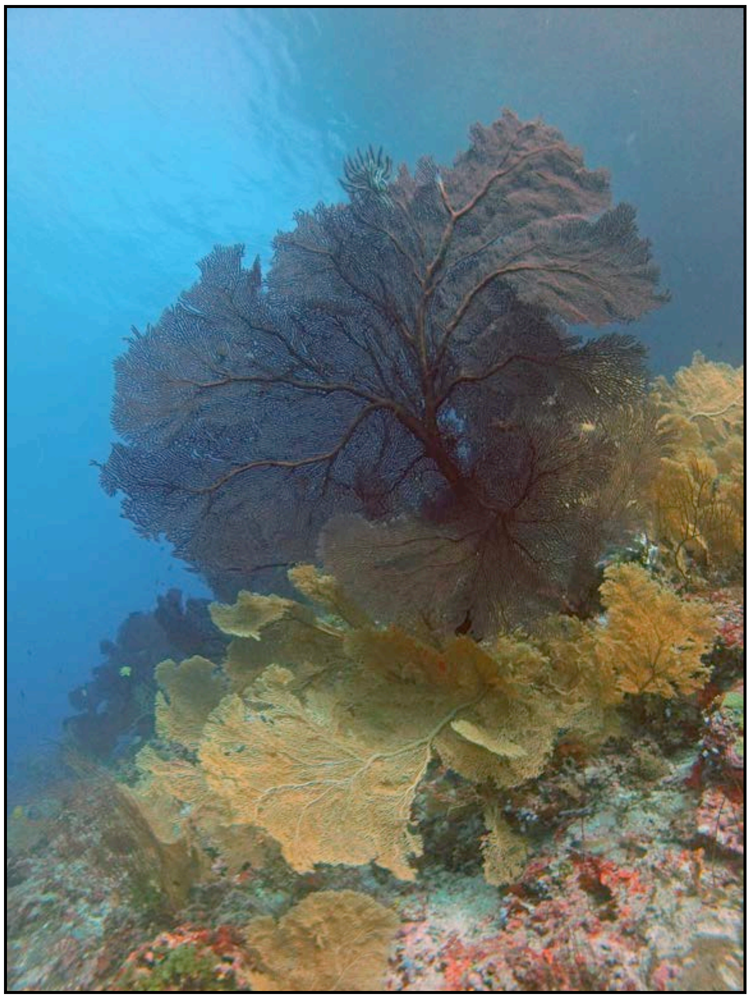
Honouring Traditional Ecological Knowledge

A qualitative approach to assessing the health of marine ecosystems.



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Abstract

The coastal communities of the Reef Islands, in the remote Temotu province, Solomon Islands, have a long history of successful customary tenure of the surrounding marine eco-systems. Sustainable exploitation was achieved partly through the inherent limitations of traditional fishing equipment and methods as well as management strategies such as seasonally closed areas and other restrictions. Historically there was a strong qualitative element to these traditional management strategies that reflected the close participatory, and often survival dependant, relationship with the marine environment. This traditional ecological knowledge allowed for adaptive responses to change due to external forces such as severe weather events. However, in more recent times internal changes such as increasing population pressure, new technology fishing techniques and periodic intensive harvesting of specific species, as well as external forces such as commercial fishing and climate change have eroded the effectiveness of traditional management techniques.

This thesis focuses on research conducted with the support and cooperation of the village of Tuo, the largest community on Fenualoa, one of the Reef Islands Island, and OceansWatch, an international NGO who have been working with the community since 2010. The aim of this research is to provide a preliminary evaluation of the effectiveness of qualitative and intuitive ways of knowing as they relate to assessing the health and sustainable use of marine ecosystems by island communities. Qualitative assessment is measured using the Free Choice Profiling (FCP) methodology, adapted by Francoise Wemelsfelder, in her work with farmed animal welfare. This is a phenomenological approach where volunteers are asked to describe, in their own terms, the inherent, discernable qualities of specific sites. The results are analysed using Generalised Procrustes Analysis (GPA). Two separate FCP surveys were conducted, one with volunteers from OceansWatch and the other with Reef Guardian trainees from Tuo. Of interest in this study is how the results can be used to develop a qualitative monitoring program that compliments traditional management practices within the framework of customary marine tenure.

In addition to the main theme of this thesis a preliminary, comparative study is made between the FCP surveys and transect data collected from the same sites using ‘Reef Check’, a quantitative monitoring methodology that utilises local stakeholders, trained in the methodology, as well as marine scientists, to create a global database of coral reef health.

Acknowledgements

As with any endeavour, this project was only possible through the support and enthusiasm of many people. To participate in the MSc at Schumacher College has been a great privilege and a wonderful part of my journey. I am, first and foremost, eternally grateful to my partner in this adventure, Jane Pares, who first introduced me to Schumacher and who has supported us while I have indulged. Thanks to my daughter Sam, who let me be on the other side of the world for such a length of time.

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My research was part of a much bigger project being undertaken by OceansWatch. Janey and I have a long association with this grassroots NGO but it was still a great display of confidence and trust in me that they decided to support my research and make it an important part of the work they are doing with the Reef Island communities. Thanks especially to Chris and Julia for embracing the ideas of traditional knowledge. To the rest of the OW team, I extend my thanks to the Jackson 4, Liz and Karlee for their support and participation in the FCP surveys. I would especially like to thank my three colleagues in the marine science team, Neil Cook, Kat Rowe and Mia Tranthem. Your enthusiasm and commitment in helping with the FCP surveys was outstanding and well beyond my expectations. I am also grateful to Neil for his translation of the FCP instructions into Pidgin.

Finally, My sincere thanks go to the people of Tuo community for inviting OceansWatch to assist them in the first place and for their generous hospitality in opening their village to us. It was a pleasure working and sharing time, stories and laughs with the Reef Guardians. Nelson, John, Lespo, Joe, Frency, Thomas, Willie, Asley, James, Lovelin and John S. I look forward to continuing our ongoing development of the Reef Guardian program in the future.

Contents

Section 1 *Introduction and Project Background*

General Introduction

Holistic science is not so much a particular discipline or field of study as it is a philosophical approach to the process of scientific enquiry. By describing holistic science as ‘a science of qualities’ the founders of this MSc program, and current practitioners of the holistic approach to science, are insinuating a very important movement towards the reunification of our objective perception and subjective experience of the world around us. Embodied in this shift is the recognition that we are not separate from that which we study, in either space or time, and indeed, have influence over and are in turn influenced by the very phenomena we are studying.

C. G. Jung described four psychological functions common to all peoples, intuition, sensing, feeling and thinking (Harding, 2009). Modern reductionist science favours thinking and relegates sensing to a secondary role that is only temporarily employed until it can be replaced with abstract measurement. Likewise intuition is subsumed by the hypothesis and subsequent experiments it initiates, while feeling is left out altogether, lest it cloud the supposed objectivity that is regarded as the basis for ‘good’ science. Holistic science on the other hand encourages us to cultivate our intuitive abilities by honing our sensory skills through prolonged and disciplined phenomenological engagement with the subject of our enquiry. The strong sense of connection that flows from this empathic engagement with our subject manifests as feelings that naturally leads us to ask ethical and moral questions about, not only the science, but also our wider relationship with the subject.

Bringing these ‘ways of knowing’ together creates the basis for holistic science and there are many examples, both historical and contemporary, for us to model our own work on. We all have our natural tendency towards a dominant way of ‘seeing’ the world but when we consciously develop all of the ways of knowing our dominant form becomes a great strength. Stephan Harding, in his book *Animate Earth* provides four outstanding examples of this with the thinking of James Lovelock, the feeling of Arne Naess, the intuition of Aldo Leopold and the sensing of David Abram (Harding, 2009). But perhaps there is no better example of how these ways of knowing can work together than Johann Wolfgang von Goethe (1749-1832). In Goethe’s scientific work we can see how rigorous attention to sensing, feeling and thinking can lead to profound intuitive knowing. (Bortoft, 1996)

This is not to deny the value of quantitative reductionism as a very useful measurement tool that can add valuable information towards deeper understanding. A good example of this is the Reef Check monitoring methodology used in this research project. By measuring abundance of key indicator species a generalised picture can emerge as to the overall health of the study area. However, as with any complex system, coral reefs have many inter and intra-species relationships, both subtle and contextual, that limit the usefulness of generalised assessments in relation to adaptive management strategies. This is where a more holistic approach to the assessment of reef health, that takes into account the dynamic qualities of each unique area, as well as the physical, social and cultural needs of the human inhabitants, can play a vital role in bringing us back into full awareness of our participatory relationship with the ecosystems we inhabit.

Many traditional cultures are characterised by the close participatory relationship they have with their immediate environment. Survival was (and in many cases still is) dependant on an intimate knowledge and deep understanding of local ecosystem dynamics, such as seasonal variations and migration patterns of key species. The combined wisdom of countless generations led to complex yet adaptive management strategies no less sophisticated, but arguably more sustainable over time, than modern science and technology based resource management policies (Berkes, 1999). There is a growing awareness amongst interested ecologists, ethno-biologists and anthropologists that this kind of traditional ecological knowledge could have contemporary implications (Johannes, 1989).

It is this participatory relationship that is at the core of this work (discussed further below) and it is this relationship that has suffered through neglecting the dynamic qualities of phenomena in scientific enquiry. Francoise Wemelsfelder's groundbreaking work on the qualitative assessment of behaviour in farmed animals shows that it is possible for us to reliably discern the subjective experience (what it is like to be) of other beings and that individual assessments show a high level of consensus amongst observers (Wemelsfelder *et al*, 2001, Wemelsfelder, 2007). The 'Free Choice Profiling' (FCP) methodology used by Wemelsfelder has subsequently been used as a means of assessing the qualities of terrestrial landscapes (Harding *et al* unpublished, Burch, 2008). Initial results also show a significant degree of consensus amongst observers in three separate trials, supporting the decision to use this methodology in the current study.

Spirit dance performed as part of our welcome to the Temotu region.

