

Co-management of sea turtle fisheries: Biogeography versus geopolitics

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ABSTRACT

Co-management between local communities and government agencies is promoted as a strategy to improve fisheries management. This paper considers the potential for co-management of sea turtle fisheries within four UK Overseas Territories (OTs) in the Caribbean, and for co-ordinated management among those territories. We focus on fisher incentives for engaging in co-management and on the potential to scale up co-management to a regional level. This paper presents data from Anguilla, British Virgin Islands, Montserrat, and Turks and Caicos Islands, where 110 turtle fishers participated in a socio-economic survey undertaken as part of the 'Turtles in the UK Overseas Territories in the Caribbean' project. Based on three established criteria for co-management (perceived crisis in stock, willingness to participate and community cohesion), results suggest that fisher support for co-management exists within each OT, but the extent of support for and views of specific management interventions varies among OTs. The implications of results for co-management in each territory, and for establishing co-ordinated management regimes in the region, are discussed in the context of current debates about the nature of resources and scalar (mis)matches between resource and management regimes.

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1. Introduction

The question of appropriate institutions and actors for managing common pool resources has long been debated in the resource management community. In the 1980s, general concerns about the failures of top-down management by government led to increased interest in communities as resource managers [1]. Community-based natural resource management emerged as a bottom-up alternative for a number of reasons, including documented examples of success, beliefs about community interests in resource sustainability and shifts towards governance models that emphasized both local participation and small government (see Agrawal [2], for a review of the emergence of

the community-based management paradigm). More recently, abilities of communities to effectively manage resources have been critically examined [3,4] and arguments to scale up conservation and management are resurging (see Wilshusen et al. [5] and Brosius and Russell [6] for a summary of resurgent arguments).

Many issues are at stake in this debate and underlying it are the assumed strengths and weaknesses of the actors involved in resource management, the scale at which strengths can be capitalized on and weaknesses overcome and how this varies for particular resources. For example, communities may be seen as capable of managing resources that can be defined as local (e.g. a forest patch), but less able to manage resources that are shared (e.g. migratory species) [1,7,8]. Similarly, governments may be less willing to delegate management to communities when there are competing interests in the resource, it has high market value or there is limited scientific understanding of it. Mobility, volatility and unpredictability of resources can make them ill-suited for

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local management, as it is difficult for users to obtain reliable information about resources and to exclude outsiders from using them [2]. For a combination of these reasons, marine resources are typically seen as difficult to manage at the community level [8,9].

Between the top-down and bottom-up models of governance lies co-management, defined as a “sharing of power and responsibility between the government and local resource users” [10]. Co-management in theory can overcome the weaknesses and capitalize on the strengths of each partner. For example, the state can take a broad view of trends in resource availability, while the community can provide detailed local knowledge [11,12]. The state can provide formal mechanisms for conflict resolution between user groups, while the community can use traditional means to enforce rules and minimize internal conflict [1]. These complementarities lead to greater efficiencies and two commonly cited gains are in knowledge, as local and scientific knowledge combined offer a more complete picture of the resource, and in monitoring, as enforcement will be more effective because rules will have local legitimacy, but users will still be accountable to state oversight [11].

Wilson [12] argues that in complex systems such as oceans, where assumptions of (relatively) complete biological knowledge do not hold, co-management is an appropriate solution. Long subjected to top-down management [13–16], fisheries now feature in the co-management literature [1,11,17,18]. At the root of support for fisher participation are arguments that: fishers have vested interests in the longevity/prosperity of stocks and hold detailed knowledge of species and habitat, and local institutions for management and conservation often already exist amongst fishers [14,19,20]. Furthermore, the widespread failure of top-down management regimes for fisheries makes alternatives like co-management worth exploring [13,21].

Although co-management is a ‘partnership’ between state and resource users, the exact balance of power and responsibility in co-management arrangements can vary greatly, from token participation by fishers to real shared authority (e.g. McConney and Baldeo [22] adopt a three-stage model of consultative, collaborative and delegated co-management). While the balance of power may result from explicit power politics (e.g. efforts by the state to retain control), it may also be influenced by the capacity of both governments and communities to enter into a partnership [1,3]. This raises the issue of conditions under which co-management will work; willingness, capacity, credibility, leadership, community cohesiveness, incentives, commitment and historic relations between the government and user groups are just some of the conditions that have been identified as influencing co-management outcomes [3,17,23].

In this paper, we examine the possibilities for co-managing sea turtle fisheries in four UK Overseas Territories (OTs) in the Caribbean, and for cooperation among those four states. We focus on three criteria for co-management: a perceived crisis in the stock, the willingness of fishers to contribute to management and cohesion among fishers. Although there are many criteria to consider in co-management, arguably too many to be carefully analysed [2], these three are commonly identified and listed among Pinkerton’s [17] 20 preconditions for success. Our choice also reflects both data availability (see methods) and our interest in fishers and their incentives to participate, an issue often both critical and oversimplified [24]. In considering the potential for co-management within OTs, our focus on fishers reflects concerns about the oversimplification of ‘community’ in much of the literature on community-based management [25]. In considering the potential for collaboration among OTs, we address the question of the scalar (mis)match between regional and community-based management of shared resources [8,26–28]. Scalar mismatch occurs when the scale of the ecological process and/or

resource extraction occurs at wider or finer scales than associated governance institutions [29]. While the scale question is relevant for resource management within individual nations, it is particularly complex in the Caribbean, where the geographical concentration of so many nations makes ‘sharing’ marine resources inevitable [30].

