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**Paper: Tobagan fishers' livelihood security and attitudes to coastal  
management in the context of declining catches**

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# **Tobagan fishers' livelihood security and attitudes to coastal management in the context of declining catches**

## **SUMMARY**

Declining fish stocks worldwide threaten the livelihoods of millions of people. Understanding fishers' perceptions of change in their marine resources and their attitudes to management will help guide policy makers as they seek to protect more marine life and habitats. Consideration of fishers' dependence upon fishing is important to avoid increased poverty in the small-scale fisheries sector. This paper examines how fishers' perception of change in their catches compares to fish landings data, on the island of Tobago. Twenty one fishers in two villages were surveyed regarding their fishing methods, socio-economic aspects of their livelihood, perceptions of change in fish catches and attitudes to management. Fishers' views of declining catches were partially validated by landings data. The principal reasons given for the decline were more fishers, industrial fishing, oil drilling and exploration, and climate change. Most fishers had another job outside the fishery providing greater livelihood security, though there is high reliance on public sector employment. Fishers' views on management are mixed though mainly opposed to fisheries restrictions but more positive regarding proposals for a marine protected area (MPA). A fuller understanding of the causes of the decline in fish catches is needed to guide fisheries policy. Fisheries management measures should first focus on the external causes of decline in fish stocks. However this research suggests the proposed MPA could be implemented with little impact on most fishers. Occupational multiplicity is providing a buffer against declining fish catches but greater employment opportunities would allow fishers to reduce their livelihood failure risk.

## **INTRODUCTION**

The world's oceans are under ever increasing pressure from anthropogenic factors leading to degradation of the marine ecosystem goods and services that millions of people depend upon (Rogers & Laffoley 2011; Millenium Ecosystem Assessment Board 2005). World marine capture fisheries have been relatively stable for the past decade (FAO 2010). However the number of fish stocks classified as overexploited, depleted or recovering has increased from 10% in 1974 to 32% in 2008 (FAO 2010). Sustainable fisheries are of particular importance to the 120 million people worldwide who are directly dependent on capture fisheries for their livelihood (World Bank 2010). Given that 97% of these people are in developing countries and 90% work in the small-scale fisheries sector (World Bank 2010), improved fisheries and coastal management is essential for helping to alleviate poverty (Béné & Friend 2011).

Fisheries management is essential to ensure sustainable harvest of fish stocks (Botsford et al. 1997). Unregulated fishing ultimately leads to depletion of the common resource (Hardin 1968) and loss of livelihood for all fishers. Current fisheries management measures are focused upon the use of "property rights" within fisheries to ensure stewardship of the resource (Beddington et al. 2007), and the use of marine protected areas (MPAs) to provide protection to marine life and habitats (Pauly et al. 2002). By excluding some or all fishing effort from an area, MPAs provide a "sanctuary" for fish and can have positive effects on adjacent fisheries by exporting juveniles or adults (Pauly et al. 2002; Roberts et al. 2001), though the magnitude and likelihood of these effects is still difficult

to quantify (Graham et al. 2011). If management measures are applied using a top-down approach, exclusion of fishers often leads to resentment and rule-breaking behaviour (McClanahan, Maina, & Davies, 2005; Peterson & Stead, 2011). Small-scale fishers in developing countries often use fishing as one of a number of livelihood options (Allison & Ellis 2001). Reducing or removing fishing as a source of income can push fishers, who are often already poor, into greater poverty (Béné et al. 2010).

The population of the Caribbean is highly dependent upon marine resources with 116 million people living within 100km of the coast (Burke & Maidens 2004). The fisheries sector is mainly comprised of small-scale and artisanal fishers (Dunn et al., 2010), employing more than 200 000 full- or part-time fishers and an additional 100 000 people in fish processing and marketing (Burke et al. 2008). Human activities, including agricultural land use, coastal development and overfishing, have caused significant degradation of Caribbean reefs (Mora 2008). The Caribbean has been fished intensively for over 100 years resulting in large reductions in reef fish populations, with fish biomass having already been reduced by 80% by the 1960s on reefs in Jamaica (Hughes 1994; Jackson et al. 2001). The need to reduce fishing pressure to a sustainable level is likely to have negative effects on fishers and many others who depend directly upon the fishing sector unless management measures are carefully considered before implementation (Béné et al. 2010). Understanding fishers' dependency on fishing and their views regarding changes in catches and management options is important to creating a sustainable fisheries management policy (Allison & Ellis 2001; McClanahan et al. 2006; McClanahan et al. 2005).