Rationale for the current project

Coastal communities such as those in the Reef Islands have a long history of successful stewardship of their marine eco-systems using traditional methods such as seasonally closed areas, fishing restrictions and other restrictions associated with significant cultural events. Historically there was a strong qualitative element to these traditional management strategies that reflected the close participatory, and often survival dependant, relationship with the marine environment. This allowed for adaptive response to changes due to external forces such as severe weather events. However, in more recent times internal changes such as increasing population pressure, new technology fishing techniques and periodic intensive harvesting of specific species, as well as external forces such as commercial fishing and climate change have, in some cases, eroded the effectiveness of traditional management techniques. This could also have the effect of eroding community confidence in their own ability to 'look after' their resources and to doubt the value of their qualitative and intuitive understanding of the local marine environment.

Honouring and validating this traditional relationship as part of an evolving, contextually appropriate management strategy should be seen as an integral part of empowering local communities to meet the considerable challenges facing them. An important step towards this is to understand how our own relationship to the ecosystems we inhabit has developed and how we can embrace alternatives to our current quantitative paradigm. I believe this research project can be beneficial towards this end.

Few would argue that coral reefs are one of the most complex living systems on the planet. Yet our scientific study of them seldom goes beyond the recognition and subsequent quantification of certain key species. This has proven to be a useful approach as a 'general indicator' of reef ecosystem health, especially as it relates to our exploitation of particular species (Hodgson, 1999). By measuring a set of pre-determined indicators, a prediction can be made as to the current and future state of a 'living system', in this case, the reef. This process necessarily requires the researcher to arbitrarily 'carve off' a section of the reef for measurement. This separated section of the reef is then given the status of representative of the whole, despite the 'whole' reef always being in dynamic motion. Never the less, this 'static' representation is then supposed to reliably predict current and future movement.

The limitation of this approach in providing whole system feedback to users and inhabitants of coral reef areas lies in its need to simplify in order to quantify. In this process the uniqueness of an individual reef is lost in favour of a generic representation that excludes the emergence of unique qualities, manifesting through the dynamic interplay between the myriad individuals, both inter and intra specific, that underpin the similarities and differences between individual reef ecosystems. This is not to say that a qualitative approach is free from the need to impose boundaries that are in essence subjective, that is, the boundary may only exist as a tool of the researcher to define an area of observation and may not be a living boundary in and of itself. The difference between the two approaches though is that while the quantitative approach seeks to impose a unity within the diversity of separate species, reefs and systems, the qualitative approach opens the possibility of experiencing the diverse manifestation of form and function within the unity of the whole (Bortoft, 1996).

Moving from Object to Subject

To experience the reef as a whole we must first accept it as an entity in and of itself that is more than just a variety of species co-habiting within a spatial environment. From this perspective the reef is a living whole with many parts rather than merely a totality of discrete parts. This is analogous with how we view ourselves; i.e. we are a whole being with many interrelating parts; legs, arms, organs etc. Putting all the parts of an individual together may give us the appearance, the outline, of a human being but it tells us very little about that particular individual human's 'beingness'. Likewise with the reef, we may see the outline and recognise the parts. We may even determine some relational causality between the parts but until we 'meet' a particular reef as a unique entity we miss experiencing its wholeness. In other words, instead of it being a reef it becomes 'this' reef. And as 'this' reef it is no longer merely an object to be studied but rather a subject that can be related to, not just on an intellectual level, but also through our subjective sensual perception. This is the phenomenological approach.

Phenomenology involves the active participation of a perceiver with the subject being perceived. It is the interplay of different sentient parts of a sentient whole. In *Phenomenology of Perception* (1962) Maurice Merleau-Ponty illuminated this interplay between the perceiver and the perceived, the act of perceiving and the experience of oneself as the active perceiver, by expelling the Cartesian dualism not only of mind and matter, but also sentience and non-sentience. Instead he asserted the primacy of the sensed world, alive to itself and manifest in the very act of sensing and being sensed. Tim Ingold, in his book *Being Alive,* sums up Merleau-Ponty's position thus, *'…since the living body is primordially and irrevocably stitched into the fabric of the world, our perception of the world is no more, and no less, than the world's perception of itself – in and through us. It is not possible, Merleau-Ponty implied, to be sentient in an insentient world'* (Ingold, 2011, Pg 12).

The Perception of Qualities

In our daily lives we are accustomed to experiencing the qualities of something as a result of our subjective interaction with it. We end up with an impression that is dependant on the context of the interaction. In other words, the perceived quality involves the integration and weighing up of everything we perceive and of the context in which we perceive it. Something that we seldom think about though is the origin of the qualities we perceive. Often there is an assumption that, because we articulate our experience of quality as a judgment, good, bad, etc, we have created the perceived quality ourselves and that it is nothing more than a projection of our own internal process. In other words, we have fallen victim to one of cardinal sins of reductionist science, anthropomorphism (Wemelsfelder, 2007).

It is this anthropomorphic stigma that often precludes the inclusion of qualities in any scientific discourse least the 'pillar' of objectivity is called into question. And yet by discarding all qualities from our scientific enquiry we are denying our fundamental experience of the phenomenal world we inhabit. In so doing we reduce science to a single dimensionality that too often bears scant resemblance to the multi-dimensional world it is supposed to represent. This is not to say that we should accept all our qualitative perception without critical rigor, but rather we should apply rigorous method to the use of our perceptive skills.

As Francoise Wemelsfelder puts it, *'It is not given that qualitative judgments are detrimental to science; if deliberately and conscientiously applied through the use of formal methodologies…'* (Wemelsfelder, 2007, Pg 28). Her development and use of the Free Choice Profiling (FCP) methodology over the past fifteen years bares this out.

As mentioned earlier, a major goal of this study is to investigate ways of honouring and validating the Reef Islander's traditional ways of relating to their marine ecosystems while at the same time exploring new and novel ways to incorporate scientific knowledge into contextually appropriate management strategies. The question of whether this process has any effect on, and is affected by, traditional knowledge and practices and the way they are perceived and honoured, both within the community and in a wider context is of particular interest. This could have useful implications for other coastal communities and for organizations working with them towards sustainable development and building resilience to the impacts of climate change and resource depletion.

Tuo Village, Fenualao Island under the rising full moon

The Reef Islands and Tuo Community

Much of the information in this section comes from OceansWatch project reports for 2010-2011 and represents (in part) knowledge passed on directly from Tuo community residents. I have supplemented this from other sources where possible. I am grateful for the use of these reports.

Figure 1. The Solomon Islands

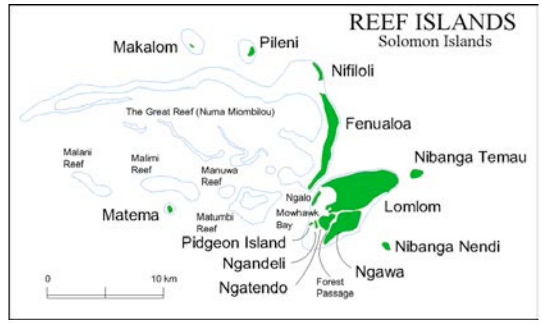


Figure 2. The Reef Islands

The Reef Islands are located in the remote Temotu province of the Solomon Islands (10º 15' S, 166º 18' E). They are an upraised atoll comprising fifteen islands with extensive coral reefs and shoals surrounding a large lagoon over 90 km2 in area. Climate is typical of these latitudes with high humidity and a fairly constant year round air temperature of around 30ºC. Weather conditions are strongly influenced by the seasonal movement and development of the South Pacific Convergence Zone (SPCZ). During the summer months of January to March the SPCZ moves south over the Solomon Islands, bringing northwesterly winds and the heaviest rainfall. During the rest of the year the SPCZ generally lies further north, bringing the Southeast trade winds to the region (Vincent, 1994). At 10º S, the Reef Islands are at the northern/upper edge of the South Pacific cyclone belt, where these storms are in the early stages of their development, so damage is generally minimal. Sea surface temperatures remain fairly constant at around 29ºC due to the Solomon Island's position at the southern edge of what is known as the Western Pacific Warm Pool; a large area of year-round high ocean temperatures that extends eastward from Indonesia, the Philippines and New Guinea (Yan et al, 1992). Ocean currents are dominated by the westward flowing south equatorial current.

The Reef Islands were most likely first inhabited in the early Lapita period (approximately 1100BCE) by early ocean voyagers from New Britain. Archeological and genetic evidence suggests that these early voyagers 'leap frogged' the main Solomon Islands group and settled in the Santa Cruz/Reef Islands but maintained trading links with New Britain (Sheppard and Walter, 2006). Most of the inhabitants of the Reef Islands today speak a Melanesian dialect although some of the villagers in the more outlying islands are thought to be of Polynesian descent.

The Tuo community inhabits the southern part of Fenualoa Island, the second largest of the Reef Islands. Fenualoa is 8 km long and only 600m wide and delineates the eastern side of the lagoon. In addition to the Tuo Community there are three other villages: Maluba, Tanga and Malapu comprising a total population of between 1500 and 2000.

With an approximate population of 1000, Tuo is the largest community on the island. Population growth in the Solomon Islands is increasing by 4.4% per year (UNDP, 2006) and the Reef islands appear to be following this trend. Members of the Tuo community belong to the Pelowe Clan (tribe of the dolphin). Clan membership is through matrilineal linkage. Members of the Pelowe clan believe that when someone of importance from the clan dies, dolphins will come ashore at Tuo to sacrifice themselves. (See appendix iii for an article reported in the Solomon Star newspaper on April 29th 2011).

Tuo's people are heavily reliant on natural resources for their daily survival. They engage in a variety of subsistence farming and fishing. In particular, fishing activities are of utmost importance due to Fenualoa's relatively small agricultural land to inhabitant ratio and the generally poor soil quality typical of coral atolls. Women harvest taro, yam and kumara (sweet potato) in their gardens. Coconuts, breadfruit, bananas and pawpaw further supplement the diet. Thus the Tuo community depends to a great extent on its extensive customary marine area for much of their food needs. The community's main income consists of the sale of surplus catch of a variety of fish and invertebrate species, as well as livestock (primarily pigs), to neighboring communities or in the market in the regional capital of Lata. In addition there is the occasional harvest and sale of bech de mer (dried sea cucumber) when the Solomons government intermittently opens the fishery.

