting turtles each year (Limpus, 2008). Results of recent  
323 Australian Government supported community-based management programmes, and bilateral  
324 Australia and Papua New Guinea projects are also not yet available (Kennett & Kitchens,  
325 2009; Australian Government 2013).

326

327 Although the level of legal take is likely to be relatively low compared to the combined  
328 threats of bycatch and illegal take, the existence of a legal fishery has been suggested as  
329 providing cover for continued illegal take of turtles (Pritchard, 2003; Reuter & Allan, 2006).  
330 Direct take can be more targeted than other causes of marine turtle mortality, often focusing  
331 on nesting females (Catry *et al.* 2009; Marco *et al.*, 2010), and although many countries  
332 within this study prohibit the take of nesting turtles, small numbers of adults can represent a  
333 large percentage of the nesting population (Limpus *et al.*, 2006; Harris & George, 2008). The  
334 impact of direct take can be worsened if high levels of take coincide with the breeding season  
335 (Martin *et al.*, 2005; Bell *et al.* 2007). The migratory nature of turtles also means that  
336 otherwise protected nesting populations can be heavily exploited in nearby countries, such as  
337 foraging adult females in Nicaragua from the largest green turtle rookery in Tortugeuro,  
338 Costa Rica (Campbell, 2003).

339

340 There were several difficulties in assessing the status of legal take, most notably the lack of  
341 data across many countries and species. Few fisheries departments contacted had any official  
342 data available, and in one country contacted data collection had lapsed unnoticed for 3-4

343 years. A lack of national level monitoring programmes meant that many estimates were  
344 based on local studies by research institutions or NGOs, with temporally sporadic data  
345 collection (Broderick, 1998; Havea & MacKay, 2009), often generating conservative  
346 estimates (Godley *et al.*, 2004). Within our study original research data were used where  
347 possible although in certain instances national estimates by authors as part of reports (eg.  
348 Kinch 2002) or personal communications were used (eg. Albania: M. White).

349

350 A decline in available papers, reports and official fisheries statistics on legal take in recent  
351 years led to an increase in the proportion of estimated data from the 1980s to present day.  
352 Many of the current legal turtle fisheries are at the subsistence level or part of small-scale  
353 fisheries which can be difficult to monitor, especially in remote regions in island states  
354 (Nichols 2003; Andrews *et al.*, 2006). Further complications in data collection and analysis  
355 can arise in the ambiguity between definitions of direct, opportunistic or incidental take by  
356 fishers and researchers (Fuller *et al.*, 1992; Godley *et al.*, 2004). Small-scale and artisanal  
357 fishers will often take turtles opportunistically on fishing trips not specifically targeting  
358 turtles (Hoyle, 1994; Fleming, 2001; Petro *et al.*, 2007; Alfaro-Shigueto *et al.*, 2011). On top  
359 of this, fishing effort can range from specialised dedicated groups, to small numbers of  
360 occasional, turtle fishers (Godley *et al.*, 2004), taking turtles both legally and illegally (Aiken  
361 *et al.*, 2001; Bräutigam & Eckert, 2006).

362

363 Legislation within many countries examined is unclear, and even officials can be operating  
364 under false assumptions of the reality of the legislation (Bräutigam & Eckert, 2006). Multiple  
365 pieces of legislation within countries have been passed without consulting prior texts for  
366 continuity (Bräutigam & Eckert, 2006) or taking into account local stakeholders (Vanuatu: F.  
367 Hickey pers. comm.), with frequent changes in restrictions (Caribbean Nicaragua: K. Garland

368 pers. comm.). Many aspects of legislation associated with legal take can be difficult to  
369 monitor and enforce, such as restrictions on turtle size and gear types (Buden 2001).  
370 Furthermore legislation that allows for subsistence or traditional take can be hard to enforce  
371 due to difficulties in definitions; for example, the Nicaraguan green turtle fishery is defined  
372 as for subsistence use only but essentially runs at a commercial level (Campbell, 2003).

373

374 The debates on the continued legal take of marine turtles span a number of complex issues  
375 including ecological principles, human rights and animal welfare (Hamann *et al.*, 2010), and  
376 still features in emotionally charged news articles (Holland, 2013). Undoubtedly, bans on  
377 large scale turtle take have helped marine turtle populations to recover (Chaloupka *et al.*,  
378 2008), and current illegal take levels in some countries do not rival those of the previously  
379 legal turtle fishery (J. Chevalier *in litt.* in Bräutigam & Eckert 2006) or current bycatch  
380 (Cornelius *et al.*, 2007). Some countries in this study reported that legal take is declining  
381 further (Fiji: M. Raicebe pers. comm.; Cayman Islands: J. Blumenthal pers. comm.).

382

383 However, when considering current legal take it should be put in the context of the wider  
384 global threats to marine turtles, such as climate change and habitat degradation highlighted as  
385 conservation priorities by turtle researchers (Hamann *et al.*, 2010). This study has shown that  
386 the relative impact of legal take on mortality could be less than the bycatch estimates from  
387 the Mediterranean alone (Casale, 2011). However further assessments are warranted to  
388 understand where conservation priorities should be focussed due to the paucity of up to date  
389 data on direct take, and a lack of both direct take and bycatch information from small-scale  
390 fisheries.

391



392 Despite a loss of traditions, turtles remain culturally significant in many countries in this  
393 study (especially within Pacific islands), and it is the desire to protect this important cultural  
394 resource that has led to control measures on turtle take by governments and traditional  
395 authorities (Adams, 2003). Cultural strengthening can play a role in resource management,  
396 and the high status awarded to turtles can provide powerful incentives for conservation and  
397 management (Adams, 2003; Hickey & Johannes, 2002). Research has indicated that with  
398 appropriate management, even depleted populations could recover whilst maintaining a level  
399 of take (Chaloupka & Balazs, 2007); although defining what level is sustainable involves a  
400 greater knowledge of the threats and links between legal, illegal and bycatch mortality of  
401 targeted turtle populations (Hamann *et al.*, 2010).