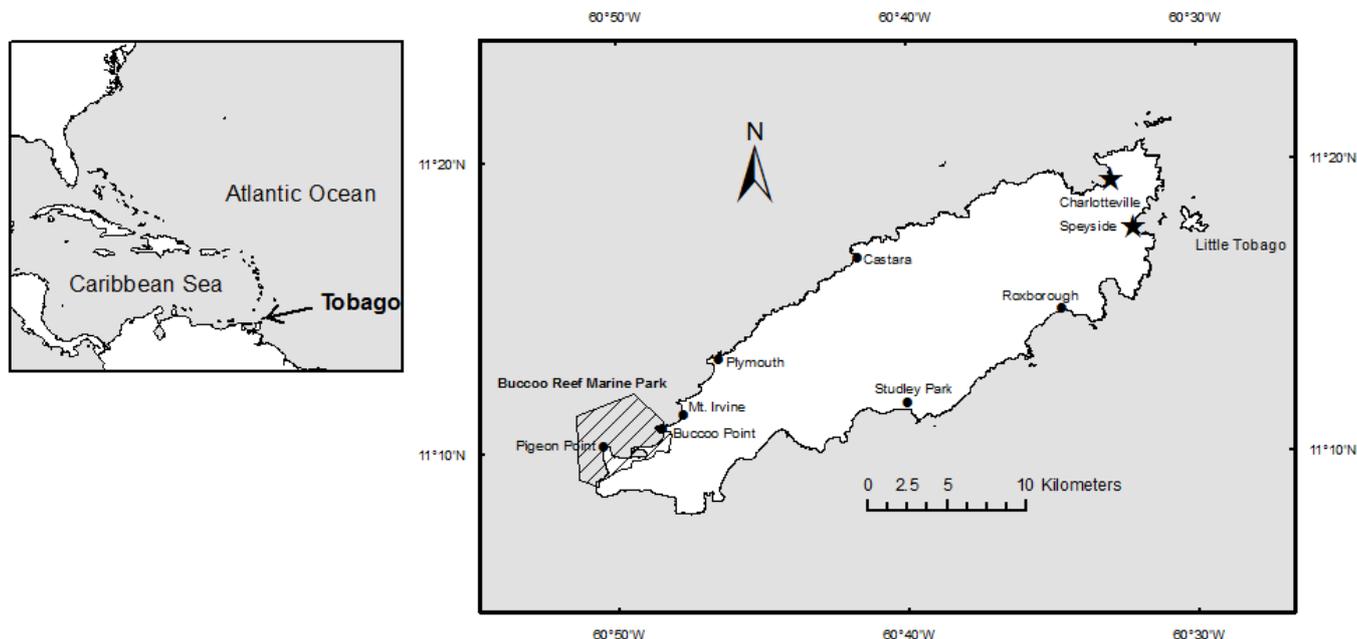
Tobago is the smaller of the two islands that make up the Republic of Trinidad and Tobago in the southern Caribbean (Figure 1). The annual direct economic benefit of coral reef associated fisheries in Tobago is relatively small, estimated at US\$ 0.7 – 1.1 million (Burke et al. 2008). However the value of the entire fisheries sector is considerably greater as catches of pelagic species and artisanal fishing are economically more important (CRFAMP 2001). The total value of the artisanal catch of just three important fish species at 10 landing sites was US\$0.9 million for the 1998 – 1999 season (CRFAMP 2001). The fishery sector also plays an important cultural role in many communities, providing jobs and a social safety net (Burke et al. 2008).

Tobago provides an interesting case study area where currently little regulation of fishing takes place (pers. comms. Ruth Redman, Department of Marine Resources and Fisheries) but proposals exist to create a new MPA (Armstrong et al. 2009; IMA [Institute of Marine Affairs] 2002). Buccoo Reef is the only existing MPA in Tobago, though it is widely recognised as a “paper park” with little enforcement of regulations and no operating budget for the management committee (Burke et al. 2008). For successful enforcement of future fishing regulations, including the use of MPAs, it is important to understand fishers' attitudes to management and dependency on fishing (McClanahan et al. 2005).

The overall aim of this study was to investigate fishers' perceptions of change in the fishery, how these changes might affect their livelihoods and attitudes to management options, including the proposed MPA. The use of fisheries landings data allowed the validation of perceived changes in fish catches. Exploring fishers' reasoning for changes in catch allows for the formulation of management measures intended to improve the security of their livelihoods. Previous studies have assessed the study area in considerable detail but none have focused on the fishers views (EDG [The Environment and Development Group] 2003; IMA 2002). Examining attitudes to

management will inform policy makers where areas of agreement exist and where resistance to regulations might be encountered thereby avoiding rule-breaking behaviour, in respect to marine resource regulations, experienced in some developing countries (Peterson & Stead 2011).