The issue of scalar mismatch is also highly relevant for sea turtles, due to their biological and other characteristics (Table 1) and to increasing emphasis on their regional management [26,31,32]. While we see both opportunities and constraints for co-managing sea turtle fisheries (Table 1), trends in sea turtle conservation have been towards eliminating extractive uses [26,33,34]. Our focus on the potential for co-managing turtle fisheries represents a departure from this approach, but one that is warranted. First, the sea turtle fisheries we describe are legal, but are mostly unmonitored; co-management may improve monitoring. Second, when talking to government officials during our research, we detected little enthusiasm for closing these fisheries (with one exception, see below) and government ability to enforce closures is questionable [23,35,36]. Third, IUCN Red List categorizations of threat of extinction are done at the global level, but in the Caribbean, both green and hawksbills turtles, the species targeted in the fisheries we describe, are believed to be increasing [37–40]. Fourth, in most instances, the fisheries at stake involve few fishers. Most catch is for subsistence and opportunistic, with no legal international trade and few national sale outlets [41]. Thus, investments in closure will involve high transaction costs and may not be the most efficient use of resources; closures could also incite a backlash from fishers [42]. For all of these reasons, we believe sea turtle fisheries are likely to continue and that the goal should be to improve their management and, ultimately, sustainability.

2. Study site and methods

Data analysed in this paper were collected as part of a larger project, ‘Turtles in the UK Overseas Territories in the Caribbean’ (TCOT). TCOT was designed to “assist the UK, the OTs and other countries in the region to support, develop and manage co-ordinated regional conservation programmes for hawksbills and other marine turtle species” [41]. The project’s research goals were to assess the status of sea turtle populations, levels of harvest and bycatch, genetic composition of stocks, and the status of current research, conservation and management efforts [41]. While assessing the potential for co-management within states and for co-ordination among them was not in TCOT’s terms of reference, some of the data collected can be used towards these ends (see methods below).

TCOT operated in six OTs: Anguilla, Bermuda, British Virgin Islands (BVI), Cayman Islands, Montserrat, and Turks and Caicos Islands (TCI). We exclude Bermuda and Cayman Islands here because fisheries are absent (in Bermuda) or very different from those in the other OTs (in Cayman, where a commercial turtle farm operates and the fishery for wild turtles is limited and highly regulated [43]). BVI, Montserrat, TCI and Anguilla (until 1995) have active, legal turtle fisheries (Table 2). Although the Anguillian fishery has been under a moratorium since 1995, we include Anguilla here, as part of our mandate was to advise on the moratorium.

Fishery regulations are similar in the four OTs (Table 2), but the size of the fisheries varies. We estimated annual capture rates in excess of 150 green and 50 hawksbill turtles in BVI, 10–30 turtles (a mix of green and hawksbill) in Montserrat, and 240–1130 green and 180–900 hawksbills in TCI [41]. In Anguilla, thousands of green turtles and hundreds of hawksbills were likely taken prior to the moratorium [41]. The variation in capture estimates reflects

Table 1
Nature of sea turtles and implications for co-management

Factor	Detail	Implications for co-management
Conservation status	Six of seven species are listed on IUCN Red List as experiencing some level of threat; species targeted in OT fisheries listed as endangered (green turtles) and critically endangered (hawksbill turtles) (www.redlist.org)	Pro: status provides incentives for management [17,61] Con: status may support a precautionary approach (in this case, suspension of fishing) ^a
Scientific uncertainty	Red List designations controversial due to data limitations [37,62–64] High uncertainty re: overall population structure [62] and due to delayed reproductive maturity [65]	Pro: data gaps create incentives for exploring local knowledge [1,11,12]. Many research projects (including TCOT) work with local fishers to gather data on species, distribution, habitat and use levels Con: uncertainty makes it difficult to assess success or failure of any decisions made under co-management (or any other) regimes
Migratory	Long-distance migrations between nesting and foraging grounds [66,67] across various political jurisdictions	Pro: fishers have incentives to work with government to solve problems of exclusion; state involvement needed to considered regional/international perspective [2,7,8] Con: problems of exclusion and subtractability compounded by plurality, and need to coordinate across national and international jurisdictions: “Rarely are there shared values, mutually agreed upon rules, local monitoring, and ways to enforce social sanctions among groups who use migratory stocks” [8]
Value	High consumptive use values in many places [53,54]; low commercial value, but high cultural value (sea turtles are featured at birthdays and other celebrations), in case study OTs [41]. Highly valued in other ways (intrinsic, existence, etc.) in many places [58]	Pro: value provides incentives for management [61]; low commercial value makes local management more feasible [2] Con: high transaction costs; scaling up difficult when values at different nested institutional levels support different management agenda [8]

^a Theoretically, fishers and governments might agree on a co-management strategy to suspend fishing (temporarily or permanently). In practice, it is unlikely that fishers would agree to participate in co-management (and bear associated transaction costs) if no use was allowed.

