

An Ecosystems Perspective for Food Security in the Caribbean: Seagrass Meadows in the Turks and Caicos Islands (TCI)

Susan Baker, Jessica Paddock, Alastair Smith, Richard K. F. Unsworth, Heidi Hertler, and Leanne C. Cullen-Unsworth

Introduction

The Millennium Ecosystem Assessment (MEA) recognises the ecosystem services provided by seagrass beds, namely provisioning services, such as food; regulating services, such as atmospheric and climate regulation, waste processing, flood and storm protection, and erosion control; and cultural services reference [1, 2]. The MEA also recognises food provisioning in the form of fisheries catch as one of the most important services derived from seagrasses [3]. Research in East Africa also confirms a diversity of seagrass related social - ecological links important for the welfare of the local population [4]. Seagrass meadows provided fishing grounds for finfish and invertebrates, whilst creating substrate for seaweed cultivation and sites for bait collection. Studies from Indonesia report similar findings [5]. In addition, measures of the economic value of seagrasses place them as one of the world's most financially valuable natural systems [6, 7]. This value is currently growing given greater understanding of their role in carbon sequestration [8], that is, as a regulating service.

Despite such importance, seagrass meadows are being lost at rates possibly equal to or faster than coral reefs and rainforests [9]. The location of seagrasses in sheltered waters places them in conflict with human users of the coastal environment, as development and poor land management act as stressors on these ecosystems [1], with consequences for human

wellbeing [10]. Seagrass beds have suffered major losses in the Mediterranean, Florida, and Australia and degradation is expected to accelerate, especially in the Caribbean [3]. Greater understanding of the social, economic and ecological circumstances that lead to such declines are required in order to facilitate effective conservation management, especially given that marine conservation policies often fail to appreciate the role of these habitats in supporting fisheries production [11].

Effective conservation requires understanding not just the type of stressors currently acting but their historic origins. Past choices, for example about economic development priorities, may create path dependencies that make it difficult to address the cause of environmental deterioration in the contemporary period. Understanding how local people use seagrass resources is needed because communities can act as both a source of environmental degradation and as local environmental champions. In addition, conservation plans have to be followed by implementation efforts. This requires a system of public administration that has the capacity to engage in effective implementation. Devising conservation plans in abstraction from understanding what the administrative system is capable of supporting will lead at best to cynicism, at worst defeatism, about undertaking conservation efforts.

This paper adopts an interdisciplinary approach to address this range of ecological, socio-economic and administrative issues. The lens of food security in the Turks and Caicos Islands (TCI) is used to examine threats to seagrass and how these can be addressed. Our interpretation of 'food security' draws on the United Nations Food and Agricultural Organisation (FAO) understanding that 'Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life' [12]. To meet the

demands of such a definition, we must look to the systems of employment, procurement and distribution that impact upon the potential to access and afford a healthy diet [13].

Furthermore, the concept also takes account of quality of life and the cultural appropriateness of the foods consumed. The lens of food security thus provides a way to explore the role of seagrasses in providing supporting services that help deliver a local food source that is central to a culturally valued way of life for inhabitants of the TCI.

To clarify the links between seagrasses, fisheries and food security, the historical interaction between the marine, coastal and terrestrial environment in providing sustenance for the growing human population across the TCI archipelago is first discussed. This focuses on the socio-genesis [14] of threats to seagrass health particular to this region is used to explore how interactions between different people at different times and places produce particular problems that, in turn, present specific conservation challenges. Data pertaining to rapid economic development in TCI, as well as qualitative in-depth interviews are used to explore the cultural and material importance of fisheries to the economy and local diet, before attention is paid to stressors that may come to undermine the security of this food source in the near future. The paper then explores the policy significance of findings, identifying conservation strategies to deal more effectively with the relationships between ecosystem services and the food system.

Methods

Our study utilises ecological and fisheries data collection as a basis for informing social research analysis. Primary research data was gathered using mixed qualitative research methods during three field trips in 2012-13. This includes 40 interviews with key informants, across all relevant government departments and public offices. Interviews with high ranking

public officials were combined with interviews of Heads of governmental departments, local government officials and field officers. Actors from governmental agencies, such as the tourism board, economic development agencies and the Fisheries Advisory Council, were interviewed; as were individuals from key third sector organisations, including the Red Cross and the Reef Fund; the fisheries community (fishing, processing and selling) and food producers; business interest associations, such as the Chamber of Commerce, and private businesses associated with marine activities, such as dive operators and the cruise centre; and local environmental consultants and activists. Interviewees were identified using a snowball sampling methods and selected on the basis of comprehensiveness, likely knowledge and accessibility (see Appendix A). We also undertook a four week period of participant observation with local community groups, including the Red Cross and church groups. Furthermore, two workshops involving administrative officials and stakeholder group were held on main islands. These targeted DEMA Conservation and Scientific Officers, The National Trust as well as Government Departments, including District Commissioners, independent environmental research consultants and local dive operators. Following a training session on the importance of seagrasses for the marine environment, participants were taught seagrass identification, and were introduced to the SeagrassWatch Protocol, which they were supported and encouraged to implement in the course of their in-water activities. Participants were invited on the basis that they were considered well placed to recognise threats to seagrasses and to identify pathways for the promotion of conservation efforts on the ground and over the long term. These challenges and opportunities were explored in break-out group discussions on both Providenciales and South Caicos. Secondary data sources, including grey and policy literature, were employed and included TCI government economic, spatial development and marine conservation plans, and legal documents. Policy documents and official statements from the UK government were also

analysed. Ecological data was collected between June and July 2013. Fifteen nearshore shallow water (<2m) sites across TCI (see Fig. 1) were assessed for their seagrass status using the SeagrassWatch protocol [15]. This examined seagrass percentage cover and key indicators of ecological health (e.g. macro algae, epiphyte cover). These sites were chosen as representative of meadows throughout TCI, as they contained reef and lagoon meadows. At eight of the sites fish surveys were also conducted to determine the presence of species utilising seagrass. These sites were located around South Caicos and were selected for their accessibility. Surveys used a beach seine net (2m x 15m), fyke nets (5m) and Underwater Visual Census along 50m transects [16, 17]. Fish surveys were only conducted at the seagrass sites in South Caicos (Lagoon and Reef meadows). The use of multiple methods that incorporated diel sampling enabled a thorough estimate of the fish species present. As all sites in the TCI could not be sampled for their fish assemblages, an additional meta-analysis (Using the Web of Science) was conducted of all fish species utilising seagrass meadows in the Caribbean and Gulf of Mexico. This includes local research papers [18]. Monthly fisheries landing data from the main TCI fin-fish landing (South Caicos) was recorded throughout 2013 by the School for Field Studies as part of their long-term monitoring program. Data from 2013 was amalgamated and the most abundant species (in terms of weight and absolute numbers) were determined. These abundant species were then examined relative to our seagrass species list to determine habitat support for the fin-fish fisheries.

