A socio-economic investigation of the Torres Strait Indigenous dugong and turtle fisheries

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Declaration on ethics

The research presented and reported in this thesis was conducted within the guidelines for research ethics outlined in the National Statement on Ethics Conduct in Research Involving Human (1999), the Joint NHRMC/AVCC Statement and Guidelines on Research Practice (1997), the James Cook University Policy on Experimentation Ethics Standard Practices and Guidelines (2001), and the James Cook University Statement and Guidelines on Research Practice (2001). The proposed research methodology received clearance from the James Cook University Experimentation Ethics Review Committee (approval number H3085).

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Abstract

Dugongs (*Dugong dugon*) and green turtles (*Chelonia mydas*) are of international ecological and conservation significance. As one of the few developed countries in their range and with globally significant populations, Australia is in a key position to ensure the survival of both species. Dugongs and green turtles are protected under Australian national and state laws and the rights of Torres Strait Islanders to hunt these species are recognised in Commonwealth and state regulations and an international Treaty between Australia and Papua New Guinea. The Australian government must therefore ensure the sustainable use of these species to comply with biodiversity principles while protecting Indigenous rights.

There is thus a potential for conflict, making sound management an absolute imperative. Local stakeholders in Torres Strait have been working together with government agencies to implement co-management arrangements for the Torres Strait Indigenous dugong and green turtle fisheries that acknowledge the ecological and cultural significance of both species. But effective management of the Indigenous fisheries also requires a good understanding of the ecological, economic and social issues operating in Torres Strait and of their interactions. A large body of literature has thus far described the ecological and social systems in the region independently. However, few studies have attempted to describe the synergy between the ecological and social systems. Moreover, economic information about these Torres Strait Indigenous fisheries is all but absent.

The overarching objectives of this thesis were thus to provide: (i) economic information, gathered from the point of view of local stakeholders that could be used to inform the management of the Indigenous dugong and green turtle fisheries in the Torres

Strait; and (ii) baseline data and insights to underpin subsequent economic investigations. Most of the information required to fulfil those objectives was collected during extended visits (amounting to almost nine months of field work) on two case-study islands: Mabuiag and St Paul's.

I used a case study approach to understand the interactions between the ecological system (dugongs and green turtles) and the social system (Torres Strait Islanders) from the point of view of the local stakeholders. I focused on providing economic information that explains at least in part the interactions between the two systems. I used several qualitative and quantitative methods from a range of disciplines to gain this information.

The first sub-objective of my research was to improve understanding of the socio-economic system in which the Torres Strait Indigenous dugong and green turtle fisheries operate. I started by looking at the financial context of those fisheries on my case-study islands using both secondary data (from the Australian Bureau of Statistics) and primary data (collected through household expenditure and shop-price surveys). Through the use of questionnaires complemented by qualitative data collected through semi-structured one-on-one interviews, I also established the size of the harvest of dugongs and green turtles by Mabuiag and St Paul's communities and generated estimates of the market 'value' of the meat, and of the financial (fuel) costs associated with the hunt.

I then explored the social processes associated with the Indigenous fisheries, focusing on the way in which the financial costs and benefits were shared. I described the complex distribution of these costs and benefits among several segments of the population within the two communities. I found that groups benefit from hunting through sharing behaviours based primarily on their relationships with hunters and their financial situation.

The ways in which meat was shared varied according to whether the hunt was for subsistence or for ceremonial purposes, and hunters reduced their direct financial costs through a complex flow of remittance payments or other indirect contributions.

This analysis clearly highlighted the fact that hunters are not the only people closely associated with these fisheries. Evidently, the complex social processes governing the sharing behaviours of traditional marine resources within communities requires a whole-community approach rather than a focus on hunters. Having learnt that it was not just hunters who were closely associated with these fisheries, I thus sought to ensure that my subsequent investigations elicited information from a broad range of people within each community on each case-study island.

Moreover, the sharing of traditional marine resources was found to extend beyond the boundaries of the Torres Strait communities to members of the Torres Strait Islander Diaspora on the Australian mainland. This information indicates that the scale of management relevant to the Torres Strait Indigenous dugong and green turtle fisheries needs to match the social processes underpinning the sharing of these traditional resources. Initiatives governing the management of those Indigenous fisheries thus need to expand to include members of the Diaspora.

The second sub-objective of my thesis was to develop appropriate methods to understand local values associated with the Torres Strait Indigenous dugong and green turtle fisheries (beyond the mere market or financial values considered in the preceding sub-objective). Rather than presenting members of the community with a list of 'values' for consideration, two lists were generated during focus group discussions – one focusing on 'benefits' and one focusing on 'costs'. During individual interviews, respondents were asked to: (a) undertake a cognitive mapping exercise designed to learn more about the relationship between the lists of 'values'; and (b) rate those values.

I found that the two communities of Mabuiag and St Paul's identified the same types of benefits and costs and that these costs and benefits could then be categorised into three cognitive clusters. Study participants referred to the benefit clusters as those relating to: community, family and individual benefits. Cost clusters were identified as being those related to the community, the family and the environment. On the 'benefit' side, a clear distinction emerged between the market and non-market benefits; such a distinction was not as clear for costs.

The rating exercises highlighted the fact that non-market aspects of the Indigenous fisheries in these two communities were perceived to be more important than market aspects. I also found statistically significant differences in the relative importance ascribed to different costs and benefit clusters by younger and older members of the two communities. Although the relative importance attributed by younger and older members of the two communities was different, both groups considered community benefits and community costs of greatest importance.

The clear distinction between the market and non-market benefits enabled me to use a replacement cost method to estimate the financial contribution of the market-related benefits (i.e., those directly linked to food for home consumption) associated with the Indigenous fisheries. My findings indicated that the gross market benefits were worth approximately 8% of household income. My results also suggested that the community benefits (i.e., non-market benefits directly linked to the cultural aspects of the Indigenous fisheries) were statistically more important than the market benefits. As such they must be ‘worth’ more than 8% of household income. Thus, even without estimating the market value of the individual benefits, I was able to conclude that the gross benefits (market and non-market) of the Torres Strait Indigenous dugong and green turtle fisheries exceed 16% of household income (this is approximately equal to the proportion of income spent by the average Australian on mortgage repayments).

My third sub-objective was to learn more about the likely social acceptability of different types of fishery management tools. This result was important because the remoteness of Torres Strait and the legal rights of the hunters mean that management tools need to be acceptable to local communities to increase compliance (external monitoring and enforcement is too costly).

In a series of individual interviews, I thus asked respondents to evaluate the perceived impacts of several management tools (some of which had already been identified in community management plans) on the different value clusters previously assessed. I argue that a good understanding of these perceptions can provide fisheries managers with an indication for the likely compliance rate of local members towards a specific management tool as well as an indication on its potential social acceptability. I found that tools such as “gear restriction”, “seasonal closure” and “spatial closure” were likely to be more acceptable to community members than tools such as “quotas”, “taxes” or “subsidies”.

The methods I used highlighted that the social acceptability of management tools was driven by their perceived impacts on the cultural aspects associated with the Indigenous fisheries. Tools that provided an increase in cultural benefits and a reduction in cultural costs would likely be more accepted than tools that did not. I conclude that policies aiming to connect cultural aspects to the environment may be more likely to succeed than those connecting financial aspects to the environment in these Indigenous fisheries.

Finally, the implications of this research for the management of the Indigenous dugong and green turtle fisheries in the Torres Strait and of other traditional natural resource use systems are discussed and suggestions made for future research.

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List of acronyms

ABS	Australian Bureau of Statistics
AFMA	Australian Fisheries Management Authority
AMMC	Australian Marine Mammal Centre
BP	Before Present
CDEP	Community Development Employment Project
CITES	Convention on International Trade in Endangered Species
CMS	Convention on Migratory Species
FAO	Food and Agriculture Organisation
IBIS	Islanders Board of Industry and Services
IOSEA	Indian Ocean – South East Asian
ITQ	Individual Transferable Quota
MC	Marginal Cost
MR	Marginal Revenue
MSY	Maximum Sustainable Yield
NAILSMA	North Australian Indigenous Land and Sea Management Alliance
OESR	Office of Economic and Statistical Research
PBC	Prescribed Body Corporate
PNG	Papua New Guinea
PZJA	Protected Zone Joint Authority
TAC	Total Allowable Catch
TC	Total Cost
TEV	Total Economic Value
TR	Total Revenue
TSRA	Torres Strait Regional Authority
TUMRAs	Traditional Use of Marine Resource Agreements
WHC	World Heritage Convention

CHAPTER 1:

INTRODUCTION

The following chapter presents the rationale for my research and also outlines the objectives of my thesis and its structure. The management of natural resources including fisheries is a complex social-ecological problem. In this chapter, I describe how in a human-dominated landscape, the careful management of natural resources requires an understanding of the relevant biophysical, economic and social systems as well as their inter-relationships. I note the lack of economic information available on a specific complex social-ecological system - the Torres Strait Indigenous dugong and green turtle fisheries - and how an economics approach can provide important information to the management of those fisheries. I conclude with the principal aim, research gaps and research objectives of my thesis.

1. General introduction

1.1 An important, and potentially controversial issue

The hunting of iconic species is a controversial issue, more so when the targeted species are threatened and protected. In Australia, Indigenous Australians, including Torres Strait Islanders hunt dugongs and green turtles. In the Torres Strait region, the hunting of both species is undertaken as part of the Torres Strait Indigenous dugong and green turtle fisheries. The hunting of those species by Indigenous Australians is contentious because it directly involves the killing of two protected iconic species for which subgroups in Australian society hold different values. These differences in values lead to heated debates between pro-hunting and anti-hunting groups. As a result, the governments of the Commonwealth and the State of Queensland are faced with the challenge of finding a solution that accommodates the needs of multiple interest groups.

Ultimately, the Commonwealth government and the State government of Queensland need to find a balance between legislation that allows for: (1) the protection of dugongs and green turtles, and (2) their customary use by Torres Strait Islanders, by sustainably managing the Torres Strait Indigenous dugong and green turtle fisheries. This is a challenging task, which requires government officials to understand a range of data that derive from the natural, social and economic sciences. New frameworks have recently been developed to help decision makers understand the system in which they operate in a holistic manner, emphasising the importance of understanding the links between humans and their environment as well as between different areas of knowledge. Such understandings are keys to modern natural resource management and require data that is context specific.

As will be described in chapter 2, the Torres Strait region is of global significance to dugongs and green turtles. Recent studies show that dugongs undertake individualistic local and regional scale movements (Fuentes and Marsh 2012) at least partially in response to local seagrass die-backs or temperature fluctuations (Sheppard *et al.* 2006). Individuals of both species cross management boundaries between and within countries (Marsh *et al.* 2011). In north eastern Australia, dugongs cross between the boundaries of the Great Barrier Reef Marine Park and the Torres Strait fishery zone, as well as between Australian and Papua New Guinean jurisdictions. This situation has important implications for regional and international cooperation in dugong management.

Similarly, the Torres Strait green turtle population is one of the largest in the world. The migratory nature of those animals at ocean basin scales results in stocks being shared among communities and countries (Kennett *et al.* 2004; Maxwell *et al.* 2011; Seminoff 2004; Wallace *et al.* 2010; Wallace *et al.* 2011). Tagging studies demonstrated that green turtles nesting in the southern Great Barrier Reef region migrate to foraging grounds in the northern Great Barrier Reef, Torres Strait, Papua New Guinea, and south-west Pacific Island states such as New Caledonia, while turtles nesting in the northern Great Barrier Reef region have been tracked to foraging grounds in the Gulf of Carpentaria, Indonesia, Papua New Guinea, and the Solomon Islands (Limpus *et al.* 1992).

The ability of both dugongs and green turtles to cross geopolitical boundaries and operate at large ecological scales indicates that Torres Strait Islanders share these animals with other communities and that a coordinated action towards their management is required (Marsh *et al.* 2011; Wallace *et al.* 2010; Wallace *et al.* 2011), especially in the light of an increase in anthropogenic threats towards these species external to the region.

As alluded to earlier, not only are dugongs and green turtles of great environmental importance but they are also of great cultural significance to Torres Strait Islanders. Dugongs and marine turtles have had considerable dietary, spiritual and cultural significance for many Indigenous Australians for thousands of years (McNiven and Feldman 2003; McNiven and Bedingfield 2008). In Torres Strait, both dugongs and green turtles also form the basis of an important subsistence economy (Kwan *et al.* 2006). Due to the significance of both species to Torres Strait Islanders, the successful management of the harvest of dugongs and green turtles is also vital from the point of view of Indigenous people. In other words, both fishery managers (here and thereafter if not defined otherwise, managers will be used to describe government agency managers for the Torres Strait Indigenous dugong and green turtle fisheries) and local Torres Strait Islanders have reasons to ensure the protection of dugongs and green turtles – even if their motives may differ.

Perhaps even more important is the fact that natural resource managers are increasingly recognising the need to involve local stakeholders to successfully achieve a sustainable use of environmental resources (Berkes and Folke 1998). In November 2010, a workshop hosted by two environment ministers (Commonwealth and State of Queensland) and involving representatives of various community groups was organised to consider the hunting of dugongs and green turtles legally carried out by Torres Strait Islanders. The outcome of the consultation called for increased participation of local Indigenous groups as an important component of effective management of the harvest (Helene Marsh and Damian Miley, pers. comm.)

Evidently, in the Torres Strait Indigenous dugong and turtle fisheries, the key question is not <u>whether</u> one should manage, but about <u>how it should be done</u>. The sustainable harvest of dugongs and green turtles is thus a vitally important issue for scientists, managers and Indigenous groups – and scientific research suggests that current levels of dugong harvesting in Torres Strait may be unsustainable (Heinsohn *et al.* 2004; Marsh *et al.* 2004b; Marsh *et al.* 2011), while similar concerns have been raised about marine turtle harvesting (Limpus 2008). Due to: (1) the environmental significance of both species to the international and Australian communities, (2) their cultural significance to Indigenous groups, (3) Australia's legal obligation to protect dugongs and green turtles, and (4) the importance of Torres Strait to the global populations of both species, wildlife managers and Torres Strait community representatives have to develop strategies for the sustainable management of dugongs and green turtles.

But effective management of these Indigenous fisheries does not just require cooperation and consultation. It also requires a good understanding of ecological, economic and social issues and of their interactions (Berkes *et al.* 1989; Berkes and Folke 1998; Ostrom 1990). As discussed in more detail later, a large body of literature has thus far described the ecological and social systems in the region independently. However, few studies have attempted to describe the synergy between the ecological and social systems. Moreover, economic information about these Torres Strait Indigenous fisheries is all but absent.

The overarching objectives of this thesis are thus to provide: (i) economic information, gathered from the point of view of local stakeholders that can be used to inform the management of the Indigenous dugong and green turtle fisheries in the Torres Strait; and (ii) baseline data and insights to underpin subsequent economic investigations.

1.2 Background definitions

Small-scale fisheries constitute a way of life for millions of people worldwide and currently account for between one-half to three-quarters of global fish production (FAO 2003). According to Berkes and colleagues (2001), traditional fisheries employ approximately 50 million of the world's 51 million fishers.

Despite their importance, small-scale fisheries continue to be poorly documented and information on the structure and functioning of this subsector is limited, even at a national or regional level. Exacerbating this lack of information is the fact that no universal definition of small-scale fisheries exists. What may be considered small-scale in one situation may be large-scale in another (Berkes and Kislalioglu 1989; Kurien 1998; Panayotou 1982; Ruttan *et al.* 2000; Smith 1979).

Furthermore, researchers continue to struggle over defining terms such as subsistence, traditional, artisanal and small-scale fisheries. Many of these terms are used interchangeably and often coupled with other terminologies such as inshore, local or coastal fisheries (Allison and Ellis 2001; Berkes *et al.* 2001; Defeo and Castilla 2005; Johnson 2006; Kurien 1998). Moreover, all these terms have distinct connotations according to the technological, economic, political, cultural, and social context (Mathew 2003) and will often be specific to a fishing operation, a market, or a type of gear (Mathew 2003). Consequently, a common view is that universal definitions and comparisons are impossible. Proponents of that position consider that the natural and social systems are complex and each individual fishery and fishing community is unique and distinctively different from others (FAO 2003).

For this study, I adopt definitions used by the Food and Agriculture Organization (FAO) (FAO 2003) which are suitable in this context. Specifically, the FAO uses the term "artisanal" to refer to the relative level of technology and the term "small-scale" to refer to the size of the fishing unity (scale). Thus, according to the definition given by the FAO, artisanal, or small-scale fisheries are:

> "*traditional fisheries involving fishing households (as opposed to commercial companies), using a relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, and mainly for local consumption. They can be for subsistence or for commercial".*

The characteristics of the Torres Strait Indigenous dugong and turtle fisheries fit the criteria of the FAO's definition for small-scale fisheries. Local men participate in these fisheries on an ad-hoc basis. The fisheries are operated from small aluminium boats or dinghies of 4.5m to 6m. The dugongs and green turtles harvested cannot be sold and are brought back to the communities for local consumption as part of day-to-day meals or for festive occasions.

As with other fisheries, the Torres Strait Indigenous dugong and marine turtle fisheries are complex social-ecological systems. Both the targeted species (ecological system) and the local communities (social system) are essential elements of the fisheries and interact with one another. As mentioned previously, modern management of social-ecological systems such as these small-scale fisheries requires a detailed understanding and the integration of the ecological, economic and social dimensions pertinent to the system and of their mutual responses.

Moreover, the objectives of some small-scale coastal fishing operations are not exclusively focused on profit, catch maximisation, competition, subsistence and innovation but often reflect other well-being needs like the desire to satisfy social obligations. Fishing is also important as a lifestyle and is part of traditional livelihood and social institutions (Kronen 2004).

As such, I am setting my research to understand the context of the small-scale Indigenous dugong and green turtle fisheries and to explore the full spectrum of costs and benefits associated with the fisheries.

1.3 Evolution of natural resource management sciences

The primary objective of natural resource management, including fisheries management, is to achieve “sustainability”. Sustainability has many definitions. The 1987 Brundtland Report defined sustainability as “*a development that meets the needs of the present without compromising the ability of future generations to meet their own needs*” (WCED 1987). Scholars interpret the concept differently and focus on different aspects of sustainability but the important contribution of sustainability-based research is to have established the interdependencies of the ecological, social and economic dimensions of a system (Berkes and Folke 1998; Norberg and Cumming 2008; Sayer and Campbell 2004).

In the past, management research often isolated the different dimensions of a system where ecological dimensions were investigated separately from the economic and social dimensions. This tendency to investigate the different components of a system independently from the others was based not only on a lack of cross-disciplinary studies but also on a failure of natural resource managers (who tend to be scientifically trained) to recognise the information provided by different disciplines.

For example, fisheries sciences used to be dominated by the natural sciences, the aim being to describe the ecological dimensions of the system (Figure 1-1) (Andrew and Evans

2011; Appeldoorn 1996; Christie *et al.* 2007; Degnbol 2003; Hall 1999; Welcomme 1979); social and economic sciences were considered relatively unimportant.

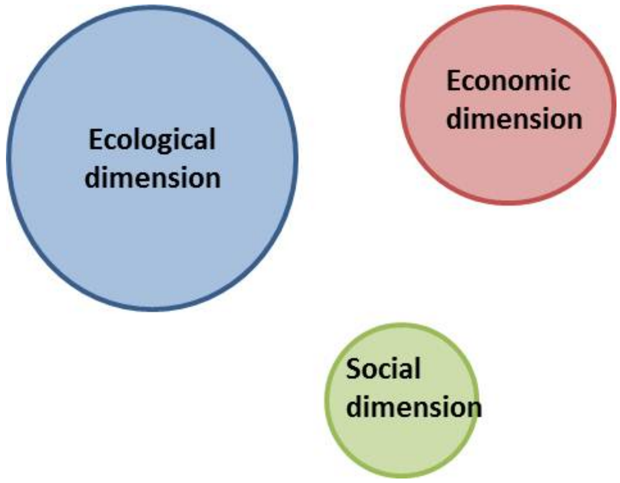


Figure 1-1. Fisheries management sciences dominated by the natural sciences and the separation of the three dimensions of fisheries.

In particular, the natural sciences provided information on the ecological variables relevant to targeted species including population size, potential yield, stock status, rate of growth, habitat and spatial and temporal movements. Mathematical models were then used to estimate the size and productivity of fishery stocks and to assess the potential effects of alternative management strategies (Appeldoorn 1996). Those models evolved from single-species surplus-production models to multitrophic, multispecies models and onwards to modern ecosystem approaches to fisheries management that recognise the interdepencies of different ecological variables operating in a fishery.

In parallel with the advances in the natural sciences in describing the ecological dimensions of a fishery, economics started to play an ever-increasing role in research relating to fisheries management (Figure 1-2), and cross-disciplinary studies began to emerge.

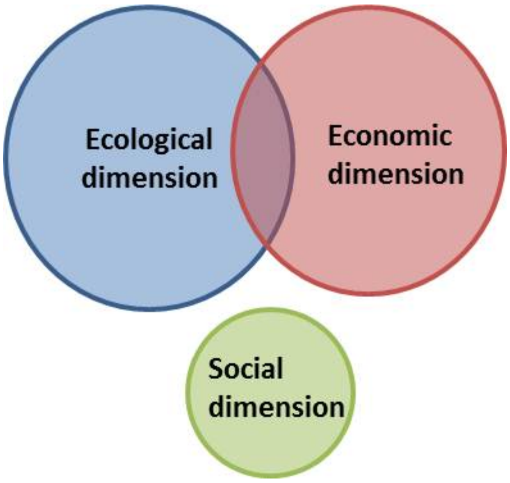


Figure 1-2. Increasing role of economics in fisheries management sciences through a focus on developing bio-economic models but still disintegration of the sciences with the social aspect of fisheries management.

For example, some economists developed bio-economic models of fisheries. These models evolved from the simple fixed-price model of Gordon (1954) that was based on the single-species Schaefer model used in the natural sciences. Later, economists also developed more sophisticated models that included multi-species and feedback loops. A large branch of the economics literature on resource use was also influenced by Hardin's seminal paper on the "tragedy of the commons" (Hardin 1968). Many economics scholars thus focused on issues associated with the rights to use resources and on how best to define those rights.

Despite advances in the descriptions of the ecological and the economic dimensions of fisheries, there was increasing evidence of the failure of conventional management strategies based on either or both dimensions. Scholars acknowledged the need for people-oriented research that would improve the understanding of the social dimensions of a fishery. And so emerged the beginnings of truly cross-disciplinary fishery studies (Figure 1-3).

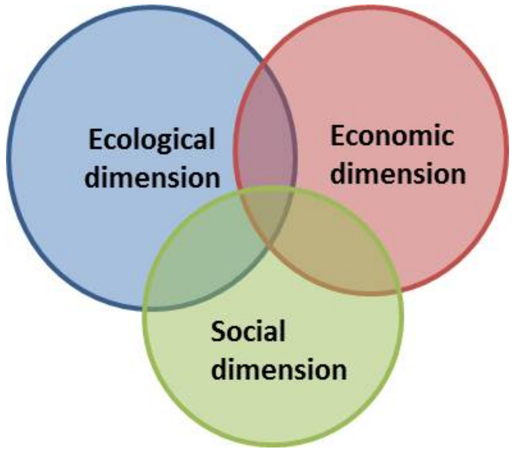


Figure 1-3. Cross-disciplinary approach to fisheries management sciences through the progressive inclusion of social sciences research.

Improved understandings of the social dimensions provided contextual information on local stakeholders' knowledge, norms, culture and beliefs. The major advance here was thus not to give more prominence to the study of the social system per se but to move towards a better integration of the different dimensions. Berkes and Folke (1998) argued that the boundaries between the environment and people were blurry and that novel approaches to management should focus on understanding the three dimensions and their interactions (Figure 1-3).

More recent approaches to management, such as adaptive management and resilience theories, thus aim to better integrate the three dimensions while also understanding the roles of institutions in defining the interactions between the ecological, economics and social dimensions of a fishery (Figure 1-4).

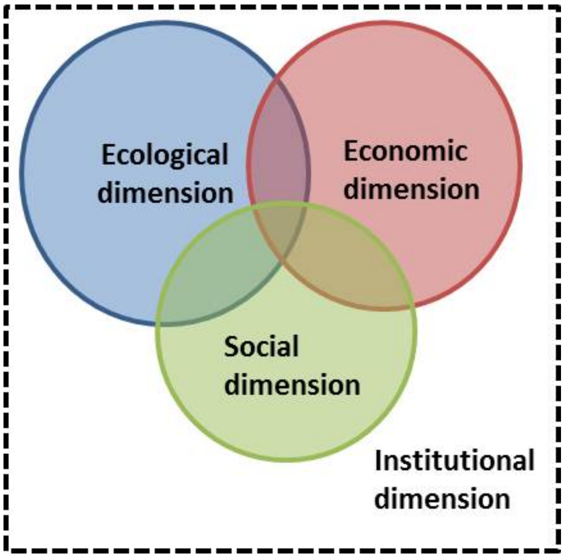


Figure 1-4. Recent integration of the three ecological, economic and social dimensions within the institutional dimension of fisheries management sciences.

In the Torres Strait region, previous studies have mainly focused on biological and anthropological research (Table 1-1). More recently, researchers have focused on some of the institutional aspects of dugongs and green turtle management including community-based management practices (Grayson 2011) and governance issues (Weiss 2011). However, an area of knowledge that has not received much attention is the economics behind the customary use of dugongs and green turtles by Torres Strait islanders (Table 1-1).

Table 1-1. The fields of research of publications relevant to research on the hunting of dugongs and green turtles in the Torres Strait.

Reference	Biology	Anthropology	Economics	Management	Legal
Haddon (1890, 1912, 1935)	X	X			
Fitzpatrick-Nietschmann (1980)		X			
Nietschmann and Nietschmann (1981)		X			
Nietschmann (1977a, b, 1984)	X	X			
Hudson (1986)	X				
Limpus and Parmenter (1986)	X				
Marsh (1986)	X			X	
Limpus and Nicholls (1988)	X				
Eley (1988)	X	X			
Cordell (1989)		X			
Limpus *et al*. (1989)	X				
Raven (1990)		X	X		
Johannes and MacFarlane (1991)	X	X			
Marsh and Saalfeld (1991)	X			X	
Williams (1994)	X		X		
Marsh (1996)	X			X	
Harris and Nona (1997)	X				
Marsh *et al*. (1997)	X			X	
Marsh (1998)	X				
Kwan *et al*. (2001)				X	
Mulrennan and Scott (2001)					X
Kwan (2002)	X			X	
AFMA (2006)			X		
Kwan *et al*. (2006)	X			X	
Grech and Marsh (2007)	X			X	
Havemann and Smith (2007)					X
Marsh and Kwan (2008)	X				
Grech *et al*. (2011)				X	
Fuentes (2010)	X				
Grayson (2011)				X	
Weiss (2011)				X	

This research tries to fill this gap in our current knowledge. My thesis focuses primarily on the socio-economic dimension of the Indigenous fisheries by gathering baseline data relevant to achieving the sustainable use of dugongs and green turtles in an Indigenous context, via managing the Torres Strait Indigenous dugong and green turtle fisheries. These economic data will help fill a substantive knowledge gap and assist in the development of a more complete understanding of: (1) the socio-economic context, (2) the people involved in the fisheries, and (3) the multiple dimensions of this social-ecological fisheries system. This thesis also highlights how the concepts and theories used in modern natural resource management, specifically fisheries management, need to be altered to fit the specific Indigenous context. Specifically, I demonstrate that the assumptions behind some of the modern frameworks and their methods are inappropriate in a remote Indigenous environment. As such, it is essential to use methods of data collection that will be both acceptable in an Indigenous context and meet the requirements of the relevant theoretical economic frameworks. In this chapter, I will explore the concepts and theories relevant to my study.

1.4 Contribution of economics to social-ecological system studies

In chapter 2, I provide more detailed information about the context of the Indigenous dugong and green turtle fisheries but a summary of the situation shows that: (i) the Torres Strait populations of dugongs and green turtles are large so there is no biological emergency that requires immediate intervention by government agencies, and (ii) that the legal rights of the Indigenous peoples of the region are strong. This situation gives managers a unique opportunity to get management 'right' in these fisheries - involving Indigenous people in developing plans for the sustainable Indigenous use of protected species.

As explained above, economics may have much to contribute to resolving the situation, so in this section, I briefly describe some key economic concepts of relevance.

1.4.1 NATURAL RESOURCE MANAGEMENT AND ECONOMICS

Economics can be defined as the '*study of the allocation of scarce resources for the satisfaction of human wants, and the problems of choice that this involves*' (Norton 1984). From an economic standpoint, the central objective of natural resource management is to maximise benefits to society, over time, from the use (including conservation) of resources (Daly 1996). It is not just about money. The costs and benefits associated with natural resources and their management include much more than strictly financial matters as will be discussed in more detail in section 1.4.3.

1.4.2 THE ECONOMICS OF FISHERIES

The history of fishing is full of examples of fisheries that have been exploited to commercial extinction (Schrank *et al.* 2003). The basic cause comes from the characteristics of fisheries – harvests are rivalrous, fish[1] are not static and thus difficult to manage, and fisheries are subject to irreducible uncertainties. The rivalry in fishing comes from the fact that fishers harvest from a resource limited in size such that what one fisher catches today cannot be caught tomorrow by somebody else. This dilemma is sometimes called the 'common-pool' problem because each fisherman is using a common resource in which the yield, at a given stock size, is more or less fixed by nature (Tietenberg 2003), and it is one affecting open-access fisheries.

[1] Although dugongs and green turtles are not 'fish', they share many of the attributes of 'fish' and their harvests in Torres Strait are regarded as 'fisheries' under Australian and Queensland laws.

Open-access fisheries typically have the following four characteristics as described by Turner and colleagues (1994):

(1) Absence of property rights over the fish;

(2) Absence of effective management of the resource;

(3) Absence of cooperation among harvesters;

(4) Free entry.

In open access, the harvesting costs imposed on others are not taken into account by fishers when they make their decision as to how many fish to catch. In the absence of management, ownership or controls on fishing, there will be too much fishing, and too many fish harvested. In essence, this is what has come to be called the 'tragedy of the commons' first publicised by Hardin in 1968 (Hardin 1968).

The basic objective of management is thus to ensure that present levels of exploitation are consistent with the replacement of fish stocks to ensure the long-term sustainability of the resource (Grafton *et al.* 2006; Turner *et al.* 1994).

The concept of maximum sustainable yield (MSY) is an important reference point in efforts towards achieving this objective and is shown in Figure 1-5 adapted from Turner and colleagues (Turner *et al.* 2004)[2]. For any renewable resource, there is a maximum rate of growth in a stock or population that may be achieved under prevailing environmental conditions. This MSY is closely related to the notion of carrying capacity in which population is limited by food supply (Turner *et al.* 2004).

[2] The diagram presented here is a simple and static representation of a fishery. Fishery economists nowadays work with much more sophisticated and dynamic models. However, this simple and static model is sufficient to illustrate the problem of open-access fisheries.

The optimal level of harvest is difficult to define because the physical or biological optimum is different from the economic optimum. If one assumes the productivity of the stock is a parabolic function of catch against effort, the biological optimum is reached at the MSY (Tietenberg 2003).

But an open access fishery is unlikely to achieve the biological optimum. If the cost of fishing is taken into account and assuming costs increase linearly with fishing effort, profits will be positive as long as total revenues (TR) are higher than total costs (TC). Thus effort will increase until profits are nil and the open access equilibrium is reached (at E_0 in Figure 1-5). It is only when this point is reached that individual fishermen in an open-access fishery will receive clear signals that further effort does not make economic sense because costs will exceed returns (Tietenberg 2003).

Unless the cost curve cuts the revenue curve at the point which exactly corresponds with the MSY, E_0 will not be a biological optimum. Moreover, it is not necessarily an economic optimum either, since in this example it would be possible to catch exactly the same amount of fish (harvest) with less effort (and hence at a lower cost). This result is illustrated in Figure 1-5 that shows that we can get an identical level of harvest (noted here as Harvest size), with high effort/at a low stock (E_0) or with low effort/at a higher stock (H_0). The diagram thus highlights the fact that conservation and economic outcomes can work hand in hand:

(1) The fishery can operate at H_0: with low effort (economic sense as profitable) and high population size (biological sense);

(2) The fishery can operate at E_0: with high effort (waste of resources in an economic sense as profit is null) and risky for population size as E_0 is beyond the MSY (no biological sense).

The economic objective is to aim for the Maximum Economic Yield (MEY), the point where there is a maximum difference between the catch line and the cost line (Marginal Revenues (MR) equal Marginal Costs (MC)). Profit is always maximised at MEY at a lower rate of fishing effort (and thus a larger stock size) than that required to achieve MSY (Figure 1-5).

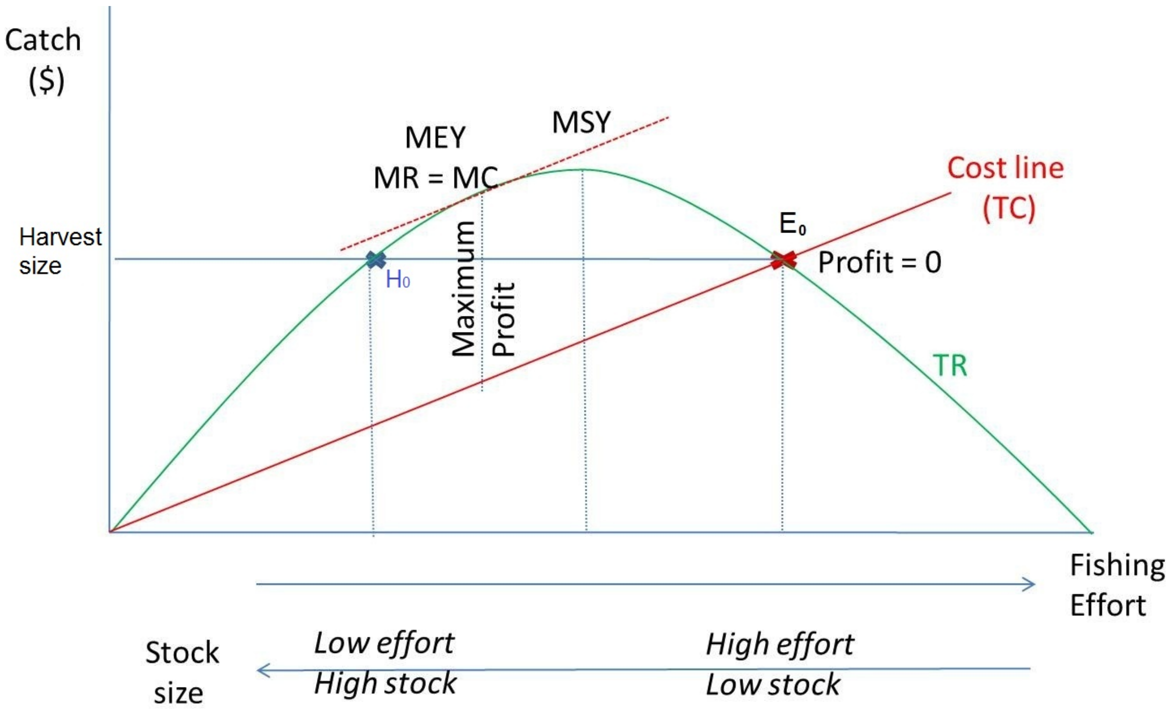


Figure 1-5. The relationship between the economic return from a fishery and fishing effort. (adapted from Turner *et al*. 2004). The maximum economic yield (MEY), where marginal revenues (MR) are equal to marginal costs (MC), is always at a level below the maximum sustainable yield (MSY).

The economic perspective is thus not that fisheries should be left unregulated, but that the regulations must explicitly consider the incentives of fishers (Pascoe 2006). The tragedy of the commons and the failures associated with open access make it all too clear that a 'laissez-faire' approach to fisheries does not work. If left unregulated, most open-access fisheries will operate at E_0 where profit is nil. For example if costs are low, this may occur at very low population levels, and might put the fishery at a risk of collapse. Hence, the need to manage fisheries[3] (Hoydal 2007; Pascoe 2006).

The traditional approach to managing fisheries has been to place the interest of the fish before the fisherman (Grafton *et al.* 2006). In many fisheries, the number one priority has been to maintain fish stocks, and it was assumed that by controlling fishing effort this goal could be achieved (Pascoe 2006). Regulations that restrict the number of vessels fishing, the gear used by fishers or time spent harvesting have been implemented in hundreds of fisheries. The common assumption with such controls is that, if implemented with sufficient vigour, the controls prevent further increases in fishing effort and ensure sustainable harvests (Hoydal 2007). But with every restriction, fishermen have responded with substitute methods of fishing to increase effort (Haapasaari *et al.* 2007).

More recently, there have been a variety of tools used to manage fisheries such as Total Allowable Catch (TAC), Individual Transferable Quotas (ITQs), spatial and temporal closures (Turner *et al.* 2004). Although those tools have been widely applied worldwide, not all have been successful in managing fisheries (Pascoe 2006) indicating that tools need to be chosen carefully with regards to the particular fishery.

[3] Costs that fishers impose on others from their harvesting need to be made perfectly clear and, ultimately, some of these costs will be borne by consumers in terms of higher prices (Grafton *et al.* 2006). For fishers to behave in a sustainable manner, they need long-term and secure rights that explicitly account for interactions across stocks, and also a participatory mandate in management (Haapasaari *et al.* 2007). Improved tenure, forcing harvesters to pay the costs of fisheries adjustments and providing fishers with decision-making responsibilities will align incentives with sustainability goals and improve fishery management outcomes (Hartwick and Olewiler 1998).

In short, an economic perspective of fisheries management is that marine resources should be managed sustainably, but also in a way that contributes to and maximises net benefits for the nation as a whole (Schrank *et al.* 2003). Indeed, sustainable and profitable fisheries are complementary. As represented in the diagram above, a level of harvest that maximises the sustainable returns from fishing (MEY) is often at a stock size that is greater than that which would maximise the overall yield (MSY) from a fishery (Grafton *et al*. 2006; Figure 1-5).

Moreover, if there are other costs associated with fishing such as habitat damage, or biodiversity and environmental losses such as from the by-catch of seabirds, dolphins or turtles, the economic optimum level of harvest that accounts for these costs would be even less, and the desirable fish stock even larger (Tietenberg 2003). In other words a fishery that is economically viable in the long run is also likely to be an ecologically sustainable fishery (Grafton *et al.* 2006).

1.4.3 Specific circumstances of the Torres Strait traditional dugong and green turtle fisheries.

As detailed in section 2.3.3.2, dugongs and turtles hold considerable cultural, social, spiritual and economic significance to Torres Strait Islanders (Johannes and MacFarlane 1991) and are of considerable environmental significance worldwide (section 2.2.1.3). As a result, the international and national environmental significance of these animals has increased pressure on the Australian Government and on Indigenous communities to ensure that their traditional fisheries are managed effectively.

The right of Torres Strait Islanders to hunt dugongs and turtles ‘traditionally’ is protected under the *Torres Strait Treaty (1985)* and the *Torres Strait Fisheries Act (1984)*.

This right requires Australian state and federal government environmental management agencies to actively involve Torres Strait Islanders in the management of a sustainable dugong and marine turtle fishery (Kwan 2005; Marsh *et al.* 2004b). However, the current biological focus of management research has created an uneasy relationship between dugong and turtle researchers, government agencies and Torres Strait Islander dugong hunters (McNiven and Bedingfield 2008). The balance of power between the different levels of institutions contributes to an uneven flow of information which exacerbates the uneasy relationship and communication problems between government managers and local community members (Weiss *et al.* 2012).

In other words, the effective management of natural resources requires an understanding of both human and biological systems (Berkes and Folke 1998) and economic theory suggests that the sustainable management of fisheries requires both good biological information (i.e., about the harvest function) and good economic information (i.e., about revenues and costs) (Hartwick and Olewiler 1998)[4].

As evidenced in Table 1-1, in these fisheries however, most available information is biophysical (or anthropological) in nature. But even the biophysical information is not precise enough to be used to empirically estimate a robust harvest function for these fisheries (Helene Marsh, pers. comm.). Economic information is even sparser – indeed it is all

[4] Specifically, if one wished to aim for an 'economic optimum' in the traditional fisheries for the dugong and marine turtles, one would need to collect enough biophysical data to estimate a harvest function (which converts to revenues often interpreted as benefits) and also enough technological and financial data to estimate the cost function. One would then empirically estimate both the revenue and cost functions in Figure 1-5 (ideally by taking into account the dynamic quality of the fishery) and determine MEY. Finally, one would then seek to implement management systems to achieve this point. This situation is particularly challenging when catch cannot be sold and when many benefits and costs are non-market.

but non-existent in this region. Hence, even if the data or information on the harvest function were known, one would not be able to determine an optimal harvest rate without the cost data or without data about the benefits of the harvest.

The problem of measuring economic costs and revenues for use in a model such as this is particularly challenging for dugongs and turtles. In most fisheries, the benefits of the harvest are assumed to be based on the relation between price (P) and quantity (Q) harvested (and in many cases, price is assumed constant, so that revenues = P * Q). However the catch in the Torres Strait Indigenous dugong and green turtle fisheries cannot be sold. As such, it is equivalent to operating in a situation where there is “no market” and hence there is no market price for dugong and turtle meat. Although it is possible to use replacement cost techniques to ‘infer’ a price, such an approach may not be appropriate in an Indigenous context since there are so many potential non-market values. More importantly though (and as discussed in section 1.1), traditional hunting activities are valued as a means of maintaining culture.

Hence the benefits of traditional fishing are not just related to the (unpriced) value of meat collected, but to other, non-market benefits. This situation means that the value of the harvest function cannot simply be derived by multiplying the price of meat (or the price of its substitute) times the quantity of meat. In the same way, the cost function is not easy to define: the boats used for hunting are also commonly used for other activities (i.e., transport, other fisheries) so that capital and fuel costs are not easily identifiable. Moreover, as with the benefits, there are likely to be non-market costs associated with hunting in Torres Strait.

Several studies have highlighted a range of potential benefits associated with the Indigenous fisheries (Beckett 1987; Bliege Bird *et al.* 2002; Bliege Bird *et al.* 2001; Fitzpatrick-Nietschmann 1980; Haddon 1912; Nietschmann 1977a, b; Nietschmann and Nietschmann 1981; Nietschmann 1984). Studies have considered costs to be based only on the modern use of fuel (Bliege Bird and Bird 1997; Raven 1990). But to date no studies have elicited information about a full range of market and non-market costs and benefits associated with the Indigenous fisheries.

Research gap: There is a paucity of information on the costs and benefits (market and non-market) associated with the Torres Strait Indigenous dugong and green turtle fisheries.

1.5 Management context

Hunting is an activity that fulfils a variety of needs important to Indigenous Australians including Torres Strait Islanders. When considering the potential contribution of hunting to the well-being of Torres Strait Islanders as well as the rights allowing them to carry on this activity and also the difficulties of monitoring and enforcement in such a remote location, it is evident that best management practices need to closely involve local stakeholders.

Historically, the management of natural resources including the management of fisheries has been the top-down command-and-control type approach. In Torres Strait, the Protected Zone Joint Authority's structure followed such a format for the management of both commercial and traditional fisheries including the Indigenous dugong and green turtle fisheries. However, across the world command-and-control approaches have had very limited success, with many fisheries collapsing (Myers and Worm 2003; Pauly *et al.* 1998; Pauly *et al.* 2003; Schiermeier 2002).

Nowadays, the emphasis is for decision-makers and managers to involve local stakeholders throughout the management process; i.e., design phase, implementation phase, monitoring phase and enforcement phase (Diaz *et al.* 2011; Olsson *et al.* 2004; Pikitch *et al.* 2004). As a result, agencies involved in the management of natural resources are increasingly developing co-management processes which rely on a partnership between government authorities at different scales and local stakeholders (Berkes 2006).

Research shows that co-management arrangements do not only provide conservation benefits but also social, health and economic benefits (Berkes 2007). In addition, Altman and Cochrane (2003) argue that the management of natural resources by Indigenous people is an important avenue for improving the employment prospects of Indigenous Australians; especially Indigenous Australians living in rural and remote areas where other employment opportunities are rare and where it is difficult to convince non-Indigenous Australians to live. Indigenous peoples throughout Australia are thus actively involved in their own resource management initiatives and have also established partnerships with government agencies. For instance, Indigenous groups are involved in the joint management of national parks, and have been engaged in the development of Indigenous Land Use Agreements as well as Indigenous Protected Areas (Gilligan 2006). Indeed in Australia, co-management approaches are now favoured as an alternative to top-down command-and-control type approaches especially in the case of natural resources used by Indigenous peoples.

Indigenous groups have also been involved in regaining their property rights over their ancestral lands following the Mabo declaration[5]. The *Native Title Act (1993)* allows Indigenous people to put a native title claim on land and in the sea. To date few Indigenous parties have been successful in establishing native title rights in the sea. The first successful sea claim was the Croker Island Sea Claim in the Northern Territory in 1998. In 2007, native title claim was declared over the waters of Blue Mud Bay in the Northern Territory. In Torres Strait, a rule from the Federal Court of Australia established that native title existed over some of the waters of Torres Strait in 2010.

The involvement of Indigenous people in conservation is also being addressed through national conservation legislation particularly the *Environment Protection and Biodiversity Conservation Act (1999)*, which provides the basis for the creation of co-management arrangements between Indigenous Australians and governments.

The development of co-management initiatives that aim to successfully implement sustainable management initiatives requires a long-term commitment from both the government and Indigenous groups. One of the main impediments to Indigenous involvement in those schemes lies in their lack of financial capacity, especially long-term. However, the Australian government has designed some programs which aim to provide long-term funding to support the development of Indigenous land and sea management (May 2010).

[5] Decision from the High Court of Australia recognising native title in Australia for the first time in 1992. Native title is "*the recognition by Australian law that some Indigenous people have rights and interests to their land that come from their traditional laws and customs*" (NNTT 2009). This decision led to the Parliament enacting the Native Title Act in 1993.

For instance, the “Working on Country” scheme was specifically designed to help Indigenous people enter natural resource management programs. The aims of the initiative was to support Indigenous Australians in protecting Australia’s environmental and heritage values through the provision of paid employment and training in land and sea management (May 2010). The “Working on Country” program had two main goals: (1) biodiversity conservation and (2) Indigenous economic development. Many Indigenous groups use the support provided by the “Working on Country” initiative to devise specific co-management plans. In the Torres Strait, many communities have used this support to facilitate the co-management of dugongs and green turtles (TSRA 2010).

So in principle, the groundwork has been laid for cooperative co-management approaches. However, the aspirations of different managers and of community representatives may be different; one group may favour management for ecological reasons while others may favour management initiatives that sustain cultural or socio-economic values. Devising collaborative management arrangements that simultaneously meet the aspirations of the different stakeholder groups who have an interest in the management of dugongs and green turtles is not an easy task.

Moreover, deciding WHO should be included within such arrangements is also non-trivial. For instance ‘sharing’ has long been an important component of Indigenous societies and has been documented for communities in Torres Strait (Nietschmann 1977a). If sharing is still important today, it may influence the definition of which stakeholder groups are likely to be impacted by management initiatives and will thus influence decisions about who should be included in co-management arrangements. Moreover, Ostrom (2007a, b) suggests the importance for managers of being able to define the different components of a complex social-ecological system. In the case of the Torres Strait Indigenous fisheries, managers thus need a good understanding of the resource system (i.e., the fisheries), the resource units (i.e., dugongs and green turtles), the governance system (i.e., institutional arrangements for the Indigenous fisheries), and the resource users (i.e., Torres Strait Islanders using dugongs and green turtles), and of their interactions. To date, there is an absence of previous research on the specific resource users of these fisheries.

Research gap: There is no clear understanding about who are the resource users of the Torres Strait Indigenous dugong and green turtle fisheries highlighting that there is no accepted definition of who should be involved in the management of those fisheries.

Finally, it is important to note that the remoteness of Torres Strait and the associated difficulty of monitoring and enforcing management strategies in this region, means that it is vitally important for managers of the traditional dugong and green turtle fisheries to understand the aspirations of community members. Compliance with new fisheries regulations is a requirement for any management actions to be successful. Nielsen (2003) demonstrate that knowing about legitimacy or social acceptability of proposed fisheries management regulations is an important factor if fisheries managers want to maximise compliance rate and minimise monitoring and enforcement costs. Such information on the potential social acceptability or legitimacy of the proposed management tools for the Torres Strait Indigenous fisheries is currently lacking.

Research gap: There is no current information on the perceptions of Torres Strait Islanders on the impacts of potential management tools for the Torres Strait traditional dugong and green turtle fisheries.

1.6 Key points

Overall, fisheries management research requires a deep understanding of the ecological, economic, social and institutional dimensions pertinent to the social-ecological system in question. The particular status of dugong and green turtle populations in the Torres Strait, where there is no immediate ecological risk of extinction of the two species, provides researchers with the time to get management right. The importance of actively involving Indigenous peoples in research is increasingly recognised. As such, natural resource management plans will be most successful if they are developed by involving local stakeholders through active participation and the sharing of traditional knowledge with western knowledge. Planning for the sustainable use of dugongs and green turtles is under way in most communities of the Torres Strait.

BUT our knowledge of the economic context of hunting is lacking.

1.7 Summary of research gaps

As highlighted in the previous sections, there is currently a paucity of data in the scholarly understanding of the socio-economic context of the Torres Strait traditional dugong and green turtle fisheries. This lack of information undermines the capacity of managers to devise management initiatives that are based on an integration of the four dimensions (i.e., ecological, economic, social and institutional; see Figure 1-4) that is advocated for sound fisheries management (see section 1.3). As such, this research aims to fill the research gaps highlighted in the previous section, and repeated below.

There is little recent information about the social component of these fisheries which would provide essential information on who are the resource users of the traditional fisheries. For instance, there is limited information on the role played by sharing in defining the resource users of the fisheries. There is also little information on how the transition of Torres Strait communities from a subsistence-based economy to a cash-based economy has influenced sharing. Only anecdotal information is available on whether hunters on the islands are the only resource users within the system, what the relationships of the hunters are with the rest of the community and if all stakeholders have sufficiently been engaged in the current management of the fisheries.

Research gap 1: There is no clear understanding about who are the resource users of the Torres Strait Indigenous dugong and green turtle fisheries highlighting that there is no accepted definition of who should be involved in the management of those fisheries.

Currently, findings of some of the required biophysical research on dugongs and marine turtles in Northern Australia are available but economic information (i.e., the costs and benefits associated with customary hunting of dugongs and marine turtles), is lacking (Table 1-1). The few studies which collected some economic information have focused on the consumptive aspect of hunting and have merely noted that there were a range of non-market values that were not investigated. Moreover, the understanding of the previous research gap will help define the resource users and as such whose benefits and costs need to be investigated.

Research gap 2: There is currently no economic information on the costs and benefits (market and non-market) associated with the Torres Strait traditional dugong and green turtle fisheries.

Finally, there is also no information on how different proposed management tools for the fisheries are perceived by local stakeholders (based on the idea that management success is linked to positive and negative perceptions).

Research gap 3: There is no current information on the perceptions of Torres Strait Islanders on the impacts of potential management tools for the Torres Strait traditional dugong and green turtle fisheries.

1.8 Thesis objectives

As suggested in this chapter, the management of natural resources needs to be holistic and should integrate information from a range of disciplines. Currently, most of the data on the Torres Strait Indigenous dugong and green turtle fisheries is biophysical and anthropological in nature (see section 1.1; Table 1-1). Moreover, little economic information has been collected on the Torres Strait Indigenous dugong and green turtle fisheries. This thesis intends to fill part of this knowledge gap by conducting an in-depth exploration of the economic factors that influence current Indigenous hunting of dugongs and marine turtles in the Torres Strait. Importantly, this work does not seek to develop sophisticated quantitative models of optimal fishery effort for the reasons outlined in section 1.4.3 (i.e., there is simply not enough data to do that).

Instead, the overarching objectives of this thesis are: (1) to provide economic information, gathered from the point of view of local stakeholders that can be used to inform the management of the traditional dugong and green turtle fisheries in the Torres Strait, and (2) to provide baseline data and insights to underpin subsequent economic investigations.

The specific sub-objectives of this research are to improve understanding of:

(1) The socio-economic system in which those fisheries operate;

(2) The costs and benefits (market and non-market) associated with the traditional fishing of dugongs and green turtles;

(3) The perceived impacts of different management strategies on the existing costs and benefits associated with the traditional fisheries of dugongs and green turtles.

By fulfilling these objectives, the project will also improve our understanding of how changes brought by new management strategies are likely to impact on this complex social-ecological system and on subsistence fisheries more generally.

My study builds upon the literature presented in this chapter by exploring the place that dugong and green turtle hunting plays in local Indigenous livelihoods, focussing on a description of the social, cultural and financial factors influencing hunting behaviour.

1.9 Thesis outline

This thesis is divided in 7 chapters (Figure 1-6). A brief description of each chapter is provided below. I also suggest two ways of reading the material of this thesis.

a) If the reader is unfamiliar with the context of the fisheries, chapters 2 and 3 will provide more contextual and background information useful to the understanding of the following data chapters.

b) If the reader is familiar with the context of the Torres Strait fisheries, s/he may prefer to move directly from the end of this chapter, to the beginning of chapter 4.

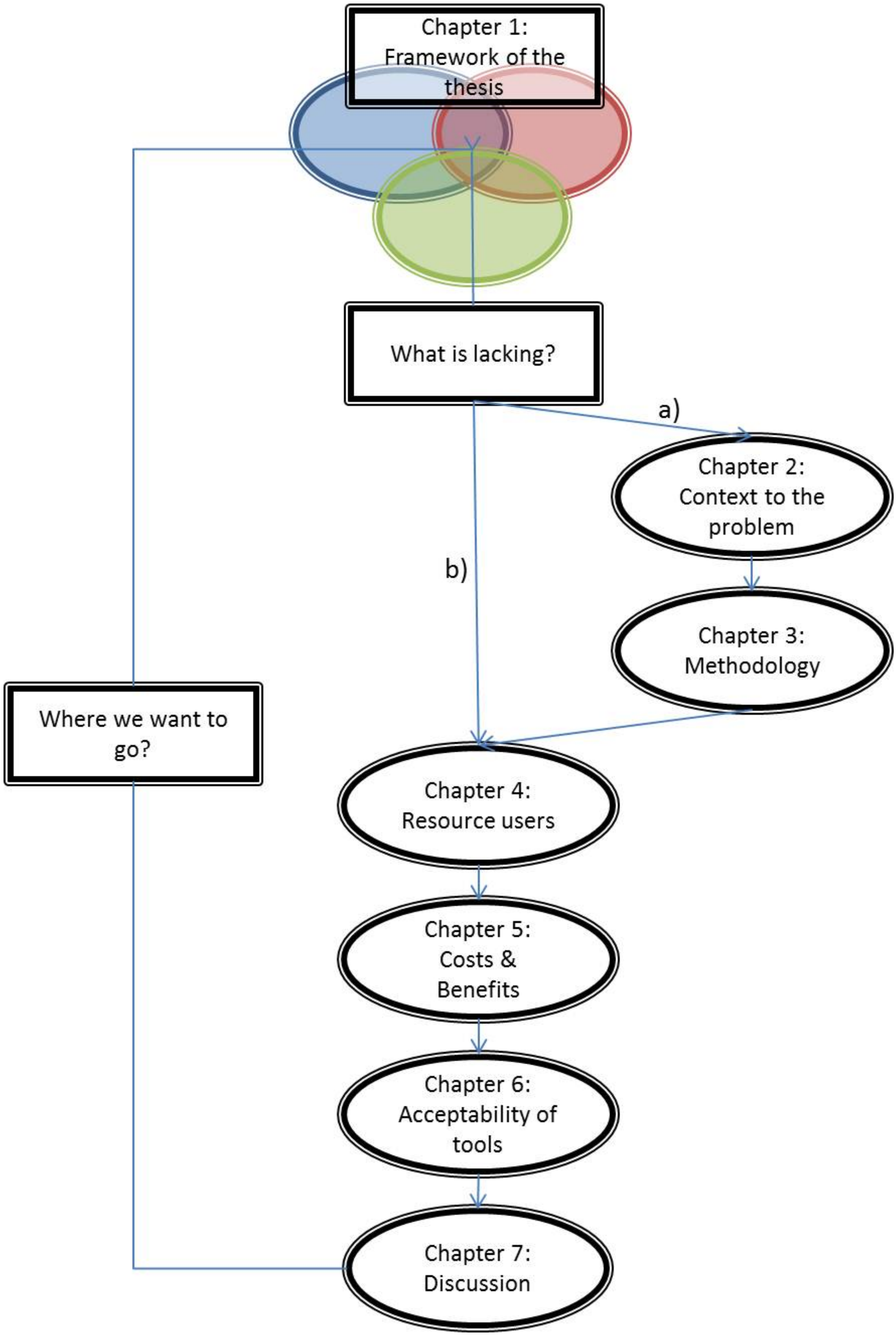


Figure 1-6. Conceptual diagram explaining the structure of this thesis in the context of the research questions and the gaps in knowledge.