## METHODS



**Figure 1** The island of Tobago, showing Buccoo Reef marine park, the two study sites (★) and 7 landing sites (●) (Source: GIS data from Town and Country Planning Dept., Tobago)

### Study Area

The combined population of Trinidad and Tobago is approximately 1.3 million with Tobago having 54 000 inhabitants and an area of 300km<sup>2</sup> (Central Statistical Office 2011). The economy is heavily dependent upon Trinidad's position as a lead producer of oil and gas within the Caribbean, with this sector accounting for 40% of GDP and 80% of exports though only employing 5% of the workforce (Central Intelligence Agency 2011).

Tobago's economy relies on state support with considerable fiscal transfers from Trinidad. The public sector currently employs 51.5% of the workforce, an exceptionally high figure (THA [Tobago House of Assembly] 2011). Disaggregated data for Tobago is difficult to obtain. However the fisheries sector plays an important role in both the economic and social lives of much of the population (Burke et al. 2008; EDG 2003). The problems of obtaining reliable fisheries data for Tobago have been noted by previous studies (Burke et al. 2008; CRFAMP 2001). The Department of Marine Resources and Fisheries (MRF) is responsible for collecting data. However lack of funding, government support and management direction has led to poor fisheries data (pers. comms. Ruth Redman and Terence Holmes, MRF). MRF were unable to provide a current estimate of number of registered fishers though literature sources put the total at approximately 1 000 and the number of fishing boats at 700, ten of these being multi-purpose vessels and the remainder pirogues (Burke et al. 2008; CRFAMP 2001).

Fishing in Tobago is mainly artisanal, i.e. individual fishers using small vessels, fishing close to shore and selling their catch mainly for local consumption (CRFAMP 2001). No fishing restrictions exist in Tobago except within the Buccoo Reef marine park (BRMP) in the south-west (Figure 1) where no extractive activities are supposed to take place (pers. comms. Ruth Redman, MRF).

### **Site selection**

The villages of Speyside and Charlotteville (Figure 1) were selected for study as they are the two largest communities in north-east Tobago, where fishing is the main economic activity (EDG 2003). Speyside is the most popular tourist destination and Charlotteville the main fishing village within this area. Both fishing communities would be affected by the implementation of an MPA in Speyside. The Institute of Marine Affairs published recommendations in 2002 that the “Speyside Reefs Marine Area” should be made a MPA over the long term, defined as 5 – 10 years (IMA 2002). A further proposal for a Speyside MPA was completed by Coral Cay Conservation (Armstrong et al. 2009), though there is no MPA at present.

Charlotteville is the largest fishing village in Tobago, located in the natural sheltered harbour of Man O’War Bay. Last census data estimated the population at 1259 with 367 households (EDG 2003). The number of fishers and boats is difficult to assess due to the lack of records, but a survey in 2003 estimated 60 fishing boats and 180 fishers (EDG 2003).

Speyside is the main tourist destination in North-East Tobago with six dive centres and three glass-bottom boat operators as well as three hotels (20+ beds) and several guesthouses. The number of fishers is estimated at 25, with only 2 full-time, by one source (IMA 2002) and 62, and 15 boats, by another (EDG 2003).

### **Data Collection**

#### ***Fishers***

Fishers (n =21) were interviewed in Speyside (n=12) and Charlotteville (n=9) between April and July 2011. Based on personal observations and conversations with fishers this sample represents at least 40% of the fisher population of Speyside and approximately 10% that of Charlotteville, though these are estimates due to the lack of accurate fisher numbers available from MRF. The questionnaire was first piloted and revised with the help of key informants in the fishing community (Bunce et al. 2000).

Key informant interviews were used to suggest suitable interviewees, with snowball sampling and convenience sampling at the landing sites used to obtain further participants (Bunce et al. 2000). All interviews were conducted face to face and recorded for further analysis. Questionnaires were used with structured, closed questions to provide quantitative data and semi-structured, open questions to provide qualitative information that was later coded. Questions were asked to determine fishing methods and self-reported CPUE, fishing grounds, dependency on fishing, perceptions of change and attitudes to management. Specific questions were asked regarding the proposal for a marine park in Speyside and a map from the most recent MPA proposal (Armstrong et al. 2009), showing a managed area and no-take zones, was used as a basis for this line of questioning. Interviews lasted approximately one hour.

All responses to questionnaires were transposed into a Microsoft Excel (Microsoft Corp., Redmond, WA) spreadsheet for analysis with the audio recordings of interview analysed for additional information. Free responses were assessed for recurrence of themes or ideas and coded based upon these. Fisher's exact tests were performed in Minitab (Minitab Inc., State College, PA) to determine the statistical significance of differences in responses between villages.

