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1 Title: Reconstructing the history of ocean wildlife around Ascension Island

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Abstract

1. In 2016, the UK government announced plans for a large-scale Marine Protected Area (MPA) around Ascension Island, a UK Overseas Territory in the South Atlantic.
2. To improve baselines for marine life to support ambitious conservation and assess change over time, archives were searched for historical accounts of wildlife from Ascension's discovery in 1501 to the present. For more recent changes, 139 interviews with past and present inhabitants were conducted.
3. Ascension's marine life has, from first discovery to the present, been consistently remarked upon for its exceptional abundance. Historical sources indicate declines in seabird and turtle populations from human exploitation and introduction of rats and cats. They are recovering with good management although still below pre-settlement abundance.
4. Interviews with residents indicate more recent changes, notably declines in catch per unit of fishing effort at popular shore angling sites, a decline in yellowfin tuna (*Thunnus albacares*) and increase in Galapagos sharks (*Carcharhinus galapagensis*).
5. What is very notable, however, based on the interviews, was that there was no temporal signal suggestive of recent systemic decline, in marked contrast to many parts of the world where recent wildlife declines have been pervasive and steep. Ascension represents a remarkable and immensely important centre of abundance in a sea of depletion and change, warranting full protection for all the island's waters.

Keywords: Ocean, island, conservation evaluation, Marine Protected Area, fishing

1. Introduction

Throughout history, marine environments have been exploited for living resources (Lotze, 2004; Lotze & Worm, 2009), progressively altering them, often over centuries (Jackson et al., 2001; Roberts, 2007). Where changes occur slowly, it can be hard to establish the extent of habitat modification through human activity (Lotze & Milewski, 2004), often resulting in confusion between altered and natural systems (Jackson *et al*. 2001). The concept of "shifting baselines" was introduced to describe intergenerational changes in perception of an ecosystem's natural state (Pauly, 1995). The phenomenon accounts for how ecosystems can progressively decline in condition unnoticed (Pinnegar & Engelhard, 2008), or conservation goals be set to maintain degraded conditions rather than recover more abundant, diverse wildlife (Plumeridge and Roberts, 2017).

To help counteract shifting baselines, historical data and perspectives can be used to develop understanding of long-term anthropogenic change (Lotze & Worm, 2009), that can be integrated into marine science and management (Engelhard et al., 2015). Historical data can be used, for example, to make stronger cases for marine protected areas (Bunce, Rodwell, Gibb & Mee, 2008; Zapelini, Giglio, Carvalho, Bender & Gerhardinger, 2017) or to select sites or targets for restoration (Braje, Rick, Erlandson, Rogers-Bennett & Catton, 2015). In a similar vein, Local Ecological Knowledge (LEK - hereby defined as information based on observations and experiences of the local environment, to provide largely qualitative measures of its condition, Turvey *et al*., 2014) is increasingly used to inform marine ecosystem management (Lima, Oliveira, de Nòbrega & Lopes, 2017; Ruddle & Hickey, 2008; Wilson, Raakjær & Degnbol, 2006). Data provided by local people acquired via questionnaires and interviews (e.g. Beaudreau and Levin, 2014; Sáenz-Arroyo & Revollo-Fernández, 2016) have been used to generate information and detailed testimonies about fisheries and target species (Johannes, 1998; Neis *et al*., 1999; Thurstan, Buckley, Ortiz & Pandolfi, 2016; Zapelini et al., 2017). For locations where scientific information

about marine ecosystems is sparse, a combination of approaches including LEK and historical literature can be particularly important (Ainsworth, Pitcher & Rotinsulu, 2008; Lima *et al*., 2017; Neis & Felt, 2000; Zapelini *et al*., 2017).

In this study, a long-term historical perspective on the marine wildlife (focussed on megafauna) of Ascension Island, is provided to inform current efforts to establish an MPA there (The Conservatives, 2015). The aim is to understand how the present abundance of wildlife compares to past states in order to inform appropriate and ambitious conversation goals and protections for the MPA. The study timeframe starts in 1501 when the Portuguese discovered Ascension and charts its settlement from 1815 onwards by the British (Irving, 2015). The human population has always been sparse because of the island's isolation and aridity, which has kept its wildlife relatively undisturbed. Biologically, Ascension's great isolation and young geological age (~1 million years) have resulted in relatively low species diversity but high endemism (Barnes *et al*., 2015; Floeter *et al*., 2008). This combination of anthropogenic and biological features is likely to make Ascension a place of high conservation priority (Kier *et al*., 2009), which warrants effective protection informed by thoroughly researched baselines. There has never been a commercial fishery based from Ascension, although recreational fishing is common, and foreign commercial vessels have fished the Exclusive Economic Zone (EEZ). The limited exploitation contrasts with many other parts of the world ocean where fishing intensity is high, and begs the question: has that made a difference to the status of the Island's waters? Recently one of very few scientific studies (O'Leary *et al*. 2018) on the present status of Ascension's marine life concluded the island's marine biodiversity to be of outstanding biological interest (Brickle, Brown, Küpper & Brewin, 2017). Without extensive quantitative data from studies or fisheries statistics, a more complete reckoning requires a deeper historical perspective (Plumeridge & Roberts, 2017) to inform modern management. This study combines archival and LEK methods to produce a long-term historical timeline of wildlife abundance and change in Ascension's waters.

2. Methods

2.1 Study Site

Ascension Island is a UK Overseas Territory, governed jointly with Tristan da Cunha and St Helena (Irving, 2015). It lies south of the equator in the tropics at 7 56'S, 14 22'W and covers 88 km2 (Figure 1). The nearest land is St Helena island 1300 km southeast. Today, around 800 people inhabit Ascension (McLeod, 2016). There is no commercial fishery operating from the island; only recreational and previously sport fishing operations.

2.2 Literature and Archival Research

To develop a historical picture of marine life associated with Ascension, literature and archival sources were searched for accounts dating from the island's discovery in 1501 to the present. The study was not comprehensive, given time limitations, but archives were explored to find as many sources of historical observations as possible. Sources were obtained online and via visits to the National Archives of the United Kingdom, National Scottish Archives, Bodleian Library Archives, Caird Library, the British Library Archives and Manuscripts, Museum of St Helena, Ascension Island Heritage Society Museum, Cable & Wireless Archive, Ascension Island Heritage Archive, 'The Islander' newspaper archives and St Helena Government Archive.