Table 2
Regulations on turtle fisheries in Anguilla, BVI, Montserrat and TCI

Turtle fishery regulations	Anguilla	BVI	Montserrat	TCI
Season	Oct. 1–May 31	Dec. 1–March 31	Oct. 1–May 31	Fishing allowed year round
Quota	No quota	No quota	No quota	No quota
Size restrictions	Captured turtles must weigh at least 20 lb	Captured turtles must weigh at least 20 lb	Captured turtles must weigh at least 20 lb	Captured turtles must weigh at least 20 lb. Hawksbill and green turtles must also measure at least 20 in
Species restrictions	No species restrictions	Capture of loggerhead and leatherback turtles prohibited	No species restrictions	No species restrictions
Geographical restrictions	Uncertain	Fishing is prohibited within marine parks and protected areas	Fishing is limited within the Maritime Exclusion Zone	Capture of turtles in national parks is prohibited
Gear restrictions	No gear restrictions	Fishing using spear guns, SCUBA gear and explosives is prohibited	No gear restrictions	Fishing using spear gun and Hawaiian sling is prohibited

Anguilla regulations are those in place prior to the 1995 moratorium [44].

differences in the number of turtle fishers, abundance of turtles in water, capture methods and whether or not fishers target turtles. For example, in TCI many fishers take turtles opportunistically and it is this opportunistic catch by a large number of fishers, rather than targeted effort, that contributes to the estimated high number of turtles caught [41]. In each OT, there are concerns about illegal fishing by itinerant fishers, but their take of turtles from OT waters is unknown.

2.1. The TCOT survey

Local government partners and TCOT staff administered a survey designed to assess the nature and value of sea turtle use

(direct and indirect) to various user groups in each OT, including the turtle fishers of interest in this paper. Sampling was stratified to target user groups and within stratifications was both purposive and opportunistic. For example, in BVI the number of past and present turtle fishers was known to be small, and we purposively sampled as many as possible. In contrast, in South Caicos, TCI, all ~200 fishers potentially caught turtles. While random sampling was theoretically possible, it was practically infeasible, due to lack of formal lists of fishers and unpredictable availability. We sampled known turtle fishers purposively and others opportunistically. In total, we captured views of 110 past or present turtle fishers, 50 from TCI, 28 from Anguilla, 17 from BVI and 15 from Montserrat.

Table 3

Questions from TCOT survey applied to three criteria for co-management

Crisis in the stock	Crisis was assessed according to fisher perceptions of increased, decreased or stable numbers of turtles seen in water (in general and for specific species) over time (5 years ago and since respondent could remember). TCOT survey Q104.
Willingness to participate	Willingness to participate was assessed by considering who fishers thought should be involved in setting the regulations for the turtle fishery. The question was open ended. Respondents could be general (e.g. the Government) or specific (e.g. the Department of Fisheries) and could identify as many or as few parties as they wished. TCOT survey Q38g.
Community cohesion	Community cohesion was assessed as shared vision among fishers of: - the need for management; TCOT survey Q110a, k, n, o - specific management options; TCOT survey Q38a–f - the value of sea turtles and importance of conserving them; TCOT survey Q110c, i, m, r, s

All survey respondents provided information on household demographics and livelihoods, opinions on trends in numbers of turtles nesting and seen in water, opinions on a variety of conservation options and their awareness of laws regulating sea turtle use. The remainder of the survey was tailored to specific user groups (the full survey is available in Appendix 2, Godley et al. [41]). Turtle fishers were questioned regarding the importance of turtle fishing, fishing effort and seasonality, preferences for and knowledge of species, commercial sale of sea turtles and their parts, and their opinions on a variety of options for sea turtle management. The majority of survey questions were structured (e.g. opinions were gauged using a modified Likert-like scale). Data analysis relies primarily on summary statistics and tests for significant differences across OTs.

We use responses to several questions to address our three criteria (Table 3). Since evaluating the potential for co-management was not part of our original mandate, there are some limitations to this approach. For example, although we asked fishers to identify who *should* be involved in regulating the fishery, we did not ask if they *would*, as individuals, be willing to participate. There are limits on our definition of community cohesion, as we lack data on important elements like kinship, ethnicity, trust, leadership, or existing institutions for rule making and enforcement. While we acknowledge data limitations throughout the paper, turtle fisher responses do offer some initial insight into their attitudes towards sea turtles and their management, in ways that can be contrasted both within and across OTs. This provides a starting point for more detailed assessment and, given the interest of some OTs in changing sea turtle fisheries management, such assessment is important.

Because of the Red List status of sea turtles and because they are protected under international agreements to which the UK and some of the OTs are signatories [44], turtle fishing can be controversial. In addition, as our research project was associated with both OT and UK governments, we had some concerns about the willingness of turtle fishers to answer our questions and to do so truthfully. Although we anticipated several problems (see Godley et al. [41] Section 2), our results suggest these did not materialize. First, we had a low refusal rate (8%). Second, many turtle fishers were positive about participating; even fishers who were suspicious of the project appreciated the opportunity to provide input [42]. Third, fishers sometimes admitted to illegal activities. Whether this was because they were confident in our assurances that such information would not be used against them, or because enforcement is low in many areas (e.g. TCI [36,45]) is unknown.