402 **ACKNOWLEDGEMENTS**

403 The authors would like to those who provided data, assistance and comments on direct turtle  
404 take including Semese Alefaio, Mohamud Hassan Ali, Diego Amorocho, Marcio Aronne,  
405 Althea Arthurton, Jorge Azocar, Laurence Bachet, George Balazs, Patrice Bartholomew, Lui  
406 Bell, Karin Bilo, Carl-Jørgen Bindslev, Janice Blumenthal, Liza Boura, Nathalie Breheret,  
407 Michael Brooke, Donald Buden, Charles Caillouet, Carlos Cantu, Michelle Cazabon, Claudia  
408 Ceballos, Didiher Chacon, Rodolfo Chang, Michele Christian, Mykl Clovis-Fuller, Nathaniel  
409 Cornuet, Eduardo Cuevas, Sam Davies, Carlos Delgado, Monte Depaune, Kiki Dethmers,  
410 Hussein Yussuf Dualeh, Stephen Dunbar, Karen Eckert, Lucine Edwards, Abdalla Nassir  
411 Elawad, Rudy van der Elst, Environmental Protection Agency Guyana, Richard Farman,  
412 Marina Fastigi, Marie-Louise Felix, Lara Ferreira, Rogério Ferreira, Angela Formia, Jack  
413 Frazier, Katy Garland, Alexandre Girard, Shannon Gore, James Gumbs, Mark Hamann,  
414 Hideo Hatase, Francis Hickey, Tetha Hitipeuw, Julia Horrocks, Crafton Isaac, Asuka  
415 Ishizaki, David Jaén, Emma Kabua, Michelle Kalamandeen, Vince Kerr, Jeff Kinch, Tarik  
416 Kupusovic, Donna Kwan, Cythnia Lagueux, Thomas Le Berre, Carl Lloyd, Tricia Lovell,  
417 Isaias Majil, Agnese Mancini, Rosalie Masu, Mike McCoy, Carolina Montalván, Dae Yeon  
418 Moon, Bruno Mugneret, Elizabeth Munro, Maggie Muurmans, Poasi Fale Ngaluafe, Wallace  
419 J. Nicholls, Steven Palik, Nancy Papathanasopoulou, Emile Pemberton, Ray Pierce, Nicolas  
420 J. Pilcher, Alwyn Ponteen, Peter Pritchard, Meli Raicebe, Christian Ramofafia, Caroline  
421 Reddy, Alan Rees, Adib Saad, Lidia Salinas, Linda Searle, Tom Stringell, Hiroyuki  
422 Suganuma, Lise Suveinakama, James Tafatu, Nenenteiti Teariki-Ruatu, Tara Teel, Dawit  
423 Tesfamichael, Yannick Tessier, Turang Teuea-Favae, Tokyo Metropolitan Government,  
424 Jorge Torrens, Feleti Tulafono, Bishnu Tulsie, Falasese Tupau, Neomai Turaganivalu-Ravitu,  
425 Nancy VanderVelde, Hilde Vanleeuwe, Colette Wabnitz, Juney Ward, Michael White, Jean  
426 Wiener, I.B.Windia Adnyana and Sarita Williams-Peter.

427   ACB and BJG would like to thank the UK Darwin Initiative for the Survival of Species. FH  
428   would like thank Blue Ventures Conservation for their support. We acknowledge the help of  
429   Samir Gandhi in the production of Figs 3, 4, S2 and S3. The authors also acknowledge the  
430   input of the Editor and the three reviewers that helped improve the manuscript.

431 **REFERENCES**

432

433 Adams, T. (2003) *Turtle fisheries in the Pacific Community area*. Marine Resources

434 Division, Secretariat of the Pacific Community, New Caledonia.

435

436 Aiken, J.J., Godley, B.J., Broderick, A.C., Austin, T., Ebanks-Petrie, G. & Hays, C.G. (2001)

437 Two hundred years after a commercial marine turtle fishery: the current status of marine

438 turtles nesting in the Cayman Islands. *Oryx*, **35**, 145–151.

439

440 Alfaro Shigueto, J., Mangel, J., Bernedo, F., Dutton, P.H., Seminoff, J.A. & Godley, B.

441 (2011) Small-scale fisheries of Peru: a major sink for marine turtles in the Pacific. *Journal of*

442 *Applied Ecology*, **48**, 1432–1440.

443

444 Allen, M.S. (2007) Three millennia of human and sea turtle interactions in Remote Oceania.

445 *Coral Reefs*, **26**, 959–970.

446

447 Andrews, H.V., Tripathy, A., Aghue, S., Glen, S., John, S. & Naveen, K. (2006) The status of

448 sea turtle populations in the Andaman and Nicobar Islands of India. *Towards an Integrated*

449 *and Collaborative Sea Turtle Conservation Programme in India: a UNEP/CMS-IOSEA*

450 *Project Report* (ed. by K. Shanker and H.V. Andrews), pp. 71-82. Centre for

451 Herpetology/Madras Crocodile Bank Trust, Tamil Nadu.

452

453 Australian Government (2013) Traditional Use of Marine Resources Agreements. Available

454 from <http://www.gbrmpa.gov.au/our-partners/traditional-owners/traditional-use-of-marine->

455 [resources-agreements](http://www.gbrmpa.gov.au/our-partners/traditional-owners/traditional-use-of-marine-resources-agreements) (accessed July 2013).

456

457 Aylesworth, A. (2009) *Oceania regional assessment: Pacific island fisheries and interactions*  
458 *with marine mammals, seabirds, and sea turtles*. Project GloBAL, Beaufort, North Carolina.  
459 Available from <http://bycatch.env.duke.edu> (accessed October 2010).

460

461 Babcock, H.L. (1938) The sea-turtles of the Bermuda Islands, with a survey of the present  
462 state of the turtle fishing industry. *Proceedings of the Zoological Society of London (A)*, **107**,  
463 595-601.

464

465 Bell, C., Solomon, J., Blumenthal, J., Austin, T., Ebanks-Petrie, G., Broderick, A. & Godley,  
466 B. (2007) Monitoring and conservation of critically reduced marine turtle nesting  
467 populations: lessons from the Cayman Islands. *Animal Conservation*, **10**, 39-47.