Figure 1: Location of Sites in TCI Assessed for Seagrass Flora and Fish Assemblages about here

Part 1: Socio-Economic Profile of TCI

TCI lie at the south-eastern extremity of the Bahamas Archipelago. They were first re-inhabited by Bermudan ‘salt rakers’ around 1668, following the decimation of the previous communities by Spanish slave raiders in the 15th century [19, 20]. Despite the successes of the salt export industry, which played a significant role in the development of TCI, the sector ultimately fell into decline and eventually closed in 1974 [20, 21]. In direct response, the government turned to tourism as an alternative driver of development and the sector has expanded substantially [21, 22]. In 2011, just over 1 million tourists visited TCI [23], aided by the opening of a cruise liner terminal in 2006 [24]. Overall, the TCI Government reports that hotels and restaurants now contribute around 42 % of GDP [25].

The tourism sector has had major impact on the physical and socio-economic characteristics of the islands. In addition to rapid infrastructure development, particularly on Providenciales, tourism has brought a reversal of the net out-migration that followed the decline of the salt industry [26, 27]. However, several of the islands, including North and Middle Caicos, remain undeveloped. Census data confirms that the population grew from an estimated 12,000 in 1990 to more than 31,000 in 2012 [28]. This has increased pressure on island resources, including food and scarce fresh water. The immigrant population brings a mixture of higher level professional, technical and managerial skills, alongside larger numbers of low and unskilled labourers. TCI also has influxes of illegal immigrants, particularly from neighbouring Haiti and the Dominican Republic, leading to an estimated additional population of somewhere between 3,000 and 6,000 above the official 2001 census data [29, 30]. More recently, the House of Commons Foreign Affairs Committee report an estimated 2,000 illegal immigrants having settled or found work on TCI in 2006, and an additional 850 in 2007 [31]. Interviews, especially with the TCI Red Cross, indicate that illegal immigrants and newly documented unskilled incomers are only weakly integrated into the labour force.

They accepted harsher working conditions and work below the minimum wage [32]. By contrast, the state protects the ‘Belonger’, that is an individual who is free from immigration restrictions having acquired Belonger status under the relevant law. It is closely tied to citizenship [33]. The possibility of acquiring Belongership status for persons not born to TCI citizens is generally restricted. Between 1970 and 2011 the proportion of the adult population classed as non-belongers increased from 3.6 % to 57.5 % [34]. Key stakeholder interviews reported competition between belongers and the newly arrived immigrant populations, and that this has resulted in social tensions and reduced social cohesion [35, 36].

The tourism sector is the largest and the fastest growing sector of the economy [25], with expansion in North and Middle Caicos currently planned and new hotel complexes on South Caicos in progress. Other significant sectors are Financial Services, the Public Sector (including defence and social services) and Real Estate [25]. By contrast, the historically important formal fisheries sector now contributes less than 0.65% to GDP (2011) [32].

Despite its declining economic importance, the sectors is nonetheless of social and economic significance for certain islands groups. Spiny lobster (*Panulirus argus*) and Conch (*Strombus gigas*) fisheries continue to supported an export sector, provide fish for the tourism industry and meet local subsistence needs [25]. Consistent findings from interviews, as well as discussions at workshops, indicate that extensive subsistence, but unrecorded fishing takes place around TCI. Tensions between the multiple demands on fishing stocks [export, tourism and local subsistence] is mentioned in government policy documents (Turks and Caicos Government 2013) and in interviews with both government officials and with social organisations.

In addition to socio-economic change, the islands have undergone a recent period of political turmoil. Deepening concerns over allegations of political corruption and the lack of good governance led to the imposition of Direct Rule in July 2008 (The British Foreign and Commonwealth Office [37]. Corruption in the planning system, for example, saw uncontrolled development, including in the protected areas, with consequential impact on seagrasses. Direct rule led to a range of measures to improve governance, including legislative overhaul, civil service reforms and a new Constitution Order in 2011 [38]. Following a British Government loan guarantee of £260 million over five years (2011-16) [38], in part to support reforms, the islands have a total external debt representing 27.4% of GDP in 2011 [39]. Servicing this debt is believed by stakeholders to strongly inform priorities of the Governor's Office and to restrict the room for public policy development (interviews: DEMA Official; Governor's Office) [40].

Resentment continues to colour local feeling about the imposition of Direct Rule, making it difficult to galvanise civil society participation in public affairs (interview: environmental activist). Civic engagement is also difficult to realise given the rapid influx of new immigrant populations and the number of undocumented and unemployed people living on the islands. The elections in November 2012, that brought an end to Direct Rule, brought a return to power of the Progressive National Party, resulting in some concern among both the administrative elites and community groups as to the reach and popularity of the reforms imposed (interview: senior government official).

Although reforms have strengthened lines of accountability, oversight and control within the system of public administration, the capacity of the system has weakened. This is not least because reforms saw a reduction of staff and in funding. The Department of Environment and

Marine Affairs (DEMA) has been significantly affected, where budget cuts resulted in the loss of several key members of staff. The Department have also lost its own dedicated environment fund. This Conservation Fund traditionally received 1% of the Accommodation Tax and was used specifically to fund the operations of the Protected Area System (PAS) and for Community Conservation Projects [41]. The loss of the Fund is highly significant as it financed much of DEMA's work and afforded the Department a degree of autonomy (interview: Senior DEMO official). Our research findings are supported by the UK JNCC that argues that the loss of the Fund means that much-needed conservation measures are now largely unfunded [40].

The fragile base of the island's economy, the lack of agricultural food production, the growing but socially fragmented population, combined with the weak system of public administration, all play a role in shaping natural resource use and management on TCI.

Part 2: The Role of Seagrasses in Supporting Food Security

Status of Seagrass Meadows in TCI

Three species of seagrass were recorded throughout TCI: *Thalassia testudinum*, *Syringodium filiforme* and *Halodule wrightii*. Meadows are spatially expansive occupying a high proportion of the shallow waters of the Caicos banks [42, 43]. The aquatic macrophyte *Ruppia maritima* (sometimes referred to as a seagrass) was also found within mangrove channels. Reef seagrass meadows were dominated by *Thalassia testudinum* and lagoon seagrasses dominated by *Halodule wrightii*. Reports and peer reviewed literature identify that seagrass in TCI (e.g. South Caicos and Leeward marina) have declined in extent and density as a result of tourism developments [44, 45]. Our research has revealed that the tourism

sector acts as one of the key stressors. Dredging for shipping channels, marinas and cruise liner ports are major problems, as are coastal developments, especially hotel construction. The use of chemicals for hotel landscape maintenance also causes excess nutrient run-off into the marine system. Other concerns relate to the clearance of near shore seagrasses to make way for what is perceived to be more idyllic sands; and the rise in the use of motor boats, whose anchors and propellers can damage seagrass beds. Several interviews and workshop discussions also spoke of the widespread use of destructive fishing practices, particularly by subsistence fishers using bleach fishing. Fishermen highlighted large scale loss of seagrass across the Caicos bank from Tropical Storm Hanna and Hurricane Ike.

