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Leatherback turtle conservation in the Caribbean UK overseas territories: Act local, think global?

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ABSTRACT

Leatherback turtles migrate across the jurisdictions of multiple sovereign states and present complex challenges to those responsible for their conservation. Concern for marine turtles has led to their protection under range state legislation and protective listing under a suite of multilateral environmental agreements. Evidence suggests that a distinct, reproductive sub-population of leatherback turtles is shared amongst a number of northern Caribbean range states, including the UK overseas territories (UKOTs) of Anguilla and the British Virgin Islands (BVI). The post-nesting movements of three female leatherbacks were tracked after they nested in Anguilla ($n=1$, tracked for 228 days) and the BVI ($n=2$, tracked for 12 and 13 days, respectively). These turtles used territories of multiple range states, with the leatherback tracked from Anguilla also migrating through high seas to foraging grounds in Canadian waters. In addition, a review of regional leatherback flipper tag return records helps define the range of this northern Caribbean nesting population (NCNP), which appears to be in recovery in some range states. While national legislation and conservation efforts appear to have contributed to these population recoveries, most relevant MEAs appear to have played little or no role. However, opportunities for constructive dialogue between NCNP range states exist under the Cartagena Convention the United Nations Convention on the Law of the Sea and the International Commission for the Conservation of Atlantic Tuna (ICCAT). UKOT conservation managers would, therefore, be justified in prioritising unilateral leatherback conservation action, and multilateral efforts through the Cartagena convention and regional fishery management mechanisms, over potentially costly accessions to additional MEAs.

1. Introduction

The conservation of migratory marine vertebrate species is complex and challenging. Basic understanding of their expansive ranges has traditionally been limited by the logistical difficulties in accurately documenting their migratory behaviour at sea [1]. However, contemporary research has made significant contributions to understanding of the ranges of migratory marine vertebrates and has elucidated the political challenges of managing them [2]. Where animals migrate across geo-political borders, they are subject to differing national natural resource-use policy, management capacity and conservation priorities [3].

Marine turtle mark-recapture studies, which usually involve the application of flipper tags on females at nesting beaches, have revealed migrations across the territories of multiple sovereign states [4,5]. The recognition of migratory marine turtle species as 'shared resources' has led to several authors calling for cooperative international management efforts (for examples see [3,6,7]). To address this perceived need, several multi-lateral environmental agreements (MEAs) encourage or oblige signatory states to protect marine turtles and their habitat (see [8,9]). In addition, some multi-lateral Regional Fisheries Management Organisations (RFMOs) have adopted fishery-specific management measures to mitigate harmful marine turtle interactions [10].

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Leatherback turtles (*Dermochelys coriacea*) are migratory, and are highly adapted to utilise habitats across ocean basins, including tropical nesting beaches and temperate marine foraging grounds [11,12]. The species is listed globally as 'critically endangered' by the International Union for the Conservation of Nature [13], and some authors have forecast imminent extinction for nesting populations in the Indo-Pacific [14]. In contrast, some leatherback nesting populations in the Atlantic basin appear to be increasing in size [15,16].

Mark-recapture and genetic studies of leatherbacks nesting in Puerto Rico and the US Virgin Islands (USVI) suggest that the Northern Caribbean nesting population (NCNP) is a distinct stock [15,17,18], which also uses beaches in the neighbouring UK overseas territories of Anguilla and the British Virgin Islands (BVI), as well as other Antillean states [18,19]. The most southerly of these is Dominica, which also lies within the Southern Caribbean/Guianas leatherback stock range [15]. In order to address leatherback conservation concerns, national protective legislation and conservation efforts at nesting beaches have been established in Puerto Rico, the USVI and the BVI for a number of decades, which have contributed to apparent nesting population recoveries in those range states [18,20,21].

Although little is known about the post-nesting migrations of turtles from the NCNP, two tag recoveries from non-nesting turtles suggest that their foraging range extends as far north as the eastern seaboard of the USA and Canada [22,23]. Knowledge of leatherback behaviour at sea has, however, been revolutionised in recent decades by the application of satellite telemetry using the Argos System [24]. Satellite tracking studies have increased understanding of leatherback migration and habitat use, and facilitated the identification of threats and management priorities [25–28]. To date, there has been limited published research from satellite telemetry studies on nesting leatherbacks from the NCNP [15]. The earliest study recorded internesting movements of a single turtle between USVI and Puerto Rico [29], another study recorded a limited post-nesting movement of a single leatherback tracked from Puerto Rico [30], and a more recent study recording local internesting movements of two turtles fitted with satellite transmitters after nesting in Dominica [31]. Unpublished post-nesting tracking data from a leatherback fitted with a satellite transmitter in Puerto Rico suggest that the NCNP range may also extend into the North East Atlantic [15].