In chapter 2, I provide a description of the context of my study. I explicitly describe the specific characteristics that affect the management of dugong and green turtle fisheries in the study region by including details on the different components of this complex social-ecological system. Specifically, I provide discussions about: (1) dugongs and green turtles, (2) the Torres Strait region and the Torres Strait Islanders, and (3) the institutional arrangements relevant to the Torres Strait Indigenous dugong and green turtle fisheries.

In chapter 3, I provide an overview of the general methods used for my data collection. I explain the rationale behind the choice of a case study approach and describe the process of engaging directly with two local communities. A detailed description of each method pertinent to individual components of my research is further considered in the relevant data chapters.

Chapters 4 through 6 investigate the role the dugong and green turtle fisheries play in the livelihoods of Indigenous inhabitants of the Torres Strait. These three chapters have been written in a format that facilitates publication in peer-reviewed journals.

In chapter 4, I describe the complexities of the social system surrounding the traditional dugong and green turtle fisheries. I provide information on the socio-economic characteristics of Torres Strait Islanders that provide the background for their engagement in the traditional fisheries. I explore the components of the social-ecological system under study: the resource system, resource units, governance system and resource users of the Torres Strait Indigenous dugong and green turtle fisheries. I focus on the resource users and investigate the current role of sharing behaviour to describe the involvement of different resource users in the traditional fisheries and to illustrate the complex relationships (direct and indirect) between each resource user in the system. Parts of this chapter will be submitted to *Marine Policy* while the other part will complement a manuscript to be submitted to *Conservation Biology*.

In chapter 5, I investigate the benefits and costs (both market and non-market) associated with hunting dugongs and green turtles from the point of view of local stakeholders. I also consider the appropriateness of using typical western economic frameworks to match Indigenous worldviews. A modified version of this chapter will be submitted to *Marine Policy*.

In chapter 6, I consider how six proposed fishery management tools are perceived to potentially impact the current benefits and costs (market and non-market) associated with the Indigenous fisheries and explored in chapter 5. I use this information to infer on the possible social acceptability of these different management tools. Additionally, I consider the enforceability of each different management tools and investigate the potential social consequences that enforcement and monitoring could have on the two Torres Strait communities. This chapter has been prepared for submission to *Marine Policy*.

Finally in chapter 7, I summarise the themes and insights that emerged from the previous data chapters. I highlight the contributions of my work to the management of the Torres Strait Indigenous dugong and green turtle fisheries and to the broader academic and natural resource management community. Moreover, I present some suggestions on how government and local communities can improve their ability to co-manage these fisheries. I also provide a description of the academic and methodological contributions of this research project. Finally, I conclude with recommendations for future research that will build upon the findings of this thesis.

1.10 Chapter summary

- This research involves the study of a complex social-ecological system: specifically, the Torres Strait Indigenous dugong and green turtle fisheries.
- Those fisheries are based on Indigenous marine resource use and the harvest of two protected species.
- The sustainable management of these fisheries, like any other small-scale fisheries requires an understanding of the ecological, economic, social and institutional dimensions that make up the social-ecological system in question as well as their interactions.
- Several disciplines can provide valuable information for the sustainable management of small-scale fisheries. Disciplines like ecology and anthropology have thus far contributed to the scholarly knowledge of the two Indigenous fisheries but there is a lack of economic data.
- Learning more about the economics of these fisheries will help link the different elements of the social-ecological system.
- This study aims to gather the necessary economic information that could help inform those interested in promoting the sustainable management of the Indigenous fisheries.
- The study will thus investigate: (1) the socio-economic characteristics of the resource users, (2) the costs and benefits associated with the fisheries, and (3) the costs and benefits associated with potential management actions.

CHAPTER 2:

CONTEXT OF STUDY

The management of natural resources needs to be context-specific and is influenced by the biophysical characteristics of the resource in use, the characteristics of the local stakeholders and the institutional arrangements. In this chapter, I describe the features that need to be considered for the management of the Torres Strait Indigenous dugong and green turtle fisheries. I include background discussions of: (1) the Torres Strait region and its inhabitants; (2) the biology, ecology and conservation status of dugongs and green turtles; and (3) the institutional arrangements relevant to dugong and green turtle management in the region.

2. Context of study

As explained in chapter 1, this research focuses on the Torres Strait Indigenous dugong and marine turtle fisheries; two small-scale customary fisheries operating in a remote region of Australia, primarily for subsistence. In the following sections, I review the attributes that make these fisheries an example of a complex social-ecological system of marine resource use. After providing a brief overview of the biophysical region in which this study is located, I use the framework introduced in chapter 1 to organise a literature review that describes: (1) the ecological dimension of the system of interest, (2) the social and economic dimensions, and (3) the institutional context which regulates the human-nature interactions operating in these Indigenous fisheries. I also provide information on the current management context for the Indigenous dugong and green turtle fisheries of Torres Strait.

2.1 The study region

My research takes place in the Torres Strait region (Zenadth Kes), a complex marine ecosystem with noteworthy characteristics owing to its geographic location, environment and human population. The region is a shallow shelf that lies between 142°00’E and 144°00’E, and between 9°00’S and 11°00’S in north-eastern Australia between the tip of Cape York in north Queensland and the coast of Papua New Guinea. The region is broadly defined to the west by the Arafura Sea and to the east by the Great Barrier Reef and the Coral Sea (Williams 1994). Geomorphically, the Strait was formed following the inundation some 8000 years ago of the land bridge connecting the Australian mainland and Papua New Guinea (Barham and Harris 1983; Johannes and MacFarlane 1991; McNiven and Hitchcock

2004). Consequently, the area consists of approximately 48 000 km^2 of shallow open water, extending for 150 km north-south and 250 km east-west (Figure 2-1), and is composed of more than 100 islands, cays, sand banks and reefs (Harris *et al.* 2008).

Torres Strait is a key marine habitat for many species. The Strait sustains high marine biodiversity and is also home to the most extensive seagrass beds in the world (Coles *et al.* 2003; Taylor 2012; Williams 1994). Seagrasses extend over an area of 17 000 km^2 in a range of habitats, particularly in the north-western part of Torres Strait (Poiner and Peterkin 1996; Taylor 2012). These seagrass beds constitute the primary food sources of local megafauna including dugongs and marine turtles and provide key habitats for important fish populations and other hand-collectables like trochus, bêche-de-mer, crayfish and lobster that support thriving commercial and subsistence fisheries upon which local populations have depended for many generations. The earliest evidence of turtle harvest in the region dates from 7 000 years ago (Wright 2011); the dugong harvest goes back at least 4 000 years (Crouch *et al.* 2007) and has been substantial for at least 400 – 500 years (McNiven 2010).

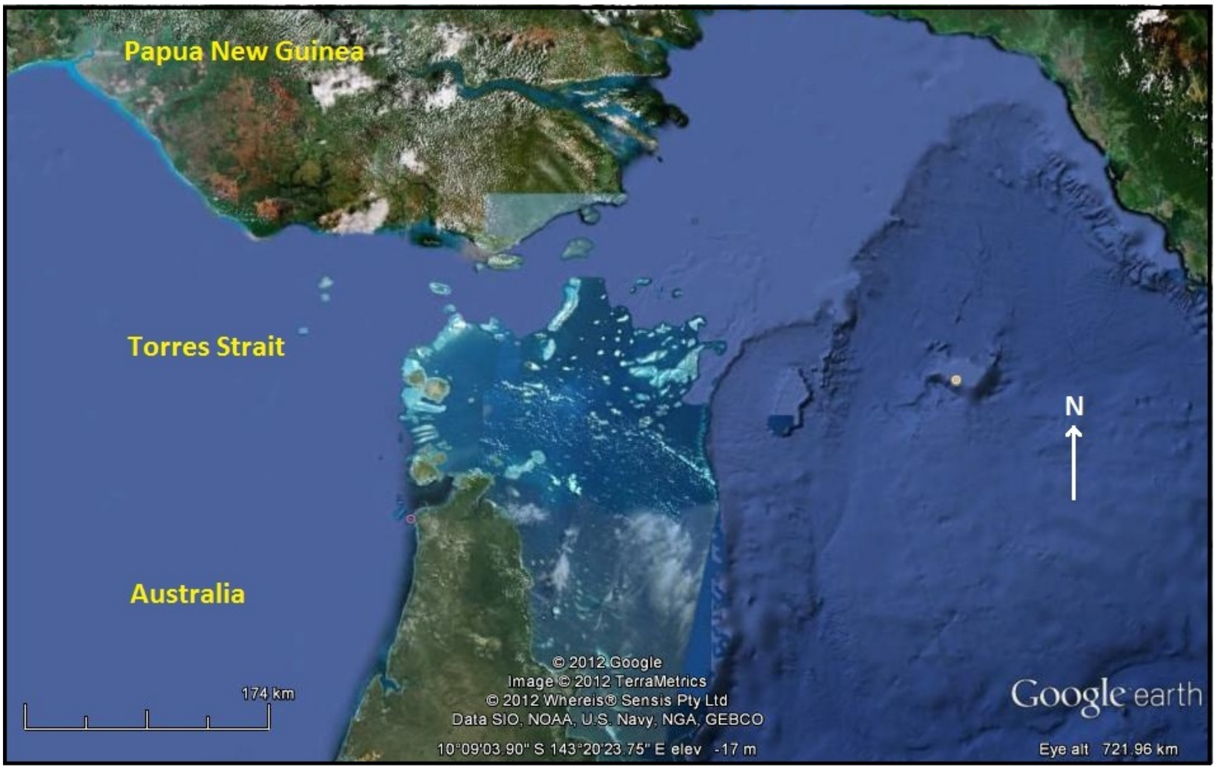


Figure 2-1. Location of the Torres Strait between the north-eastern coast of Australia and Papua New Guinea (from Google earth).

2.2 The ecological dimension: species of interest

As explained above, the Torres Strait region sustains several commercial and subsistence fisheries. This study concerns the traditional[6] dugong and green turtle fisheries. Those two fisheries involve the customary hunting (fishing) of dugongs and green turtles and the traditional harvest of eggs from six species of marine turtles by Indigenous people living in Zenadth Kes.

Recently there have been concerns about the sustainability of the dugong harvest in the region (Heinsohn *et al.* 2004; Marsh *et al.* 2004a, b; Marsh *et al.* 2011). Evidence of turtle decline exists also in parts of Northern Australia (although this decline has not been directly linked to the Australian Indigenous harvest) (Limpus 1995). For these reasons, sound

[6] Traditional here does not refer to the method of harvest but to the purpose of hunting.

management of the Indigenous fisheries is required and needs to consider the context-specific characteristics of the two fisheries.

Fisheries management is typically informed by the biophysical characteristics of the harvested species. Managers collect information on population size, sex ratio and life history parameters of the primary target species. In the paragraphs below, I describe the life history strategies of the two main targets of the Torres Strait Indigenous dugong and marine turtle fisheries, followed by an account of the global conservation status of these species and the situation in the region of interest.

2.2.1 DUGONGS AND GREEN TURTLES

2.2.1.1 Biology

The Australasian region supports some of the world's largest remaining populations of dugong and six species of marine turtles. The dugong (*Dugong dugon* or "sea cow") has a large geographical range which has been estimated to cover approximately 860 000 km^2 (Marsh *et al*. 2011; see Figure 2-2). Potential habitat extends across 38 to 44 countries and territories in tropical and subtropical coastal and island waters from East Africa to Vanuatu (Marsh *et al*. 2011; see Figure 2-2).

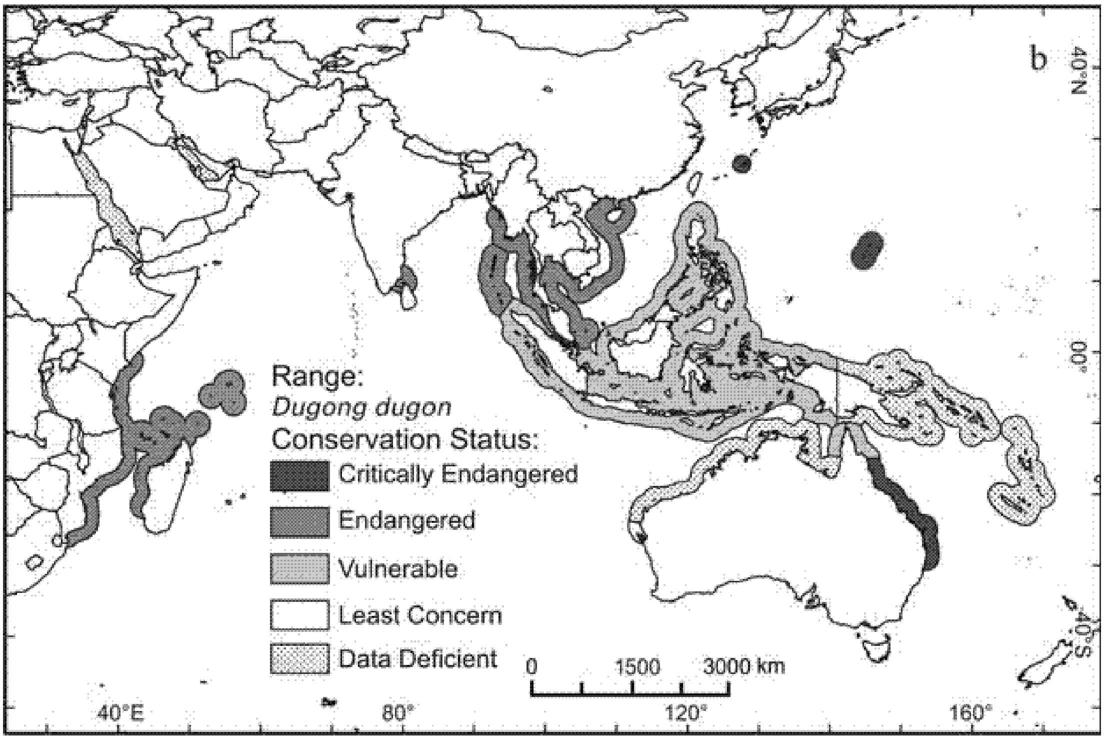


Figure 2-2. The known range and conservation status of the dugong (from Marsh *et al*. 2011). Drawn by Adella Edwards, reproduced with permission.

The green turtle (*Chelonia mydas*) inhabits tropical and sub-tropical waters worldwide (Limpus 2008). Australia supports one of the largest remaining breeding populations of green turtles in the world (Limpus 2008; Wallace *et al.* 2010). Seven stocks of green turtles have been identified in Australia and these stocks are managed as seven separated regional management units (Jensen 2010; Limpus 2008). Although the seven green turtle stocks have different breeding distributions, their feeding areas overlap. These stocks also share feeding grounds with green turtles from other stocks that have nest in neighbouring countries (Limpus *et al.* 1992).

Both dugongs and green turtles have life-history strategies that make them particularly susceptible to anthropogenic impacts (Limpus 2008; Marsh *et al.* 2011). Dugongs are large long-lived marine mammals that are slow to reach sexual maturity and have intervals of several years between successive calving events (Marsh *et al.* 2011). Green turtles reach sexual maturity at approximately 30 to 40 years (Limpus 2008). Although female turtles can produce up to several hundred eggs in a season, they may only breed once every several years, with high egg and juvenile mortality (Iverson 1991).

2.2.1.2 Susceptibility to threats

The greatest danger to the population stability of dugongs and green turtles is their sensitivity to changes in the survival probability of adults through Indigenous hunting, illegal hunting (i.e., poaching), incidental capture in nets, marine debris and vessel strike (Marsh *et al.* 2011). Other threats include a reduction in available foraging habitat (i.e., through coastal development) and poor water quality (i.e., through pollution). These impacts threaten dugong survival in over 80% of the species' geographical range (Marsh 2008); their effects on green turtles are likely to be of similar magnitude.

The extent of the threats to both species calls for targeted and coordinated conservation actions. Australia has a key position to play in the protection of dugongs and green turtles. Australia is only one of few developed nations in the ranges of these species and is one of the few countries whose coastline is likely to experience relatively low levels of coastal development in the near future (Marsh *et al.* 2002; Marsh *et al.* 2011). Most other countries in the ranges of dugongs and green turtles are unlikely to be able to protect these species effectively due to: (1) increasing pressures from human population growth, (2) associated coastal development and pollution, and (3) a lack of resources for conservation (Marsh *et al.* 2011; Wallace *et al.* 2011).

Thus, the large populations of dugongs and green turtles in Australia's waters and the capacity of Australia to manage anthropogenic impacts threatening those species emphasise the importance of Australia fulfilling its obligations under the various international conventions that aim to protect dugongs and green turtles. These conventions include the *Convention on the Conservation on Migratory Species of Wild Animals* (the Bonn Convention, CMS), the *Convention on International Trade of Endangered Species of Wild Animals* (CITES), the *Convention on Biological Diversity*, and the *World Heritage Convention* (WHC).

2.2.1.3 Conservation status

2.2.1.3.1 International level

At the international level, the dugong is classified as “vulnerable to extinction” in the IUCN’s Red List of Threatened Species due to anthropogenic threats and lack of effective management (Marsh 2008). Thus the dugong is considered to face a high-risk of extinction in the wild in the medium-term future at a global scale. The *Convention on Migratory Species* lists the dugong in its Appendix II (CMS 2012). The dugong is also listed in Appendix I of the *Convention on International Trade of Endangered Species of Wild Animals*. Australia signed a *Memorandum of Understanding on the Conservation and Management of Dugongs* (*Dugong dugon*) *and their Habitats throughout their Range* which is administered through the Convention on Migratory Species. Other international frameworks that aim to engage countries in dugong’s conservation include the United Nations Environmental Project Dugong Status Report and Action Plan for Countries (Marsh *et al.* 2002), and the South Pacific Region Environmental Programme’s Dugong Action Plan (Gillespie 2005).

Green turtles are classified as “endangered” in the IUCN’s Red List of Threatened Species. Green turtles are listed under the *Convention on Migratory Species* in its Appendices I and II (CMS 2012) and in Appendix I of the *Convention on International Trade of Endangered Species of Wild Animals*. Australia has also signed the *Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats in* *the Indian Ocean and South-east Asia* (IOSEA) under the Convention on Migratory Species. Through this international agreement, Australia is obligated to protect green turtles from extinction and to implement measures that ensure population stability.

2.2.1.3.2 National level

Nationally, the Australian government lists both dugongs and green turtles as "species of conservation concern" and as such has translated some of the international dugong and green turtles conservation guidelines into its domestic legislation (Havemann and Smith 2007). At the level of the Commonwealth, the *Environment Protection and Biodiversity Conservation Act (EPBC Act) (1999),* lists the dugong as a "listed marine species" and "listed migratory species" and green turtles as "listed marine species" and "vulnerable species". In Queensland, state legislation lists both the dugong and green turtle as "vulnerable" under the *Nature Conservation Act (1992)*.

2.2.1.4 Status of the dugong and green turtle populations in the Torres Strait

Although dugongs and green turtles are listed as threatened at a global scale, not all populations are facing the same level of threat (Marsh *et al.* 2011; Wallace *et al.* 2010; Wallace *et al.* 2011). In an estimated one-third of its geographical range, dugong populations are in decline or already extinct (Marsh 2008; Marsh *et al.* 2011). The data are so scarce in approximately half of its range that the status of the populations is unknown (Marsh 2008; Marsh *et al.* 2011). The status of dugong populations has been assessed as possibly stable in the remainder 17% of its range; mostly in the remote coastal areas of northern tropical Australia (Marsh 2008; Marsh *et al.* 2011). The overall dugong population inhabiting Australian waters has been estimated to be at least 70 000 animals (Marsh *et al.* 2011). This estimate is based on the data compiled from aerial surveys covering more than 120 000 km^2

of coasts since 2005 (Marsh *et al*. 2011). However, this figure is almost certainly an underestimate of the actual population size as: (1) estimates are out-dated or unavailable for several large regions of Australia and (2) aerial surveys provide underestimates of population size (Marsh *et al*. 2011). Within Australia, the Torres Strait region supports the highest proportion of the Australian dugong population and has been described as home to the largest remaining populations of dugongs in the world (Marsh *et al.* 2002; Marsh *et al.* 2011) (see Figure 2-3).

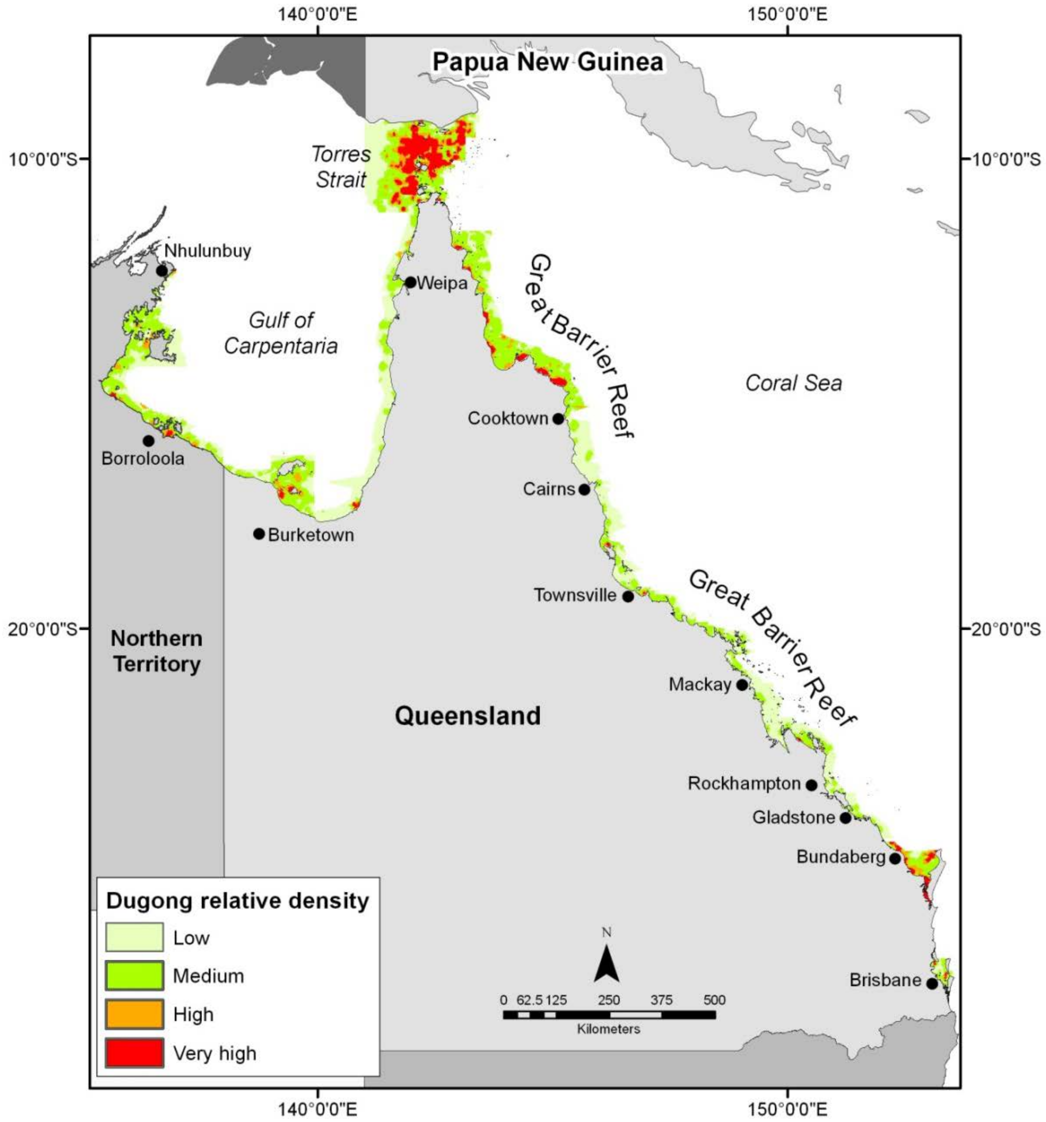


Figure 2-3. Spatial model of the relative density of dugongs on the east coast of Queensland and the Gulf of Carpentaria, Australia (Grech *et al*. 2011). The model confirms the importance of Torres Strait as dugong habitat. Drawn by Alana Grech, reproduced with permission.

The worldwide status of green turtle populations indicates that different stocks are under threat in most of the geographical range (Wallace *et al.* 2011). In Australia, the stocks of green turtles are assessed as of high conservation importance and are under a medium level of threats (Wallace *et al.* 2011). The Torres Strait region is particularly important for green turtles. Although the size of the population in Torres Strait has not been estimated (Harris *et al.* 2000), Torres Strait is home to extensive nesting sites (i.e., Bramble Cay and Murray Island), and provides abundant seagrass and coral habitat for turtles for all life stages. Torres Strait also serves as a major migratory pathway for turtles travelling between feeding grounds in the Arafura Sea to nesting grounds in the Great Barrier Reef World Heritage Area, and back (Harris *et al.* 2000).

Thus in contrast to most other parts of their ranges, Torres Strait is unusual as both dugongs and green turtles are abundant. As such, there is no immediate ecological risk of extinction of the target species of the Indigenous fisheries in the study area. Nonetheless, management actions are required because of the scientific and community concerns that exist over the sustainability of the harvest within both fisheries in the Torres Strait. Furthermore, the successful management of both populations in Torres Strait is seen as vital for the long-term viability of these species worldwide (Limpus 2008; Marsh *et al.* 2011).

2.3 The social and economic dimensions: Torres Strait Islanders

The relative abundance of both dugongs and green turtles in the Torres Strait and the close proximity of human settlements with the marine environment contributed to the Torres Strait region becoming a primary harvesting region for the local Indigenous communities. As highlighted in section 1.3, the management of a complex social-ecological system demands a good understanding of the ecological system, the economic system, the social system and their interactions. There is also a growing recognition that successful management of small-scale fisheries requires: (1) consideration of socio-economic factors and (2) the incorporation of the interests of small-scale fisheries and the needs of coastal communities in management arrangements (Berkes 2004, 2005; Grant and Berkes 2004; Singh-Renton *et al.* 2003).

This section thus describes key characteristics of the socio-economic system – with a focus on the people of the Torres Strait - the principal resource users of the Indigenous dugong and green turtle fisheries.

2.3.1 General characteristics

Archaeological evidence suggests that the Torres Strait region was inhabited 8000 – 6000 years before present (BP) at the time when most of the islands were still attached to the Australian mainland (David *et al.* 2004). Occasional visits to the Western Island group (Figure 2-4) from Cape York Peninsula is evident from 6000 to 3500 BP while evidence of permanent occupation of the current islands started 3500 years BP (David *et al.* 2004).

Torres Strait is home to the Torres Strait Islanders who are of Melanesian origin[7] and form a second Indigenous group in Australia to Aborigines. Torres Strait Islanders have a distinct culture which they refer as *Ailan Kastom* (Island Custom) (Kwan 2002). The people of Torres Strait are outstanding sea-fearers, and possess a strong connection to the sea through their customs, lifestyle and traditions (Beckett 1987).

[7] It is important to note the ancestry of Torres Strait Islanders is multi-cultural and that many Torres Strait Islanders have Asian, European, Pacific Islander and/or Aboriginal ancestry.

The Torres Strait acts as a bridge between the hunter-gatherer societies of mainland Australia and the more horticulturalist societies of Papua New Guinea (Barham and Harris 1983; Barham *et al.* 2004). The Strait is shared among Australian Torres Strait Islanders and Papua New Guineans living in the villages on the south-eastern coast of the island of Papua New Guinea (i.e., the Western Province of Papua New Guinea) (Figure 2-4). The Australian part of Torres Strait was historically divided into clusters of islands following the five traditional island nations: Guda Maluiligal (top Western group: swampy mud islands), Maluiligal (Western group: high continental Islands), Kemerkemer Meriam (Eastern group: volcanic islands), Kulkalgal (Central group: low sandy islands) and the Kaurareg Nation of Kaiwalagal (which include the Inner group: high continental islands and the Northern Peninsula Area of the mainland; the Kaiwalagal nation being Aboriginal). These distinct regional groups are still in use today for the purpose of managing shared resources between neighbouring islands (Figure 2-4).

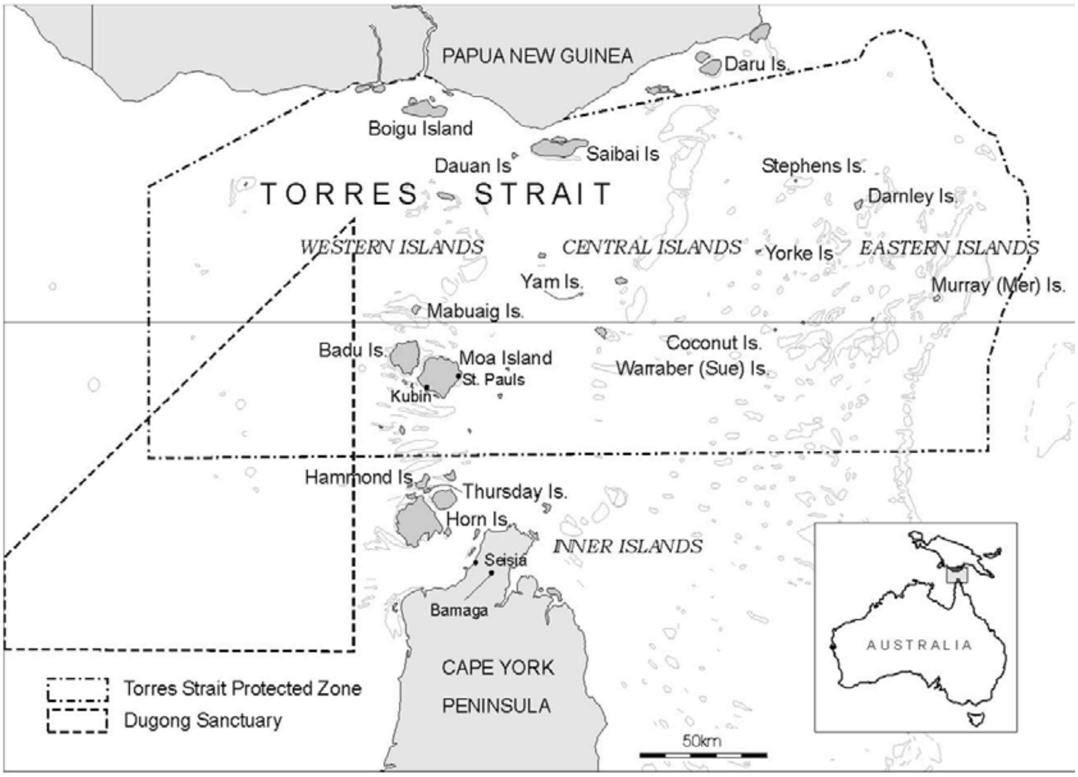


Figure 2-4. Location of the Torres Strait Island communities showing the Torres Strait Protected Zone established by the Treaty between Australia and Papua New Guinea and the Dugong Sanctuary, an area closed to dugong hunting established under fisheries regulations (source Kwan *et al.* 2006).

The population of the Australian parts of the Torres Strait is currently scattered among 17 remote islands and two mainland communities - Seisia and Bamaga. These two mainland settlements are populated by Torres Strait Islanders who were moved from outer island communities such as Saibai and Boigu to live on mainland Cape York Peninsula (Arthur 1997).

At the time of the first European contact, the human population residing in the Torres Strait was estimated to be between 4 000 – 5 000 people and was composed of numerous communities who lived on islands where water was available (Beckett 1987). Due to the introduction of diseases by Europeans - to which Torres Strait Islanders had little resistance - the population declined radically to reach as low as approximately 2 000 people by the 1860s (Beckett 1987). Numbers slowly started to increase after the 1910s and have fluctuated between 6 000 – 7 000 people since the 1960s (Table 2-1).

At the last census, the regional population of Torres Strait was estimated at 7 489 people (2011 Census of Population and Housing), a slight decrease from the previous Census which estimated that 8 576 people (2006 Census of Population and Housing) lived in the region. In 2011, 80% of the residents living in the Torres Strait region declared that they were Indigenous.

Table 2-1. Estimates of the Torres Strait Islander population from European contact to 2011 from various sources as specified.

Date	Islander population in the Torres Strait	Reference
European contact in 1606	4 000 – 5 000	Beckett (1987)
1860s	~2 000	Beckett (1987)
1913	2 368	Beckett (1987)
1948	5 000	Beckett (1987)
1960	7 250	Beckett (1987)
1986	6 100	1986 Census (ABS 1986)
1989	6 245	Arthur (1990)
1996	5 667	1996 Census (ABS 1996)
2001	6 214	2001 Census (ABS 2001)
2006	7 105	2006 Census (ABS 2006c)
2011	5 921	2011 Census (ABS 2011a)

The main administrative centre of the Torres Strait region is Thursday Island, one of the inner islands (Figure 2-4). The inner islands support approximately 40% of the regional population with the population of Thursday Island a little more than 2500. The inner islands are also home to the largest proportion of non-Indigenous people in the Torres Strait region who are largely employed in the government sector providing health, education and other services. In contrast, the populations of each of the outer island communities range from about 70 to 750 people (ABS 2006 Census) and comprise mainly Indigenous people (Arthur and Morphy 2005).

Before the end of World War II, Torres Strait Islanders were restricted to living in the Torres Strait region by law through the *Aboriginals Protection Act (1904)* (Beckett 2010). Migration was allowed after the end of World War II and there has been a substantial movement of people from their island communities to the Australian mainland. These large-scale movements have resulted in a redistribution of Torres Strait Islanders and many are now resident in major cities along eastern Australia (Taylor and Arthur 1992). This migration was initially associated with a search for employment opportunities (Taylor and Arthur 1992). Population censuses estimated the size of the Torres Strait Diaspora[8] to be 9 663[9] in 1971, 16 533 in 1976, 15 324 in 1981 (Beckett 1987), 33 000 in 1996 (ABS 1996 Census), 44 000 in 2001 (ABS 2001 Census), 47 000 in 2006 (ABS 2006 Census) and 46 829 in 2011[10] (ABS 2011 Census). As of 2011, the Diaspora represents 89% of the entire Torres Strait

[8] Torres Strait Islanders residing elsewhere in Australia.

[9] Comprises people who are Torres Strait Islander and both Aboriginal and Torres Strait Islander in origin.

[10] The ABS 2011 Census was the first to officially record a count specific to the Torres Strait Islander population.

Islander population. Torres Strait Islanders now live in the different states of Australia, mainly in Queensland cities such as Cairns, Townsville and Brisbane (ABS 2011 Census). Although the Torres Strait Islanders from the Diaspora are growing in numbers and often hold Native Title Rights in Torres Strait, the status of the "mainland islanders" and of their representation in issues regarding Torres Strait is still debated (Watkin-Lui 2012).

2.3.2 SOCIO-DEMOGRAPHIC CHARACTERISTICS

I examined the socio-economic profiles of the Torres Strait population using secondary data collected from the 2006 Census and compared it with the characteristics of the Queensland population. As is evident from Figure 2-5a to Figure 2-5c, the Indigenous populations of Torres Strait are characterised by many children and few older people. Thus the population pyramid of the Torres Strait (Figure 2-5a)(ABS 2006a) is very different from the population pyramid of the general Queensland population (Figure 2-5b)(ABS 2006b) but is similar to the overall profile of the Indigenous population of Queensland (Figure 2-5c)(ABS 2006b).

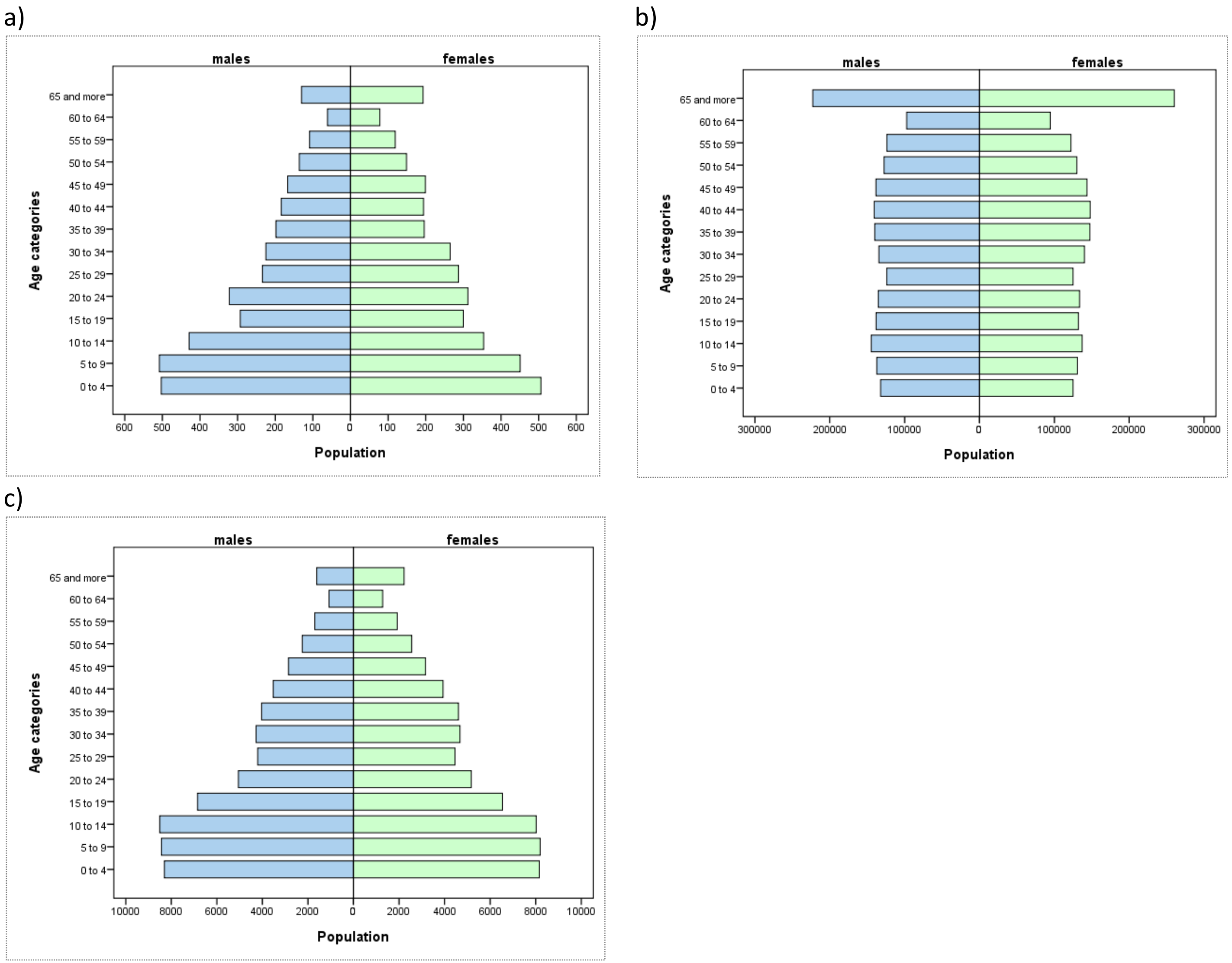


Figure 2-5. Population structure of: a) Indigenous inhabitants of Torres Strait, b) all inhabitants in Queensland, and c) Indigenous inhabitants in Queensland (using data from ABS 2006 Census).

Due to the large number of children in the Torres Strait, the Indigenous population is very young (like the Indigenous population in Queensland) with a median age of 21 years compared with 36 years for the Non-Indigenous population (Table 2-2)(ABS 2006a, b).

Table 2-2. Median age (in years) by Indigenous status comparing the populations of Torres Strait and Queensland (ABS 2006 Census).

Location	Indigenous	Non-Indigenous	Total Population
Torres Strait (Indigenous Region)	21	37	24
Queensland	20	36	36

2.3.3 The Hybrid Economy

Its demographic profile is not the only characteristic that distinguishes the Torres Strait population from the general Australian population. The economic system of the residents of Torres Strait is similar to that of most Australian remote Indigenous populations rather than that of the wider Australian community.

Altman (2001) pointed out that the nature of the Indigenous economy in Australia is different from that of the non-Indigenous economy. Specifically, his hybrid economy model explains that, contrary to the non-Indigenous economic model based on the two components of market and state, the Indigenous economy also includes a customary component. Linkages and interdependencies between those three components can be complex. Indeed Altman argues that:

1) The market sector usually exists in a consumptive rather than a productive manifestation (in essence meaning that Indigenous people 'consume' goods which are sold in the market, but rarely supply goods to the market). The productive form is

very small and might include the art industry, the retail sector, commercial wildlife harvesting and sometimes communication for mining and tourism industries.

2) The state sector is present everywhere in Indigenous land as a service and welfare safety net provider, as law enforcer and regulator.

3) The customary sector is particularly important. According to Altman (2005) the customary sector of Indigenous economies encompasses a range of productive activities derived from cultural practices that occur outside the market and include hunting, fishing, gathering, art and craft production, and caring for country[11]. This customary sector is thus largely non-monetary and is usually unquantified in mainstream socio-economic data used by the Australian Bureau of Statistics (Altman 2001).

A brief discussion of the three sectors of Altman's hybrid economy model applied to the Torres Strait region is given below.

2.3.3.1 The Market and State Sectors in the Torres Strait region

An income gap exists between Torres Strait Islanders and residents of the rest of Queensland (ABS 2006a, b). For example, the 'average' Torres Strait household (be it Indigenous, Non-Indigenous or mixed) earns 85% of the 'average' household in Queensland (Table 2-3). But the 'average' Torres Strait household is also larger than the 'average' household in Queensland (Table 2-4), so the income gap is wider if measured at the individual, rather than the household level: on average a person living in the Torres Strait (be

[11] Moreover, in the light of limited job opportunities (see section 2.3.3.1) that exist in remote areas of Australia, the customary sector of the economy has the potential to create economic development opportunities (Altman 2009, 2011).

they Indigenous or Non-Indigenous) earns 66% of the income of an average resident of Queensland (Table 2-3).

Table 2-3. Median weekly individual and household income, by Indigenous status comparing the populations of the Torres Strait and Queensland (ABS 2006 Census).

Location	Individual weekly income - Indigenous	Individual weekly income – Non-Indigenous	Individual weekly income – Total	Household weekly income – Indigenous	Household weekly income – Non-Indigenous	Household weekly income - Total
Torres Strait (Indigenous Region)	$270 (58.4% less than Non-Indigenous)	$649	$313	$809 (28.1% less than Non-Indigenous)	$1125	$883
Queensland	$318 (33.9% less than Non-Indigenous)	$481	$476	$899 (13.3% less than Non-Indigenous)	$1037	$1033

Table 2-4. Persons per household, by Indigenous status comparing the populations of the Torres Strait and Queensland (ABS 2006 Census).

Location	Persons per household – Indigenous	Persons per household – Non-Indigenous	Persons per household - Total
Torres Strait (Indigenous Region)	4.0	2.1	3.6
Queensland	3.5	2.6	2.6

In terms of employment, figures from the 2006 Census suggest a labour force participation rate of almost 67% associated with an unemployment rate of 4.4% (Table 2-5)(ABS 2006a). Those results hide features of the employment market in Indigenous communities; (1) limited labour market opportunities, (2) greater part-time employment, (3) low-skilled occupations, and (4) heavy reliance on the Community Development Employment Project (CDEP) scheme (Table 2-5)(ABS 2006a). CDEP is a work for social security scheme and is equivalent to receiving government benefits in exchange for part-time work. CDEP is restricted to Indigenous communities in Australia and is the predominant form of employment of the Indigenous population in remote Australian communities including Torres Strait. CDEP is currently being phased out by the Australian government[12] (Hudson 2012).

Table 2-5. Labour force status in Torres Strait (ABS 2006 Census).

	Male	Female	Total
Population (15 years and over)	2753	2836	5589
Employed (Mainstream)	1072	1022	2094
Employed (CDEP)	890	578	1468
Total Employed	1962	1600	3562
Unemployed	81	81	162
Total in Labour Force	2043	1681	3724
Not in Labour Force	514	996	1510
CDEP participation rate (%)	45.3	36.1	41.2
Employment rate (%)	71.3	56.5	63.8
Unemployment rate (%)	4.0	4.8	4.4
Labour force participation rate (%)	74.2	59.3	66.7

The labour market in the Torres Strait region is not well diversified. Indeed, from Table 2-6, it is clear that the 'market' sector is relatively small when compared to the 'state' sector (including public administration and safety; health care and social assistance; and

[12] At the time of writing this thesis, it was suggested that CDEP would be phased out in the Torres Strait as in other Aboriginal communities. However, although the program was discontinued in April 2012 in the majority of Aboriginal communities (ABS 2011a), it was not stopped in the Torres Strait although it is now operating under a different name (see section 4.2.1.1)

education and training): with the later accounting for more than 73% of all jobs in this region (Table 2-6)(ABS 2006a). In the outer islands, the largest source of employment is provided by the local island councils who are staffed by community members. The income of local island council employees is a mixture of CDEP and top-up (for the hours worked above the CDEP rate) (Mabuiag Island resident, pers. comm. 2009). Due to the limited full time employment opportunities in the outer islands, most households enhance their CDEP income with the customary sector through subsistence hunting and fishing.

Table 2-6. Industry of employment in the Torres Strait region ranked from the largest to the smallest sector of employment (from ABS 2006 Census).

Industry of employment	Persons	Percentage
Public administration & safety	1958	54.9
Health care & social assistance	370	10.4
Education & training	290	8.1
Inadequately described/Not stated	238	6.7
Retail trade	159	4.5
Transport, postal & warehousing	124	3.5
Accommodation & food services	109	3.1
Construction	108	3.0
Agriculture, forestry & fishing	36	1.0
Administrative & support services	36	1.0
Other services	31	0.9
Information media & telecommunications	21	0.6
Electricity, gas, water & waste services	19	0.5
Professional, scientific & technical services	18	0.5
Wholesale trade	12	0.3

Arts & recreation services	12	0.3
Rental, hiring & real estate services	10	0.3
Manufacturing	8	0.2
Mining	3	0.1
Financial & insurance services	3	0.1
Total	3565	100

2.3.3.2 The customary sector

Indigenous Australians have long relied on hunting for subsistence (Altman 1987; Cane and Stanley 1985; Meehan 1982), with target species including terrestrial animals (Palmer and Brady 1991; Tonkinson 1991; Walsh 1992) and marine animals (Chase and Sutton 1981; Dews and Harris 1995; Johannes and MacFarlane 1991; Smith 1987). The story is no different in the Torres Strait, where archaeological evidence indicates that hunting for marine species dates from 7 000 years ago (Wright 2011) as explained above.

Despite profound post-colonial changes, hunting is still prominent in the lives of many Indigenous peoples of Australia for many different reasons (Altman 1987; Coombs *et al.* 1990; Ellanna *et al.* 1988; Johannes and MacFarlane 1991; Kwan *et al.* 2006; Palmer and Brady 1991). This situation is also true in the Torres Strait.

Hunting in this region has been the focus of scientific research since the Cambridge Expedition led by Haddon in the 1890's. Much of this early research described the meaning of hunting (Bliege Bird *et al.* 2001; Nietschmann and Nietschmann 1981; Nietschmann 1984); and the level of hunting (Heinshohn *et al.* 2004; Kwan *et al.* 2006). Most studies found links between hunting and the social, economic and spiritual dimensions of Indigenous reality (McNiven 2010). It is clear that the benefits associated with traditional Indigenous hunting go beyond mere dietary needs (Ponte 1996). Such an acknowledgement was recently made by a Queensland Supreme Court decision which awarded financial compensation to the families of the victims of the Lockhart River air crash (some of whom were of Torres Strait Islander descent). In his decision, the Court took into account the loss of hunting and fishing services provided by the victims to their families ("arising from their unique cultural, economic and geographic circumstances"); which was estimated at AUD25 per hour (Gosford 2012).

For example, not only does hunting provide food for subsistence but it provides Indigenous Australians with health benefits[13] (Burgess *et al.* 2005; Burgess *et al.* 2008; Garnett and Sithole 2007; Rose 1996). Hunting may also contribute to the financial well-being of Indigenous Australians by complementing their incomes (Altman 1987; Altman and Taylor 1989; Penny and Moriarty 1977) especially when the meat provided is a cheap alternative to store goods (Altman *et al.* 2002; Dove 2006). Hunting also provides a safety net in the face of economic instability which is partly due to fluctuating consumer prices and goods availability at local shops (due to remoteness of habitation), as well as the Islanders' habit of spending cash almost immediately after it is obtained (Peterson 1993).

Hunting is also an essential part of the process of sharing which is central in hunter-gatherer societies (Bliege Bird and Bird 1997; Wenzel 1995). Sharing still remains a very important part of the social structure of Indigenous Australians even if their lifestyle has

[13] Indigenous Australians have been described as the least healthy group in the Australian population (Edwards and Madden 2001). Among the several causes that could explain this poor health, O'Dea (1984) mention that the increase in commercial food items in the diet of Indigenous people has been linked to diseases of the circulatory system. This may be at least partially attributable to wild game having a lower fat content than most commercially available meat (Naughton 1986).

been influenced by Western societies. There are various reasons explaining the importance of sharing. Sometimes it is the result of an outright demand from a party to the hunter (Peterson 1993), sometimes it can be explained by people wishing to be on good terms with members of their "country" (Collings *et al.* 1998), but it can also be explained by a desire to minimise uncertainty when resource availability varies (Collings *et al.* 1998).

Finally hunting is an essential activity that provides food for feasts which are very important in Indigenous cultures (Bliege Bird *et al.* 2001; Fitzpatrick-Nietschmann 1980; Grayson 2011; Kwan 2002; Nietschmann 1977a, b; Nietschmann and Nietschmann 1981; Nietschmann 1984). Several ceremonies are held each year in each Indigenous community as part of the maintenance of their culture and traditions.

2.3.3.3 Links between the customary, market and state sectors in the hybrid economy

The customary sector does not operate in isolation in the hybrid economy model and Altman (2005) highlights that this sector has strong linkages and interdependencies with the "state" and "market" sectors of mainstream economic models (Figure 2-6). For instance, the customary use of dugongs and green turtles in the Torres Strait Indigenous dugong and green turtle fisheries is primarily supported by the state and the market sectors. These sectors contribute to the financial operation of the Indigenous fisheries by providing jobs, pensions and other sources of income which are used to buy fuel, oil and boats for fishing (and also for transport between islands) (see chapter 6). As such, the Torres Strait Indigenous dugong and green turtle fisheries primarily operate in synergy in segments four, six and seven (Figure 2-6) of Altman's hybrid economy model – although, arguably, some hunting could take place without boats and fuel, and purely for customary purposes, thus operating in segment two. However, on both case study communities of Mabuiag and St

Paul's, personal observations and informal discussions with hunters suggest that the hunting of dugongs and green turtles is nowadays exclusively done from boats rather than from platforms, as had been customary in the Western Islands. Drift hunting does occur but travel to the hunting site is always motor-powered.

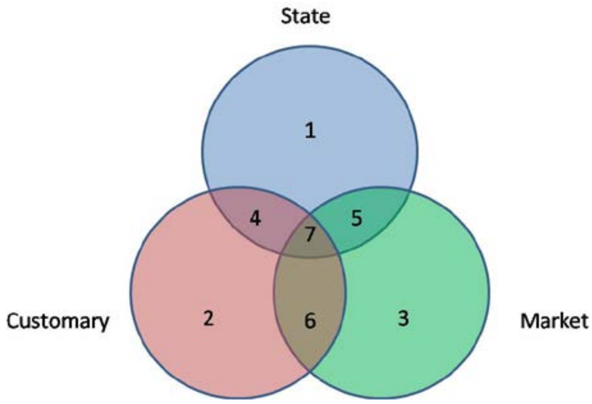


Figure 2-6. The hybrid economy model (from Altman (2005)) where numbers represent a specific combination from each sectors of the economy.

In summary, the people in the Torres Strait belong to an Indigenous group which exhibits traits of the "4th world" characterising a group of people living in a developed nation but displaying attributes that are usually common in developing countries. As described in the previous paragraphs, Torres Strait Islanders include a large number of young people, their socio-economic status is low, they face health and educational disadvantages, their employment opportunities are limited and they still rely on the harvest of wild resources for both culture and for livelihoods. Not only is the harvest of dugong and green turtles part of Torres Strait Islanders' customs but is also recognised as their traditional right.

2.4 Institutional dimension: rights regulating the human-nature interactions of the traditional fisheries

This notion of rights is of paramount importance when managing any complex social-ecological system. It is essential to understand the entitlements that have been established to regulate human-nature interactions. This section describes the different pieces of legislation that need to be considered when managing the Torres Strait Indigenous dugong and green turtles fisheries including: (1) the special political status of the Torres Strait, (2) specific environmental laws aiming to fulfil the international obligation of Australia in protecting the targeted species, (3) specific laws regarding the recognition and protection of Indigenous traditional rights, and (4) laws that are specific to the management of the fisheries.

2.4.1 Special political status of the Torres Strait

The Torres Strait region is not just an ecologically, socio-culturally distinct region of Australia but it is also politically distinct. The close proximity of the islands to Papua New Guinea (PNG) became a political debate after the independence of PNG in 1975 with Torres Strait Islanders arguing for remaining within the Australian territory (Watkin-Lui 2012). Although Torres Strait Islanders live in several distinct island clusters, their concentration in one distinct region and the recognition of a Torres Strait Islander identity made it easier for their leaders to argue for the special status of the region. On 1 July 1994, under the *Aboriginal and Torres Strait Islander Commission Act (1989)*, the Torres Strait Regional Authority (TSRA) was created as an independent Commonwealth government statutory authority. The TSRA was funded in recognition of the growing desires by Torres Strait Islanders to obtain increased autonomy to manage affairs pertaining to the region and its inhabitants. Under its mandate, the Authority aims to enhance the lifestyle and wellbeing of all Torres Strait Islanders and Aboriginal people living in the Torres Strait region by overseeing the protection of their cultural, economic, health, and environmental assets.