When all quotes about the marine environment were collated, those that did not make specific reference to abundance were removed. The remaining quotes were grouped into distinct time periods, to reflect the social background to what was witnessed and summarise the results of the quote analysis. Timeframes were delineated to match key phases in the island's history; 1501 – 1814, 1815 – 1922, 1923 – 1983 and 1984 – 2017. All references to sharks were retained because of recent interest following two shark attacks in Ascension in 2017 (BBC News, 2017; Telegraph, 2017).

2.3 Local Ecological Knowledge (LEK) from Interviews

Between July and September 2017, a consented, semi-structured questionnaire (Supporting Information 1) was conducted on 139 past and present residents of Ascension to probe their knowledge and perceptions of the island's marine life. Ninety-two were with current Ascension residents (equating to around 10% of the population); and 44 with ex-residents now retired or re-located to St Helena. Interviews were conducted face to face in the interviewee's homes, workplaces, in public spaces or aboard the 'Royal Mail Ship St Helena' during its passage to or from Ascension. In November 2017, three additional interviews were conducted via Skype with people who no longer lived on Ascension or St Helena.

Interviewees were identified via purposive sampling (Babbie, 2012), under the proviso that respondents had to have experience of the marine environment as either an amateur or professional fisher, or conservationist/naturalist, or as a recreational user, determined through informal discussions and then opening questions in the interview and to ensure appropriate information was gathered from each user group. "Snowballing" then ensued, whereby people interviewed recommended others to approach (Babbie, 2012). These methods are appropriate here due to the small population size and the knowledge of other suitable candidates. All interviews were recorded, and later transcribed, unless permission to record was declined in which case the questionnaire was completed during the interview and used in the analyses in the same way as recorded interviews. Interviews varied in length from 10 minutes to an hour and all but four were conducted individually; in the latter everyone in the group was questioned separately. As two recent shark attacks prompted interviewees to share their experiences, a specific question was asked on sharks, so that recollections were captured constructively and to free up other memories of interest in non-shark specific questions. To help interviewees relate their memories to dates, a timeline of key events in Ascension's history acted as a prompt (Supporting Information 2) (Fisher

125 & Geiselman, 1992). Similarly, to aid memory recall about marine life and to standardise
126 responses, participants were asked to work from a photographic ID sheet, and fishers were asked
127 to identify fishing grounds using a map provided.

128 **Analyses**

129 Transcribed interviews were coded using NVivo (http://www.qsrinternational.com/nvivo/what-is-
130 nvivo) and coded data summary tables were produced to link respondent characteristics to
131 responses. The results presented here represent a subset of a broader analyses (see Supporting
132 Information 4) chosen for the value of the insights they provide into historical changes.
133 Interviewees were grouped into categories based on length of time spent on the island and year of
134 first arrival, with the splits selected to produce an even split in the number of people for each
135 group. An equal divide was not possible for length of time on the island given the transient nature
136 of residents, with 65% spending less than 20 years on the island. Data were analysed via SPSS
137 Statistics 24 or Excel, whereby non-parametric binomial tests were used on interview questions,
138 and Pearson Chi-squared to examine respondent characteristics and their answers. Results were
139 classed as significant if probability values (P) were <0.05. It is a reported stereotype that people
140 who fish have a tendency to exaggerate their catches (e.g. Sullivan, 2003). Hence, for semi-
141 quantitative data, outlying points for particularly exceptional or unusual fishing events were
142 removed prior to analyses. One outlier for tuna and two for 'fish' and grouper each were removed
143 in this way, identified as observations a minimum of five times higher than typical values reported
144 by other respondents.

3. Results

3.1 Historical Timeline

In total, 627 historic observations were found referencing Ascension's marine environment in 230 document sources, reduced to 272 quotes after discarding all that did not specifically mention abundance of marine life. These observations are sorted by historical period, below. The full table of quotes is provided in Supporting Information 3.

3.1.1 The Forgotten Island: Post-discovery 1501-1814

The earliest illustrations of Ascension (Figures 2 and 3) supported by the accounts throughout this period (Table 1; Supporting Information 3) give an impression of great abundance of marine life. Most commonly referred to was the abundance of birds of which large numbers were killed (Mundy, 1936, Osbeck, 1765). Turtles and fish attracted fewer comments but were evidently plentiful (Avis, 2000; Cowell & Read, 1765; Mundy, 1936; Mundy, Temple & Anstey, 1907; Pyke, 1705; Welch, 1950 in Teale, 1978). Fishing on the island is first referred to in 1656 and was clearly easy with plenty of fish caught (Mundy, 1656). Many people noted the value of turtles as food (Cowell & Avis, 2000; Dampier & Masefield, 1906a; Osbeck, 1765; Ovington, 1696; Cowell & Read, 1765) and in the 1600s Ascension's reputation as a prime place to catch turtles grew (Ashmole and Ashmole 2000, Cawley, 2015).

3.1.2 The H.M.S. Ascension: 1815 – 1922

After Ascension was settled, from 1815 onwards, references to marine life increasingly comment on the quantities taken (AIG, no date) (Table 2). From this time, turtle hunts became intensive and well-organised. Turtle meat provided food for residents and live animals were traded with passing ships (Ashmole & Ashmole, 2000). Turtles were caught by hand on shore after laying their eggs then stored alive on their backs. Between 1815 and 1829, turtle storage ponds were built on Ascension to increase the survival time of captured animals (Ashmole & Ashmole, 2000). From 1868 onwards, accounts increasingly refer to decreasing turtle numbers, with 'great scarcity' described in 1892 (Anon., 1892). In 1901, the annual catch was down to 250 (Aiton, 1901) after much higher previous catches (Figure 4). In 1922, despite an average turtle catch of only 38 for the three previous years, calls to protect these animals were opposed, due to the importance of turtle meat for islanders (Anon., 1922c).