### ***Fisheries data***

MRF collects catch data from fishers at eight landing sites between one and four times per month, with the data collector staying from approximately 8:00 to 16:00. Catch per unit effort (CPUE) data (lbs boat<sup>-1</sup> trip<sup>-1</sup>) was obtained from MRF records for the years 2005 to 2011. It was not possible to isolate the landing sites for Speyside and Charlotteville specifically as data are not collected at Speyside and data for a single landing site would be too limited to allow meaningful analysis, hence the data are aggregate for the eight landing sites around Tobago: Buccoo Point, Castara, Charlotteville, Mount Irvine, Pigeon Point, Plymouth, Roxborough and Studley Park (Figure 1).

Mean catch per unit effort (CPUE) for the years 2005 – 2010 was calculated for the three main methods of fishing and the six most important target species as determined from the fisher interviews (Table 1). Data were imported into Excel and regression analysis performed to determine if there were significant trends. MRF recognise that the landings data are not of the highest quality due to irregular landing site sampling. However by examining CPUE for several methods and species it was hoped that any trends could be corroborated across the datasets.

## **RESULTS**

### **Fisher profile**

All fishers interviewed were male with only one female fisher (one of the key informants) existing within the communities surveyed. The mean age of the fishers was 46 (SD 12) with the majority (76%, n = 16) having lived in their community all their life and left school after secondary school (62%, n = 13) or elementary school (19%, n = 4). There is a strong tradition of fishing as a traditional way of life in both the villages studied and 90% (n = 19) of the fishers stated that they had started fishing with family or friends at an early age, even going out on boats as young as seven. Responding to why they fish, all except one individual classified their fishing as commercial though many added that they "love it" and it was a part of their life. All of the fishers stated that they keep some of the fish they catch to eat themselves.

Most fishers (86%, n = 18) interviewed used a standard 7m long open deck pirogue with engines in the range 40-75 horsepower (hp), although 40hp was the most common used by 57% (n = 12) of fishers. Seventy one percent (n = 15) of fishers owned their own boat with the remainder using boats of friends or family. Profits minus running costs (fuel and oil) are split equally between boat owner and boat user when fishers borrow boats. Fishers all used multiple gear types (mean [SD], 3 [1]) and fishing methods except one seine net fisher who was exclusive in his gear use. Fishers vary fishing methods according to the seasonal movements of the target species which were reported as being variable each year, with many fishers reporting increased seasonal variability in the last 5-10

years. The fishing methods and target species are not described in the literature hence this information is summarised here (Table 1).

**Table 1 Description of the three most common fishing methods, including usage, target species and seasons**

<b>Fishing method</b>	<b>Trolling</b>	<b>Banking</b>	<b>A-la-vie (live bait)</b>
<b>Fishers using method</b>	90% (n = 19)	81% (n = 17)	62% (n = 13)
<b>Description of method</b>	Four to six lines towed from bamboo outriggers. Commonly 3 lines weighted to sink, 2 running on the surface. Artificial bait (squib) or small pieces of bonito ( <i>Euthynnus alletteratus</i> ) used on each hook; one per line.	Bottom line fishing from either anchored or drifting boat. Line with 10 - 50 hooks baited with bonito or other small fish. Done on “banks” offshore (15-30m depth) found by triangulation of landmarks. Lines can also be attached to buoys and checked periodically.	Line fishing with up to four nylon hand lines per person, using hooks with live bait ( <i>Clupeidae</i> family spp.). Small quantities of live bait are thrown into water at intervals to attract target species. Bait is caught using beach seine nets or cast nets.
<b>Main target species: Local name (scientific name)</b>	Kingfish ( <i>Scomberomorus cavalla</i> ), Dolphin ( <i>Coryphaena hippurus</i> ), Blackfin & Yellowfin tuna ( <i>Thunnus atlanticus</i> & <i>Thunnus albacares</i> ), Wahoo ( <i>Acanthocybium solandri</i> ), Bonito ( <i>Euthynnus alletteratus</i> )	Grouper ( <i>Epinephelus</i> spp., mainly <i>Epinephelus flavolimbatus</i> & <i>Epinephelus itajara</i> ), Snapper ( <i>Lutjanus buccanella</i> )	Blackfin & Yellowfin tuna ( <i>Thunnus atlanticus</i> & <i>Thunnus albacares</i> ), Kingfish ( <i>Scomberomorus cavalla</i> ), Salmon ( <i>Elagatis bipinnulata</i> ), Amberjack ( <i>Seriola rivoliana</i> ), Dolphin ( <i>Coryphaena hippurus</i> )
<b>Main season</b>	November – May	June - September	May - October

### Perceptions of change

To compare fishers’ perceptions of changing catches to trends in the landings data, fishers were asked “Are there more, less or the same number of fish compared to when you started fishing?” The majority of fishers (95%, n = 20) responded that they had seen a decline in catch over the period of time they had been fishing with many fishers also noting a decline in the size of fish. There are 4 main reasons given by the fishers for this change: (1) more boats fishing locally, hence catch divided amongst a greater number of people; (2) industrial fishing boats offshore fishing out stocks, luring fish away from the shore with lights and, in the case of trawlers, destroying habitat; (3) offshore oil rigs acting as FADs (Fish Aggregation Devices) drawing fish away from shore, and seismic oil explorations scaring fish away and destroying habitat; and (4) climate change (Table 2).