Plate 1 about here

CAPTION: Seagrass burning in shallow waters

Acknowledgements: Richard Unsworth

Particular sites of concern were those at the Leeward area of Providenciales that were patchy and of low density and subject to high disturbance from boat activity and dredging (25±3% seagrass cover); East Bay on South Caicos, where seagrass meadows were extensively damaged by physical removal as a result of development [44]; and meadows in North Creek Grand Turk, where epiphytes covered at least 60% of leaf surface area. Lagoon sites on the West Coast of South Caicos were low in seagrass cover $9.2 \pm 3.1\%$, but it is likely that the shallow nature and sediment composition (high percent silt) of these sites limits meadow development. There was also extensive evidence of seagrass burning throughout the TCI (9 of 15 shallow water seagrass sites visited), suggesting climate related impacts, but the effects of solar radiation and shallow water heating on seagrasses [46, 47] are poorly understood.

Despite concerns for the status (e.g. high epiphytes, low % cover) of seagrasses at some sites, the majority of visits identified healthy meadows (high density and extensive continuous distribution), exhibiting high % cover, low macroalgae, high water clarity and low epiphytic cover, particularly those within sub-tidal and deeper waters. The average cover was 40.4 ±3.6%. However, knowledge is limited by incomplete spatial assessment of seagrasses and poor historical assessment of the distribution of marine habitats in TCI [44].

The islands are also under increased development pressures, where land use planners have zoned several sites, including in the underdeveloped North and Middle Caicos islands, for further tourist expansion and for secondary home construction. This will require considerable infrastructural building.

Plate 2 about here

CAPTION: Seagrass damage due to coastal development

Acknowledgement: Richard Unsworth

Given the impact of existing development on the health of the marine ecosystem and the continuing weaknesses in policy responses, the likelihood that future development will in turn result in further seagrass degradation is high. This points to the need to apply the precautionary principle, a principle central to international environmental governance regimes, including the CBD, to put in place effective conservations plans to protect against potential, future negative trends that pose threats to the remaining healthy seagrasses of TCI. This approach is supported by the TCI National Trust (interview: National Trust official), several actors involved in conservation efforts, including within government departments (interview: Senior DEMA official) and stakeholder groups (Oral Evidence: Workshops).

Seagrass Support for Fisheries on TCI

The fish assemblages of seagrass meadows in TCI were found to contain 56 species from 22 families, many being juvenile. This species list, together with the meta-analysis of the Caribbean and Gulf of Mexico, was compared against recorded fisheries landings from 2013 in TCI. This reveals that the most abundant species landed in commercial fin- fish fisheries were known to use seagrass meadows at various periods of their lifecycle (see Fig. 2). The most abundant species caught was the Yellowtail Snapper (*Ocyurus chrysurus*), observed through our field studies to use seagrass meadows exclusively as a juvenile.

Figure 2: Fish Abundance

About here

The species contributing most to the overall wet weight of the TCI fishery was the Nassau Grouper (*Epinephelus striatus*), a species not found in seagrass by our study. However, previous surveys have recorded it exclusively as a juvenile in deeper water seagrass meadows in TCI [18]. The economically important Conch and Lobster fisheries are also dependent upon seagrass meadows, with research documenting how seagrass meadows act as their nursery and feeding habitat [48, 49]. According to interviews the majority of the Conch caught is taken from seagrass meadows on the Caicos Bank.

Plate 3 about here

CAPTION: Conch found utilising seagrass habitat

Acknowledgment: Richard Unsworth

Fisheries and Food Security in TCI

Taking an historical perspective, the seasonal Bermudan salt rakers were directly sustained by the then plentiful marine life; which was also traded with surrounding islands for other consumables such as fruit, sugar cane, vegetables and rum [27, 50, 51]. Although agriculture did later appear on TCI, the primary focus was growing cotton for export. Stakeholder interviews, triangulated by documentary analysis, indicates that there are no significant agricultural activities, arguably related to the wider ‘modernisation’ of the islands, especially the growth of the service sector [52 - and discussed further below]. This means that while conch and lobster have continued to be exported [53, 54], TCI is almost entirely reliant on imported food. Much of the local fish catch is diverted to the tourists’ table. Just over 90% of all food consumed on the islands (measured by financial value) is now imported. In 2012 TCI spent over \$60 million on imported food, the third largest import expense after mineral fuel and machinery [25]. In the same year, the value of imported fish alone rose from \$4.2 million in 2011 to \$4.4 million [55]. This growth is explained by the steadily growing volume (by weight) of fish imports to TCI, and also mirrors the wider regional pattern in which most of the fish eaten on Caribbean islands are now shipped in from overseas [56].

Plate 4 about here

CAPTION: fish imports into TCI

Acknowledgement: Susan Baker

FAO data shows that, following a spike in fish production 2001-2003, fish exports rose sharply, with a limited increase in imported fish, thus leaving a trade deficit in fish and fish products between 2001/2003 and 2008/2010 [57]. In response, fish consumption per capita fell from 41.2 Kg a year to 35.4 Kg a year, resulting in a reduced local supply. This fall in

local fish consumption was reversed in 2008-2010, alongside a commensurate crash in the export of fish. With availability of local fish outweighing exports for the first time, the reported local consumption of fish rose to 39.1 Kg per capita [57]. This indicates the strength of local demand. It is important to note, however, the FAO statistics on per capita consumption do not account for undocumented population, or the unreported fish catch. On this basis, it can be suggested that the actual availability of fish for consumption per head of local population has been in decline: as both illegal immigration and temporary visitor numbers have risen while informal catch is reported to be in decline by local fishers. This evaluation is certainly supported by more recent official figures that show reductions in the catch of both spiny lobster (reducing from a recent peak of over 984,000 lbs in 2006 to 444,000 lbs in 2011) and harvests of Queen Conch (down to just over 943,000 lbs against a quota of 1.6 million lbs) [32].