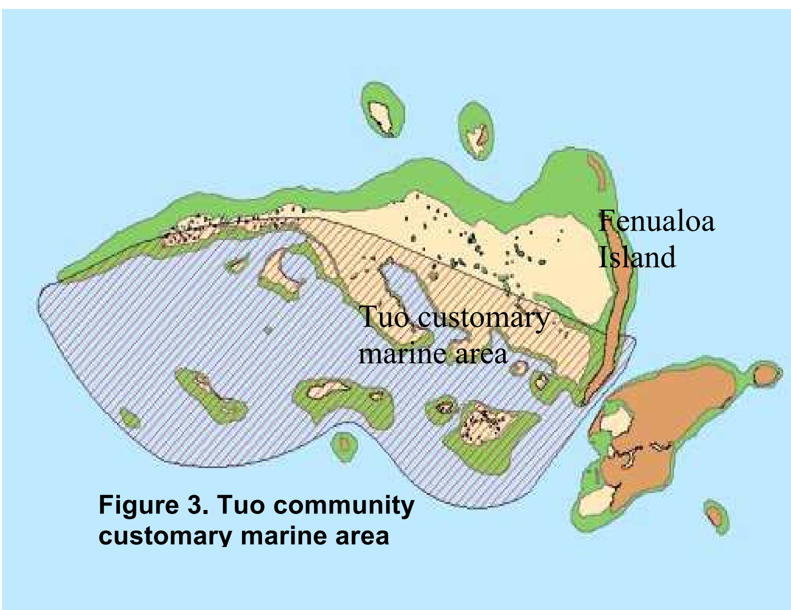


Figure 3. Tuo community customary marine area

Tuo's customary marine tenure encompasses most of the extensive lagoon (77 km2) and includes reef flats, patch reefs and pinnacles inside the lagoon as well as extensive reefs outside the main lagoon. Their tenure also includes a portion of the deep channel between Fenualoa and Lomlom. Fishing effort is equally split between lagoon areas and deeper waters off the fringing reefs. Due the large westward extension (approx. 26 km), reef use decreases with distance from the village.

The furthermost reef is less used due to the relatively long travel time by canoe. The lengthy trip also limits fishing trips to days when weather permits such ventures but fishermen report the biggest catches from this area, mainly snapper and bream (*Lutjanidae* & *Nemipteridae*). The central section of the reef is predominantly used by adult males and occasionally by women looking for clams (as they are no longer found in areas closer to shore). The elderly and women, catching smaller fish, predominantly use the nearest reefs to the village. Fishing in deeper waters off the southern lagoon edge is either done by canoe or communally from an outboard powered boat. At specific times of the year when there are westerly winds and it is difficult fishing in the lagoon area, these activities are moved to the deep channel between Fenualoa and Lomlom.

Nearby communities are excluded from using Tuo's reefs, however people from other villages may ask permission to fish in Tuo's customary area when special occasions such as customary feasts require the stocking up of food. This request is usually granted, however Tuo's villagers note the regular poaching from neighbouring communities. Further, illegal fishing operations by external commercial vessels within Tuo's fishing grounds appear to also pose a problem.

Traditionally, Tuo's fishery consisted of the use of cages made out of bamboo and local twine, deployed at low tide and a line and stone (as hook) during high tide. Women and children would use mangrove roots, sharpened to use as spears (Nago). A change from traditional fishing practices started in the 1960s with the introduction of metal hooks. Soon after, people visiting Honiara started to bring back monofilament gill nets. The use of fishing nets swiftly found wide acceptance due to their high efficiency, allowing the sale of surplus catches, thus opening a small market/trade with neighboring communities. Displaced by the more efficient fishing nets the use of bamboo cages was ultimately abandoned in the 1980s.

Current fishing practices include day and night diving as well as the use of spears (simple metal rods). In parallel to the introduction of new fishing techniques there has also been a change in fishing effort. Whereas traditionally there was a division of gear and fishing practices among fishermen nowadays everyone uses every technique. In addition, higher population levels have lead to an increase in the number of villagers going out to sea in search of food.

Tuo's fishermen started observing a decline in fish catches as early as the 1980's with the 1990's being described as the worst decade. The shift in necessary fishing effort was described as follows: during the 60's a fishermen needed about 1hr to catch enough fish to fill a canoe but by the 90's it would take a whole day to achieve the same catch.

Overall, Tuo's fishermen perceive the use of gill nets as having the most detrimental effect on their marine resources, with night fishing also having an impact. Two fish species have ceased to be found within Tuo's customary marine area, the orangefin ponyfish (*Leiognathus bindus*) and the six feeler threadfin (*Polydactylus sexfilis*). These two species used to be regularly caught inshore. Further, Tuo's fishermen report the absence of the yellow boxfish (*Ostracion cubicus*) and boxfish (*Ostraciidae*) in general in their waters after having been heavily fished in the past.

Tuo's veteran fishermen also report a substantial bleaching event, which took place in 1993. The event affected both shallow as well as deeper reefs, predominantly branching Acropora sp. Corals apparently did not recover and were eventually overgrown by algae. They report observing further minor bleaching events since 1993 together with a decline in fish associated with corals. Further environmental changes have been mentioned with regards to ocean currents. Fishermen report changes in the predominant currents within the lagoon. Whereas in the past they used to be from the west, nowadays currents are more erratic and difficult to predict. There has been a dramatic increase in coastal erosion since the 1980's, which is likely to be directly attributable to these current changes.

In response to the issues outlined above the Tuo community decided to close an area of their customary marine area to allow fish stocks to recover. It was at this stage (in early 2010) that the community decided to contact OceansWatch to ask for assistance in helping them achieve this. The resulting Marine Protected Area (MPA) area encompasses a small island that was submerged sometime around the 1980s. This area was chosen primarily because the Tuo fisherman observed that fish use the area as a spawning ground. This points towards a traditional conservation ethic amongst this community (discussed further in relation to Traditional ecological knowledge below).

Tuo's main graveyard is now below the high tide line due to coastal erosion

Fore shore adjacent to Tuo village, Fenualoa Island.

OceansWatch

OceansWatch is an international not for profit organisation that was set by a group of Ocean sailors who were inspired by the plight of isolated island coastal communities in remote areas of the South Pacific. Many of these communities were only accessible by boat and often ‘off the map’ for larger established NGOs. OceansWatch recognised there was a large pool of ‘untapped’ resources and talents within the cruising yacht fraternity that could be mobilised to ‘sail with a cause’ and respond to invitations from communities seeking assistance.

OceansWatch’s vision is for healthy marine ecosystems that support sustainable livelihoods for island communities. Their mission is to assist communities in regaining or maintaining their livelihoods through the protection of their marine ecosystems from over fishing, pollution and climate change. To achieve this OceansWatch works with sailors, divers, conservationists and scientists to help island communities address these issues and develop adaptive management strategies that are appropriate to the needs of both the marine environment and the community.

OceansWatch is a grass roots organisation, relying almost entirely on member contributions and volunteer support to run its expeditions and is motivated by the determination of the communities it works with to find solutions to the challenges they face. This includes establishing marine management plans, which may include Marine Protected Areas (MPAs) or other types of pressure-reducing initiatives, such as restrictions on hook type, and hook and net mesh sizes. OceansWatch approaches marine conservation issues from a multidisciplinary point of view and believes that the human dimension must be included in the conservation equation. This is especially true of communities where coral reefs, and associated species, form an important part of their cultural traditions and beliefs. OceansWatch also provides marine conservation resources and support, and raises awareness about the effects of climate change.

The Reef Guardian Program

The Reef Guardian program was initiated by OceansWatch to provide communities with a framework for monitoring their marine resources and in particular, monitor changes within the community based MPAs. To date the aim of the Reef Guardian programme has been to train community members in simple monitoring techniques, using transects, to count key indicator fish and invertebrate species as well as substrate identification and percentage of cover. It is hoped that this data can provide communities with important information on any localized changes such as bleaching events, changes in fish numbers as well as obtaining continuous data on their MPA. However, there is scope to build on this initial training and simple transect based monitoring by introducing ecosystem based management principles. Of particular value is the concept of the relational wholeness of the ecosystem that identifies and acknowledges the complex web of relationships that contribute to the bio-diversity and resilience of ecosystems at all levels. Contributing to this development is one of the major goals of my research and involvement in this project.

Section 2 *Literature Review*

The Role of Traditional Ecological Knowledge

'Ecosystems sustain themselves in a dynamic balance based on cycles and fluctuations, which are nonlinear processes... Ecological awareness, then, will arise only when we combine our rational knowledge with an intuition for the nonlinear nature of our environment. Such intuitive wisdom is characteristic of traditional, non-literate cultures, … in which life was organized around a highly refined awareness of the environment' (Capra 1982, Pg 41).

Developing Traditional Ecological Knowledge

Traditional ecological knowledge (TEK) is the term used by ethno-scientists and researchers, including ethno-ecologists, to describe the experience based knowledge, accumulated over hundreds or thousands of years, by a cultural group in relation to their immediate environment. In his book *Sacred Ecology* Fikret Berkes defines traditional ecological knowledge as *a 'cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment'* (Berkes, 1999, Pg 8).

There are different levels to this *knowledge-practice-belief complex,* beginning with practical, empirical knowledge gained through long term observation. This represents the in depth knowledge of local animals, plants and environment. The next level represents the application of this knowledge through resource management practices that require an understanding of the ecological processes at work including inter and intra species relationships. These practices need to be framed within social structures that encompass rules of use, codes of conduct and social mechanisms for cooperation and the coordination of ongoing monitoring and reviewing of the rules. This level represents the ability to make adaptive modifications to resource use and management practices. Finally there is the overarching worldview, which gives shape and context to environmental perceptions and provides a framework for meaning in relation to environmental observations (Berkes, 1999).