The proximity of the Torres Strait Islands to the Papua New Guinean mainland justified a specific collaborative arrangement between Australia and Papua New Guinea. In 1985, governments of both countries ratified the *Torres Strait Treaty (1985)*. The Treaty defines sovereignty and maritime boundaries in the area between the two countries and guides decision makers on the importance of: (1) protecting the way of life and livelihood of traditional inhabitants, (2) managing and protecting habitats, and (3) sharing commercial and traditional fisheries resources. The harvests of dugongs and green turtles are legally defined as fisheries under the Treaty.

2.4.2 A DICHOTOMY: PROTECTED SPECIES BUT LEGALLY HARVESTED

In Australia, both dugongs and turtles are protected under national and state laws, but Australian laws also recognise both species as harvestable resources for traditional purposes (Kwan *et al.* 2006). As a signatory of the *Convention on Biological Diversity*, Australia is legally bound to respect the rights of Indigenous peoples to use and manage biological resources on traditional territories, in accordance with traditional cultural practices (Ban *et al.* 2008; Green *et al.* 2005; Smyth 1997). The Indigenous right to hunt dugongs and green turtles is assured under section 211 of the *Native Title Act (1993)*. Moreover, the *Environment Protection and Biodiversity Conservation Act (1999)* dictates a legal role for Indigenous peoples in the conservation and ecologically sustainable use of Australia's biodiversity. The Act also calls for further cooperation with Indigenous people through a greater recognition of their traditional ecological knowledge. In addition, both

Australia and Papua New Guinea are legally required to protect hunting as part of the traditional way of life and livelihood of the traditional inhabitants under the *Torres Strait Treaty (1985)*; an international binding agreement (Kwan 2002).

2.4.3 MANAGEMENT FOR DUGONGS AND MARINE TURTLES

The interests of Indigenous Australians must be addressed when bilateral agreements, management plans, recovery plans, wildlife conservation plans or threat abatements plans are being developed, and when permits are issued to Indigenous Australians permitting them to take listed species[14]. To help achieve this goal, the Australian government released its “Sustainable Harvest of Marine Turtles and Dugongs in Australia - A National Partnership Approach” (DEH 2005). The “Partnership Approach” aimed: (1) to improve the information base available to Indigenous communities for managing the sustainable harvest of turtles and dugongs, (2) encourage respect for Indigenous and non-Indigenous knowledge and management, (3) improve education and awareness, (4) identify the economic, social and cultural factors that may contribute to unsustainable harvest levels and identify and implement measures to address them, and (5) protect sea country resources.

Numerous management arrangements for dugongs and green turtles are in place in the Torres Strait. Most importantly, the *Torres Strait Treaty (1985)* mandates that Australia and Papua New Guinea share the natural resources of the Torres Strait including dugongs and green turtles. The Treaty established the Torres Strait Protected Zone within which both nations manage access to fisheries resources. Each country exercises sovereign jurisdiction for the resources on either side of the agreed jurisdiction line. Fisheries and environmental

[14] Torres Strait Islanders do not require a permit to harvest dugongs and green turtles in Torres Strait.

legislations at both the federal and state level control various functions and decision making processes in the Australian jurisdiction (Havemann and Smith 2007). Similar legislation directs and guides decision making in the islands and sea under the jurisdiction of Papua New Guinea. The Treaty also aims to protect the traditional way of life and livelihood of traditional inhabitants of the region. The governments of both countries have established a Protected Zone (Figure 2-4). The Protected Zone is an area of the Torres Strait recognised by Australia and Papua New Guinea as needing special attention. The main reason for the Protected Zone is to enable Torres Strait Islanders and the coastal people of Papua New Guinea to carry on their traditional way of life. For example, traditional people from both countries may move freely (without passports or visas) for traditional activities in the Protected Zone (DFAT 2012).

The Australian government established the Protected Zone Joint Authority (PZJA) to manage the Protected Zone. The *Torres Strait Fisheries Act (1984)* ensures that the obligations of Australia under the Treaty are met and the objective of the Act "*is to give effect, in Australian law, to the fisheries elements of the Torres Strait Treaty*" (AFMA 2012). Through the *Torres Strait Fisheries Act (1984)*, dugongs and green turtles are considered as traditional fisheries in Torres Strait. Both species are referred as 'fish' for the purposes of Indigenous rights to harvest marine resources as agreed in the Act (Havemann and Smith 2007). The Torres Strait PZJA is in charge of overseeing the management of these traditional fisheries alongside the other commercial fisheries operating in the Protected Zone (Figure 2-7).

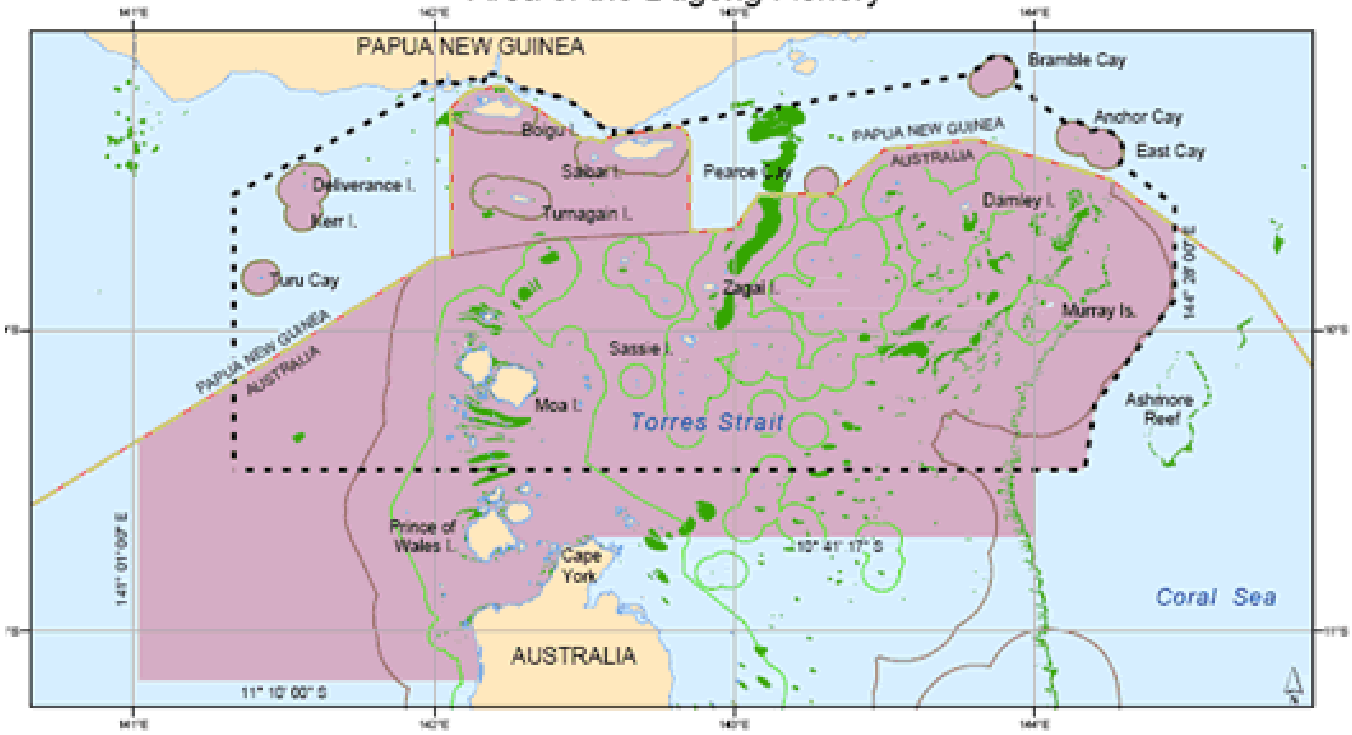
Members of the Protected Zone Joint Authority include the Commonwealth Minister for Agriculture, Fisheries and Forestry, the Queensland Minister for Primary Industries, Fisheries and Rural and Regional Queensland, and the Chair of the Torres Strait Regional

Authority (Cain 2004). Currently, the Protected Zone Joint Authority does not formally involve Torres Strait Islanders in the decision-making processes regarding the different fisheries, and their position is more advisory than a decision-making role. This consultative position is unsatisfactory to many Islanders who feel that their inputs in the management of the fisheries may not necessarily be translated into actions (Loban 2007).

The management arrangements for dugongs and marine turtles under the *Torres Strait Fisheries Act 1984* are as follows:

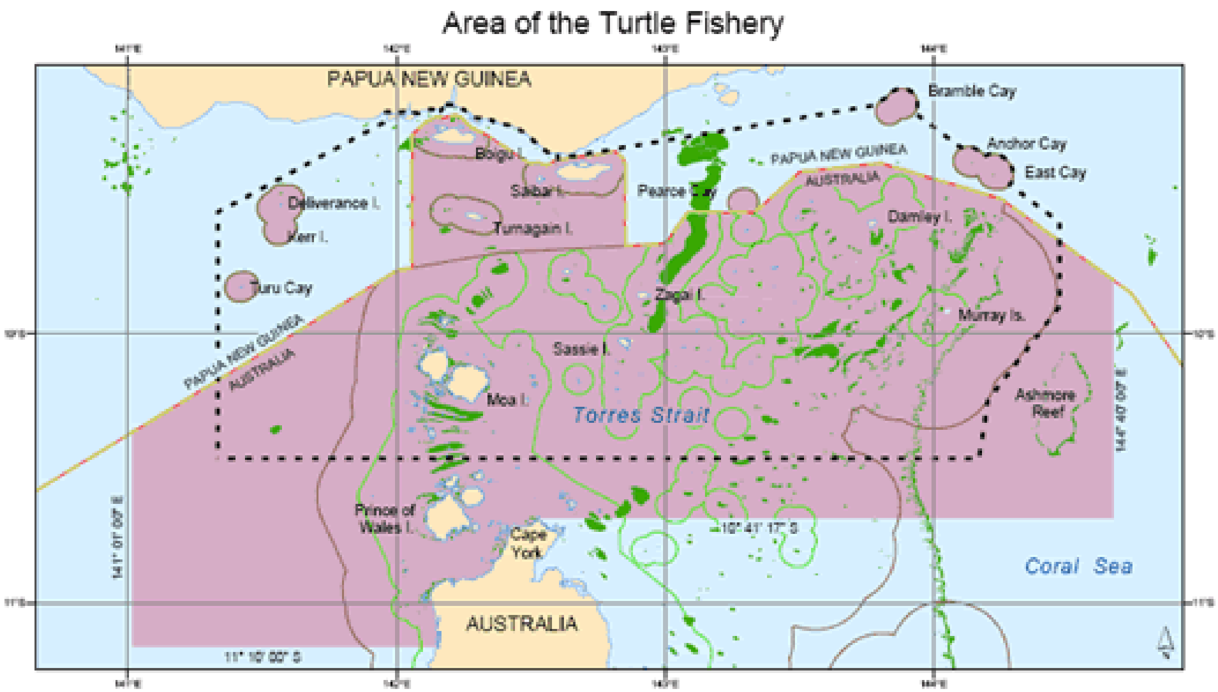
- Dugongs and turtles may only be taken by traditional inhabitants;
- Dugongs may only be taken using the traditional spear (wap);
- Dugong hunting is prohibited in the dugong sanctuary, a large area of western Torres Strait;
- Dugongs and marine turtles cannot be taken or carried in a commercially licensed fishing vessel greater than 6m in length;
- Dugongs and marine turtles caught cannot be sold.

Area of the Dugong Fishery



Coastal Waters Limit (3nm)
Exclusive Economic Zone (200nm)
Fisheries Jurisdiction Line
Protected Zone Boundary
Territorial Sea Limit (16nm)
Low tide elevation and reefs
Torres Strait Fisheries
Dugong Fishery

1. The area of the Fishery is sourced from the Torres Strait Fisheries Regulations 1986.
2. Within this Fishery, arrangements exist between the Commonwealth and QLD, whereby the Coastal Waters of that State are deemed part of the AFZ.
3. The Fisheries Jurisdiction Line and Protected Zone shown on this map are established under the Treaty between Australia and the independent state of Papua New Guinea. This Treaty entered in to force on 18 February 1985.
4. The maritime zone boundaries shown on this map are sourced from the Australian Maritime Boundaries (AMB) v.2.0 .



___ Coastal Waters Limit (3nm)
___ Exclusive Economic Zone (200nm)
___ Fisheries Jurisdiction Line
_ _ Protected Zone Boundary
___ Territorial Sea Limit (16nm)
Low tide elevation and reefs
Torres Strait Fisheries
Turtle Fishery

1. The area of the Fishery is sourced from the Torres Strait Fisheries Regulations 1986.
2. Within this Fishery, arrangements exist between the Commonwealth and QLD, whereby the Coastal Waters of that State are deemed part of the AFZ.
3. The Fisheries Jurisdiction Line and Protected Zone shown on this map are established under the Treaty between Australia and the independent state of Papua New Guinea. This Treaty entered in to force on 18 February 1985.
4. The maritime zone boundaries shown on this map are sourced from the Australian Maritime Boundaries (AMB) v.2.0 .

Figure 2-7. Maps of the area of: a) the Torres Strait dugong fishery and b) the Torres Strait marine turtle fishery. The area of each fishery is shown in pink. Note the marine turtle fishery extends further to the east than the dugong fishery as turtles are caught in all areas of the Torres Strait while dugongs are mainly harvested in the western region. The boundary of the Torres Strait Protected Zone is the dotted line. Both maps were produced by Geoscience Australia for the Australian Fisheries Management Authority, August 2006 and adapted for clarity.

2.4.4 Specific co-management arrangements for dugong and green turtles in the Torres Strait

The Australian government has invested in developing co-management arrangements for dugongs and green turtles in Torres Strait. This focus is warranted due to the importance of the Torres Strait regions to both species (Limpus *et al.* 2003; Marsh *et al.* 2011) but also because Torres Strait Islanders have long been involved in the traditional hunting of both dugongs and green turtles (Crouch *et al.* 2007). In 2006, as one of the five regions concerned with the Dugong and Marine Turtle Project coordinated by North Australian Indigenous Land and Sea Alliance (NAILSMA), the Torres Strait Regional Authority received partial funding to develop community-based dugong and turtle management plans. The funding was used to employ Dugong and Turtle project officers in eight pilot communities. With the assistance of personnel from the Torres Strait Regional Authority Land and Sea Management Unit, eight project officers assisted communities to draft their respective dugong and turtle community-based management plans through a significant community consultation process in 2008. The Torres Strait Regional Authority was later successful in securing additional funding to continue with the development of co-management arrangements and to oversee their implementation on the ground through the creation of a Sea Ranger program. As of 2011, 15 community-based dugong and turtle management plans have been released. The plans had to be approved by the relevant Traditional Owners and when finalised were provided to the PZJA and passed through the Bilateral Treaty process with Papua New Guinea. The implementation of the specific measures available in those plans started in 2008 through the Sea Ranger program. Sea Rangers were first employed in the eight pilot communities which participated in the Dugong and Turtle Project coordinated by NAILSMA. The implementation of the additional seven plans released early 2011 started that year. The plans are reviewed each year to assess how the agreed activities are implemented on the ground. Each community has agreed to a specific set of measures that may not be identical to the measures applied in other communities. Importantly, each plan is not legislated and compliance is thus on a voluntary basis (Loban 2012).

2.5 Chapter summary

- The case study presented in this thesis focuses on the traditional dugong and green turtle fisheries.
- Australia has significant dugong and green turtle populations and has international and national obligations to protect them. The Torres Strait is an important region for the global survival of both species.
- Torres Strait Islanders are at a financial disadvantage compared with non-Indigenous residents of the Australian mainland. As such, the customary use of marine species including dugongs and green turtles can provide an avenue to supplement their incomes.
- Strong Indigenous rights have been established to allow Torres Strait Islanders to hunt (fish) dugong and green turtles and to include them in any decisions involving the management of the traditional fisheries.
- The catch of these animals cannot be legally sold under Australian legislation.
- Managers have both the time and responsibility to incorporate Indigenous points of view into the management of the traditional dugong and green turtle fisheries.

CHAPTER 3:

GENERAL METHODS

In Chapter 3, I describe the specific requirements for undertaking research involving Indigenous Australians in Torres Strait. I provide an introduction to the general field set-up, outline the methodology I developed to conduct my research with two Torres Strait Island communities and explain my main data collection methods. The use and analysis of these data to answer specific research questions are clarified in the subsequent data chapters (4, 5 and 6).

3. Methodological approach

3.1 The research process

As explained in chapter 1, the principal aim of this study was to provide an economic understanding of the different factors (social, cultural and financial) that influence the traditional hunting of dugongs and green turtles in the Torres Strait.

Although Western research has taken place in Torres Strait for more than a hundred years, information has always been collected sporadically, on a number of topics without much regard for integration or continuity. Apart from the socio-economic information collected every five years through the national Census, data relevant to the Indigenous dugong and green turtle fisheries are scattered among different reports that have been commissioned by different governments and agencies over the years. Furthermore, most reports published by the various governments so far have either considered the ecological aspect or the financial aspect of the activity, rather than its broad economic aspect (see Table 1-1). As such, I couldn’t use existing secondary data for this research.

The synergy that exists between the socio-economic conditions of the local stakeholders and their cultural priorities has yet to be investigated. As discussed previously, economic data that could be used to inform management and/or to build bio-economic models is all but non-existent (see section 1.4.3). Due to this paucity of data relevant to my research, it was necessary for me to collect primary data on the subject.

The context in which this study takes place influenced my primary data collection methods. The research occurred in a primarily Indigenous region where community members have low literacy rates and where the culture is different from that of a "Western" society. As a result, the standard means of collecting data in a western society (i.e., mail out surveys, phone interviews, internet surveys…) was unlikely to work. Moreover, I could not assume that economic information relevant to fisheries operating in a "western" context could be used to draw inferences about the Torres Strait Indigenous dugong and green turtle fisheries. Hence the need for me to undertake a detailed study using innovative techniques.

Before discussing the methods used, I detail the approach that underpins how those tools were applied and how the research was conducted in more general terms.

3.1.1 ADAPTIVE RESEARCH

During a course on cross-cultural awareness (for researchers planning to work with Indigenous communities (section 3.2.2)), I learned that when undertaking community-based research in a cross-cultural setting; it is important that the researcher understands that most knowledge is context and place specific. A researcher thus requires an understanding of cultural discourses, social relationships, and the broader historical, political and economic contexts within which he/she is planning to collect and discuss data (Hammersley and Atkinson 2005). To be reflexive in this way requires the researcher to engage with the culture of his/her informants.

Therefore, I lived with local families for extended periods of time, participating in daily activities, and sharing experiences on a regular basis that allowed me to experience and understand the interplay of cultural ideas and perspectives. By doing this, the intentions and objectives of both myself (the researcher) and informants (the community) were combined to determine the content of the knowledge produced.

3.1.2 THE CASE STUDY APPROACH

In order to provide the level of detail necessary to fulfil my research objectives (see section 1.8) I needed to undertake an in-depth analysis of hunting from a community's point of view. Such depth was impossible to achieve in 17 communities for logistical reasons. A case study approach was thus deemed appropriate. This approach would enable me to study in the detailed contextual conditions that frame each community under investigation. The case study approach enabled me to gather both quantitative and qualitative information while at the same time be granted access to multiple sources of data, and benefit from the prior development of theoretical propositions (Berg 2007; Yin 2003).

Smith (2006) argued that case studies: *"acquire theoretical importance through three dialogues: between the researchers and informants; between the local dynamics of the subject under study and the larger structures within which it is embedded; and between analysis of the case and theory"*. "*Case studies allow a deep understanding of phenomenon, events, people, or organization which allows the researcher to make sense of the way societies under investigation respond to a particular stimulus*" (Weick 1995). As such, the case studies provided the data necessary for a deeper understanding of the current system operating in the Torres Strait and a way to investigate perceived changes that could occur in the system following management actions targeting the traditional dugong and turtle fisheries.

Case studies have their limitations, however. Many criticisms argue that case studies cannot be used to generate general conclusions as they might be unrepresentative (Smith 2006). Although those limitations need to be kept in mind by researchers, Smith (2006) also mentioned that such a view presented "*a lack of knowledge of how cases do their analytical* *work and the preoccupation of positive science with representativeness to the exclusion of other dimensions of analysis*".

To improve insight into the role played by Indigenous hunting in the social and economic realms of the wider Torres Strait, I knew that more than one study community would be needed. My research was thus based on two in-depth community case studies. While Indigenous communities in the study region are governed under the same system, previous works highlight that there is notable variation across communities in the rules governing village life, enforcement of those rules, territorial resources, population, and levels of social capital and social organisation (Beckett 1987). By looking at more than one community, I was able to gain a more comprehensive understanding of the issues, and thereby improve my ability to theorise about a broader context than would have been possible through the use of a single case. As Yin (2003) argued, I hoped to provide research findings that are "*considered more compelling and… more robust*".

3.1.3 SELECTION OF STUDY COMMUNITIES

Originally I planned to select study communities from a broad geographical range in the Torres Strait by involving communities from different island groups (Figure 2-4). In October 2008, I participated in a dugong management workshop held on Thursday Island with representatives from each island communities. I used this opportunity to present my proposed project and start discussion with communities which showed interest in being involved in such a study. As a result, four communities expressed an interest in this project, including Boigu Island from the Top Western Islands, Mabuiag Island and St Paul's community from the Western Islands and Mer Island from the Eastern Islands. The aim was to subsequently start discussions with each of these communities to determine the level of support for the project on the ground. It is important to note that the level of hunting dugongs and green turtles is not uniformly practiced across Torres Strait (AFMA 2006). As such, the choice to work with communities which harvest both species eliminated communities from the Eastern Torres Strait where the habitat is not as suitable for dugong population (AFMA 2006).

However, the only airline operating services between the outer islands in Torres Strait was grounded for six months from mid-October 2008. This grounding made it impossible both financially and logistically to involve communities that were located far apart and/or difficult to reach without airline support. When a new airline started operating in April 2009, Mabuiag and St Paul's were selected due to: (1) the community interest in the project and (2) their facility of access by dinghy[15].

Fieldwork began in May 2009 and ended in December 2010. I spent a total of nine months living within the communities.

3.1.4 Study sites

This study was conducted on two island communities: Mabuiag Island and St Paul's community on the eastern side of Moa Island (Figure 3-1 and Figure 3.2). The two study communities were chosen for several reasons, over and above the logistical issues discussed in the previous section:

(1) They are of similar size;

[15] Dinghies are small aluminium boats of approximately 4.5m to 6m in length and are used as the main mode of transport by Islanders in the Torres Strait. I used this mean of transport on several occasions to reach one or both of the study communities involved in this project. The crossing from the inner island groups where the main airport is located to St Paul's takes 2 to 2.5 hours on average by dinghy. From St Paul's, it usually takes 1.5 hours to arrive at Mabuiag Island.

(2) They are both involved in the management of dugongs and green turtles;

(3) Both communities were involved in the natural resource management pilot project overseen by NAILSMA in 2006 (see section 2.4.4);

(4) One dugong and turtle project officer was employed on each island to undertake community consultation to subsequently draft an island-specific community-based management plan. Both of these plans were released in the early part of 2008 after which funding was secured by TSRA to hire community sea rangers whose role it was to implement their island-specific management plan on the ground.

The sea ranger program was officially launched on both islands on different dates:

- On Mabuiag Island, a community run sea ranger program began in early 2009 (this coincided with the beginning of the data collection phase of my research project). A total of three local community rangers were employed, including one senior ranger.
- On Moa Island (where St Paul's is situated), the sea ranger program was implemented once a senior sea ranger was hired on St Paul's in September 2010. However, the sea ranger unit on Moa Island only became fully operational in December 2010 when local community rangers from both communities on Moa Island (St Paul's and Kubin) were appointed. The start of the community sea ranger program on Moa Island coincided with the end of my data collection phase.

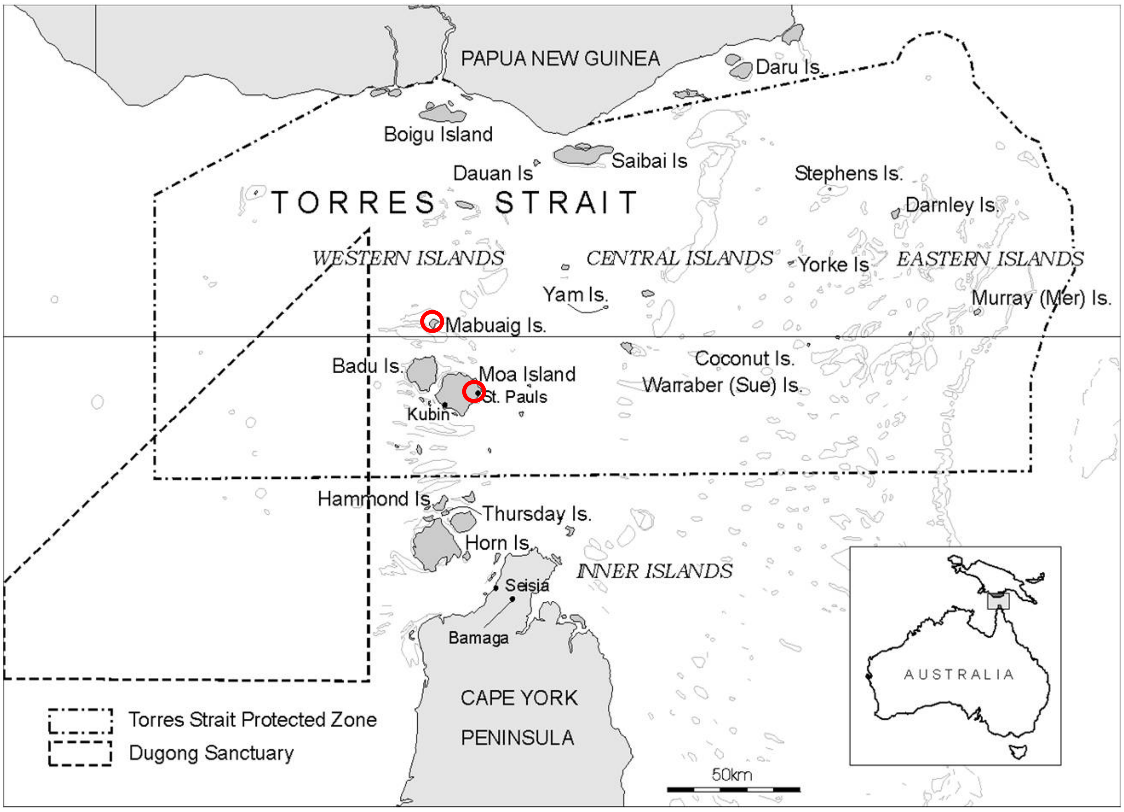


Figure 3-1. Location of the two case study communities within the Torres Strait Region, Mabuiag and St Paul's. The map shows the Torres Strait Protected Zone established by the Treaty between Australia and Papua New Guinea and the Dugong Sanctuary, an area closed to dugong hunting established under fisheries regulations (source Kwan *et al*. 2006).

Figure 3-2. Picture of Mabuiag Island taken from the hill and showing the bitumen roads, local houses as well as the island council located in the centre of the picture.

The two islands can be reached either by dinghy (2.5 hours Horn Island to St Paul's and 1 hour extra to reach Mabuiag one-way) or by small plane departing from Horn Island airport. St Paul's does not have an airstrip and people traveling to the community can land on Kubin which is a 30 minutes-ride by car from St Paul's.

As described in section 2.3.1., archaeological evidence suggests that the Torres Strait region was inhabited 8000 – 6000 years before present (BP) at the time when most of the islands were still attached to the Australian mainland (David *et al.* 2004). Occasional visits to the Western Island group (Figure 2-4) from Cape York Peninsula is evident from 6000 to 3500 BP while evidence of permanent occupation of the current islands started 3500 years BP (David *et al.* 2004). Based on the study of Torres Strait Islander language, linguists have hypothesised that Mabuiag was settled after Boigu and Saibai in the north from men who "*settled in Mabuiag after taking women from Boigu and Saibai"* (Lawrence and Lawrence 2004). There is no clear evidence on the precise time of Mabuiag occupation but a dugong bone mould found on Mabuiag and dating from 4 000 years ago (Crouch *et al*. 2007) suggest that human settlement on Mabuiag could be dated as far back. On the other hand, permanent settlement on St Paul's is fairly recent. Discussions with an elder woman living on St Paul's described St Paul's was funded after the Queensland government decided to resettle Pacific Islander labourers who had married into Torres Strait Islander families. The settlement was also inhabited by former Mabuiag residents after a family dispute over the land. As such, community members living on St Paul's are not the Traditional Owners of Moa Island.

Although the two communities have not been settled for the same period of time, they are both socially cohesive through the strong networks of families and the permanence of rituals and ceremonies which serve to strengthen community ties (Beckett 1987).

As mentioned previously, both communities are of similar size. During my field work, bitumen roads in both Mabuiag and St Paul's were built or extended to replace existing dirt roads. Although Mabuiag is a small island, the use of cars is prevalent and the concrete roads were patiently awaited (A. Delisle, pers. obs.).

Through my experience living in the two communities, life on the two islands is centred around the opening of the local shop, school and island council. The local shop and city council provide services for residents but also a place to meet at the centre of the island to talk with family and friends which help give this "community feeling" to both places. People who are working at the school, island council, or shop usually work from 8am to 4pm.

Most people living on the island are employed through the CDEP program. If they are not working on a specific week, men and women spend their time doing things around the house, spending their time with one another, visiting family and friends in another island or fishing. In the evening, according to the weather and tide conditions, people will go to the beach to fish or glen from the sea shore. On weekends, residents take the opportunity to go fishing and to meet with their family and friends. On Sunday, the morning usually starts with a mass service at the local church and is followed by time with family and friends.

Throughout the years, many occasions are used to celebrate special events in the Torres Strait calendar and to come together as a community to celebrate special occasions such as birth, birthdays, funerals, tombstone openings…which give the occasions to spend time with family members who do not reside on the island but also help strengthen community cohesion.

3.1.5 Prior involvement of each community with researchers

An important part of the research process was to build trust between the community members and myself. Trust depends on several factors including prior involvement with researchers, external perceptions and media. The prior involvement of stakeholders with researchers can have both advantages and disadvantages. Stakeholders previously engaged with researchers may better understand the requirements behind a research process, while others who do not have a history of working with researchers may hold misconceptions and mistrust towards research activities. However, the positive or negative past experience of working with researchers can also influence the opinion of stakeholders.

Mabuiag and St Paul's communities have had different experiences of research and researchers. Mabuiag Island has been actively involved with researchers since Haddon's expedition in the late 19th century (Haddon 1890, 1912, 1935). More recently, Nietschmann stayed for over a year on Mabuiag to study the traditional use of marine resources in the late 1970s-early 1980s, Kwan studied the dugong catch at the end of the 1990s while McNiven and his anthropologist team have participated in archaeological excavations in the early 2000s. In contrast, St Paul's community has rarely been involved with researchers interested in hunting apart from government monitors who periodically visited each of the island communities in the Torres Strait to collect data on their dugong and turtle catch in 2000 and 2001 (AFMA 2006).

There were advantages to working in a community such as Mabuiag which had already experienced being part of a research project, as key members on the island understood the research process. Some of the Mabuiag residents also remembered Donna Kwan who worked and lived on the island in the late 1990s and for the most part had positive memories associated with her research.

On the other hand, it took nine months for members of St Paul's community to agree to participate in my research due to misconceptions and questions about the research process, which had to be dealt with on a case-by-case basis. Nevertheless, there were also benefits in engaging with a community such as St Paul's with little prior experience in research. Questions asked by local residents about the research project helped me to better define my work and to communicate to a wider audience. The involvement of a community such as St Paul's also helped in the dissemination of potential research benefits to a larger number of islands located in the Torres Strait by involving different communities in research projects instead of only a few of them. Such participation fulfils one of the goals of the Torres Strait Regional Authority which advocates research taking place in different communities to: (1) spread research benefits over the Torres Strait region and (2) to relieve the possible burden of "over-research" occurring in a limited number of communities.

As stated above, the early establishment of trust between researcher and participating stakeholders is a vital pre-requisite of a positive human dimensions' research. Many Indigenous communities are wary of unequal power relationships and a lack of control over the research process. Most Indigenous people know of cases where Indigenous peoples have been the subjects of research without being adequately consulted (Gibbs 2001; Tuhiwai Smith 1999). I put a lot of effort into developing relationships and building trust with participants, and encouraged them to voice any concerns they had about my research (Howitt and Stevens 2005).

However, external pressure can easily harm this professional relationship. For example, media reports specifically discussing the issue of Indigenous hunting were followed by periods of concern towards the use of my research from some residents of both study communities. I avoided speaking to journalists throughout my research and made a point of discussing potential concerns arising from media attention as soon as they arose.

A particular incident on Mabuiag Island illustrates how media attention can hinder research efforts. In September 2009, a French-speaking TV crew from La Réunion spent a few days on Mabuiag Island filming a documentary on the way of life of its inhabitants. I was not present on the island during that time. When I visited the island a month later for one of my field trips, several members of the communities were obviously concerned about my presence. Mabuiag residents were evidently angry about the behaviour of the TV crew who had recently left. Some residents associated me with the TV crew as I am French and they believed that the presence of the film crew was a result of my involvement. I had to reassure people that I had no association with the documentary crew. I helped community representatives in their attempt to communicate with members of the crew regarding the footage they had obtained without prior permission. I also received support from members of the community, thanks to the relationships I had established through my previous visits on the island.

3.2 Community engagement

3.2.1 Rules of community engagement

Several steps are required to undertake any research in the Torres Strait Islands. First ethics permission for this project was obtained in September 2008 from the JCU Human Ethics Committee prior to commencing data collection (Ethics permit number: H3085). Second, the Torres Strait Regional Authority has developed its own set of protocols for research to be undertaken in Torres Strait, so I was required to provide detailed information on the project following the TSRA protocols. This information was then passed on to nominated communities in the Torres Strait region for their approval. These requirements were fulfilled in October 2008.

Once the project was approved, the two nominated communities of Mabuiag and St Paul's reiterated their interest through their dugong and turtle project officer. I then sought authorisation to visit both communities from the Prescribed Body Corporate (PBC) Chair of each community (Appendix A). The PBC is a native title corporation that may hold and/or manage native title for the whole native title[16] holders group (NNTT 2006) on each island. Permission to work on Mabuiag Island was obtained from the local PBC Chair in March 2009. Approval to work at St Paul's community was eventually granted in July 2009. The approval process for St Paul's was more complicated as the native title holders who decide if the research is to be authorised do not reside at St Paul's but at Kubin, another community on the other side of Moa Island. At the time, the community of Kubin did not want to be involved in the management of turtles and dugongs, a possible explanation for the delayed approval. Following approval from the respective PBCs of the two communities', I started my research on the ground with the only condition that the Councillor and Island Manager of each community were informed before each visit.

3.2.2 Cultural awareness

As part of my ethics approval, I was required by the James Cook University Human Ethics Committee to undertake a cultural awareness program. I participated in two cultural awareness workshops organised by the School of Australian Indigenous Studies at James Cook University prior to visiting the islands and starting my data collection. Those workshops are specifically designed for researchers aiming to carry out research involving Indigenous Australians and aim to emphasise appropriate and culturally-sensitive ways of conducting research in Indigenous communities.

Development of my research protocols was also informed by several documents and guidelines for working with and conducting research about Aboriginal and Torres Strait Islander people, including protocols developed by the Queensland Department of Aboriginal

[16] As described in section 1.5, native title is "the recognition by Australian law that some Indigenous people have rights and interests to their land that come from their traditional laws and customs".

and Torres Strait Islander policy (QDATSIP 1999), and the principles of research negotiation developed by the Australian Institute for Aboriginal and Torres Strait Islander Studies (AIATSIS 2000).

3.2.3 VISITING THE STUDY COMMUNITIES

3.2.3.1 Introductory trips

After all the requirements for undertaking research on the study communities were met, I went to each island on an introductory trip. The purpose of this visit was to introduce myself and the project to community members (Appendix B). These visits were conducted over three days in May 2009 on Mabuiag Island and July 2009 at St Paul's. During these introductory trips, I clarified the research process and possible outcomes to the communities and became familiar with the key community representatives chosen to be my main points of contact throughout this study. We also had a question and answer session, and made sure that everyone was happy with the project before proceeding.

3.2.3.2 Cultural protocols for each visit

During every visit to Mabuiag and St Paul's, two meetings were organised with key community representatives. Those meetings provided the opportunity to test some of my methodologies, pilot diverse data collection methods, and discuss the progress of the research. On arrival at the island, a meeting was organised with the key community representatives previously selected by community members. On Mabuiag, three key representatives were selected; namely the PBC Chair, the Councillor of Mabuiag and the Island manager. During the course of the study, there was a change in the position of Island manager but the new appointee was happy to be involved in the project and took part in the different research meetings. At St Paul's, the community decided to appoint six people to act as a research committee. This panel comprised men and women, hunters and elders.

These meetings provided me with the opportunity to summarise the progress of the project and explain the methods to be used during each visit. For example, semi-structured interviews or questionnaires were tested during the course of one of these meetings to ensure clarity of the questions, to explain the rationale behind the methods and/or also to field questions as well as to ensure that questions were culturally appropriate. This step was crucial to giving members of each community a sense of involvement throughout the research process.

At the end of each visit, another meeting was organised with community representatives to discuss the ongoing data collection, provide information about any issues that arose during the visit and talk about the way forward.

3.2.3.3 Getting accepted in the study communities

Community participation in this project was very important. I lived within the communities. I also participated in a range of activities on both islands to get to know people and to show them that I was not coming to observe from a distance. I organised different activities with school children and participated in school presentations. I helped women on the islands organising community events such as local rugby games. I helped community residents with their computing skills on a case-by-case basis.

An important aspect of community life on the islands of the Torres Strait is sharing. From my first visit onwards, I tried to share experiences of my way of life in my own country and share some of my skills. When being introduced to a new person, it is important for a Torres Strait Islander to understand where this new individual comes from. In the case of another Islander, it involves the sharing of the name, the island of origin and one's kinship. In my case, I shared pictures of my family, my hometown and of different activities my family and I like to participate in back home. I also carried pictures of my uncle who likes hunting. Those pictures and stories about my way of life back in France helped community members "place me" and relate to me.

During each visit, I also baked chocolate cakes that I brought to the local community hall for everyone to share. The sharing of these cakes soon became an important feature of my visits on each island. These occasions provided an avenue for residents to gather in one place, start talking to me and get to know me better.

Through my participation in the life of the inhabitants of Mabuiag and St Paul's, I developed strong friendships with a number of residents. I was invited to stay and live with a family on each island. On Mabuiag Island, I was invited to call my host "Aunty" as a mark of affection. On St Paul's, I later received the nickname of "white daughter" and have been invited to share important family events such as tombstone openings and weddings. Members of both communities were from the start incredibly welcoming, and treated me with immense kindness.

3.3 Data collection

As is evident from the foregoing discussion, I built trust between myself and the residents of Mabuiag and St Paul's. This trust allowed me to collect the information necessary for my research.

My practices in the field were thus guided and informed by local expectations, while many of the methods I adopted were shaped through interactions with local people and their institutions, rather than being preconceived. This methodological process ties to what Nelson (1991) calls an “interactive, adaptive” approach, where a better understanding of the local context improves use of the methodological toolbox. It is an approach that helps the researcher deal with the varied, rich and challenging world in which they work, and helps determine how best a certain method may be used, as well as steer the researcher away from relying on fixed, preconceived notions and expectations. The “interactive” component involves working with local actors to supplement knowledge and improve the design of research methods, while the “adaptive” involves the constant scoping of the research context in order to respond, and make any necessary changes to the theory and methods guiding the work.

3.4 Overview of data collected

To address the objectives and sub-objectives of the research listed in chapter 1, I collected data from Mabuiag and St Paul’s communities, between May 2009 and December 2010 over the course of eight field trips of two to three weeks each on both islands. The data I collected provided information on:

(1) The socio-economic characteristics of the community households and individual community members, including hunters living in the two case study communities;

(2) Household expenditures;

(3) Food prices at the local community shop of each island;

(4) The hunting effort, hunting period, hunting methods, and number of animals by species taken by village hunters;

(5) The characteristics of the harvest, including its fate (eaten at home, at ceremonies etc…), and its destination (community, other island, mainland);

(6) The reasons for sharing dugong and green turtle meat with people living outside the two case study communities;

(7) The costs and benefits (market and non-market) of traditional dugong and green turtle fishing as perceived by individual community members residing in the two case study communities;

(8) The perceived impacts of different management tools proposed to manage the Torres Strait traditional dugong and green turtle fisheries.

3.4.1 Description of methods

According to Winchester (2000), qualitative research is "*concerned with elucidating human environments and human experiences within a variety of conceptual frameworks*". Qualitative methods include case studies, participant observation, face to face interviews, focus groups and interpretive analysis. In contrast, quantitative research seeks to make "*valid and objective description of phenomena to discover principles and laws which can be generated to the larger population*" (Winchester 2000) and often includes methods such as surveys, statistical tests and controlled experiments. Many researchers consider the apparent dichotomy between qualitative and quantitative research approaches to be artificial (Bryman 2001; Tashakkori and Teddlie 2003). A new approach - termed "mixed methods" - was originally an outgrowth of the triangulation of methods movement. The main goal of triangulation is to confirm a study's results by using both qualitative and quantitative methods. A mixed method approach now goes beyond the initial purposes of triangulation (confirmation of results), and is used to gain a better understanding (comprehension) of results, discover new perspectives, or develop new measurement tools (Creswell and Plano Clark 2007).

Qualitative methods based on the use of open-ended questions and in-depth exploration are especially effective in the initial stages of measurement development (Krause 2002). By encouraging people to talk freely, researchers can identify the dimensions most relevant to the people for whom they are developing the measure. In addition, the words and phrases evoked during a free conversation can be used later in the construction of closed-ended items (Krause 2002).

Morgan (1998) developed a framework of complementary qualitative and quantitative methods. According to this framework, qualitative approaches can precede or follow quantitative approaches. When qualitative methods are used first, they can illuminate the domains to be quantified. When qualitative methods follow quantitative methods, they can help explain the quantitative findings. Hence it is important to consider the nature of the information required before deciding whether quantitative or qualitative approaches should be used first.

Recognising the strength of both qualitative and quantitative approaches, this research project thus used both approaches to answer the questions posed by this thesis. These are summarised in subsequent sections where I describe the specific data collection methods and their relationship to particular research objectives in more detail (Table 3-1).

Table 3-1. Summary of methodological approaches used in this research.

Data collected	Method	Data coverage	Chapter
Contextual information and cultural insight	Participant observation - A total of 9 months living in the two case study communities	Whole of community	Throughout thesis
Demographics and economic characteristics of community household	Household questionnaire	Almost 50% of Indigenous households were surveyed on both islands	Chapters 4, 5 and 6
Socio-economic context (unavailable from secondary sources)	Household questionnaire on expenditures	Almost 50% of Indigenous households were surveyed on St Paul's	Chapter 4
	Survey of food prices at the local shops and on the mainland	All items of both island shops and identical items from a shop in a regional Queensland population centre were surveyed.	Chapter 4
Hunting and sharing characteristics	Household hunting questionnaire	Almost 50% of Indigenous households were surveyed on both islands	Chapters 4 and 5
	Semi-structured individual interviews	Almost 50% of Indigenous households were surveyed on both islands and 13 Torres Islanders living on the mainland while visiting their families in the communities	Chapters 4 and 5
Values associated with Indigenous hunting	Semi-structured individual interviews Cognitive mapping via one-on-one interviews Ranking and rating exercises via one-on-one interviews	40% of the adult Indigenous population of both islands	Chapter 5
Perceptions on the costs and benefits of hunting management strategies	Semi-structured individual interviews Rating exercises via one-on-one interviews	40% of the adult Indigenous population of both islands	Chapter 6

3.4.2 Specific research methods

3.4.2.1 Participant observation

Participant observation goes hand in hand with an interactive, adaptive approach (Winchester 2000). DeWalt and DeWalt (2002) defined participant observation as a "*research method that aims to gain a close and intimate familiarity with a given group of individuals and their practices through an intensive involvement with people in their natural environment*". In the context of my work, this involved talking to people, watching what they did and taking part in their everyday activities – achieved through living with Torres Strait Islander families on each island. I used participant observation wherever possible as a means of gaining contextual information and cultural insights (Bernard and Ryan 2010; DeWalt and DeWalt 2002), especially a clearer understanding of the broad cultural context within which the research was being carried out. In addition, participant observation helped me identify potential informants with whom to collaborate. This process required me to spend a considerable amount of time in the field, and using everyday conversation as a technique to record general observations, with informal, unstructured interviewing the method of choice (Bernard and Ryan 2010). As part of an interactive, adaptive approach, participant observation helped me continually reassess my research strategy, including the development of new approaches in response to new insights.

3.4.2.2 Socio-economic characteristics of the two case study communities

In addition to the contextual and cultural insights provided by participant observation, I collected primary information on the socio-economic conditions characterising life in the two case study communities. These quantitative data collected through a preliminary household census, household expenditure survey and shop survey also helped me contextualise and discuss the results of my subsequent research activities.

3.4.2.2.1 Household census

A preliminary household census was completed in my first weeks of fieldwork in each community. This census helped identify the households that were interested in taking part in the research project. Only data provided by participating households was collated for the purpose of this research. The data collected for each household is outlined in Table 3-1, and data collection sheets can be found in Appendix D. The households identified as willing to participate were then subsequently interviewed on several occasions throughout the data collection phase. Participating households covered almost 50% of the total number of households on both Mabuiag and St Paul’s. The data collected during the household census aimed to ensure that the participating households constituted a representative sample of households on both islands.

A total of 20 and 27 households were surveyed in Mabuiag and St Paul’s respectively; covering 108 people in Mabuiag and 93 people on St Paul’s. The demographic composition of the sampled households was analysed and compared with the secondary socio-demographic data available from the Australian Bureau of Statistics to enable me to evaluate the representativeness of my sample (Figure 3-3a and b). One sample z-tests for population proportion were used to compare the sample characteristics with data from the 2006 Census (ABS 2006d, e). There were no statistical differences between the household composition of the sampled population and the socio-demographic data from the 2006 Census.

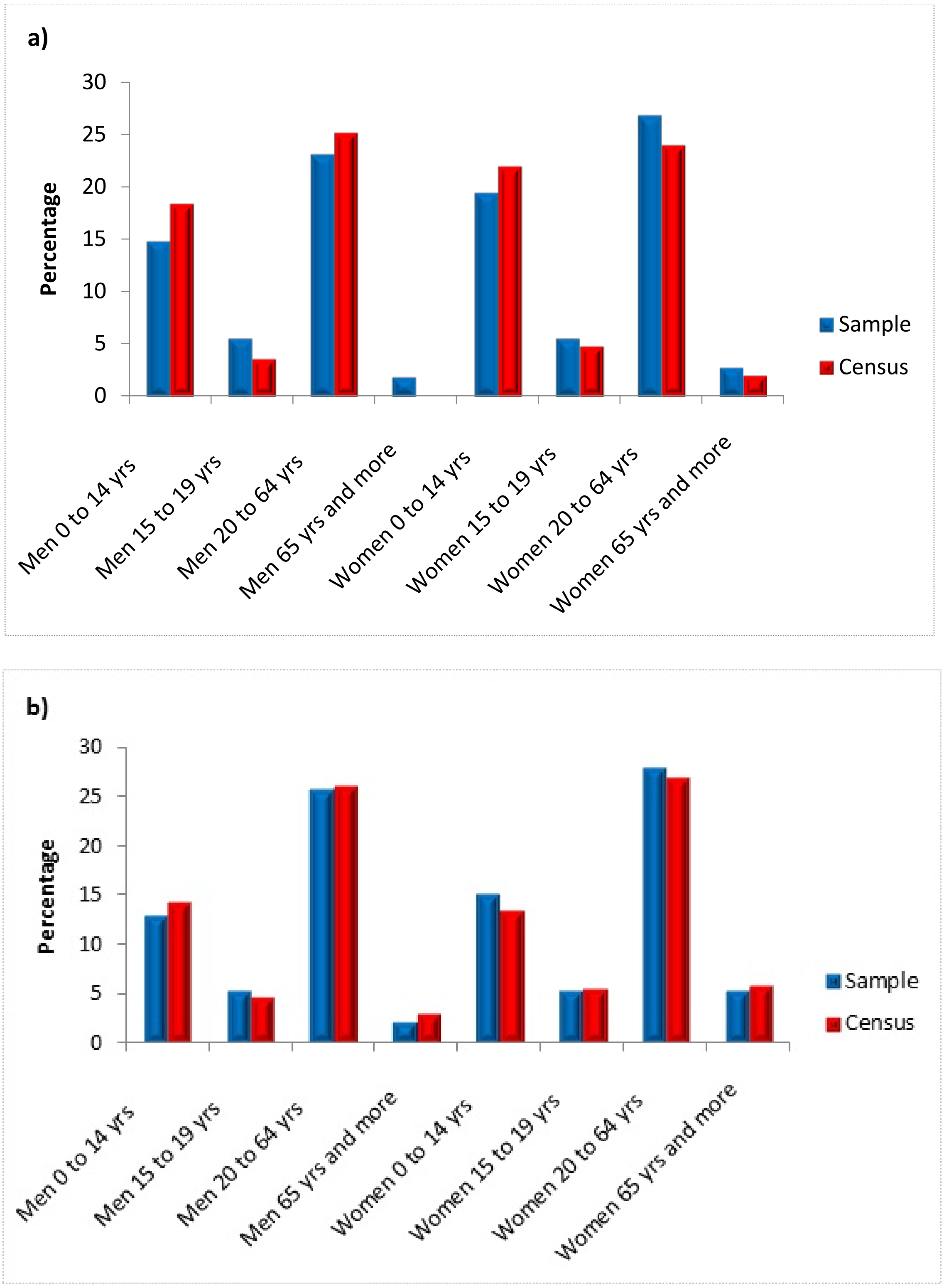


Figure 3-3. Household composition of: a) Mabuiag Island and b) St Paul's communities by age and by gender based on my study sample compared with the ABS 2006 Census.

3.4.2.2.2 Household expenditure survey and shop survey

The secondary data provided by the 2006 Census showed that Mabuiag and St Paul's have young populations, face financial disadvantages and low job prospects (see section 4.2.1.1). However, this secondary data did not provide sufficient information on the conditions of life on those islands. The statistics only gave a picture about the differences that exist between Torres Strait Islanders and mainlanders but they did not provide details on how income is spent and on how people access general commodities.

In order to provide a clearer picture of the life conditions that exist in my two case studies, I collected data on the cost of living in both Mabuiag and St Paul's which included data on household spending patterns through a modified Household Expenditure Survey instrument and a detailed study of the prices of commodities available at the local shops through a shop survey.

3.4.2.3 Hunting and sharing

I conducted household interviews based on a formal structured questionnaire to collect data about the hunting characteristics of the participating households in my research. Before collecting this information, I tested my questionnaire with experts with a long experience of working with Indigenous communities. A revised version of the questionnaire was then presented and tested with Torres Strait Islanders to make sure that: (1) the wording of the questions was clear and easy to understand, and that (2) the questions were culturally correct. The final version of the questionnaire was administered to all the ongoing participants covering almost 50% of all Indigenous households[17] from both Mabuiag and St Paul's.

This questionnaire collected data on the presence of hunters in the household, on the hunting gear available at the household level, the frequency of hunting trips for both dugongs and turtles, the success rate of hunting trips, the cost of an average hunting trip and methods of payment for the trip, the sharing of the harvest (including number of shares, to whom it was shared with and where), and the number of times a household received shares of the harvest provided by other households.

During the course of the project and through a better understanding of the issue I was investigating, it became apparent that it was important to gather data on the reasons behind the sharing of traditional meat (dugong and green turtles) with people living outside the two Torres Strait Islander communities. I performed semi-structured interviews with my recurrent interviewees to understand the reasons for doing this.

I also performed 13 semi-structured interviews with Torres Strait Islanders living on the mainland but who were visiting relatives on Mabuiag or St Paul's during one of my field trip. Due to the limitation attached to my funding for this project, I could only conduct interviews on the islands and could not interview members of the Diaspora on the mainland.

3.4.2.4 Values associated with Indigenous hunting

One of the objectives of this research was to clarify "what is important" to Torres Strait Islander communities and to clarify the costs and benefits (market and non-market) associated with the Indigenous dugong and green turtle fisheries. In order to answer this

[17] Using the definition adopted by the ABS, I defined an Indigenous household as a household where at least one member is Indigenous (ABS 2006a, b, d, e).

research question, data were needed on the communities' perceptions of what is of value to them in terms of traditional hunting.

If a concept or phenomenon needs to be understood because little research has been done on it, then it merits a qualitative approach. Qualitative research is exploratory by nature, and is therefore particularly useful when the researcher does not know which important variables to examine (Creswell 2003). Accordingly, the first phase of this research project used a qualitative approach to identify key values (i.e., market and non-market costs and benefits) that were grounded in local meanings (Miles and Huberman 1994), in order to illuminate the various aspects of traditional dugong and marine turtle hunting that were important to two Torres Strait Island communities.

Once those costs/benefits were identified, they could then be studied more specifically. The inter-relationships between each value was assessed via cognitive mapping techniques (described in detail in section 5.2.2) to provide a collective picture of how members of two Torres Strait communities perceive hunting cognitively. Details about each value given by the participants helped formulate questions for ranking and rating exercises. The combined data gathered via these different techniques allowed me to investigate the relative importance of the market and non-market costs and benefits of Indigenous hunting.

3.4.2.5 Perceptions on the costs and benefits of hunting management strategies

Once the costs and benefits discussed above were identified, semi-structured interviews were also performed with the same individuals to understand how different management tools were perceived to potentially impact those values.

During this phase of the research, I performed multiple one-on-one interviews with 40% of the adult Indigenous population of both study communities. One-on-one interviews were conducted with men and women, young and old from the recurrent participating households.

3.5 Chapter summary

- The data relevant to the management of the Torres Strait Indigenous dugong and green turtle fisheries are out-of-date, scattered among different reports and non-existent on some aspects especially on economics. It was thus important for me to collect primary data relevant to this research.
- Successful research in Australian Indigenous communities requires time and commitment from the researcher in order to build a relationship based on trust with community participants.
- The acceptance by community members of the principal investigator strengthens the reliability of the data gathered.
- External pressure from the media may hinder research efforts and suggest that researchers working in the Torres Strait should pay attention to media releases or other events that may potentially affect their research. Early communication with community participants is vital to resolve community concerns that may arise following media attention.
- Local socio-economic conditions of case study communities (i.e., evidence of poverty, low educational achievement and literacy rate) need to be taken into consideration when developing appropriate data collection methods so as to ensure that the data collected will be relevant and meaningful.
- I conducted a case study approach with two Torres Strait communities.
- I used a mixed-methods approach for data collection.