By 1870, a decline in seabird numbers was noted (Kerby, 1871), likely due to their predation by introduced rats and cats (Ratcliffe *et al*., 2009; Stonehouse, 1962). Further evidence of seabird decline is evident on a map from 1838 (Bedford, 1838) which shows that previous booby (three species of booby reside on Ascension - Masked booby (*Sula dactylatra*), Brown booby (*Sula leucogaster*), Red-footed Booby (*Sula Sula*)) nesting grounds were no longer in use (Hughes, Martin & Reynolds, 2008).

The quantity and variety of fish from Ascension was regularly noted (Brandreth & Power, 1835; Burnett, 1858b; Campbell, 1816; Gill, 1878; Haggard, 1878; Martin, 1843; Porter, 1843; Studley, 1898; Thomson, 1878; Twigg, 1919; Webster, 1834). For example, in 1815, H.M.S Peruvian logged 110 fish caught averaging 3lbs, with enough hauled via a seine from the shore to feed two crews (i.e. around 240 people) (Stonehouse, 1960). By 1880, fishing was noted as a regular occurrence on Ascension (Roe & Parsons, 1885).

3.1.3 Ascension, the Island of Communication: 1923 – 1983

Quotes from this period mainly referred to the exceptional fishing around Ascension (Table 3), whereby a variety of species were said to be caught in remarkable numbers with little effort. In the 1920s, the number of turtles captured fell to practically zero (Figure 4) and no references to the numbers of turtle on Ascension between 1923 and 1983 were found. In 1926, a report stated, "turtles seemingly no longer land in the vicinity of the town. The more remote beaches at NE and SW, formerly resorted to by the turtles in hundreds now only land in tens" (Lander, 1927a). Regardless, hunting for turtles continued unabated until 1934 in efforts to supply turtle meat to residents and markets in the UK where it featured at Royal banquets (Ashmole & Ashmole, 2000; Simmons, 1927). In 1935, the license to hunt turtles at Ascension was revoked for economic reasons (Bartlett, 1935a), but the animals continued to be caught for local consumption (Bartlett, 1935b) until they became protected under the Wildlife (Protection) (Ascension) Ordinance (Chapter 129) in 1944 (Huxley, 1997). In 1927, 1929 and 1936 seabirds were noted to "darken Ascension's sky" (Keilor, 1997, Simmons, 1927, Watts, 1936), but accounts from 1945 onwards indicate they became significantly less abundant, with the heavy use of Ascension's runway during WW2 blamed for 'decimation' (Anon., 1948). When the British Ornithologist's Union surveyed seabirds on Ascension in 1957-59, they reported the Sooty tern population at 750,000 (Hart-Davis, 1972), down by a third compared to an estimate 15 years earlier (Chapin, 1954).

3.1.4 Modern Ascension: 1984 – 2017

More quantitative data on marine life became available in the modern period as scientific studies and observations developed (Table 4). Comments on the quality and quantity of fishing continue to feature, despite repeated failed attempts to establish a commercial fishery operation on Ascension (Wills, 1955). There was, however, evidence of foreign commercial fishing; during the second half of the 20th century, commercial fishing pressure further offshore within Ascension's EEZ increased as Japanese and Taiwanese fleets mainly used longlines to target tuna (*Thunnus albacares*, *Thunnus obsesus* and *Katsuwonus pelamis*) (RSPB, 2017). A licensing system was introduced in 1988 in response to growing fishing pressure; the number of licensed fishing vessels peaked at 80 in the 1990s (RSPB, 2017) and fishing days around the island peaked in 2011 at 4,231 (Figure 5).

Offshore commercial fishing in Ascension's waters was prohibited between 2005 and 2009 and again in 2014/15 whilst options for future fisheries management were considered (Armstrong & Reeves, 2015; Reeves & Laptivosky, 2014). When the fishery re-opened in 2015, an area of 50 nm around the island and the whole of the southern half of Ascension's EEZ was closed to commercial fishing with just two licenses sold for the remainder of waters where fishing was allowed (Pers. Comm. J. Brown, 2017; RSPB, 2017).

Although Ascension has no domestic commercial fishery today, residents commonly fish inshore for recreation and personal consumption (Armstrong & Reeves, 2015). In 2002, the first sport-fishing company was established, but in 2016 the then three sport-fishing companies ceased work after the island's airport closed for long-term repairs (Pers. Comm. B. Chester; E. Cuylaerts; M. Hennigsen, 2017). Shore fishing was unaffected (Armstrong & Reeves, 2015) with grouper (*Epinephelus adscensionis*) and moray eel ('Congers' *Gymnothorax moringa*) the main target species. Large game fish, including sharks, are frequently caught (Figure 6), with tuna catchable

229 from the shore at certain times. From photographic evidence and interviews with residents, marlin,
230 yellowfin tuna and other game fish are regularly caught using spearfishing and trolling amongst
231 other methods (Armstrong & Reeves, 2015). Presently, there are no government limits on
232 recreational or sport fishing catches, apart from a 10 kg per person limit on exports (Armstrong &
233 Reeves, 2015).

234 Today both seabirds and their eggs are fully protected on Ascension under the Ascension Island
235 Wildlife Ordinance implemented in 2013 (AIG, 2013), though the rat population is still present
236 despite an eradication programme (AIG, 2015a), seabird populations show signs of recovery.

237

238 **3.1.5 History of sharks, shark attacks and details of other 'problematic' fish**

239 Twelve species of sharks have been recorded around Ascension and in 2017, two shark attacks
240 occurred there, potentially for the first time, although in the course of this study the description of
241 a possible shark attack in 1858 was found in a letter from John Haggard held in the Caird Library.
242 One of the authors (PB) also witnessed sharks in the inshore environment in high abundance during
243 fieldwork in 2017 (Figure 7). Table 5 compiles all historic shark related accounts identified to put
244 modern observations of sharks into context.

245 References to the danger sharks pose are common (Anon., 1923; Anon., 1964; Bartlett, 1972b;
246 Burnett, 1858a; Cant, 1973; Chapman, 1985; Cross, 1980; Edgar & Morris, 1997; Faulkner, 1954;
247 Hart-Davis, 1967; Keilor, 1997). Sharks have long been reported to take fish from fishing lines
248 (Beeckman, 1718; Gill, 1878) such that at certain times it was rare for fishers to land fish unscathed
249 by sharks (Clarke 1942; Stonehouse, 1960), something that PB witnessed whilst on Ascension in
250 2017 (Figure 7).