468

469 Bell, L.A.J., Favae, T.T., Nenenteiti, T.-R., Bebe, R., Anderson, P. & Siota, C. (2010)  
470 *Kiribati marine turtles profile*. Secretariat of the Pacific Regional Environment Programme  
471 (SPREP), Apia.

472

473 Bräutigam, A. & Eckert, K.L. (2006) *Turning the tide: exploitation, trade and management*  
474 *of marine turtles in the Lesser Antilles, Central America, Colombia and Venezuela*.  
475 TRAFFIC International, Cambridge, UK.

476

477 Brikke, S. (2009) Local perceptions of sea turtles on Bora Bora and Maupiti islands, French  
478 Polynesia. *SPC Traditional Marine Resource Management and Knowledge Information*  
479 *Bulletin*, **26**, 23 - 28.

480

481 Broderick, A.C., Frauenstein, R., Glen, F., Hays, G.C., Jackson, A.L., Pelembe, T., Ruxton,  
482 G.D. & Godley, B.J. (2006) Are green turtles globally endangered? *Global Ecology and*  
483 *Biogeography*, **15**, 21-26.

484

485 Broderick, D. (1998) *Subsistence hunting of marine turtles in the Solomon Islands. Patterns*  
486 *of resource use in Kia, Wagina and Katupika communities, Isabel and Choiseul Provinces.*  
487 Report to the Ministry of Forests, Environment and Conservation and the Ministry of  
488 Agriculture and Fisheries, Solomon Island Government.

489

490 Buden, D.W. & Edward, A. (2001) Abundance and Utilization of Sea Turtles on Pohnpei,  
491 Federated States of Micronesia: Islanders' Perceptions. *Micronesica*, **34**, 47–54.

492

493 Campbell, C.L. (2003) *Population assessment and management needs of a green turtle,*  
494 *Chelonia mydas, population in the western Caribbean* Doctor of Philosophy, University of  
495 Florida.

496

497 Cantú, J.C. & Sanchez, M.E. (1999) *Trade in sea turtle products in Mexico.* Teyeliz A.C.,  
498 Mexico.

499

500 Casale, P. (2011) Sea turtle by-catch in the Mediterranean. *Fish and Fisheries*, **12**, 299–316.

501 Catry, P., Barbosa, C., Paris, B., Indjai, B., Almeida, A., Limoges, B., Silva, C. & Pereira, H.  
502 (2009) Status, ecology, and conservation of sea turtles in Guinea-Bissau. *Chelonian*  
503 *Conservation and Biology*, **8**, 150–160.

504

505 Chaloupka, M. & Balazs, G.H. (2007) Using Bayesian state-space modelling to assess the  
506 recovery and harvest potential of the Hawaiian green sea turtle stock. *Ecological Modelling*,  
507 **205**, 93-109.

508

509 Chaloupka, M., Bjørndal, K., Balazs, G.H., Bolten, A.B., Ehrhart, L.M., Limpus, C.J.,  
510 Suganuma, H., Troëng, S. & Yamaguchi, M. (2008) Encouraging outlook for recovery of a  
511 once severely exploited marine megaherbivore. *Global Ecology and Biogeography*, **17**, 297–  
512 304.

513

514 Cornelius, S.E., Arauz, R., Fretey, J., Godfrey, M.H., Márquez-M, R. & Shanker, K. (2007)  
515 Effect of land-based harvest of *Lepidochelys* *Biology and Conservation of Ridley Sea Turtles*  
516 (ed. by P.T. Plotkin), pp. 231-251. The Johns Hopkins University Press, Baltimore.

517

518 Daley, B., Griggs, P. & Marsh, H. (2008) Exploiting marine wildlife in Queensland: The  
519 commercial dugong and marine turtle fisheries, 1847–1969. *Australian Economic History*  
520 *Review*, **48**, 227-265.

521

522 Eckert, K.L., Overing, J.A. & Lettsome, B.B. (1992) *WIDECAST Sea Turtle Recovery Action*  
523 *Plan for the British Virgin Islands*. CEP Technical Report No. 15. UNEP Caribbean  
524 Environment Programme, Kingston, Jamaica.

525

526 FAO (2011) *FishStatJ - software for fishery statistical time series Version 2.0.0*. Food and  
527 Agriculture Organization of the United Nations. Available at:  
528 <http://www.fao.org/fishery/statistics/software/fishstatj/en> (downloaded 2 March 2013).

529

530 Finkbeiner, E.M., Wallace, B.P., Moore, J.E., Lewison, R., Crowder, L.B. & Read, A.J.  
531 (2011) Cumulative estimates of sea turtle bycatch and mortality in USA fisheries between  
532 1990 and 2007. *Biological Conservation*, **144**, 2719-2727.

533

534 Fleming, E.H. (2001) *Swimming against the tide: Recent surveys of exploitation, trade, and*  
535 *management of marine turtles in the northern Caribbean*. TRAFFIC North America.  
536 Washington, D. C.

537

538 Fleming, E.H. (2001) *Swimming against the tide: Recent surveys of exploitation, trade, and*  
539 *management of marine turtles in the northern Caribbean*. TRAFFIC North America.  
540 Washington, D. C.

541

542 Frazier, J. (1980) Exploitation of marine turtles in the Indian Ocean. *Human Ecology*, **8**, 329-  
543 370.

544

545 Frazier, J. (2003) Prehistoric and ancient historic interactions between humans and  
546 marine turtles. *The biology of sea turtles, Volume II* (ed. by P.L. Lutz, J.A. Musick and J.  
547 Wyneken), Vol. 2, pp. 1– 38. CRC Press, Boca Raton, FL.

548

549 Fuller, J.E., Eckert, K.L. & Richardson, J.I. (1992) *WIDECAST Sea Turtle Recovery Action*  
550 *Plan for Antigua and Barbuda*. CEP Technical Report No. 16. UNEP Caribbean  
551 Environment Programme, Kingston, Jamaica.

552

553 Godley, B.J., Broderick, A.C., Campbell, L.M., Ranger, S. & Richardson, P. (2004). *An*  
554 *assessment of the status and exploitation of marine turtles in the United Kingdom Overseas*



555 *Territories in the Wider Caribbean*. Final project report for the Department of Environment,  
556 Food and Rural Affairs and the Foreign and Commonwealth Office.