A common thread in the worldviews of many indigenous peoples is that of a *'community of beings',* in which the human is not separate from the other animals and plants nor indeed from any of the physical characteristics of their surroundings (Berry, 1999). Further, this wider community is infused with agency and soul "*anima mundi"* (Abram, 1996, Berry, 1999, Harding, 2009, Jung, 2008). Our modern worldview discounts this '*animism'* as a superstitious belief that imbues life and spirit into otherwise inanimate objects, but as Tim Ingold points out, this is misleading as *'…we are dealing here not with a way of believing* ***about*** *the world, but with a condition of being* ***in*** *it'* (Ingold, 2011, Pg 67).

From this perspective we can see that the development of TEK is not only the consequence of time spent observing and interacting with ones surroundings but, perhaps more importantly, of being an integral part of the flow of life processes of an area, to the point where the individual's sense of self becomes inseparable from those processes. In other words, the life, and wellbeing, of the individual is completely embedded in the life and wellbeing of the 'wider community'.

This is important because, as a number of researchers have pointed out, there is often a time lag between the settlement of an area by people and the development of sustainable resource use practices. This time lag in the development of TEK has been described as the transition from invader to native (Berkes, 1999) and is perhaps best illustrated by the correlation of species extinctions and the arrival of humans on previously isolated islands. The islands of Aotearoa/New Zealand are a good example, where the extinction of at least forty four endemic species of land birds, including the giant, flightless Moa, coincided with pre-historic settlement of the islands by the ancestors of the Maori (Steadman, 1995). However this example also illustrates how, over time, people learn from their early '*mistakes*' and develop ecological knowledge, practice and environmental ethics appropriate to their new home, as is the case with contemporary Maori culture (Roberts et al. 1995).

Traditional Conservation Ethics

Tropical ecologist, Robert Johannes, proposes that a group of people can be said to possess a traditional conservation ethic if they have *'an awareness that they can deplete or otherwise damage their natural resources, coupled with a commitment to reduce or eliminate the problem'* (Johannes 1994, Pg 85). The development of a conservation ethic seems to depend on many factors including the relative abundance of resources. It is unlikely to develop unless there is a period of over-exploitation resulting in a noticeable depletion. People who live on smaller islands in the Pacific often have well developed conservation ethics, which are likely to be related to the relatively clear feedback they receive about their resource exploitation. A strong conservation ethic would enhance their ability to learn and to revise their management systems (Berkes, 1999).

The development of environmental or conservation ethics as part of TEK is by no means universal and there are numerous examples of continued over-exploitation of resources leading to ecological collapse. In Oceania the rapid and total deforestation and subsequent population collapse of Rapa Nui/Easter Island is perhaps the best-known example and represents an unusual extreme in that the population continued their destructive behaviour despite the obvious impact it was having (Johannes, 2002). However, the more usual story of migration and settlement throughout the Pacific Islands and Oceania seems to be one of initial over-exploitation followed by a period of adaptation to their new environment.

Traditional conservation ethics do not necessarily coincide with western ideals of environmental conservation. Whereas the primary goal of modern western conservation is the protection of habitat and bio-diversity, traditional, indigenous conservation is more usually concerned with the sustainable exploitation of certain species within an ecosystem, while still maintaining the overall integrity of that ecosystem (Berkes, 1999).

Social anthropologist, Edvard Hviding's study of the cultural/bio-diversity relationship in Marovo Bay, Solomon Islands, describes this *'wise use*' approach.

> *'Marovo people's knowledge of the environments of sea, reef and rainforest is dynamic and constituted in an ongoing process of transmission, individual learning and collective wisdom. For example, through the wealth of terms and concepts relating to the marine environment, the people of Marovo organize their knowledge of the migration patterns and seasonal aggregations of important food fishes. A pattern thereby emerges of rotational exploitation of fishing grounds and target species that may have a long-term conservation potential'* (Hviding, 2006, Pg 80, 81).

This is not to say that the two are mutually exclusive. Indeed there are a growing number of examples of co-management relationships between indigenous peoples and government departments or other external organisations. But in order for these to work, recognition of the different worldviews informing the conservation ethics of each group must be acknowledged and respected. For example, in New Zealand the Conservation Act of 1987 requires the Department of Conservation to work with local Maori in developing co-management relationships in accordance with the Treaty of Waitangi, New Zealand's founding constitutional document that guarantees indigenous land rights. However, the conservation ethics and goals of each party are informed by different worldviews. Whereas the Conservation Act involves the preservation and protection of ecosystems for the purpose of maintaining their intrinsic value, the Maori perspective focuses more on the '*wise use'* concept that embeds humans within their ecological home in a reciprocal relationship, requiring a sense of guardianship (*kaitiaki)* (Roberts *et al*, 1995).

Traditional Meets Contemporary Ecological Knowledge

The science of ecology in a modern context is relatively young and yet the body of knowledge accumulated over the past 150 years is impressive. Much of this scientific ecological knowledge however is the product of the Newtonian, reductionist worldview that portrays ecological processes in terms of machinelike causal relationships (complexity theory not withstanding). Of course this positivist approach is challenged by many scholars and scientists, including ecologists, who recognise the shortcomings of removing moral and ethical responsibilities from the scientific process, hence the growing interest and respect for traditional ecological knowledge and its potential contribution to re-establishing human existence within the wider ecological community. Understanding the differences between these two approaches is the first important step in this process.

The list below is a generalised overview of these differences presented as part of 'The International Program on Traditional Ecological Knowledge' (Berkes, 1993).

1. *TEK is mainly qualitative (as opposed to quantitative)*
2. *TEK has an intuitive component (as opposed to being purely rational)*
3. *TEK is holistic (as opposed to reductionist)*
4. *In TEK, mind and matter are considered together (as opposed to a separation of mind and matter)*

5. TEK is moral (as opposed to supposedly value-free)

6. TEK is spiritual (as opposed to mechanistic)

7. TEK is based on empirical observations and accumulation of facts by trial-and-error (as opposed to experimentation and systematic, deliberate accumulation of fact)

8. TEK is based on data generated by resource users themselves (as opposed to that by a specialized cadre of researchers)

9. TEK is based on diachronic data, i.e., long time-series on information on one locality (as opposed to synchronic data, i.e., short time-series over a large area).

Traditional ecological knowledge can profoundly influence ecological management decisions that are in turn a response to the social, cultural and economic needs of the community. Economic needs and changing trends can affect the performance of traditional management systems and can also influence the ethics of management. Fikret Berkes points out that traditional ecological knowledge is not only cumulative but also dynamic and adaptive to change through the continuous experience of resource use in a particular environment (Berkes, 1999). This is an important point in relation to the increasing emphasis on the use of ecosystem based management (EBM) principles for marine resource use at local, regional and national levels. The overarching goal of EBM is to ensure the long-term capacity of marine ecosystems to deliver a range of ecosystem services while maintaining the integral health and viability of the ecosystem as a whole. This inevitably includes multiple, often competing, goals that necessitate tradeoffs between resource use and conservation (Halperna *et al,* 2010). Traditional ecological knowledge can provide the moral, ethical and practical framework in which to achieve these goals.

Traditional fishing canoe, Tuo village, Fenualoa Island.

Traditional Ecological Knowledge in the Reef Islands

The information in this section comes primarily from interviews with Tuo fishermen, in particular John Nando, who were participants in the Reef Guardian program and who took part in the Free Choice Profiling Survey.

The primary framework in which traditional ecological knowledge is practiced in the Reef Islands is through *'Customary Marine Tenure'*, a widely used marine resource management strategy throughout the islands of the South Pacific. Customary marine tenure provides the social and institutional structure for the regulation and control of fishing practices, codes of conduct, social mechanisms for cooperation and the coordination of ongoing monitoring and reviewing of the rules (Berkes, 1999). It has been and continues to be an effective way of managing the common property resources of surrounding reefs and lagoon in the Reef Islands.

The largest customary area belongs to the Tuo community, located at the southern end of Fenualoa Island. There appears to be a complex system of permissions for access to the customary area that involves community affiliation (possibly through marriage), clan membership and birthright. It is the role of the paramount chief (a member of the Pelowe, dolphin clan) to grant special permissions and institute any major changes or restrictions to use such as taboo areas (see box 1), or restricted access, while the fishermen themselves can introduce other measures such as restrictions on night fishing and the use of nets in certain areas and at certain times.

Box 1.

Creating a Taboo Area

Taboo areas are created in response to observed changes within the customary area. The process of enacting a taboo area in the Tuo customary area was explained to me by John Nando who has been involved in the process twice, once in the early 1990's and again in the setting up of the current taboo area that makes up the temporary and permanent MPAs.

The fishermen know the reefs well. If they notice a decline in their catch over a period of time they go to talk with the Paramount Chief. The Chief will call a meeting of the fisherman from the Tuo community, including those who live in other villages on Fenualoa and the neighbouring islands in the Reef group. After listening to everyone's views the paramount chief will suggest that the taboo area be set up and with the fishermen will decide on the location and size of the area as well as how long it should be in place for, traditionally 3 years.

Once this has been decided the paramount chief sends out an invitation to the chiefs of all the other communities in the Reef Islands to attend a feast at Tuo. After the feasting the paramount chief tells the story of the decreasing fish stocks and announces the taboo area. He then instructs the other chiefs to go back to their communities and tell their fisherman not to fish inside the taboo area. Meanwhile the Tuo fishermen mark the Taboo area with large branches stuck into the reef so that everyone knows where it is.

On the whole most people respect the taboo area but if anyone does break the taboo and is caught they must pay a fine to the paramount chief who keeps it in the village fund to be used for procuring communal supplies.

Custom fishing inside the taboo area:

Periodically the paramount chief might grant an exemption to fish inside the taboo area. This would generally only happen for very special 'custom' occasions and would usually carry strict limits, including fishing technique, species targeted and catch limits. The fisherman carrying out custom fishing (Nai ve) would have to pay the community to go fishing in the taboo area.

Box 2.