3.2 Local Ecological Knowledge: Questionnaire Results

3.2.1 Respondent characteristics

Amongst respondents, 114 (82%) were male and 25 (18%) female, with the majority aged between 41-50. Time on Ascension ranged from 1 to 55 years and the earliest date of arrival was 1952. See Supporting Information 5 for more details on respondent characteristics.

3.2.2 Fishing

To the question, "Would you say the amount of effort you have to use to catch fish has changed during your stay on Ascension?", 40% (n = 35 out of the 87 who completed this part of the questionnaire) said 'no', and 43% (n = 37) said 'yes', with all the latter stating that there was a *reduced* catch per unit of fishing effort. The remaining 17% (n = 15) all noted that catch per unit effort had reduced because of shark predation on their catches. The difference between the respondent answer groups was non-significant (two-tailed binomial test, p = 0.09). One respondent commented:

> "*All I can say is that it's not as easy to catch them like it used to be, it's not uncommon to go fishing one afternoon and not catch anything. I remember before days you could never say you'd go fishing and not come back with a fish*." (Interview AI 008 – Arrived in 1987 and been on Ascension almost 30 years)

Figure 8 splits respondents by length of time on Ascension, defined by arrival pre- or post- 1990, and shows that a person's length of time on island did not affect how they perceived change in their catch per unit of fishing effort over time. (Figure 8*a*; $CPUE\ trend\ vs\ year\ of\ first\ arrival\ x^2 > 2.156$, P = 0.340, Figure 8b; CPUE trend vs time spent on island $x^2 > 0.484$, P = 0.785).

3.2.3 Attitudes to Sharks

All 139 respondents answered the question "What is your view on sharks in Ascension waters?" (Figure 9) (N = 299, multiple answers per respondent) with results giving little suggestion that people had feared sharks in the past; for example one interviewee remarked:

> "*…when we come [in] from fishing and if you're bloody you could actually dive over the side by the pier to wash off, wash your clothes; there's no way right now you would do that*." Interview SH 003, arrived 1983 and on Ascension for 18 years.

Although sharks were always recognised as having been common before, their behaviour appears to have changed, exemplified by not only the attacks but also observations such as:

> "*I see one shark grab the propeller on a little boat and shake it. Stuff I see in these two years I've never seen or heard of before*" Interview AI 066, been on Ascension since 1999.

> *"I've been in the water, not only me, with 12 sharks around. I've even tried to feed them, I had a short hand spear, shoot a blackfish and tried to give it to him, and watch him get excited when they fight one another and never had any experience of having to fight them off."* AI 036, been on Ascension since 1962.

Eight interviewees felt the present situation, wherein large sharks are being seen in abundance inshore, wasn't completely new, for example:

> *"Sometimes there were, twice a year, there were massive huge ones, they changed the colour of the water they were so close together you'd think you could get out the boat and walk."* SH 044, on Ascension 1998 – 2008.

Six out of eight respondents who said sharks had previously been frequently seen in high numbers, arrived between 1960 and 1969. For the forty-seven respondents who felt the present abundance of sharks was completely new, 28 came to Ascension for the first time between 1990 and 2017, with 19 arriving before then.

Of those who felt shark numbers had increased (N = 71), 25 arrived between 1950 and 1989 and 46 after 1990. Of these 22 had been on the island 21-55 years and 49 between 1-20 years. Those who first experienced Ascension earlier (binomial, P = 0.02), and who had been on Ascension longer (binomial, P = 0.002), were less likely to perceive shark numbers as having increased.

3.2.4 Perceived changes in fishing locations

Figure 10 displays respondents' answers to "Are there any places you used to fish that are no longer productive or vice versa?" and shows widespread perceptions of site-specific declines in productivity, given the large number of fishing sites named, with only a select few noted to have conversely increased. English Bay was the location most frequently mentioned to have declined in productivity. Overall, fishing productivity was said to have decreased in 171 sites but improved in only 11 (Figure 11). In sites where it had decreased, four were named by more than ten people. Thirty-four respondents felt no fishing sites had changed in respect to productivity.

3.2.5 Perceptions of fishing productivity

Answers to the questions "What is/was a typical day's catch?" (for your most recent fishing year on Ascension) and "Can you remember what a typical day's catch was then? (for your first fishing year on Ascension)" are shown on Figure 12 where (a) all fish and (d) tuna (*Thunnus albacares*) show significant changes in perceived productivity of their fishing over the timespan of interviewees' experience.

3.2.6 Perceptions of species decline or increase

When asked "Are there any species you know of that have decreased in numbers during your stay on Ascension?", 50 respondents believed nothing had declined but 146 named instances of decrease (Figure 13). Of these, Grouper (*Epinephelus adscensionis*) was most commonly named (N = 21), closely followed by tuna (*Thunnus albacares*) (N = 20) (consistent with Figure 12), 'fry' (N=20) and blackfish (N=18). ('Fry' can refer to juveniles of a variety of fish species. In general, interviewees mentioning fry runs meant species such as Kingston (Mackerel Scad, *Decapterus macarellus* and other members of the Decapterus genus), Mackerel (Chub mackerel, *Scomber japonicus*) and Steenbrass (Bigeye Scad, *Selar crumenophthalmus*) which come inshore in large numbers, chased in by larger fish such as tuna species and Yellowtail (also known as Rainbow runner, *Elegatis bipinnulata*) (Pers. Comm. Andy Richardson, 2018; Edwards, 1990). Fry events can also include juvenile grouper (*Epinephelus adscensionis*) and squirrelfish (*Holocentrus adscensionis*) accumulating inshore, depending on oceanographic conditions (Pers. Comm. Andy Richardson, 2018). There was no statistically significant difference between categories for first year of arrival (chi-squared $x^2 < 0.007$, p=0.93) or length of time on Ascension (chi-squared $x^2 < 1.57$, p=0.21).

Of the 123 responses to, "Are there any species you know of that have increased in numbers during your stay on Ascension?", almost the same number said no as named at least one species (N = 62 and 61 respectively). Though frequently cited by interviewees as in decline, Grouper (*Epinephelus adscensionis*), was the species most commonly perceived by respondents to have increased (N = 11) followed by turtle (*Chelonia mydas*) (N = 9).