3. Results

3.1. Criterion: crisis in stock

Many turtle fishers did not comment on changes in numbers of turtles seen in water. Most of these fishers either no longer fished

Table 4Fisher perceptions of change in numbers of sea turtles seen in water since 5 years ago and since they can remember, shown as percentage (n = number of fishers responding to the question)

	Increase	Same	Decrease
<i>Change in number of turtles since 5 years ago</i>			
<i>Green turtles^a</i>			
Anguilla ($n = 16$)	100	0	0
BVI ($n = 7$)	57	0	43
Montserrat ($n = 5$)	80	0	20
TCI ($n = 17$)	47	35	18
<i>Hawksbill turtles^b</i>			
Anguilla ($n = 16$)	100	0	0
BVI ($n = 6$)	33	33	33
Montserrat ($n = 5$)	80	0	20
TCI ($n = 12$)	67	25	8
<i>Change in number of turtles since fishers can remember</i>			
<i>Green turtles^c</i>			
Anguilla ($n = 14$)	43	0	57
BVI ($n = 7$)	43	29	29
Montserrat ($n = 5$)	80	0	20
TCI ($n = 17$)	47	35	18
<i>Hawksbill turtles^d</i>			
Anguilla ($n = 13$)	54	0	46
BVI ($n = 6$)	33	17	50
Montserrat ($n = 5$)	80	0	20
TCI ($n = 12$)	67	25	8

When 'increase' and 'same' are combined, there are no significant differences in fisher opinions across OTs:

^a $\chi^2 = 7.051$, $p = 0.07$;

^b $\chi^2 = 5.864$, $p = 0.118$;

^c $\chi^2 = 5.986$, $p = 0.1124$;

^d $\chi^2 = 5.615$, $p = 0.1319$.

for turtles or did so only occasionally. Thus, data in Table 4 are based on a variable subset (24–57%) of turtle fishers in each OT. Of these, most perceive increases or no changes, rather than decreases, over the last 5 years and since they can remember, for both green and hawksbill turtles. In two instances, more turtle fishers perceive declines (for green turtles in Anguilla and for hawksbills in BVI, since fishers can remember). While the non-response rate requires that these data be treated with caution, there appears to be no widespread perception of a crisis in turtle stocks.

3.2. Criterion: willingness to participate/cooperate

Turtle fishers within and across OTs are largely in agreement that government and fishers are the two most appropriate actors to regulate turtle fisheries (Table 5). All other actors are identified by fewer than 25% of turtle fishers.

3.3. Criterion: community cohesion

There is little support among turtle fishers for an unregulated fishery and turtle fishers believe the government should be active

Table 5

Parties (%) who should be involved in regulating the sea turtle fishery, shown as percentage of turtle fishers identifying them

	Anguilla (n = 26)	BVI (n = 14)	Montserrat (n = 13)	TCI (n = 44)
Government ^a	100	64	77	91
Fishers ^a	35	86	85	48
Public	23	0	8	5
Scientists	0	7	15	2
NGOs/conservationists	0	21	0	0
Police	4	0	8	0
Other	12	0	0	5

Turtle fishers could identify as many or as few parties as they wished (*n* = number of fishers who answered question).

^a No significant difference in proportion of respondents identifying government and fishers, $\chi^2 = 7.642$, $p = 0.0540$.

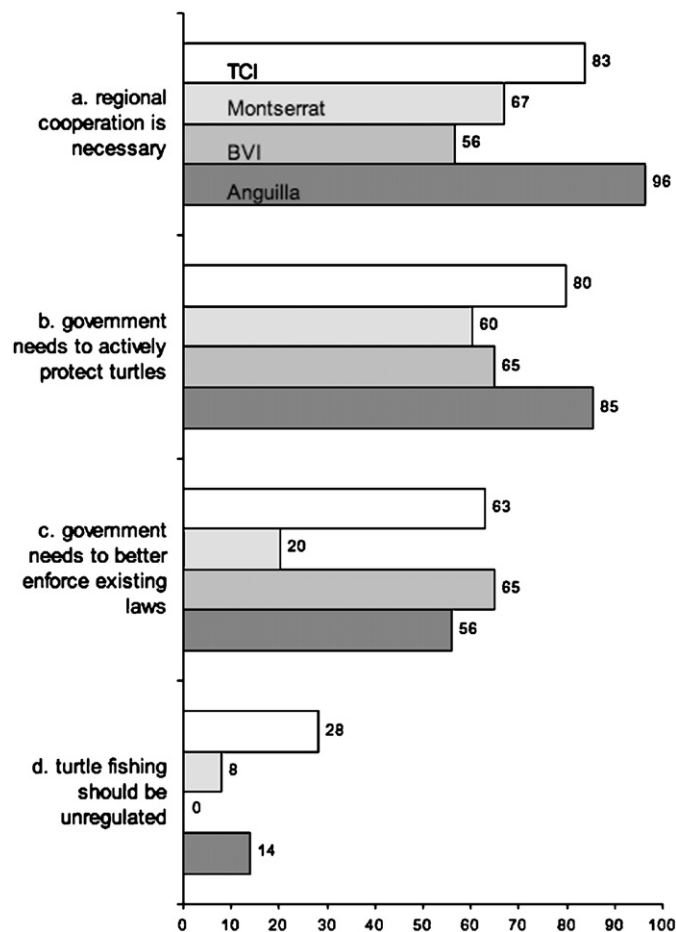


Fig. 1. Views of existing and future need for regulation, shown as percentage of fishers in each OT agreeing with statements. Views of fishers across OTs vary significantly for statements a ($\chi^2 = 39.76$, $p < 0.001$), b ($\chi^2 = 22.22$, $p = 0.001$) and c ($\chi^2 = 14.32$, $p = 0.026$). The number of fishers answering each question (*n*) varied. In TCI: *n* for a/b was 48, for c was 49 and for d it was 47. In Montserrat: for a/b/c, 15; d, 13. In BVI: for a, 16; b/c/d, 17. In Anguilla: for a, 26; b/c, 27; for d, 22.