**Table 2 Fishers reasons given for declining catch. Multiple reasons may be given by one fisher, hence percentages do not sum to 100%.**

<b>“Why is there less fish now compared to when you started fishing?” Primary themes of responses (sub-categories of responses)</b>	<b>Percentage of respondents (n)</b>	<b>Sample response</b>
More boats (locally) (More boats/ more noise/ more people)	48% (n = 10)	<i>“I would say there is less fish now, because why, long time [ago] there was less boats, wasn’t much boat around, so now there is more boats and less fish” S3, Speyside</i>
Industrial fishing boats (Longliners/ big boats / trawlers destroying habitat and taking all the fish)	33% (n = 7)	<i>“The trawlers, with the nets and big lines, totally killing the fishing ground.” C1, Charlotteville</i>
Offshore oil drilling (Oil rigs/ seismic exploration for oil)	33% (n=7)	<i>“Before, the fishing was real good, but since the exploration of Petro-Canada, that’s the oil company, that affect the fishing, I won’t say 100%, approximately 32%”. “...you’ve got to go deeper: before if you used to go by that rock, now we have to go twice the distance to that rock” S4, Speyside</i>
Climate change (Climate change/ changing climate of the water)	24% (n = 5)	<i>“I think the climate also, because I mean like, from starting to fishing to now, we’re not even catching half the fish we were catching in the early days.” C1, Charlotteville</i>
Increased run-off/ pollution from land (Sediment and pollution running into bay/ landslides)	14% (n = 3)	<i>“Sometimes when the rain fall, and we get a lot of mud-slip, all the rivers release to the water and because of the dirt that comes down into the sea it moves the fishes away and they won’t come back till it’s clean” C3, Charlotteville</i>

There was considerable inter-village variability in fishers’ reasons for declining catch however the differences were not found to be significant ( $p > 0.1$  in all cases).

### **Dependence**

Ninety percent (n = 19) of fishers had an occupation other than fishing, with the vast majority of these (76%, n = 16) working either directly or indirectly for the Tobago House of Assembly (THA: local government body for Tobago) in semi-skilled or unskilled jobs such as road maintenance, and 33% (n = 7) working in the tourism industry. One fisher without a THA job was receiving a government scholarship for a training course. The vast majority (81%) of those employed by the THA worked 5 days a week for 3.8hrs (SD 1.6) on average.

Despite the self-reported decline in catch, only 14% (n = 3) of fishers said that they would ever consider leaving fishing with the remaining 86% (n = 18) saying they would only stop fishing due to old age, i.e. when they were incapable of doing so. This resilience to leaving fishing is at least partly due to fishing being not just a living but a way of life for many fishers interviewed, exemplified by the following response:

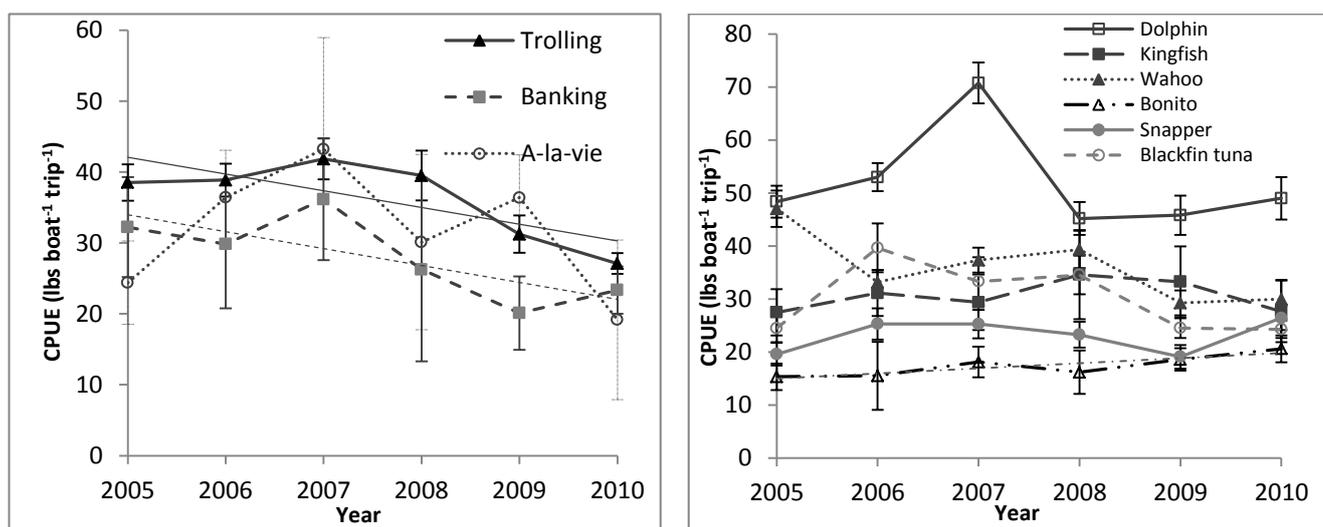
“No, I will never stop fishing” ... “I love it. Not just the business part of it, the fun part of it. You know when you go out and fish, you know what it is to feel a fish on your line and you’re fighting it, makes you feel happy.” C9, Charlotteville