4. Discussion

The findings of this study reveal that Ascension's marine life has been consistently remarked upon for its abundance by generations of explorers, travellers, fishers, residents and scientists from the first observations to the present day, particularly for seabirds, turtles and fish life. Many historical studies show that fishing and anthropogenic pressures have seriously damaged ecosystems (Jackson *et al*., 2001; Roberts, 2007) and though changes are evident (Figure 14), Ascension Island seems to have escaped the level of harm seen elsewhere. However, when comparing seabird and turtle populations to the present day, they appear considerably smaller than in the past. Although high abundance of fish life appears to have been a constant, recent significant declines in tuna (*Thunnus albacares*) were perceived by interviewees. Many interviewees also noted nearshore fishing grounds have declined and said they had experienced a decreased catch per unit effort.

One of the most striking consistencies among the historical accounts examined were comments on the great abundance of fish. From Linschoten's "great store of Fish" in 1589 (Linschoten, 1596) through to the 20th century, the ease of fishing and its productivity are apparent. Also striking were the depictions of abundant fish and seabirds in early images of the islands. These are unusual features of early engravings, leading one to infer that Ascension marine life was considered abundant centuries ago.

Historic accounts have, however, revealed changes particularly in seabirds and turtles, which have both declined in abundance due to direct exploitation, and for birds from habitat modification and introduced predators (Sections 3.1.2 & 3.1.3). Both groups show signs of recent recovery but are still well short of historic numbers. Since the 1970s, numbers of turtle nests have increased from 3,752 to 23,724 (Weber *et al*., 2014) and in 2006 Broderick *et al*. estimated a 285% increase in the Ascension population. This contrasts with many other places, for example the Caribbean, where Green turtle numbers are estimated at just 0.3% of what they once were (McClenachan, Jackson

361 & Newman, 2006). There are also indications of recolonization by four species of seabirds and
362 reduction in sooty tern mortalities, though their recovery is limited by the continued presence of
363 rats (Ratcliffe *et al*., 2009).

364 The interview data provided contrasting perspectives on recent change (post 1950). For example,
365 45% of respondents could not think of an example of a species that had increased, whereas 55%
366 named at least one species they thought had increased. Similarly, 35% of respondents could not
367 list any species that had decreased but the remainder considered at least one species to have done
368 so. The significant perceived declines in tuna and 'fish' catches noted by interviewees supports the
369 perception that some key species have declined. Many interviewees also reported that some fishing
370 grounds had declined, especially the most accessible coastal sites, and experienced a decreased
371 catch per unit effort in their fishing trips. These results present a worrying picture of modern
372 decline, that highlight the need for precautionary and effective management to be developed for
373 Ascension Island's marine environment. Protecting the area now will limit further change and help
374 maintain an upward trajectory for recovering species.

375 One consistent feature of the interviews is the absence of any clear temporal signature in
376 perceptions of changes in abundance for most marine species. Notably, people who had been on
377 island for longer or first saw it in the more distant past were not more likely to report changes than
378 those more recently acquainted with Ascension. In comparison, other studies using interview
379 techniques have picked up significant, consistent changes, for example Ainsworth et al. (2008)
380 and Sáenz-Arroyo, Roberts, Torre, Cariño-Olvera & Enriquez-Andrade et al. (2005a). There were
381 few consistent observations of changes with a variety of species noted as fluctuating by
382 interviewees with different experiences of the Island. This suggests that, with a few exceptions,
383 like for sharks where there was broad agreement on recent increase, interviewee testimonies
384 simply reflect experience of a rich marine environment experiencing cycles of change.

385 The apparent maintenance of high fish abundance over the course of centuries through to the
386 present day makes Ascension highly unusual in a fast-changing world in which overexploitation
387 and species declines are commonplace (Jackson *et al.*, 2001; Roberts 2007). For example, a recent
388 survey found three times more groupers around Ascension than St Helena; along with population
389 structure differences, suggesting the impact of higher fishing pressure in St. Helena (Choat &
390 Robertson, 2008). In the Gulf of California, Mexico, exploitation of Gulf Grouper (*Mycteroperca*
391 *jordani*) led to population declines of up to 99%, as shown by historical records (Sáenz-Arroyo,
392 Roberts, Torres & Cariño-Olvera, 2005b) and fishers reported catching 25 times more grouper in
393 the past (Sáenz-Arroyo *et al*., 2005a). Other historical studies across the world also contrast with
394 this study's results. Jackson (1997) concluded coral reefs experienced widespread deterioration
395 before modern studies began, a view supported by Pandolfi *et al*. (2003). Lotze & Milewski (2004)
396 described major historical alterations to the Quoddy Region in the Bay of Fundy, while Lotze *et*
397 *al*., (2005) revealed ecosystem transformation of the Wadden Sea dating back over 2,500 years.
398 Around the UK, Thurstan, Brockington & Roberts (2010) used fishery statistics from 1889 to 2010
399 to reveal that trawl fisheries productivity fell by 94% over 118 years. Historical accounts unearthed
400 by Sáenz-Arroyo, Roberts, Torre, Cariño-Olvera & Hawkins (2006) indicated major losses of key
401 exploited species in the Gulf of California, like turtles, pearl oysters and fish. When Baum & Myers
402 (2004) compared catch data from the Gulf of Mexico from the 1950s to 1990s, they revealed
403 declines of up to 99% for sharks. Similarly, Rosenberg *et al*. (2005) found cod biomass on the
404 Scotian shelf was 1.26 million MT in 1852 compared with a modern 'peak' biomass in the 1980s
405 of 300,000 MT. Surveys of local ecological knowledge have also uncovered widespread fisheries
406 declines in Raja Ampat, Indonesia, (Ainsworth *et al*., 2008), the Yangtzee River (Turvey *et al*.,
407 2010) and the Southwestern Atlantic (Zapelini *et al*., 2017). Unlike Ascension, most of these
408 places have been exposed to intense anthropogenic pressures. Strong protection from similar
409 pressures in an MPA should safeguard Ascension's marine life into the future.