in protecting turtles (Fig. 1). There is some variation among OTs on the latter point, with turtle fishers in Montserrat being less supportive of the need for better/more enforcement. The majority of turtle fishers in all OTs believe that regional cooperation is necessary for turtle conservation, although BVI fishers are least enthusiastic about this possibility. In terms of specific manage-

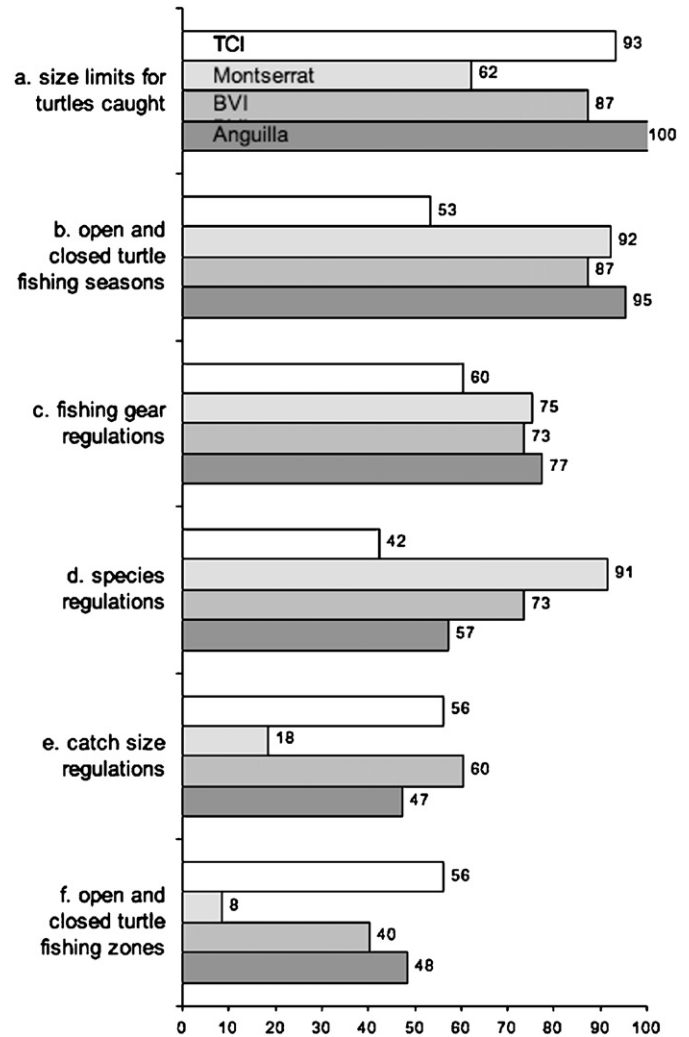


Fig. 2. Views on the values of sea turtles, shown as percentage of fishers in each OT agreeing with statements. For statement e, Anguillan fishers specified they were referring to economic value before the moratorium. Fisher views across OTs differ significantly for statements d ($\chi^2 = 17.45$, $p = 0.008$) and e ($\chi^2 = 44.24$, $p < 0.0001$). The number of fishers answering each question (*n*) varied. In TCI: *n* for a/b/d/e was 49 and 48 for c. In Montserrat: a/b/c/e, 15; d, 14. In BVI: a/c/d, 16; b/e, 17. In Anguilla: a/b/d/e, 27; c, 26.

ment measures, overall support is highest for size limits and seasonal restrictions and lowest for area zoning and restricting numbers of turtles caught (Fig. 2). There is some variation among OTs, for example, support for size limits is significantly different in Montserrat as is support for seasonal restrictions in TCI. Overall, a large majority of turtle fishers agree with value statements (Fig. 3), with the exception of 'turtles are economically valuable in this OT', which receives little support from Montserrat turtle fishers. Support for the statement 'turtles should be protected, regardless of their use to humans' varies significantly among OTs, but the statement was supported by the majority of turtle fishers in each OT.

4. Discussion

We organize the discussion around our two objectives, i.e. to assess the potential for co-management within OTs and for collaboration among OTs.