While marine turtle researchers have recently included the NCNP in a broader regional management unit that spans the North Atlantic [32], they also emphasise that definition of regional management units should not detract from the treatment of nesting populations as conservation and management units. To this end, there has been a call for further research to refine understanding of the status and range of the NCNP and identify states that share responsibility for the conservation of this stock [18]. However, conservation managers in the region have varied capacity and limited resources [33]. For example, conservation management authorities in the Caribbean UK overseas territories are characteristically responsible for a suite of marine resource use issues, but are often under-resourced, with insufficient capacity and financial support available for marine biodiversity conservation [34]. Authorities in the region tasked with leatherback turtle conservation must therefore decide how best to contribute to the management of this species.

This study uses a combination of satellite tracking data from leatherbacks and regional flipper tag recapture data to further elucidate the range of the NCNP. The study describes causes of leatherback mortality within the range; NCNP range states' national legislation pertinent to leatherback protection; and assesses the impact of several relevant MEAs on leatherback nesting trends. Based on this analysis, priority management measures are suggested for UKOT authorities tasked with leatherback turtle conservation.

2. Material and methods

Adult female leatherback turtles were opportunistically fitted with Satellite Relay Data Loggers (SRDL—Sea Mammal Research Unit) after they nested on beaches in Anguilla and the BVI. A single SRDL attached to a modified and bespoke harness (see [35]) was deployed consecutively on two turtles in Tortola, BVI in May 2003. The first female leatherback, Turtle 1 (Curved Carapace Length, CCL=156.2 cm), was fitted with the SRDL and harness on the night of the 1st May 2003 after it nested on Josiah's Bay (64.591°W 18.446°N). On the night of the 14th May 2003 the turtle returned to emerge on the same beach. Noting damage to the harness, researchers removed it and recovered the SRDL before the turtle returned to the sea. The harness was refurbished and was re-deployed with the SRDL on the night of the 16th May 2003 on another female leatherback, Turtle 2 (CCL=144.8 cm), after it nested at Josiah's Bay. Turtle 3 (CCL=149.5 cm) was fitted with a SRDL and harness after it nested at Captain's Bay, Anguilla (62.980°W 18.264°N) on the 13th May 2005.

Satellite Tracking and Analysis Tool [STAT, see [36]] was used to manage the data. Movements were mapped using Argos location classes (LC) 3, 2, 1, A and B. These location classes can be reliable when subject to adequate filtering [37], and therefore a speed filter was used to remove locations suggestive of travel speeds greater than 10 km h^{-1} and azimuth filtering (minimum threshold 25°). Best daily locations were then interpolated to create a smoothed track. Haul out data were examined to determine subsequent emergences.

In addition, flipper tag return data were collected through personal communication with researchers in the region and through flipper tag recovery records reported to the authors through the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) Marine Turtle Tagging Centre. Information regarding national legislation and accession to multi-lateral environmental agreements was also reviewed [38–45].

3. Results

3.1. Satellite tracked movements

After being fitted with the SRDL and harness, Turtle 1 travelled due north for two days into open ocean, approximately 85 km from Tortola, where it remained for a further two days (Fig. 1). The turtle then travelled southwest to waters 16 km off the north-eastern tip of Puerto Rico where it stayed for a further two days, before heading east through the US Virgin Islands and returning to Tortola to nest 13 days after it was tagged.

After SRDL deployment, Turtle 2 also travelled due north for two days into open ocean but then travelled due east for a further three days before heading south (Fig. 1). This turtle arrived in Puerto Rico's inshore waters on the 24th May, eight days after it was tagged in Tortola. The turtle then travelled east along Puerto Rico's north coast to the inshore waters of the Fajardo–Luquillo region on the northeast tip of Puerto Rico where it emerged on Paulinas Beach (65.689°W 18.366°N), on the night of the 26th May. Transmissions ceased from this tag on the afternoon of the 28th May when the turtle was apparently heading due north away from Puerto Rico.