Figure 3: Availability of Fish and Fish Products on TCI

About here

We argue, however, that the demand for local fish noted above, alongside the decline in its availability, has implications for food security. Not least, with a reliance on imports, islanders face high prices and vulnerability to supply restrictions in cases of extreme weather, a not uncommon event. These dynamics refer to *affordability* and *access* to food as two of the three pillars upholding the UN's definition of food security. Our argument draws attention to a further and less well considered dimension of food security – the *appropriateness* of food. That is, when the full nuances of the UN's definition are considered, we see that TCI Belongers and non-Belongers are lacking access to local fish as a form of culturally appropriate food. For this reason, we make a case for highlighting the importance conserving

seagrass meadows for the cultural ecosystem services they uphold. That is, there is a crucial role for cultural services in bringing to light an often overlooked principle of food security – the appropriateness of food. Compounding the issue of lack of availability of culturally valued food, most imported food is processed and canned, providing poor quality for consumers, especially when compared to a diet rich in local and fresh produce. Currently, poorer communities in TCI face the double bind of losing access to local fish (as it is redirected to the tourism industry) while becoming increasingly reliant upon high priced, processed imports food. The fact that import levies act as a significant source of government revenue, providing for example 35% of revenue in 2008/9, reduces the incentive for government to act on this issue.

We eat a lot of fish if we can get it but it's like costly. [...] It's expensive. You can probably get some periodically, but it's relatively expensive to buy (Community Activist)

Poorer communities often fish in nearshore and easily accessible seagrass meadows, despite the fact that many such sites are under the extensive marine protection area system on the islands. Our research with community groups highlights the importance of subsistence fishery in providing a social safety net for poorer communities.

People depend on fish especially [...] where [...] a lot of people are unemployed and ... they can go out and catch a few fish and at least they can sustain their life (Director, TCI Red Cross).

Moreover, the Director of the Red Cross TCI also raised health concerns about changing dietary habits resulting from the non-affordability of traditional foods:

...before it was a major fish, conch type diet, a lot of seafood. [...] It's become more expensive, it's harder to get now [...] It's much easier to afford the processed unhealthy foods than the healthy ones (Red Cross Representative).

This constrains islanders' ability to pursue an 'active and healthy life, a key characteristic of FAO definition described above [12]. As traditional diets disappear, changes in food preparation practices are also occurring.

Our food culture's been lost because we're so Americanised now cheap quality of foods and a lot of parents who can't afford the old food or have the time to prepare the food [...] they're opting for the cheaper version of it so we're losing a lot of our traditional foods (Director of Culture)

For example, conch is no longer mainly prepared using traditional and arguably healthier methods, such as casseroled conch to more Americanised versions of 'crack conch' (fried in oil and coconut). Islanders also eat more fried potatoes and less traditionally milled gritz or plantain. These trends place islanders on a trajectory that disengages them from traditional and culturally appropriate food practices and risks more unhealthy lifestyles arising from changing food consumption patterns.

Both the TCI Red Cross as well as representatives from Government Departments (Culture Department; Ministry of Gender Affairs; Department for Economic Planning and Statistics) express concern that the changing diet of islanders does not simply represent a shift in cultural ideas about food consumption practice - with consumers preferring novelty over traditional ingredients and cooking styles. Rather, they suggest that they arise from the interplay of global market forces that make local fish increasingly unavailable or only accessible through illegal, or informal means [58].

We can't afford the cost of the healthy stuff – it's just like – did you see the cost of the fruits? \$10 for a bag of salad, \$8 –\$9 for a pack of grapes. I'm telling you, berries, strawberries is \$7. I mean eating healthy here, it costs so much money (Community Activist)

The protection of a healthy marine environment serves as one of the most viable routes towards securing long-term benefits from a culturally and materially important food source. A number of possible responses to the issue of food security on TCI can be envisaged. On the basis of interviews with government officials, it emerged as highly likely that the government will aim to strengthen and deepen TCI's integration into international food supply networks, for example through port development (interview: senior government official). To potentially complement this, some argue for the adaptation of agricultural development policies from other islands in an effort to make the most of the limiting physical geography of the islands for domestic food production. However, a third policy option highlighted by stakeholders is to promote better conservation of endogenous fisheries.

Part 3: Towards Effective Conservation

This next section explores the prospect for and barriers to effective management of TCI marine resources. It highlights the challenge involved, while also identifying possible solutions that may lead to better policy outcomes.

Strong Legal Protection

The marine environment in TCI is protected by a strong, multi-level regulatory framework. First, TCI is included in the UK's ratification of several international environmental agreements. Although not yet a signatory to the Convention of International Trade of Endangered Species of Wild Flora and Fauna (CITES), DEMA is charged with establishing a quota for harvest in accordance with CITES rules for export of queen conch (live, shells or meat). In addition, TCI is also involved in regionally specific conventions, including the

Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region [59]. The territories are also expected to make a strong contribution to the achievement of UK targets and agreements under the CBD, as described in the UK *Strategy for the Conservation and Sustainable Use of Biodiversity in the UK Overseas Territories* [60]. The Strategy specifically mentions the need to protect the marine environment as a source of economically, culturally and socially important ecosystem services.

Conservation of marine habitats is also supported by local legislation, including Fisheries Protection Regulations (1989), Marine Pollution Ordinance (2010) and an Endangered Species Bill (under final review) including provisions for CITES. Seagrasses are specifically protected under marine conservation legislation (Interview: Senior DEMA official). Regulation is supplemented by a comprehensive Protected Area System (PAS) [61] and supported by several strategic policy plans, including the *Strategy for Action to Implement the Environment Charter of the Turks & Caicos Islands* [62] and a Marine Resources Management Plan is under construction. In 2009, a new National Policy for the Management and Development of the Fisheries Sector was introduced in an effort to ensure that the islands ‘uses its natural resources wisely, being fair to present and future generations’ [25].

Weak Capacity

This regulatory framework has the potential to afford the required protection to the marine environment of TCI, including to its seagrass meadows. However, enforcement of legislation is weak and there are major deficits with respect to the implementation of PAS management plans (interviews: DEMA senior official; DEMA field officers; TCI National Trust; environmental activists). This weakness is acknowledged by the UK government in their

statement that ‘... in most UKOTs, funds are not available for monitoring or enforcement, and governance issues can affect the effectiveness of enforcement’ [63].

Several factors account for the gap between formal protection of the marine environment in TCI and actual practice, including the lack of policy capacity, that is, the ability of different governance levels to act in pursuit of specified public policy goals [64]. Capacity-building instruments are widely used instruments of public policy (Painter and Pierre 2005), and typically include technical assistance, skills training and the development of management skills (Radin 2003). The UK OTs biodiversity Strategy hopes that encouraging OT governments to develop and participate in cross-territory and regional initiatives will promote capacity enhancement. In addition, funding is being made available through a new Overseas Territories Environment and Climate Fund, administered alongside the DEFRA Darwin Plus Initiative. This may however, only partially compensate for the fact that the OTs remain ineligible for many international funds, including the Global Environment Facility (GEF), the key funding mechanism for the CBD, because they are not developing states as such, but part of the UK; but are excluded from European Union funds because, while they are under the jurisdiction and sovereignty of the UK, they are not part of it and thus not members of the EU.