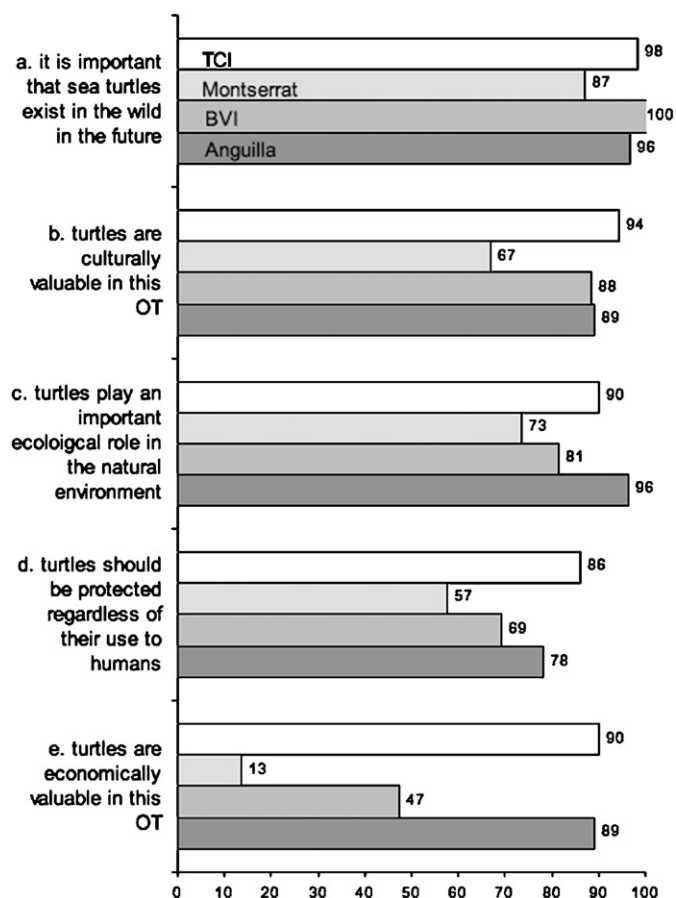


Fig. 3. Views on particular management measures, shown as percentage of fishers in each OT supporting each measure. Views of fishers across OTs vary significantly for statements a ($\chi^2 = 39.76$, $p < 0.001$), b ($\chi^2 = 22.22$, $p = 0.001$) and c ($\chi^2 = 14.32$, $p = 0.026$). The number of fishers answering each question (n) varied. In TCI: n for a/b/c/d/f was 45 and 43 for e. In Montserrat: a, 13; b/c/f, 12; d/e, 15. In BVI: a/b/c/d/f, 15. In Anguilla: a/d, 23; b/f, 21; c, 33; e, 19.

4.1. Co-management within OTs

In general, results suggest that, based on attitudes of turtle fishers, prospects for co-management within individual OTs are good, but variable. One criterion was not filled in any OT; there is no perception of crisis in turtle stocks, and this could be an important roadblock for co-management. As Chuenpagdee and Jentoft [46] argue, co-management does not arise because it is perceived as “nice to do”, but most often out of duress. However, in the case of charismatic species, particularly ones of global conservation concern, there may be other, equally compelling and more appropriate criteria for co-management. Specifically, perceived threats to the fishery may be relevant, with such threats driven by conservation goals that are sometimes independent of stock status. During our research, it was clear that turtle fishers are aware of the ‘special status’ of sea turtles. In BVI, NGOs boycotted a grocery store that sold sea turtle meat and a controversial ban on leatherback capture on nesting beaches was well publicized [47]. In TCI, students at the School for Field Studies have paid fishers to release turtles alive (our research team was offered this opportunity while on site). In Anguilla, turtle fishers credit the current moratorium to a US-based NGO’s lobbying efforts. Thus, the threat of fishery closures may provide incentives for fishers to engage in co-management, even in absence of a perceived crisis in turtle stocks; well-regulated fisheries may be better able to withstand outside scrutiny. Indeed,

one of the arguments for the *Anguilla* moratorium was that stock status and impacts of fishery on it were unknown.

In terms of the need for management and willingness to participate, fishers in all OTs agree that fisheries should be managed and that government and fishers are the most appropriate parties for doing so. While a general belief that fishers *should* participate may not translate into individual willingness to participate, results are encouraging in terms of the potential for cooperation. Some variation among OTs exists and, although not statistically significant, it is interesting for what it suggests about local context. In Anguilla and TCI, fewer than 50% of fishers identified themselves as relevant actors. In Anguilla, the 1995 moratorium was implemented with limited input from fishers, and was similarly extended in 2000. Lower identification of fishers as legitimate participants may reflect their past marginalization in decision making rather than unwillingness to participate. In contrast, in TCI, lower identification of fishers may reflect some unwillingness. Silver and Campbell [42] found that many TCI fishers were frustrated with TCOT’s focus on turtles. Although most believe that turtles are economically valuable overall, turtles are unimportant in comparison to conch and lobster. This is not to suggest that fishers are ambivalent about the turtle fishery; many expressed concerns about and resistance to potential closure [42]. Nevertheless, some TCI fishers may be less willing to invest in managing a turtle fishery when they see other fisheries as more important. It is possible that the subset of TCI turtle fishers who target turtles commercially may be more inclined to invest in co-management, or that co-management could be coupled to management of other fisheries, but further research is required.

The criterion for community cohesion, measured here as shared opinions on the value of sea turtles and on management measures, is largely met. Almost all fishers agree that sea turtles are a valuable resource (culturally, and to a lesser extent, economically). Fishers agree that ‘turtles play an important ecological role’ and ‘it is important that sea turtles exist in the wild in the future.’ It is easy to be cynical about results that show broad support for such statements, as support costs respondents little. However, turtle fishers did not support all statements blindly. For example, the statement ‘turtles should be protected, regardless of their use to humans’ was more divisive; while supported by a majority of fishers in all OTs, it had a higher number of fishers actively disagree with it and responses varied significantly across OTs.