CHAPTER 4:

RESOURCE USERS

In chapter 4, I explore the components of the social-ecological system under study: the resource system, resource units, governance system and resource users of the Torres Strait Indigenous dugong and green turtle fisheries. I focus on the resource users, noting that there is existing information on the resource system, units and governance system. Specifically, I investigate the financial, social and cultural factors influencing exchanges of dugong and turtle meat among resource users and then describe the complex system of sharing. This study allowed me to identify the resource user groups who are both directly and indirectly involved in the fisheries; the main conclusion being that the resource users are not just the fishermen. This finding has two main implications: (1) there is a mismatch between the ecological boundaries of the resource units, the administrative boundaries of the governance system and the social and cultural boundaries of the resource users, and (2) I needed to talk to many people within each community (not just the fishers) to learn more about the costs, benefits and potential impacts of management in these Indigenous fisheries.

4. Challenges of management: implementation in a dispersed social-ecological system

4.1 Introduction

As described in chapter 1, the aim of the Australian government and of community representatives of the Torres Strait is to ensure the sustainable management of the Torres Strait indigenous dugong and turtle fisheries. The Australian government's primary concern appears to lie in the conservation of dugongs and green turtles to meet their international requirements while Torres Strait Islanders appear to be more concerned about their rights to maintain their traditional culture and lifestyle. Whatever the reasons, both parties wish to devise management rules that will ensure the sustainable use of dugongs and green turtles by Torres Strait Islanders.

To be effective those management rules and the required institutions need to be adaptive and to recognise the specificities of the social-ecological system. The Torres Strait Indigenous dugong and green turtle fisheries are complex social-ecological systems that have evolved in the context of the relationship between the Torres Strait Islanders and their marine environment. The different components of the socio-ecological systems interact and are also influenced by external factors (Berkes and Folke 1998; Ostrom 2007a, b; Ostrom *et al.* 2007).

The difficulty for managers resides in understanding these interactions and feedbacks. However, the study of such systems can be quite overwhelming if one tries to look at all the components and interactions simultaneously. Although the components of a social-ecological system are linked by definition, one can partition any social-ecological system into different broad level subsystems (Dietz *et al.* 2003). Those subsystems still interact with one another but can also function as independent entities with different attributes that can all be studied to understand the system as a whole[18].

Ostrom (2007a; Ostrom *et al*. 2007) introduced a framework for the study of complex linked social-ecological systems. She suggested that at a broad level, a researcher can start studying linked social-ecological systems by analysing how the characteristics of the following sub-systems jointly affect and are affected by each other:

- the resource system (e.g., a fishery…),
- the resource units produced by that system (e.g., dugong, turtle…),
- the governance system (i.e., legislation, norms, informal guidelines…), and
- the users of that system (i.e., companies, tourists, fishers…).

The analysis of such a social-ecological system should consider the socio-economic and political settings as well as the temporal and spatial scales of the interactions between the different sub-systems, noting that the system could also be influenced by others (modified from Ostrom (2007a).

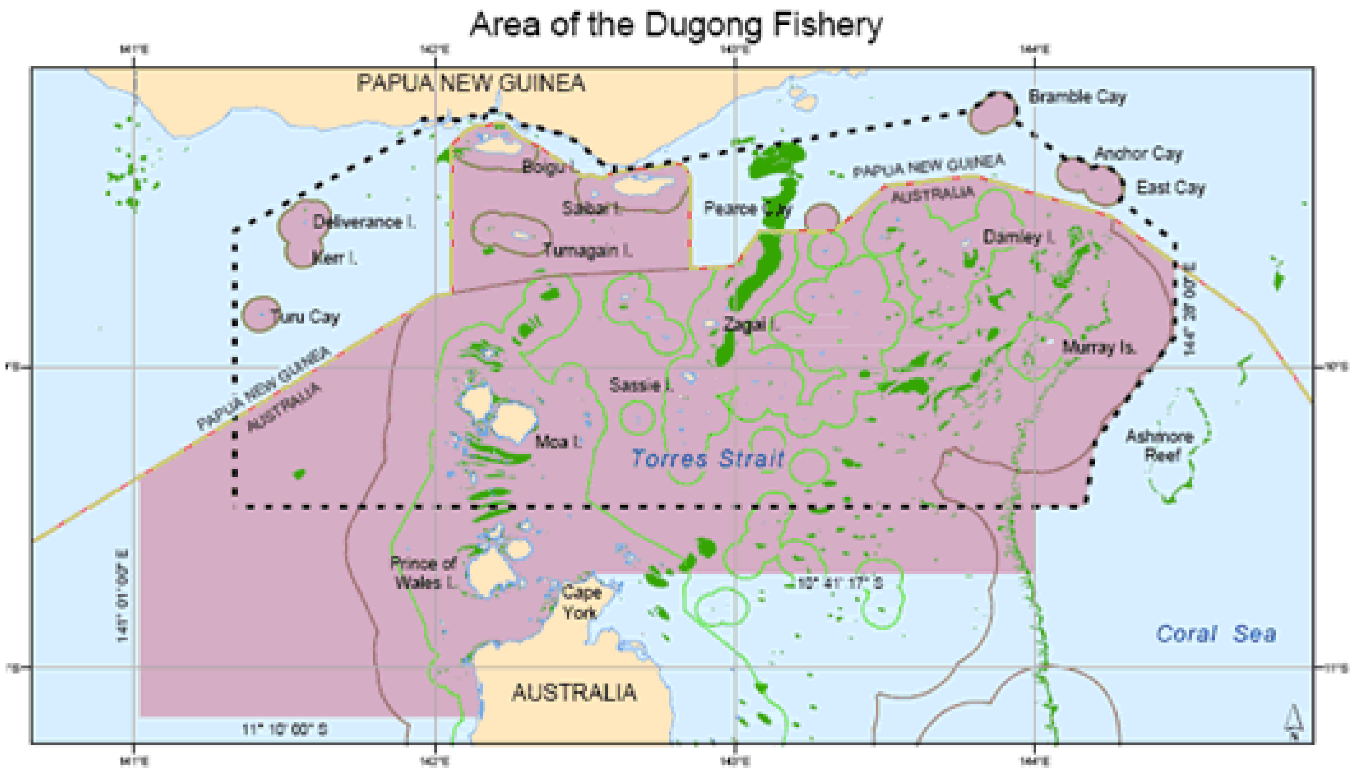
Embedded in Ostrom's definition is the need to define the boundaries of the different components of the social-ecological system of interest defined in terms of the boundaries of the resource system, the resource units, the governance system and the

[18] The attributes of social-ecological systems are the subject of some debate in the literature. Agrawal (2002) identified 30 attributes of such systems that are relevant to their understanding and management. Not all attributes are important to predicting success or failure of management. The main goal is to identify those attributes that define the characteristics of social-ecological systems that are easy to manage or prone to failure.

resource users. Clear boundaries provide a fishery with its identity, which has consequences for its governance, the legitimacy of the different management institutions, the resource harvested, the nature of assessments and the appropriateness of management responses (Andrew and Evans 2011). Critically, defining the boundaries of the fishery system makes the focal scale of management explicit (Walker *et al.* 2004). Of course, any fishery will be influenced by processes working at both smaller and larger spatial scales, but recognising the primary scale of focus is a necessary step (Andrew and Evans 2011; Dietz *et al.* 2003; Ostrom 2007b; Young 2002).

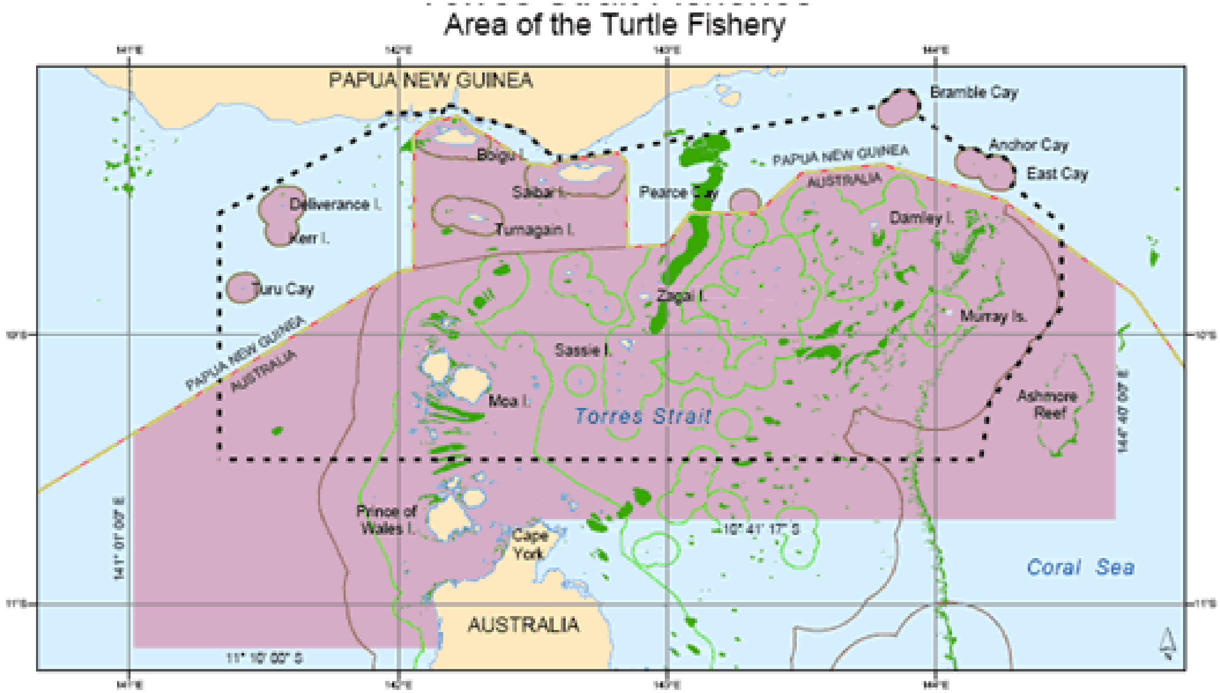
The need to match management institutions and the associated boundaries of the governance system to the ecosystems (i.e., resource system) they manage is now widely accepted (Dietz *et al*. 2003; Young 2002). But there is much less general recognition of the need to match the boundaries of a fishery system with its social and cultural boundaries; and still less work has been done on ways of defining the boundaries of the resource users' sub-system.

With regard to the resource systems of relevance to this thesis (described in chapter 2), the boundaries of the Torres Strait Indigenous dugong and green turtle fisheries have been administratively defined by the Australian Fisheries Management Authority (AFMA) as shown in Figure 2.7 and reproduced in Figure 4-1.



Coastal Waters Limit (3nm)
Exclusive Economic Zone (200nm)
Fisheries Jurisdiction Line
Protected Zone Boundary
Territorial Sea Limit (16nm)
Low tide elevation and reefs
Torres Strait Fisheries
Dugong Fishery

1. The area of the Fishery is sourced from the Torres Strait Fisheries Regulations 1986.
2. Within this Fishery, arrangements exist between the Commonwealth and QLD, whereby the Coastal Waters of that State are deemed part of the AFZ.
3. The Fisheries Jurisdiction Line and Protected Zone shown on this map are established under the Treaty between Australia and the independent state of Papua New Guinea. This Treaty entered in to force on 18 February 1985.
4. The maritime zone boundaries shown on this map are sourced from the Australian Maritime Boundaries (AMB) v.2.0 .



Coastal Waters Limit (3nm)
Exclusive Economic Zone (200nm)
Fisheries Jurisdiction Line
_ _ Protected Zone Boundary
Territorial Sea Limit (16nm)
Low tide elevation and reefs

Torres Strait Fisheries

Turtle Fishery

1. The area of the Fishery is sourced from the Torres Strait Fisheries Regulations 1986.
2. Within this Fishery, arrangements exist between the Commonwealth and QLD, whereby the Coastal Waters of that State are deemed part of the AFZ.
3. The Fisheries Jurisdiction Line and Protected Zone shown on this map are established under the Treaty between Australia and the independent state of Papua New Guinea. This Treaty entered in to force on 18 February 1985.
4. The maritime zone boundaries shown on this map are sourced from the Australian Maritime Boundaries (AMB) v.2.0 .

Figure 4-1. Maps of the area of: (a) the Torres Strait dugong fishery and b) the Torres Strait marine turtle fishery. The area of each fishery is shown in pink. Note the marine turtle fishery extends further to the east than the dugong fishery as turtles are caught in all areas of the Torres Strait while dugongs are mainly harvested in the western region. The boundary of the Torres Strait Protected Zone is the dotted line. Both maps were produced by Geoscience Australia for the Australian Fisheries Management Authority, August 2006 and adapted for clarity.

But the geographical range of the resource units (i.e., dugongs and green turtles) as also described in chapter 2 extends far beyond those administrative boundaries (see Figure 4-2).

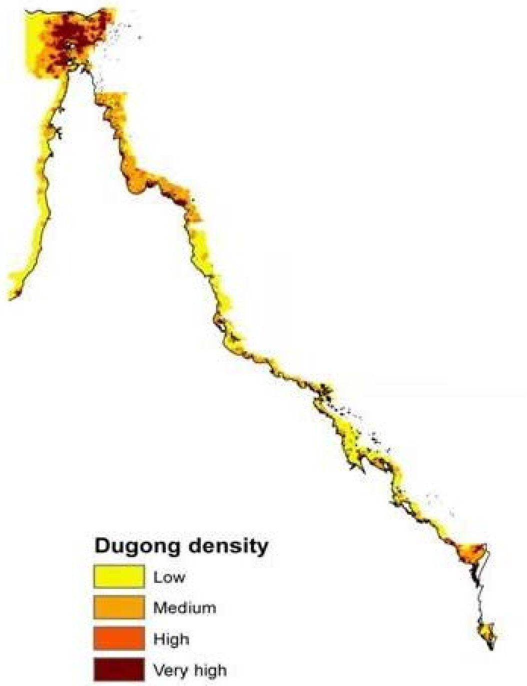


Figure 4-2. The distribution of dugongs along part of the Queensland coast based on 25 years of aerial surveys. Dugongs are one of the resource units of the Torres Strait traditional dugong and turtle fisheries. Drawn by Alana Grech, reproduced with permission.

Considerable information is available on the resource units of these systems and more research is currently taking place to understand the genetics of the stocks and the movements of dugongs and green turtles within and outside the boundaries of the fisheries. Indeed, current tagging studies have highlighted that dugongs move beyond the boundaries of the Torres Strait dugong fishery system (Figure 4-1) to travel to the Great Barrier Reef in the south (Figure 4-2) (Fuentes *et al.* 2012). Similarly, tagging studies of green turtles in the Torres Strait confirm their movement outside the boundaries of the Torres Strait turtle fishery system (Figure 4-1) travelling to the Great Barrier Reef, the Arufura Sea or beyond

Australia's jurisdictions (Limpus *et al*. 1992). Due to the animals' movements, it is evident that there is a mismatch between the administrative boundaries of the resource system (Figure 4-1) and the ecological boundaries of the resource units even at the scale of Australia (Figure 4-2).

In chapter 2, I described the agreements and legislation that regulate the fisheries from the international to the local level (see section 2.4.3). I highlighted that these fisheries are Commonwealth fisheries that are managed under the *Torres Strait Fisheries Act (1984)* and the *Torres Strait Treaty (1985)*. The PZJA is in charge of overseeing the management of these fisheries on the Australian side, but the management of these fisheries is occurring at the community level within Torres Strait through community-based management plans (most communities have established a set of rules to manage the harvest of dugongs and green turtles by their members and around their island). A regional approach to the management of these fisheries is also in place through the Torres Strait Regional Authority, the current authority in charge of the monitoring and review process of the community-based management plans and of the affiliated community ranger program.

Outside the Torres Strait and along the coast of Queensland, the management of dugongs and green turtles is: (1) the shared responsibility of the Commonwealth and Queensland governments under the Great Barrier Reef Intergovernmental Agreement 2009 for animals found in the Great Barrier Reef region (blue in Figure 4-3), (2) the responsibility of the state government for animals found in Queensland waters (including in Queensland marine parks as indicated in red in Figure 4-3), and (3) the responsibility of the Commonwealth in waters seaward of the Queensland state waters outside the Great Barrier Reef region (Marsh *et al*. 2011).

Just as there is a mismatch between the administrative and the ecological boundaries of these resource systems, so too are the legislative/governance boundaries poorly aligned.

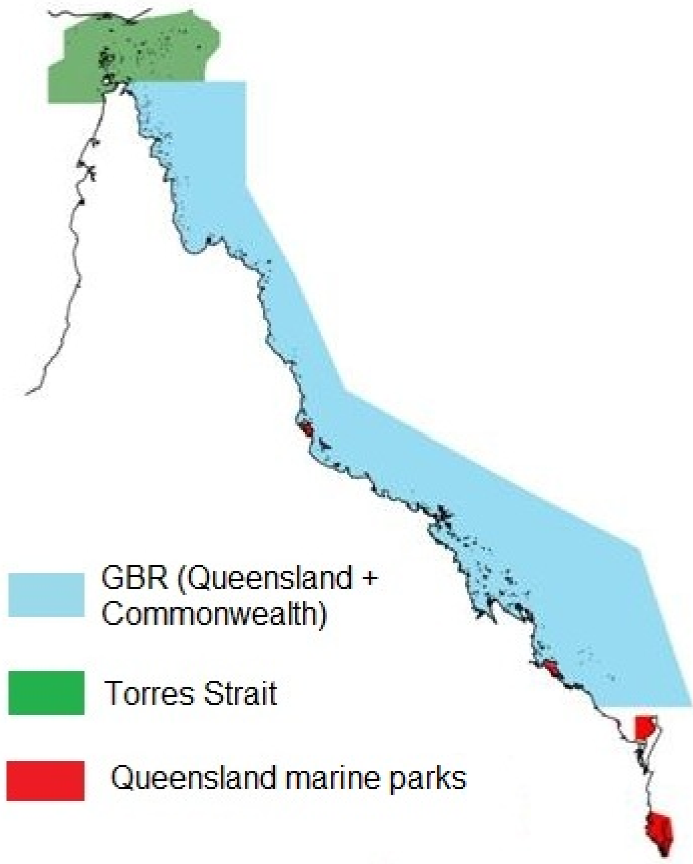


Figure 4-3. Governance systems applicable to dugongs and green turtles along the east coast of Queensland. Note that south of the Great Barrier Reef region, the state of Queensland is responsible for management within three nautical miles of the coast and the Commonwealth for waters beyond the three nautical miles limit.

The last subsystem of the framework concerns the resource users. For some fisheries, the boundaries of the resource user sub-system seem to be obvious – particularly when there is a clear relationship between the natural resource and the people who use it (Berkes *et al.* 2001; Evans and Andrew 2011). In many cases, fisheries management considers only the immediate users of the resource: the fishers who are spatially located in the vicinity of the ecological range of the harvested species or who travel to the location of the resource. However, Berkes and colleagues (2001) pointed out that a fishery management system that concentrates "*solely on fish populations and the fishermen-as-right-holders*" was likely to be misguided as fishermen are part of a larger social system defined by kinship relations, social obligations, norms, networks and reciprocities. Evidently, one needs to look beyond the formal administrative or ecological boundaries of the fishery system to understand the resource users who may have either a direct or indirect interest in the fisheries. This is a focus of this chapter.

Torres Strait Islanders who are native title holders are the only group allowed to harvest dugongs and green turtles in the Torres Strait and it is illegal for non-Indigenous people to consume turtle and dugong meat. But apart from anthropological records describing Torres Strait Islanders' way of life and current aggregate statistics on their socio-economic level as a group (see section 2.3), little information is publically available on the actual users of the fisheries. For instance, there is no current information on the number of resource users involved in the traditional fisheries or on the relationship between the socio-economic context of the resource users and the fisheries. This chapter thus helps fulfil that information gap by providing some current information on the resource users of these fisheries.

In this chapter, I describe the complexity of the social system that defines the resource users of the Torres Strait Indigenous dugong and green turtle fisheries. I do this by investigating the sharing networks operating in Torres Strait and by following the flow of traditional (dugong and turtle meat) and monetary resources in the communities of Mabuiag and St Paul's[19].

Thus, this chapter addresses the first sub-objective of my thesis by defining and describing the people who are directly and indirectly involved in the Torres Strait Indigenous dugong and turtle fisheries and their relationships and using that information to draw inferences about the boundaries of the resource user sub-system.

For clarity, the methods and results sections of this chapter have been grouped by topic. There is a single discussion at the end of the chapter.

4.2 Methodology and results

4.2.1 Socio-economic context of community members

4.2.1.1 Socio-demographic profile of Mabuiag and St Paul's

In chapter 2, I highlighted the differences that exist between the socio-economic characteristics of Torres Strait Islanders and Australians living on the mainland. In contrast this chapter considers the socio-economic and demographic characteristics of the two case study communities using data on household demographics, income and employment collected by the Australian Bureau of Statistics during the 2006 Census.

As for the Torres Strait as a whole, the population pyramid on both islands (Figure 4-4a and b)(ABS 2006d, e) is very different from that of the general Queensland population

[19] The purpose of this chapter is not to highlight or conduct a detailed ethnographic study on sharing but rather to use sharing as a means to identify groups of resource users who may be affected by management and as such who should be consulted as part of institutional arrangements of the Indigenous fisheries.

(Figure 2-5b)(ABS 2006b) but is similar to the profiles of the Indigenous population in Queensland (Figure 2-5a)(ABS 2006c) and in Torres Strait (Figure 2-5c)(ABS 2006a) in being characterised by a young population (Table 4-1) with many children and few older people.

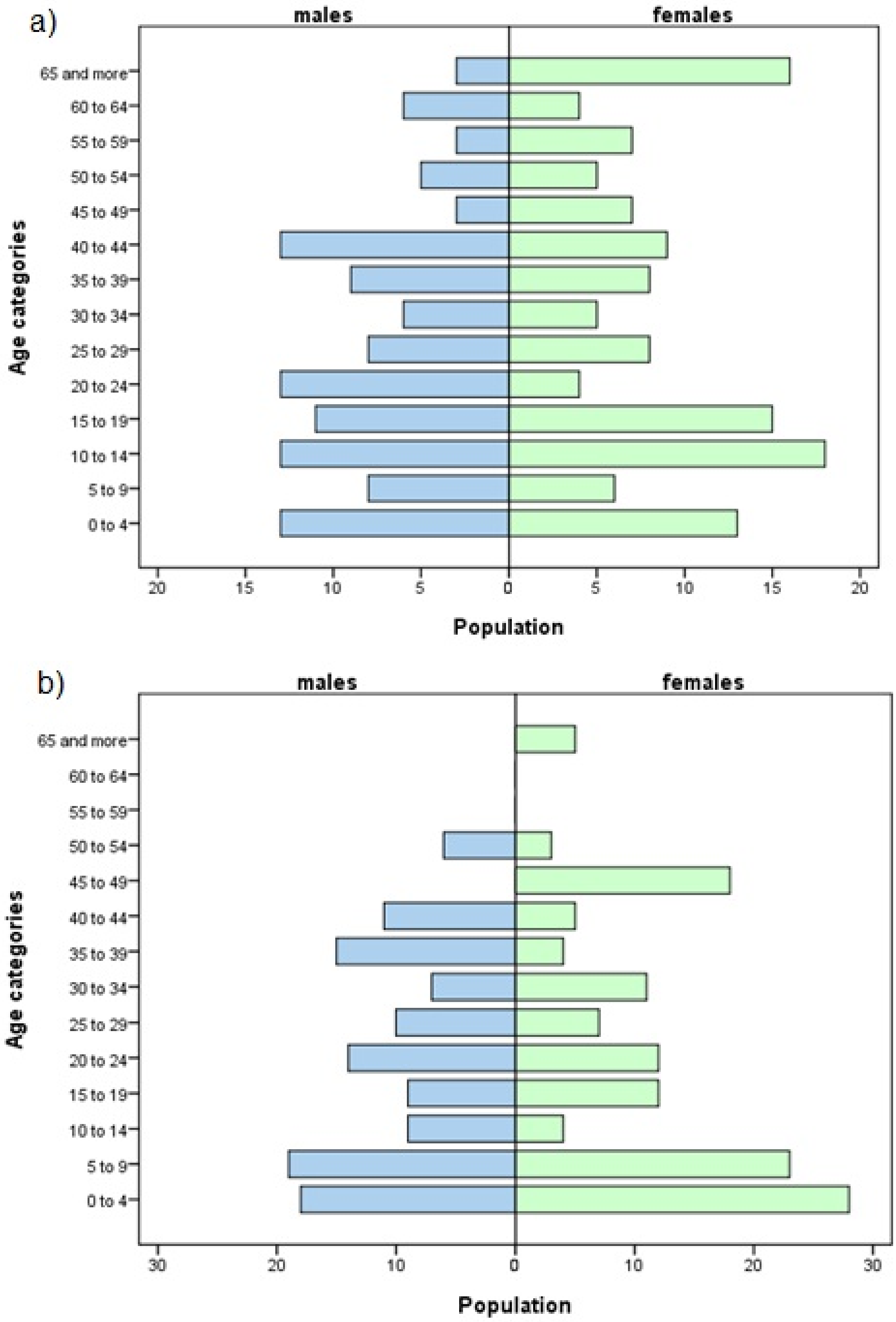


Figure 4-4. Population structure of: a) St Paul's community and b) Mabuiag (from ABS 2006 Census).

Table 4-1. Median age (in years) of the two study communities, by Indigenous status (from ABS 2006 Census).

Location	Indigenous	Non-Indigenous	Total Population
Mabuiag (Indigenous Area)	20	36	21
St Pauls (Indigenous Area)	25	42	27

As in the remainder of the Torres Strait region, an income gap exists between the members of the two communities and the residents of the remainder of Queensland (ABS 2006b, d, e). The individual income is low; approximately 48% (Mabuiag Island) and 55% (St Paul's community) of the Queensland average individual income (Table 2-3). At the household level, income is also low in the communities (Table 4-2) compared with the average Queensland household income (Table 2-3). For example, the 'average' household in Mabuiag (be it Indigenous, non-Indigenous or mixed) earns 79% of the 'average' household in Queensland (Table 2-3 and Table 4-2); plus the 'average' household in Mabuiag is larger than the 'average' Queensland household (Table 4-1).

Table 4-2. Median weekly individual and household income, by Indigenous status (from ABS 2006 Census).

Location	Individual weekly income - Indigenous	Individual weekly income – Non-Indigenous	Individual weekly income – Total	Household weekly income – Indigenous	Household weekly income – Non-Indigenous	Household weekly income - Total
Mabuiag (Indigenous Area)	$225	$499	$229 (48% of Queensland resident)	$819	$900	$817 (79% of Queensland household)
St Pauls (Indigenous Area)	$252	$500	$261 (55% of Queensland resident)	$675	$900	$703 (68% of Queensland household)

Evidently, these communities are, if anything, at an even greater financial disadvantage[20] than the Torres Strait region as a whole (Table 2-3 and Table 4-2).

An employment gap is also evident in both communities with a large proportion of local residents earning their living through participating in the Community Development and Employment Project (CDEP) scheme (Table 4-3). The CDEP scheme ceased in April 2012 for remote indigenous communities (ABS 2011b), but the Queensland Industrial Relations Commission replaced it with the Torres Strait Islander Communities - Community Development Employment Projects (Torres Strait) award. This new scheme is to be administered and funded by the Torres Strait Regional Authority as from 31 August 2012 (Queensland Industrial Relations Commission 2012), suggesting that most employment in the Torres Strait will still be carried out under the auspices of the CDEP scheme albeit in a modified form.

[20] However, it is important to note that Torres Strait Islanders may be "considered" advantaged in comparison to other Australians when looking at other indicators such as time spent with family and children, time spent commuting to work, community cohesion, family expenses, number of languages spoken etc.

Table 4-3. Labour force status in St Paul's community and Mabuiag (from ABS 2006 Census).

	St Paul's	**Mabuiag**
Population (15 years and over)	168	150
Employed (Mainstream)	34	36
Employed (CDEP)	89	76
Total Employed	123	112
Unemployed	0	0
Total in Labour Force	123	112
Not in Labour Force	26	32
CDEP participation rate (%)	72.4	67.9
Employment rate (%)	100	100
Unemployment rate (%)	0	0
Labour force participation rate (%)	72.8	76.2

Although this information collected via the national Census, conducted by the Australian Bureau of Statistics every five years, provides important contextual information, it omits key information about the cost of living in these two outer island communities. I thus complemented this secondary data with primary data that I collected via both a Household Expenditure Survey and a shop survey. It was necessary to do this because the Australian Bureau of Statistics currently does not collect household expenditure data or consumer price information in remote areas (including Torres Strait communities).

4.2.1.2 Household expenditure survey

I conducted interviews with almost 50% of the total households on St Paul's island (The PBC[21] Chair of Mabuiag Island decided not to involve members of his community in this part of the study). These interviews were used to collect information on the spending patterns of Torres Strait Islanders using a Household Expenditure Survey instrument that was developed by Stoeckl et al. (2011)[22]. Household interviewees were asked to provide their total fortnightly expenditure on a variety of different goods and services (as per the questionnaire provided in Appendix C). Some questions regarding major types of goods and services asked about annual expenditures. In the case of purchases that span a number of years, interviewees were asked about the price of purchase and the date of acquisition in order to calculate a yearly rate. The midpoint of each expenditure category was taken as an indication of the amount spent on each type of good. I used these data to estimate weekly household expenditure patterns.

Data collected from the surveys were compared with household expenditure data collected by the Australian Bureau of Statistics in Queensland, highlighting the fact that the spending pattern of residents in St Paul's is different from the average household in Queensland. The main category of expenditure was Food and Beverage which represented 40% of total household income rather than 20% for the average Queensland household (Australian Bureau of Statistics Household Expenditure Survey 2009-2010) (Figure 4-5).

[21] Prescribed Body Corporate is a "native title corporation that may hold and/or manage native title for a group" (NNTT 2006)

[22] A copy of the Household Expenditure questionnaire used in this study is provided in Appendix C.

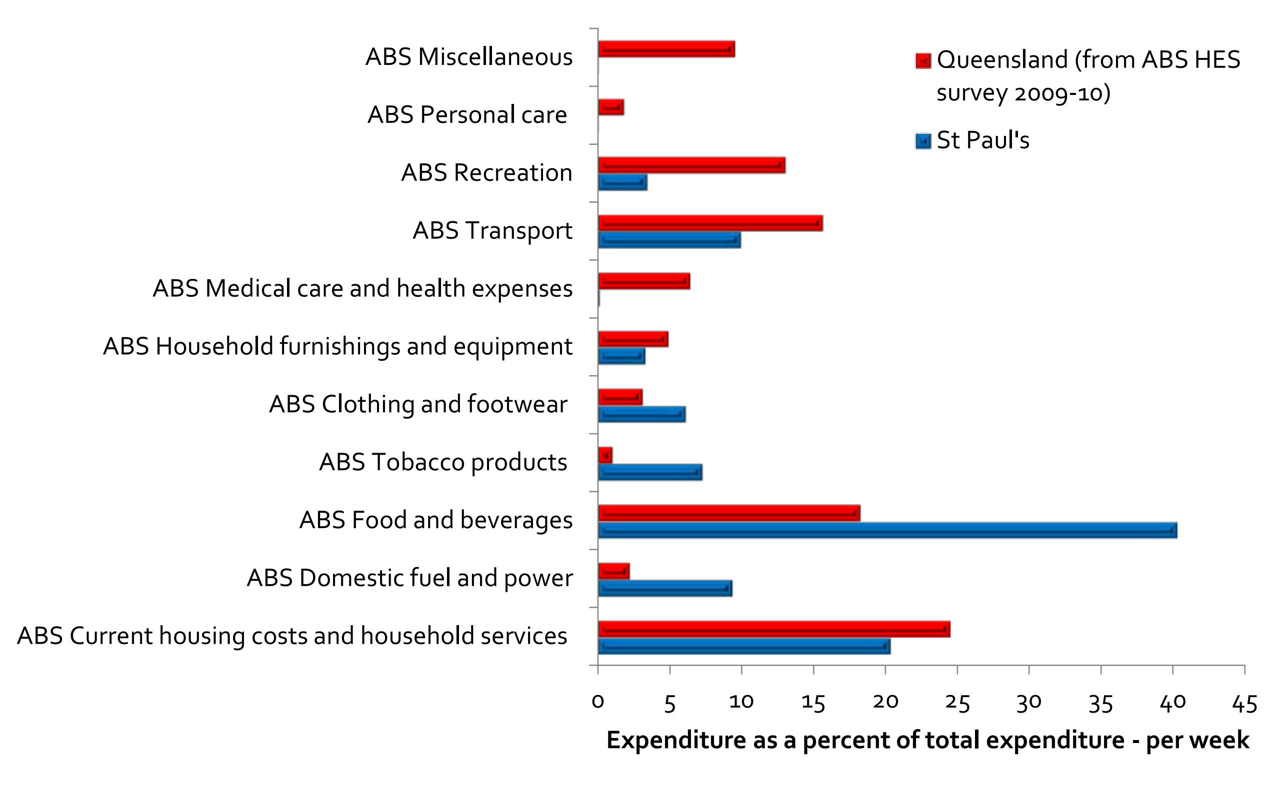


Figure 4-5. Household Expenditure Survey comparing expenditure patterns of St Paul's households with the expenditure pattern of the average Queensland household. The information on the expenditure patterns of 50% of St Paul's households was collected by the author in July 2010 via a modified version of the survey instrument developed by Stoeckl *et al*. (2011).

4.2.1.3 Shop survey

The Consumer Price Index is an index that provides important information on the economic status of communities relative to one another. In Australia, the Australian Bureau of Statistics collects price data for the Consumer Price Index in capital cities. In Queensland, the Office of Economic and Statistical Research (OESR) develops regional data price indices but does not collect data relevant to Mabuiag and St Paul's communities. So it was necessary for me to collect primary data on prices in the two islands and to compare them with prices in a regional centre to learn more about the cost of living in Mabuiag and St Paul's (compared to other locations).

Both Mabuiag and St Paul's have one local shop selling necessities. These shops are provisioned once a week from a visiting barge[23]. After obtaining permission from the local manager of the island shop operated by IBIS (Islanders Board of Industry & Service), I recorded in October 2009 the price of all items available at the shops (≈ 500 items). For each item, I collected information on the product name, capacity, brand name and price. If an item was on special, I recorded the undiscounted price. Although the availability of some items differed between the two communities, the prices were identical.

Immediately after my return from the field in October 2009, I conducted the same price survey at a local shop in a major regional centre (Townsville, Queensland). I conducted the shop survey in the store which sold identical items and brands to those available on the island[24]. I restricted the collection of my data to the 500 items that were available in the island shops to allow for price comparison[25]. Then I compared the price of every item available from the island shops with the price of similar items available in the major regional centre.

Finally, I collated the information following the ABS standard product classification (ABS 2010), so that comparisons could be made using categories used by the other data collection agencies. I used the method described by the Australian bureau of Statistics to

[23] In some instances (particularly during the wet season), rough weather and seas or breakdowns prevent the barge from making weekly deliveries. I experienced several such occasions during my field visits and witnessed how low supplies became after one week.

[24] The shop was Walters IGA in Townsville, the only supermarket chain which sells Black and Gold goods as found on the island stores.

[25] It is important to note that many other grocery stores are available to the consumer in the regional centre and that the availability of supermarket chain stores would allow consumers living in Townsville to look for the cheapest prices.

compare the prices of commodities. For instance, the average price of meat was derived from the calculated "per kilo" price of the types of meat available in the shops surveyed. The percentage difference was calculated with the mainland price as the divisor and thus underestimates the price difference as would have been calculated using the island price as the divisor. The shop survey demonstrated that the price of goods purchased on Mabuiag and St Paul's was around 53% higher than on the mainland (Figure 4-6) and that the average price of meat was $19.80 per kilo rather than $9.50 a kilo on the mainland.

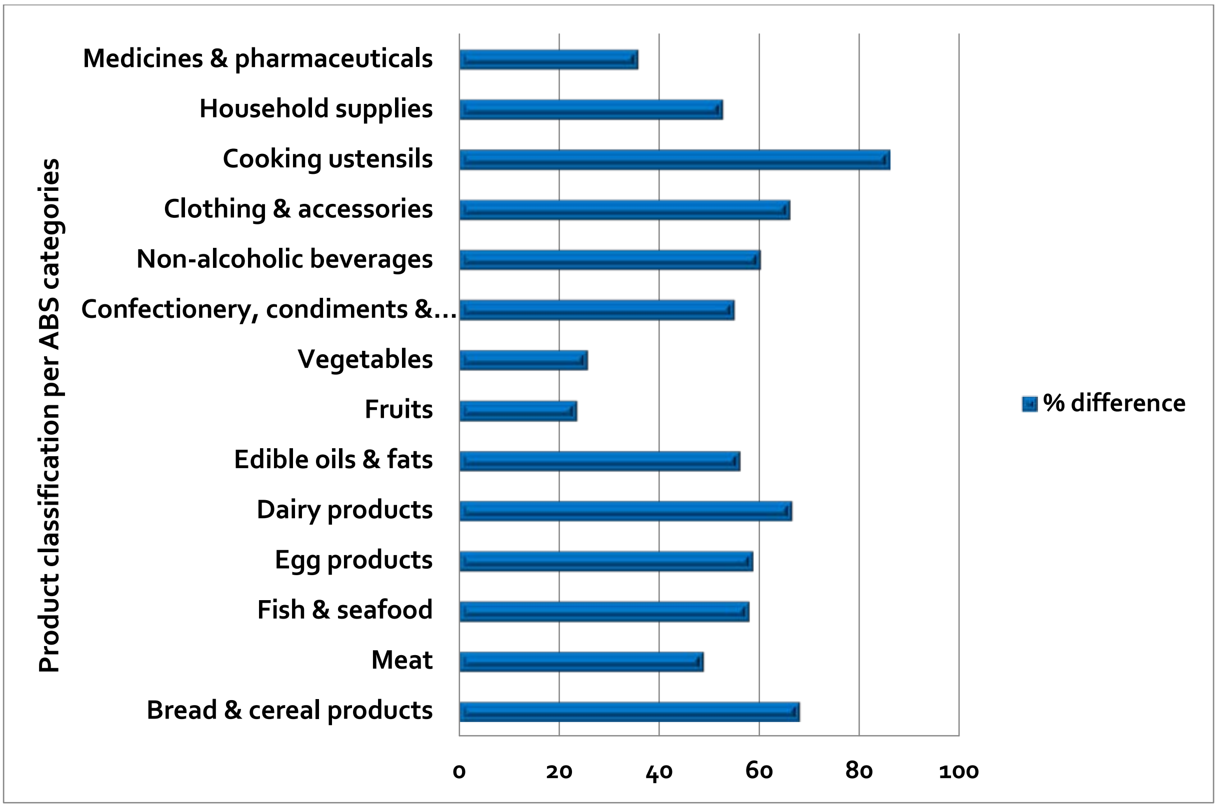


Figure 4-6. Average price difference among shop products on Mabuiag and St Paul's, and a regional centre (i.e., Townsville). The percentage difference was calculated with the mainland price as the divisor. Prices of approximately 500 items sold in the island shops were collected in October 2009 by the author and compared with prices of the same items sold in Townsville one week later.

The low incomes of Torres Strait Islanders (described in section 4.2.1.1) combined with the high prices they must pay places residents under considerable financial pressure. Most people are employed via the CDEP scheme which provided an individual income at

$222 per fortnight at the time of the study. At the household level, the median nominal income of an Indigenous household in the communities of Mabuiag and St Paul's (data from both communities combined) was approximately 74% of the median nominal income of the average Queensland household (Table 2-3 and Table 4-2) even though households have more people in the Torres Strait. Taking into consideration the price difference between island communities and the mainland, the real income of a household in those two communities was equivalent to less than half of the real income of the average Queensland household.

Financial disadvantage is even more apparent at an individual level. The nominal income of an Indigenous person living in the communities of Mabuiag and St Paul's was equivalent to 50% of the nominal income of the average Queenslander (Table 2-3 and Table 4-2). The price difference meant that the real income of an Indigenous person living in the Torres Strait was equivalent to 33% of the real income of the average Queenslander.

These results clearly highlight the "double burden" on residents of the two case study communities; i.e., low incomes and high commodity prices. This socio-economic context provides some justification for Torres Strait Islanders turning to the sea for alternatives to store-bought meat.

4.2.2 Identification of the resource user groups

To learn more about the resource users, I conducted focus groups with key representatives of both Mabuiag and St Paul's communities to discuss the role that traditional dugong and green turtle hunting plays in the livelihoods of their residents[26]. The

[26] Although I acknowledge that residents of the two communities use other sea resources, I focused my question on the specific role played by dugong and green turtle harvest.

group discussions lasted approximately one hour with six people on Mabuiag and eight people on St Paul's. The focus groups involved men and women, young members of the communities and elders as well as hunters and non-hunters.

When asked about the role that hunting plays in the livelihoods of members of their communities, focus group members emphasised the need to understand that the benefits of dugongs and green turtle hunting extended far beyond the hunter's households. They advised that I could not understand the role played by hunting in the livelihood of Torres Strait Islanders without understanding the extensive sharing of dugong and green turtle meat among several segments of the population.

Based on those discussions, I decided to ask focus group members to categorise the different segments of the population into homogenous groups with different relationships with the resource units (dugongs and green turtles). Instead of imposing a basis for the categorisation of resource user groups in the Torres Strait Indigenous dugong and turtle fisheries[27], I chose to let community members decide the basis for the categorisation of their community. The categorisation of the islander population helped me to revise the questions of my household hunting questionnaire to understand the sharing behaviour among the different resource user groups defined by the focus group members.

Focus group members emphasised that households on the islands benefit differently from the sharing of traditional meat according to a combination of factors including location, presence of hunters, relationship to hunting households and income level. In total, eight types of household were identified (Table 4-4) and provided a framework for the

[27] Most studies relating to food sharing behaviour in traditional societies categorise households based on active participation in the harvest and/or on wealth rankings.

different resource user groups who are directly and indirectly involved in the Torres Strait Indigenous dugong and green turtle fisheries. These resource user groups are present in three spatial scales (Table 4-4). The micro-scale refers to people living on Mabuiag or St Paul's, the meso-scale or regional scale is defined as encompassing the Torres Strait region (including communities on the coast of Papua New Guinea) while the macro-scale considers that some resource user groups are beyond the boundaries of the Torres Strait.

These groups have been used in subsequent sections to analyse the complex social system that defines the way in which the Ailan Kastom of sharing helps extend the boundaries of the resource users beyond the boundaries associated with both the resource units or governance system of these traditional fisheries.

Table 4-4. Hunting household categorisation of Mabuiag and St Paul's communities based on focus group discussions. The focus group discussions were led by the author and held in each community in November 2009.

Location	Type of Household
Island (micro-scale)	Non-hunting, no family ties to hunters (both wages and CDEP)
	CDEP Non-hunting and family ties to hunters
	Wages non-hunting and family ties to hunters
	CDEP hunting
	Wages hunting
	Pensioners
Rest of Torres Strait (meso-scale)	Family
Australian mainland (macro-scale)	Family

Using the combined information collected from the community focus groups, household hunting questionnaires and informal interviews, I developed conceptual frameworks to summarise the roles played by the dugong and green turtle fisheries in the livelihoods of Torres Strait Islanders. These frameworks explain the relationships between the different categories of households that exist through traditional hunting.

Each framework highlights the flow of harvested and monetary resources based on the use of dugong and green turtle meat by community members for home consumption or ceremonies. I will commence my consideration of the frameworks with the different household types recognised through focus group (Table 4-4) and progressively add the different relationships as they are investigated throughout the next sections.

4.2.3 Catch data

4.2.3.1 Household hunting surveys

I conducted household surveys[28] with almost 50% of households on both islands (see chapter 3). I aimed to understand: (1) the hunting behaviour of the different categories of households (based on the categorisation elicited by focus group participants) on the two islands and (2) the sharing behaviour of the households. More specifically, I set out to find answers to the following questions:

1) Who were the hunters? How often did they go hunting and what were their success rates?
2) What was the cost of an average hunting trip and who provided financial support to cover the associated expenses?
3) How often did hunters share their catch and with whom?

As a result of the trust I gained with community members, I was able to identify all of the hunters in each community and obtained informal interviews with 75% of all hunters

[28] A copy of the household questionnaire is provided in Appendix D.

operating in both Mabuiag and St Paul's. The data I subsequently collected through participant observation, informal discussions, individual interviews and household hunting questionnaires (see Appendix D) allowed me to generate estimates of the total number of animals (dugongs and green turtles) caught, the numbers used for ceremony and the numbers shared within and outside the communities (Figure 4-7). The data collected via the household questionnaire was complemented later on by individual interviews with at least one member of a household to gain a detailed understanding on the "sharing" behaviour of each household. The discussion below explains how the estimates for each – labelled (A) to (D) – were derived.

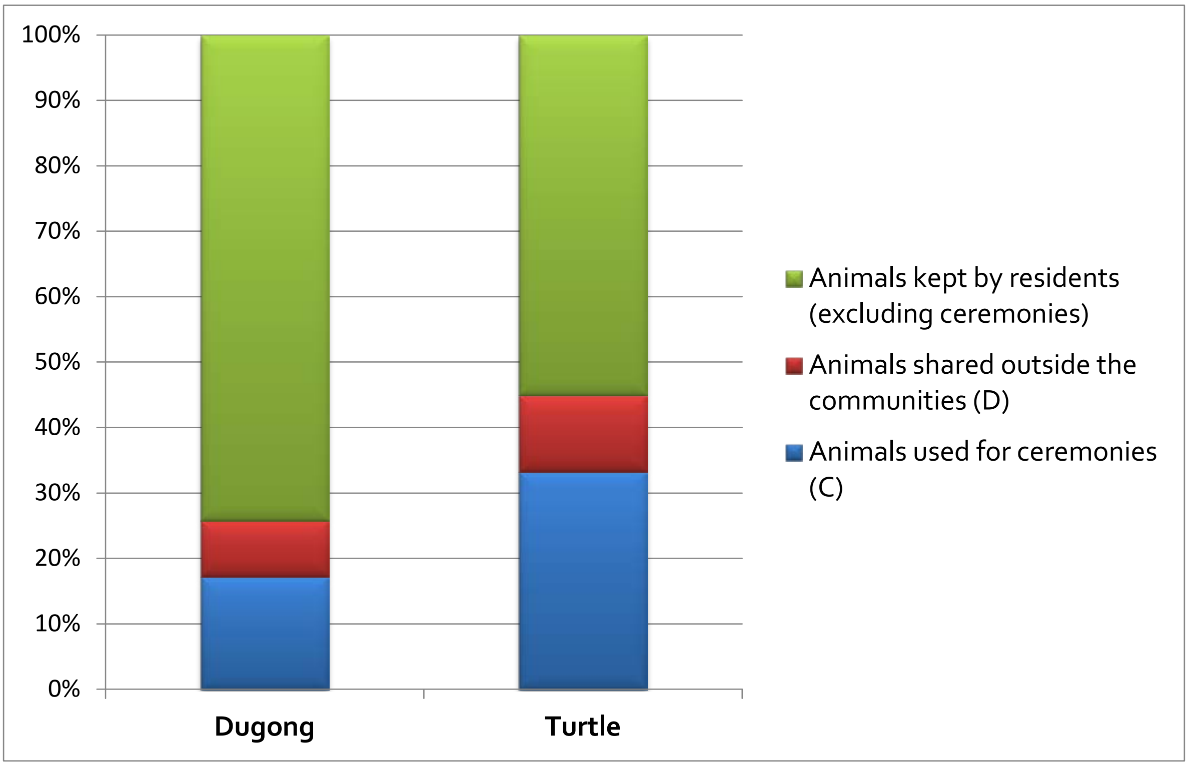


Figure 4-7. Size of the traditional harvest of dugongs and green turtles on Mabuiag and St Paul's and its proportional purpose. The data was collected via the household hunting questionnaires administered by the author during several field trips from August 2009 to June 2010.

4.2.3.1.1 Section (A) – Actual animals caught by respondents

The household hunting questionnaires enabled me to record the frequency of hunting trips and the success rate of each hunter residing in a household. Using these two variables, I calculated the number of dugongs and green turtles caught by each hunter on a yearly basis. There was a large discrepancy between hunters. Only three to four hunters per island were responsible for undertaking most of the hunting trips and accounted for more than 50% of the community catch. This is in line with previous studies which have highlighted that a small number of 'avid' hunters are responsible for a large part of the total catch on the islands (Kwan *et al*. 2006).The success rate was also highly variable between hunters. On average, 66% of all hunting trips resulted in at least one dugong or one green turtle being caught and were subsequently defined as successful in my analysis.

4.2.3.1.2 Section (B) – Estimated animals caught by community

Through informal discussions, I estimated the proportion of the total catch from all hunters on both islands that was attributable to the sample of hunters interviewed. In each community, a small number of avid hunters is responsible for most of the total catch and my interview sample captured data from all these avid hunters on Mabuiag and St Paul's. As mentioned earlier, I was able to interview 75% of the hunters operating in both islands. I was informed by community representatives that the hunters I interviewed were collectively responsible for approximately 80% of the catch. This information allowed me to estimate the total numbers of animals caught (dugongs and green turtles) by community members using Equation 4-1:

Total number of dugongs and green turtles caught by respondents * 100/80 =
Estimate of the total number of dugongs and green turtles caught by community members on a yearly basis

Equation 4-1

4.2.3.1.3 Section (C) – Animals used for ceremonies

It became apparent through informal discussion, participant observation and the information I collected through the household hunting questionnaires that I would need to differentiate between dugong and turtle meat caught for home consumption and for ceremonies. Community representatives from Mabuiag Island considered that an average of 12 ceremonies took place on Mabuiag each year. I assumed the same number of ceremonies took place on St Paul's. One dugong and two turtles are usually caught for each ceremony. Informal discussions with hunters on Mabuiag indicated that they had caught three dugongs for ceremonies to take place in other Torres Strait communities in the past year.

4.2.3.1.4 Section (D) – Animals shared outside the communities

Next, I calculated the proportion of animals shared with people living outside the communities (both in the Torres Strait region and elsewhere) using Equation 4-2. I was able to do this because the household hunting questionnaire indicated that on average a dugong is shared among 12 households while a turtle is shared among six. The household hunting questionnaire also highlighted that the probability of sharing at least one portion of meat from a dugong with people living outside a community was 70% while one share of meat from each turtle was shared outside the community 80% of the time.

Probability of sharing outside the communities / number of shares =
Proportion of dugong and green turtles shared outside the communities

Equation 4-2

These proportions were then used to estimate the number of dugongs and green turtles that are shared outside the communities of Mabuiag and St Paul's on a yearly basis using Equation 4-3. It is important to note that in most cases, only one share of meat from a dugong or a green turtle is shared outside the community at any one time. As such, I estimated an equivalent number of dugongs and green turtles shared outside the communities on a yearly basis. This estimated number of animals shared does not represent the number of entire animals shared outside the communities because sharing occurs at the level of portions of meat rather than entire animals.

Total number of dugongs and green turtles caught by community members on a yearly basis * proportion of animals shared outside the communities =
Equivalent number of dugongs and green turtles shared outside the communities on a yearly basis

Equation 4-3

4.3 Relationships between resource user groups

The previous findings highlight the extent of the harvest of dugongs and green turtles in the two communities of Mabuiag and St Paul's. However, there is no current information on the expenses incurred by the hunters to catch dugongs and green turtles. An investigation into the direct financial costs associated with catching a dugong or a turtle would: (1) emphasise the proportion of the household budget used to go hunting, and (2) ways that hunters could potentially share those costs.

But I was not only interested in costs. As mentioned earlier, sharing has long been an important element of Islander culture (Ailan Kastom) (Beckett 1987). Sharing of dugong and turtle meat was recorded on Mabuiag in the late 1970's and early 1980's (Nietschmann 1977a, b; Nietschmann and Nietschmann 1981; Nietschmann 1984) while recent studies have analysed the anthropological reasons for sharing turtle in the Eastern islands (Bliege

Bird *et al.* 2001). So, with the knowledge on the catch harvested by Mabuiag and St Paul's hunters, I wanted to record what happened to the catch once it was landed on the islands.

I then used the description of those sharing arrangements (both in terms of costs and benefits) to build the conceptual frameworks explaining the relationships that exist between different resource user groups and the importance that the Indigenous fisheries play in the livelihoods of Mabuiag and St Paul's residents using the user groups identified in section 4.2.2 (Table 4-4) as the unit of analysis.

These conceptual frameworks describe sharing arrangements over two 'characteristic' weeks (x and y). It was necessary to do this because there are differences in residents' income source[29] from week to another that affect the sharing relationships (explained in more detail in section 4.3.1.1). But it is important to note that decisions to go hunting were based on several criteria including environmental conditions, the abundance of animals in the relevant hunting ground, time of year, lunar cycle and the size of other commercial fisheries (Kwan *et al.* 2006). The number of total hunting trips and the number of hunting trips targeting a particular species varied throughout the year. Thus, it is important to understand that hunting does not occur in every 'characteristic' week.

I also divided my investigation into the sharing arrangements between the provision of dugong and turtle meat caught for home consumption and for ceremonies – since, as noted earlier, there were clearly substantive differences in sharing arrangements in each of these situations. This division is highlighted in the section headings below.

[29] These income sources are determined by government cycles. CDEP and pensions are paid fornightly

4.3.1 FOOD FOR HOME CONSUMPTION

4.3.1.1 Costs

I calculated the cost associated with an average hunting using the method described by Bliege Bird (2001). This method reduces the cost to the use of fuel and oil to power the outboard motors. However, the total cost of hunting would also include the capital and maintenance costs of boats and motors or other associated costs such as boat registration, trailers, towing vehicles, safety equipment and other necessary equipment. Thus the estimated financial cost for a hunting trip could be an under-estimate of the true costs if we take into account all the costs associated with the maintenance of the boats.

I asked hunters about the time it took them to catch a dugong or a turtle and the average cost of a hunting trip. On average, it took five hours to catch a dugong (min. = 3 hours; max. = 12 hours) and 3.5 hours to catch a green turtle. A trip to catch a dugong or a turtle was not cheap, mainly because of the need to purchase fuel and oil, both of which are much more expensive in Torres Strait than on the mainland. On average, one hunting party would use two to three twenty litre drums of fuel per successful trip. At $2 per litre[30], this amounted to between $80 and $120 of fuel expenses per successful trip. This information enabled me to estimate the cost of a successful hunting trip using equation Equation 4-4:

$$\frac{\textbf{\textit{Cost of fuel on an 'average' trip}}}{\textbf{\textit{likelihood of success}}^{31}} =$$

Estimated cost of a successful hunting trip

Equation 4-4

[30] Fuel cost was more than AU$3 per litre on some outer islands in 2012.

[31] Success is defined as a hunting trip where at least one dugong or one green turtle was caught.

The true cost of a successful hunting trip thus ranged between $120 and $180. As mentioned earlier, the average income level of Torres Strait Islanders is low: $229 and $261 per person per week on Mabuiag and St Paul’s respectively according to the ABS 2006 Census (ABS 2006d, e). The cost of a hunting trip was thus equivalent to 52% – 79% of the average weekly income of a Mabuiag resident and equivalent to 46% – 69% of the average weekly income of a resident of St Paul’s.