Globally, shark exploitation has caused widespread declines (Davidson, Krawchuk & Dulvy, 2016; Ward-Paige & Worm, 2017). For example, in the Northwest Atlantic, certain species declined by 75% over 15 years at the end of the 20th century (Baum et al., 2003). The archival research indicates sharks have been consistently noted around the island, and the more recent interview results demonstrate a perceived increase in numbers. The abundance of sharks around Ascension represents a rare counterpoint to general overexploitation, strengthening the case for strong protection from fishing there to avoid declines seen elsewhere. At St Paul's Rocks for example, 940km away from Ascension off the coast of Brazil, historical records indicate commercial fishing caused extinction of the once abundant Galapagos Shark population (Luiz & Edwards, 2011).

Historical accounts are easy to criticise as anecdotal, non-quantitative, and with limited relevance to contemporary management (Pinnegar & Engelhard, 2008). Hence it is important to bear in mind the possibility that explorers might have embellished their accounts when caught up in the excitement of new places (Sáenz-Arroyo *et al*., 2006). That said, historical perspectives have improved understanding of the ecology of a growing number of places (e.g. Dalzell, 1998; Jackson *et al*., 2001; McClenachan *et al*., 2006; McClenachan, Ferreti & Baum, 2012; Roberts, 2007; Sáenz-Arroyo *et al*., 2006). The inferences in this study, due to the nature of personal observations, are mainly limited to megafauna and species that were caught or seen easily. It cannot be said that this study is reflective of the entire marine ecosystem, but it does provide evidence of populations of larger species of marine life over time from which much can be learnt. Historical accounts are also of particular use when combined with one or other measures of change (Jackson *et al*., 2001). This study presents an extensive but not exhaustive collection of references to Ascension Island's marine life. There are gaps in the accounts, and the earliest account is around 90 years on from when the island was discovered, which could result in important elements being missed from this analysis. Data collected, for example in Figure 4, could be inaccurate or incomplete. Another

interpretation could be that people's perceptions of abundance changed over time. Despite this risk, other studies using similar methods have shown clear indications of decline (e.g. Jackson, 1997; Sáenz-Arroyo et al., 2006). Our results use similar methods to find no consistent trend in decline, supporting inferences of abundance from our analysis of historical records. The information collected has enabled us to generate an extended historical timeline. The detail and increasing frequency of observations as time goes on, together with the consistency in descriptions from the earliest accounts to the present, suggest that substantial confidence can be placed in our conclusions.

Surveys of local ecological knowledge also have drawbacks, primarily that respondents may not notice change, especially if gradual. For example, in this study only nine respondents felt turtles had increased, and one felt the opposite, whereas quantitative data shows the Ascension Green turtle (*Chelonia mydas*) population has increased by 285% since 1970 (Broderick *et al*., 2006). This misperception could be due to conservation regulations implemented in 2014 limiting access to turtle nesting beaches and so also, opportunities for observation (AIG, 2015b). Other studies looking to judge the effectiveness of LEK by comparison with quantitative data have also had mixed results (O'Donnell, Pajaro & Vincent, 2010). For example, Anadón, Giménez, Ballestar & Pérez (2009) found that LEK produced large-scale, cost effective and reliable data on terrestrial tortoise abundance in South-eastern Spain. In his study from the Seychelles and Western Indian Ocean, Daw (2008) found such discrepancies between official data and local knowledge that it called into question the veracity of both. On balance, however, for Ascension, the many consistencies among accounts that have been compiled, from multiple different perspectives over a period of centuries, have allowed a reliable narrative of temporal change in its marine wildlife to be pieced together.

458 The world today is very different in many ways to the past, with species extinctions and climate
459 change making complete recovery of marine ecosystems to past states impossible (Harris, Hobbs,
460 Higgs & Aronson, 2006; Pitcher, 2001). For example, Weber *et al*. (2014) concluded that due to
461 large-scale ecosystem changes, Ascension turtles may not be recoverable to pre-exploitation
462 levels. However, these findings suggest that such an abundance of marine life persists that, unlike
463 many other areas which have been seriously degraded, Ascension can be protected permanently
464 on a proactive rather than reactive basis. This will be increasingly important as climate change
465 effects intensify and to which remoteness offers no protection; the creation of an MPA many also
466 foster adaptation and alleviate impacts (Roberts et al., 2017). The continued high abundance of
467 marine life around Ascension represents a rare survival in the Anthropocene, making the island of
468 extreme conservation importance. The recent closure of the airport there, which shut sport fishing
469 operations, and the great reduction in commercial longline fishing within Ascension's EEZ in the
470 last few years, presents an extraordinary opportunity to create a highly protected refuge of global
471 significance in the heart of the Atlantic Ocean. In 2019, the UK Government committed to highly
472 protect all of Ascension's waters in an MPA.

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Tables

Table 1: Timeline of key quotes from Ascension's history and observations of the marine environment from 1501-1814 (references from Osbeck, 1765, translated from German). Material in square brackets added for clarity.

Quote
"It hath certain faire and white Sandes about it, and great store of Fish, wherein it surpasseth S. Helena, but in it there are no beastes at all, onely by reason of the great quantitie of Fishes ther are so many birds in it yt. it is strange, and they are of the bignesse of young Geese, & came by thousands flying about our ships, crying and making great noyse, and ranue up and downe in the shippe, some leaping and sitting on our shoulders and armes, not once fearing us, so that we tooke many of them, and wrung of their neckes, but they are not good to eate, because they taste morish [*strong-tasted or fishy*]." (1589, Jan Huygen van Linschoten, reported in Linschoten, 1596, pp. 261).
"...there is not soe much as fresh water upon it, verie bare and nothinge to bee had there but Sea Fowle and fish, of which there is aboundance." 1634, Peter Mundy, reported in Mundy, Temple & Anstey, 1907, pp. 333
"Here are a vast plenty of fish so every man without any means of learning may catch as many as he pleases with a line and hook. We sent our long boat to fish with 5 hands and they brought more on board in a very little time that...from the

whole ships company and going again that night they brought aboard 700 large fish..." 1705, James Pyke, reported in Pyke, 1705
"When our men landed, they were surpriz'd to see the vast number of large Sea-fowl on the Rocks; such as Boobees, nodees, Men of War, Tropick Birds, &c. that suffr'd themselves to be taken off from their eggs..." 1715, Daniel Beeckman, reported in Beeckman, 1718, pp 201.
"The largest turtles, or sea-tortoises, have their residence on it, and are sometimes caught by hundreds in one night." 1752, Pehr Osbeck, reported in Osbeck & Forster, 1771, pp. 78
"The bay abounds with fish, particularly a small cod, but they have a black appearance..." 1793, George Maxwell, reported in Avis 2000

812

Table 2: Timeline of key quotes from Ascension's history and observations of the marine environment from 1815 - 1922. Material in square brackets added for clarity.