Turtle 3 spent 14 days within Anguilla's northern inshore waters after SRDL deployment, with haul-out data suggesting a subsequent emergence on the northeast shore of Anguilla on the

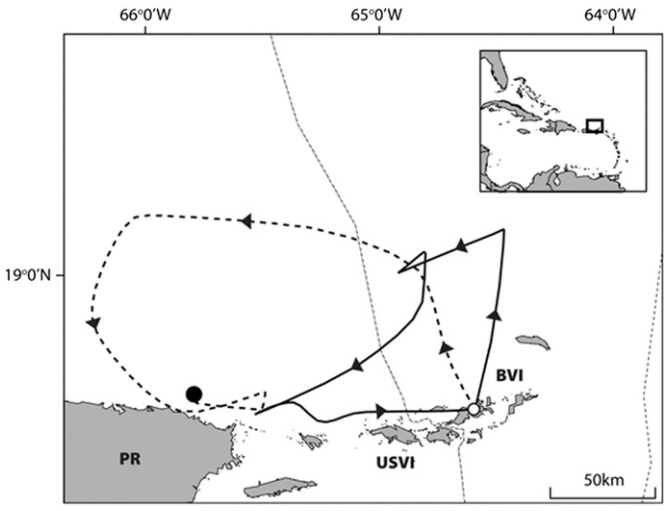

Fig. 1. Post-nesting migrations of adult female leatherbacks tagged in the British Virgin Islands, including Turtle 1 (solid track) and Turtle 2 (dashed track). Broken lines show territorial borders, white circle indicates the release site and the black circle shows the last transmitted location of Turtle 2.

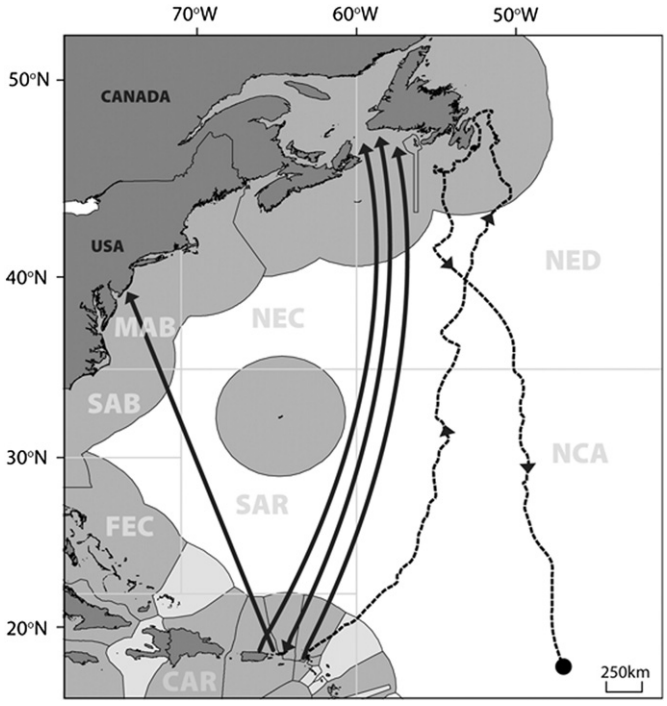

Fig. 2. Post-nesting migrations of adult female leatherbacks tagged in the North Caribbean nesting population range, including satellite tracked Turtle 3 (dashed track). The solid black arrows indicate international movements of flipper tagged female leatherbacks (this study and [23,29]), and connect tagging and recapture locations but do not imply travel routes. Darker shaded exclusive economic zones indicate where legislation completely protects leatherbacks and lighter shaded exclusive economic zones indicate where legislation regulates some legal take ([38,39] and Y Leon pers comm. 2011). High seas are white. USA National Marine Fisheries Service long line Caribbean (CAR), Sargasso (SAR), North Central Atlantic (NCA), Florida East Coast (FEC), South Atlantic Bight (SAB), Mid-Atlantic Bight (MAB), Northeast Coastal (NEC) and Northeast distant (NED) reporting areas are also shown.

night of the 27th May. On the 1st June the turtle then moved in a north easterly direction, briefly passing through the Exclusive Economic Zone of Antigua and Barbuda, before heading into open ocean (Fig. 2). The turtle arrived at the Eastern Shoals off Newfoundland, Canada on the 14th August 2005 and stayed within continental shelf waters off Newfoundland until 1st October when it moved south again. Transmissions ceased on the 27th December at 46.959°W 17.478° over the Mid-Atlantic Ridge some 1700 km due east of Anguilla.