Traditional Fishing Practices

In depth local ecological knowledge was the foundation for the development and use of particular fishing techniques. Below is a description of a technique known as '*Nape'*. The full name of the technique would also include the fisherman's name, which signified who the *nape* belonged to. For example, *Nape ra Tamoli* means this is the *nape* of Tamoli.

Construction of a nape involved the fisherman building a converging 'runway' of coral rocks up to about 15 to 20 metres long and approximately 6 to 8 metres wide at the opening, narrowing down to about 2 metres at the end. The nape is constructed in shallow water with the sides built up high enough so that at low tide fish are unable to swim over them. At low tide the fisherman would position himself at the narrow end of the nape and hold a bamboo framed net (pomblou) across the opening. He would then herd fish into the wide opening either by throwing stones from the narrow end towards the opening or getting his children to scare the fish into the nape. With no escape route the fish were forced into the waiting pomblou. A variety of species could be caught in this way.

The *nape* is a good example of appropriate technology that provided sufficient return for effort but had enough built in restrictions (labour intensive, limited catch potential, tide and weather dependant, permanent structures with ample room between each *nape* for a high percentage of fish to avoid them) to avoid over exploitation. *Nape* were in use in the Reef Islands until the 1980s although their use started to decline in the early 1970s with the introduction of monofilament gill nets. Another feature that I noticed when I visited several old *nape* with John Nando is that the rocks used to form the runway have created living reef structures (with live coral growth and fish habitat) in otherwise flat sandy areas. Whether this was an intentional outcome was unclear but it does illustrate how human habitation combined with appropriate technology use can potentially have a positive impact on local biodiversity and ecosystem productivity.

Nape showing converging runway

Construction of the Nape has created new habitat

Free Choice Profiling

Overview

Free choice profiling (FCP) is a qualitative assessment methodology originally designed for use in sensory science, especially the food technology sciences, as a way to measure the amount of consensus amongst a subject group of consumers asked to describe the qualities of new food products (Arnold & Williams 1985). What is distinctive about the free choice profiling approach is that participants are asked to describe these qualities in their own words rather than being given a pre-fixed list of descriptors. This allows the participant to fully explore their own subjective experience of the study subject, opening the way for them to freely describe the qualities they are discerning. In contrast to the inherently objective process of scoring a set of pre-fixed terms provided by the researcher, the participant is invited to 'meet' the expressive qualities of the subject directly. In the second phase of the FCP survey participants are then asked to score the subject against each of their self generated terms by choosing a point, between minimum and maximum along an otherwise unmarked line. In other words, the participant decides how much each term describes the qualities of the subject. By leaving the line unmarked participants are encouraged to score each term based on their intuitive perception rather than through an intellectual 'score out of ten' process.

Because there are multiple subjects (in this case, ten different coral reefs), each participant will end up with a list of terms that represent the qualities expressed by all ten reefs. This inevitably means that particular terms will resonate more with some reefs and less with others. This will be reflected in the position along the unmarked line, associated with each term, that the participant scores that particular reef. The precise location of the score for that reef is measured for later analysis. This provides the opportunity to measure the participant's consistency of use of their terms and also provides the framework for comparing the semantic consistency amongst participants.

Thanks to animal behavioural scientist, Francoise Wemelsfelder, FCP has now been recognized as a valid and useful method for assessing qualities in a wider context. Her research on the spontaneous qualitative assessment of behavioural expression in animals dates back to 1997 and encompasses more than 60 FCP trials involving a variety of, mostly, farm animals. In all of these studies Wemelsfelder and her colleagues have found significant agreement between observers in the interpretation of the animals' expressive behaviour (Wemelsfelder, 2007, Wemelsfelder et al 2000, 2001). Inspired by this work, FCP has been used to conduct landscape studies as part of the MSc in Holistic Science at Schumacher College. In the three studies, conducted in 2006 and 2008, significant observer agreement was found. Further, the level of semantic convergence in the characterization of landscape expression between culturally disparate observers, viewing landscapes in two different countries, never the less indicated a significant commonality in perception of landscape quality (Harding *et al*, unpublished, Burch 2008).

Method of Analysis

The following is an overview only. Further explanation can be found in ***Section 3, Research Methods.*** *For a full and detailed explanation of the FCP and GPA please see Wemelsfelder et al, 2000 & 2001).*

Participant vs. Observer. *In Francoise Wemelsfelder's work with farmed animals she has used the word observer to describe the volunteers in her studies. This is an understandable and appropriate term in light of the fact that the volunteers were indeed 'observing' the animal subjects' expressive behaviours. However, in this project 'participant' seems a more appropriate term to describe the process of 'meeting' the living reef and discerning its expressive qualities. This is in keeping with the participatory relationship discussed elsewhere in this thesis.*

The strength of FCP as an assessment tool is that it safeguards participant (observer) independence while at the same time allowing for the measurement of inter and intra participant reliability in relation to observed qualities. This is achieved through the use of a multivariate statistical technique called Generalized Procrustes Analysis (GPA), which calculates participant agreement independently of fixed descriptors (Wemelsfelder, 2001).

> *'GPA can be thought of as a pattern matching mechanism and is based on the assumption that even if observers use different variables (terms) for measurement, the distances between samples as specified by the various measurements are comparable, because the samples are the same. In other words, GPA takes for granted that measurement patterns that deal with the same samples will converge, and is designed to compute the coordinates of the convergent configuration (the so-called 'consensus profile)'. Thus, GPA detects the level of consensus between observer assessment patterns not on the basis of fixed reference points (terms), but on the basis of the (multi-dimensional) inter-sample distances specified by each observer'* (Wemelsfelder et al*,* 2000).

To achieve this each participant's terms and scores are entered into individual data matrices. GPA then assesses each matrix as a multi-dimensional configuration, which has as many dimensions as terms. The reefs are placed in this multidimensional space according their scores and then through a series of iterative transformations a 'consensus profile', or 'best possible fit', can then be attained. How well individual participant configurations fit the consensus profile is then quantified by the, so-called, Procrustes statistic. The larger the Procrustes statistic the more the participants agree about the geometric configuration of the reefs (but not necessarily about the terms used) (Wemelsfelder, et al*,* 2001).

Once the validity and statistical significance of the consensus profile has been established the Procrustes statistic can determine the amount of similarity/disparity of individual participant configurations relative to the final consensus. Using Principal Coordinate Analysis (PCO) a two (or more) dimensional 'participant plot' is created showing the distribution of participants with a 95% confidence region (Williams & Langron, 1984; Arnold and Williams, 1985; Gains & Thompson, 1990). At this stage GPA has transformed the individual participant configurations into one multidimensional consensus profile, defined purely in terms of its geometric properties, independent of any interpretive judgment by the experimenter, and free from any semantic connotations. Principal Component Analysis (PCA) is then used to reduce the number of dimensions of the consensus profile to one or more, two dimensional 'sample plots' which show the principal axes of the consensus profile and how much of the variation between reefs each of these axes explains.

Individual participant word charts are then created containing all their terms and showing the correlation of those terms to the principal axes of the consensus profile. The higher a term's correlation with an axis the more weight it has as a descriptor (Wemelsfelder et al, 2001). The degree of semantic convergence between word charts indicates the extent to which individual participants concur in their assessment of the qualities of the reef. If there is adequate semantic convergence between the participant word charts the experimenter can perform a final step of interpretation by summarizing this convergence. If the participant assessments show significant convergence then the consensus profile can be used to appraise qualitative differences between individual reefs.

This interpretation by the experimenter is completely post hoc and plays no role in the computation of the consensus profile. The strength of GPA is that it preserves semantic information, independently of the experimenter's interpretation, throughout the entire data analysis process. (Wemelsfelder et al, 2001) This makes it possible to investigate whether participants apply their qualitative vocabulary in similar ways to assess the qualities of reefs.

Reef Check

Reef Check was developed in 1996 as a volunteer, community-based, monitoring protocol designed to measure the health of coral reefs on a global scale. ‘Coral reef health’ is a general concept that refers to a balance in the ecosystem that may be shifted by e.g., disease or human activities (Hodgson, 1999). The Reef Check Foundation was established as an international non-profit organization dedicated to conservation of tropical coral reef ecosystems. Reef Check is headquartered in Los Angeles but has volunteer reef monitoring teams in more than 90 countries and territories. Reef Check works to create partnerships among community volunteers, government agencies, businesses, universities and other non-profits. Reef Check goals are to: educate the public about the value of reef ecosystems and the current crisis affecting marine life; to create a global network of volunteer teams, trained in Reef Check's scientific methods, who regularly monitor and report on reef health; to facilitate collaboration that produces ecologically sound and economically sustainable solutions; and to stimulate local community action to protect remaining pristine reefs and rehabilitate damaged reefs worldwide (www.reefcheck.org).

In 1997, Reef Check conducted the first-ever, scientifically based, global survey of coral reef health. The results provided scientific confirmation that coral reefs were in crisis due to over-fishing, illegal fishing, and pollution (Hodgson 1999). This was followed by the publication of ‘*The Global Coral Reef Crisis – Trends and Solutions’* in 2002. Based on data collected by thousands of Reef Check volunteer divers in over 80 countries and territories, the report was the first scientific documentation of the dramatic worldwide decline in coral reef health over a five-year period (Hodgson et al 2002). Since then Reef Check has continued to collect data from around the world and publishes an annual report on the global state of coral reef health.

Monitoring Protocols

Reef Check’s monitoring protocols focus on the abundance of particular reef organisms that best reflect the condition of the ecosystem as a whole and that are easily recognizable to the general public. Selection of these ‘indicator’ organisms is based on their economic and ecological value, their sensitivity to human impacts and ease of identification. These indicators include a broad spectrum of fish, invertebrates and algae that indicate human activities such as fishing, collection or pollution. Some Reef Check categories are individual species while others are families. For example, the hump head wrasse *Cheilinus undulatus* is the most sought after fish in the live food fish trade, whereas the banded coral shrimp *Stenopus hispidus* is collected for the aquarium trade. Both species are very distinctive organisms and excellent indicators of human predation. On reefs where these organisms are heavily exploited, their numbers are expected to be low compared to their abundance on unexploited reefs (Hodgson et al 2006).