Fishers had not increased their number of hours spent fishing to compensate for decreased catch, with 48% (n = 10) stating they had reduced the numbers of hours spent fishing over their lifetime and 33% (n = 7) making no change. Of those who reduced their time spent fishing, 33% (n = 3) did so as because they were getting older and 50% (n = 5) because of (other) work commitments. 72% (n = 16) of fishers responded that they had changed their method of fishing, however no major changes were cited with the introduction of artificial bait (squib) being the most common change (n = 9).

### CPUE data

CPUE for all methods of fishing showed a general decrease in annual catches since a peak in 2007 with considerable variability in the a-la-vie catches (Figure 2a). This variability and the large standard errors associated with the a-la-vie and banking data is partially explained by the limited landings records for these two methods (90 for banking, 145 for a-la-vie compared to 538 for trolling). Linear regression analysis showed significance at the  $p < 0.1$  level only in the banking ( $r^2 = 0.57$ ,  $p = 0.08$ ) and trolling ( $r^2 = 0.60$ ,  $p = 0.07$ ) regression. Both regression lines show a declining CPUE trend (Figure 2a).

CPUE data according to species showed little change, though dolphin showed a spike in catches in 2007 (Figure 2b). This maximum is in the same year as the maximums for all three methods CPUE data. Regression analysis showed a significant linear relationship only for the bonito data ( $r^2 = 0.75$ ,  $p = 0.03$ ) with the trend in CPUE demonstrating a slow increase (Figure 2b).



**Figure 2 CPUE against year data for Tobago: (a) for three most common fishing methods in study area, including regression lines for trolling and banking; (b) for five most important target species. Values are given as means  $\pm$ SE. Table 1 provides description of fishing methods and scientific names of fish species (Source: MRF fisheries data)**

An interview with the Captain of Tobago's only commercial longliner (Bird of Paradise) gave anecdotal evidence of falling CPUE: 2 years ago lines with a total of 700 hooks would yield approximately 200 – 300 fish whereas now only 14 – 15 fish are caught using the same lines and hooks (target species yellowfin tuna, bycatch of dolphin and marlin (*Makaira nigricans*)).

### **Attitudes to management**

Most fishers (86%, n = 18) said there were no fishing restrictions except the turtle closed season, though a few fishers (14%, n = 3) stated that there were some gear (no “white nets”; nets with fin mesh size) and area restrictions (Goat Island and Little Tobago reefs (Figure 1) off-limits to fishing). A majority of fishers (62%, n = 13) were against any management of their fishing. However there was low significance ( $p = 0.06$ ) inter-village variation in response to this question with 58% (n = 7) of fishers in Speyside answering that they would thought some management would be useful but 89% (n = 8) of fishers in Charlotteville against management . This dichotomy is illustrated by responses from fishers in each village to the question “Do you think there should be management of fishing?”:

*“Our area is really a scuba diving haven for scuba divers worldwide and I'd really like to see a little more protection somewhere along the line. It's too free for each and everyone to come and do what they really want, so I personally believe there should be some sort of management”. S4, Speyside*

*“I don't see it fit for something like that, because fishing is seasonal and then there is time that you can't go out there to fish, so shouldn't have a restricted time because it's all seasonal.” C8, Charlotteville*

It should be noted that within the group of fishers opposed to management of fishing, there were several (n = 3) who would like to see restrictions on industrial boats (trawlers and longliners) but not on the local fishers, and 30% (n = 4) responded positively to the proposals for a MPA in Speyside.