557

558 Groombridge, B. & Luxmoore, R. (1989) *The green turtle and hawksbill (Reptilia:*  
559 *Cheloniidae): world status, exploitation and trade*. CITES Secretariat of the Convention on  
560 International Trade in Endangered Species of Wild Flora and Fauna, Cambridge.

561

562 Hamann, M., Godfrey, M.H., Seminoff, J.A., Arthur, K., Barata, P.C.R., Bjorndal, K.A.,  
563 Bolten, A.B., Broderick, A.C., Campbell, L.M., Carreras, C., Casale, P., Chaloupka, M.,  
564 Chan, S.K.F., Coyne, M.S., Crowder, L.B., Diez, C.E., Dutton, P.H., Epperly, S.P.,  
565 FitzSimmons, N.N., Formia, A., Girondot, M., Hays, G.C., Jiunn, C.I., Kaska, Y., Lewison,  
566 R., Mortimer, J.A., Nichols, W.J., Reina, R.D., Shanker, K., Spotila, J.R., Tomás, J., Wallace,  
567 B.P., Work, T.M., Zbinden, J. & Godley, B.J. (2010) Global research priorities for sea turtles:  
568 informing management and conservation in the 21st century. *Endangered Species Research*,  
569 **11**, 245–269.

570

571 Hamann, M., Limpus, C.J., Hughes, G., Mortimer, J.A. & Pilcher, N.J. (2006) *Assessment of*  
572 *the conservation status of the Leatherback turtle in the Indian Ocean and South East Asia,*  
573 *including consideration of the impacts of the December 2004 tsunami on turtles and turtle*  
574 *habitats*. IOSEA Marine Turtle MoU Secretariat, Bangkok.

575

576 Harris, E.H. & George, S. (2008) *Nesting Ecology and Conservation of Marine Turtles in the*  
577 *Commonwealth of Dominica, West Indies: 2008 Annual Project Report* (ed. by K.L. Eckert).  
578 Prepared by the Dominica Sea Turtle Conservation Organization (DomSeTCO), in

579 partnership with WIDECAST, for the Ministry of Agriculture, Fisheries and Forestry  
580 (Forestry, Wildlife and Parks Division). Roseau, Dominica, West Indies.  
581

582 Havea, S. & MacKay, K.T. (2009) Marine turtle hunting in the Ha'apai Group, Tonga.  
583 *Marine Turtle Newsletter*, **123**, 15-17.  
584

585 Hickey, F. (2003) Traditional marine resource management in Vanuatu: world views in  
586 transformation; sacred & profane. *Putting Fishers' Knowledge to Work, Fisheries Centre*  
587 *Research Reports 2002 Volume 11 Number 1* (ed. by N. Haggan, C. Brignall and L. Wood),  
588 pp. 117-137. Fisheries Centre, University of British Columbia, Canada.  
589

590 Hickey, F., R & Johannes, R. (2002) Recent evolution of village based marine resource  
591 management in Vanuatu. *SPC Traditional Marine Resource Management and Knowledge*  
592 *Information Bulletin*, **13**, 8-21.  
593

594 Holland, M. (2013) *Horror video shows sea turtles and dugongs being killed in barbaric*  
595 *fashion by Torres Strait Islanders*. July 1, 2013. The Daily Telegraph (Australia). Available  
596 from: [http://www.dailytelegraph.com.au/news/nsw/torres-strait-islanders-hunting-animals-](http://www.dailytelegraph.com.au/news/nsw/torres-strait-islanders-hunting-animals-under-native-titles-act-slammed-by-animal-welfare-groups/story-fni0cx12-1226672204034)  
597 [under-native-titles-act-slammed-by-animal-welfare-groups/story-fni0cx12-1226672204034](http://www.dailytelegraph.com.au/news/nsw/torres-strait-islanders-hunting-animals-under-native-titles-act-slammed-by-animal-welfare-groups/story-fni0cx12-1226672204034)  
598 (accessed July 2013).  
599

600 Hoyle, M. (1994) Continuing sea turtle exploitation in Antigua and Barbuda, West Indies.  
601 *Marine Turtle Newsletter*, **64**, 21-22.  
602

603 Humber, F., Godley, B.J., Ramahery, V. & Broderick, A.C. (2011) Using community  
604 members to assess artisanal fisheries: the marine turtle fishery in Madagascar. *Animal*  
605 *Conservation*, **14**, 175–185.

606

607 IUCN (2013) *IUCN Red List of threatened species, version 2013.1*. Available at:  
608 <http://www.iucnredlist.org> (accessed March 2013).

609

610 Jackson, J.B.C. (1997) Reefs since Columbus. *Coral Reefs*, **16** (Suppl), S23-S32.

611

612 Johannes, R. & MacFarlane, W. (1991) Sea turtles. *Traditional fishing in the Torres Strait*  
613 *Islands*, pp. 53-71. CSIRO Division of Fisheries, Hobart.

614

615 Kare, B.D. (1995) A review on the research and fisheries of barramundi, reef fish, dugongs,  
616 turtles and Spanish mackerel in the Papua New Guinea side of the Torres Strait. *Joint*  
617 *FFA/SPC workshop on the management of South Pacific inshore fisheries*. South Pacific  
618 Commission, Noumea, New Caledonia.

619

620 Kennett, R., Mununguritj, N. & Yunupingu, D. (1998) The Dhimurru Miyapunu Project.  
621 *Marine turtle conservation and management in northern Australia, Proceedings of a*  
622 *workshop held at the Northern Territory University, Darwin, 3–4 June 1997* (ed. by R.  
623 Kennett, A. Webb, G. Duff, M. Guinea and G. Hill), pp. 69-75. Centre for Indigenous Natural  
624 and Cultural Resource Management & Centre for Tropical Wetlands Management, Northern  
625 Territory University, Darwin.

626

627 Kennett, R. & Kitchens, J. (2009) *Dugong and Marine Turtle Project. Project Final Report*  
628 *to National Heritage Trust Regional Competitive Component*. North Australian Indigenous  
629 Land & Sea Management Alliance, Darwin.