Reef Check surveys collect four types of data:

1) A description of each reef site based on over 30 measures of environmental and socio-economic conditions and ratings of human impacts.
2) A measure of the percentage of the seabed covered by different substrate types, including live and dead coral, along four 20 m sections of a 100 m shallow reef transect.
3) Invertebrate counts over four, 20 m x 5 m belts along the transect.

4) Fish counts, up to 5 m above the same belt. Ideally two depth contours are surveyed for each site; a shallow transect (3 - 6 m) and a mid-depth transect (< 6 – 12 m).

Survey teams are usually made up of a mixture of volunteer divers trained in the methodology (but with no formal marine scientific training), a team leader and a team scientist. Site selection is done by team scientists and depends on many factors including reef zone types, human impacts, and socio-economic considerations as well the ability to revisit sites in subsequent years (for a detailed explanation of site selection please see Hodgson et al 2006).

Data Analysis and Interpretation

Data entry is standardised using pre-formatted Excel worksheets provided by Reef Check International. These worksheets contain all the formulas required for attaining the basic statistics needed for interpreting the data. This includes the standard deviation (SD), how widely the distribution of observations is distributed around the mean, standard error (SE), which is decreased with more replicates, as well as the means from each section of a transect (Hodgson et al, 2006).

The data collected from Reef Check surveys can contribute to the ongoing global assessment of coral reef health but can also be used to look at more localised inter and intra reef health over time. The reliability of these assessments is strongly influenced by the repeatability of the surveys and the number of replicates completed at each site. The interpretation of data collected is based on mean distribution of key indicator species and how they compare to other sites. This is useful in making comparative studies and can give an indication of trends over time. However, due to the 'shifting baseline syndrome' (Sheppard, 1995) this assessment doesn't relate any information about the state of reef health in comparison to pre-human exploitation. A further limitation is that it is likely to be beyond the ability of local communities to successfully interpret the meaning of the results without the input of 'outside' scientific help. Never the less, much useful information can be gained that can inform future management and conservation decisions (please see Hodgson, 1999 & Hodgson et al, 2006 for a detailed discussion on analysis and interpretation).

Section 3 *Research Methods and Results*

FCP Surveys

Methods and Design

For this project two separate FCP surveys were conducted using, two groups of volunteers. The first consisted of OceansWatch team members and the second, Reef Guardian trainees from Tuo Village. Both surveys followed the same experimental procedures and were conducted using exactly the same sites. The two surveys will be referred to simply as OW and RG respectively.

The Reefs

Ten reefs were selected for the surveys. The criteria for selecting the reefs were that: each reef was representative of the various habitats that make up the Tuo customary marine area, there was a mix of sites inside the permanent and temporary MPAs as well as outside the protected areas and that there was a degree of qualitative differences between all ten sites ranging from exaggerated to subtle. The aim was to include reefs that were not only representative of the various habitats but also covered a range of health and/or degradation `within the customary area. A final criterion was that the reefs were accessible enough to conduct the surveys in a safe and timely fashion. *Below is a brief description of each reef.*

Reef 1

Location: Tuo 5y03,

RC transect orientation NE to SW

Latitude: 10º 16’. 620S

Longitude: 166º 16’. 677E

Site Description:

Site is located on the margin between the back reef and the lagoon. It is within the community chosen 5 year MPA. This MPA has been in place for 2 years. There are moderately extensive coral reef areas interspersed with sand patches. Average depth at the reef areas is 3-4 metres while the sand areas are between 3-6 metres. There is a variety of hard coral species primarily from the Acropora family. Fish life is reasonably abundant but lacking any large individuals and a low numbers of key indicator species such as parrot fish, grouper and snapper.

Reef 2

Location: Tuo5y02,

RC transects orientation, NE-SW.

Latitude: 10º 16'. 160S

Longitude: 166º16'. 677E

Site Description: This site is also within the 5 year MPA, on the reef flats in shallow water 1-3 metres deep. It has a predominance of broken branching coral with extensive rubble areas. These are interspersed with sandy areas. Hard coral cover is quite low and fish density is also low. This area would be prone to storm surge damage, especially during the wet season when NW winds prevail. There are also indications of nutrient indicating algal growth with a corresponding lack of algal grazers.

Reef 3

Location: Outside 5yr MPA, close toTuo Village.

Latitude: 10º 16.058' S

Longitude: 166º 17.260' E

Site Description: This is a shallow reef flat area more towards the back of the reef crest. The reef crest is extensive and this area has a little more coral cover than adjacent areas. The whole reef crest area would be prone to storm damage from the wet season NW winds but is sheltered for the rest of the year. The coral cover is predominantly branching, encrusting and massive corals but there is also quite a lot of blue coral.

Reef 4

Location: Outside 5yr MPA, close to Tuo Village.

Latitude: 10º 16.155' S

Longitude: 166º 17.368'E

Site Description: This site is on the same part of the reef crest as Site 3 and is quite close by. However the two sites are quite different in the amount of coral cover with much less at this site.

Reef 5

Location: 5 year MPA.

Latitude: 10º 15.888' S

Longitude: 166º 16.881' E

Site Description:

This site is a collection of raised coral structures that rise approximately 2-4 metres above the surrounding sand area. It is predominantly broken staghorn and other Acropora species. It is a highly degraded area but does have some new growth corals.

Reef 6

Location: 5 year MPA.

Latitude: 10º 15.995' S

Longitude: 166º 16.490' E

Site Description:

This site is a large raised reef area between two lagoons that are both inside the outer fringing reef. It has a reasonable amount of coral cover and fish life and is in overall good condition. There are also bare rock and sand substrates. It drops to 10 to 12 metres on the inside lagoon and to about 20-25 metres on the outside lagoon.

Reef 7

Location: Permanent MPA, TuoP02.

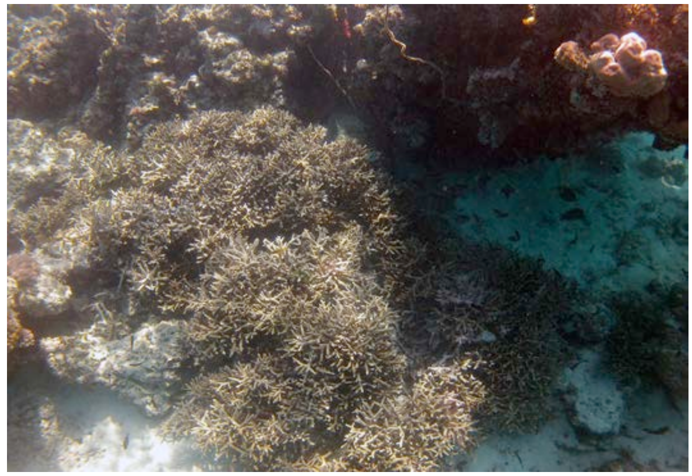
Latitude: 10º 15.325' S

Longitude: 166º 15.559' E

Site Description:

This site is a collection of raised coral structures that rise approximately 3-6 metres above the surrounding sand area. It is a very mixed substrate but predominantly rock, sand, rubble and hard coral. There is some new growth but also a few cases of coral bleaching. There is a moderately diverse fish population including key indicator species such as sweetlips, surgeonfish, parrotfish and snapper.

Reef 8



Location: Permanent MPA, South West boundary.

Latitude: 10º 15.400' S

Longitude: 166º 15.595' E

Site Description:

This is a reef edge on the boundary of the MPA. The reef top is only 1-2 metres deep but slopes steeply to approximately 15m before sloping more gently to greater depths. The reef crest has a mixture hard and soft corals as well as sponges, ascidians and other filter feeders, however there are large areas of bare sand and rock. The wall has several overhangs that provide ample shelter for grouper etc. There are some resident hump head wrasse and a large grouper. The fish life at this site is more diverse than most of the other sites.

Reef 9

Location: 5 year MPA, eastern boundary.

Latitude: 10º 16.331' S

Longitude: 166º 16.887' E

Site Description:

This site is on the outer reef edge on the boundary of the MPA. The reef top is only 1-2 metres in most places but there are several deeper gullies along the wall. Coral cover is excellent in some areas but sparse in others and fish life is reasonably varied and more prolific than some other sites.

Reef 10

Location: 5 year MPA, eastern boundary.

Latitude: 10º 16.606' S

Longitude: 166º 16.678' E

Site Description:

This site is a prominent point at the south-eastern end of a large reef. It is exposed to southerly sells and is washed by water flowing through a deepwater channel between Fenualoa and the neighbouring island of Lomlom. There is a reef crest that drops vertically on the eastern side to 30m then shelves to 100m plus. On the western side it is more gently shelving to 20m then slopes away to greater depths. There is abundant hard coral of a variety of species on the crest and walls. It is the most diverse and prolific of all the 10 sites. There is also good fish abundance and diversity with substantially more, large fish such as parrotfish and grouper. This site is prone to strong currents but consistently good visibility of 30m plus.

The Participants

The participants in the OW survey come from a range of educational and professional backgrounds and age range. Included in the mix are three marine scientists, two marine conservationists, a senior university researcher, a speech therapist, an electrician, and a permaculturalist. Most of these participants have at least some scuba diving or snorkelling experience although only one participant had visited the Reef Islands before. All are native English speakers from similar cultural backgrounds, i.e. UK, Australia and New Zealand.

Participants in the RG survey are all from Tuo Village on Fenualoa Island. Some of the group have had high school education, either in the regional capital of Lata or in Honiara but for others formal education finished at primary level. All the participants are multi-lingual with the primary language their own local Melanesian dialect (simply known as language). As there are many different dialects throughout the Solomon Islands, Pidgin is also spoken as the universal language. All of the Reef Guardians have at least a basic understanding of spoken English (with some very fluent in both spoken and written English) but some found writing in English challenging. All but one of the nine are fishermen who are fishing the reefs more or less on a daily basis, and so are very familiar with the Tuo customary marine area. However, some of the fishermen had not visited the specific survey sites for quite some time, especially the sites in the permanent MPA that are much farther away from the village.