Even if policy capacity was enhanced, tensions remain at the heart of public policy in TCI. On the one hand, there are strong policy preferences driving traditional forms of economic development, including in the tourism sector; on the other hand, there are increasing demands for and legislative commitment to the protection of the environment of TCI, including its significant marine biodiversity and habitats. Under current development models, the marine environment is threatened by tourism development, despite the fact that environmental

quality plays a key role in attracting tourists to TCI, as reflected in the islands' tourism development strategy. There has been some attempt to address this problem of sectoral policy integration. In 2001, for example, the TCI and the British government signed an Environmental Charters, which include measures for integrating environmental conservation into policy planning [65]. However, while the recent TCI Development Strategy 2013-17 admits that the problem of integration remains, the Strategy does not suggest steps to address the issue [25].

Societal Engagement for Capacity Enhancement

Finding alternative ways to increasing policy capacity is particularly important for effective governance when structures of public administration are not fully developed. Our research points to the potential that could be derived within TCI from drawing from the capacity of civil society and economic stakeholder groups. Increasingly, network styles of governance are making positive contributions to the steering of collective, public policy action. While TCI has a weak and highly fragmented civil society, our research has identified a strong stakeholder community, especially among the tourism sector that depends on environmental quality for continued business, including dive operators. Workshops revealed a high degree of willingness among dive operators and local consultants to become involved with seagrass conservation. Recent high profile cases of damage to seagrasses provide opportunities to work with specific tourist operators to raise the profile of seagrasses and have these companies involved in conservation activities. Such stakeholder engagement has already been shown to make positive contribution to conservation policy, particularly at the implementation stage, and also to be in keeping with the trend towards corporate environmental responsibility.

In addition, opportunities exist to promote conservation through enhancing environmental awareness. Knowledge of the importance of seagrasses is lacking across civil society in TCI – “As a teacher the environment tends not to be very important to children” (Interview: TCI Red Cross). For example, many of the islands’ protected areas, including those that straddle on and off shore sites, are not identified by local signs or on local maps, and few people are aware of their whereabouts and purpose. The importance of environmental awareness and public involvement in promoting wise environmental practices has been recognised by the Government of TCI, as evidenced by the *Environmental Awareness and Involvement: A Strategic Plan 2008-2011*. To instigate such learning, the Director of the Department of Culture explains that importance of recruiting communities into the appreciation of their marine environment.

I tell them about the way it’s good for the body and how important it is for tourism, our livelihoods is really based on this because our beauty is the ocean surface and below. [...] so we should learn more about the reef and the forest below the ocean – our inner space. That’s very important to get them to respect it. [...] So it’s a way to take control of your environment, to learn more about what you are, [...] it’s built around that ocean of ours so we need to be a part of that so it’s definitely part of being proud of it, do more, learn more about your inner space (Director, Department of Culture).

Instigating this learning, the Director suggests, can help overcome a somewhat blasé attitude among local people in taking the marine environment – and the ecosystem services it provides - for granted. Furthermore, local people do not to seek recreation in the water, but develop from childhood a fear of this very environment as a place wherein dangers, both mythical and real, are understood to lurk. Instilling an appreciation of the marine environment, for example through education and cultural events, could help progress a precautionary response to the myriad threats facing the TCI marine environment. Through the

development of such an approach, the role of seagrass as a cultural ecosystem service that boosts food security is both highlighted and strengthened at the local level.

Conclusion

This paper has explored the link between fish provision and habitat conservation, in particular seagrass meadows, pointing to the importance of conservation efforts for supporting ecosystem services for food security. The link between provisioning services (fish) seagrass meadows were highlighted in the paper. However, our research revealed that there is no simple, linear relationship between conservation of supporting services, maintenance of provisioning services and social wellbeing, in this case understood as food security.

Provisioning services can be subject to multiple, often conflicting demands, in our case, the requirement that fisheries serve as a base for sectoral development, provide for tourist needs and act as a source of subsistence food provisioning. At the same time, tourism developments have been shown to be a source of direct threat to seagrasses and thus also to fisheries. Our research also revealed that the conservation of ecosystem survives requires a degree of social cohesion, not least because the presence of an undocumented and socially excluded migrant population on TCI poses risks for conservation efforts. Enforcement would, in this context, require unrealistic levels of policing. In contrast, we point to widely documented experience that shows how conservation successes are critically dependent upon societal participation. However, in a society fractured on the basis of cultural identity and entitlement politics, attention should be paid to obtaining support from economic stakeholders. When social cohesion is lacking, there is a strong role for promoting ecosystem services as cultural value. While understanding of cultural ecosystem services in TCI remains underdeveloped it could

from the basis of a more robust pre-emptive engagement with marine conservation, given the importance of effective societal participation in conservation efforts.

Acknowledgements

This research was funded by Darwin M&E Programme Overseas Territories Challenge Fund (EIDCF010).