3.2. Flipper tag return data

Flipper tag records (Fig. 3 and Supplementary Table 1) suggest that Puerto Rico, the USVI, the BVI, Anguilla, St. Kitts and Nevis and Dominica are all NCNP range states. In addition, individual turtles tagged in these states have also been recorded nesting in St. Maarten, Antigua and Barbuda, St. Eustatius and Guadeloupe suggesting that these are also NCNP range states. Leatherbacks flipper tagged in confirmed NCNP range states have not, to date, been recorded by researchers in the Dominican Republic, to the east of Puerto Rico (Y Leon, pers comm. 2011). This study did not identify any records of NCNP turtles nesting in Saba and Montserrat, where nesting by this species occurs but is considered to be infrequent [39,46]. Leatherbacks tagged in Dominica have been recorded nesting on Martinique immediately to the south, and therefore Martinique may also host nesting females from the NCNP [47].

Opportunistic beach monitoring and flipper tagging of nesting leatherbacks in Anguilla has yielded new information. This includes the first record of a turtle originally tagged in Puerto Rico in 1999 nesting in Anguilla in 2004. Two turtles tagged after they nested in Anguilla have for the first time confirmed that turtles move from Anguilla to nest in the USVI. One of these turtles, flipper tagged in 2007, was then captured by researchers in inshore waters of Cape Breton Island, Canada in September of the same year, and subsequently recorded nesting in the USVI in 2009 (Fig. 2—M. James, pers comm. 2007; J Horrocks, WIDECAST, pers comm. 2009). In addition, a leatherback flipper tagged after nesting in Anguilla in 2009 went on to nest on neighbouring St. Maarten in the same season (T Bervoets pers. comm. 2011).

Turtles tagged on the Puerto Rican island of Culebra have also been recorded nesting in the BVI, and are regularly recorded nesting in the USVI, where turtles tagged on mainland Puerto Rico are also recorded [48,49]. Flipper tag data show that this population also nests on more southerly Antillean islands (Fig. 3), with leatherbacks originally tagged in Puerto Rico and the USVI recorded nesting in Dominica [18,50]. Leatherbacks tagged in Guadeloupe are also regularly recorded nesting in Dominica, and vice versa [47], while turtles tagged in St. Kitts and Nevis have been recorded nesting on Guadeloupe [47], the USVI [49], St. Eustatius [51] and Antigua and Barbuda (M. Clovis pers. comm. 2011).

A leatherback, originally flipper tagged after nesting in the USVI, was recaptured in Canadian inshore waters and provides further evidence that these waters provide foraging habitat for the NCNP (Fig. 2—M. James, Canadian Sea Turtle Network, pers. comm. 2011).

3.3. Legislation and the MEAs

Legal protection for leatherbacks varies across the NCNP range states identified in this study (Figs. 2, 3 and Supplementary Table 2). Canada's Species At Risk Act (SARA) fully protects leatherbacks in waters under Canadian jurisdiction [52], and the USA Endangered Species Act (ESA) fully protects leatherback turtles and their eggs in the USA and territories of Puerto Rico and the USVI [38]. Legislation under the ESA also protects nesting habitat in USVI and obliges USA registered fishing vessels to take specific measures to mitigate against marine turtle bycatch during fishing activities in USA waters and on the high seas [53]. National legislation protects leatherbacks and their eggs in

Anguilla, the BVI, the Netherlands Antilles, St. Maarten, Guadeloupe and Martinique, while legal take of leatherbacks is regulated by legislation in Antigua and Barbuda, St. Kitts and Nevis and Dominica [39]. Montserrat is the only NCNP range state with legislation that allows the take of nesting marine turtles and their eggs during an open season [40], although take is considered to be at low levels and leatherbacks rarely nest on the island [46].