Opinions regarding the proposed MPA were not significantly different ( $p > 0.1$ ) between the two villages, though only 22% (n = 2) of fishers in Charlotteville were classified as having a negative response to the question “Do you think the proposed marine park will have an effect on Speyside?” compared to 50% (n = 6) in Speyside. Overall 48% (n = 10) of fishers expressed positive opinions regarding the MPA, 38% (n = 8) negative and 14% (n = 3) neutral. Of those fishers' voicing negative opinions only two were completely opposed to the principal of a MPA, with the remaining six concerned with access, as they need to pass through the proposed MPA to reach their fishing grounds. None of the fishers currently fish within the no-take zones proposed in the MPA plan. The diverging opinions are captured by the following responses:

*“This is good. You see in these areas, fish will come here and breed and then we'll have a growth in here.”..... “I don't see any problem in that. Very good position. Good for fishing, it will increase the number of fish.” S9, Speyside*

*“We don't need that. I don't want it” C7, Charlotteville*

*“When they start this way, they gonna start restricting people in other areas like Giles and these things, I don't think it would be nice. Now, coming to think about it I don't think it would be nice. It's a very nice idea though.” C9, Charlotteville*

This last comment reflects a concern that may underlay some negative responses to the MPA proposal; that one restriction will lead to more, eroding the fishers' current freedom.

### **Key results summary**

Most fishers have a public sector job, though fish commercially, using three methods of fishing on average. Fishers are noticing a decline in both catch quantity and size of fish, with their main reasons for the change given as: more fishing boats (locally), the presence of trawlers and longliners, offshore oil exploration/ oil rigs and climate change. MRF data shows decreasing CPUE since a peak in 2007, though with respect to CPUE according to fish species, there appears to be no significant change. Opinions regarding management of fishing are mixed with the majority against management of their own fishing, but more open to other options such as controls on industrial fishing boats. The MPA proposal had similarly mixed responses though more fishers expressed positive views than negative.

## **DISCUSSION**

### **Actual and perceived change in fish catch**

The declining CPUE seen in the data for the three most commonly used fishing methods is not replicated in the analysis of CPUE by fish species which shows yearly variation but little overall change. As the catch data is for the whole island it is possible that other methods of fishing maintained the catch levels for these species as CPUE for trolling, banking and a-la-vie has dropped. This may point to local variations in CPUE as fishers' perceptions of declining catches agree with the declining CPUE by fishing methods trend.

While the evidence for declining CPUE presented here is poor at best, other reports provide some evidence to support this trend, with 80% of the stocks in Trinidad and Tobago's exclusive economic zone listed as overexploited or collapsed (Sea Around Us Project 2011) and evidence of declining fish catches despite increasing effort (Potts et al. 2008).

### **Causes of declining CPUE**

Causes of change in catch are difficult to assess, especially in highly migratory species such as the kingfish, dolphin, tunas and wahoo which are some of the most commercially important fish in the areas surveyed. Increased boat numbers locally are likely to play a small role in the reduction in catch rates as Tobago's fishing fleet is still artisanal and small-scale compared to the more industrialised fishing fleets of surrounding islands and countries, namely Trinidad, Venezuela and Barbados. Local fishing pressure is likely to reduce within the areas surveyed as several fishers' remarked fewer young people are entering the fishery, confirmed by the high mean age of those interviewed (46).

The "big boats", longliners and trawlers that many fishers blame for reducing fish stocks mainly come from Trinidad (pers. comms. Ruth Redman, MRF), though intrusions of fishing vessels from Barbados and Venezuela into Trinidad and Tobago's national waters are known to be fairly common:

*"All them Bajans come down right up to our side of Giles and all about there and catching them fish and going back up in Barbados. Years they doing that. Venezuela and Barbados and them doing that."* S8, Speyside

A long running dispute with Barbados regarding access to flying fish stocks off the coast of Tobago is still unresolved (Blake & Campbell 2007) with continued problems of Barbadian fishing vessels entering Tobagan waters (pers. comms. Ruth Redman, DMRF).

Offshore oil exploration and drilling and its effect on fish stocks is an important current issue as negotiations with fishers were in progress (June 2011) regarding compensation for potential decreased catches due to seismic surveying. The effects of anthropogenic noise on fish are poorly understood, though reduction in fish catches after seismic surveys with air guns has been reported (Popper & Hastings 2009). Fishers claimed that the seismic surveys undertaken by oil companies offshore scared the fish away, hence reducing their catch, a claim echoed by fishers' in Trinidad (Aboud 2011).

Fishers were concerned about the fish aggregating effect of offshore oil rigs. They blamed these rigs for reduced catches due to the safety exclusion zone around them so that fishers are unable to benefit from the FAD effect of the rigs and lose fishing grounds. The fish aggregating effects of oil rigs are well known (Love et al. 2006) as is increased fishing activity within the surrounding area (Jablonski 2008). However there are no reports of fishers suffering decreased catches as a result. This does not preclude the possibility and given the number of fishers expressing concern over catch decline due to oil rigs and seismic surveys, it could be one of the local reasons for declining catches.