Quote
"They have plenty of fine turtle and fish of various kinds." 1816, Captain Colin Campbell, reported in Campbell, 1816.
"At Ascension the crew spent most of their time fishing and made huge catches." 1829, Jules-Sébastien-César Dumont D'Urville, reported in D'Urville & Rosenman, 1987, pp. 269.
" I have already stated, that in one year upwards of 2500 [turtle] were turned on the beaches, among which were several that weighed from six hundred to eight hundred pounds each." 1829, Captain H.R. Brandreth, Brandreth & Power, 1835, pp. 249.
"Considerable numbers of poultry are reared, and turtle and various kinds of fish abound on the coast." 1843, G.R. Porter, reported in Porter, 1843, pp. 390.
"The sandy shore adjoining George Town, I was informed, is no longer so rich and profitable a beach as it once was, the reason probably being that turtle, like birds of passage, return again and again to the same spot to deposit their eggs; and on this beach, as being the most accessible, the greatest number have been turned, so that but few visit it at present." 1868, Cuthbert Collingwood, Collingwood, 1868, pp. 426

"Very many years ago, sea fowl must have covered the island, and deposited plenty of guano, as is evident from the marks upon the clinker, but for many years they (with the exception of the "wide-awake") have been confined to Botswain Bird Island, the Gillar rocks, and other small islet[s] round the coast, and to the parts of the island which are almost and quite inaccessible." 1870, Edward Kerby, reported in Kerby, 1871.
"There is a good quantity of edible fish to be caught from the rocks, or in the open sea from a boat and this sport affords good food for anybody." 1919, Francis Twigg, reported in Twigg, 1919.

815

Table 3: Timeline of key quotes or events from Ascension's history and observations of the marine environment from 1923 - 1983 (References from Diels et al., 1927 translated from German). Material in square brackets added for clarity.

Quote or key event
"...in the pure blue waters we saw scores of black fish gloriously striped with azure on each side of the dorsal fin; several of these were caught on lines for they will eat anything." 1925, ER Gunther, reported in Gunther, 1925.
"There is such an abundance of fish on the anchorage that the unfortunate, black and blue striped fish can be grasped by hand from the boat." 1927, Diels et al., reported in Diels et al., 1927, pp. 103.
"To realise the vast numbers of the Wideawakes it was a good scheme to take a shot-gun out to the Plain, and fire a blank cartridge in the air, when the thousands of startled birds would almost darken the sky." 1929, John Keilor, reported in Keilor, 1997, pp. 33.
"In the clear waters, the sandy bottom can be seen teeming with fish; from the shark, the albacore and the tiger conger to the dainty five finger, the waters abound with their natural inhabitants." 1934, L.S. Bartlett, reported in Bartlett, 1972a.

“There were plenty of fish in the sea around Ascension…The principal catch included tuna, albacore and wahoo, weighing from sixty to eighty pounds each. There would be a few jacks weighing about twenty pounds each. On a good day a boat would bring in six or seven hundred pounds of fish.” 1942, Clarke, reported in Clarke, 1942.
"Now only the Wideawake Terns breed in any force on the main island; the remaining species can nest only on inaccessible cliffs or isolated stacks like the one we were watching." 1960, Bernard Stonehouse, reported in Stonehouse, 1960, pp. 45-46.

818

819 *Table 4: Timeline of key quotes or events from Ascension's history and observations of the marine environment from 1984 - 2017.*

Quote
"...that they went out on Saturday morning with a group of fishermen and came home 'loaded'. When asked 'what with', this very same co-owner reported 'oh yes, well there were 6 sail, 24 wahoo, 60 tuna..." 1985, The Islander, reported in Anon., 1985a.
"A week past Saturday Buffalo caught 18 tuna, in his own words "no big ones". On Sunday 9 tuna were caught. Then last Saturday they caught 21 and a quarter! The other 3/4s went to a hungry shark" 1985, The Islander, Anon., 1985b.
"Fishing goes on all around the island - grouper, silver fish, soldier fish and Moray eels (!) being the most common catches though small sharks are also frequently landed." 1997, Sue Edgar & Debbie Morris, reported in Edgar & Morris, 1997, pp. 12.
"Although the fish diversity is low, one species is extraordinarily abundant. This is the Blackfish *Melichthys niger*..." 2000, Philip & Myrtle Ashmole, reported in Ashmole and Ashmole, 2000, pp. 241.
"Two are standing at the prow, the others are sitting on the sides of the fishing smack, whose bottom is full of fish. I managed to make out sixteen big fish, either tuna fish or others which I don't recognise." 2000, Sergio Ghione, reported in Ghione, 2002, pp. 53.

"A second boat arrives with another twenty or so tuna fish and then a third with an enormous tuna: it has to be tied with a rope and it needs six men to haul it up the pier." 2002, Sergio Ghione, reported in Ghione, 2002, pp. 54.
"The tuna remains are thrown back into the sea, which immediately just swarms with blackfish, which are absolutely voracious but inedible." 2002, Sergio Ghione, reported in Ghione, 2002, pp. 54.
"A precipitous decline of 2 million birds occurred between 1965 and 1985." 2013, B. John Hughes, Hughes, 2013, pp. 70.
"The Galapagos shark is the most common shark species seen in the nearshore waters around Ascension. Anecdotal evidence suggests their numbers are thought to be increasing again." Robert Irving, reported in Irving, 2015, pp. 58

820

821 *Table 5: Historical references to the presence, behaviour and abundance of sharks around Ascension Island. Additions added to quotes for*

822 *clarity are included in square brackets.*

Quote
"And at the time when the turtle resort to these places to lay their eggs, they are accompanied with abundance of Fish, especially sharks…" 1684, William Dampier, reported in Dampier & Masefield, 1906b, pp.133.
"But we were often plagu'd with young Sharks, that wou'd run away with our Hooks and Lines. The water was so clear that we cou'd see the Fish take the Bait; and when we saw a Shark coming towards it, we made what haste we cou'd to pull up our Lines; yet they were so quick that they wou'd catch the Bait sometimes on the very Surface of the Water." 1715, Daniel Beeckman, reported in Beeckman, 1718, pp. 201.
"Sharks are so numerous in these latitudes that it is only when very smooth (a rare occurrence) that one can venture with safety to plunge in to the sea under shade of a rock." 1858, Captain William Burnett, reported in Burnett, 1858a, pp. 4.
"Both [men] were probably pulled off by the sharks of which there were several near." Referring to Goring & Cook, men involved in boat wreck off Ascension. 1878, John Haggard, reported in Haggard, 1879, pp. 2.