Because of the importance of this investment as a proportion of the household budget, hunters and their party need to raise money to cover the costs associated with hunting. Hunters (either on wages or CDEP) use their income to pay for the expenses involved in a hunting trip (fuel and oil), but the household surveys and informal interviews highlighted the fact that the costs of a hunting trip were not always the sole responsibility of the hunting party. Although the costs of hunting (fuel and oil) were the responsibility of the person who was perceived to have the best economic position among the hunting party (hunters who are on wages), these costs were usually divided among the three members of a hunting party so most hunters paid about $40 to $60, an amount equivalent to 18% - 26% of the individual weekly income of a Mabuiag resident and 15% -23% of the individual weekly income of a St Paul’s resident. In this instance, hunters usually shared fuel and oil expenses before the trip so that there was no profit observed among any of the hunters.

However, the informal interviews highlighted that other mechanisms also exist for hunters to reduce their contribution towards the cost of hunting trips. Hunters use their CDEP income on their pay week and on alternative weeks use other resources.

(1) Hunters can draw upon the resources of pensioners[32] (who, throughout the year, receive pension payments on alternate weeks from residents on CDEP) and,

(2) Hunters may receive money from contributions from family members living in other Torres Strait communities or on the mainland[33]. These contributions may be financial or may include other compensation such as providing other goods not available on the island or accommodation when traveling. Monetary compensation was also given to hunters if someone on the island requested them to go hunting on their behalf.

Figure 4-7 summarises the flow of money or of other compensation between various resource user groups of the traditional fisheries as a way to share costs among resource users. I used a hypothetical timeline (weeks x and y) to highlight the importance of the timing of income payments among the different categories of households, especially the timing of CDEP payments and pensions' payments.

[32] Due to a combination of financial pressure, poor money management and government payment timelines, some pensioners were asked to provide money for fuel and oil by their younger relatives in exchange of a share of the harvest. Community representatives of both Mabuiag and St Paul's recognised that such behaviour was taking place although they considered that pensioners should receive shares of traditional meat as a priority and without contributing to the cost of hunting.

[33] Those contributions which are either financial or in other forms can be described as the equivalent of remittances. Remittances in those communities are likely to be important as in other Pacific Island communities (Jayaraman *et al*. 2009) however no studies to date have looked at remittances in Torres Strait.

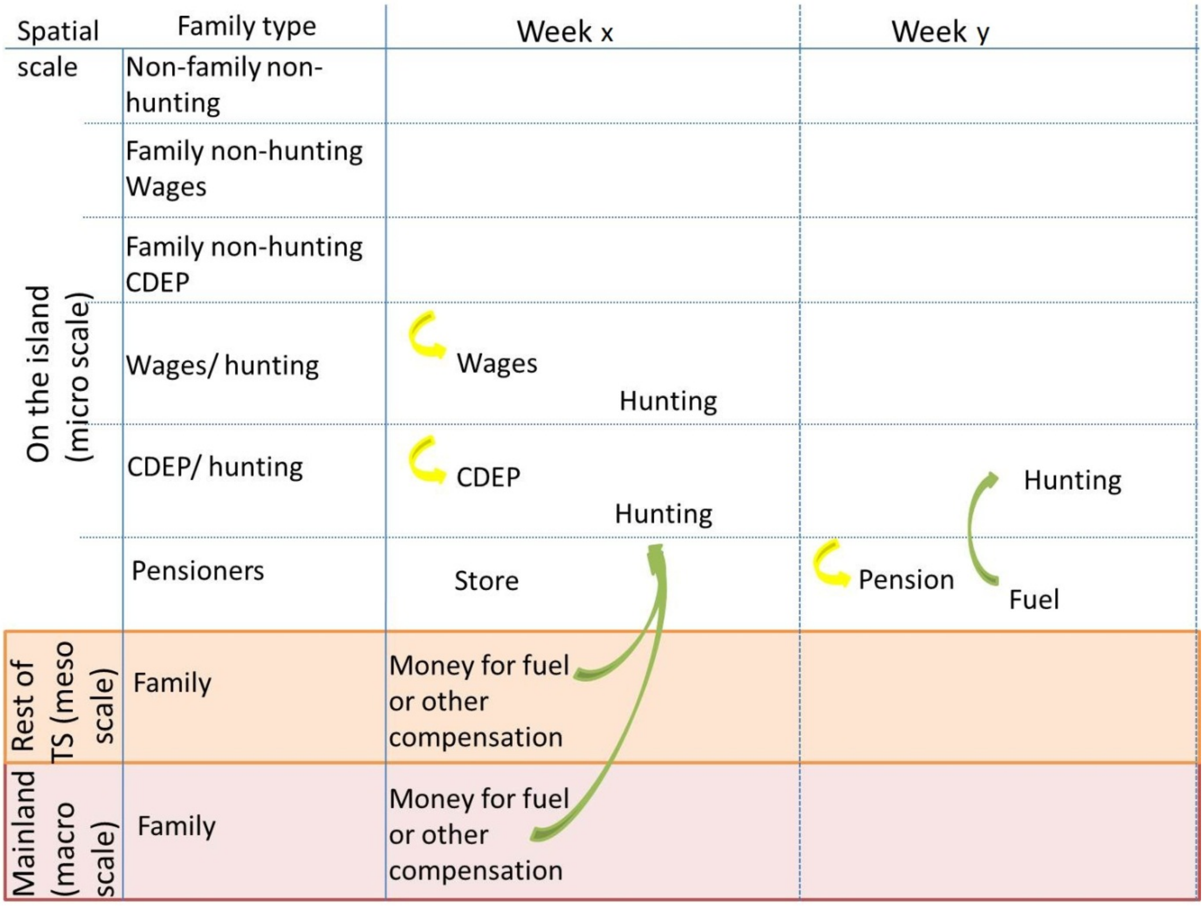


Figure 4-8. Sharing cost arrangements between the different resource user groups of the traditional fisheries. Yellow arrows show direct financial contributions towards the cost of hunting, green arrows show indirect financial contributions. The framework summarises the data I collected via informal discussions, individual interviews and household hunting questionnaires from August 2009 to June 2010.

4.3.1.2 Benefits

4.3.1.2.1 Sharing of food for home consumption

Once a hunting party was successful, the animals were butchered on the islands and then shared among other community members external to the direct hunter's household.

Household surveys indicated that 90% of the harvest caught for subsistence was shared outside the direct household unit of the hunters. Of those shared catches, 90% was shared among hunters and their kin[34]. The remainder 10% was not shared among hunters

[34] Kin represent people with whom a person has strong connection and responsibilities towards. Members of the same kin do not have to share a direct blood relationship.

and their families but among their kin and their immediate neighbours who were in the most part blood relatives (Figure 4-8). Kins and immediate neighbours are represented as the two categories of “family non-hunting” and as the category of “pensioners” in Figure 4.8.

The size of the share provided to family members depended on criteria of perceived “need”. Hunters explained that they shared their catch more often with members of their families that had a low income and/or who were responsible for a large number of dependents. Although the frequency of sharing with households in need was higher than with others, the size of a share was not proportional to the size of the household. For example, the size of the share of dugong or green turtle meat received by a household of three individuals would be the same as a household of nine individuals after a particular hunt. However, the number of occasions on which a household received traditional meat reflected the size of the receiving household.

As discussed in section 4.2.3.1.4, the household surveys also showed that the sharing networks were not restricted to family members living on the same island but involved sharing outside communities. Traditional meat was exported to other families living on another island in the Torres Strait (including Papua New Guinea) or to the Australian mainland. If a dugong or a turtle was landed for purposes other than community feasting and celebrations, there was a 70% chance that at least one share would be sent outside the communities for dugongs and 80% chance for turtles (either to other Torres Strait Islands or Australian mainland) (Figure 4-8).

In sum, at any given time, a household in the Torres Strait must make a decision regarding provisioning of meat. As noted above, there were three sources of meat on the islands and different categories of households had differential access to them. For households with no hunters and with no connection to hunting parties, the only source of meat was the local store (source 1). For households with at least one male hunter and households related to a hunter via kinship, the meat could be sourced either from the local store (source 1), hunted (source 2) or received through sharing behaviour from another household (source 3).

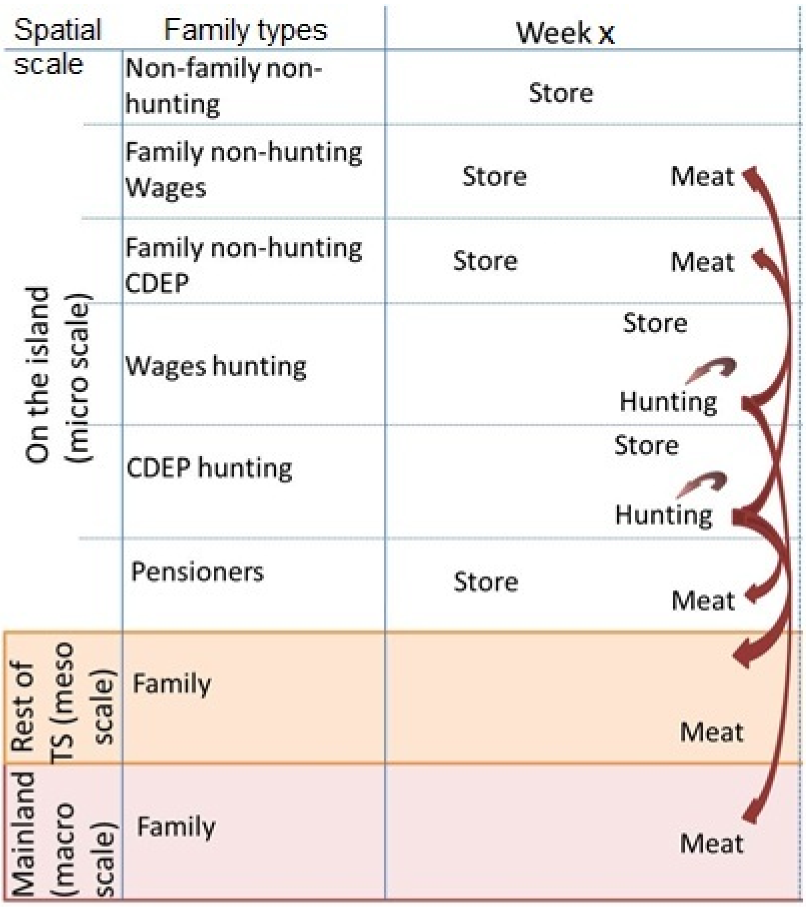


Figure 4-9. Sharing arrangements between the different resource user groups of the traditional fisheries. Pink arrows show meat distribution. The distribution of meat between different resource user groups does not always involve all groups following a successful hunt and might be restricted to only a few of the resource user groups. The framework summarises the data collected via informal discussions, individual interviews and household hunting questionnaires from August 2009 to June 2010.

Figure 4-9 summarises these different relationships – including information about both the cost-sharing arrangements (presented earlier in section 4.3.1.1) and the meat sharing arrangements discussed here. Evidently, the sharing behaviour provides different households with the benefits of dugong and turtle meat rather than meat from local store. In return, the reciprocity arrangements covering the costs associated with hunting help explain the maintenance of the sharing behaviour in the modern setting (i.e., hunters are hunting from boats requiring fuel and oil as opposed to hunting from canoes or platforms).

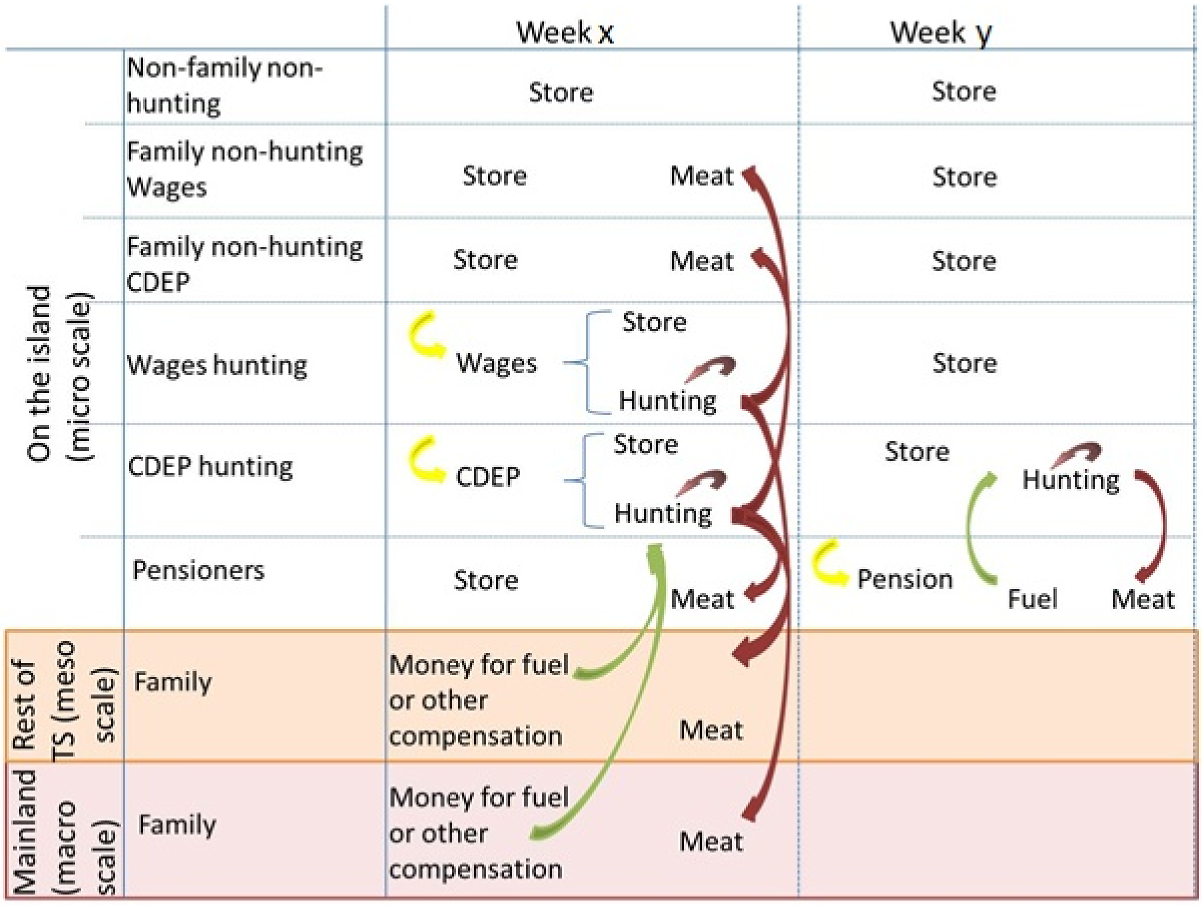


Figure 4-10. The sharing network in the traditional dugong and green turtle fisheries for meat used for home consumption. Pink arrows show meat distribution; yellow arrows show direct financial contribution; green arrows show indirect financial contribution. I used weeks in the timeline to draw a relationship between household income and decisions to go hunting or receive meat. Week x and week y highlight that hunting trips were not occurring every week. The framework summarises the data collected via informal discussions, individual interviews and household hunting questionnaires from August 2009 to June 2010.

4.3.2 Food for ceremonies

Apart from contributing to the subsistence sector of the economy on both islands, hunting was also a feature of community events and feasting. When important ceremonies such as a male initiation, a male first shaving celebration or a 21st birthday party were scheduled on one of the islands, the family members organising the event recruited hunters to harvest dugongs and green turtles. Extended family members living in the community would be asked to contribute money towards the fuel costs of the hunters. In the case of a special community event organised on an island (for instance opening of a guest house on Mabuiag), all members of the community provided some money to help pay for the fuel costs of the hunters. The household hunting questionnaires, the subsistence and the ceremonial frameworks indicated that hunters were asked to go hunting by other people 25% of the time. Irrespective of the purpose of a ceremony (family or community), all members of the community benefited from a share of the traditional meat (Figure 4-10).

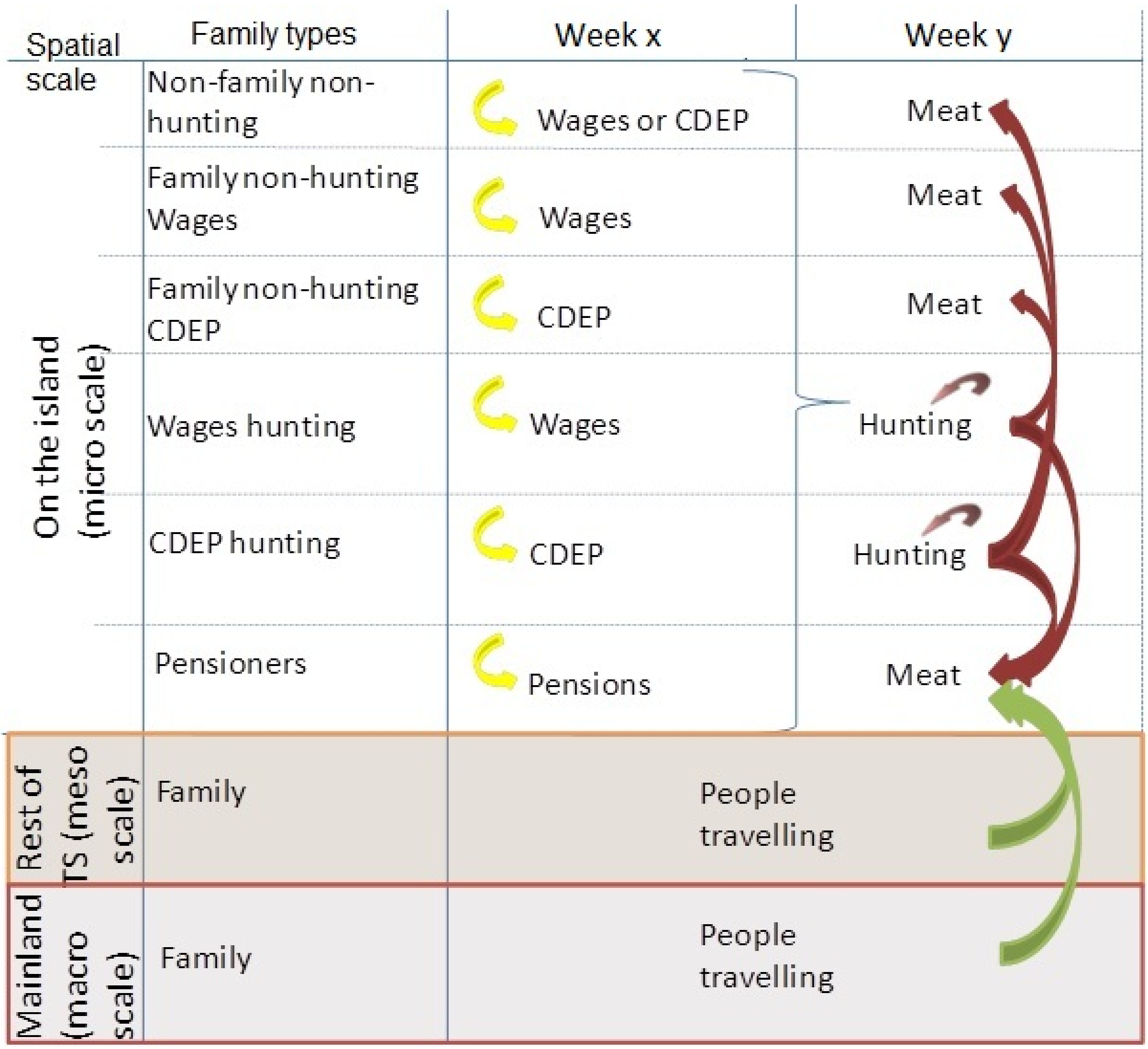


Figure 4-11. Conceptual framework of the flow of monetary, traditional resources and people for a ceremonial event. Pink arrows show meat distribution; yellow arrows show direct financial contribution; green arrows show indirect financial contribution through people travelling to attend the ceremonial event in Torres Strait. I used weeks in the timeline to highlight that the direct financial contributions towards the cost of hunting may occur for a period of time prior to the event. The framework summarises the data collected via informal discussions, individual interviews and household hunting questionnaires from August 2009 to June 2010.

There were important differences in the directions of the flow between the meat used for home consumption and the meat used for ceremony when it came to resource user groups living outside the focal communities. In the home consumption framework (Figure 4-9), the traditional meat of dugongs and green turtles moved outside the communities (to other Torres Strait communities, coastal villages in Papua New Guinea or to the Australian mainland). On the other hand, in the ceremonial network (Figure 4-10) the resource user groups residing outside the communities' boundaries moved while traditional meat stayed within the Torres Strait community.

4.4 Discussion

This chapter described the resource users of a complex linked social-ecological system; i.e., the traditional Torres Strait dugong and green turtle fisheries. Characteristics of these resource users were highlighted and provided the context for the management of these fisheries.

Relative to the wider Australian community, Torres Strait Islanders are disadvantaged according to most financial indicators (see section 2.3.2). This disadvantage is even more marked for Torres Strait Islanders living on the outer islands as exemplified by the two communities of Mabuiag and St Paul's. Residents of these two communities are at a significant financial disadvantage compared with people living on the mainland due to the cumulative effects of low income, high commodity prices and the necessity of spending a high proportion of their household budget on food items.

Much has been said about the disadvantage faced by Australian Aboriginal (Indigenous) communities (ABS 2005; Adams 2002; Altman and Hunter 2003; Duncan 2003; Edwards and Madden 2001; Trewin and Madden 2003). However, most of the conclusions have been drawn from national datasets that gather standard information about the Australian population in general. These data are usually collected by the Australian Bureau of Statistics whose role is to provide a picture of the Australian population at a particular point in time. However, beyond data collected at a national level during its five-yearly

Censuses, the ABS collects only limited socio-economic information specific to Indigenous communities during its survey of Aboriginal and Torres Strait Islander Health. Survey instruments on the prices of commodities are not administered in very remote locations and the national Household Expenditure Survey is not administered in remote locations and does not have a flag for Indigenous households.

Researchers working with Aboriginal communities make reference to the price of some commodities but few studies have quantified the socio-economic context of an Indigenous community using secondary data complemented by primary data in the form of shop surveys and Household Expenditure Surveys. Stoeckl and colleagues (2011) was the first study to compare household expenditures based on Indigeneity. I extended this work by obtaining information on the incomes of people living in the two communities of Mabuiag and St Paul's. I combined this information with information on commodity prices to compare the real income of the two Indigenous communities and to highlight the "double burden" faced by people living in these remote islands.

This significant financial disadvantage justifies supplementing the household budget with wild resources[35] and provides some (but not all, see chapter 5) reason for Torres Strait Islanders to go fishing or hunting: it offers an alternative to store-bought meat. Torres Strait Islanders have a long seafaring tradition and have taken advantage of their proximity and knowledge of the sea to use marine resources for at least 7 000 years (Wright *et al*. 2011). As well as hunting for dugongs and green turtles, Torres Strait Islanders (men, women and children) often glean or fish from the shore or go on fishing day trips (pers. observation).

[35] Kwan *et al*. (2006) highlighted the negative correlation that exists between crayfish revenues and dugong harvest.

There are also a number of other commercial fisheries in the Torres Strait which are important for the local economy (TSRA 2005). These include prawn, tropical rock lobster, spanish mackerel, pearl shell, barramundi, finfish, crab, trochus and sea cucumber fisheries (PZJA 2012). The tropical rock lobster fishery is an important commercial fishery in the Torres Strait and a study by Kwan and colleagues (2006) highlighted the inverse relationship which exists between crayfish revenues and the frequency of dugong and turtle hunting. Other hand-collectable fisheries such as bêche-de-mer, trochus and other shellfish are also important in the Central and Eastern parts of Torres Strait. Only the financial aspects of those commercial fisheries have been studied and no study to date has looked at the other benefits or costs of those fisheries as done in this study for the Torres Strait Indigenous dugong and green turtle fisheries (which are referred as the two only "traditional fisheries" in the Torres Strait).

Marine resources and products grown on the islands were the only food resources available to residents of the outer islands until the Australian government started to provide alternative forms of food (Beckett 1987). Following the provision of food imports from the mainland, Torres Strait Islanders started to change their diet from reliance on harvested food to a diet based on store-bought foods (Beckett 1987; Raven 1990). Many communities abandoned their gardens and culture of traditional vegetables such as taro and yams (Mabuiag female resident pers. comm.), although community gardening still produces root vegetables in some islands (Green 2006). This change in diet had unforeseen consequences for the health status of Torres Strait Islanders. Like many other Indigenous people in Australia, Torres Strait Islanders now have a high rate of obesity and diabetes (McDermott 2005; McDermott *et al.* 2007). Several studies have highlighted the consequences of this change in diet from subsistence-based to processed carbohydrates on the health of Indigenous communities and island communities in the Pacific. For instance, studies have shown that many small island countries have the highest per capita rate of obesity (Brooks 2011). In Australia, other studies have shown the nexus between health and the change of diet (O'Dea 1984). Although the change in diet is apparent in communities in Torres Strait, modern day living has not eradicated the traditional relationship between Torres Strait Islanders and their marine environment which they continue to use to feed their families.

Torres Strait Islanders' reliance on seafood (including dugongs and green turtles) is now also influenced by the relatively high cost of store-bought meat (Figure 4-6). Thus, hunting for dugongs and green turtles contributed to the provisioning of meat to Torres Strait Islander families who are otherwise suffering from the "double burden" of low income and high commodity prices.

However, the modern practices of hunting incur substantial financial costs. In addition to the initial cost of purchasing a boat (which most households have), hunting requires financial commitment to pay for fuel and oil. The practice is costly especially for less skilled hunters who have a low success rate. Due to the cost of the activity and its importance in terms of relative income and household budget, hunters have established mechanisms to finance their activities. Fuel and oil can be purchased by the person in a hunting party who is perceived to be the most well-off. In most cases, hunters in a hunting party divide the costs of fuel and oil between them. Hunters may also get part of the money necessary to fund a hunting trip from their relatives including pensioners.

Sharing costs means that the communities of Mabuiag and St Paul's are investing in the traditional dugong and green turtle fisheries. In return, the benefits of a successful hunting trip are shared with various community members. Different rules exist on how many shares are divided and who in the community will benefit. These rules are quite extensive and have evolved over time as circumstances change. The rules of resource sharing have not been mapped in their entirety, but some of them were described in Haddon (1890, 1912) and Nietschmann (1977b). It appears from a comparison with those previous studies that sharing used to involve the whole community while sharing is nowadays mostly restricted to family members as described in this study. Although hunters are the central players in the provision of traditional meat on an island, the reciprocity arrangements for costs and benefits among several households mean that the resource users are not only defined by hunters and their immediate households but also by the whole community that is directly investing in the costs of the fisheries and receiving its benefits. These arrangements extend the resource users beyond hunting households to the whole outer island community and beyond. Sharing not only takes place within communities but also between communities (including those in PNG) and the mainland.

Thus, the reciprocity arrangements highlighted in this chapter enabled me to define the boundaries of the resource users' system and to highlight the mismatch between the current resource unit boundaries, the governance system boundaries and the resource user sub-system boundaries (Figure 4-11). Clearly, the boundaries of the resource user sub-system are not well aligned with the boundaries of the other sub-systems (Figure 4-11).

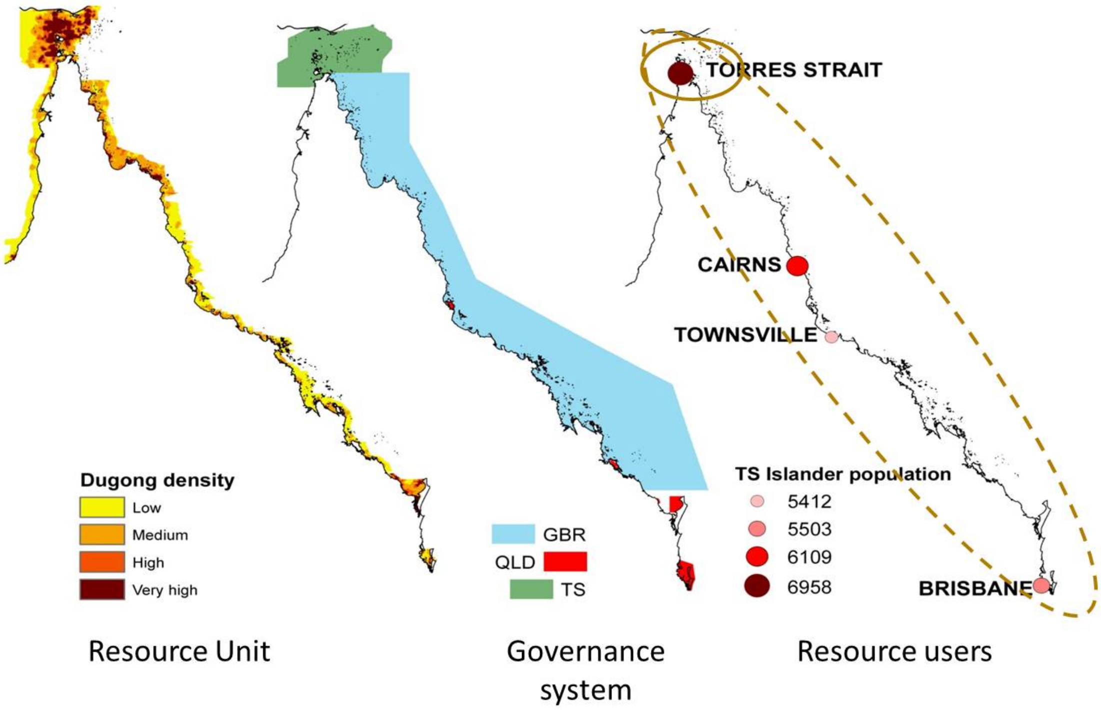


Figure 4-12. Boundaries of the resource unit, governance system and resource user sub-systems of the Torres Strait traditional fisheries. The resource unit and governance system maps were drawn by Alana Grech and reproduced with permission. The data used to map the resource users and highlighting the size of the Torres Strait population in diverse locations was derived using data from ABS 2006 Census.

This mismatch indicates the importance of considering whether current management arrangements (that are focused on the individual communities) should be extended to include resource users outside the current management boundaries. The size of the Torres Strait Islander population that currently resides on the Australian mainland means that their views and demand for traditional dugong and turtle meat needs to be taken into consideration. This question for further research is currently being explored by Stoeckl, Watkin-Lui, Marsh and myself in an Australian Marine Mammal Centre-funded project.

Moreover, as mentioned in section 4.3.1, the reciprocity arrangements between residents in the Torres Strait and family members living on the mainland might be described as a form of remittance (although here it is clearly reciprocal in nature – not just money flowing from those who have moved away to those remaining in the traditional homeland). Remittances are very important in Pacific Island countries and contribute to the growth and economic development of those countries (Jayaraman *et al.* 2009). To date, no studies have explored the importance of remittances in the Torres Strait. As with the other contributions and the cultural links which exist between the different resource user groups, a study on remittances, their geographical source, their importance and their role could help in determining the size of the socio-economic system of the Torres Strait Indigenous fisheries but also the size and boundaries of the socio-economic system of customary social-ecological systems in general.

The findings of this thesis posit that the current management arrangements for the Torres Strait Indigenous dugong and turtle fisheries may not be optimal due to the tight relationships between the different groups of resource users which share both benefits and costs of the fisheries. These findings in terms of fisheries management might be less relevant in non-Indigenous societies which are more market-oriented. Generally, the wider Australian community is not involved in the management of fisheries as Torres Strait Islanders people described in this study are. This may not be a bad thing because the wider Australian public does not usually share the costs associated with fisheries and the borders between those who 'supply' and those who 'demand' are less imprecise than they are in the dugong and turtle fisheries. As a result, the boundaries of the management systems for other more market-oriented Australian fisheries might aim to follow the rules described by Ostrom (2007) but should probably not be extended to include all the buyers as resource users. However, future research should investigate how the findings of this thesis can be applied to fisheries management in Aboriginal Australian contexts as sharing might also be an important part of the way of life of Aboriginal people.

Finally, it is important to note that the existence of a conceptual framework for the home consumption of traditional meat and for ceremonies demonstrates that the costs and benefits of hunting extend beyond financial considerations. The other aspects of hunting are explored and discussed in more detail in the next chapter.

4.5 Chapter summary

- Members of Mabuiag and St Paul's communities are financially disadvantaged in comparison with the average Australian.
- Traditional hunting provides an alternative to store-bought meat.
- A traditional hunt is an expensive activity costing the equivalent of 46% - 79% of the average weekly individual income of a resident of Mabuiag or St Paul's.
- To reduce the financial costs associated with traditional hunting, hunters solicit money to pay for their hunting trip expenses from other hunters, family members including pensioners.
- The distribution of traditional meat for the purpose of home consumption involves complex interactions among the different actors involved in the traditional dugong and green turtle fisheries. The frequency and intensity of the interactions were based on kinship and socio-economic context.
- Traditional hunting is an activity that involves the whole community, not just the hunters.
- Due to the number of people involved in the traditional dugong and green turtle fisheries, managers need to be aware of the potential consequences of a new management system on different resource user groups.
- As the sharing of traditional dugong and green turtle meat extends beyond Torres Strait, management should also consider the consequences for the potential involvement of stakeholders from Papua New Guinea and the Australian mainland (i.e., the Diaspora).

- Investigations into the costs and benefits of these fisheries and/or potential impacts of managerial arrangements need to incorporate information from all resource users (not just the hunters).

CHAPTER 5:

BENEFITS AND COSTS ASSOCIATED WITH THE TORRES STRAIT INDIGENOUS FISHERIES

In this chapter, I investigated the benefits and costs that were associated with the Torres Strait Indigenous dugong and green turtle fisheries, focusing on the opinions of local community members. I worked with two Torres Strait communities: (1) using interviews to generate lists of the costs and benefits that Torres Strait Islanders considered to be associated with traditional hunting; (2) using cognitive mapping to group different types of costs and benefits into homogenous, but independent clusters; (3) learning more about the relative importance of those clusters (in non-monetary terms); and (4) using the replacement cost method to generate a monetary estimate of the market benefits associated with hunting. As this research considered the views of Indigenous people who may have a different value system to that prevalent in "Western" societies, I also evaluated the extent to which the clusters of homogeneous values identified by Torres Strait Islanders matched the clusters contained within the Total Economic Value framework.

5. Understanding complex interactions between market and non-market values for Natural Resource Management: a remote Australian Indigenous community case study.

5.1 Introduction

Much past work on natural resource use has concentrated on ecological issues, although economic factors have received greater attention in recent years (Mather and Chapman 1995). The ecological work has been useful in documenting the extent of the biophysical problems and the attributes of natural environments, but has generally been unable to provide information that is useful to policy makers when choosing between alternative uses for a particular ecosystem (Field and Field 2006). Economics is, essentially, the science of choice, and thus has much to offer in this area.

From an economic standpoint, the central objective should be to maximise values to society, over time, from the use (including conservation) of resources (Daly 1996). In theory, an efficient allocation of resources can be achieved if the marginal benefits of an activity are equal to its marginal costs. The first step is then to define the different benefits and costs of an activity before valuing them. However, the task of defining and subsequently valuing the benefits and costs associated with an activity are complex and challenging particularly when they are both within and outside the market as in the case of many activities associated with an Indigenous or other traditional livelihood system (Adamowicz *et al.* 1998a).

Since the days of Alfred Marshall, economists have recognised the important distinction between price and value (hence the concept of consumer surplus) (Marshall

1920). Moreover, they have long recognised that there are numerous values associated with the environment and that many fall outside existing markets, giving rise to the concept of Total Economic Value (TEV).

A growing body of literature is dedicated to non-market valuation techniques that are used to generate monetary estimates of these 'values'. Most researchers seek only to estimate a component of TEV (e.g., recreational use values) (Gurven 2004). But some seek to estimate TEV by firstly generating an estimate of the value of each component, and then adding (Franzen 2004; Oxford Economics 2009). However, practitioners of this approach need to be wary: components may not be mutually exclusive (or separable) and values should not be double-counted (Kengen 1997). The United Nations Environmental Programme guidelines for environmental valuation warn against simply adding up the resultant values of different components to obtain TEV (UNEP 2007), although this practice appears to be common. Not only are there difficulties in ensuring the separability of the broad categories (such as use and non-use), but there are challenges within given categories. Many authors disagree, for example, about whether to include option values as use or non-use values; some authors have restricted non-use values to include only existence values (Adger *et al.* 1995; Torras 2000), while most studies consider bequest values as well as option values. Cummings and Harrison (1995) also note that the separability of option, bequest and existence values has not been proven. In short, there does not seem to be any clear and unambiguously sensible way in which to classify the different components of TEV.

In addition, the values associated with the environment are likely to be influenced by cultural and social norms which are likely to be different in Indigenous and Non-Indigenous contexts. Thus, assuming that both Indigenous and Non-Indigenous people have similar views about the components of TEV and their interactions may be incorrect. Thus proceeding to 'do' a 'typical' valuation study of a 'traditional' component of TEV, without first testing the validity of such assumptions, may generate false and/or misleading information.

In order to understand the benefits and costs associated with Indigenous hunting in Torres Strait, I developed an alternative approach to learning more about the TEV of Indigenous hunting and the relative importance of its components. My underlying hypotheses were that: (a) TEV is comprised of many components; which (b) may or may not be classified according to traditional economic descriptors such as 'use' and 'option' and 'non-use' values; and which (c) may or may not be separable. I assumed that if one can create groups of components – hereafter termed 'clusters' – which are internally homogeneous and externally heterogeneous (i.e., separable), then it was valid to compare the relative importance of those 'clusters' to learn more about the contributors to TEV in an Indigenous community.

I had several key objectives:

(1) To learn more about the costs and benefits of Indigenous hunting in a remote Indigenous community – linked to hypotheses (a) and (b) above;
(2) To test the efficacy of cognitive mapping as a tool for identifying separable 'clusters' of costs and benefits – used to test hypothesis (c) above and;
(3) To compare the relative importance of separable components of the costs and benefits associated with hunting.

To fulfil my objectives, I used three different techniques. First, I used open-ended interviews to elicit values in terms of costs and benefits (market and non-market) that are associated with the Indigenous fisheries. At the beginning of the interview, I described an example of costs and benefits. I provided an illustration of costs and benefits associated with my experience in living in a rural community rather than an urban area. This demonstration helped the participants to understand that costs and benefits are not only associated with the market.

Next, I used cognitive mapping in an Indigenous context to provide a practical demonstration of a non-monetary method for eliciting information and identifying clusters of homogeneous costs and benefits that are associated with Indigenous hunting. For this part of the research, I used cognitive mapping as a technique to improve understanding of the mental construct of 'values' (Ozesmi and Ozesmi 2004). This technique is described in greater detail in section 5.2.2. Suffice to say here, concepts which 'go together' are depicted as being close together in a cognitive map, while those that do not go together are far apart. The advantage of this technique is that many beliefs and attitudes can be pictured simultaneously in order to see their interrelationships (Studley 2005). So, cognitive mapping could test for the inter-relations or independence of components of the TEV of Indigenous hunting. Thus, my research demonstrates the way in which cognitive mapping (a tool which is relatively common in some other social sciences, but relatively uncommon in economics) can be used to shed light on the vexing problem of separability that is crucially important to many non-market valuation techniques.

Finally, I used rating exercises to gain valuable insights about the relative importance of the clusters of homogeneous costs or benefits (market and non-market) associated with the Indigenous hunting of dugong and green turtles. I decided to use those exercises rather than other non-market valuation techniques such as contingent valuation, which have been criticised as being unsuitable for research in Indigenous communities (see review by Adamowicz *et al.* 1998b; Venn and Quiggin 2007).

In the next section, I describe the specific methods used in this chapter, I then present my results; and finish with some concluding comments.

5.2 Methods

5.2.1 IDENTIFICATION OF THE COSTS AND BENEFITS OF TRADITIONAL HUNTING

After consultation, one-on-one interviews involving men and women on both Mabuiag and St Paul's communities were deemed to be an appropriate method for collecting data to test hypotheses (a) and (b) above[36]. A meeting attended by community representatives was organised in each community to identify appropriate interviewees from a cross-section of the local population.

The first step in understanding the market/non-market values of Indigenous hunting was to generate a list of benefits and costs via free listing. Interviewees were asked two focal questions:

(1) What are the benefits of Indigenous dugong and green turtle hunting?

(2) What are the costs of Indigenous dugong and green turtle hunting?

The first interviews were conducted with a man or a woman who had been selected by the community representatives as the appropriate first person to interview. At the beginning of each interview, I emphasised that the participant could contribute any items

[36] Ethics approval for this project was received by the University's ethics human committee (permit number H3085); and a prior consent was obtained for each participant.

that he/she believes should be on the list. Interviews lasted between 20 to 50 minutes during which each response was recorded in a notebook.

The next interviewees were selected among the list of appropriate interviewees provided by community representatives of Mabuiag and St Paul's communities and reflected a cross-section of the local population. The selection of participants for those preliminary interviews stopped once the point of saturation was reached (i.e., no new elements were identified by new interviewees) (Stark and Torrance 2006). In each community, this occurred after interviewing ten participants; six men and four women on Mabuiag Island and five men and five women on St Paul's. Items were reviewed after each interview to eliminate duplicates and generate final lists of benefits and costs. The final lists were collectively reviewed by the interviewees of each island to check for accuracy and to develop an agreed set of definitions for each item. This step was important to prevent possible misunderstandings from people who had not been part of the initial interview process but were potential participants in the next stage of the research.

5.2.2 Separability of values: testing cognitive mapping

As stated earlier in hypothesis (c), the components constituting TEV of dugong and green turtle hunting in Torres Strait may or may not be separable. I chose to use cognitive mapping to identify separable 'clusters' of costs and benefits.

Cognitive mapping is an umbrella term that encompasses such techniques as causal mapping, semantic mapping and concept mapping. A cognitive map can be described as a qualitative model of how a given system operates. The map is based on defined variables and their relationships. These variables can be physical quantities or abstract ideas (Ozesmi and Ozesmi 2003). The person making the cognitive map decides on the important variables that affect a system and then either draws causal relationships among these variables (i.e., causal mapping); with the possibility of indicating the relative strength of the relationships with a number between −1 and 1 (i.e., fuzzy causal mapping); or decides how the variables are interrelated (i.e., concept mapping).

Cognitive mapping techniques have been used to study decision-making as well as to examine people's perceptions of complex social systems (Axelrod 1976; Brown 1992; Carley and Palmquist 1992). Such techniques have been successfully applied in natural resource management to improve decision-making, define management objectives and analyse stakeholders' perceptions of ecosystems (Hobbs *et al.* 2002; Mendoza and Prabhu 2003; Ozesmi and Ozesmi 1999; Radomski and Goeman 1996). Although the three main cognitive techniques listed above may differ in their practicability, all try to understand how an individual interprets concepts. The general method is to obtain from individuals a list of statements about a given problem focusing on meaningful concepts and the relationships among those concepts. The idea is to describe those concepts and their relationships in a graphical layout (Fiol and Huff 1992).

I used cognitive mapping to test for the separability (and potential lack of separability) of those values that were elicited during the first part of the project. I aimed to acquire a collective understanding of hunting value interactions based on each informant's individual understanding of those relationships. The finalised items for benefits and costs were used in a sorting exercise to increase understanding of how the different benefits (or costs) were related to one another. The result of the exercise provided the data needed to generate clusters or groups of values that are closely linked.

The ten people from each island who had participated in the preliminary interviews were invited to take part in this activity. Additional members of the communities were also invited to perform this exercise to obtain a more representative sample. The exercise consisted of one-on-one sessions, each of which lasted 30 to 45 mins. On Mabuiag, a total of 40 residents were asked to participate out of which 38 residents (29 men and 9 women) agreed (giving a 95% response rate that represents 38% of the permanent Islander adult population of Mabuiag). On St Paul's, 45 Islander adults were asked to participate and a total of 40 agreed (30 men and 10 women) (giving a 89% response rate, with a sample that represents 31% of the permanent Islander adult population on St Paul's). Participants on both islands were recruited through snowball sampling to characterise a cross-section of the population as well as a cross-section of the different locations where people live in each community.

Each session involved an individual sorting activity designed to learn about how the participant viewed and categorised individual values (Coxon 1999; Rosenberg and Kim 1975). Each participant was presented with two sets of cards representing the costs or benefits of Indigenous hunting obtained previously. Each card contained only one item. I explained how the items had been generated to the new participants. Respondents were asked to use each set of cards to describe the relationship between the different items based on their perceived similarity. Specifically, they were asked to compare the items (or values) and place them into clusters that "went well together". The participants were informed that each card could be placed in only one cluster; and that they should avoid grouping the cards into only one cluster. Those rules helped the subsequent analysis and pre-empted the problem of the exercise resulting in only one cluster containing heterogeneous items. In addition to sorting their cards into clusters, participants were asked to provide a name or label for each of their clusters. The exercise was performed twice, once to cluster the benefits of Indigenous hunting according to their perceived similarity and once to cluster the costs of hunting. I encouraged each participant to explain the rationale behind his/her categorisation.

Several methods were used to analyse the sorting results to obtain an "all participants" map depicting the relationships between: (1) the benefits and (2) the costs. The clustered data from each participant were translated into separate binary matrices with "presence of the item in the same group" as key criteria. The resulting matrices were analysed both at the aggregate and individual level through Multidimensional Scaling (MDS). MDS is a multivariate technique that aims to reduce multidimensional relationships among data to a smaller number of dimensions that capture the essence of the relationships in a format that is easier to visualise and interpret (Kruskal and Wish 1978). The basis of this iterative analysis was to use a matrix of (dis)similarities between each pair of values based on their grouping. For each pair of values, a distance was calculated. The MDS graphical output was interpreted with items similar to one another plotted together (Kruskal and Wish 1978) and through the stress values of the different solutions. Stress in MDS studies represents the degree of distortion between the points on the MDS map and the input data.

For the aggregated level, the matrices were aggregated across participants for each community and analysed through non-metric MDS. In this case, a particular cell of the matrix represents the number of interviewees that placed item *i* in the same group as item *j*. In addition, the binary matrices of each respondent were analysed separately through metric MDS which allowed for subject differences in the analysis process and resulted in an "all participants" cognitive map of the results. The analysis of the data through MDS (either metric or non-metric) aimed to investigate if the grouping of values conducted individually could be representative of a grouping that existed at the community level.

I then used the data gathered at the aggregated level to compare the collective cognitive maps of Mabuiag and St Paul's communities following the methodology of Blake and colleagues (Blake *et al.* 2003). To determine the comparability of the "all participants" cognitive maps of Mabuiag with the "all participants" cognitive maps of St Paul's, I correlated the distance between each of the possible pairs of values in one cognitive map with the corresponding distances on the other map. I first calculated the Euclidean distances separating all points on the cognitive maps of Mabuiag and the cognitive maps of St Paul's. Next, I used those Euclidean distances to calculate a Pearson R correlation between Mabuiag and St Paul's. I repeated the analysis for benefits and for costs.

For all MDS analyses, either non-metric or metric, I used the option PROXSCAL of the software package PASW 18 (formerly known as SPSS).

5.2.3 Relative importance of the value clusters associated with hunting

I also collected data regarding the perceived relative importance of items associated with Indigenous hunting. I used the sets of cards (described above) that had been provided for the sorting session. Interviewees were asked to score each item on a scale from 0 = not important to 10 = very important. Scores were then normalised, in order to account for individuals who always gave high or low scores, so that the sum of all the scores given by any single individual equalled 1.

Information from the cognitive mapping exercise was then used to group the items and associated scores, into separable clusters "*k*" (defined later as clusters of benefits "k^B" and clusters of costs "k^C"). Both the average and the relative 'value' of each cluster were calculated using Equation 5-1 and Equation 5-2:

$$\textbf{\textit{average 'value' of cluster k}} =$$

Mean value of items belonging to cluster k for each individual "i"

Equation 5-1

$$\frac{\textbf{\textit{Mean value of cluster k}}}{\sum_{k=1}^{n} \textbf{\textit{value of all clusters}}} =$$

Relative value of cluster k for each individual "i"

Equation 5-2

I also compared the relative importance of each cluster of benefits or costs based on community of origin and age. Age groups were defined as: (i) "young people" for community residents under the age of 35 years and (ii) "older people" for community residents aged 35 years old and above. The age cut-off was chosen after discussion with residents from both communities.

5.2.4 Using insights on relative values to draw inferences about total values

In the situation where all items within a given cluster are directly associated with the market, we can generate a monetary (dollar-value) estimate of that cluster (in this study, in AU$).

As will be discussed in section 5.3.5, this step was only performed for benefits. In the case of costs, each cluster identified in the cognitive mapping exercises contained both market and non-market items so the monetary value of an individual cluster could not be estimated from the data. In the case of the benefits, I used the replacement cost method to generate a monetary estimate of the value of a cluster that was associated with the home consumption of dugong and green turtle meat. Further information regarding this particular method is provided in section 5.3.5.

5.3 Results

5.3.1 *IDENTIFICATION*

Eighteen benefits and eleven costs [37](Table 5-1) relative to the Indigenous hunting of dugongs and sea turtles were identified through the interviews. Since the wording used during free listing may have been different between individuals, the content of the list and the different themes elicited by individuals were qualitatively analysed for similarity. A final list was generated by accounting for the similarities between the ideas of different participants and discarding redundancies, and was used for the following exercises.

5.3.2 *SEPARABILITY OF VALUES*

Each participant used the cards to explain their mental construct in regards to the benefits and costs of Indigenous hunting and drew boundaries around the groups of values they identified as clusters. An example of ONE such drawing is given in Figure 5-1. Those boundaries show the existing interactions that exist among values in the mind of that interviewee.

[37] The same benefits and costs were elicited on both islands although different terms were used. I worked with the primary interviewees from both communities to develop a common set of terms and their associated definitions. I then used these terms and definitions in the subsequent part of the study for both islands.

Each individual "cognitive map" was then interpreted and the data were entered as a binary matrix as per section 5.2.2 and investigated through MDS. MDS outputs were then analysed for number of dimensions and for stress.

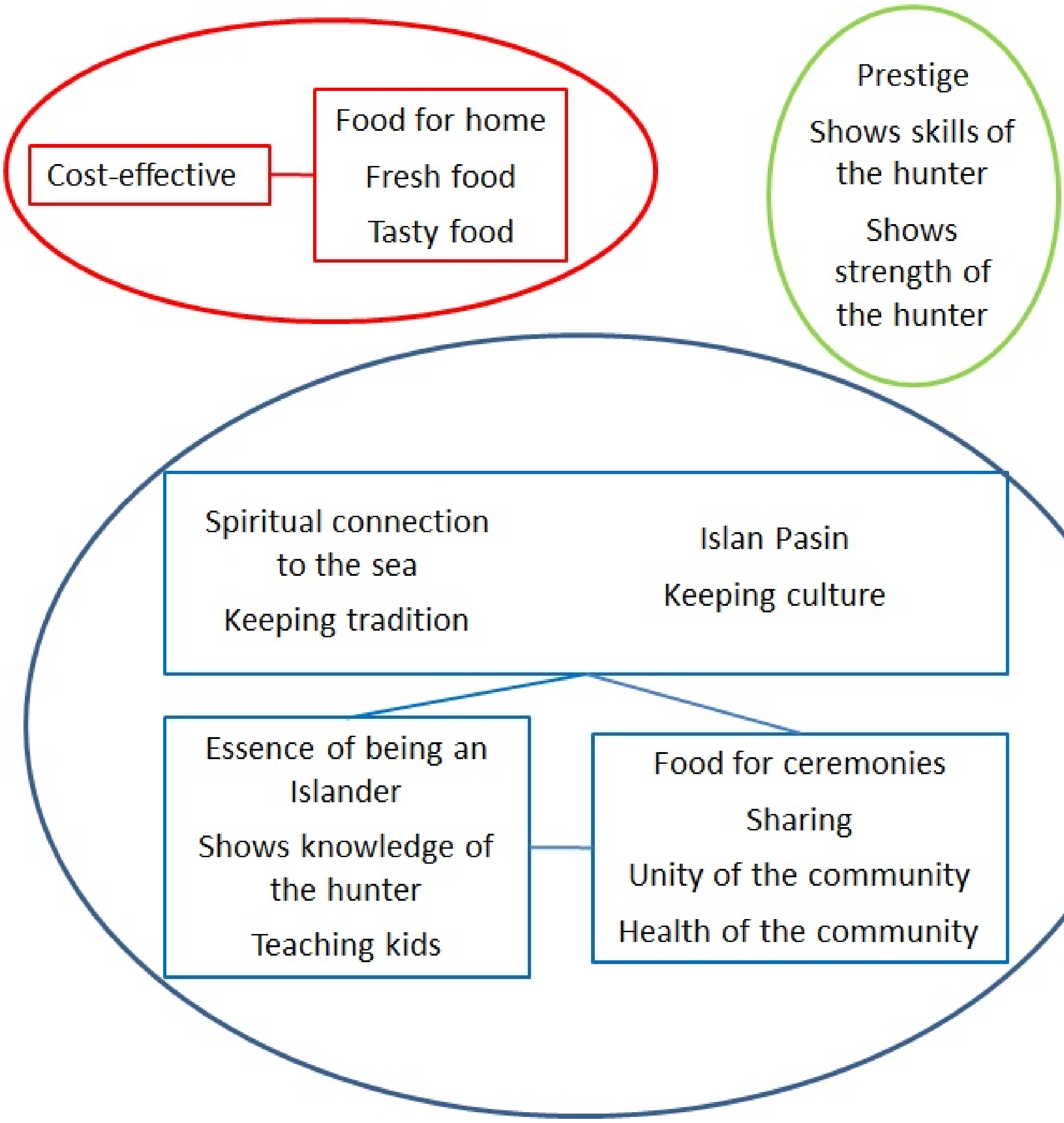


Figure 5-1. Example of how one participant clustered the benefits associated with hunting.

All stress values of the MDS graphical outputs were acceptable according to Kruskal and Wish (1978)'s "rules of thumb" for interpreting stress where a stress of 0.025 is excellent and 0.10 is fair (Figure 5-2a-d). The stress values of the MDS indicated that a three-dimensional solution produces the best fit at both the aggregated and individual levels.

The graphical representations of the results of the MDS analyses helped identify three clusters in the benefits of hunting (Figure 5-2a and b). The content of these clusters was identical in both the aggregated and the individual analysis for both Mabuiag and St Paul's communities. The two representations of the benefits of hunting were highly correlated at 0.989 and significant at the 0.01 level. As a result, the cognitive maps of the combined respondents of Mabuiag and St Paul's are represented here (Figure 5-2a and b).

Both the aggregated and the individual level analyses also identified three distinct and identical clusters for costs associated with hunting for Mabuiag respondents. However, the aggregated and the individual level analyses identified four distinct and identical clusters for St Paul's. The comparison of the two aggregated representations based on the island of residence were perfectly correlated (≈1.0) and significant at the 0.001 level. As a result, the cognitive maps of the combined respondents of Mabuiag and St Paul's were analysed. Once all respondents were combined, the analyses identified the same three distinct clusters that were defined by the Mabuiag respondents. As a result, the cognitive maps of the combined respondents of Mabuiag and St Paul's are represented here (Figure 5-2c and d).