Climate change was a further explanation given for not only the declining catches but also the increased variability in the fishing seasons:

*“How the times change now; well times change a lot, everything’s change up a lot. It’s global warming right now, everything’s just changed. The fish just changed.” S11, Speyside*

The pelagic fish which constitute the majority of the target species in the area surveyed are migratory, with water temperature affecting their migratory patterns and distribution (Fréon & Misund 1999). Predictions for climate change in the Caribbean show annual average temperatures will increase between 1.4°C and 3.2°C by 2100, with more frequent extreme dry seasons and an overall decrease in precipitation (Solomon et al. 2007). Such changes are likely to alter the migratory patterns and cause changes in the latitudinal and depth ranges of these pelagic species, as has already been observed in the North Sea (Perry, Low, Ellis, & Reynolds, 2005). This would result in even greater variability in fishing seasons (Lehodey et al. 2006) and the possible loss of some species from Tobago’s waters.

### **Fishing as a livelihood**

All the fishers interviewed spoke passionately about fishing as not just a means of earning a living, but as part of their lives. This partially explains their reluctance to leave the fishery sector in the face of falling catches. Most fishers have also not increased their fishing effort, a common adaptation strategy to declining catches (McClanahan et al. 2005). The critical reason is most likely linked to their “occupational multiplicity”, with only two of the fishers interviewed working full-time in the fishery. This livelihood diversification is common amongst fishers worldwide and allows them to buffer the seasonal and cyclical fluctuations in stock, and hence fishing income, with income from other sources (Allison & Ellis, 2001). Tobago is unusual in the high numbers of fishers having a

public sector job. From conversations with retired fishers as well as those interviewed, it was apparent that these jobs offered security in the form of a constant income, which allows them to access credit, and provides them with a pension. While these public sector jobs offer security at the moment, they are dependent upon continued fiscal transfers from Trinidad (THA 2011) which subsidises Tobago through revenue principally derived from oil and gas.

### **Management options**

Given the current lack of restrictions on fishing in Tobago, it is unsurprising that a majority of fishers were against fisheries management. The greater objection to management among Charlotteville's fishers is explained by the village's strong fishing heritage, and independence. In contrast Speyside has a smaller fishing community with tourism playing a greater factor in the local economy (EDG 2003). More surprising was the majority positive opinion towards the MPA proposal. Many fishers saw the potential benefits of protection for local tourism (in Speyside), and for fishing through the protection of breeding areas. This contrasts with a study of MPAs in Kenya where all fishers had low perception of benefits of closed areas (McClanahan et al. 2005). The more positive views encountered in the surveyed areas are likely to be due to a combination of factors including better education regarding MPAs, greater environmental awareness and a higher standard of living (Cinner et al. 2010). As most fishing in the area is offshore, the MPA would not be expected to reduce the fishing grounds available to those interviewed. Most of the objections were therefore related to boats being able to pass freely through the MPA. However two retired fishermen in Speyside expressed concern for the livelihoods of people who supplement their living by line fishing from the shore and the rocks within the proposed MPA area.

Although there is considerable variation in fishers' attitudes towards management, efforts to create an MPA could be successful if education programmes and community involvement are pursued. Full consultation with the fishing community could ensure important fishing grounds are not closed-off and passage through the MPA is not restricted.

### **CONCLUSIONS**

All of the factors cited by the fishers as causing declining catch are likely to increase in severity. Climate change, industrial fishing, and further oil exploration will combine to put fish stocks and fishers' catch rates under greater pressure. Lack of information regarding the magnitude of these effects hampers efforts to predict the effect on fishers' livelihoods, and hence further research is deemed vital. Efforts to assess the maximum sustainable yield of migratory fish stocks including dolphin, kingfish and tuna have been undertaken (CRFM 2010). However lack of reliable and complete fisheries data precludes estimation of sustainable harvest limits (CRFM 2010). MRF should aim to improve and expand its landings data monitoring program to allow better assessment of local fish stocks. Restrictions on local fishing effort seem unnecessary given the non-destructive, small-scale nature of the fishery and the greater impact of external factors.

Fishers' occupational multiplicity provides them with a buffer against variations and declines in fish catches, but strong dependence on public sector jobs is likely to be a risk in the long term with potential redundancy due to state

funding cuts. State investment in Speyside and Charlotteville should focus on encouraging private enterprises not dependent on state support and employment opportunities for those wishing to exit the fishery sector.

The proposed MPA for Speyside is likely to meet some resistance within the fishing community but current efforts to create a community based group capable of managing the MPA are more likely to gain support than externally imposed restrictions and management (McClanahan et al. 2006). With most fishing done offshore, and the proposed MPA area focused on nearshore reefs, consultation with the fishing communities should enable the creation of a MPA acceptable to the majority of fishers.

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