In terms of specific management options, in three of the four OTs there are three or four regulations that are acceptable to approximately three-quarters of respondents; in contrast, TCI fishers only agree on the need for size restrictions. Montserrat fishers are most united, either widely accepting or rejecting all but one of the management measures. One notable feature of opinions on management is that fishers in all OTs tend to be more positive about regulations already on the books, and less positive about ones that are not. For example, all OTs have existing size restrictions and three of the four have open and closed seasons, the two most widely accepted options. In contrast, there are currently no restrictions on the numbers of sea turtles that can be caught in any of the three OTs, one of the management measures that received least support. One notable exception to the correspondence of accepted and experienced regulations is area closures, in place in three of the four OTs. Opinions on these are split in BVI and TCI and area closures receive little support in Montserrat (where fishers are already restricted in the neritic areas they can fish as a result of ongoing volcanic activity).

While our results suggest support for many management measures, they should be treated with caution, since the survey did not specify the details of restrictions. For example, while there

is wide support among fishers for size restrictions, existing size restrictions allow for the capture of large turtles. Existing biological theory suggests these are the most reproductively valuable members of the population [48] and, if TCOT recommendations are followed [41], maximum rather than minimum size restrictions will be implemented. Fisher support for size limits may not translate into support for *new* size limits.

Based on our combined results, we suggest that co-management will not be unduly constrained by fisher attitudes in any OT, but will face context-specific challenges in each. In BVI, fishers most frequently identify themselves as the stakeholder, who should be involved in management, and are in broad agreement regarding the value of turtles and on the necessity of many management mechanisms. In contrast, Montserrat fishers are less supportive of the need for government to do more, see little economic value in turtles, and actively resist several potential regulations. In both BVI and Montserrat, there are two advantages for co-management: few fishers are involved in directed fishing and few turtles are taken overall [49,50]. In Anguilla, the prospects for co-management need to be considered in the context of the moratorium. Fishers would likely be willing to engage in co-management when the alternative is no fishery. Results show high acceptance of the government's role in management, support for a variety of management measures, and high value attached to turtles and their conservation. But the impact of the moratorium on government relations with fishers may complicate any negotiations, should the government decide to reopen the fishery. Finally, in TCI, high levels of support for government involvement and for the value of turtles and their conservation need to be weighed against some evidence that engaging fishers could be challenging and of widespread support by fishers for only one potential management tool. Any co-management effort in TCI will face additional challenges associated with the high number of fishers catching turtles (and in greater numbers than other OTs), who are spread out over a large geographic area, and who would need to be co-ordinated.

4.2. Collaboration among OTs

As with the potential for co-management within OTs, collaborative management among OTs would not be constrained by differing attitudes of fishers. There is widespread agreement on stock status, relevant stakeholders, and various aspects of turtle conservation and management. Most disagreement arises with respect to specific management interventions, and this may be more important for management within OTs than for collaboration between them. It is unlikely, for example, that intra-OT collaboration would attempt to regulate gear. It might, however, address stock allocation and size restrictions, both of which could be controversial.

We have focused on the potential for collaboration among particular geopolitical units of interest to the UK; our treatment of Anguilla, BVI, Montserrat and TCI is a function of colonial history. Given the support OTs receive from the UK and the UK's role in representing OTs in international agreements governing fisheries and sea turtles, the geopolitical focus has some merit. The relationship between these geopolitical units and the biogeography of sea turtles, however, remains an open question. Ongoing genetic analyses suggest that the foraging green and hawksbill turtles targeted in the fisheries likely originate from a number of rookeries in the region, possibly with a bias to a few larger ones [41]. However, in addition to the magnitude of rookery of origin, prevailing currents and distance from source are likely to influence the genetic make-up of any foraging aggregation [51]. Further genetic analysis may indicate, for example, that Anguilla, BVI and Montserrat are fishing the same regional subpopulations,

but that TCI draws on a different one. Thus, from a resource perspective, biogeographical rather than geopolitical boundaries might be more appropriate for regional management.

Whether geopolitical or biogeographically defined, fishers did express support for regional cooperation, though less strongly in BVI. Again, this is likely a function of geography, specifically proximity of USVI. Turtle fishing is prohibited in the USVI under the US Endangered Species Act (ESA); while USVI Code, Title 12, Chapter 9A section 318 allows for a seasonal sea turtle fishery, the ESA takes precedence. Thus, if regional cooperation implies cooperating with USVI, BVI fishers may fear this would mean the end of the turtle fishery. Furthermore, many BVI fishers complained that USVI fishers illegally fish for turtles in BVI waters. That BVI fishers think of USVI when asked about regional cooperation is itself a reflection of the artificial nature of 'region' when defined by colonial history. While BVI attitudes are context specific, they may be instructive regarding the potential for broader regional collaboration. Chakalall et al. [30] outline a number of constraints on regional initiatives in the Caribbean, including differences in land mass, population size, level of development and governance structure. In our case, an important feature of difference is attitudes towards sea turtle conservation. Some countries in the region have adopted and advocate for complete protection of sea turtles (e.g. Costa Rica [26]) while others continue to use turtles as an extractive resource (e.g. Grenada [52,53], Nicaragua [53]), some in a highly regulated manner (e.g. Cuba [54], until 2007). Countries that have committed to a protectionist stance based on non-extractive values of sea turtles are unlikely to engage in any process that legitimizes sea turtle fisheries, and may actively work against them. This will pose an additional constraint on efforts at wider regional management.