The Reef Guardians with the OW marine science team.

The OceansWatch team.

Experimental Procedures

The procedures used were the same for both surveys and follow the Free Choice Profiling (FCP) developed by Wemelsfelder and colleagues (2000, 2001), for use in animal behavioural science, and further adapted by Harding, Wemelsfelder and Burch (2006, 2008) for holistic landscape studies. The methods and procedures were further adapted to suit the remote marine setting of this project but are consistent with the earlier studies. FCP consists of two phases. In phase 1 participants visit each reef and focus on finding descriptive terms for observed reef qualities. These terms are then assigned visual analogue scales (VAS), and in phase 2 participants revisit the same reefs (although in a different order) and use their self-generated terms to quantitatively score the reefs' expressive qualities.

Prior to the start of the surveys both groups of participants were given written and verbal instructions, with an introduction and overview of the project and it's goals (see box 3 for Reef Guardian instructions and appendix i for a Pidgin translation). This included an explanation and discussion of what was meant by *'expressive qualities'* and examples to help the participants make the distinction between qualities as expressed by the reef and their own response to those qualities. Participants were asked to approach their observation of each reef as '*meeting*' a living entity, with the ability to communicate its state of being. It was emphasised that there were no wrong answers but that they were to try as much as possible to set aside their previous knowledge and pre-conceptions and instead try to discern the 'living' qualities of each reef in its own right. They were also asked to avoid using purely physical descriptions, such as rock or sand, and instead search for terms that described the expressive qualities emanating from within the physical presence of the reef.

In addition, participants were encouraged to use as many or as few terms as they liked, including previously used terms, as long as they were the terms they felt best described the living qualities of that reef. Participants were asked to keep their terms to themselves and not to talk about them with anyone else until the end of both phases of the survey to ensure the independence of their assessment.

A very interesting outcome of the training sessions with the Reef Guardians was a discussion about the 'spirits' of the reef. This was initially started through discussions about the various totem animals familiar to them, such as dolphins, sharks and turtles (many people in the Tuo community belong to the Pelowe, dolphin clan) as well as the land spirits of the forest. I pointed out that, even though not everyone (especially people from western countries, including most scientists) believes in the spirits of the forests and reefs that doesn't mean that they are not there and able to talk to us if we learn how to listen. I suggested that a way of viewing the spirits of the reef were not as separate beings that inhabit the reef, but rather, as the 'soul' of the reef itself that is manifest through all the inhabitants of the reef. This was met with nods and smiles of approval, especially from some of the elders of the village who were sitting in on the training sessions.

*I am in no way assuming any specific knowledge of the spiritual belief systems, traditional or otherwise, of the Tuo community. However, I had a very clear sense that my words, and sentiments, resonated with something deeper than had been the case prior to this discussion, perhaps touching on what Tim Ingold describes as '… a condition of being in the world' (*Ingold, 2011, Pg 67).

Photographic interpretation of the spirit of the reef (using slow motion blur).

Box 3. Showing the instructions given to the Reef Guardian participants

Instructions for Reef Guardian FCP Study, Tuo, Reef Islands, July 2012.

- This is part of your training as Reef Guardians but is different from the training you have had so far.
- In previous training you learnt how to count different species and measure the amount of coral covering the reef. Now we are going to learn how to see the reef as one living being.
- The reason for doing this is to learn how to understand what the reef can tell us about whether it is healthy or unhealthy. We are trying to understand and describe what the reef can tell us about itself.
- This is a new way of studying the reef and you are the first Reef Guardians to do this.
- We will be using a scientific method called Free Choice Profiling to see if this is a good way to understand and look after the reef.
- By using FCP we will be able to see how much agreement there is between individual Reef guardians and what qualities of the reef you see in common.

  What are qualities?

1. The reef is a living being. Just like us, it is made up of lots of different parts. We know that we have to look at the whole person if we want to learn about them. We also know that each person is different. They have different qualities and we get to know them by spending time with them and seeing how they act and behave. We also know that people behave differently depending on how they are feeling. If they are feeling healthy they might be very active and happy but if they are feeling unwell they might be very quiet and look sad.
2. The reefs are living beings that also have qualities that we can see by getting to know them and seeing how they behave. Sometimes the different qualities of each reef are easy to see because they are very different from other reefs (just like us) but sometimes they are harder to see. Then we have to look more carefully so that we see what is special about each reef. Just like you might have different words to describe the different qualities of people you know, we want you to find the right words that describe the different qualities that each reef is showing you. Try to imagine that the reef is talking to you and you are telling us what the reef is saying about itself.
3. Just like when you are talking to another person, you might have a response to the reef. This is like when a friend tells you something that makes you feel happy or sad or angry or frightened. This is ok and we can talk about how each reef makes you feel later but for this study we want to find the best words that describe the reef's qualities, not your response to the reef. This might be hard at first but don't worry because we can practice so that we can learn to tell the difference between the qualities we see in the reef and how those qualities make us feel.
4. Here is an example to help you. We might see a big shark that makes us feel frightened, but the word "frightened" describes our response to seeing the shark. It doesn't mean that the shark is frightened. Instead we need to ask ourselves, 'what it is the behaviour or quality of the shark that makes us feel frightened? We might get the sense that the shark is hungry and looking for food and this makes us frightened that the shark might think we are food. So the best word to describe the behaviour or quality of the shark is "hungry". Remember that this is just an example. When we are studying the reefs we want to sense the quality of the whole reef, not just a part of it, like fish or sharks.
5. Sometimes though the word for your response and the reef's quality can be the same, and this is OK. Here is another example to help you. We might see a reef that is empty and this can make us feel empty. In this example the quality the reef is emptiness and this is also how we feel. If you aren't sure whether the word you choose is a quality of the reef or from your own feelings you can ask yourself this question. '**What is it like to be this reef'?** Use this question to check that your word makes sense to you and describes a quality of the reef.
6. Sometimes you might be tempted to use words that just describe the physical look of the reef. Examples of words that are just physical descriptions are words like rocky, sandy and coral. These words don't describe the qualities of the reef; only what it is made of. We want to try to use words that have more meaning than just a physical description. Remember that we are trying to understand how the reef is feeling. Here is an example of words that describe the qualities we might see. If we are looking at a sandy area of the reef we might notice whether the sand is clean or whether it is covered in algae. We can ask ourselves '**what is it like to be this sand'?** If the sand is clean we might sense the sand as feeling *fresh, clean or energised* but if the sand is covered in algae we might sense it as *smothered, choking or constricted.*
7. Don't worry because there are no wrong answers. You just use the words that seem right to you. **It is very important that you don't tell your words to the other Reef Guardians (or anyone else in the village) until we have finished both parts of the training.**

Phase 1

For logistical reasons phase I of each survey was conducted over two afternoons. We used the two inflatable tenders from the project yachts to transport the participants out to the reefs. The closest reef (3) was approximately 0.5 nautical miles from the village and the farthest (7), approximately 4 nautical miles from the village. Because of the small size of the tenders we were dependant on having calm conditions, especially for the further reefs. It was hoped that both teams would visit the reefs in the same order but due to weather and tide conditions this was not possible. It is very unlikely that this will have had any effect on the outcome of the two surveys. The OW team visited reefs 1, 5, 6, 9 & 3 on Saturday 21st July and reefs, 10, 4, 2, 7 & 8 on the 23rd. The RG team visited reefs 1, 5, 6 & 3 on Tuesday 24th July and reefs 7, 8, 10, 9 & 4 on the following afternoon, 25th.

Prior to leaving the beach participants were given written and verbal instructions as to how phase 1 would proceed (see appendix ii). At each site I pointed out the area to be observed. The participants then donned mask, snorkel and fins and floated on the surface 'meeting' the reef for 5 minutes. At my signal they were then asked to spend another 10 minutes continuing their 'meeting' of the reef and at the same time, choose and write their terms on the plastic under water slate provided. I collected the slates between each site to avoid participants accidently seeing others' terms.

It was interesting that on both surveys participants initially took the full 10 minutes to choose the appropriate terms but as they progressed through the reefs the terms seemed to come more quickly to them. Most of the participants of both surveys agreed that it took the first few reefs to 'get the hang of it' but once they were into the rhythm of viewing the reef as a living being it became easier to find the right terms.

Phase 2

In phase 2 the same ten reefs were visited but in a different sequence. Again the surveys were spread over two afternoons. The OW team visited reefs 9, 10, 2, 6 & 3 on Thursday 26th July, followed by reefs 7, 8, 5, 1 & 4 on the 27th. The RG team started with reefs 3, 4, 5, 9 & 10 on Wednesday 1st August then reefs 7, 8, 2, 1 & 6 the following afternoon. Participants were provided with an A4 sheet of waterproof paper for each reef. The sheets were printed with visual analogue lines (VAS) 125mm long, marked with minimum at the left hand end and maximum at the right hand end. Each participant's terms were printed at the left hand side of the lines. The terms were listed on each sheet in a different order to avoid 'rote' marking.

Once again participants were asked to float on the surface and observe the reef for 5 minutes then score the reef against each term by putting a single, vertical, mark through the VAS using the wax crayon provided. They were given as much time as needed to complete their scoring but in most cases this took 5 minutes or less. The scoring process generally went very well with the only issue being a little confusion on the part of some of the RG participants regarding the minimum and maximum. For example, one of the participants was scoring his term 'shallow' the wrong way, i.e. scoring shallow sites towards the minimum (meaning less shallow) end and deeper sites towards the maximum end (more shallow). I was able to point this out to him after the second reef and he corrected his scores.

OW participant 'meeting' the reef during Phase 1.

RG participant scoring his terms during Phase 2.

Data Processing

To prepare the outcomes of the two surveys for analysis the scores attributed by participants to the reefs' qualities were determined by measuring the distance, in millimeters, between the left 'minimum' point of the VAS and the point where they had marked the line. These scores were then entered into data matrices, one for each participant, with each matrix defined by the number of terms (in columns) used by that participant and ten rows, one of each reef (see appendix ii for an example). Thus, each of the individual data matrices will consist of 10 rows containing a score for each term between 0 and 125. These data matrices are then ready for analysis using General Procrustes Analysis (GPA).