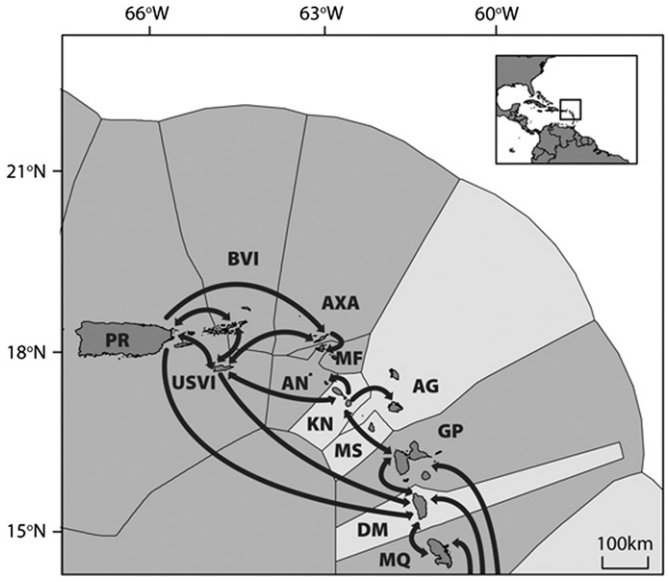

Fig. 3. Map showing levels of leatherback turtle protection under national legislation in North Caribbean nesting population range states and shared leatherback nesting as indicated by flipper tag recapture data (data from this study and [18,19,29,38,47–51,75]). Darker shaded exclusive economic zones indicate where legislation completely protects leatherbacks and lighter shaded exclusive economic zones indicate where legislation regulates some legal take (see supplementary Table 2). The black arrows indicate international movements of flipper tagged female leatherbacks and connect tagging and recapture locations (see supplementary Table 1) but do not imply travel routes. Countries shown are Puerto Rico (PR), US Virgin Islands (USVI), British Virgin Islands (BVI), Anguilla (AXA), Netherlands Antilles of Saba, St. Eustatius and St. Maarten (AN), Saint Martin, part of Guadeloupe overseas department (MF), St. Kitts and Nevis (KN), Antigua and Barbuda (AG), Guadeloupe (GP), Dominica (DM) and Martinique (MQ).

All NCNP range states have acceded to the United Nations Convention on the Law of the Sea (UNCLOS) and the Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Table 1). Antigua and Barbuda, BVI, Netherlands Antilles and St. Kitts and Nevis have published Sea Turtle Recovery Action Plans (STRAPs) under the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), a Regional Activity Network established under the Cartagena Convention [44,54]. While most range states have acceded to the Convention on International Trade in Endangered Species (CITES), only a minority of the NCNP range states have acceded to the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) to the Cartagena Convention, the Convention on Migratory Species (CMS) and the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC). Plenipotentiary states representing most NCNP range states ($n=7$) are contracting parties to International Commission for the Conservation of Atlantic Tunas (ICCAT) [55], the most relevant regional fishery management organisation. The UK is a contracting party to ICCAT on behalf of the relevant UKOTs, which pay membership fees to the Commission. However, while BVI still maintains membership Anguilla withdrew active membership in 2006.

4. Discussion

This study has provided new insights into the migratory behaviours of the North Caribbean nesting leatherback population, and for the first time tracked international post-nesting movements of leatherbacks nesting in the UK overseas territories (UKOTs). Some leatherbacks nesting in Anguilla and the BVI subsequently use critical habitats located across multiple sovereign states between consecutive nesting events and between nesting seasons. Furthermore, the NCNP nests on beaches in the territories of at least ten range states found between Puerto Rico and Dominica, and forages in Canadian and USA waters, with

Table 1
Year of accession to MEAs relevant to leatherback turtle conservation in range states of the North Caribbean nesting population, including the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC); the Convention on Migratory Species (CMS); the Protocol Concerning Specially Protected Areas And Wildlife (SPAW) to the Cartagena Convention; Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region; the Convention on International Trade in Endangered Species (CITES); the United Nations Convention on the Law of the Sea (UNCLOS) and the International Commission for the Conservation of Atlantic Tunas (ICCAT). '–' indicates no accession to date and N/A=Not applicable. Dates in parentheses in CARTAGENA column indicate publication date of Sea Turtle Recovery Action Plan (STRAP) with WIDECAST (* indicates where alternative national Marine Turtle Recovery Action Plans are in place).

Country	IAC	CMS	SPAW	**CARTAGENA** (WIDECAST STRAP)	CITES	UNCLOS	ICCAT
Canada	–	–	N/A	N/A*	1975	2003	1968
USA **Puerto Rico** **US Virgin Islands**	2001	–	2003	1984*	1975	1996	1967 (USA)
British Virgin Islands **Anguilla** **Montserrat**	–	1985 – 1985	–	1986 (BVI 1992)	1987 – 1976	1997 (UK)	1998 (UK)
Netherlands Antilles	2001	1983	1992	1984 (1992)	1999	1996 (NL)	1997 (EU)
Antigua & Barbuda	–	2007	–	1986 (1992)	1997	1989	–
St. Kitts & Nevis	–	–	–	1999 (1992)	1994	1993	–
Guadeloupe	–	1990	2002	1985*	1978	1996	1968 (France)
Dominica	–	–	–	1990	1995	1991	–

individuals migrating between breeding and foraging grounds through the high seas.