References

1. Orth, R.J., et al., *A global crisis for seagrass ecosystems*. *Bioscience*, 2006. 56: p. 987-996.
2. SEQ Ecosystem Services Project. *Millennium Ecosystem Assessment Reporting Category: Seagrass*. 2014 03/06/2014]; Available from: <http://www.ecosystemserviceseq.com.au/step-1-reporting-categories/seagrass>.
3. UNEP, *Marine and Coastal Ecosystems and Human Well-Being Synthesis 2006*, United Nations Environment Programme: Nairobi.
4. de la Torre-Castro, M. and P. Ronnback, *Links between humans and seagrasses - an example from tropical East Africa*. *Ocean & Coastal Management*, 2004. 47(7-8): p. 361-387.
5. Unsworth, R.K.F., et al., *Economic and subsistence values of the standing stocks of seagrass fisheries: Potential benefits of no-fishing marine protected area management*. *Ocean & Coastal Management*, 2010. 53(5-6): p. 218-224.
6. Costanza, R., et al., *The value of the world's ecosystem services and natural capital*. *Nature*, 1997. 387: p. 253-260.
7. Barbier, E.B., et al., *The value of estuarine and coastal ecosystem services*. *Ecological Monographs*, 2011. 81(2): p. 169-193.
8. Fourqurean, J.W., et al., *Seagrass ecosystems as a globally significant carbon stock*. *Nature Geosci*, 2012. advance online publication.
9. Waycott, M., et al., *Accelerating loss of seagrasses across the globe threatens coastal ecosystems*. *Proceedings Of The National Academy Of Sciences Of The United States Of America*, 2009. 106(30): p. 12377-12381.
10. Cullen-Unsworth, L.C., et al., *Seagrass meadows globally as a coupled social-ecological system: implications for human wellbeing*. *Marine Pollution Bulletin*, 2013.
11. Unsworth, R.K.F. and L.C. Cullen, *Recognising the necessity for Indo-Pacific seagrass conservation*. *Conservation Letters*, 2010. 3: p. 63-73.
12. FAO, *The State of Food Insecurity in the World*. 2013, FAO: Rome.
13. Lang, T. and D. Barling, *Food security and food sustainability: reformulating the debate*. *The Geographical Journal*, 2012. 178(4): p. 313-326.
14. Harvey, M. and S. Pilgrim, *The new competition for land: Food, energy, and climate change*. *Food Policy*, 2011. 36, Supplement 1(0): p. S40-S51.
15. McKenzie, L.J., et al., *Seagrass-Watch: Community Based Monitoring Of Seagrass Resources*. *Biol. Mar. Medit.* , 2000. 7: p. 393-396.
16. Edgar, G.J., N.S. Barrett, and A.J. Morton, *Biases associated with the use of underwater visual census techniques to quantify the density and size-structure of fish populations*. *Journal of Experimental Marine Biology and Ecology*, 2004. 308(2): p. 269-290.
17. Nagelkerken, I., et al., *Day-night shifts of fishes between shallow-water biotopes of a Caribbean bay, with emphasis on the nocturnal feeding of Haemulidae and Lutjanidae*. *Marine Ecology Progress Series*, 2000. 194: p. 55-64.
18. Claydon, J.A.B. and A.M. Kroetz, *The distribution of early juvenile groupers around South Caicos, Turks and Caicos Islands*. *Proceedings of the 60th Gulf and Caribbean Fisheries Institute*, 2008: p. 345-350.
19. Curet, L.A. and M.W. Hauser, *Islands at the crossroads : migration, seafaring, and interaction in the Caribbean*. 2011, Tuscaloosa: University of Alabama Press.
20. Sadler, H.E.S.M.C.K., *Turks Islands landfall : a history of the Turks & Caicos Islands*. 1997, Grand Turk, Turks and Caicos Islands: Marjorie E. Sadler.

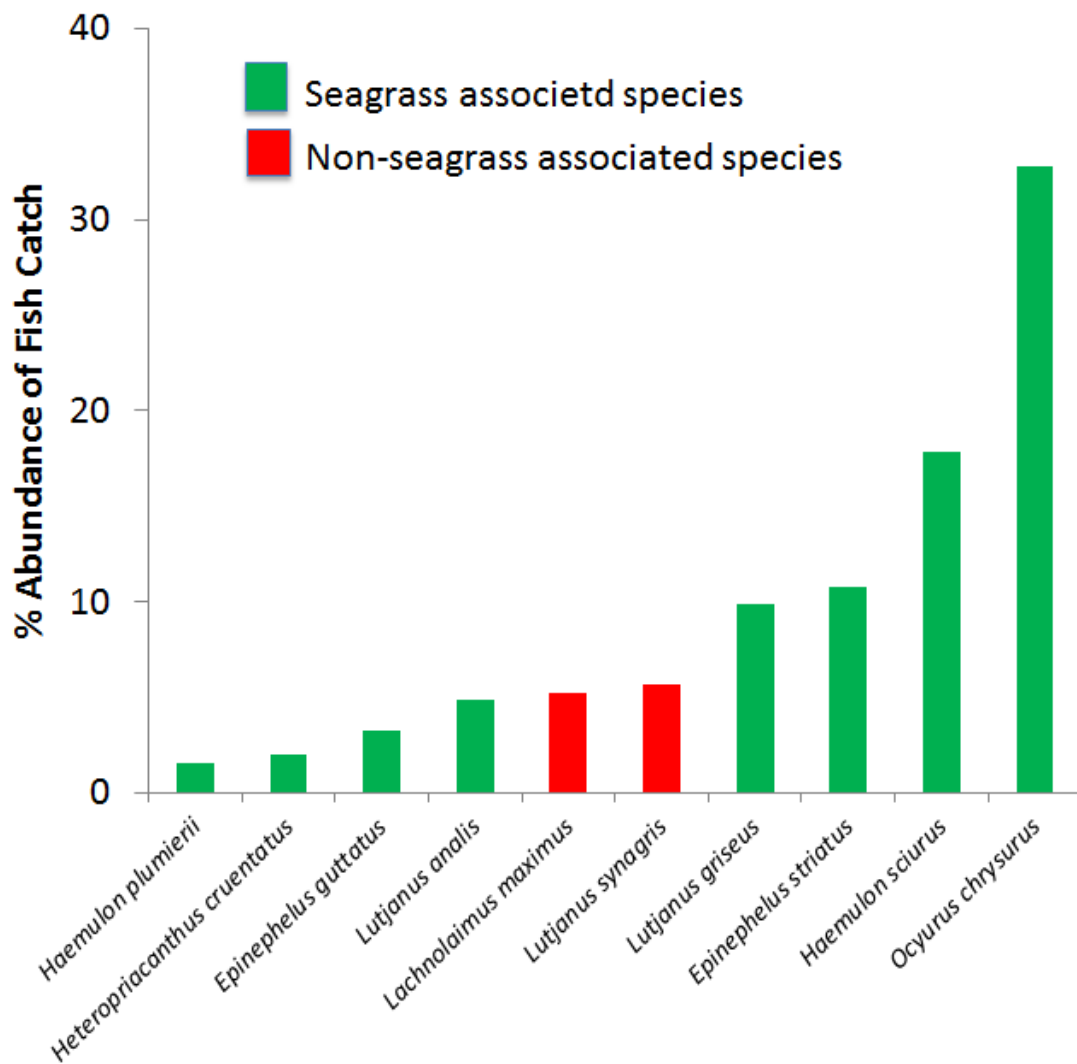
21. Clare, W., *A History of Tourism in the Turks & Caicos Islands*, in *The History of the Turks and Caicos Islands*, C. Mills, Editor. 2008, Macmillan: Oxford.
22. Cameron, C.M. and J.B. Gatewood, *Beyond Sun, Sand and Sea: The Emergent Tourism Programme in the Turks and Caicos Islands*. *Journal of Heritage Tourism*, 2008. 3(1): p. 55-73.
23. Turks & Caicos Islands Tourist Board. *Turks & Caicos Islands Tourist Board Statistics Tourism Statistics- 2011*. 2012; Available from: <http://www.turksandcaicostourism.com/news--ResourceID--7144.html>.
24. Jamaica Observer, *Turks cruise terminal closes after illness outbreak*. 2013.
25. Turks & Caicos Government, *Turks and Caicos Islands Development Strategy 2013-2017*. 2013.
26. McElroy, J.L. and K.d. Albuquerque, *Migration Transition in Small Northern and Eastern Caribbean States*. *International Migration Review*, 1988. 22(3): p. 30-58.
27. Rudd, M.A., *Fisheries landings and trade of the Turks and Caicos Islands*. Fisheries Centre Research Reports, 2003. 11(6): p. 149-61.
28. Government Press Office, *Preliminary 2012 Census Data Published*. 2012: Grand Turk, Turks and Caicos Islands.
29. Clerveaux, W. and T. Fisher. *Socio – Economic and Demographic Concerns in Fisheries and Coastal Area Management: Turks and Caicos Islands Case Study*. 2005; Available from: <http://www.caricom-fisheries.com/LinkClick.aspx?fileticket=7XM4MoQQSEE%3D&tabid=86>.
30. Bennett, E., *Country Report: Turks and Caicos*, in *Management of conflict in tropical fisheries*. 1999, Centre for the Economics and Management of Aquatic Resources, University of Portsmouth.
31. Committee, F.A., *Overseas Territories : seventh report of session 2007-08*. 2008, Stationery Office: London.
32. Turks & Caicos Government, *Turks and Caicos Islands Development Strategy 2013-2017*. 2013.
33. TCI-Government. *Naturalization, Ministry of Home Affairs & Public Safety*. 2006; Available from: http://www.tciyellowpages.com/templates/jt006_j15/images/pdfforms/Naturalization-application.pdf.
34. TCI-Weekly-News. *Non-Belongers account for 57.5 % of adult population - Population growth in sync with TCI's development*, *Forbes*. 2014 Friday 9 May, 2014]; Available from: <http://tcweeklynews.com/nonbelongers-account-for-percent-of-adult-population-population-g-p2768-128.htm>.
35. Selver, E., *Racism and Discrimination*, in *Turks and Caicos Weekly News*. 2013.
36. Gleaner, T. *Turks And Caicos To Work With Haiti To Prevent Illegal Migration*. 2013 27/05/2014]; Available from: <http://jamaica-gleaner.com/extra/article.php?id=2383>.
37. FCO, *White Paper The Overseas Territories: Security, Success and Sustainability*. 2012.
38. FCO, *The Turks and Caicos Islands, Jon Lunn International Affairs and Defence Section, Briefing Paper*. 2012.
39. TCI-Government. *Turks And Caicos Islands Development Strategy, 2013-2017*. 2013; Available from: http://www.tcinewsnow.com/documents/development_strategy2013-2017.pdf.
40. JNCC, *The UK Overseas Territories Biodiversity Strategy: Review of Progress*. 2013, Joint Nature Conservation Committee.