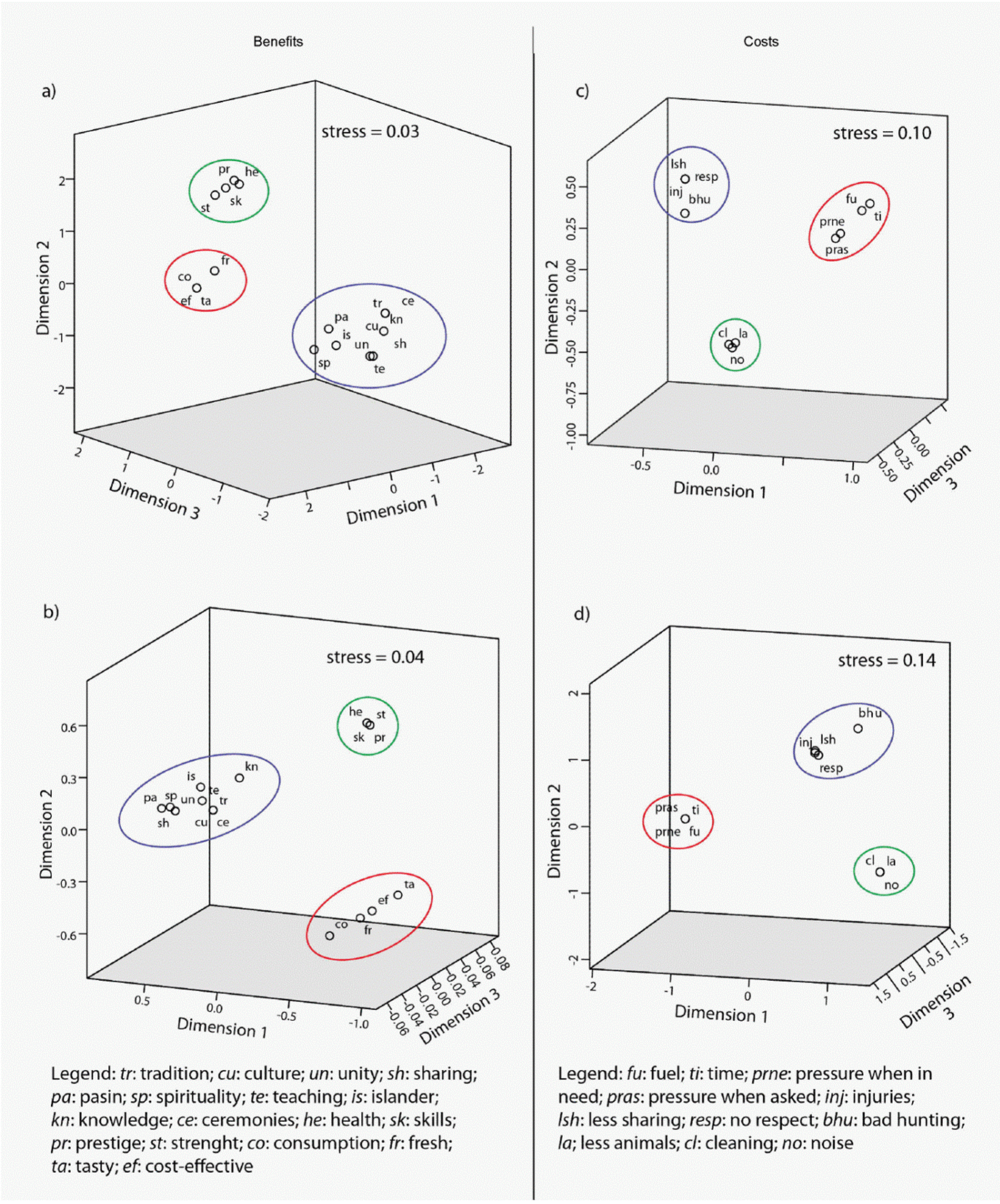


Figure 5-2. MDS representations of the clusters of benefits "k^B" (left column) and clusters of costs "k^C" (right column) at the aggregated level (a) and (c); as well as at the individual level (b) and (d) for the combined respondents of Mabuiag and St Paul's communities (N=78).

5.3.3 VALUE CLUSTERS

Both metric and non-metric MDS techniques indicated that, as a group, people from Mabuiag Island and St Paul's interpreted both the benefits and costs of hunting across three clusters (Table 5-1). After showing the results of the exercise to community representatives of both communities and describing the items in each cluster, the representatives together agreed to label each cluster. The benefits were labelled by community representatives of Mabuiag and St Paul's as community, family or individual benefits. Interestingly, when addressing issues associated with the benefits of hunting, typical market benefits (i.e., termed family benefits and comprising benefits associated with being able to access cost-effective fresh and tasty food for home consumption) were distinctly separated from non-market ones (i.e., community benefits - associated with cultural aspects; individual benefits - those associated with prestige and skills of the hunter).

In contrast, the cost clusters were interpreted by community representatives as community (associated with cultural aspects), family (associated with expenses for hunting and outside pressures) or environmental costs (associated with the impacts of hunting on the marine environment). The separation between typical market and non-market costs was less evident. For instance, costs interpreted as family costs by community representatives are associated with both market costs (i.e., fuel and time) and non-market costs (i.e., pressure to catch food for own household and pressure to catch food for other people). Those pressures relate to the strain hunters are under at particular times when they feel they need to achieve a successful hunt (i.e., catch at least one dugong or one turtle). Those costs are clearly not measurable in the market (i.e., catching food for other people).

Table 5-1. Interpretation of the clusters of benefits "k^B" (left column) and clusters of costs "k^C" (right column) identified at the community level. The content of the clusters represent the cognitive views of the respondents from Mabuiag and St Paul's communities and analysed through MDS.

Benefits		**Costs**	
Cluster name	**Items**	**Items**	**Cluster name**
Community benefits	Keeps Tradition	No respect for cultural protocols	**Community costs**
	Keeps Culture	Bad hunting	
	Sharing	Less sharing	
	Unity of the community	Injuries	
	Islan Pasin (traditional island way of life)		
	Teaching the kids		
	Spiritual connection to the sea		
	Food for ceremonies		
	Shows the knowledge of the hunter		
	Essence of being an Islander		
Family benefits	Food for home consumption	Fuel	**Family costs**
	Fresh food	Time	
	Tasty food	Pressure for results when in need for food	
	Cost-effective practice	Pressure for results when asked to go hunting	
Individual benefits	Shows skills of the hunter		
	Shows strength of the hunter		
	Prestige		
	Health		
		Few animals	**Environmental costs**
		Cleaning animal wastes on the beach	
		Disturbance of animals from noise	

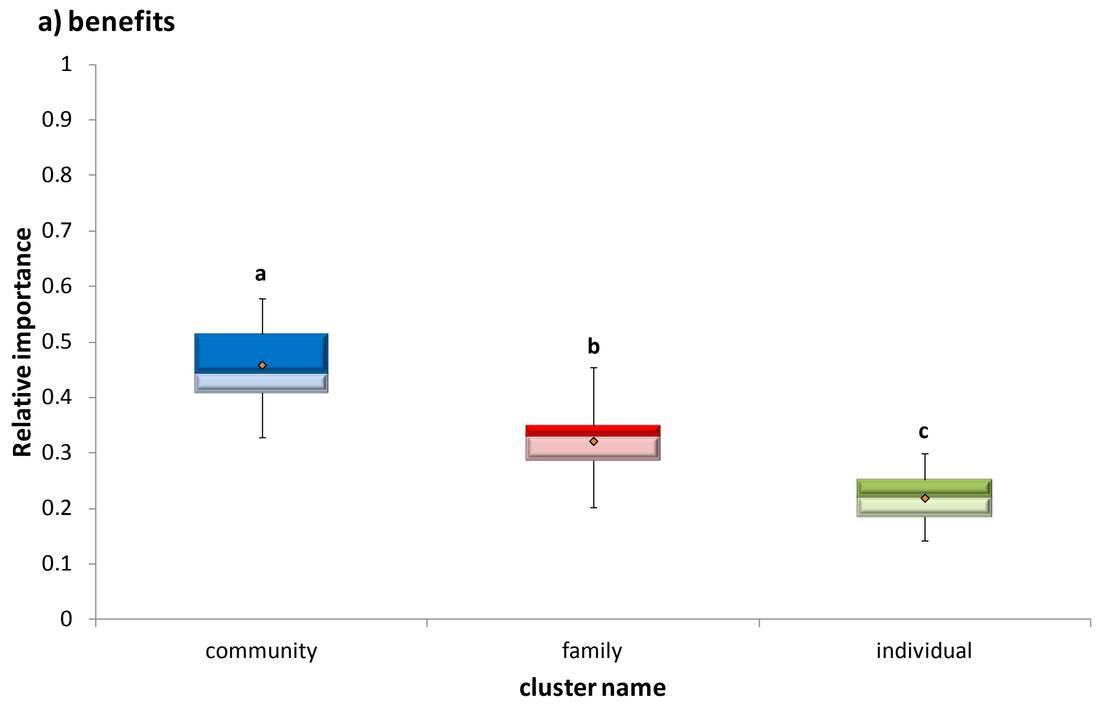
[1] Injuries were perceived by many respondents as a community cost due to the incapacity of an injured hunter to provide to the community or because injuries were perceived to be a sign of wider community problems.

5.3.4 *RELATIVE IMPORTANCE OF THE VALUE CLUSTERS*

The cognitive mapping exercise enabled me to group items into clusters that were internally homogeneous and separable. As such, it was valid to estimate the average 'value' of each cluster using Equation 5-1 and to compare the relative value of each (Figure 5-3).

Community benefits (none of which were associated with the market) were significantly greater than family (p=0.000; Wilcoxon test) and individual benefits (p=0.000; Wilcoxon test) (Figure 5-3a). Family benefits (which were all associated with food for home consumption and thus strongly linked to the market) were significantly greater than individual benefits (p=0.000; Wilcoxon test) (Figure 5-3a). At the 5% level, there were no statistical differences between Mabuiag and St Paul's in regards to the relative importance of community and family benefits (p=0.686, community benefits; p=0.330, family benefits; Mann-Whitney test) but at the 10% level individual benefits were perceived to be higher on Mabuiag Island than on St Paul's (p=0.084, individual benefits; Mann-Whitney test).

As with benefits, the island of residence was not a statistically significant determinant of the relative importance of the cost cluster (p=0.861, community costs; p=0.313, family costs; p=0.513, environmental costs; Mann-Whitney test). Community costs (none of which was associated with the market but rather with the failure to respect the cultural aspects of traditional hunting) were significantly greater than family (p=0.000; Wilcoxon test) and environmental costs (p=0.000; Wilcoxon test) (Figure 5-3b). There were no statistically significant differences between the costs associated with hunting expenses and family pressure (i.e., family costs) and the costs associated with environmental impacts (i.e., environmental costs) (p=0.060; Wilcoxon test) (Figure 5-3b) although the difference approached significance at the 5% level.



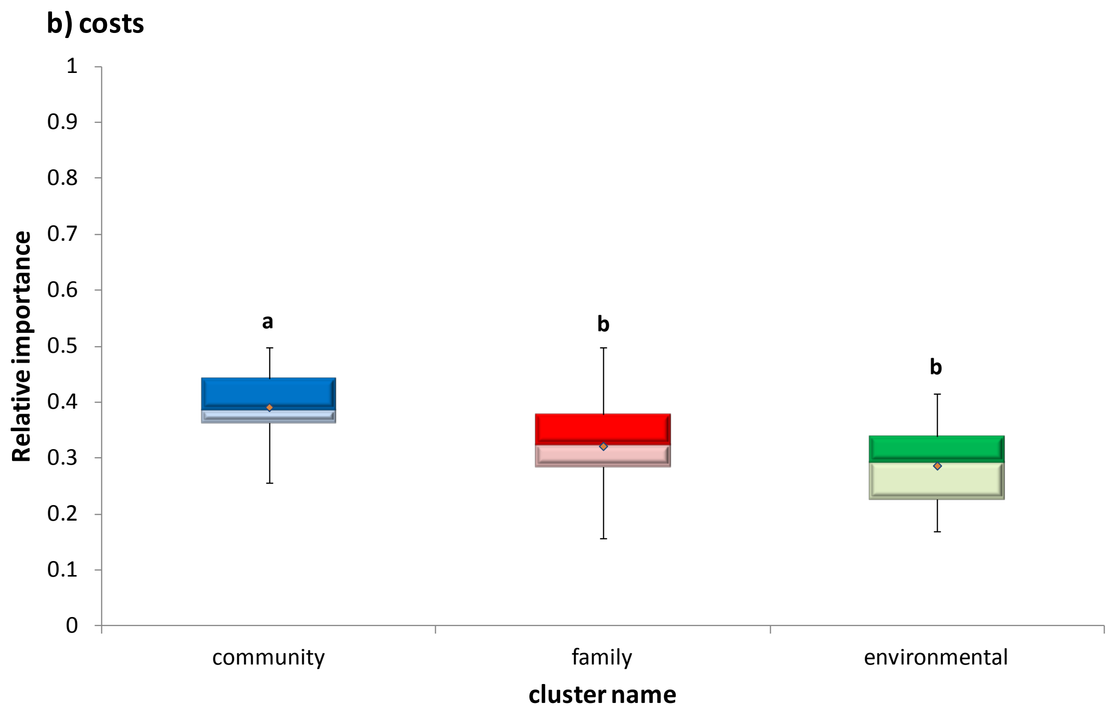


Figure 5-3. Relative importance scores: a) Benefits' clusters "k^B" and b) Costs' clusters "k^C" for respondents of Mabuiag and St Paul's (N=78). In the box plots, the median is represented by the line, the box represents the inter-quartile range, the whiskers represent the data range. Box plots which do not share the same letter are derived from distributions that are significantly different from each other at p<0.001 (using the Wilcoxon test).

These results were consistent across all categories of individuals. However, the age of male residents was a statistically significant determinant of the relative importance of a cluster. Younger men placed more importance on family benefits (typically associated with the market) (p=0.000; Mann-Whitney test) (Figure 5-4a); while older men placed more importance on community benefits (i.e., strongly associated with the cultural aspects of traditional hunting) (p=0.000; Mann-Whitney test) (Figure 5-4a). Age had no significant effect on the relative importance of individual benefits (p=0.094; Mann-Whitney test) (Figure 5-4a).

Older men considered community costs (i.e., non-market costs associated with the failure to respect the cultural aspects of traditional hunting) to be more important than the younger men did (p=0.000; Mann-Whitney test) (Figure 5-4b). Younger men considered family costs (i.e., associated with hunting trip expenditures and family pressures) to be more important than the older men did (p=0.003; Mann-Whitney test) (Figure 5-4b). The relative importance of environmental costs was independent of age (p=0.548; Mann-Whitney test) (Figure 5-4b).

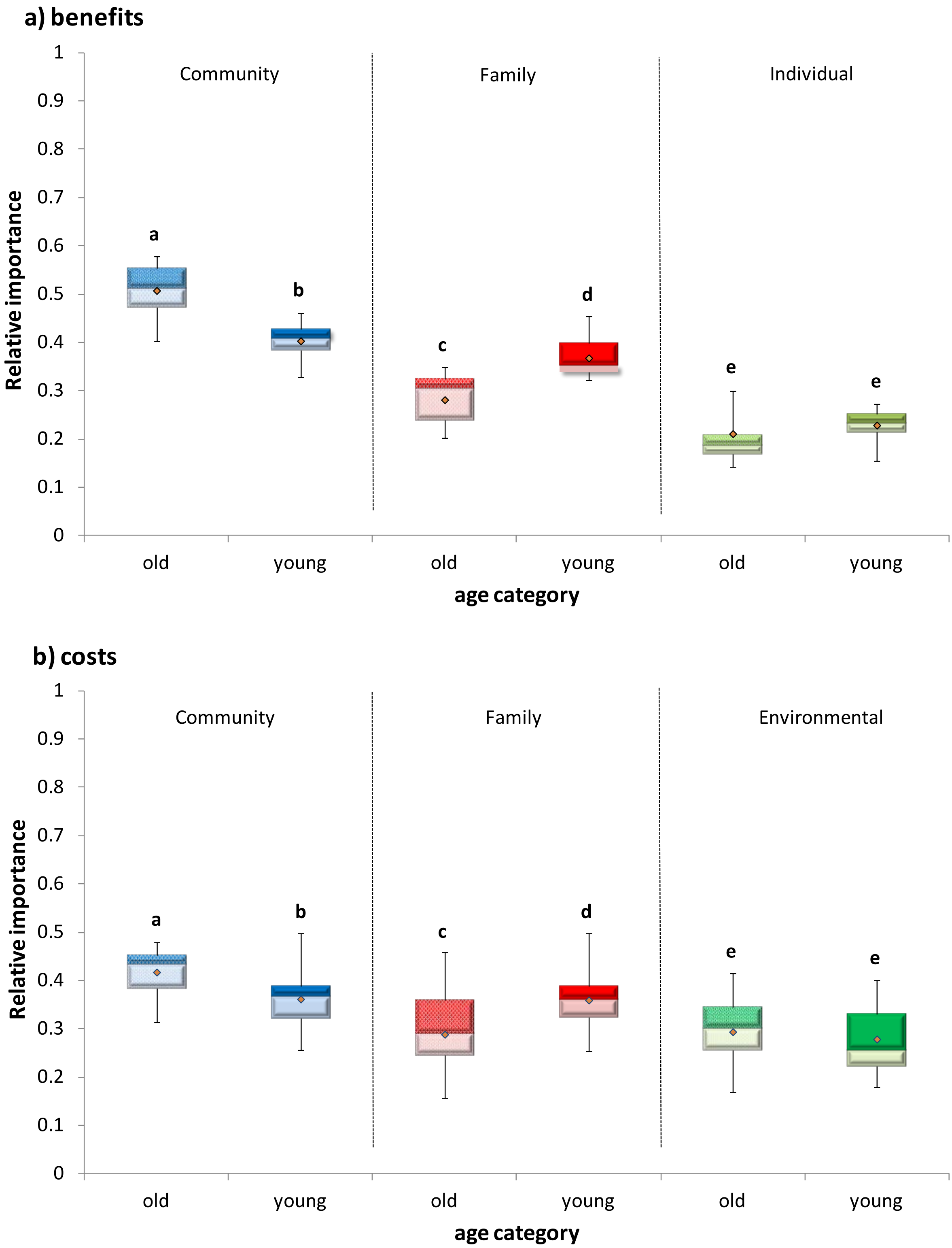


Figure 5-4. Relative importance scores: a) Benefits' clusters "k^B" and b) Costs' clusters "k^C" for male respondents of Mabuiag and St Paul's (N=60) categorised on the basis of age (older > 35 years; younger ≤ 35 years). In the box plots, the median is represented by the line, the box represents the inter-quartile range, the whiskers represent the data range, the diamond represents the mean. Box plots which do not share the same letter are derived from distributions that are statistically different from each other at p<0.01 (Mann-Whitney test).

5.3.5 USING INSIGHTS ON RELATIVE VALUES TO DRAW INFERENCES ABOUT TOTAL VALUES

The benefits associated with Indigenous hunting were clearly separable into market and non-market categories. The items making up the “family benefits” cluster were all closely associated with food for home consumption (Table 5-1). As such it was valid to use the replacement cost method to derive a monetary estimate of the value of dugong and turtle meat consumed at home by residents of Mabuiag and St Paul’s on a yearly basis. The step-by-step analysis is detailed below[38].

As described in section 4.2.3.1, the data I collected via the household hunting questionnaires provided me with the necessary information to estimate: (i) the total number of animals caught (dugongs and green turtles) by respondents and (ii) the size of the sharing of traditional meat outside the communities. With the information gathered for Figure 4-7, I could have assumed that the number of animals (both dugongs and green turtles) consumed on Mabuiag and St Paul’s was equivalent to the number of animals caught (Equation 4-2) minus the equivalent number of animals shared outside the communities (Equation 4-4). However, as described in Table 5-1, family benefits (i.e., those tightly associated with food for home consumption) did not encompass food consumed for ceremonies (i.e., which belonged to the “community benefits” cluster). As such, the quantity of meat consumed at home by residents of both communities is not equal to the total number of animals caught and retained on the islands; one must exclude the number of animals consumed for ceremonial purposes. The key problem here is that I did not have information about how

[38] This type of approach was not possible for costs. Items tightly associated with hunting expenditures were not clearly separable from distributional items (i.e., pressures from outside) in the “family costs” cluster (Table 5-1).

much of the meat shared outside the communities was for home consumption and how much was for ceremonies.

So I estimated the total quantity of meat for home consumption in two ways: (1) I estimated the total quantity of meat consumed at home by community members only (Equation 5-3), and (2) also estimated the total quantity of meat consumed at home by community members inclusive of the quantity of meat shared outside the communities (Equation 5-4). The rationale for the second estimation is that although the meat shared outside will not be consumed directly at home in both Mabuiag and St Paul's, residents gain direct benefits from sharing this meat (i.e., as a way to maintain family ties and as an exchange for other goods provided by family members living outside the communities) (see chapter 4 for further details). Informal discussions with community members highlighted that the sharing of dugong and turtle meat could in some occasion be substituted by sharing crayfish and other fish. Those two evaluations allowed me to derive a minimum and a maximum estimate of the quantity of meat consumed at home knowing that the correct quantity would lie somewhere in between.

(Total number of dugongs and green turtles caught by community members – total number of animals used for ceremonies – equivalent number of animals shared outside the communities) * equivalent edible meat[39] =

Quantity of dugong and turtle meat consumed at home by community members in Torres Strait

Equation 5-3

[39] I used the edible meat calculations provided by Nietschmann (1982) of 115kg of edible meat per dugong and 50 kg of edible meat per green turtle.

(Total number of dugongs and green turtles caught by community members – total number of animals used for ceremonies) * equivalent edible meat =

Quantity of dugong and turtle meat consumed at home by community members in Torres Strait and outside the communities

Equation 5-4

Finally, I used the average price of meat products as classified per the ABS categorisation from my shop survey (chapter 4) (A$19.81 per kilo) to derive a replacement cost for the traditional meat consumed at home (strictly in the Torres Strait and also inclusive of the meat shared outside the communities) using Equation 5-5:

Quantity of dugong and turtle meat consumed at home ((1) on the islands only or (2) inclusive of the meat shared outside the communities) * average price of meat =

Value of meat consumed at home

Equation 5-5

These assessments indicated that the estimated replacement value[40] of the dugong and green turtle meat caught by both communities combined was approximately AU$360,000 per annum for the meat strictly consumed on the islands and reached up to AU$398,000 per annum for the meat consumed on the islands inclusive of the meat shared outside the communities (i.e., inclusive of other Torres Strait communities and elsewhere) (Table 5-2).

[40] A change in the price of the edible meats available in the island shops would have both income and substitution effects and would thus lead to a change in the estimated replacement value of dugong and green turtle meat.

Table 5-2. Estimation of the gross annual replacement value of dugong and green turtle meat for two Torres Strait communities.

	Mabuiag	**St Paul's**
	Dugong and Turtle	**Dugong and Turtle**
Replacement value on the islands (AU$)	$245199	$114591
Replacement value on the islands and outside (AU$)	$268921	$129161

According to my results in section 5.3.4, the non-market benefits are more important to members of these communities than are the family benefits associated with the home consumption of dugong and green turtles (Figure 5-3) and these differences were statistically significant. Thus it can be asserted that the cultural/community benefits are worth more than AU$360,000 – AU$398,000 per annum for Mabuiag and St Paul's combined and that the individual benefits are worth less than AU$360,000 – AU$398,000. Although we cannot provide a specific financial estimate of those non-market benefits, it can thus be inferred that collectively the yearly gross economic benefits of hunting to Mabuiag and St Paul's residents would be equivalent to at least twice AU$360,000 (to account for both family and community benefits) in addition to the financial estimate of individual benefits (which lies somewhere between AU$0 and less than AU$360,000).

The net value of dugong and turtle hunting to Mabuiag and St Paul's residents was not estimated as market costs could not be calculated due to their non-separability (see section 5.3.2).

5.4 Discussion

The effective management of natural resources requires an understanding of both human and biological systems (Berkes and Folke 1998) and economic theory suggests that the sustainable management of hunting requires good biological information and good economic information (Hartwick and Olewiler 1998). There is no market for the products of the Torres Strait Indigenous dugong and green turtle fisheries. So, measuring the social costs and social benefits in order to define efficient resource allocation in economic terms is not easy; particularly since traditional dugong and turtle hunting in Torres Strait provides numerous non-market costs and benefits (Table 5-1).

I identified multiple benefits and costs (both market and non-market), associated with a particular service (hunting), and held by the members of the two Indigenous communities. I was thus able to confirm my first hypothesis that TEV (in this case of Indigenous hunting) is comprised of many interrelated components. As such, this part of my study allowed me to better understand the value system of Torres Strait Islanders (as far as Indigenous hunting is concerned). This understanding is important for the management of dugongs and green turtles and could result in conservation initiatives more inclusive of the local communities of Torres Strait. In fact, resource managers are more and more required to take into account differences in value systems that may arise from differences in cultural background (English 2002; Jackson 2006). This requirement arises from the need to include members of an affected community in discussions regarding the management of their natural resources (Berkes 2004; Hackel 1999; Jackson 2006). An understanding of the values attached to a particular system by community members could avoid misinterpretation and mistakes from managers and could contribute to more open discussions between all stakeholder groups.

The identified benefits and costs were largely consistent with the literature but provided a more detailed description of the themes identified in previous studies. For example, the Cambridge Expedition led by Haddon in 1890 (Haddon 1890) reported that green turtles and dugongs were an essential part of the diet of Mabuiag Islanders, a fact confirmed by subsequent studies in the Torres Strait (Bliege Bird and Bird 1997; Bliege Bird *et al.* 2001; Johannes and MacFarlane 1991; Kwan 2002, 2005; Kwan *et al.* 2006; Nietschmann 1977a; Nietschmann and Nietschmann 1981; Nietschmann 1982; Raven 1990). Both species are also important for ceremonies (Fitzpatrick-Nietschmann 1980; Smith and Bliege Bird 2000; Smith 2004). Bliege Bird and colleagues (2001) showed that hunting provided the hunters of eastern Torres Strait with prestige and recognition within the community. Outside Torres Strait, anthropologists also noted how dugongs and green turtles contributed to Indigenous peoples' maintenance of social relations through sharing (Bradley 1997), reaffirmed their identity (Bradley *et al.* 2006) and helped in the transmission of ecological knowledge (Bradley 1997).

Most studies on the significance of dugongs and green turtles to Indigenous communities have only focused on the benefits but have rarely looked at the costs associated with hunting. Assessments of costs have usually been limited to financial costs associated with a hunting trip. For instance, Raven (1990) calculated the cost of dugong and green turtle hunting in Boigu (i.e., one of the Top Western Torres Strait Island) (Figure 2-4) by estimating the fuel cost of hunting trips. In the eastern Torres Strait, Bliege Bird and Bird (1997) calculated the energetic value of turtle hunting (i.e., based on total amount of calories provided by turtle meat) using time as a cost associated with search, travel and processing of the hunt. My study provided more information on costs by extending the common list of direct market costs (fuel and time) to include non-market costs associated with culture and the environment (Table 5-1). It is important to note that community costs (i.e., tightly associated with the failure to respect cultural aspects) were identified by community members. My discussions with Torres Strait Islanders in charge of managing the Indigenous dugong and green turtle fisheries highlighted that if Indigenous hunting was practiced the correct way, then the cultural aspects of traditional hunting should be respected and the identified community costs should no longer be present.

I successfully applied the cognitive mapping technique to test for the qualitative separability or independence of values in the case of Indigenous hunting (Figure 5-2). My cognitive maps allowed for the identification of clusters which included items perceived as cognitively similar by respondents while ensuring that clusters are separable. Importantly, the technique did not depend on a large sample size and could be useful in many other contexts. Moreover, my results demonstrated that the independent clusters of values as cognitively perceived by local individuals span a number of the traditional categories of the TEV (Figure 5-5) highlighting that in the case of Indigenous hunting of dugongs and green turtles in the Torres Strait, the components of TEV do not follow a similar classification as the traditional economic descriptors of 'use', 'option' and 'non-use' values.

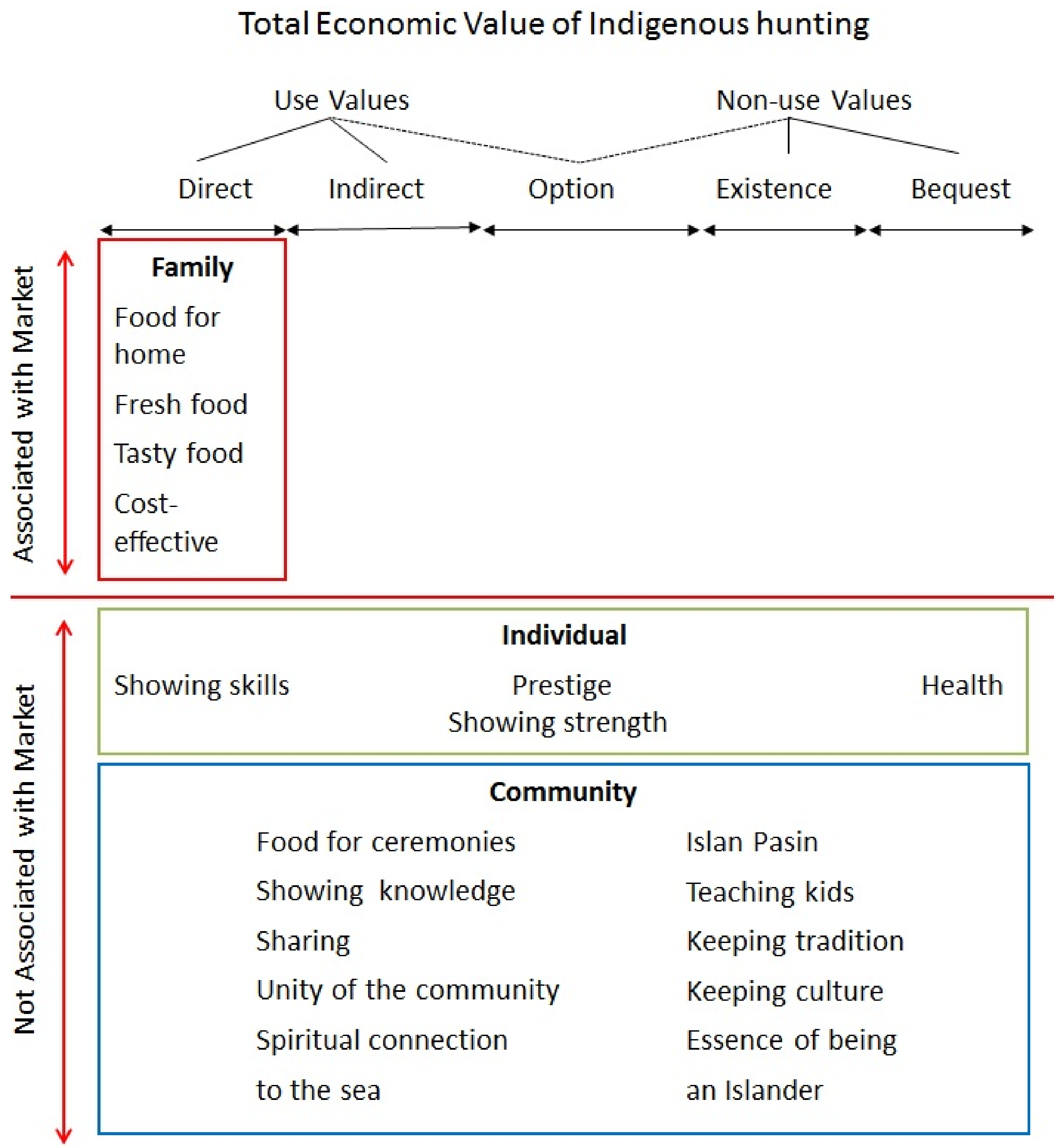


Figure 5-5. Comparison of the TEV terminology with the clusters of benefits associated with traditional hunting by Torres Strait Islanders.

Evidently, it would have been erroneous to use expert opinion to fit the values identified by the residents of Mabuiag and St Paul's into a TEV framework. For example, in traditional Western science, education and research benefits are usually considered to be direct benefits. In the Torres Strait Islander society "teaching kids" not only refers to the direct enjoyment of teaching but also refers to the benefits of ensuring that cultural practices are passed on and maintained which could encompass option, existence and bequest values. In the same way, "food for ceremonies" might have been categorised by an external person as a direct consumptive use but according to the classification of Mabuiag and St Paul's residents, "food for ceremonies" refers more to the symbolism of the food rather than its consumptive or sustenance use. Important benefits recognised by Torres Strait Islanders like "keeping tradition", "keeping culture" and "spiritual connection to the sea" refer to the importance of the cultural aspects of living in Torres Strait with a strong emphasis on maintaining tradition and links with ancestors as is observed in many other small islands (Moyle and Evans 2008). Benefits such as "sharing" and "unity of community" may be an expression of maintaining community ties and fulfilling cultural obligations directly and as an option during times of need.

In short, there does not seem to be a sensible way of categorising the values associated with Indigenous hunting using the categories frequently employed in the traditional TEV. Instead of trying to categorise such values and assume their separability, I consider it is more appropriate to use approaches such as cognitive exercises to elicit values from the relevant community and then group those values in ways that are meaningful to those being asked to assess them.

Having identified separable and homogeneous clusters of benefits and costs, I was then able to use rating exercises to look at the 'value' of those clusters; enabling me to meet objective (3) of this chapter. Torres Strait Islanders from both Mabuiag and St Paul's clearly identified three clusters of benefits. They considered that the community benefits of Indigenous hunting (i.e., very few of which are even remotely associated with the market) were more important than family benefits (i.e. which are strongly linked with the market) (Figure 5-3). Younger hunters apparently placed more importance on market benefits than older hunters; while older hunters placed more importance on benefits associated with cultural aspects of Indigenous hunting (Figure 5-4). A longitudinal study could investigate how the importance of those benefits evolves across time. Two scenarios are envisaged; either the current value system of younger hunters remains static across time (i.e., social values in the community will slowly change), a situation which would pose interesting questions for the management of hunting in the future or the value system evolves to match the one from today's older hunters (i.e., peoples' values evolve as they grow older but social values in the community remain constant).

In contrast, respondents from both communities did not make the distinction between market and non-market costs as they did for benefits. However, a close analysis highlighted that community members from St Paul's might be able to differentiate market and non-market costs (see section 5.3.2). This result shows that it is important to understand the value system of local people (who are known to have different value systems than "Western" societies). The grouping of costs of Indigenous hunting from the point of view of economists could have resulted in quite a different understanding, especially when considering the two types of "pressures" which do not occur in the market.

Mabuiag and St Paul's residents considered that the externalities associated with hunting (i.e., community costs and environmental costs) were twice as important as the more direct costs which included fuel and time (Figure 5-3). Since the inter-relationships that exist between market costs and non-market costs of traditional hunting is still poorly understood, I was unable to derive financial estimates of the costs and hence the net market value of the Torres Strait traditional dugong and green turtle fisheries although I provided more information on the direct financial costs of a hunting trip in chapter 4. Respondents from Mabuiag and St Paul's communities were able to define that family costs included fuel, time and external pressures. I estimated that on average fuel costs ranged from $120 to $180 per trip. As such, family costs will be higher than fuel costs alone.

However, I was also able to draw inferences about the likely 'financial' worth of some of the benefits of hunting[41]. I was able to do this because the market benefits (i.e., family benefits associated with the home consumption of dugong and green turtle) identified in the study were clearly separable from the non-market benefits (i.e., community and individual benefits). I used a replacement cost method to estimate the financial value of those market benefits. The replacement cost technique is only valid if one can find an appropriate substitute from which to get a price. There probably is no appropriate substitute for price when looking at cultural values or individual values (i.e., community and individual benefits). Thus I only used this method to estimate the food used for home consumption, where it is probably more valid to think of other meats as being substitutable for dugong and green turtles. I found that the total market benefits of traditional hunting in those two communities alone was approximately AU$360,000 to AU$398,000 per annum. This quantum is significant; it is roughly equivalent to 8% of total household income. A previous study conducted by the Australian Fisheries Management Authority (AFMA) estimated the combined value of the dugong and green turtle harvest following a monitoring programme undertaken in 15 Torres Strait communities in 2001 to be between AU$1,320,000 and

[41] Those estimates were only calculated from data collected for Mabuiag and St Paul's and would be different in other Torres Strait communities due to the difference in the level of hunting practiced by different islands in the Torres Strait (AFMA 2006).

A$1,750,000 per annum (AFMA 2006). Those estimates were roughly equivalent to AU$214 –A$284 per person per annum compared to the estimate in my study which were equivalent to contribute A$1246 – A$1377 per person per annum.

The difference in these estimates between my study and the one conducted by AFMA can be explained by three factors: (1) the admitted under-estimation of the dugong and green turtle harvest resulting from the sampling method applied by AFMA, (2) by the average price used by AFMA to estimate the replacement value of the harvest, and (3) the inflation between market prices in 2006 when AFMA published his report and 2009 when I collected my data. The average price chosen by AFMA was based on the average price of one kilo of chicken in a supermarket on Thursday Island (i.e., the administrative centre of Torres Strait). The price I used to estimate the value of the meat consumed at home was more than 2.5 times as expensive. Prices in the outer islands are greater than on Thursday Island (A. Delisle pers. obs.) and I did not assume which type of meat could be substituted for dugong and green turtle and thus calculated the average price of one kilo of meat on the islands.

Another study conducted with the Bardi Jawi people of Western Australia estimated that the harvest of dugongs and green turtles was equivalent to 11% of total household income (Buchanan *et al.* 2009). However, both the AFMA and the Bardi Jawi studies assumed that the catch from dugong and green turtle would be used for one benefit only (i.e., food) and noted that their method could only provide a partial estimate of the TEV of hunting (Buchanan *et al.* 2009). In contrast, I was able to distinguish between market and non-market benefits associated with Indigenous hunting. For instance, I was able to understand that the value attached to dugong and green turtles as food for home consumption is different from the value attached to both species when used for ceremonial purposes. Importantly, this understanding allowed me to infer that community benefits which are mainly related to the cultural aspect of the activity would then exceed AU$360,000 – AU$398,000 per annum because their relative importance was significantly higher than family benefits used to derive the financial contribution of the market benefits while individual benefits would be somewhat less.

Those financial estimates of the market benefits (i.e., associated with food for home consumption) and of the relative importance of non-market benefits would be useful to managers who want to use subsidies to manage Torres Strait dugong and green turtle Indigenous hunting. In fact, subsidising meat available at local shops has long been proposed by some natural resource managers who believe that this management tool would enable Torres Strait Islanders to purchase meat for less and as a result would give an incentive to go hunting less often. In contrast, another group of natural resource managers believe that subsidies would increase real income and as a result allow people to afford to hunt more. My research shows that such debates miss a vitally important issue; that “food” for sustenance is but part of the whole story and it is not clear how subsidies would affect the other important components of TEV. This topic is further explored in chapter 6.

5.5 Conclusions

Practitioners involved in natural resource management require a comprehensive understanding of the economic, social and environmental systems associated with the natural resource they want to manage. Researchers such as Ostrom (Ostrom 1990; Ostrom *et al.* 1999) and Berkes (2004) emphasise the importance of including local communities in natural resource management. This approach is particularly important when working with Indigenous communities with value systems that are poorly understood by Western scientists. My results showed that cognitive mapping could help increase our understanding of a complex value system. I was also able to compare the relative importance of different attributes of Indigenous hunting clearly highlighting: (a) the significance of Indigenous hunting to those communities; (b) the importance of non-market values; and (c) the importance of both social and environmental externalities. My results may not be readily transferrable but the methods are. There is a clear need for further work on this important topic and I welcome research that seeks to test, replicate and refine this methodology in different contexts.

5.6 Chapter summary

- Cognitive mapping helped identify separable values in order to avoid double counting when valuing a resource use.
- Results suggested that some value systems do not fit really into the categories frequently employed in the TEV framework suggesting a need to explore such systems before applying concepts and methods developed in other cultures.
- The non-market benefits associated with Indigenous hunting were more important that the market benefits.
- Market benefits were estimated to be worth between AU$360,000 – AU$398,000 per annum and equivalent to 8% of total household income.
- Non-market benefits are worth more than market benefits, indicating that the total benefits of the fisheries must exceed AU$720,000 per annum.
- Non-market externalities were a significant contributor to costs. These externalities could be reduced if more attention was given to the cultural components of hunting.
- More work is needed to understand costs better, particularly the inter-relationships that seem to exist between market and non-market costs.

CHAPTER 6:

IMPACTS OF MANAGEMENT

In chapter 6, I use the results of the previous chapter (i.e., information about the different benefits and costs associated with Indigenous hunting) to investigate the perceived impacts of different management tools. I look at the way in which six fishery management tools are perceived to impact the existing value system associated with the dugong and turtle fisheries so as to gain information on the possible social acceptability of these different management tools. I also present information about the type of monitoring and enforcement systems which communities consider would be necessary for each management tool to be successful. I discuss the potential social consequences that these enforcement strategies could have on the Torres Strait communities.

6. Cultural management strategy evaluation for an Indigenous traditional fishery

6.1 Introduction

The main purpose of fisheries management is to ensure a sustainable level of harvest. In the wake of the collapse of many large, industrialised marine fisheries worldwide (Myers and Worm 2003; Pauly *et al.* 1998; Pauly *et al.* 2003; Schiermeier 2002), the success of accepted fisheries management practices has been questioned. Long-established top-down approaches relying on government control and privatisation are being replaced by more inclusive bottom-up approaches built on a partnership between fisheries stakeholders (Diaz *et al.* 2011; Olsson *et al.* 2004; Pikitch *et al.* 2004).

Irrespective of whether they choose a top-down or a bottom-up approach, managers have a range of fisheries management tools at their disposal. These tools include a combination of limits on the fishery (area, time, gear and effort) and on the catch (size, sex, species) (Grafton *et al.* 2006) and can be divided into two main categories: (1) command-and-control tools, and (2) incentive-based tools (Grafton *et al.* 2006).

In fisheries management, the command-and-control tools usually involve input restrictions (such as mesh sizes...), area closures (nursery areas...), seasonal closures (during the mating season...), limits on size (avoid harvesting juveniles...) and total size limits of harvest (Grafton *et al.* 2006); all of which have a biological emphasis on stock management. Although these management tools could potentially release the pressure of over-exploitation if correctly targeted (Grafton *et al.* 2006), they do not remove the pressure from fishermen who focus on the short-term and continue increasing their efforts so that catches continue to rise even with these input restrictions. In contrast, incentive-based tools focus on fishing permits, taxes, and subsidies and aim to offer fishers incentives and a mandate to look after the marine environment (Grafton *et al.* 2006), thus escaping from the above-mentioned problem and (abstracting – for the moment- from monitoring and enforcement costs) achieving similar environmental targets at lower expense.

Typically management tools have been selected by managers based on factors including real or perceived costs, the occupation and education of resource users and the past history of management interactions (Aswani 2005; Richardson *et al.* 2005). Much of the economic literature on fisheries advocates incentive-based tools since they are believed to provide benefits in terms of economic efficiency (Grafton *et al.* 2004) and productivity ((Fox *et al.* 2003). What is frequently lacking however, is an understanding of fishers' perceptions and attitudes towards these management tools (Hanna 2001; McManus 1996) and how that might impact upon efficiency.

Any new fisheries management tool is likely to impact upon fisher communities in several ways. For instance, tools could increase economic pressures but could also have adverse social (i.e., community disruption) and cultural consequences (i.e., if management tools are not culturally appropriate for everyone). If those adverse consequences are significant, they could lead to conflicts. Conflicts can also occur if natural resource managers' goals do not match those of the resource users (McClanahan *et al.* 2008). Such conflicts could potentially hinder the successful implementation of natural resource management (Christie 2004; Hilborn 2007) because conflicts increase the rate of non-compliance (Hanna and Smith 1993; Kaplan 1998); thus reducing the efficiency of the tool below that expected from models which abstract from the existence of these real world complications.

Thus, it is useful for managers to gain an understanding of those consequences before implementing new regulations (Kaplan and McCay 2004). One way to achieve such understanding is to recognise that the willingness of people to implement and respect a policy is related to their perception of the policy's likely impacts (Jentoft 2000; Jentoft and McCay 2003; Sutinen and Kuperan 1999). People's acceptance of a policy will thus influence the policy's likely success. As such the net efficiency of a management tool will depend at least partially on its legitimacy (Nielsen 2003) or social acceptability. This argument is particularly important in areas where monitoring and enforcement are difficult. If local people neither accept nor support a policy, they will not willingly comply; so this policy will more than likely prove ineffective without significant investment in monitoring and enforcement.

In other words, fisheries management can be improved by designing management systems that do not solely rely on rules and regulations <u>but also consider</u> community world views (Berkes *et al.* 2001). Fisheries managers should thus focus at least part of their management efforts on understanding the perceptions of the stakeholders (fishers and non-fishers alike) who will be affected by managerial decisions (Berkes *et al*. 2001). Once those perceptions are known, the perceived impacts of different management actions can be investigated. Through this understanding of perceived impacts, managers and stakeholders can identify areas of potential conflict and agreement (Cocklin *et al.* 1998) that could be addressed to design acceptable solutions (McClanahan *et al.* 2008).

To date, most research has been concerned with evaluating these different management tools in terms of achieving goals that are mainly biological and/or financial. For instance, in Torres Strait, most of the recommended management strategies have sought to decrease the number and/or size of dugongs and green turtles caught each year by Torres Strait Islanders or to change the catch's sex ratio. Regulators often focus on these biological goals for the successful management of fisheries without any information on the perceptions and expectations of local resource users.

Research on the perceived impacts of members of the community about different fisheries management strategies has not received as much attention although some studies have concentrated on understanding the factors that influence fishers' behaviour (Blyth *et al.* 2002; Hatcher *et al.* 2000; Richardson *et al.* 2005), on investigating their perceptions of the benefits of marine protected areas (Dimech *et al.* 2009; Leleu *et al.* 2010; Suman *et al.* 1999), or on investigating fishers' perceptions and attitudes towards the management of marine protected areas (Gelcich *et al.* 2008; Gelcich *et al.* 2009; McClanahan *et al.* 2005; McClanahan *et al.* 2008). The wider community's perceptions about the likely impacts of management strategies have rarely been explored.

This omission may be significant and helping to fill this gap was the focus of this part of my research, which aimed to understand the perceived impacts of different proposed management tools in the Torres Strait. Specifically, I was interested in learning about community residents' (hunters and non-hunters) perceptions of the likely impacts of a variety of different management tools on their existing value system. Moreover, because successful management tools also require long-term monitoring as well as evidence of enforcement, I also investigated community residents' opinions on who should be in charge of monitoring each fisheries management tool and whether there were foreseeable enforcement issues for those tools.

This investigation was based on the following assumptions:

(1) Community members who are likely to be affected by a proposed management tool will have preconceived notions about its impact before it is implemented;
(2) The perceived impacts of different tools will make some tools more attractive to community members than others;
(3) Those responsible for making decisions about which tools to implement should consider community views about the perceived impacts of those tools before introducing them because perceptions are likely to influence success.

This investigation had several objectives:

(1) To improve understanding of the perceived opinions about the likely impacts of different fishery management tools on the members of two communities reliant on traditional fisheries;
(2) To learn more about community-wide perceptions of the impacts of different management tools using a variety of methods for aggregating individual perceptions into potential "whole of community" views;
(3) To determine if the perceived impacts of each management tool differ across: (a) communities, and (b) age groups;
(4) To learn more about some of the potential problems with enforcing the different management tools.

In order to fulfil these objectives, I built on the results of chapter 5 that identified the existence of several clusters of benefits "k^B" and costs "k^C" associated with the Indigenous dugong and green turtle fishing activities in Torres Strait. I used these 'clusters' in my analysis to evaluate perceptions of the relative impacts of different management tools at a social and cultural level, and to determine whether perceptions differed by community group or age.

For clarity, the methods and results sections of this chapter have been grouped by topic. There is a single discussion at the end of the chapter.

6.2 Methodology and results

6.2.1 Individual perceptions of different management tools on the "clusters" of values

One-on-one interviews were conducted with members of the two case study communities: Mabuiag and St Paul's. A small subset of participants (five in each community) was asked to take part in a pilot study to test the applicability of the methodology. Subsequently, 78 interviews were conducted, 38 on Mabuiag Island and 40 at St Paul's community with the same people interviewed previously (see chapter 5).

Respondents were asked to consider six different management tools. These tools reflected several command-control tools as well as incentive-based tools (Table 6-1) that have been proposed by regulators. Some of these instruments have been included in existing community-based management plans (Table 6-1) that were drafted in both Mabuiag and St Paul's in 2008 through a partnership between local community members and government representatives (TSRA 2011a, b)[42].

[42] Each community-based management plan is available to community members through the community's Prescribed Body Corporate and is not widely available to the public. TSRA Land and Sea Management officers can first be consulted to obtain information on each dugong and turtle community management plans (Loban 2012). Some background on the dugong and turtle community-based management plans in provided in section 2.4.4.

Table 6-1. List of management tools presented to interviewees from Mabuiag and St Paul's communities in Torres Strait.

Management tool presented to interviewees	Meaning accepted by respondents	Terminology typically used in the economics and fisheries literature	Inclusion in the community-based management plans
Spatial closure	A permanent sea area closed for dugong and/or turtle hunting similar to the existing dugong sanctuary[1].	A permanent sea area closed for a number of prescribed activities	In principle[2], for both Mabuiag and St Paul's
Temporal closure	A seasonal sea area closed for dugong and/or turtle hunting.	Temporal restriction on a prescribed number of activities in a sea area during critical life stages of a resource	In principle, for both Mabuiag and St Paul's
Gear restriction	The use of nets, firearms and/or spotlights is prohibited in favour of the use of the traditional wap[3].	Imposed restriction on the type and size of gear used for harvest	Ban on the use of shotgun, spotlighting and nets[4]
Quotas	A limited number of animals can be caught by an individual hunter	Imposed restriction on the number of animals caught by species	In principle, at St Paul's only
Taxes on catch	An individual pays a fee to catch dugongs and/or green turtles	Payment of a fee to catch a specific species	No mention
Subsidies to reduce catch	An individual is paid to reduce his catch of dugong and/or green turtles	Payment given to the resource user to decrease his take of a specific species	No mention

[1] The dugong sanctuary covers an area on the western side of Torres Strait where a total ban on dugong hunting is currently in place (see Figure 2-4).

[2] Management tool included as part of the community based-management plan but not yet implemented or enforced.

[3] A wap is the traditional harpoon used by Torres Strait Islanders to hunt dugong and turtles.

[4] Shotguns and nets are already banned in the Western region. Spotlighting bans are under consideration.

During their interview, each individual was asked to consider how each of the six different management tools listed in Table 6-1 would impact on his or her own value system; specifically on the 'clusters' of benefits and costs associated with the Indigenous dugong and green turtle fisheries. I asked each respondent to provide a categorical assessment of the significance of the impacts of each management tool on each 'cluster' based on a five-point Likert scale; i.e. very negative impact, minor negative impact, no change or status quo, minor positive impact, and very positive impact. Thus, each interviewee "*i*" provided six evaluations of the impacts of each tool "*j*". One evaluation for each of the three clusters of benefits "k^B" (Equation 6-1) and one for each of the three clusters of costs[43] "k^C" (Equation 6-2):

$$\boldsymbol{E^{B}_{ijk}} = \textit{Individual i's perceived impact of tool j on Benefit cluster } k^B$$

Equation 6-1

$$\boldsymbol{E^{C}_{ijk}} = \textit{Individual i's perceived impact of tool j on Cost cluster } k^C$$

Equation 6-2

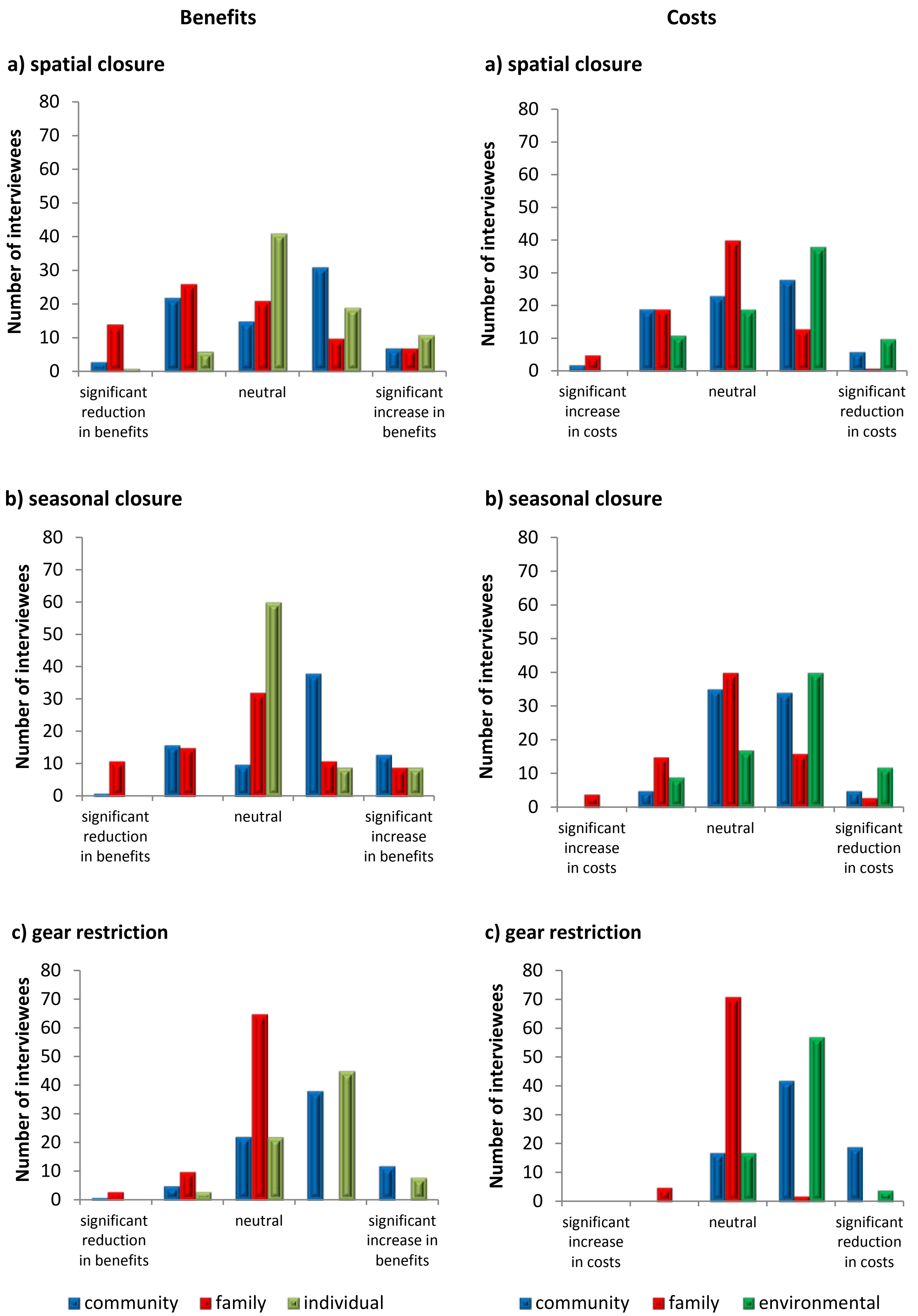
where k represents a specific 'cluster' of benefits or costs out of the total of six (chapter 5, Table 5-1).