Individual leatherbacks have been recorded nesting in both Dominica and Martinique, suggesting that Martinique may also be a NCNP range state (E Delcroix pers. comm. 2011). However, these individuals may have originated from the Southern Caribbean/Guianas genetic stock, which has also been recorded nesting there, as well as in Guadeloupe [15,17,47,50], and it is therefore likely that these islands represent an area where the two stocks overlap as shown in Fig. 3. Understanding of the range of leatherback stocks in the Caribbean is still evolving, and future genetic analysis and tag recapture data may lead to further revisions.

4.1. National management within NCNP range states

The legal protection for leatherbacks afforded under national legislation in BVI, USVI and Puerto Rico is considered, in part, to have contributed to increasing nesting trends detected there [18,20,21]. In addition, conservation authorities in these states have invested significant resources in protection and monitoring efforts at index nesting beaches for over twenty five years [19,20], which has reduced illegal take of females and eggs [18,38,56]. Relocation of threatened leatherback turtle nests is also thought to have contributed to population recovery in USVI [18]. Despite protection for leatherbacks introduced in 1995, under a temporary and ongoing moratorium (see [40,57]), nesting trends in Anguilla are unknown because systematic beach monitoring only commenced in 2009 [58,59]. Similarly, nesting trends in Antigua and Barbuda, Dominica, Guadeloupe, Martinique, Netherlands Antilles and St. Kitts and Nevis are unknown because index beach monitoring only commenced in these range states within the last decade [39,60]. Only a few NCNP range states have published Sea Turtle Recovery Action Plans (STRAPs), but WIDECAST coordinates other support activities through a network of 'Country Coordinators', and these are present in all NCNP range states [44,54]. WIDECAST efforts are viewed favourably through much of the NCNP range. In BVI, for example, the STRAP is believed to have contributed, in part, to the increasing leatherback nesting trends [56], whereas the Netherlands Antilles STRAP shaped recently-established beach monitoring efforts in St. Eustatius [51].

Legal protection and nesting beach conservation efforts are unlikely to be the only contributing factors to population recoveries recorded within the NCNP. Environmental factors have been proposed as important causal factors behind concurrent population recoveries at other West Atlantic nesting beaches [16,27]. However, within the NCNP, recorded population trends differ, with a decreasing trend in annual nesting activities at Culebra's protected and monitored beaches contrasting with the increasing trends recorded on mainland Puerto Rico [21]. In the USVI, apparent decreasing trends in the annual recruitment of neophyte female turtles contrasts with overall increasing trends in annual nesting activity [61]. The drivers affecting these varying trends are worthy of further investigation, but a prerequisite to investigating these effects is better understanding of population trends across the range of the NCNP management unit.

4.2. Sources of mortality within the NCNP range

Anthropogenic threats to leatherback turtles are well documented [62], but the extent and impacts of anthropogenic mortality within the NCNP are poorly understood. The impacts of direct take of turtles and eggs, and chronic threats, including disturbance and destruction of nesting habitat through coastal development, are unknown [38,39].

Conservation managers in the Caribbean UKOTs recently identified coastal development as the short-term threat of most concern to marine and coastal environments [34]. In Anguilla and BVI extensive sand mining and coastal development is linked to degradation and disturbance of nesting habitat [58], and such effects may be further compounded by the effects of sea level rise [63].

Illegal take of leatherbacks and their eggs has been recently documented in most NCNP range states [18,38,39,50,56,58,64] with take of adults apparently less widespread than take of eggs. Nevertheless, leatherbacks are regularly taken in small numbers in St. Kitts and Nevis [39,64], and in larger numbers in Dominica [50].

Monitoring presence during the nesting season can also provide insights into the interactions of breeding female leatherbacks with fisheries gear at sea. Up to 39.1% of leatherbacks nesting in USVI each year bear fresh injuries indicative of interactions with various fishing gears [48,49,61]. Injuries associated with long-line gear, including line entanglement and hooking, are the most frequently recorded in USVI, and similar injuries on nesting leatherbacks are also recorded in Anguilla (P Richardson pers. obs 2004) BVI (S Gore pers. obs 2008), Puerto Rico (H Horta pers comm. 2003), St. Maarten (T Bervoets pers. comm 2011), St. Eustatius (J Berkel pers. comm 2011) and Antigua and Barbuda (M Clovis pers. comm. 2011). In contrast, while leatherbacks foraging in Canadian shelf waters often show injuries incurred by interactions with fixed gear used in the region [26], they rarely show fresh injuries indicative of longline interactions (M. James pers. comm. 2008). This suggests that the fresh injuries regularly seen on nesting NCNP leatherbacks are a result of interactions with longline fisheries encountered en route to the nesting sites. Leatherback bycatch is incurred by the USA Atlantic longline fleet fishing in the Caribbean, Sargasso, North Central Atlantic, Florida East Coast, South Atlantic Bight, Mid-Atlantic Bight, Northeast Coastal and Northeast distant long-line fishery reporting areas [65–67] (Fig. 2). Canadian longline fleets fishing within the Northeast Coastal and Northeast distant areas also record leatherback bycatch [52]. Leatherbacks tracked migrating from foraging grounds in shelf waters off Nova Scotia travelled on southerly bearings through several of these fishery areas [26]. In this study, Turtle 3 spent most of its tracked journey on the high seas, and travelled through the North Central Atlantic and Northeast Distant fishery areas during both its post-nesting and post foraging migrations (Fig. 2).