41. Green, R., *'Conservation Fund Tax Absorbed Into General Fund, in Free Press Turks and Caicos. 2012.*
42. Wise-Network, *Assessing temporal change in seagrass distribution using remote sensing data: Turks and Caicos Islands. 2013, Aberystwyth University, UK.*
43. Mumby, P.J., et al., *Measurement of seagrass standing crop using satellite and digital airborne remote sensing. Marine Ecology Progress Series, 1997. 159: p. 51-60.*
44. Zuidema, C., R. Plate, and A. Dikou, *To Preserve or to Develop? East Bay Dredging Project, South Caicos, Turks and Caicos Islands. Journal of Coastal Conservation, 2011. 15: p. 555-563.*
45. Erickson, L., *Local sediment management at Leeward-going-through in Providenciales, Turks and Caicos. Terra et Aqua, 2005. 10: p. 3-12.*
46. Campbell, S.J., L.J. McKenzie, and S.P. Kerville, *Photosynthetic responses of seven tropical seagrasses to elevated seawater temperature. Journal of Experimental Marine Biology and Ecology, 2006. 330: p. 455-468.*
47. Unsworth, R.K.F., et al., *Solar Radiation and Tidal Exposure as Environmental Drivers of *Enhalus acoroides* Dominated Seagrass Meadows. Plos One, 2012. 7(3).*
48. Stoner, A.W., *What constitutes essential nursery habitat for a marine species? A case study of habitat form and function for queen conch. Marine Ecology-Progress Series, 2003. 257: p. 275-289.*
49. Behringer, D.C., et al., *Is seagrass an important nursery habitat for the Caribbean spiny lobster, *panulirus argus*, in Florida? New Zealand Journal of Marine and Freshwater Research, 2009. 43: p. 327-337.*
50. Sadler, N., *The Bermudians and the Start of the Salt Industry, in The History of the Turks and Caicos Islands, C. Mills, Editor. 2008, Macmillan: Oxford. p. 95-101.*
51. Kennedy, C.M., *The Other White Gold: Salt, Slaves, the Turks and Caicos Islands, and British Colonialism. Historian, 2007. 69(2): p. 215-230.*
52. Lobao, L. and K. Meyer, *The Great Agricultural Transition: Crisis, Change, and Social Consequences of Twentieth Century US Farming. Annual Review of Sociology, 2001. 27: p. 103-124.*
53. Hesse, C. and K.O. Hesse, *Conch industry in the Turks and Caicos Islands. Underwater Naturalist, 1977. 10(3): p. 4-9.*
54. Statistical Office, *TCI Environment A Closer Look 2004. 2004, Department of Economic Planning and Statistics.*
55. DEPS and CD, *EXTERNAL MERCHANDISE TRADE REPORT 2012. 2012.*
56. Caribbean 360. *Caribbean per capita fish consumption results in high imports. 2013; Available from: <http://www.caribbean360.com/index.php/news/813339.html#ixzz2ZIIaLcmpu>.*
57. FAO. *Yearbooks of Fishery Statistics: Summary Tables of Fishery Statistics. No Date; Available from: ftp://ftp.fao.org/fi/stat/summ_tab.htm.*
58. Warde, A., *Consumption, food, and taste : culinary antinomies and commodity culture. 1997, London; Thousand Oaks, Calif.: Sage Publications.*
59. UNEP, *Convention and Protocols Status Page. 1983.*
60. DEFRA, *United Kingdom Overseas Territories Biodiversity Strategy. 2009.*
61. Encyclopedia of Earth. *Protected areas of Turks and Caicos Islands. 2009 07/01/2014]; Available from: http://www.eoearth.org/article/Protected_areas_of_Turks_and_Caicos_Islands.*
62. Turks & Caicos Government, *Strategy for Action to Implement the Environment Charter of the Turks & Caicos Islands. No Date.*

63. UK Parliamentary Office of Science and Technology, *Biodiversity in UK Overseas Territories - POST Note 2013*.
64. Painter, M. and J. Pierre, *Unpacking Policy Capacity: Issues and Themes*. In *Challenges to State Policy Capacity: Global Trends and Comparative Perspectives*, M. Painter and J. Pierre, Editors. 2005, Palgrave/Macmillan: Basingstoke. p. 1-18.
65. UKOTEP, *Environment Charter Turks and Caicos Islands*. 2001, UK Overseas Environment Protection Programme.