Figure 6-1 showed the number of respondents selecting each level of impact across both Mabuiag and St Paul's communities. Evidently, individuals perceived each management tool to have a different impact on his/her existing value system. For instance, most respondents perceived that a fishery management tool such as "gear restriction" would provide a significant increase in benefits as well as a significant reduction in costs. In contrast, most interviewees were of the opinion that "taxes" could result in a significant reduction in benefits and a significant increase in costs (Figure 6-1). Interviewees were

[43] In the case of costs, a negative impact implies an increase in costs while a positive impact implies a decrease in costs.

capable of perceiving positive or negative impacts when presented with hypothetical tools. Although in the first instance, there appear to be a large number of “status quo” responses, the mere fact that the total number of respondents who selected a “status quo” response varied across strategies and ‘clusters’ implied that interviewees were able to identify the level of impact that different management tools would have on his/ her value system.

Moreover, respondents also perceived that each management tool would impact ‘clusters’ of benefits and costs differently. In the case of “gear restriction”, responses indicated that such a tool was perceived as increasing community benefits (i.e., benefits strongly related to cultural aspects of traditional hunting) and individual benefits (i.e., those associated with the status of the hunter) ‘clusters’, while 83% of interviewees were of the opinion that this tool would have no impact on the benefits associated with the family ‘cluster’ (i.e., associated with food for home consumption) (Figure 6-1). This result suggests that respondents may have been of the opinion that “gear restriction” would change the way in which animals are caught but not necessarily the number of animals caught. The same findings applied to the diverse impact of “gear restriction” on the different ‘clusters’ of costs associated with the fisheries (Figure 6-1).


Benefits
Costs
a) spatial closure
a) spatial closure
b) seasonal closure
b) seasonal closure
c) gear restriction
c) gear restriction
Number of interviewees
0
10
20
30
40
50
60
70
80
significant reduction in benefits
neutral
significant increase in benefits
significant increase in costs
neutral
significant reduction in costs
community
family
individual
community
family
environmental

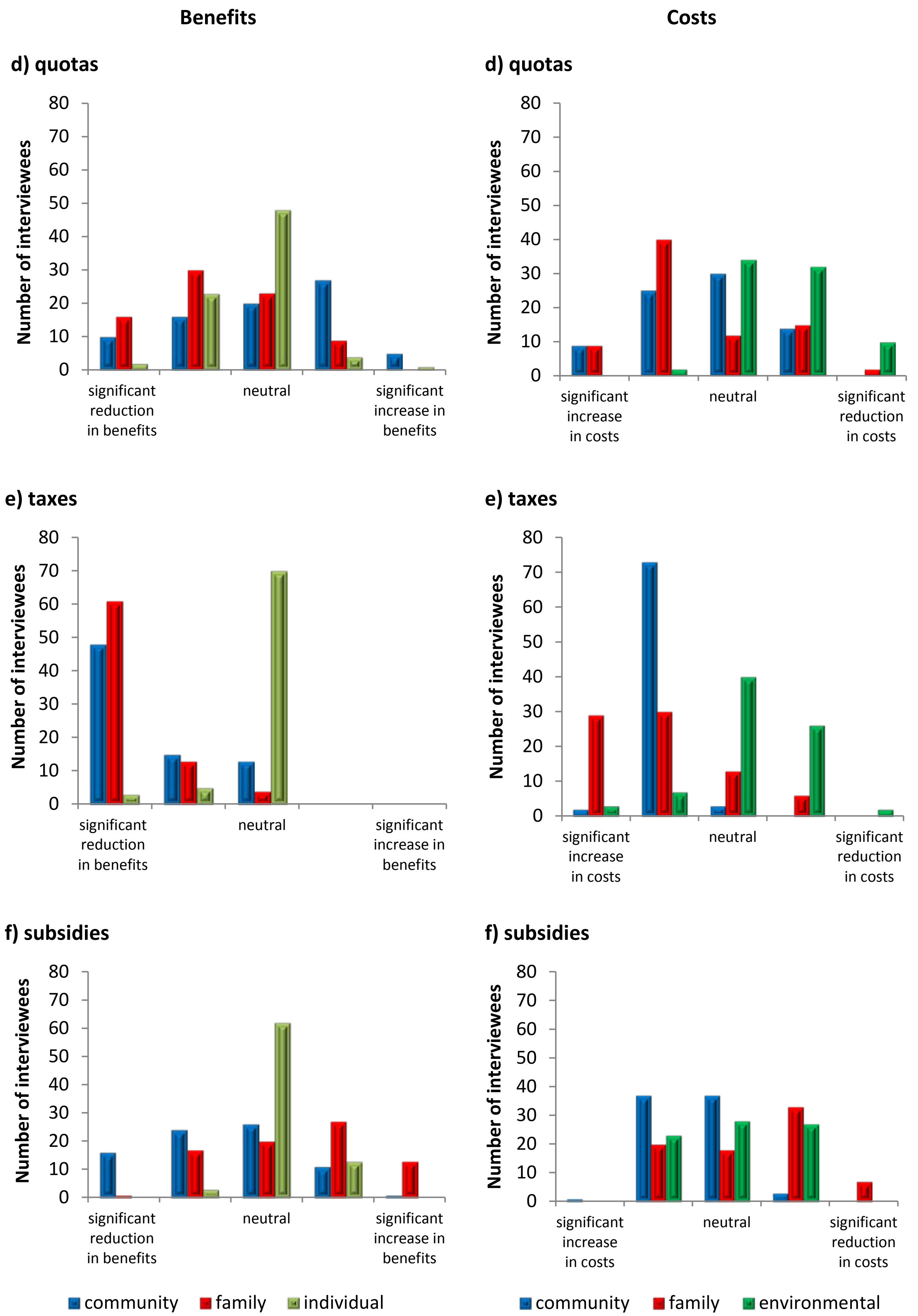


Figure 6-1. Count of the number of interviewees who mentioned a specific perceived level of impact of different management tools on the 'clusters' of benefits and costs (N=78).

6.2.2 COMMUNITY PERCEPTIONS

The data obtained at an individual level did not provide a clear picture of the community-wide perceptions of the impacts of each management tool. So I analysed the data collected in three different ways to enable me to draw inferences about: (i) the perceived average impact of each management tool on a value 'cluster' and (ii) the community-wide perceived impact of each tool.

6.2.2.1 Average perceived impact on a value 'cluster'

In the first instance, I coded the data obtained from the five- point Likert scale into "-3" very negative impact, "-1" minor negative impact, "0" status quo, "+1" minor positive impact, and "+3" very positive impact. I then used this numerical assessment to look at two different ways of estimating the average impact of each management tool "*j*" on each value cluster "k^B" and "k^C" across all respondents. I estimated an arithmetic and a weighted mean as detailed below:

1) Method 1: The arithmetic mean $\bar{E}$ was calculated for each benefit cluster "k^B" (Equation 6-3) and each cost cluster "k^C" (Equation 6-4) for each management tool:

$$\overline{\boldsymbol{E}^{\boldsymbol{B}}_{\boldsymbol{jk}}} = \frac{\sum_{i=1}^{n} \boldsymbol{E}^{\boldsymbol{B}}_{\boldsymbol{ijk}}}{\boldsymbol{n}} =$$

Arithmetic mean of the perceived impact (across all n individuals) of tool j on Benefit cluster k^B

Equation 6-3

$$\overline{E^C_{jk}} = \frac{\sum_{i=1}^{n} E^C_{ijk}}{n} =$$

Arithmetic mean of the perceived impact (across all n individuals) of tool j on Cost cluster k^C

Equation 6-4

where *n* represents all interviewees from both communities.

2) Method 2: I also calculated the weighted mean $\bar{\bar{E}}$ for each benefit cluster "k^B" (Equation 6-5) and each cost cluster "k^C" (Equation 6-6) for each tool. Weights $\bar{V}$ represented the relative importance of each value cluster to each individual "*i*" (see section 5.3.4 and Equation 5-2).

$$\overline{\overline{E^B_{jk}}} = \frac{\sum_{i=1}^{n} V^B_{ik} E^B_{ijk}}{n} =$$

Weighted mean of the perceived impact (across all n individuals) of tool j on Benefit cluster k^B

Equation 6-5

$$\overline{\overline{E^C_{jk}}} = \frac{\sum_{i=1}^{n} V^C_{ik} E^C_{ijk}}{n} =$$

Weighted mean of the perceived impact (across all n individuals) of tool j on Cost cluster k^C

Equation 6-6

Figure 6-2 to Figure 6-5 show that community perceptions about the average perceived impact of management varied across type of fisheries management tool and across value cluster. Since I used a five-point Likert scale, it was not strictly statistically correct to convert the scale data into numbers and to then calculate means, but doing so facilitated an easy visual representation of responses. To ensure analytical rigour, the

Wilcoxon signed rank test was used to check for statistically significant differences in the distribution of responses across categories (as opposed to simply comparing means). Letters have been added to each “bar” on Figure 6-2 to Figure 6-5 to show the results of those tests.

The first method highlighted that the “arithmetic” average impact of some management tools was perceived to be similar. For instance, “gear restriction”, spatial closure” and “seasonal closure” were on average all perceived to increase community (i.e., related to cultural aspects) and individual benefits (i.e., related to status of the hunter) while decreasing family benefits (i.e., associated with food for home consumption) (Figure 6-2). The same strategies decreased both community (i.e., associated with the non-respect of culture) and environmental costs while increasing family costs (i.e., associated with fuel, time and family pressures) (Figure 6-3).

“Taxes” and “quotas” were not perceived to impact values in a similar way. On average, both tools were perceived to decrease all ‘clusters’ of benefits (Figure 6-2) and increase both community and family costs while decreasing environmental costs (Figure 6-3). “Subsidies” were perceived to act differently from any other fishery management tool. Subsidies were the only tool perceived to increase family benefits (Figure 6-2) and decrease family costs (Figure 6-3).

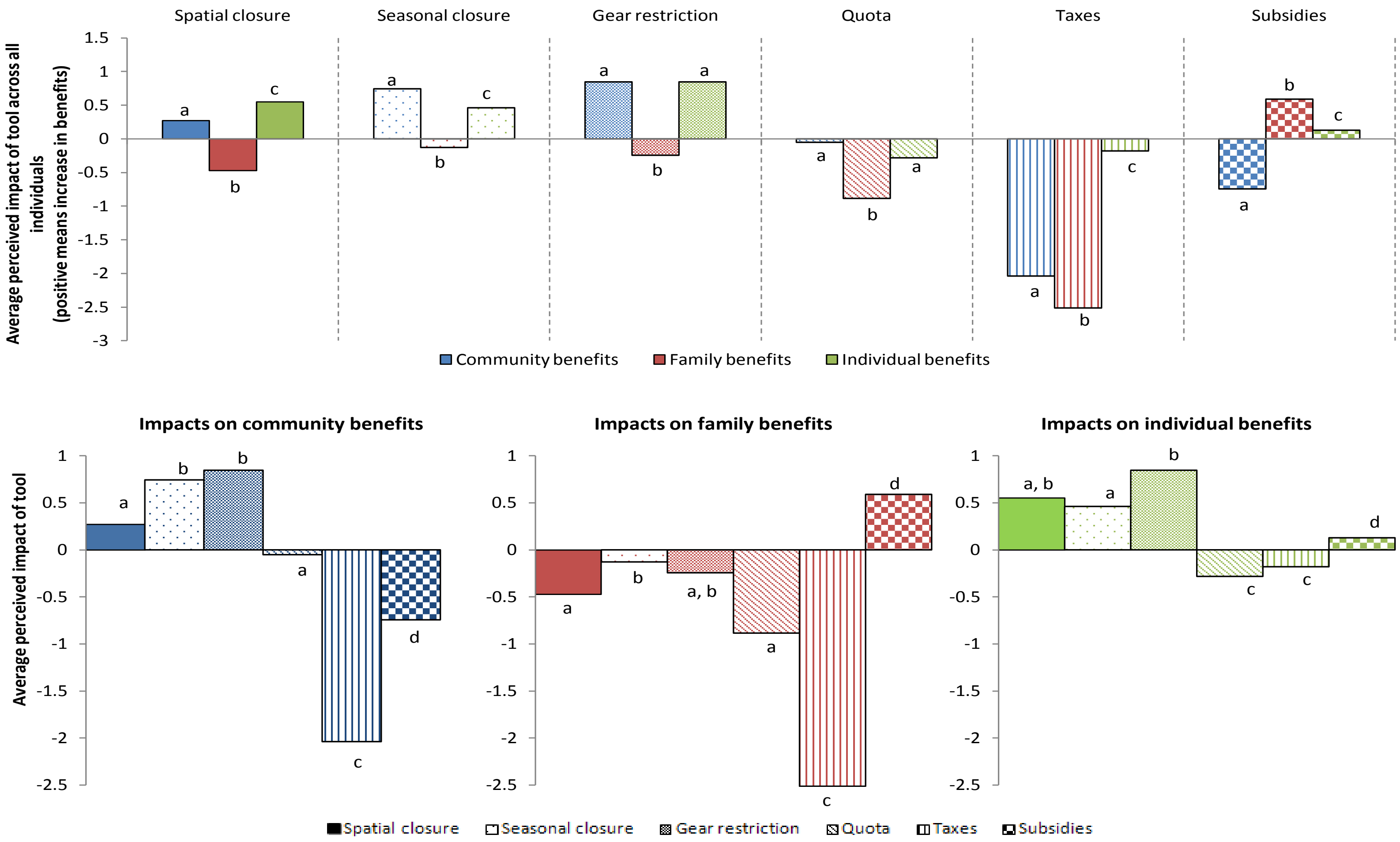


Figure 6-2. Arithmetic mean of the perceived impact of each management tool on the 'clusters' of benefits across all respondents (N=78). Responses from Mabuiag and St Paul's are combined as the two communities elicited the same clusters of benefits. Bars which do not share the same letter are derived from distributions that are statistically different from each other at p<0.05 (Wilcoxon test).

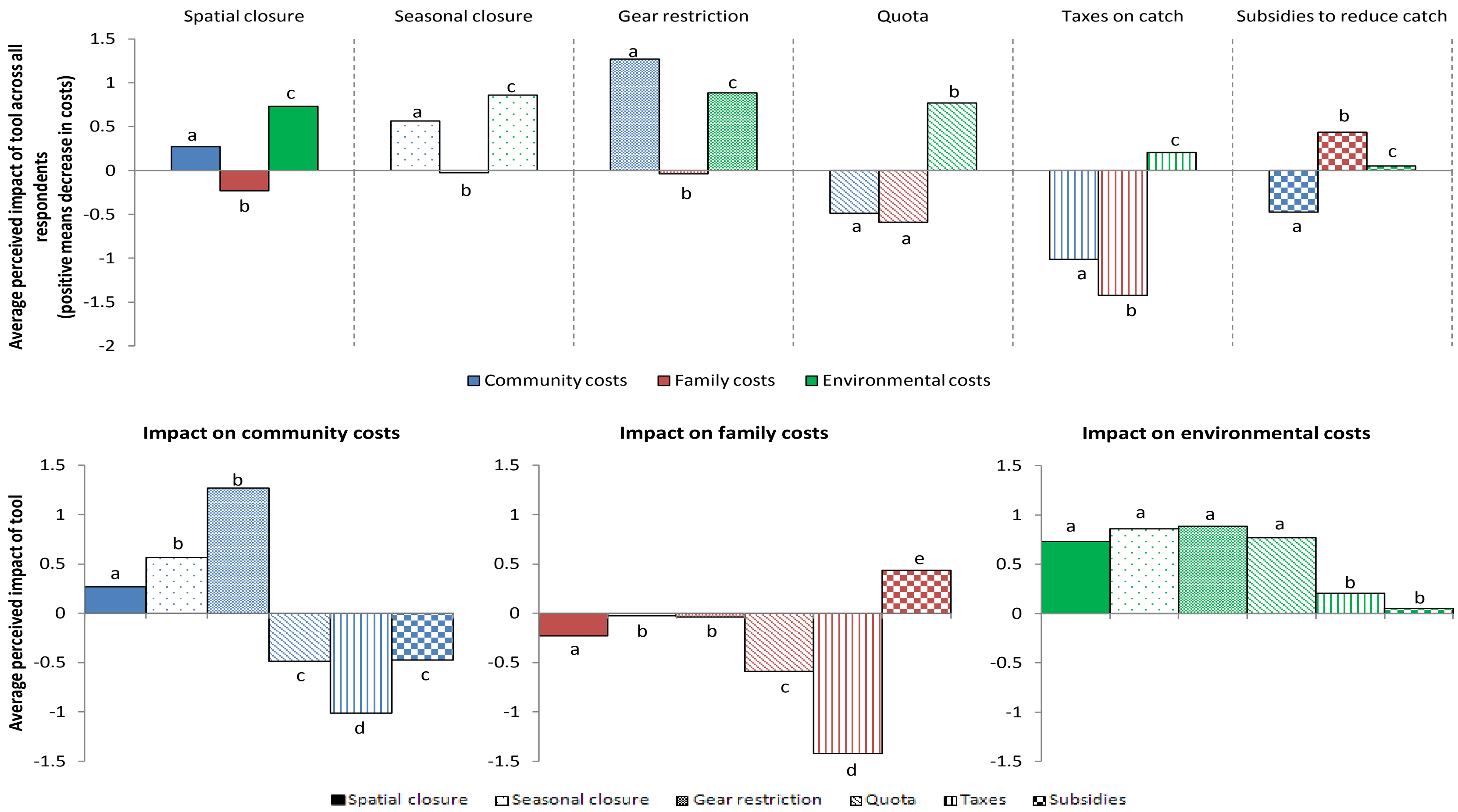


Figure 6-3. Arithmetic mean of the perceived impact of each management tool on the 'clusters' of costs across all respondents (N=78). Responses from Mabuiag and St Paul's are combined as the two communities elicited the same clusters of costs. Bars which do not share the same letter are derived from distributions that are statistically different from each other at p<0.05 (Wilcoxon test). Positive perceived impact on the y axis means a decrease in costs.

Figure 6-4 and Figure 6-5 presented similar information as the arithmetic method but using the weighted averages. Two observations can be concluded from Figure 6-2 to Figure 6-5:

(1) The overall pattern of responses with regards to the likely impact of all management tools on the different value clusters is similar for both methods. Management tools that were perceived to have a positive impact on a value cluster did so irrespective of whether I used the arithmetic average or the weighted average. The same held true for tools that were perceived to have a negative impact. Thus across respondents, the mean importance of each value cluster assigned by each individual did not influence the positive or negative perception of a particular tool.

(2) Yet, the initial weight *V* attributed to each value cluster by community members influenced the relative importance of the perceived impact when using weighted averages. In the case of “taxes”, the “arithmetic” average impact was perceived to be more important on family benefits than on community benefits (Figure 6-2). However, once the initial weight assigned to community benefits was taken into account, the relative importance of the “weighted” average impact of “taxes” on community benefits was magnified (Figure 6-4) and was now more important than the “weighted” average impact of “taxes” on family benefits.

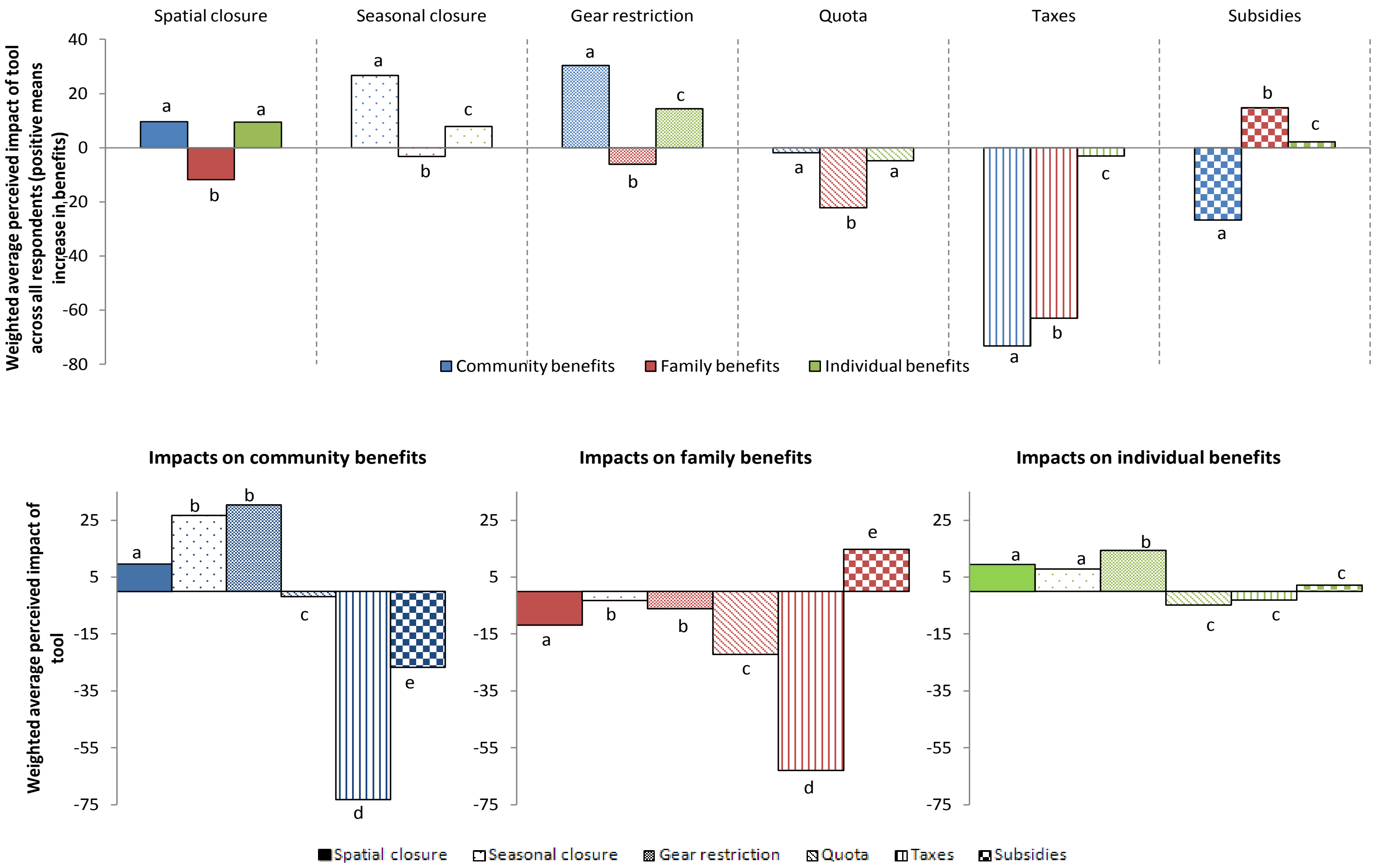


Figure 6-4. Weighted mean of the perceived impact of each management tool on the 'clusters' of benefits across all respondents (N=78). Responses from Mabuiag and St Paul's are combined as the two communities elicited the same clusters of benefits. Bars which do not share the same letter are derived from distributions that are statistically different from each other at p<0.05 (Wilcoxon test).

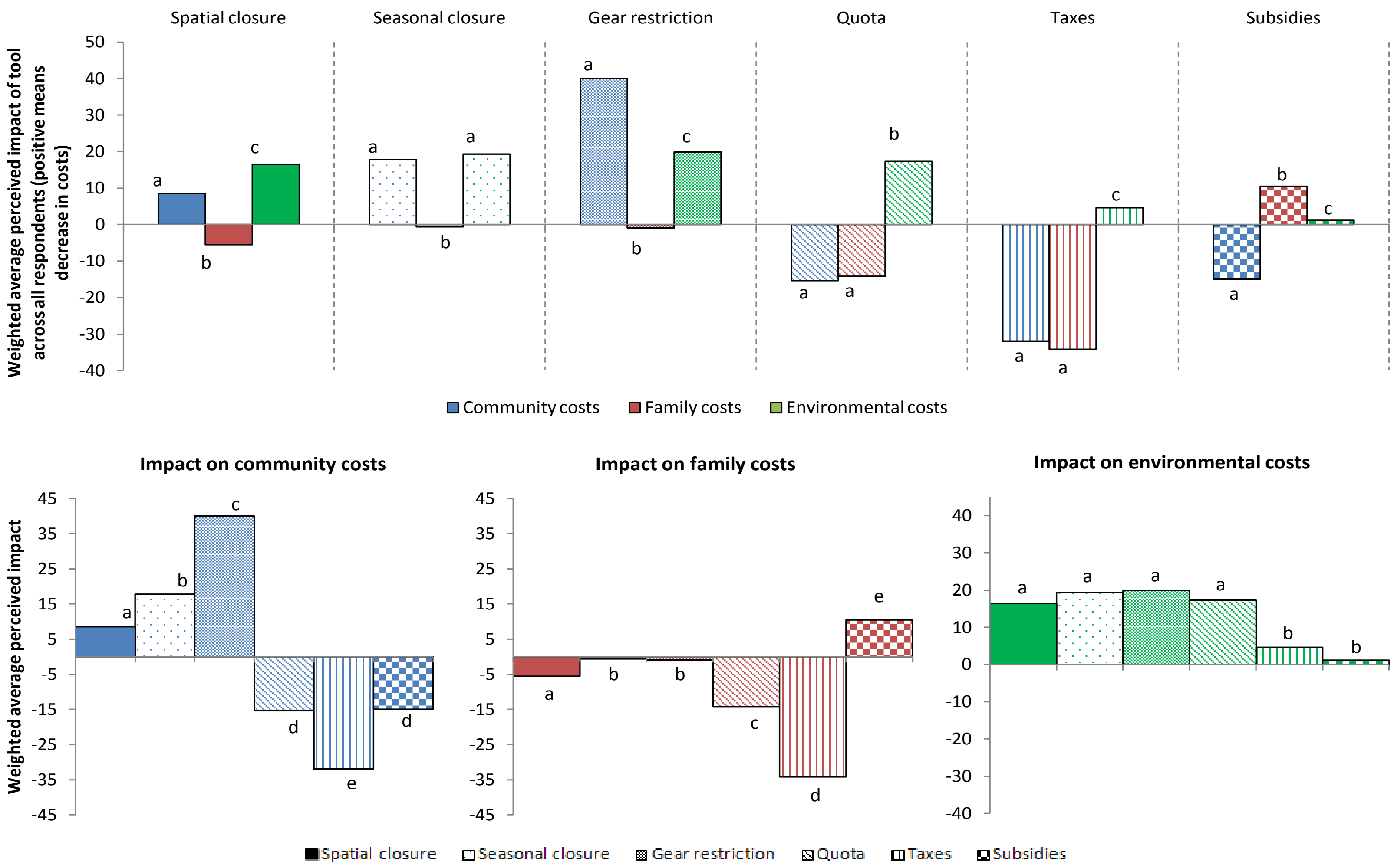


Figure 6-5. Weighted mean of the perceived impact of each management strategy on the 'clusters' of costs across all respondents (N=78). Responses from Mabuiag and St Paul's are combined as the two communities elicited the same clusters of costs. Bars which do not share the same letter are derived from distributions that are statistically different from each other at p<0.05 (Wilcoxon test). Positive perceived impact on the y axis means a decrease in costs.

6.2.2.2 Combined perceived impact on the average individual across all clusters

My previous results (from chapter 5) on the benefits and costs associated with these fisheries highlighted that the 'clusters' of benefits and costs were separable and as such additive on an individual level (see section 5.3.2). Thus, I next estimated the combined perceived impact of each tool "*j*" on each individual "*i*" across all clusters of benefits or all clusters of costs. I used results on the average impact of each tool on each value cluster estimated previously using the arithmetic mean and the weighted mean. I calculated the combined impact across the three clusters of benefits and the three clusters of costs for each individual "*i*" as summarised by Equation 6-7 to Equation 6-10:

combined impact on individual i of tool j on all Benefit clusters k^B using arithmetic mean

$$\boldsymbol{T_{ij}^{B} = \sum_{k=1}^{3} E_{ijk}^{B}}$$

Equation 6-7

combined impact on individual i of tool j on all Cost clusters k^C using arithmetic mean

$$\boldsymbol{T_{ij}^{C} = \sum_{k=1}^{3} E_{ijk}^{C}}$$

Equation 6-8

combined impact on individual i of tool j on all Benefit clusters k^B using weighted mean

$$\boldsymbol{WT_{ij}^{B} = \sum_{k=1}^{3} V_{k}^{B} E_{ijk}^{B}}$$

Equation 6-9

combined impact on individual i of tool j on all Cost clusters k^C using weighted mean

$$WT_{ij}^{C} = \sum_{k=1}^{3} V_k^C E_{ijk}^{C}$$

Equation 6-10

Then I looked at the average combined impact across all members of the community as described in Equation 6-11 to Equation 6-14:

mean combined impact (across all n individuals) of tool j on all Benefit clusters k^B using arithmetic mean

$$\overline{T}_j^B = \sum_{i=1}^{n} T_{ij}^{B}$$

Equation 6-11

mean combined impact (across all n individuals) of tool j on all Cost clusters k^C using arithmetic mean

$$\overline{T}_j^C = \sum_{i=1}^{n} T_{ij}^{C}$$

Equation 6-12

mean combined impact (across all n individuals) of tool j on all Benefit clusters k^B using weighted mean

$$\overline{\overline{T}}_j^B = \sum_{i=1}^{n} WT_{ij}^{B}$$

Equation 6-13

mean combined impact (across all n individuals) of tool j on all Cost clusters k^C using weighted mean

$$\bar{\bar{\boldsymbol{T}}}_{\boldsymbol{j}}^{\boldsymbol{C}} = \sum_{\boldsymbol{i}=\mathbf{1}}^{\boldsymbol{n}} \boldsymbol{WT}_{\boldsymbol{ij}}^{\boldsymbol{C}}$$

Equation 6-14

The combined perceived impacts across all 'clusters' of benefits and costs allowed me to distinguish between fisheries management tools. Both methods (arithmetic and weighted) showed that the average individual perceived the combined impact across all clusters of tools such as "gear restriction", "seasonal closure" and "spatial closure" to be one which increased benefits and lowered costs (Figure 6-6). In contrast, both methods showed that the average individual perceived the combined impact across all clusters of tools such as "quotas" and "taxes" to decrease the benefits and increase the costs associated with the fishing activities (Figure 6-6). Both methods showed mixed outcomes for the impact of "subsidies" on an average resident. Subsidies had little or no perceived impacts on benefits while they either marginally decreased or increased costs (Figure 6-6).

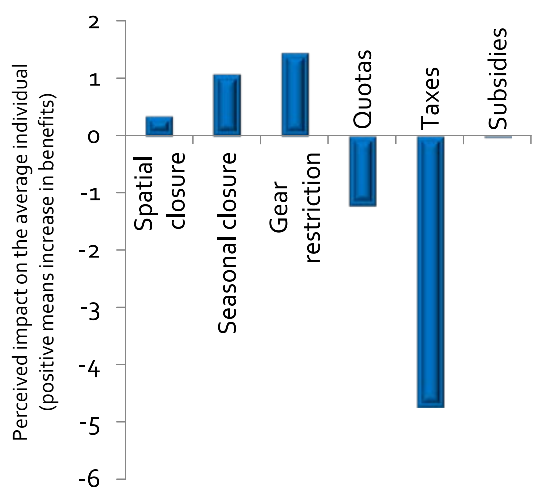
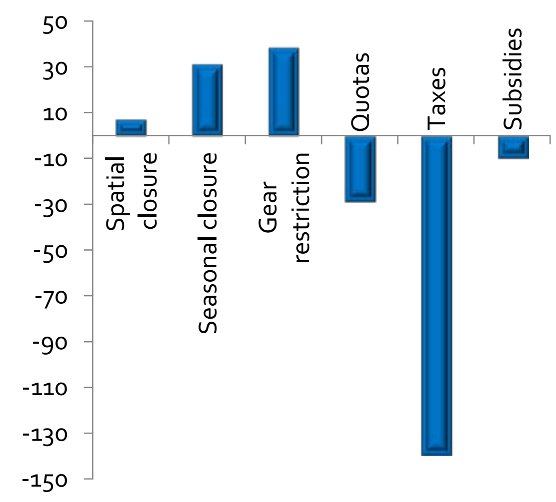
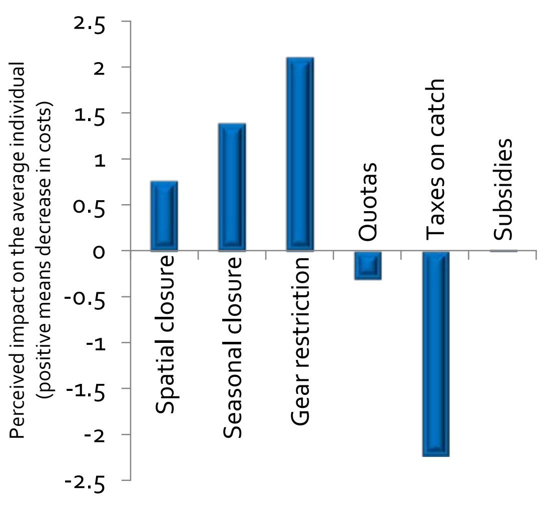
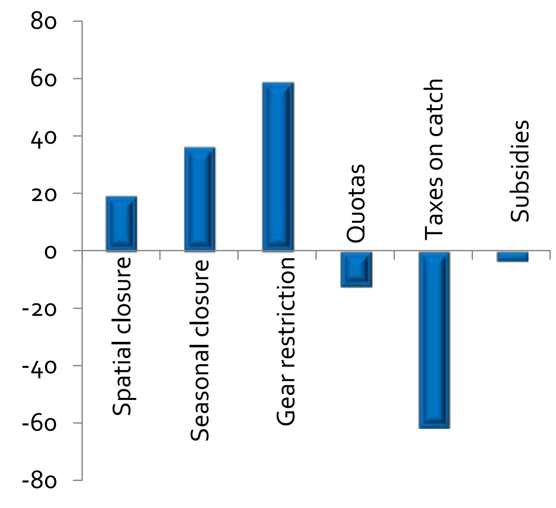
	Mean combined impact (arithmetic method)	**Mean combined impact (weighted method)**
Subjective benefits		
Subjective costs		

Figure 6-6. Subjective impact of each management tool on the average individual at Mabuiag and St Paul's communities using Equation 6-11 to Equation 6-14.

6.2.2.3 Subjective impact on social welfare

Finally, I allowed for the fact that the data about the combined impact of a management tool on the average individual did not take into consideration the distributional impacts of each tool among individuals[44]. The basic difficulty here was that there was no

[44] The Pareto principle (Juran 1954), states that a policy change is socially desirable if, by the change, everyone can be made better off or at least some are made better off while no one is made worse off, allows one to look at the change in welfare in terms of the change in individual welfare.

obvious way of comparing welfare across individuals, and, in particular, no way of verifying whether the welfare of Individual A obtained from a state x was more or less than the welfare of Individual B obtained from a state y. So I have instead focused my efforts on trying to understand the combined distributional impacts of each management tool on the social welfare of the community using two different approaches.

Specifically, I assumed that the aggregation of the impacts of each management tool at the community level was notionally equivalent to trying to calculate the total gain or loss in welfare resulting from each tool; i.e., considering the total perceived impacts of a tool across all 'clusters' of benefits and costs and across all individuals.

First, I estimated the total importance of the value 'clusters' pre-management and post management for each individual "*i*". To do this, I added the reported value which each individual assigned to each value cluster (Equation 6-15 and Equation 6-16) to get a total importance score pre-management (i.e., before the implementation of any fisheries management tools).

Total importance score pre-management across all Benefit cluster k^B

$$\textbf{\textit{Pre-TV}}_{i}^{B} = \sum_{k=1}^{3} V_{ik}^{B}$$

Equation 6-15

Total importance score pre-management across all Cost cluster k^C

$$\textbf{\textit{Pre-TV}}_{i}^{C} = \sum_{k=1}^{3} V_{ik}^{C}$$

Equation 6-16

Then I used the reported perceived impact (section 6.2.1) described by each respondent to draw inferences about the importance of each cluster post-management, assuming that importance post-management is equalled to the sum of the importance pre-management and the level of impact for each respondent. Third I added these post-management scores across all clusters to get an estimate of the total importance post-management (Equation 6-17 and Equation 6-18).

Total importance score post-management of tool j across all Benefit cluster k^B

$$\textbf{\textit{Post-TV}}_{ij}^{B} = \sum_{k=1}^{3} (V_{ik}^{B} - E_{ijk}^{B})$$

Equation 6-17

Total importance score post management of tool j across all Cost cluster k^C

$$\textbf{\textit{Post-TV}}_{ij}^{C} = \sum_{k=1}^{3} (V_{ik}^{C} - E_{ijk}^{C})$$

Equation 6-18

Once the total impact (benefit or cost) from the Indigenous fisheries of each respondent was calculated pre-management and post-management, I could then use this information to draw inferences about the likely impact of tool "*j*" on Social Welfare.

A number of aggregation techniques exist to scale upwards from the individual to the community and are derived from the economics literature on Social Welfare Functions. The Social Welfare Function estimates the level of social welfare corresponding to a particular set of individual welfares attained by members of society (Stiglitz 2000). It was not my intent to contribute to the debate on the estimation of Social Welfare Functions (as I had not collected the relevant data to undertake such a study), rather I used insights from this debate to run a sensitivity analysis on my data using two contrasting perspectives to check the robustness of my results: (i) an additive approach (Equation 6-19); and (ii) a multiplicative approach (Equation 6-20).

An example of this approach is described below for the benefits of the Indigenous fisheries. The same methodology was used for the costs.

(1) Additive approach to estimating the subjective impact on social welfare

Estimated social impact of tool j assuming additive form of an impact on social welfare

$$S_j^A = \left(\sum_{i=1}^{n} Pre - TV_j\right) - \left(\sum_{i=1}^{n} Post - TV_{ij}\right)$$

Equation 6-19

(2) Multiplicative approach to estimating the subjective impact on social welfare

Estimated social impact of tool j assuming multiplicative form of an impact on social welfare

$$S_{ij}^{M} = \left(\prod_{i=1}^{n} Pre - TV_j \right) - \left(\prod_{i=1}^{n} Post - TV_{ij} \right)$$

Equation 6-20

Importantly, for either of these aggregation methods to be strictly valid, I had to assume that the level of impact expressed by each respondent from -3 to +3 was identical for each interviewee. This was unlikely to be true, so my results should be taken as indicative only.

The two aggregating methods: (a) additive; and (b) multiplicative used to scale upwards the impacts of each management tools from individual to community, indicated the same overall ranking of the management tools for both benefits and costs (Figure 6-7). This replicability suggested that my results were robust.

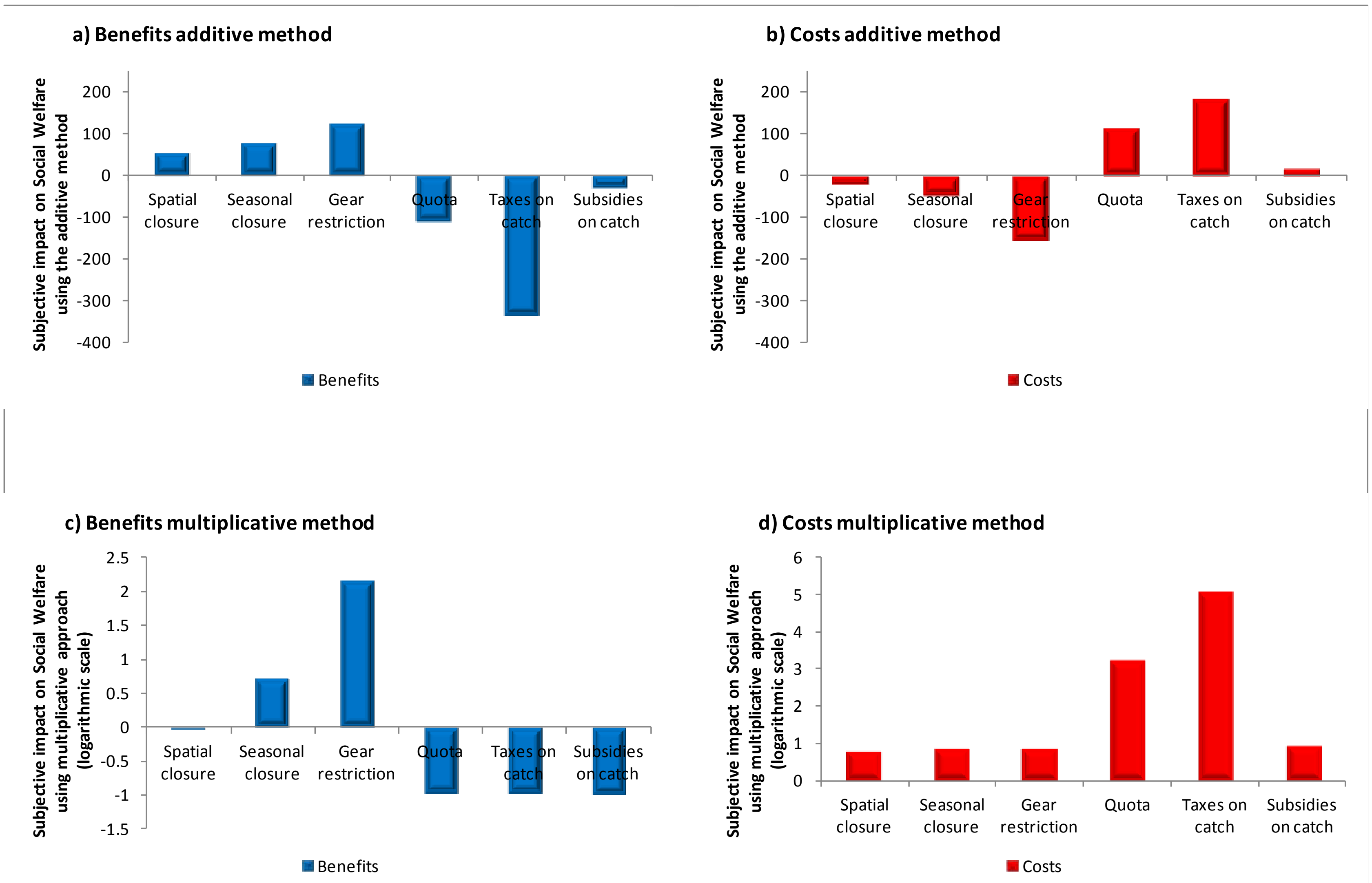


Figure 6-7. Perceived impact on Social Welfare using the additive and multiplicative approaches using Equation 6-19 and Equation 6-20.

In the two communities of Mabuiag and St Paul's, interviewees' perceptions of the impact of different fisheries management tools indicated that "gear restriction", "seasonal closure" and "spatial closure" were tools that were perceived as generating an unambiguously positive net impact on the benefits of the Torres Strait Indigenous dugong and green turtle fisheries. This is because of: (1) their perceived positive impacts on community benefits, and of (2) their perceived potential to reduce the costs associated with the fisheries especially community/cultural costs. In contrast, "taxes" and "quotas" were perceived to jointly decrease benefits and increase costs, indicating that these tools were perceived as generating an unambiguously negative net impact.

6.2.3 Difference in the perceived impacts of management tools

The raw data were analysed using the non-parametric Wilcoxon test to examine if a difference existed in the level of perceived impact of each management tool on the different 'clusters' of benefits and costs among resource users (Figure 6-2 to Figure 6-5).

I also examined the heterogeneity in resource users by examining whether and how responses were related to: (1) the community of residence and (2) age group using the non-parametric Mann-Whitney test.

As in chapter 5, age groups were defined as: (i) "young people" for community residents under the age of 35 years and (ii) "older people" for community residents aged 35 years old and above. The age cut-off was chosen after discussion with residents from both communities.

6.2.3.1 Community differences

There were only two statistically significant differences between the perceptions of interviewees from Mabuiag and interviewees from St Paul's when comparing the impacts of the different management tools. Mabuiag residents perceived that taxes had a greater negative impact on individual benefits (p=0.004; Mann-Whitney test) and that subsidies had a greater negative impact on community benefits (p=0.01; Mann-Whitney test).

However, those statistical differences between Mabuiag and St Paul's did not change the overall ranking of the management tools based on their perceived impact on social welfare.

6.2.3.2 Age group differences

Similarly, there were several statistically significant differences in the perceptions of old versus young members of both communities. Overall, older people perceived that each management tool would increase benefits associated with the fisheries more than young people did. Only in the cases of the impact of gear restriction on individual benefits, subsidies on community benefits and subsidies on family benefits did older people perceive that the impact would be less than the impact perceived by young people. Again, the differences in the impact of each management tool as perceived by older and young people of both Mabuiag and St Paul's did not alter the overall ranking of the management tools.

6.2.4 ENFORCEMENT

6.2.4.1 Method

Interviewees were also asked to comment on the ways in which each management tool could be enforced in order to be successfully implemented. I first asked them to indicate if enforcement should occur at the community or government level and to express possible concerns they have with enforcing specific management tools.

6.2.4.2 Results

Community members from both Torres Strait communities considered that enforcement of tools including “gear restriction”, “seasonal closure”, “spatial closure” and “quotas” should be the responsibility of their respective community. On the other hand, the administration of “taxes” and “subsidies” should be the role of the government (Table 6-2).

Table 6-2. Enforcement and some concerns of community members from Mabuiag and St Paul’s over the success of different management tools.

Management tool	Enforcement	Concerns
Spatial closure	Community level	“This need to be agreed by the elders but how do we tell hunters from other islands” (*Mabuiag resident*)
Seasonal closure	Community level, different areas should be closed at different times and monitored by community members	“the whole community needs to talk about it...some people do not care” (*St Paul’s resident*)
Gear restriction	Community level	“Them pla [*Those people in local language*], they say they do not use motors but I know” (*St Paul’s resident*)
Quotas	Community level, need legal authority to fine offenders	“People won’t fine their family” (*St Paul’s resident*) “What if “I need to hunt for someone” (*St Paul’s resident*)
Taxes on catch	Government level	“I will not fill in the catch survey form” (*Mabuiag resident*)
Subsidies to reduce catch	Government level	Difficult to administer, “many people who do not hunt might come forward” (*Mabuiag resident*)

Respondents expressed different concerns about the practical difficulties of implementing different management tools. For example, approximately a third of respondents were concerned about the actions of individuals who did not belong to their communities when it comes to area closures both permanent and seasonal. These concerns highlighted the fact that a successful implementation of area closures whether seasonal or permanent needs to involve discussions between different neighbouring communities. This topic of discussion was very important as traditionally; islanders have defined "shared areas" of sea that extended beyond their home reefs, where an island community was recognised as responsible for the management of the sea resource but allowed islanders from other communities to fish for their livelihood. Exclusion was rarely a method of choice as it was seen to be contrary to good Ailan Pasin [Island Way] (National Native Title Tribunal 2010). However, discussions involving several neighbouring islands could explain that closures apply to everyone and will not be used as a form of exclusion of particular Torres Strait Islanders. As such, closures could be more readily accepted and possibly complied with.

Respondents also expressed doubts about the compliance of some individuals if they were required to change their fishing gear. Concerns about the monitoring and enforcement of "taxes" and "subsidies" were also expressed. Members of both communities perceived some problems with administering both tools in terms of the involvement of community members. On the one hand, "taxes" might lead to a decrease in the participation of local people or a decrease in the willingness of reporting catch data. On the other hand, "subsidies" might attract people that were not involved in the Indigenous dugong and green turtle fisheries.

Another issue for residents concerned the practicality of enforcing management tools such as "quotas" if enforcement required community residents to fine their own family members. Although such concerns were expressed only when talking about "quotas", the same issue might arise with other management tools enforced at the community level (Table 6-2).

6.3 Discussion

6.3.1 Overall evaluation of fisheries management tools

Interviewees were able to evaluate the subjective costs and benefits of different fisheries management tools, including perceived impacts on social and cultural values associated with the Indigenous fisheries. These perceptions could provide useful information on the likely preferences of local stakeholders because perceptions are one of the drivers of opinions which in turn motivate actions (Petrosillo *et al.* 2007) and thus potentially increase compliance

My approach was able to quantify the perceived relative impact of management on all of those values whether they are consumptive or intrinsic values such as culture, tradition, ceremony or status. I demonstrated how the perceived impact of each fisheries management tool differed across 'clusters' of values. For instance, "gear restriction" was generally perceived as being able to increase intrinsic values associated with the fisheries while marginally decreasing consumptive benefits (Figure 6-2 and Figure 6-4). In contrast, "subsidies" were perceived to decrease family costs and environmental costs but to increase community costs (Figure 6-3 and Figure 6-5). This observation held true irrespective of whether I assessed the perceptions using arithmetic or weighted means.

In the context of the Torres Strait Indigenous fisheries, the perceptions held by community members suggested that no matter which method I used to look at the impacts of the six different management tools, "gear restriction" was perceived to generate the most benefits while “taxes” were perceived to generate the most negative impacts (Figure 6-2 to Figure 6-7). Interestingly, “gear restriction”, “seasonal closure” and “spatial closure” were always perceived as increasing benefits and decreasing costs which suggested that the perceived <u>net</u> impact of these tools is unambiguously positive (Figure 6-7). In contrast, “taxes” and “quotas” were always perceived as decreasing benefits and increasing costs which suggested that the perceived <u>net</u> impact of these tools is unambiguously negative (Figure 6-7).

In other words, “gear restriction”, “seasonal closure” and “spatial closure” were consistently perceived more positively than “subsidies”, “quotas” and “taxes”. As such, my results provided insights on the type of policies that were likely to be effective for the management of the traditional dugong and green turtle fisheries.

This methodology and assessment could prove useful in other settings apart from the Torres Strait Indigenous dugong and green turtle fisheries. In fact, devising collaborative management arrangements that simultaneously meet the aspirations of the different stakeholder groups who have an interest in the management of dugongs and green turtles is not an easy task. An understanding of the perceptions of different management tools using the methodology presented in this chapter could provide managers involved in the design of management tools with information that they could use at the scoping phase. For instance, managers could use the information on perceptions to start discussion with community members on best ways to devise or revise management arrangements. A great opportunity would be for the method to be used in the context of other management arrangements for the protection of dugongs and green turtles in Australia. Recently, the development of Traditional Use of Marine Resource Agreements (TUMRAs) between the Great Barrier Reef

Marine Park Authority and traditional owners of the Great Barrier Reef region has provided a new opportunity for co-management. The Australian government created TUMRAs as a framework which could reconcile the sustainable harvest of dugong and green turtles with the needs of subsistence and biodiversity conservation (Havemann *et al*. 2005). The most important principle of TUMRAs was to encourage Indigenous peoples to exercise their stewardship role in conservation in a culturally appropriate and scientifically robust manner (Marsh 2006). To date the Great Barrier Reef Marine Park Authority and Queensland Department of Environment and Resource Management have accredited five TUMRAs. The methodology presented in this chapter could thus be another tool for managers at the Great Barrier Reef Marine Park to evaluate the perceptions of communities interested in the development of TUMRAs. The information could help those managers discuss ways to meet both community goals and biodiversity indicators as required by the Great Barrier reef marine Park mandate in a way that would likely maximise compliance rate for the TUMRAs.

6.3.2 Perceptions of impacts and familiarity with management tools

My observations confirmed the outcomes of the meta-analysis of Wilson and colleagues (1994) who surveyed 32 studies of regulations applied at the local level in small-scale/ traditional societies worldwide. These small-scale and traditional societies preferred and used rules pertaining to control of territories, limitation of access, seasonal closures, technology restrictions, breeding stock protection, protection of juveniles, and size limits (Wilson *et al.* 1994). Although Wilson and colleagues (1994) did not include the use of incentive-based mechanisms; they found that management rules in these traditional societies almost always focused on fisher behaviour and qualitative controls, rather than on quantitative controls such as quotas.

The tools identified by Torres Strait Islanders as likely to generate the fewest negative (and largest positive) impacts were similar to the traditional institutions studied by Johannes (1978) in the Pacific. Johannes (1978) highlighted that traditional rules were in place in tropical Pacific fisheries in the past. Johannes (1978) explained that "almost every basic fisheries conservation measure devised in the West was in use in the tropical Pacific centuries ago." These findings were significant: "The fact that such regulations are found so widely and have lasted for such a long time suggests that such rules may have been highly adaptive" (Wilson *et al.* 1994)[45].

Foale and colleagues (2011) refuted the claims that past and current traditional practices used in the Pacific fisheries were primarily a response to the environmental limitations to subsistence fisheries. Rather, they considered that strong social rules and norms were controlling factors in the evolution of traditional institutions governing the Pacific subsistence fisheries (Foale *et al.* 2011). Foale and colleagues (2011) suggested the need for a better understanding of the cognitive and social underpinning behind such practices so as to be successfully used in community-based management frameworks. It is important to not only understand the ecological basis of management but also its social basis. This chapter addressed that need.

Torres Strait Islanders recognised that all hypothetical management tools could reduce the environmental costs associated with the traditional fisheries (Figure 6-3 and

[45] However, Foale and colleagues (2011) warn of the ambiguous meaning of "adaptive" in this context. It is important to distinguish between community-based adaptive management, a process where management is put in place, monitored, assessed and changed iteratively in response to local conditions, as opposed to "adaptation" by traditional societies in response to the limitation of their environment. (Foale *et al.* 2011)

Figure 6-5). However, the total impacts of one management tool seemed to be driven by the Islanders' perceptions about impacts on community benefits and on community/cultural costs rather than by the perceived impacts on environmental costs. So, successful natural resource management in the Torres Strait should not assume a conservation ethic from community members. Foale and colleagues (2011) came to a similar conclusion for other modern Pacific fisheries. Management tools based on the social and cultural aspects associated with a traditional fishery are likely to be more acceptable to the communities than management that ignores these aspects.

Although the research process allowed an understanding of the perceptions of community members of the hypothetical management tools on environmental costs, future research should also explore the perceptions of community members towards the potential environmental benefits of different management tools. Environmental benefits are important indicators for government policy and it would be interesting to understand the opinions of on the ground community members on the potential conservation effectiveness of different management tools.

6.3.3 NET EFFICIENCY AND SOCIAL ACCEPTABILITY OF MANAGEMENT TOOLS

Torres Strait Islanders considered management tools that were familiar to them more attractive than others. However, these tools might not be the most effective. As suggested by economic theory, management tools such as "quotas", "taxes" and "subsidies" should be most efficient since the generated dead weight losses associated with such tools are generally less than those associated with quantity restriction (Common and Stagl 2005; Costanza *et al.* 1997). But such an analysis abstracts from many real world problems concomitant to the implementation of policies. Ultimately, the net efficiency of those market-based tools will also be influenced by the specific design of the institutions which implement the tool.

These institutions often assume that the management tool applied will require little monitoring and enforcement (Common and Stagl 2005). But the reality is often different and the successful implementation of management tools requires some sort of monitoring and enforcement. As such, it is important to consider monitoring and enforcement costs before concluding that one tool is more “efficient” than another.