Recent technological advances in longline fishing gear and practice, which can significantly reduce marine turtle bycatch [68,69], have been adopted by the USA fleet under the Endangered Species Act [53], and by 'a large proportion' of the Canadian fleet [52]. However, there are currently no obligations for other long-line fleets to adopt similar bycatch mitigation measures [10], including, for example, the Taiwanese fleet which targets the Sargasso and North Central Atlantic areas immediately to the north of the NCNP nesting range [70]. Marine turtle experts have identified research into marine turtle bycatch and mitigation as a global research priority [71], and this clearly applies to NCNP interactions with long-line fisheries in the region.

4.3. Multilateral environmental agreements affecting the NCNP

Despite the establishment of a suite of MEAs with provisions to protect leatherback turtles, the NCNP range states have not adopted a collaborative regional approach. While the majority of range states have acceded to the Cartagena Convention, CITES and UNCLOS, relatively few have acceded to the IAC, CMS and the SPAW Protocol. These MEAs, with limited range state accession, as well as CITES, are unlikely to have contributed to any of the

population recoveries within the NCNP. For example, even though the USA acceded to the IAC in 2001 and ratified the SPAW Protocol in 2003, leatherback nesting recovery on mainland Puerto Rico and USVI was evident years beforehand, and after many years of protection and conservation efforts under the ESA [18,21]. Although CITES affords leatherbacks the highest level of protection, there has not been significant regional trade in leatherback products in recent history [38,39]. In contrast, while the text of the Cartagena Convention has no specific provisions to protect leatherback turtles, it appears to have played an important role in influencing unilateral conservation initiatives in some NCNP range states through the activities of WIDECAST.

Leatherbacks travelling between the nesting range and the northerly foraging grounds can spend much of their journey in the high seas beyond the remit of national legislature, but where UNCLOS applies. All NCNP range states have acceded to UNCLOS, either directly or through their plenipotentiary states. UNCLOS obliges parties to protect and preserve the marine environment on the high seas, and the UNCLOS 1995 Fish Stocks Agreement (UNFSA) obliges parties to minimize bycatch and deleterious impacts on associated species [10,72]. However, to date UNCLOS has no specific provisions to oblige parties to mitigate marine turtle bycatch [9].

The most relevant Regional Fishery Management Organisation (RFMO) to the conservation of the NCNP is ICCAT, which entered into force in 1969 [10]. Politically influential plenipotentiaries, including the USA, UK, France and the European Union, are contracting parties to ICCAT and represent the majority of NCNP range states. In addition, Chinese Taipei (Taiwan) is a Cooperating Non-Contracting Party [55], with Taiwanese vessels operating out of St. Maarten having participated in ICCAT-supported catch sampling programmes [70]. Opportunities exist within ICCAT to contribute to the conservation of the NCNP. For example, an ICCAT resolution in 2003 encourages parties to collect and share data on marine turtle interactions and mitigation measures, and encourages the live release of caught turtles [10]. However, ICCAT is unlikely to have contributed to NCNP recoveries to date because, unlike RFMOs operating in other ocean basins, it has not adopted legally binding measures that require contracting parties to use gear technology proven to mitigate turtle bycatch in the region [10].

4.4. Management implications for the UK overseas territory range states

The UK overseas territories have a role to play in the conservation of the NCNP, but have limited resources to allocate for marine turtle conservation [34,58]. It could be argued that little further conservation action is necessary in these UKOTs because actions in Puerto Rico, USVI and the BVI appear to have contributed to increasing trends in the NCNP. Indeed, leatherbacks are protected indefinitely in BVI, and protected until 2020 in Anguilla. Despite a lack of legal protection for leatherbacks and their eggs in Montserrat, the island is not considered important for the NCNP and the impacts of additional action there would indeed be negligible. However, without additional action in BVI and Anguilla, there would be ongoing uncertainty regarding nesting trends in Anguilla, and nest fate and nesting population structure in both Anguilla and BVI. The integrity of existing beaches may well continue to be compromised under a 'do nothing else' strategy, which would not, therefore benefit the NCNP or contribute to regional understanding of its conservation status. Conservation managers must therefore prioritise the most cost-effective conservation measures from the following options.