630

631 Kinch, J. (2002) *The development of a monitoring program for the management and*  
632 *sustainable use of sea turtle resources in the Milne Bay Province, Papua New Guinea*. A  
633 proposal prepared for the South Pacific Regional Environment Program, Apia, Western  
634 Samoa.

635

636 Koch, V., Nichols, W.J., Peckhamb, H. & Toba, V.d.l. (2006) Estimates of sea turtle  
637 mortality from poaching and bycatch in Bahía Magdalena, Baja California Sur, Mexico.  
638 *Biological Conservation*, **128**, 327 – 334.

639

640 Lagueux, C.J., Campbell, C. & McCoy, M.A. (2003) Nesting and conservation of the  
641 hawksbill turtle, *Eretmochelys imbricata*, in the Pearly Cays, Nicaragua. *Chelonian*  
642 *Conservation and Biology*, **4**, 588–602.

643

644 Lam, T., Ling, X., Takahashi, S. & Burgess, E.A. (2011) *Market forces: An examination of*  
645 *marine turtle trade in China and Japan*. TRAFFIC East Asia, Hong Kong.

646

647 Lewis, C.B. (1940) The Cayman Islands and marine turtles. *Herpetology of the Cayman*  
648 *Islands. Bulletin of the Institute of Jamaican Sciences Series, no. 2* (ed. by C. Grant), pp. 56-  
649 65. Institute of Jamaica, Kingston.

650

651 Limpus, C.J. (1980) The green turtle, *Chelonia mydas* (L), in eastern Australia. *Management*  
652 *of turtle resources. Research Monograph 2* pp. 5-22. James Cook University of North  
653 Queensland, Townsville.

654

655 Limpus, C.J. & Parmenter, C.J. (1986) The sea turtle resources of the Torres Strait region.  
656 *Torres Strait Fisheries Seminar* (ed. by A.K. Haines, G.C. Willimans and D. Coates), pp. 95-  
657 107. Canberra Publishing and Printing Company, Canberra.

658

659 Limpus, C.J. (2008) *A biological review of Australian marine turtles. 2. Green Turtle*  
660 *Chelonia mydas (Linnaeus)*. Queensland Government Environmental Protection Agency.

661

662 Limpus, C.J., Boyle, M. & Sunderland, T. (2006) New Caledonian loggerhead turtle  
663 population assessment: 2005 Pilot Study. *Proceedings of the Second Western Pacific Sea*  
664 *Turtle Cooperative Research and Management Workshop. Volume II: North Pacific*  
665 *Loggerhead Sea Turtle* (ed. By I. Kinan), Western Pacific Regional Fishery Management  
666 Council, pp.77-92. Honolulu.

667

668 Maison, K.A., Kinan-Kelly, I. & Frutchey, K.P. (2010) *Green turtle nesting sites and sea*  
669 *turtle legislation throughout Oceania*. U.S. Dep. Commerce, NOAA Technical  
670 Memorandum. NMFS-F/SPO-110.

671

672 Mancini, A., Senko, J., Borquez-Reyes, R., Póo, J.G., Seminoff, J.A. & Koch, V. (2011) To  
673 poach or not to poach an endangered species: elucidating the economic and social drivers  
674 behind illegal sea turtle hunting in Baja California Sur, Mexico. *Human Ecology*, **39**, 743-  
675 756.

676

677 Marco, A., López, O., Abella, E., Varo, N., Martins, S., Gaona, P., Sanz, P. & López-Jurado,  
678 L.F. (2010) Massive capture of nesting females is severely threatening the Caboverdian  
679 loggerhead population. *Proceedings of the Twenty-eighth Annual Symposium on Sea Turtle*  
680 *Biology and Conservation* (ed by K. Dean and M.C. Lopez-Castro). NOAA Technical  
681 Memorandum NMFS-SEFSC-602, pp. 93-94. Miami.

682

683 Martin, C.S., Jeffers, J. & Godley, B.J. (2005) The status of marine turtles in Montserrat  
684 (Eastern Caribbean). *Animal Biodiversity and Conservation*, **28.2**, 159–168.

685

686 McClenachan, L., Jackson, J.B.C. & Newman, M.J.H. (2006) Conservation implications of  
687 historic sea turtle nesting beach loss. *Frontiers in Ecology and the Environment*, **4**, 290–296.

688

689 Milliken, T. & Tokunaga, H. (1987) *The Japanese sea turtle trade, 1970-1986. A Special*  
690 *Report prepared by TRAFFIC (Japan)*. The Center for Environmental Education,  
691 Washington D. C.

692

693 Moore, M.K., Bemiss, J.A., Rice, S.M., Quattro, J.M. & Woodley, C.M. (2003) Use of  
694 restriction fragment length polymorphisms to identify sea turtle eggs and cooked meats to  
695 species. *Conservation Genetics*, **4**, 95–103.

696

697 Mrosovsky, N. (1996) Sea turtles. Past and present utilisation. *Wildlife resources. A global*  
698 *account of economic use* (ed. by H.H. Roth and G. Mertz), pp. 88-96. Springer, Toronto.

699

700 Mrosovsky, N. (2003) *Predicting extinction: fundamental flaws in IUCN's Red List system,*  
701 *exemplified by the case of sea turtles.* Available at: <http://members.seaturtle.org/mrosovsky/>.

702

703 Nada, M. & Casale, P. (2008) *Marine turtles in the Mediterranean Egypt: threats and*  
704 *conservation priorities.* WWF Italy, Rome.

705

706 National Marine Fisheries Service & U.S. Fish and Wildlife Service (1998) *Recovery plan for*  
707 *U.S. Pacific populations of the East Pacific green turtle (Chelonia mydas).* National Marine  
708 Fisheries Service, Silver Spring, MD.

709

710 Nichols, W.J. (2003) *Biology and conservation of sea turtles in Baja California, Mexico.*  
711 Doctor of Philosophy with a major in wildlife ecology University of Arizona, Tucson.

712

713 Peckham, S.H., Maldonado-Diaz, D., Koch, V., Mancini, A., Gaos, A., Tinker, M.T. &  
714 Nichols, W.J. (2008) High mortality of loggerhead turtles due to bycatch, human  
715 consumption and strandings at Baja California Sur, Mexico, 2003 to 2007. *Endangered*  
716 *Species Research*, **5**, 171–183.