5. Conclusions

Any move to co-management within OTs or collaboration between them will not be predicated on fisher interest alone. Governments must also be interested. In the case of Anguilla, a recent decision by the government to extend the moratorium on turtle fishing a further 15 years (to 2020) suggests a sea turtle fishery, co-managed or otherwise, is unlikely in the near future. Governments in Montserrat and BVI might be dissuaded from investing in co-management by the small, likely decreasing, numbers of fishers engaged in sea turtle fishing and the low catch levels. The resulting high transaction costs might make investments in such fisheries irrational compared to investments that could be made elsewhere. In contrast, the government of TCI is working to improve sea turtle fisheries management and will engage fishers in discussions of how best to do so. Compliance with fishery legislation has been poor in TCI [36,45,55] and resources for enforcement are limited. While these conditions are similar to those in the other OTs, TCI has the largest fishery and the highest number of turtle fishers who are geographically dispersed across the inhabited islands. Thus, the scope of the 'problem' of sea turtle fisheries management is larger, as are incentives for authorities to seek solutions; in the absence of another workable approach, involving fishers in the decision-making process for a relatively low economic value fishery may be seen as the only effective and efficient way to ensure fisher buy in/compliance. Turning to co-management when other forms of management have failed is a common feature of the co-management literature. The problem arises when factors attributed to such failures (e.g. a weak or overtaxed state) also impact on the success of co-management regimes [11].

This last point links to the issue of capacity. Capacity of both fishers and governments is critical to co-management. Rudd et al.

[23] identify 'community capacity' as "the ability of the community to use social networks and norms for mutually beneficial collective action" and 'institutional capacity' as "the ability of the government to provide public goods and assure that property rights are honoured". Co-management is most likely to succeed when both community and government capacity are high; while high capacity in one partner can help overcome low capacity in another, low capacity in both can spell failure [23]. We have not assessed capacity here, but other research from the region is informative on this point. McConney and Baldeo [22] suggest governments in the Caribbean are particularly weak on the social and cultural dimensions critical to co-management. Chakalall et al. [30] characterize the Caribbean as legislative rich and enforcement poor when it comes to marine resources, a characterization reinforced in the case study OTs [44]. In all four OTs, governments are constrained by lack of resources, particularly the number of personnel dedicated to fisheries and availability of equipment for monitoring and enforcement [41]. On the community side, pre-existing fishing cooperatives (e.g. in Montserrat) or co-management arrangements for other fisheries (e.g. conch and lobster in TCI) might be linked to or at least inform efforts to co-manage sea turtles. Regardless, any movement towards co-management will require assessment of capacity of both fishers and governments, and investment in 'capacity building' may be required.

At this point, we return to the nature of the resource. We have argued that in some OTs, the low commercial value of turtle fisheries and the lack of resources for enforcement may make governments unable or unwilling to invest in costly policy change or related capacity building. Similarly, the low commercial value of the fisheries may limit fisher willingness to participate, especially as co-management would likely entail increased (or at least changed) regulation. However, the nature of sea turtles as 'symbolically significant' common pool resources [56] and fisher desire to maintain access to them for cultural reasons may provide incentives for economically 'irrational' investments in management, particularly in the face of external pressure for fisheries closures. Similarly, the special status of sea turtles as animals of high conservation interest may motivate a 'policy entrepreneur'—defined as an agency or organization with the time, resources, commitment and authority to facilitate a costly policy change [24]—to invest in improving the management of relatively small fisheries. In this case, it would likely be the UK government or a non-government agency. Thus, just as the biological features of sea turtles may constrain or facilitate co-management efforts, other features—like the social and cultural value attached to sea turtles—could influence the willingness of fishers, governments and policy entrepreneurs to invest in managing sea turtle fisheries.

At the level of intra-OT collaboration, the biological and symbolic natures of the resource also interact. There are few models for scaling up co-management initiatives. Berkes [8] addresses the issue of scale and scalar mismatches for marine resources in particular, and argues that for highly migratory species, national oversight is not enough and "an international agreement becomes necessary to solve the scale mismatch problem." While community involvement in such agreements is theoretically possible, weak vertical linkages between scales can limit this potential [8]. The scale question is relevant for the Caribbean as a whole, where there are simultaneous calls for regional management (due to the shared nature of resources) and greater collaboration with fishers (due to the nature of fisheries and governance institutions) [35]. It is particularly relevant for sea turtles, the migratory nature of which underlies support for international agreements for their conservation [31]. In keeping with general trends in sea turtle conservation policy [26,34], such agreements, including the Inter-American Convention for the

Conservation of Sea Turtles, work to limit and/or eliminate sea turtle fisheries [44,57]. Just as the symbolic cultural value of sea turtles may serve to offset transaction costs for fishers engaging in co-management, the symbolic existence value of sea turtles to the conservation community [58,59] and in parts of the Caribbean [60] may dissuade the UK from pursuing co-ordinated management. While several small-scale sea turtle fisheries may escape outside scrutiny, efforts to co-ordinate these might be conflated with efforts to expand them. Given the low commercial value of these fisheries, some evidence of declining demand for sea turtle products [41], increasing regional populations and the questions regarding the biological utility of managing across OTs, investments in context specific co-management in individual OTs may be preferable.

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