4.4.1. National conservation action

Proactive nest conservation programmes are not currently implemented in either Anguilla or BVI. Such efforts have been effective in increasing hatchling production elsewhere in the NCNP range and could therefore be prioritised. Detailed recommendations to address some of the local threats to the integrity of leatherback nesting beaches have been made elsewhere [58,73] and could also be considered priority actions in Anguilla and BVI.

Nesting trends in most range states, including Anguilla, are poorly understood. Consistent, systematic and long-term index beach monitoring is a minimum requirement needed to detect these trends [74]. Other NCNP states have already recognised the importance of such programmes, and monitoring should also be a priority for marine turtle conservation resource allocation in Anguilla. In addition, systematic saturation flipper tagging regimes in Anguilla and BVI, similar to those in USVI and Puerto Rico, and implemented on selected index beaches, would provide insights into trends in the female NCNP structure and broader conservation status [18,21]. While such regimes are more problematic to implement than daily beach monitoring, nocturnal patrols facilitate inspection of nesting females and would therefore provide insights into the levels of fishery interactions.

Given that there is no local demand for leatherback meat, oil or other body parts in Anguilla, adoption of post-moratorium legislation fully protecting leatherbacks would not disadvantage local interests, but could contribute to the management of the NCNP by protecting nesting females from any future threats within Anguillian territory. Ongoing reports of illegal egg take in Anguilla and BVI indicate that there is a need to improve existing enforcement efforts at the nesting beaches. Enforcement would be enhanced by monitoring regimes as described above, as patrols can deter illegal egg take, as well as non-human predation [76], and thus contribute to NCNP hatchling production.

4.4.2. Multi-lateral actions

As a plenipotentiary, the UK is responsible for accession to MEAs on behalf of its overseas territories [40]. Therefore Anguilla and BVI must request that the UK extends its accession to MEAs, a process that can incur significant ongoing institutional, administrative and reporting costs for governments in the UK and the respective territories [8,40]. Conservation of shared turtle populations through existing multi-species MEAs may be promoted as the ideal [3], and inevitably there may be cumulative incentives for different threatened species resulting from accession to multi-taxa MEAs. However, with respect to the conservation of the leatherback turtles alone, there is little incentive for conservation managers in Anguilla and BVI, or indeed appropriate government departments in the UK, to allocate limited resources for accession to additional MEAs. Opportunities exist through the Cartagena Convention Regional Activity Network to support unilateral actions in the UKOTs, as well as multi-lateral dialogue amongst the NCNP range states. Indeed, arguably this convention presents the only multi-lateral forum for lobbying those NCNP range states where there is ongoing anthropogenic mortality of nesting leatherbacks.

Unilateral action in the UKOTs may well lead to a better understanding of leatherback interactions with high seas longline fisheries, but cannot result in bycatch mitigation. Only multilateral action, through UNCLOS and ICCAT, holds the potential to address regional concerns about NCNP interactions with longline and other high seas fisheries. Limited progress has already been made towards developing an understanding of marine turtle bycatch through ICCAT, but additional lobbying by the UK and other plenipotentiary states on behalf of NCNP range state territories could lead to of adoption stronger, legally binding fishery

management mechanisms, as have been achieved through RFMOs elsewhere.

5. Conclusion

Within the UKOTs, Anguilla, the BVI and, to a much more limited extent, Montserrat, share responsibility for management and conservation of the NCNP. Conservation managers in Anguilla and BVI would be justified in allocating limited resources to national actions, perhaps with support through the Cartagena Convention, over and above costly accession to additional conservation MEAs. Indeed, other NCNP range states in comparable, resource-limited situations may well be justified in making similar decisions. Understanding and mitigating leatherback bycatch in high seas fisheries does require multi-lateral action. The UK Government and other politically influential plenipotentiaries are well placed within existing international institutions to lobby for stronger multi-lateral measures to address concerns over leatherback bycatch in regional fisheries. Nevertheless, whether or not the UK takes such action may well depend on the UKOT governments' capacity to justify their concerns using data generated through national efforts.

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Appendix A. Supplementary materials

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.marpol.2012.08.003.

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