717

718 Peñate, J.G., Karamoko, M., Bamba, S. & Djadji, G. (2007) An update on marine turtles in  
719 Côte d'Ivoire, West Africa. *Marine Turtle Newsletter*, **116**, 7-8.

720

721 Petro, G., Hickey, F., R & Mackay, K. (2007) Leatherback turtles in Vanuatu. *Chelonian*  
722 *Conservation and Biology*, **6**, 135-137.

723

724 Pritchard, P.C.H. (2003) Global Status of Sea Turtles: An Overview. *Inter-American*  
725 *Convention for the Protection and Conservation of Sea Turtles First Meeting of the Parties,*  
726 *Final Report* (ed. by IAC Secretariat), pp. 81-93. Secretariat Pro Tempore, Inter-American  
727 Convention for the Protection and Conservation of Sea Turtles, San José, Costa Rica.  
728

729 Reuter, A. & Allan, C. (2006) *Tourists, Turtles and Trinkets: a look at the trade in marine*  
730 *turtle products in the Dominican Republic and Colombia.* TRAFFIC North America,  
731 Washington D.C.  
732

733 Richardson, P., Broderick, A., Campbell, L., Godley, B. & Ranger, S. (2006) Marine turtle  
734 fisheries in the UK Overseas Territories of the Caribbean: Domestic legislation and the  
735 requirements of multilateral agreements. *Journal of International Wildlife Law and Policy*, **9**,  
736 223–246.  
737

738 Rudrud, R.W. (2010) Forbidden sea turtles: Traditional laws pertaining to sea turtle  
739 consumption in Polynesia (including the Polynesian Outliers). *Conservation and Society*, **8**,  
740 84-97.  
741

742 Rudrud, R.W., Kroeker, J.W., Leslie, H.Y. & Finney, S.S. (2007) The sea turtle wars:  
743 Culture, war and sea turtles in The Republic of the Marshall Islands. *SPC Traditional Marine*  
744 *Resource Management and Knowledge Information* **21**, 3-29.  
745

746 Stoddart, D.R. (1980) Little Cayman: ecology and significance. *Atoll Research Bulletin*, **241**,  
747 171-180.  
748



749 van Dijk, P.P. & Shepherd, C.R. (2004) *Shelled out? A Snapshot of bekk trade in selected*  
750 *locations in south-east Asia*. TRAFFIC, Southeast Asia.

751

752 Vander Velde, N. (2008) *A sea turtle genetic sampling, data collection and analysis project*  
753 *in the Marshall Islands*. Women United Together in the Marshall Islands (WUTMI), Majuro.

754

755 Wallace, B.P., Lewison, R., McDonald, S.L., McDonald, R.K., Kot, C.Y., Kelez, S.,  
756 Bjorkland, R.K., Finkbeiner, E.M., Helmbrecht, S. & Crowder, L.B. (2010) Global patterns  
757 of marine turtle bycatch. *Conservation Letters*, **3**, 1–12.

758

759 Wayne King, F. (1995) Historical review of the decline of the green turtle and the hawksbill.  
760 *Biology and Conservation of Sea Turtles. Revised Edition* (ed. by K.A. Bjorndal), pp. 183-  
761 188. Smithsonian Institution Press, Washington D.C.

762

763 WWF (2005) *Recent news from the WWF Africa & Madagascar marine turtle programme*.  
764 WWF, Gland.

## **BIOSKETCH**

Frances Humber is Conservation Programmes Manager at Blue Ventures Conservation and a PhD student at the University of Exeter. She is interested in increasing the knowledge of the status of traditional and artisanal fisheries through community-based assessment, in particular the traditional shark and turtle fisheries of Madagascar.

Annette Broderick is a Senior Lecture in Conservation Biology at the Centre for Ecology and Conservation, University of Exeter. Her research focuses on the exploitation and status of marine vertebrate populations, in particular marine turtles.

Brendan Godley is Professor of Conservation Science at the Centre for Ecology and Conservation, University of Exeter. His research largely focuses on the study of marine vertebrates, but more recently has involved invasive species and the impacts of renewable energy facilities.

F.H., A.B and B.G conceived the ideas; F.H collected and analysed the data, and led the writing.

## FIGURE LEGENDS

**Figure 1.** The number of countries or territories that permit the direct take of turtles (as of 1st January 2013) showing type of legislation in place or absence. N = Protection absent; L = Legislation allows for a level of harvest of one or more species of turtles; T = Full protection but traditional hunting exemptions exist; M = Moratorium in place only at present; U = Unable to verify legislation.

**Figure 2.** The current estimate of annual legal take by species (n = 42 countries) (data from 1st January 2010 to 1st January 2013). O. Ridley = Olive Ridley; K. Ridley = Kemp's Ridley.

**Figure 3.** Estimated current annual legal marine turtle take by country or territory (data from 1st January 2010 to 1st January 2013). Data for the Caribbean (CAR) and Pacific (PAC) regions have been grouped and are shown in further detail in Figures 4(a) and 4(b). No take = no known legal or illegal take; Unquantified take = illegal take data found only or take known to occur but no data available. \* = Country with moratorium.

Country abbreviations (countries in brackets indicate dependency): ALB = Albania; AND = Andaman and Nicobar Islands (India); AUS = Australia; BOS = Bosnia and Herzegovina; CHI = Chile; COP = Colombia (Pacific coast); GUY = Guyana; IND = Indonesia; JAP = Japan; KIR = Kiribati; MAL = Maldives; MAR = Marshall Islands; MIC = Federated States of Micronesia; MXA = Mexico (Atlantic coast); MXP = Mexico (Pacific coast); PAL = Palau; PAP = Papua New Guinea; PIT = Pitcairn Islands (UK); SAO = Sao Tome and Principe; SYR = Syria.

Take is also shown for countries with unverified legislation (ALG = Algeria; NKO = North Korea; SOM = Somalia).

Note: Position of symbols is not representative of locations of take data.

**Figure 4.** Estimated annual current legal marine turtle take for (a) the Caribbean and (b) the Pacific regions highlighted in Figure 3 (data from 1st January 2010 to 1st January 2013). No take = no known legal or illegal take; Unquantified take = illegal take data found only or take known to occur but no data available. \* = Country with moratorium.