"Sharks were plentiful all around the coast, and rendered bathing very dangerous except in the shallow coves like comfortless and South West Bay." 1929, John Keilor, reported in Keilor, 1997, pp. 35.
"Sharks were plentiful also. It was not unusual to be hauling in a fighting tuna and have the line go slack as a shark hit a bleeding tuna. We would then haul in the remainder consisting of a head or a tuna with a large chunk removed" 1942, Clarke, reported in Clarke, 1942.
"A shark guard with M-1 rifles was posted on a motor launch to protect the swimmers from the feared predators. Being an expert marksman, my job that memorable day was with the shark guard." 1942, W.A. Chapman, reported in Chapman, 1985, pp. 7.
"The beaches here are really beautiful...but the undertow is dangerous and there is also the danger of sharks. One beach is safe-Comfortless Cove...but we are supposed to post a watcher for sharks." 1954, Faulkner, reported in Faulkner, 1954.
"3. Bathing. It is, at present, an offence to swim in the sea without a permit, due to the dangerous sea conditions and the presence of sharks. The law is not, however, enforced but everyone is warned that, other than at Comfortless Cove, it is

dangerous to swim except for strong swimmers and anyone doing so swims at his own risk." 1964, Anon., reported in Anon., 1964.

823

824 **Figure Legends**

825 **Figure 1**: Location of Ascension Island with EEZ shown by dashed line and zoomed in view
826 to identify key locations on the island.

827 **Figure 2**: Engraving of Ascension Island found in Linschoten's Itinerario (1605) by Theodore
828 de Bry (1601) (Bry & Becker, 1601). Image provided by Library Regionaal Archief Alkmaar,
829 Netherlands (though earlier versions in English exist by William Rogers, as seen in Linschoten
830 (1596)).

831 **Figure 3**: Illustration from Linschoten's (1596) accounts of his travels. Although attributed to
832 Ascension Island (sourced as for sale through Amazon (https://www.amazon.com/Antique-
833 10Print-ASCENSION-ISLAND-WHALE-FLYING-FISH-De-Bry-1601/dp/B01MY78S72))
834 the edition seen could not be traced to check the location of the scene. It is likely from the
835 German version of the edition of the text with new engravings made by Johann Theodor and
836 Johann Israel de Bry.

837 **Figure 4**: Annual Turtle catches on Ascension Island from 1834 to 1934 when concessions for
838 their capture ended ($R^2 = 0.48$, $t = -6.47$, $P < 0.0001$). Data sources: Anon., 1864; Anon., 1906;
839 Anon. 1922a; Anon., 1922b; Anon., 1928; Anon., 1931; Anon., 1933; Bartlett, 1934; Dumas,
840 1910; GB Hydrographic Office, 1963; Huxley, 1997; Kerby, 1871; Lander, 1925; Lander,
841 1927b; Willmott, 1930; Willmott, 1932; Willmott, 1933; Wood, 1928; Wood, 1929.

842 **Figure 5**: Licensed commercial fishing days within Ascension Island's Exclusive Economic
843 Zone (source: Pers. Comm. Ascension Island Government Conservation department, 2017
844 (unpublished data)).

845 **Figure 6**: Selection of fish caught around Ascension Island: a) 1337 lb marlin caught 2002; b)
846 102 lb wahoo caught 1992; c) Hooked shark, no exact date but known to have been sometime
847 between 1988-2002).

Figure 7: Galapagos sharks (*Carcharhinus galapagensis*) around Ascension Island, July – September 2017 a) attacking hooked tuna, b) surrounding boat following fishing activity c), d) from the pier head in Georgetown in shallow water. Photos by Polly Burns.

Figure 8: Answers given as percentages on whether respondents felt their catch per unit effort had changed around Ascension, in relation to their first year on island (a) x^2>2.156, P = 0.340 and overall length of time there (b) x^2>0.484, P = 0.785.

Figure 9: Responses to "What is your view on sharks in Ascension waters?" around Ascension (N = 299). BBI – Botswain Bird Island; NEB = North East Bay; SE Bay = South-east Bay. 'Completely new' refers to the present state of shark abundance and proximity to the island as not seen previously by the respondent and 'not completely new' means the opposite.

Figure 10: Locations named as having decreased in productivity for fishing around Ascension (N = 171), with locations mentioned as decreased for the same locations reflected in negative numbers (N = 11).

Figure 11: Summary of answers given to the question "Are there any places that you used to fish that are no longer productive or vice versa?" around Ascension (N = 235). The categories of 'Somewhere has decreased' and 'Somewhere has increased' are grouped responses which named a specific location.

Figure 12: Responses for the number of fish caught in a 'typical day's fishing' around Ascension for the most commonly named species mentioned by respondents. Linear regression lines are displayed with equation and R2 values. a) 'Fish' – where non-specific species were referred to, N = 40, R2 = 0.3145, P<0.0001, t = -4.15; b) 'Grouper' *Epinephelus adscensionis*, N = 44, R2 = 0.06, P = 0.1, t = -1.68; c) 'Eel' *Gymnothorax moringa* N = 30, R2 = <0.0001, P = 0.96, t = -0.06; d) 'Tuna' *Thunnus albacares* N = 47, R2 =0.39, P<0.0001, t = -5.37.

871 **Figure 13**: Answers given to "Are there any species you know of that have decreased in
872 numbers during your stay on Ascension?" (N = 196 responses).

873 **Figure 14**: Summary figure of changes through the delineated periods on Ascension – larger
874 arrows represent greater trends.