Policy makers have focused on financial incentives to stakeholders in the hope that they would adopt a more environmentally-friendly behaviour. These market-based incentive schemes assume that if people mainly care about financial aspects (more than they do about the environment), then a policy which connects money to the environment is likely to change behaviour, and thus ‘succeed’ (Common and Stagl 2005). But this assumption may not hold in all contexts. The results of my study suggest that cultural aspects are more important than financial or even environmental aspects. The most appropriate policy for the management of the Torres Strait Indigenous dugong and green turtle fisheries is thus likely to be based on connecting culture rather than money to the environment, as a way of changing fishers’ behaviour.

However, it is important to understand that the most appropriate policy in Torres Strait might not be the most appropriate policy to apply to the management of the dugong and green turtle fisheries operated by their Papua New Guinean neighbours with whom they share stocks of dugongs and turtles. Hunters living on the Papua New Guinean side of Torres Strait do not have access to the same services as Torres Strait Islanders. The conditions of life in this developing country are very different from those on a remote island in Torres

Strait. Although Torres Strait Islanders are disadvantaged in comparison to the average Australian, they have access to government benefits and other government-funded facilities such as health care and education. The values associated with the Indigenous hunting of dugong and green turtles from the point of view of Papua New Guineans are thus likely to be very different from those of Torres Strait Islanders since they do not live in such a secure environment. The perceived impacts of the management tools may also be different. Papua New Guineans may perceive that financial aspects of management are more important than social and cultural aspects. It is thus important to consider the local context of management, the values attached to a particular resource and the local perceptions of the impacts of different management tools so as to choose the most effective management tool; as my research highlighted.

I focused on the perceptions of the impacts of different hypothetical management tools rather than investigating real impacts. Whether or not the perceptions of the impacts are similar to the real ones may be somewhat irrelevant as the success of a specific management tool is likely to be influenced by the willingness of the community to implement and respect it. In turn, this is likely to be strongly related to the perceptions of its impacts (Jentoft and McCay 2003; Sutinen and Kuperan 1999) and as such to its legitimacy (Nielsen 2003). My research suggested that policy makers involved in the management of the Torres Strait dugong and green turtle Indigenous fisheries should consider implementing gear restrictions, seasonal closures and/or spatial closures. Those tools were consistently perceived to provide a net impact which was unambiguously positive. Such positive impacts at the community level are likely to be met with compliance and respect of those tools.

6.3.4 LOCAL ENGAGEMENT FOR MONITORING AND ENFORCEMENT

Regulatory compliance is required for the success of any management tool. Enforcement is thus a key implementation issue. My results showed that community members would prefer to be in charge of enforcing the compliance of community members towards tools such as “gear restriction”, “seasonal closure”, “spatial closure” and “quota”. In contrast, they believe that the government should be involved when it comes to administering “subsidies” and “taxes” (although those tools should probably not be considered by managers at this stage given my results). If “subsidies” or “taxes” should be implemented in the Torres Strait, a solution would be for local communities to partner with other agencies as those agencies have typically more capacity to manage financial operations.

My results also indicated that community members could foresee potential problems with each management tool and in turn influence the rate of compliance. The implementation of fisheries management is challenging in remote locations where most community members have relatives in neighbouring communities and where the successful implementation of a tool depends on the behaviour of fishers from neighbouring communities. Fishers might not comply with a tool if they feel that they are the only ones who are asked to make an effort. A solution would be for community members of different islands to discuss the implementation of common management tools. Enforcement would then involve members of all the communities engaged in the process.

Another issue concerns the degree of enforceability of each management tool. I did not collect data that would enable me to weight the degree of enforceability of each fisheries management tool. It was clear from comments of community members that enforceability was an important issue. My results showed that managers need to consider the social as well as financial issues associated with enforcement. It would be important to consider the social consequences that result from involving local people in enforcing rules imposed on their community. Involving locals in the use of enforcement tools such as ‘community shame’ is socially acceptable, although care must be taken to select the appropriate people within the community to implement the penalties. The administration of fines by local people could also lead to a disruption of a community’s social cohesion. Such a situation could impair the success of a proposed management tool and could create unforeseen community tensions that extend beyond fisheries management.

6.4 Conclusions

Several management tools are available in the toolkit of fisheries’ managers. In the case of the Indigenous dugong and green turtles fisheries, this study into the perceived impacts of different hypothetical fishery management scenarios indicated that “gear restriction” would have fewer negative (and more positive) impacts than “seasonal closure”, “spatial closure”, “subsidies”, “quotas” and “taxes” in that order. The perceived impacts of each management tool were less driven by impacts on conservation/environmental values than on the potential social and cultural impacts of fishery tools.

Although this case study has several atypical characteristics, the results have broader implications for the management evaluation of fisheries. Management success will largely depend on the social acceptability of a particular management tool to fishers. Stakeholders need to participate in discussions throughout the phases of natural resource management. Assessment of both costs and benefits of various management tools should not be restricted to biological and financial matters but should include community values.

My study also highlighted compliance as a major issue for local residents. Community members require the capacity to enforce management tools in partnership with government agencies. Compliance is likely to be increased if local residents understand that management will be applied at a regional scale. Appropriate methods for enforcing different management tools also need to be evaluated as some enforcement penalties might disrupt social cohesion (i.e., if financial fines are to be collected by family members). Such knowledge could influence managers to educate stakeholders about some management tools or avoid spending valuable conservation money in mechanisms that will have negative social and cultural impacts. A longitudinal study would also be required to assess whether preferred management options translate into effective management options and/or the preferred management options are chosen because community members are most familiar with them.

6.5 Chapter summary

- Different fishery management tools are perceived to have different levels of impacts on costs and benefits.

- In the case of the Torres Strait Indigenous dugong and green turtle fisheries the perceived total impacts of management tools were driven by community perceptions of the impacts on community benefits and community costs (i.e., perceived impacts on cultural values).

- Although the management tools perceived to have the most positive impact at the community level are not those often considered to be most "efficient", such assessments of economic efficiency often fail to account for monitoring and enforcement costs. Tools that are perceived favourably are likely to be the most successful in the context of the Torres Strait fisheries where monitoring and enforcement are difficult and as such costly. As they are likely to be accepted and as such self-monitored, those tools will gain in efficiency by lowering overall transactions costs that are likely to remain high if non-accepted tools are put in place.

- Policies aiming to change traditional fishers' behaviour should focus on the importance of the cultural aspects that are associated with the Indigenous dugong and green turtle fisheries. Policy tools that aim to connect cultural aspects to the environment may be more likely to succeed than those that connect financial aspects to the environment, since all indications are that financial concerns are of less importance to people in these communities than are cultural concerns.

- The enforceability of each management tool needs to be evaluated against financial and social indicators.

- It is important to understand the context of management. For instance, tools that are perceived to provide positive impacts in Torres Strait may not be those that generate the most positive impacts in Papua New Guinea. It is important for policy makers to understand the value system of local communities and the perceived impact of different management tools on those values. Then, policy makers should choose to align their management practices based on the concerns of local stakeholders. In the case of Torres Strait, policy makers should align their policies with the social and cultural concerns of community members and choose management tools that connect culture with the environment in changing fishers' behaviour. On the other hand, if community members are more concerned with financial impacts, then policy makers may be better off aligning policies with the market and thus use market-based instruments.

CHAPTER 7:

DISCUSSION

This chapter relates my findings to the central aims of this thesis and identifies the implications for the sustainable management of Indigenous fisheries, research and policy. I explore and discuss the key themes of the thesis: the economic, social and cultural issues that influence the overall sustainability of the Torres Strait Indigenous dugong and green turtle fisheries and make some recommendations for policy intervention in the short- and long-term. I end with remarks on my potential methodological and theoretical contributions to the wider literature and with suggestions for future research.

7. Discussion

7.1 Summary of findings

The overarching objectives of this thesis (section 1.8) were to provide: (i) economic information, gathered from the point of view of local stakeholders that could be used to inform the management of the traditional dugong and green turtle fisheries in the Torres Strait; and (ii) baseline data and insights to underpin subsequent economic investigations. To fulfil these objectives I structured this thesis around three sub-objectives. I now explore how my research contributed to answering each of these sub-objectives.

7.1.1 Socio-economic boundary of the Fisheries system

Sub-objective 1: Understanding the socio-economic system in which the Torres Strait Indigenous dugong and green turtle fisheries operate.

I documented the socio-economic context of residents of the remote outer islands of the Torres Strait by combining income data gathered through a secondary source (i.e., the ABS) with primary data on household expenditures and commodity prices. Although Torres Strait Islanders are not suffering from poverty at the level of their Papua New Guinean neighbours, my findings highlighted the "double burden" faced by Torres Strait Islanders in comparison with most other Australians as they combine relatively low incomes with relatively high prices.

This socio-economic context explains one possible motivation for dugong and turtle hunting; hunting provides an alternative to meat purchased from the local store. Torres Strait Islanders living in the remote outer islands considered that gathering resources from the sea lessened the financial pressure on their household budgets. Among these resources, dugongs and sea turtles provided the greatest return in terms of quantity of meat per animal caught. But access to dugong and turtle meat is not the exclusive prerogative of 'hunting' households (with at least one male family member who hunts) because hunters share both the costs of hunting and their catch with people outside their immediate household.

Sharing is a long-held practice among Torres Strait Islanders and this research confirms that the custom it is still strong today. As with many other Indigenous societies, sharing is an inherent part of the way of life (Beckett 1987; Nietschmann and Nietschmann 1981; Nietschmann 1984). Previous anthropological studies in Torres Strait and elsewhere have found that sharing contributed to a number of functions such as the survival of community groups in times of need, the maintenance of family ties and good relations between groups and clans (Bliege Bird *et al*. 2001; Wenzel 1995). Nowadays, sharing of dugong and turtle meat on the islands of Mabuiag and Moa may not directly contribute to the physical survival of families; but it nonetheless contributes to their economic survival in an environment of low income and high food prices.

Although sharing is still occurring today, its nature has changed. Sharing of dugongs and green turtles used to involve all members of one community (Haddon 1912). Today, this type of sharing only occurs if the catch of dugongs and turtles is intended for ceremonial purposes. The meat is then distributed among all Torres Strait Islanders attending the ceremony. In contrast, sharing for home consumption is now kinship-based. This change is likely a result of both the population growth experienced on the islands since 1913 (see Table 2-1) that potentially reduces the size of a share for everyone and the availability of refrigeration which enables meat to be stored. The change might also relate to modern hunting methods. Hunters have replaced canoes or platforms with motorboats. While this change in technology has increased the ease and extent of access to dugongs and turtles, it has also increased the financial cost of hunting.

The costs associated with a successful hunt (i.e., catch of one dugong or one turtle) are now substantial when compared to local incomes: one successful hunting trip is likely to incur fuel costs that are between 46% and 79% of weekly median individual income of a resident of Mabuiag or St Paul's. Thus, perhaps out of financial necessity, hunters do not only share the benefits of their efforts, but also share the costs.

Hunters share costs amongst members of the hunting party but also rely on the reciprocity of other resource users including family members and pensioners. As a result, the line between suppliers and receivers in a traditional supply and demand exchange system is blurred. The receivers (through reciprocity arrangements) provide the means for the suppliers to provide the end product. As such, receivers have a strong interest in the way that the fisheries are operating. The wider Australian community is not generally involved in the management of fisheries as Torres Strait Islanders people described in this study are. The wider Australian public does not usually share the costs associated with its 'mainstream' fisheries and the division between those who supply the fish and those who demand it are more precise in the 'mainstream' fisheries than they are in the traditional dugong and turtle fisheries. So the findings of this thesis in terms of fisheries management might be less relevant in non-Indigenous societies which are more market-oriented. However, future research should investigate how the findings found in this thesis apply to fisheries management in Aboriginal Australian contexts.

Moreover, the current hunting practices require money to flow between the hunters and the beneficiaries of hunting. The continuity between the flow of money and traditional practice is an example of the hybrid economies of Indigenous peoples described by Altman (2001, 2009): the state and the market sectors of the economy provide the financial means to pursue the customary sector of the economy through the use of income to fund a hunting trip (i.e., wages and CDEP payments are used to pay for fuel and oil). The transition of Torres Strait Islanders to the cash economy did not put an end to the customary sector; rather the Indigenous society evolved its practice to accommodate the new order. Kwan and colleagues (2006) highlighted the inverse relationship that exists between the intensity of dugong hunting on Mabuiag and Island and crayfish revenues. Moreover, the flexibility of work provided by the CDEP scheme also allows hunters to go hunting during weekdays and to take advantage of good weather conditions.

My study of these reciprocity arrangements (costs and benefits) has thus demonstrated that the resource users of these traditional fisheries do not only reside in Torres Strait. The frameworks I developed to summarise the flow of meat and money between different resource user groups emphasised that the meat caught by members of one island community was shared with other island communities, Papua New Guinea and the Australian mainland. Through the cultural dimension of sharing, the socio-economic boundaries of the fisheries system need to be extended beyond Torres Strait to include all resource users. Through these reciprocity arrangements, the boundaries of the community of place on each island have been extended to include the whole community of practice.

7.1.2 Costs and Benefits

Sub-objective 2: Understanding the costs and benefits (market and non-market) associated with the Indigenous fisheries?

The findings summarised above directly informed my research on the costs and benefits associated with the Indigenous fisheries, especially the need to interview as many members of my study communities as possible to capture all the costs and benefits associated with the resource 'users'[46]. Thus on the islands, my interviewees included male hunters and non-hunters and women. This approach departed from the usual method of collecting data about hunting which has tended to focus on gathering information from hunters. My sampling was also directly linked to the necessity of collecting data on the costs and benefits that are outside the market, in contrast to most other research methodologies that restrict their questions to hunters about their costs of production (costs) and harvest size (benefits) (Allebone-Webb 2009; Kümpel 2006).

My methodological approach was also informed by a commitment to collect data from the point of view of the resource users. I was mindful not to start my investigation with pre-conceptions about the potential values that Torres Strait Islanders hold towards the traditional fisheries. As such, I decided that I would not use the 12 social values that have been defined by Brown (Brown and Reed 2000; Brown 2004) and commonly used when asking people about the values they hold towards the environment. I also decided not to use

[46] As found in chapter 4, the resource users of the traditional fisheries do not only reside in the Torres Strait. The initial design of the project (funded by MTSRF) focused research activity entirely on the Torres Strait. During the project it became evident that the opinions of Torres Strait Islanders living on the mainland were important. As a result, a grant proposal was successfully put to the Australian Marine Mammal Centre to involve Torres Strait Islanders living in Townsville, Cairns and Brisbane. Further research on this topic is now underway.

a typical western economic framework; i.e., the Total Economic Value Framework to conduct the valuation of the traditional fisheries. The differences between Western and Indigenous worldviews have been documented for several topics such as for the environment (Houde 2007), for health matters (Pattel 2007) and education (Hart 2010). For these reasons, my methodological approach avoided the categorisation of Indigenous values into a framework which may not have matched Indigenous value systems; instead having resources users define their own set of 'values'.

To be more specific, I held several focus group meetings, on each island, were participants were asked to identify costs and benefits (market and non-market) which they felt were associated with the fisheries. Two lists were generated during these discussions – one focusing on 'benefits' and one focusing on 'costs'. During individual interviews, respondents were asked to (a) undertake a cognitive mapping exercise designed to learn more about the relationship between the lists of 'values'; and (b) rate those values.

The costs and benefits identified during the focus group discussions included both market and non-market components, and both the metric and non-metric MDS analysis of data collected during the cognitive mapping exercises indicated that, as a group, people from Mabuiag Island and St Paul's interpreted both the benefits and costs of hunting across three statistically separable clusters.

The benefit clusters were labelled by community representatives as: *community benefits* (associated with cultural aspects), *family* benefits (associated with being able to access cost-effective fresh and tasty food for home consumption) and *individual* benefits (associated with prestige and skills of the hunter). The cost clusters were termed: *community costs* (associated with cultural aspects), *family* costs (associated with expenses for hunting and outside pressures) or *environmental costs* (associated with the impacts of hunting on the marine environment). Interestingly, when addressing issues associated with the benefits of hunting, typical market benefits (i.e., termed family benefits and comprising benefits associated with being able to access cost-effective fresh and tasty food for home consumption) were distinctly separated from non-market ones (i.e., the community and individual benefits.

Since this analysis established that the clusters were statistically separable, I was able to quantify and compare the relative importance of the clusters against one another while avoiding the trap of double counting. In both communities, community benefits were rated as being more important that other benefits, whilst community costs were rated as being more important than other costs. These differences were statistically significant. That said, a difference seemed to exist between older and younger members of both Mabuiag and St Paul’s communities. It appeared that differences existed between the relative importance of the different clusters of benefits and costs between older and younger men. However, both older and younger members found that community benefits and community costs were of greater concerns to them.

As noted earlier, when considering benefits, non-market benefits were clearly distinguishable from market benefits. I was able to capitalise on this finding, to generate financial estimates of the ‘value’ of market benefits using the replacement cost method. The results highlighted the financial importance of the two Indigenous fisheries for the community members of Mabuiag and St Paul’s. Market benefits alone accounted for approximately 8% of total household income. Knowing that community benefits were statistically more important than family benefits it can thus be inferred that the total benefits of the traditional fisheries must be 'worth' in excess of 16% of the household budget. To put this in perspective, this is the average proportion of income which the 'average' Australian household spends on their mortgage[47].

My findings have provided more detailed information than previous studies on the costs and benefits associated with the Australian Indigenous dugong and turtle harvest. Previous studies have noted the existence and potential importance of non-market aspects associated with the practice of dugong and green turtle hunting (AFMA 2006; Buchanan *et al*. 2009) but my findings are the first to attempt a quantification of those values; even if only benefits are concerned.

My findings also confirm the salience of my methodological approach. Although the market/family benefits which were associated with food for home consumption could be fitted into the Total Economic Value (TEV) framework as "direct values", the non-market benefits (i.e., community and individual benefits) did not strictly match the categorisation used by that framework. Evidently, other researchers working in other cultures may also encounter value systems that are likely to be different from more western value systems. These results indicate that they should test the applicability of value systems that have been

[47] I did not place a definite number on the worth of the traditional fisheries. I understand that trying to assign a dollar value on community benefits (i.e., strongly link to cultural aspects of the fisheries) might be upsetting to local people. Those benefits were found to be statistically more important than the market benefits. I could only conclude that the community benefits would then be worth more than \$360 000 – 398 000 per annum but there is no upper limit and their worth could be infinite for various people. Some people (Traditional owners, scientists and managers) may object in principle to assigning a financial value to culture (Levin Institute 2012). Beyond the simple financial valuation of the market benefits, my methodological approach allowed me to express the worth of the fisheries in terms of range so that we have an idea of the sheer value of the fisheries for policy decision making.

imported from other locales, rather than simply assuming that they will be replicated and setting out to measure them accordingly.

These findings also have consequences for those wishing to populate traditional bio-economic models with economic data. Like the case-studies examined here, people in other regions may feel that non-market values are more important than market values. As such much work will have to be done to conceptualise how best include more complex non-market considerations within the Gordon-Schaeffer model.

7.1.3 Impacts of Management

Sub-objective 3: Understanding the impacts of different management tools on the existing costs and benefits associated with the Indigenous fisheries of Torres Strait

Most studies evaluating the potential impact of natural management strategies in the marine environment[48] have been concerned with pre-determined indicators mostly biological or financial. I did not use a pre-determined list of indicators; rather I chose to investigate the potential perceived impacts of management on existing values associated with a particular practice to be affected by management changes[49]. My motivation was directed by the need to explore the potential impacts of fisheries management not only on a

[48] Most studies have largely focused on a description of the potential impact of marine protected areas.

[49] The use of those existing values and an understanding on how they could be affected could provide managers with the necessary information to devise discussion with resource users on how best to prevent impacts or diminish potential negative impacts.

biological or financial level but also on their potential impacts on the social and cultural aspects of fisheries[50].

I used the costs and benefits identified by my respondents in the preceding analysis as a baseline, and then asked people (in private interviews) to indicate how each of those values could potentially be affected by six different types of management tools. I then used insights from literature relating to the Social Welfare Function to aggregate individual responses in a variety of different ways, thus learning more about the potential changes in social welfare that might occur if different management tools were used

Irrespective of aggregation method, members of both study communities indicated that “gear restrictions”, “seasonal closures” and “spatial closures” were consistently perceived as being able to increase existing benefits and decrease existing costs. As such, I was able to conclude that those three management tools were perceived by the communities as being able to provide unambiguous net benefits. On the other hand, “quotas” and “taxes” were consistently perceived to decrease benefits while potentially increasing costs. Evidently these tools were perceived as unambiguously generating net costs. Reactions to subsidies were mixed.

[50] The Torres Strait dugong and turtle management plans were officially released in 2011 at the end of the data collection for this project. The implementation of the plans is carried out in the different communities but is voluntary and monitored through the sea ranger program. As management strategies were not in place during my investigations, I focused on the perceptions of people towards different proposed management strategies. I argue that perceptions are important to understand in the development of management strategies as they influence motivations and potentially behaviour towards compliance or non-compliance.

Interestingly, I was also able to discern few differences between older and younger members of both Mabuiag and St Paul's regarding the perceived impacts of different management tools on the different clusters of benefits and costs.

The use of the different market and non-market costs and benefits for the investigation also allowed me to understand what values drove overall positive or negative perceptions. In the case of the Indigenous dugong and turtle fisheries of Torres Strait, the perceived overall impact of management strategies was strongly driven by the perceived impacts of each management tool on the cultural aspects of these fisheries. Management strategies such as "gear restrictions" and "seasonal" and "spatial closures" were consistently perceived to provide an increase in community benefits that were strongly associated with culture and a decrease in community costs (also strongly associated with culture). On the other hand, "quotas" and "taxes" were consistently perceived to cause negative impacts on both cultural benefits and costs.

Overall, my approaches showed that the framework used to: (1) elicit the values associated with a particular resource, (2) measurement of the relative importance of those values, and (3) assess the perceived impacts of different management tools on those values can provide information on the social acceptability of proposed management tools. The more acceptable a tool, the more likely will people be to comply, and possibly also the lower should be the associated monitoring and enforcement costs. This information should thus be valuable to managers during the scoping phase of any fisheries management program especially in a remote region such as Torres Strait where monitoring and enforcement will be difficult or onerous unless they are carried out by community members.

7.2 Implications for the management of the Torres Strait Indigenous fisheries

My findings are relevant to the future management of the Torres Strait Indigenous dugong and green turtle fisheries in several respects. First, it is evident that the fisheries represent more than meat/money to the community members of both Mabuiag and St Paul's. The provision of dugongs and green turtles for sustenance is one aspect of the fisheries but this service is complemented by cultural, social and individual aspects that are particularly important and indeed appear to be of greater relevance than the provision of food for home consumption.

The people of Torres Strait want to protect their culture; they appear less interested in protecting dugongs and green turtles per se. This finding has interesting policy implications, if one compares this finding with the message of traditional economic policy which implicitly assumes that people who do not care about the environment can be enticed into acting as if they do putting a 'price' on the environment (i.e. by tying the market to the environment). I strongly suspect that if people in the Torres Strait care more about culture than about financial matters (i.e., in this particular context); then culture-based incentives might prove to be more effective in promoting environmentally 'friendly' behaviours than market-based incentives.

It thus seems that managers should consider choosing management tools that link culture to hunting practice. Tools such as "gear restrictions", "seasonal closures" and "spatial closures" were found to be more socially acceptable than "subsidies", "quotas" and "taxes" because of their perceived positive impacts on the cultural aspects of the Indigenous fisheries. Gear restrictions such as bans on spotlight and zagul hunting (hunting at night) have been included in the community-based dugong and turtle management plans of some Torres Strait communities (TSRA 2011a, b, c). "Seasonal closures" restricting the take of green turtles during the mating season is also in place in one community while talks are under way to propose a permanent spatial closure outside the dugong sanctuary as well as expanding the nature of the Dugong Sanctuary to become a Dugong and Turtle Sanctuary (Helene Marsh and Damian Miley, pers. comm.).

Although the current value system of Torres Strait Islanders seems to favour the cultural aspects associated with the Indigenous dugong and green turtle fisheries, managers need to take into account the apparent differences between older and younger members of Mabuiag and St Paul's. Although the differences did not appear to change the overall social acceptability of the different management tools, they emphasise the importance for managers and community members adopting a strategy of adaptive management for these fisheries. Managers need to monitor whether the collective social values of both communities remain static (i.e., the values of the current young members change as they grow older to match those of the current older people) or change (i.e., the values of the current young members do not change as they grow older so that the collective community values change). If the social values evolve, the drivers behind the perceived impacts of management may also evolve so that community/culturally targeted strategies become less effective over time.

Moreover, managers need to understand that the traditional fisheries are not just about the hunters. Hunters may exclusively harvest the resource, but the 'sharing' culture of these communities mean that people throughout the wider community (not only on the island but to other Torres Strait communities, Papua New Guinea and the mainland of

Australia) are also resource users (albeit somewhat indirect). Fisheries managers should thus consult with all these different resource users. On the islands, managers should consult with the wider population to discuss potential management actions so that the impacts of such actions on different resource user groups are understood. Within Torres Strait, managers and community members may want to talk about the conditions around sharing (i.e., permission, purpose…).

Villages in Papua New Guinea should also be part of the wider management of dugong and green turtle harvest in the Torres Strait waters. Currently, there is no information available on the size of take of the animals by Papua New Guinean (PNG) hunters or on the reasons driving that harvest. Given the very different socio-economic context (there is no social security in PNG and the village people of Western Province have a low Human Development Index (Gillivray 2012)), it is likely that the values associated with dugong and turtle hunting (defined in terms of costs and benefits) and their relative importance are quite different than for Australian Torres Strait Islanders. Fisheries managers and the Australian government should thus continue – and ideally build upon – the engagement process with the Papua New Guinean neighbours under the conditions established by the *Torres Strait Treaty (1985)*.

Members of the Torres Strait Diaspora should also be engaged in the management process. Although my data suggest that the amount of meat shared with the Diaspora may not be significant relative to the total size of the harvest, the size of the Diaspora and its potential influence on the behaviour of hunters call for their potential involvement in the management of the fisheries or at least for effectively communicating management efforts taking place on the home communities with “mainland islanders”. For instance, some hunters on the islands may be pushed to breach the rules of their community-based management plans, if resource users from the Diaspora demand dugong or green turtle meat.

A project funded by the AMMC and led by a JCU research team is currently investigating the motives behind the sharing of traditional dugong and turtle meat among Torres Strait Islander families and the awareness and potential involvement of members of the Diaspora into the management of the traditional fisheries. Gaining an improved understanding of the motives of the Diaspora is not only important for the successful management of the Torres Strait traditional fisheries but could also provide information that could help deal with the concerns of the wider Australian community about the rights of members of the Diaspora in accessing dugong and turtle meat. The lack of available information on the quantities of dugong and turtle that are shared with members of the Diaspora and recent media reports on the possible “illegal eskie trade” prompted indignations and questions from the wider Australian communities about the legality of the sharing and an unsuccessful effort to change the relevant Queensland legislation in 2012 (Elks 2012).

My findings also suggest that fisheries managers should consider scaling up the current management process in a geographical sense, a move that would make both biological and social sense. The voluntary actions at the community level presently embodied in the 15 separate community-based management plans need to be coordinated first at the island cluster level and then at the scale of the whole of Torres Strait. The ecological range of both dugongs and green turtles and their movements suggest that the different communities are sharing the same resources but also that the actions of one community will affect the resources available to the others. My preliminary exploration into the enforcement of the different management tools highlighted that the compliance of the members of one community was strongly linked to the actions of the neighbouring communities. So, managers should reinforce the need for community members to voluntarily comply with the rules of their community-based management plans while encouraging dialogue between different islands so as to match potential community decisions with one another and to organise combined monitoring and enforcement efforts. The need for coordination is recognised by Traditional Owners, rangers operating in the communities and TSRA (Helene Marsh, pers. comm.)

The motivations for managing the Torres Strait traditional dugong and green turtle fisheries appear to be different for different stakeholder groups. For instance, my findings suggest that the motivations for at least some Torres Strait Islanders to adopt dugong and green turtle management plans *may be* to create a vehicle to advocate for cultural survival and renewal. But government agencies funding community-based management efforts in the Torres Strait are apparently more interested in the biological sustainability of the two fisheries; other stakeholder groups in the wider Australian society are motivated by animal welfare issues about the need for Torres Strait Islanders to use 'humane' methods of killing dugongs and green turtles. These concerns recently prompted the Queensland government to amend the *Animal Care and Protection Act (2001)* so as to align Queensland animal welfare rules with those of the other Australian states (Queensland Government 2012). The amendments to the *Animal Care and Protection Act (2001)* specifically addressed the need for Indigenous peoples to use 'humane' procedures when killing dugongs and green turtles (Queensland government 2012). TSRA will be engaging with the different Torres Strait communities about the new legislation (Damian Miley, pers. comm.). It is thus imperative for the managers of the traditional fisheries to develop a suite of performance indicators that take into considerations the different motivations behind the management of the fisheries – and seek to find ways of capitalising on those differences (e.g. by using socio-cultural incentives in place of market-based incentives). As part of this exercise, it will vital to understand the extent in which the different indicators align or compete with one another.

7.3 Further research

Throughout this thesis, I focused my investigations in gathering in-depth information on the resource users of the Torres Strait Indigenous dugong and green turtle fisheries. I used a holistic approach which allowed me to gather information beyond the mere financial aspects of the Indigenous fisheries and to also explore the non-market aspects of the two fisheries. My methodological approach was novel as it combined theoretical insights of economic theory (through: (i) the use of the Total Economic Value framework, (ii) the definition of values in terms of costs and benefits, (iii) the use of insights from literature relating to the Social Welfare Function); with methodological insights from other social sciences disciplines such as anthropology and sociology. The holistic conceptual approach and the trans-disciplinary research methods used are likely to be appropriate to different situations and many of my findings[51] are relevant beyond Torres Strait and fisheries management.

[51] The findings of this thesis are not without limitations. The choice of an in-depth case study approach allowed me to gather in-depth data on a number of topics related to the resource users of the traditional fisheries but limited my ability to replicate this work on more than two Torres Strait Islands. The field work conditions at the start of my data collection phase also meant that I had to choose to work in two islands that were located in close proximity so as to allow me to travel from one to other without counting on an airline which could have been grounded unexpectedly. The consequence for this research is that the findings may not apply to the whole of Torres Strait.

First, my research contributes to the literature on traditional societies, hunter-gatherer societies, artisanal fisheries and bushmeat where accessing natural resources through sharing may be important. I highlighted the importance of studying the sharing arrangements taking place in a particular resource use system so as to define direct and indirect resource users. This finding is significant because any management measure has an impact not only on the direct resource users but also on the indirect resource users. If indirect resource users are marginalised (elderly, women, poorer segment of the population) such information is important to ensure that management does not increase the burden on those people. Some funding agencies are also interested in potentially combining conservation objectives with development objectives (Berkes *et al*. 2001). The identification of all resource users might decrease the risk for management policies solely directed towards biodiversity conservation to negatively affect the potential economic situation and development of indirect resource users in the target population.

Correctly identifying resource users is also important when considering whom to include in management discussions. Resilience theory insists on defining the focal system and major stakeholders within it (Ostrom 2007a). In most cases, the stakeholders are defined in terms of their direct use of a resource but in some cases (such as the Torres Strait Indigenous fisheries); resource users may be more appropriately defined through their demand for the resource (Berkes 2006; Berkes *et al.* 2006; Evans and Andrew 2011). Studies need to focus on understanding the patterns and motivations behind the demand for natural resources. Even if the demand is not important, consultation should engage resource users who may have an indirect influence in changing the behaviour of other users.

The importance of the demand for natural resources from external users needs to be recognised. This is particularly true in a world where people increasingly move from one country to the other and where the demand and supply of goods is international. To fail to account for the influence that external users have upon a resource system may be to overlook significant contributors to problems – and potential solutions. My findings are thus relevant to the academic literature linking migration and natural resource management as well as to the literature on the relationship between culture and food.

Most of the literature on the links between migration and natural resource management has investigated the positive or negative impacts of migration on the natural environment of the host communities or the impacts that the removal of people is having on the natural resources of the source communities (Robson 2010). However, my findings suggest that we need to investigate more closely the pressures on the natural resources of source communities resulting from the demands of migrants. This situation is especially important if the demand targets endangered species or threatens the sustainability of the source ecosystem.

My approach which aimed to understand the inter-relationships between the flow of money and the flow of natural resources could be useful in studying the trade of endangered species and their management. Studies on the trade of natural resources including endangered species could use a conceptual approach such as the one I used or methodologies such as social network analyses to highlight the main resource user groups supplying and demanding natural resources. Once those resource user groups are identified, management strategies could consider involving such groups in the management process and/or building social marketing campaigns directed at them. Such a conceptual approach could be important in the case of the Chinese trade in wildlife including the trade in endangered species.

The Chinese trade in wildlife products highlights the importance of understanding the different resource user groups within a system and the motivations driving each resource user group demanding or supplying the resource. The demand for natural resources is driven by a range of factors (Fabinyi 2012) that need to be identified and evaluated. As in the Torres Strait traditional dugong and green turtle fisheries, the Chinese demand for wildlife products may go beyond the provision of food for sustenance and be more related to tradition and potential medicinal properties of the products (Fabinyi 2012).

My approach has the potential to provide insights into the nexus between food and culture in many migrant societies. The use of cognitive mapping or of other methodologies aiming to separate between the different values that natural resources provide can help to identify those different contributions. If the demand for natural resources from migrants is growing and potentially threatens natural ecosystems, then the information on the values associated with such resources could inform appropriate management strategies and information campaigns involving migrants.

The findings of my research and my conceptual approach could also potentially contribute to the scholarship and management of bio-culturally rich areas. Recent studies have highlighted the correlation existing between areas of rich biodiversity with areas of rich culture (Maffi and Woodley 2010). The sustainable management of those areas is critical in terms of both biodiversity and cultural conservation (Maffi and Woodley 2010). In those areas where culture and environment are strongly linked, managers should investigate policies that directly link culture to the environment as a way to protect both the environment and culture.

Policy makers should thus assess if their policy proposals for the management of natural resources make the most effective use of underlying value systems. Most government agencies favour biodiversity outcomes when designing biodiversity conservation projects and perceive potential cultural outcomes as co-benefits. The 'economic perspective' often prevails, the unvoiced but nonetheless implicit underlying assumption being that people may not 'care' about the environment but they certainly 'care' about money. As such there has been much focus on market based instruments, since they are assumed to be able to help align conflicting goals. But this research has shown that there are at least two communities which consider socio-cultural values to be (significantly) more important than financial/market values. There are likely to be other communities (such as but not restricted to Indigenous Australian communities) who feel similarly. In cases such as these, policies that seek to align cultural and environmental values (i.e. using socio-cultural incentives) may thus prove to more effectively protect ecological and/or biodiversity values than those which focus on market based incentives.

An interesting area of further research will be to understand the process of cultural change which may affect the practice and management of the Torres Strait Indigenous dugong and green turtle fisheries. Changes are taking place in Torres Strait. From the early account of Haddon (1890, 1912) who described the people of Western Torres Strait hunting for dugong and turtles from platforms, we can see that those canoes and platforms have long been replaced by the use of outboard motor boats. The change in the mode of transport used to go hunting and the hunting method (from a stationary platform to a moving outboard motor) may be the result of a process described as "cultural selection" (Crozier 2008). In the context of the Indigenous fisheries of Torres Strait, cultural selection may favour the use of dinghies over canoes or platforms due to technological progress but also due to their appeal for minimising physical effort. In the same way, the process of cultural selection has not altered the desire of current Torres Strait Islanders to go hunting due to the importance of the cultural aspects associated with dugong and green turtle hunting. However, the importance of the values associated with hunting was statistically different between the older and younger member of the communities which pose interesting questions for the future management of the two Indigenous fisheries. Would the management arrangements designed to reinforce the cultural aspects of the fisheries be relevant if the young people of today value hunting for its family benefits (i.e., food for home consumption)?

A similar question should be investigated to understand the opinions of members of the Torres Strait Diaspora. As mentioned earlier, a project is under way to understand the current motivations of the Diaspora for demanding dugong and green turtle meat. The project should be seen in the longer term as members of the Diaspora especially young people may be more influenced by Western views which would influence their values and the process of cultural selection towards different behaviours relating to Indigenous hunting.

Moreover, having an improved understanding of the primary motivations of stakeholders, and of their perceptions about the likely 'impact' of different management tools could help managers select approaches that are likely to maximise compliance rates. This is because compliance is likely to be greatest if the (perceived) impact of a policy leads to an increase in personal well-being (Larson 2010).

Policies that align socio-cultural values with environmental values, and that adopt tools that are socially acceptable could also result in other indirect benefits to government agencies. Studies have shown that working on country provides a range of externalities beyond biodiversity conservation (Edyvane 2012). The social capital of Indigenous people increases with employment opportunities (Austin 2012) as well as with empowerment while other externalities of working on country have been linked to better health outcomes (O'Dea 1984).

Funding agencies also recognise the need to design programmes that do not just focus on one outcome (such as biodiversity conservation) and may thus favour programmes that enhance the likelihood of achieving a number of objectives such as biodiversity conservation coupled with social benefits to local communities (Edyvane 2012). As such, by designing policies that work with the value systems of local communities (rather than imposing value systems from other cultures), one may be able to target the drivers behind the motivations of Indigenous peoples that could increase their participation in a range of programmes, government agencies maximise funding on programmes that are directed in providing benefits to the communities beyond just biodiversity conservation. Policy programmes that reinforce the link between culture and environment could potentially provide the government with the biodiversity outcomes it requires as well as with outcomes for Indigenous communities that help bridging the gap between the status of Indigenous Australians and the wider Australian community on a number of well-being indicators.

In conclusion, this research succeeded in meeting its overall objectives. However, the information provided in this research is in many ways providing the start for further investigations. As Godoy (2001) realised, long-term studies help researchers to learn as they go along. I hope that my study through its unique approach has provided baseline economic information that can help future researchers in refining their research questions and in designing management systems that are more likely to be effective (preferably at meeting multiple objectives). The methodologies I used could be explored in other contexts but strongly highlight the importance of understanding the values people attach to their environment. In terms of policy implication for the management of the Torres Strait fisheries, my suggestions outlined above require a continuous financial and political support to strengthen the work undertaken by Torres Strait Islanders in the sustainable management of their marine resources.

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APPENDICES

Appendix A

Miss Aurélie Delisle
PhD Candidate
School of Business / School of Earth & Environmental Sciences
Telephone: (07) 4781 5014
Facsimile: (07) 4781 4019
E: aurelie.delisle@jcu.edu.au

Dear Mr. Terrence Whap,

My name is Aurélie Delisle and I am a current PhD student at James Cook University working on a project entitled "The Economics of Hunting and its long-term management" which is supported by the TSRA's Land & Sea Management Unit.

In brief, the objective of my project is to gather relevant information about the costs and benefits (market and non-market) of traditional hunting of dugongs and marine turtles from the community's point of view. I have also attached a fact sheet and poster providing more details on the project which also aims to gather relevant information about the costs and benefits (market and non-market) of the management plan that your community released last year and to understand the potential costs and benefits of the sea ranger program from the community's point of view. It will not only look at the values that are financial but it aims to understand all the values associated with these different activities especially cultural and social values.

It is very important to get this information from the community itself because the community manages dugongs and turtles. The results of the project could then be used to inform other communities that want to develop their own sustainable management plans.

For your information I have also included a copy of the completed Torres Strait Research Protocols for my project.

I am writing today to ask permission from the PBC to conduct my project in partnership with your community. The project will involve a number of trips to Mabuiag Island. The date and length of those trips will depend on the availability of participants and appropriateness of the stay. The research will be conducted according to JCU Human Ethics guidelines and I will make sure that the project is conducted in a culturally appropriate manner.

I will be phoning you within a week to confirm your decision as well as to arrange accommodation etc but please feel free to contact me if you have any questions.

Kind Regards,

Aurélie Delisle

Appendix B

Marine and Tropical Science Research Facility

MTSRF Project 1.4.2b

The economics of hunting and its long-term management

Mabuiag Research Trip #1

Introduction

About this project

Traditional hunting is a topical issue and one over which there are differences in the interests of Indigenous communities, management agencies and the wider community. But all costs and benefits associated with this activity are not completely understood. This project will not only focus on the financial costs and benefits of hunting but will consider these costs and benefits in a wider context. This can involve money, time, social benefits and/or cultural benefits that do not have a $ value but they are important and need to be recognised. The project will also look at the costs and benefits of management programs from the community's point of view. The results of the project could then be used to inform other communities that want to develop their own sustainable management arrangements.

People involved

Aurélie Delisle

Aurélie is from France. She is a researcher with James Cook University. This project is part of Aurélie's PhD and she will be spending a lot of her time working with community members throughout the project.

Natalie Stoeckl and Helene Marsh are researchers with James Cook University. They are project leaders and are Aurélie's supervisors.

Purpose of this trip

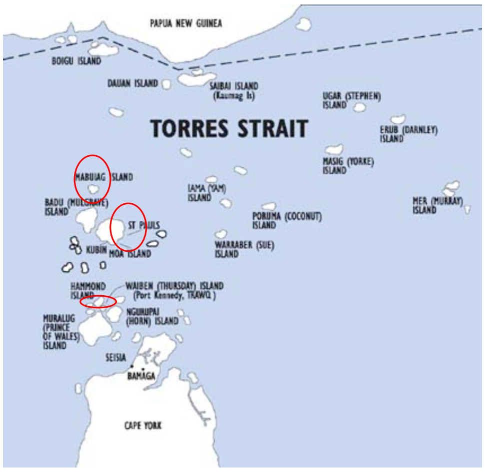
Of the Torres Strait Island communities that have expressed interest to become involved with this project, Mabuiag, St Paul's community and Hammond Island have been selected initially because of their strong involvement in the management of these fisheries

The purpose of this trip is to:

- Introduce the project to your community
- Explain the objectives of the project to your community
- Introduce Aurélie Delisle to the islander communities
- Discuss values of traditional hunting and its management with community members
- Preliminary group work and interviews if possible

Marine and Tropical Science Research Facility

Where this project will be working



In October 2008, the project was presented to 8 turtle and dugong project officers during a spatial management workshop on Thursday Island. Some project officers expressed a keen interest in the project and talked about the potential benefits to their communities. These include Mabuiag and St Paul's community on Moa. Some work may also be undertaken on Hammond Island. The outcomes of this study can inform policy makers about all the costs and benefits of traditional hunting activities and its management in the Torres Strait from the communities' point of view. The results can help other Indigenous communities develop their own sustainable management plans.

What this research will involve in the future

Over the next two years this project is looking to:

- Develop research agreements
- Conduct group work and interviews to understand the costs and benefits from traditional hunting activities from the community's point of view, not only financial values but also cultural and social values
- Conduct group work and interviews to understand the costs and benefits from the management of turtles and dugongs from the community's point of view, not only financial values but also cultural and social values
- Provide information to the communities on Mabiuag, St Pauls and Hammond Island that can be included in their sustainable management of turtles and dugongs.

Contact Details

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Australian Government

JAMES COOK UNIVERSITY AUSTRALIA

Reef & Rainforest RESEARCH CENTRE

TORRES STRAIT REGIONAL AUTHORITY

Appendix C

HOUSEHOLD INFORMATION

1. How many people 'normally' live in your house (including yourself)? _______________

If the number of people changes from week to week, then ask for an 'average' number

2. How many of those people are Aboriginal or Torres Strait Islanders? _______________

Fill in number

3. How many of those people are ***Fill in number***

________ Under 20 years old? ________ Between 35 and 65 years old?

________ Between 20 and 34 years old? ________ More than 65 years old?

4. What is the highest level of education that anyone in your household has achieved?

Please tick appropriate box

☐ Primary school ☐ High school ☐ University

☐ Trade ☐ Other ***(please specify)*** ________________________

5. How many of the people who 'normally' live in this house (including yourself) are; ***Please fill a number beside each category. For example, if two people in the house are employed, write the number "2" next to the word Employed.***

_____Retired _____Unemployed _____Student

_____Employed _____On CDEP *(Commonwealth Development Employment Program)*

6. What types of work do the people in your household do? (i.e. where do you work, and what do you do?)

Person 1: ____

Person 2: ____

Person 3: ____

Person 4: ____

Person 5: ____

Person 6: ____

Person 7: ____

HOUSEHOLD EXPENDITURE

7. Please tell me approximately how much all the people in your household (added together) spend on each of the following goods and services each week or each fortnight (**Don't forget to indicate timescale on the data sheet)**. *Tick appropriate box.* *If the spending is high in some weeks e.g. $400 and low in other weeks e.g. nothing, ask to give details to work out an 'average' – e.g. $200*

	Approximate dollars PER WEEK ☐ or PER FORTNIGHT									
	$0	$1 - 20	$20-50	$50-100	$100-150	$150-200	$200-300	$300 - 400	$400 - 500	Other (*specify)*
Rent (or Levy)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Mortgage repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Credit card repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other loan repayments	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Food consumed at fast food places	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Groceries	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Tobacco products	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Clothing and footwear	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Recreation (e.g. movies, gym fees)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Fuel (petrol, diesel)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Communication (e.g. telephone, internet)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Gas & Electricity	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other *(please specify)*………………	☐	☐	☐	☐	☐	☐	☐	☐	☐	$

8. Please tell me approximately how much all the people in your household (added together) spend on each of the following goods and services each YEAR. ***Tick appropriate box.*** *If people purchase some things once every few years then ask details so as to work an average amount (e.g. If people in the household buy a freezer once every two years, then ask the cost of the freezer and report one-half the cost of the freezer). Write the details.*

	Approximate dollars PER YEAR									
	$0	$1 - 50	$50-100	$100-250	$250 – 500	$500-$1000	$1000-$2000	$2000-$4000	$4000-$8000	Other (*specify*)
Insurance (e.g. car, house, boat, medical)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Hiring tradespeople to maintain cars, home, etc	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Medical goods/services and pharmaceuticals	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Hardware or equipment for hobbies (e.g. camping gear, pet supplies)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
School Fees	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Personal care (e.g. hairdresser)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Cars and Vehicles	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Household furnishings (including whitegoods)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Transport (e.g. airplane and bus tickets)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other Travel / Holiday expenses (e.g. hotels)	☐	☐	☐	☐	☐	☐	☐	☐	☐	$
Other *(please specify)*……………	☐	☐	☐	☐	☐	☐	☐	☐	☐	$

HOUSEHOLD SAVINGS, TAX, INTEREST AND LOAN PAYMENTS

Money that is spent locally gets passed around to others in the community. Money that is taxed (taken away by the government), saved (in pillow cases or elsewhere), or that is paid as interest to banks outside the local region does not get passed around within the community. This money is taken out of the system. The following questions allow me to estimate how much of your household income gets taken out of the system.

9. Approximately how much of your total household income is

Saved? __________________ ***Example: If you save about 10 dollars from every 100 dollars that you earn, then write "10%" (or one-tenth); if you never save any money then write "0".***

Taxed? ____________________ ***Example: If approximately 50% of all your household income is paid in tax, then write "50%" (or one-half).***

10. Does anyone in the household have a credit card? ***Please tick appropriate box.***

☐ No ***Please to question 20*** ☐ Yes

What is the rate of interest charged on the credit card(s)______ % *If there is more than one credit card, please just give me the 'average' interest rate. If you always pay off your credit card before being charged interest, then please write '0'.*

11. Does anyone in your household have a home loan or mortgage? ***Please tick appropriate box.***

☐ No ***Please to question 21*** ☐ Yes

What was the total amount borrowed (when the loan was first taken out)? $_________ *If there is more than one mortgage, then add the amounts together*

What is the term of the loan (How many years were you given to repay it, counting from the start of the loan)?______years. *If there is more than one mortgage, please tell me the LONGEST term.*

What is the rate of interest you are being charged on that loan?______ % *If there is more than one mortgage, please just give me the 'average' interest rate.*

12. Does anyone in your household have any other loan? ***Please tick appropriate box.***

☐ No ***Please to question 22*** ☐ Yes

If yes, was the money borrowed from a 'local' person (someone in Kowanyama)? ***Please tick appropriate box***

☐ No ☐ Yes

What was the total amount borrowed (when the loan(s) were first taken out)? $_________ *If there is more than one loan, please add the amounts together*

What is the term of the loan (how many years were you given to repay it, counting from the start of the loan)?______years *If there is more than one loan, please tell me the LONGEST term*

What is the rate of interest you are being charged on that loan?______ % *If there is more than one mortgage, please just give me the 'average' interest rate*

GENERAL HOUSEHOLD INFORMATION

13. What is the total, combined, annual income of ALL the people who 'normally' live in your house? ***Please tick appropriate box***

☐ <$20,000 AUS Dollars

☐ $20,000-$40,000 AUS Dollars

☐ $40,000-$60,000 AUS Dollars

☐ $60,000-$80,000 AUS Dollars

☐ $80,000-$100,000 AUS Dollars

☐ $100,000-$120,000 AUS Dollars

☐ $120,000-$140,000 AUS Dollars

☐ $140,000-$160,000 AUS Dollars

☐ > $160,000 AUS Dollars

Appendix D

Interview guide 5

1. Introduction

Greetings

Thank respondent for participation

Explain goal of interview and get informed consent: emphasise that the answers will be strictly confidential and will not be linked to the respondent. Respondent will be identified by a number only. Responses will be kept in a locked cabinet at James Cook University.

Ask prior consent to take pictures of paperwork produced during the interview, no pictures of people will be needed.

2. Household *(questions about your household)*

Before we start talking about hunting, I would like to ask you some general questions about you and your household

How many people are currently living in the house?

	Newborns	Kids (<15 ys)	15-19 ys	Adults (20-64 ys)	>65 ys
Males (at home)					
Females (at home)					
Currently away from home					
Males (away)					
Females (away)					

How many males are hunting?

Now, since I am interested in talking about hunting, I will ask you some questions regarding some goods you may possess in order to catch a dugong or a turtle.

Goods			
Wap (#)		Yes	No
Throwing net (#)		Yes	No
Spotlights		Yes	No
Boat (#)		Yes	No
	Type		
	Size		
	Date		
Outboard motor		Yes	No
	Type		
	Size		
GPS		Yes	No
	Handheld		
	Mounted *(when)*		
Safety gear *(what)*		Yes	No
Picture taken		Yes	No
What happens if boat is out of order? If engine does not work? Who fixes? In St Paul's? In TI? In Cairns?			
Use of boat?			
How many people are using it?			
Frequency (per use? per person)			
Distance travelled per use?			
Do you have access to someone else's boat?		Yes	No

How often?	
Purpose of use?	
Distance travelled per use? Time for hunting Dugong / Turtle. (Average per trip or ask min / max).	

Comments: How often does every hunter in the Household go hunting? (week, month...). Separate turtle / Dugong. How many dugongs / turtles does each hunter catch? What is your success rate (ask about the proportion of time each hunter does not catch a dugong / a turtle?)

If you are in a hunting party, what is your role? *(hunter, boat driver, etc...)*
Does that mean that you are responsible for what...? Do you need to bring anything? During hunt? After hunt?How are the expenses share (ie. fuel)?

How many drums do you take per hunting trip?

Dugong?

Turtle?

Do you pay whole expenses? Do you share?

Who pays for the fuel?

3. Hunting

Now, I would like to get into the hunting part of the chat (interview)

First, I would like to know if members of your household are involved in:

Dugong hunting	Yes	No
Turtle hunting	Yes	No
Egg harvest	Yes	No

Which tides do you prefer to hunt on?	
Low (Y/N)	*High (Y/N)*
Small (Y/N)	*Big (Y/N)*
Neaps (Y/N)	*Springs (Y/N)*

How do you decide whether to go fishing or hunting?

If you are on a boat (travelling or fishing) and see a dugong/turtle, do you change the purpose of your trip?

If you see a dugong, skinny, water fat, wati dangal, juveniles what do you do?

If you catch a dugong, what parts of it do you use?

Meat		Yes	No
	All	Yes	No
	Liver	Yes	No
	Kidney	Yes	No
	Stomach	Yes	No
	Gut	Yes	No
	Other		
Oil		Yes	No
Tusk		Yes	No
Bone		Yes	No

What happens to the blood/ carcass?

Are there dugongs that are not good for eating?

How often do you go hunting to catch dugong for ceremonies only?

How often do you go hunting to catch dugong for your home consumption?

Dugong (Consumption)		
FIRST CEREMONIAL ONLY for ceremonial purposes	Yes	No
How many ceremonies?		
NOW NON-CEREMONIAL How often will you enjoy dugong meat?	Fqy	
	Condition *(If seasonality, do you fill freezer and then use later in off-season?)*	
	Provenance (family, other island).	
Meat served *(which part)*	Ceremonies	Kai Kai

Once you have some dugong meat, do you always eat the meat cooked on the day? Y / N

Do you keep some for later consumption (frozen? How long would you keep it?)? Y / N

Do you share what you catch with others? Y/ N How many people? Ask about average number of shares for dugongs / turtles?

On the island (relationship)(#share/fqy)	On other islands (relationship)	On the mainland (relationship)

Turtle hunting? For ceremonies only: how often?
For home consumption only: how often?

Have you ever seen sick turtles? *Fqy? What do you do?Are there turtles that are not good for eating?*

What do you do if you see a tagged turtle?

If you catch a turtle, what parts of it do you use?

Meat	Yes	No
Fat	Yes	No
Black fat (wuru)	Yes	No
Shell	Yes	No
Ovaries	Yes	No
Shell	Yes	No

<table>
<tr><td colspan="3">Turtle</td></tr>
<tr><td>FIRST CEREMONIAL
ONLY for ceremonial purposes</td><td>Yes</td><td>No</td></tr>
<tr><td rowspan="3">NOW NON-CEREMONIAL
How often will you enjoy turtle meat?</td><td colspan="2">Fqy</td></tr>
<tr><td colspan="2">Condition (If seasonality, do you fill freezer and then use later in off-season?)</td></tr>
<tr><td colspan="2">Provenance: only your catch?

From shares given to you? How often?</td></tr>
<tr><td>Meat served (which part)</td><td>Ceremonies</td><td>Kai Kai</td></tr>
</table>

Do you always eat the meat fresh? Y/ N

Do you keep some for later consumption? Y/ N

Do you share what you catch with others? Y/ N

How many shares on average per turtle?

On the island (relationship) (#shares/fry)	On other islands (relationship)	On the mainland (relationship)

Egg harvesting (during the season)? Is it on a daily basis? Weekly? Very uncommon?

What species? (*probe for tracks, size of egg, location, time of year*)

Do you share what you collect with others?

On the island (relationship)	On other islands (relationship)

Turtle eggs	
During season, how often do you eat turtle eggs?	

4. Income (I don't want to know your income but the sources…it will be important when looking at the prices at the shop)

In terms of expenses, I would like to ask you some questions about the sources of income in the household?

Sources of income		
CDEP	Yes	No

How many hours did you do last week?		
Other type of employment	Yes	No
Job 1: how many hours per week? (FT/PT) or which day did you work and for how long last week?		
Job 2: how many hours per week? (FT/PT) or which day did you work and for how long last week?		
Family tax benefit	Yes	No
How many?		
Parenting payment	Yes	No
How many?		
Unemployment benefits?	Yes	No
How many?		
Child support?	Yes	No
Rent assistance	Yes	No
Other pensions/ allowances?	Yes	No
What types?		

Comments:

Do you have concerns if CDEP runs out?