Country abbreviations (countries in brackets indicate dependency): Figure 4a: ANG = Anguilla (UK); ANT = Antigua and Barbuda; BEL = Belize; BRI = British Virgin Islands (UK); CAY = Cayman Islands (UK); COA = Colombia (Atlantic coast); DOM = Dominica; GRE = Grenada; HAI = Haiti; HON = Honduras; MON = Montserrat (UK); NIA = Nicaragua (Atlantic coast); STK = St. Kitts and Nevis; STL = St. Lucia; STV = St. Vincent and the Grenadines; TUR = Turks and Caicos.

Take is also shown for countries with unverified legislation: PAA = Panama (Atlantic coast). This take was not included in grouped take CAR in Figure 3.

Country abbreviations (countries in brackets indicate dependency): Figure 4b: COO = Cook Islands (New Zealand); FIJ = Fiji; NAU = Nauru; NEW = New Caledonia (France); NIU = Niue; SAM = Samoa; SOL = Solomon Islands; TOK = Tokelau (New Zealand); TON = Tonga; TUV = Tuvalu; VAN = Vanuatu; WAL = Wallis and Futuna (France).

Note: Position of symbols is not representative of locations of take data.

**Figure 5.** The ten countries with the highest annual legal take of marine turtles as of 1<sup>st</sup> January 2013. Country abbreviations are: PAP = Papua New Guinea, NIA = Nicaragua (Atlantic coast), AUS = Australia, COA = Colombia (Atlantic coast), SOL = Solomon Islands, PAL = Palau, HAI = Haiti, TON = Tonga, SAO = Sao Tome and Principe; STV = St. Vincent and the Grenadines. \*Legislation prohibits take in Principe only since 2009.

**Figure 6.** The estimated annual legal take of turtles per decade since 1980 for those countries and territories (n = 46) within this study, including those with current moratoria. Current represents data from 1st January 2010 to 1st January 2013 and does not include countries with current moratoria (n = 42).

## FIGURES

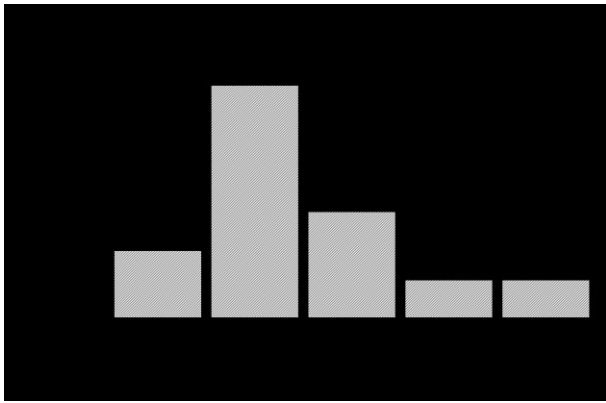
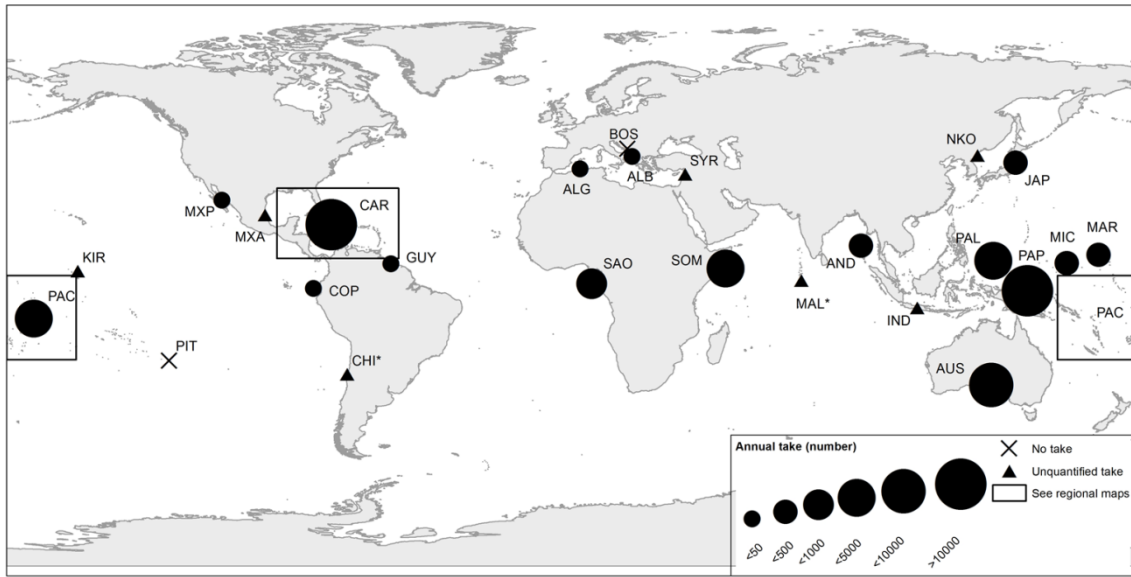


Figure 1.