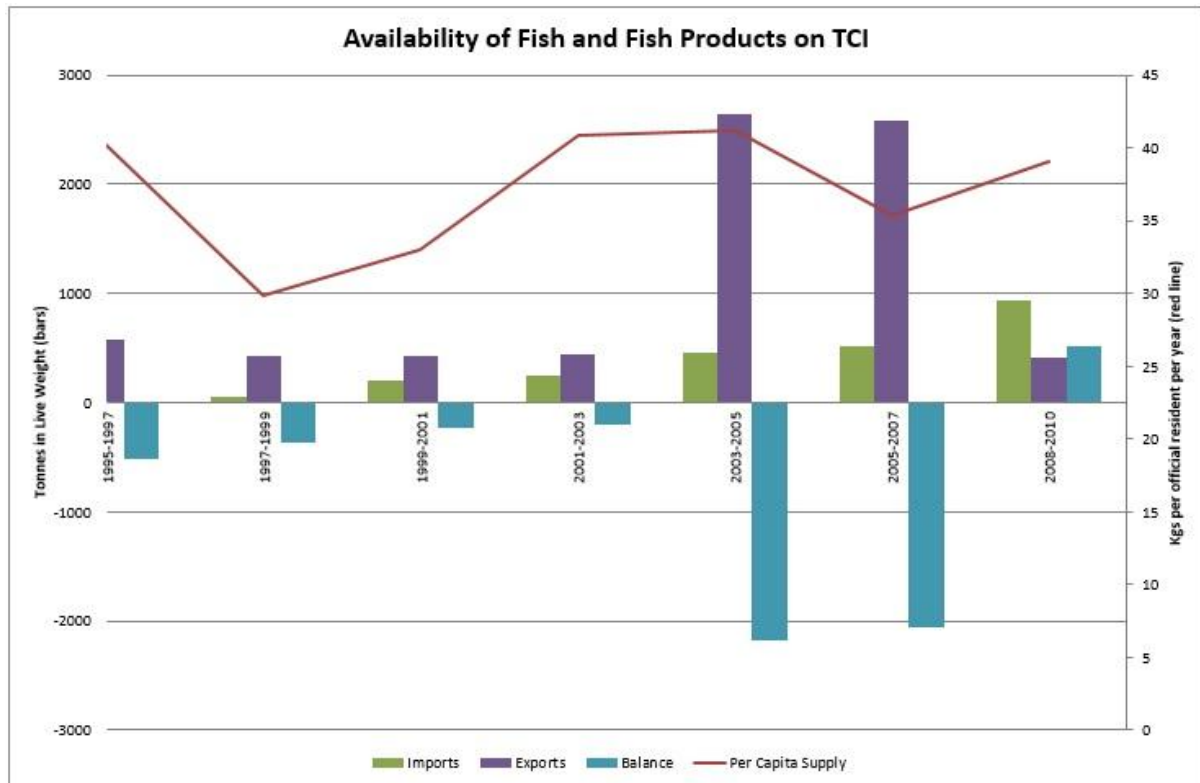
Figure 1: *Location of Sites in TCI Assessed for Seagrass Flora and Fish Assemblages*
Sent separately at e-submission as JPEG file

Figure 2 Fish Abundance



Comment: The ten most abundant fish species caught in the small scale artisanal fishery of South Caicos during 2013 (Data School for Field Studies). South Caicos is the main landing site in TCIU for fin fish. Only two of these species were not associated with seagrass during their lifecycle.

Figure 3: Availability of Fish and Fish Products on TCI



Appendix A: Qualitative Data Sources

	Organisation/Affiliation Formal Interviews (recorded and transcribed)	Location
1	Agriculture Department	Providenciales
2	Cruise Centre Development	Grand Turk
3	DEMA	NEC, Providenciales
4	DEMA	Grand Turk
5	DEMA	Grand Turk
6	DEMA	Providenciales
7	Department of Gender Affairs	Grand Turk
8	Department of Gender Affairs	Providenciales
9	Department of Economic Planning and Statistics	Grand Turk
10	Fish Plant	Providenciales
11	Fish Retailer	Providenciales
12	Fisheries Cooperative	Providenciales
13	Fisheries Cooperative	Grand Turk
14	Fisheries Cooperative	Grand Turk
15	Former FAC & Fisheries Cooperative	Grand Turk
16	Former FAC, Fisheries Cooperative	Grand Turk
17	Formerly DEMA, formerly SFS CMRS adjunct	SFS, South Caicos
18	Formerly DEMA, formerly SFS CMRS adjunct	South Caicos
19	Investment Unit	Grand Turk
20	National Museum	Grand Turk
21	Planning Department	Grand Turk
22	TCI Red Cross	Grand Turk
23	TCI Red Cross	Providenciales
24	SFS CMRS	SFS, South Caicos
25	Soroptomists International and Business Licensing	Grand Turk
26	TC Reef Fund	Providenciales
27	TCI Tourist Board	Grand Turk
28	Welfare Department	Grand Turk
29	Welfare Department	Providenciales
30	Producers (arable and livestock farmers)	Middle Caicos
31	Producers (arable and livestock farmers)	North Caicos
32	Middle Caicos Co-op (artisanal crafts)	Middle Caicos
33	Seaside Restaurant Owner	Middle Caicos
34	TCI National Trust	Providenciales
35	TCI National Trust	Middle Caicos
36	Governor's Office	Grand Turk
37	Governor's Office	Grand Turk

38	Integrity Commission	Grand Turk
39	Environmental Consultant	North Caicos
40	Environmental Consultant	South Caicos
	Organisation/Affiliation Workshops	Location
	Local Dive operators, independent environmental research consultants, TCI Red Cross, DEMA (Officials, Conservation Officers and Scientific Officers) Department of Culture and TCI National Trust.	Providenciales
	DEMA Conservation Officers, Local Fishermen, District Commissioner and School for Field Studies: Centre for Marine Resource Studies.	South Caicos
	Organisation/Affiliation Participant Observation and In-situ Interviews	Location
1	TCI Red Cross – volunteering in community thrift shop (10 hours)	Providenciales
2	Disaster Reduction Team Meetings (3 hours)	Providenciales
3	TCI Red Cross – volunteering in community thrift shop (10 hours)	Grand Turk
4	Dock landing sites (5 hours)	South Caicos
5	Dock landing sites (5 hours)	Providenciales