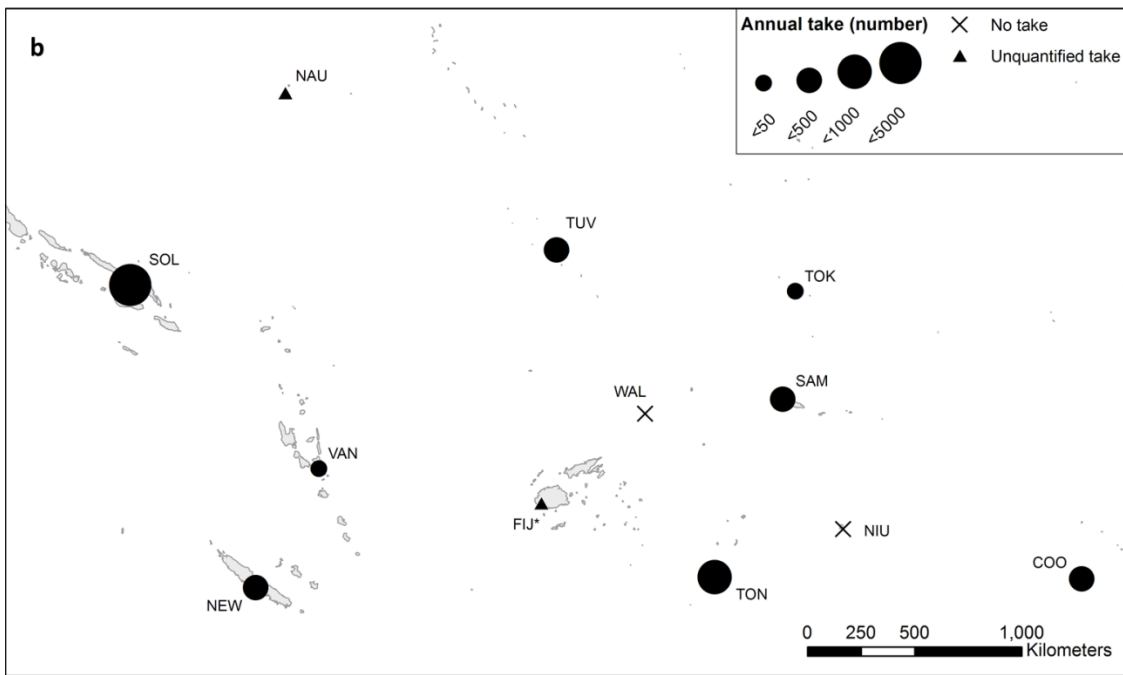
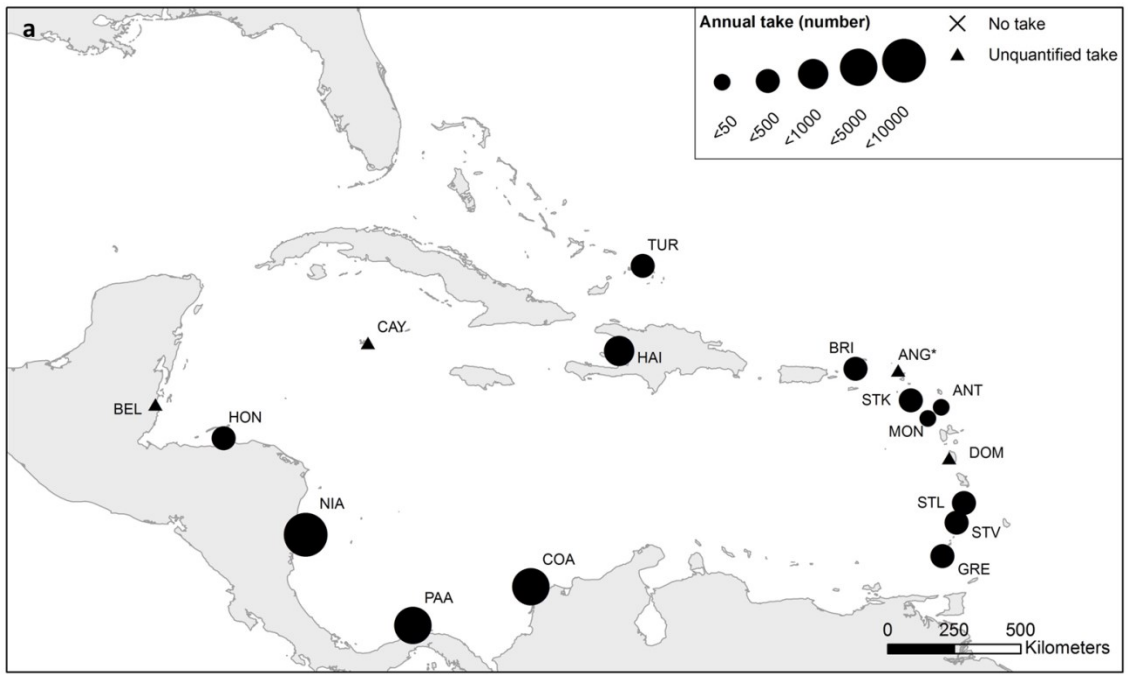


**Figure 2.**

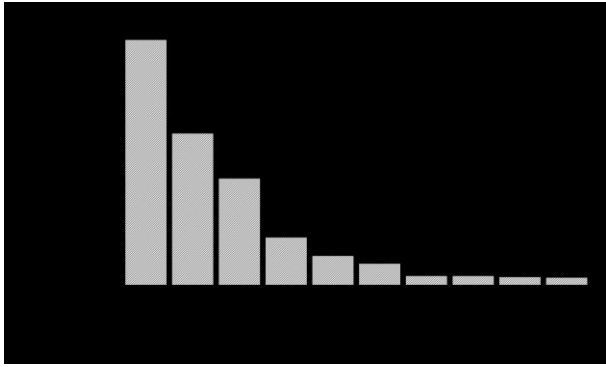


**Figure 3.**

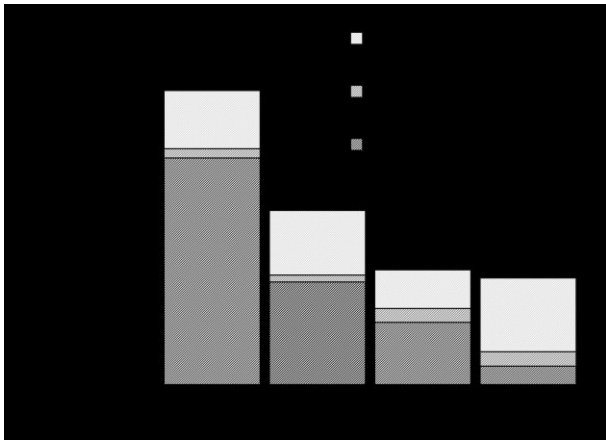




**Figure 4.**



**Figure 5.**



**Figure 6.**

## **SUPPORTING INFORMATION**

Additional Supporting Information may be found in the online version of this article:

Figure S1 Estimated past annual turtle take.

Figure S2 Estimated global breakdown by species.

Figure S3 Regional estimated global breakdown by species.

Figure S4 Top countries by species for current estimated annual take.

Table S1 Estimated current annual take by species.

Appendix S1 Supporting references.