Statistical Procedures

The following explanation of the statistical procedures borrows heavily from the published work of Francoise Wemelsfelder (in particular Wemelsfelder et al, 2000 & 2001). Permission to use this work is gratefully acknowledged.

The concordance between participant matrices was investigated using a multivariate statistical technique called Generalized Procrustes Analysis (GPA) (Gower, 1975; Oreskovich et al., 1991). GPA does not depend on the use of fixed variables, and can be thought of as a pattern matching mechanism, assuming that even if participants use different variables (terms) for measurement, the distances between samples (reefs) will be comparable because the samples are the same. Each data matrix is regarded as a multidimensional configuration with as many dimensions as it has terms, on which the reefs are located through their scores. Columns of zeros are then added so that all participant configurations have equal dimensionality.

GPA then matches the configurations through a series of iterative mathematical transformations (translation, rotation**/**reflection and scaling) while preserving relative inter-sample relationships within each configuration. A 'consensus profile', or the 'best-possible-fit', is produced from the mean of the transformed configurations. How well individual participant configurations fit the consensus profile is then quantified by the, so-called, Procrustes statistic. This statistic reflects the degree of similarity **(**as regards projected geometric distances between reefs**)** between transformed participant configurations and the consensus profile. The larger the Procrustes statistic the more the participants agree about the geometric configuration of the reefs (but not necessarily about the terms used) (Wemelsfelder, *et al,* 2001).

The next step is to evaluate the statistical significance of the consensus profile and its 'goodness of fit' through a randomization process (Wakeling *et al,* 1992). This involves analyzing the original data in randomized form a large number of times (in this case 100). GPA then derives a 'goodness of fit ' statistic for this random association between matrices that can then be evaluated against the original consensus profile and 'goodness of fit' using a Student's *t* test (one tailed) with a probability of $p<0.001$ to indicate whether the consensus profile is a meaningful feature of the data set or a statistical artifact.

Once the validity and statistical significance of the consensus profile has been established, through the randomization process, the next step is to use the Procrustes statistic to determine the amount of similarity/disparity of individual observer configurations relative to the final consensus. Using Principal Coordinate Analysis (PCO) a two (or more) dimensional 'participant plot' can be created. The participant plot shows the distribution of participants with a 95% confidence region. Participants lying outside this region are potential outliers that in some sense may differ from the other participants in their assessment of the reefs (Williams & Langron, 1984; Arnold and Williams, 1985; Gains & Thompson, 1990). If there are valid reasons for excluding the outliers from analysis (e.g. different age or background), GPA can be run again to find a new consensus profile.

At this stage GPA has transformed the individual participant configurations into one multidimensional consensus profile, defined purely in terms of its geometric properties, independent of any interpretive judgment by the experimenter, and free from any semantic connotations. The first step towards interpretation is to reduce the number of dimensions of the consensus profile, through Principal Component Analysis (PCA), to one or more, two dimensional 'sample (reef) plots' which show the principal axes of the consensus profile and how much of the variation between reefs each of these axes explains. A standard error ellipse can be drawn indicating the reliability of each reef's position on the two axes. These axes are still defined purely in terms of their geometrical properties. Their coordinates reflect relative GPA scaling values and as yet, have no relationship to any semantic meaning.

The next step however does confer semantic meaning onto the principal axes of the consensus profile. This is achieved by calculating how the coordinates of the consensus profile correlate with the coordinates of the individual participant data matrices. The result is a two-dimensional 'word chart' for each participant, containing all their terms and showing the correlation of those terms to the principal axes of the consensus profile. The higher a term's correlation with an axis the more weight it has as a descriptor (Wemelsfelder et al, 2001). The degree of semantic convergence between word charts indicates the extent to which individual participants concur in their assessment of the qualities of the reef. For example, in one participant's chart the terms plentiful/stimulated may show the highest correlation with the consensus profile's main axis, while in another participant's chart the terms abundant/energized take their place. Even though these are different terms, they have similar meaning, and the two participants seem to agree about what they saw. If on the other hand another participant describes the main axis in terms of vacant/quiet, disagreement obviously occurred. In principle it is possible to find a valid consensus profile for which participants show poor semantic agreement, and which therefore makes little sense. An important second measure of participant agreement, in addition to the Procrustes Statistic therefore, is whether the individual participant Word Charts displays any semantic convergence (Wemelsfelder et al, 2001).

If there is adequate semantic convergence between the participant word charts the experimenter can perform a final step of interpretation by summarizing this convergence. If the participant assessments show significant convergence then the consensus profile can be used to appraise qualitative differences between individual reefs.

This interpretation by the experimenter is completely post hoc and plays no role in the computation of the consensus profile. The strength of GPA is that it preserves semantic information, independently of the experimenter's interpretation, throughout the entire data analysis process. (Wemelsfelder et al, 2001) This makes it possible to investigate whether participants apply their qualitative vocabulary in similar ways to assess the qualities of reefs.

Results

Conventional statistical expositions of GPA generally follow the order discussed above by presenting Sample Plots first and Participant Plots last. However as the central theme of this thesis is the inter and intra-observer reliability of spontaneous assessments of the reefs' expressive qualities, it seems more appropriate to follow in the footsteps of Wemelsfelder et al and present Participant Plots and Word Charts first, followed by the Reef Plots.

Consensus Parameters

Table 1 shows the consensus parameters for both studies, indicating that agreement between participant assessments was significantly higher than could be explained by random association. The Procrustes Statistic for the consensus profile of the OW survey is 78.44, meaning that its' 'goodness-of-fit' explains 78.44% of the total variation between participant matrices. The mean of 100 randomized profiles explains 60.20% of the variation between matrices, with a simulation variation (SV) of 0.9331. A one-tailed Student's t -test shows that the consensus profile of the OW survey differs significantly from the randomized profiles (df=99, 13.09, $p < 0.001$).

The Procrustes Statistic for the consensus profile of the RG survey is 67.73, while the mean randomized profile explains 61.69% of the variation between participant matrices with a simulation variation of 0.8767. The consensus profile of the RG survey also differs significantly (although less so than OW) from the randomized profiles (df= 99, 4.40, $p < 0.001$). These results show that neither of the consensus profiles is an artifact of GPA procedures.

Table 2 shows the percentage of variation between reefs accounted for by the first three consensus dimensions in each survey. In both cases the first two dimensions account for most of the variation (OW = 70.7%, RG = 58.4%) and are worth investigating further.

Table 1. Procrustes Statistics for OceansWatch and Reef Guardian, Reef surveys.

Reef Qualities study	Consensus Procrustes Statistic	Randomised Procrustes Statistic ± SV	Student's- t df=99	p value
OceansWatch	78.44	60.20 ± 0.9331	13.09	***
Reef Guardians	67.73	61.69 ± 0.8767	4.40	***

Table 2. Percentage of variation in consensus profile accounted for by first 3 dimensions.

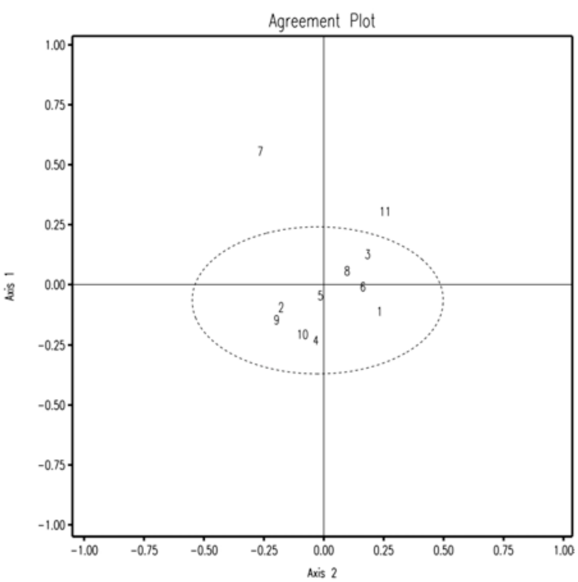
Reef Study	Consensus Dimensions		
	1	2	3
OceansWatch	60.7	10.0	6.9
Reef Guardians	45.3	13.1	8.3

Participant Plots

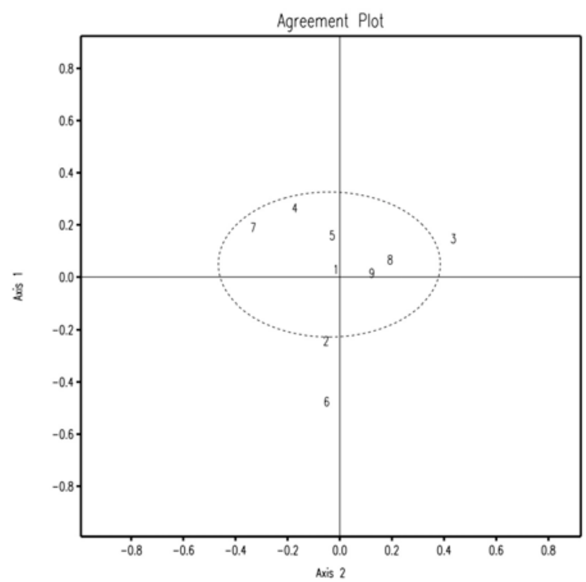
Fig. 1 shows the Participant Plots for both surveys. These plots show the relative distance between individual participants (numbered) as a measure of the level of consensus between individual participant assessments. The dotted circles define a 95% confidence region for what can be considered the ‘normal population’ of participant assessments. Overall there is good consensus for both surveys with most participants falling within the confidence region. None of the outliers in either survey warrant further scrutiny as they have not unduly affected the significance of participant agreement and, because this study is interested in the overall semantic meaning of participant terms, it would be counter productive to remove them and re-run GPA to produce a new consensus profile for analysis.

Figure 1. Participant plots for a) the OceansWatch study and b) the Reef Guardian study. In both studies there are outliers (OW = 2, RG = 3) that fall outside the 95% confidence region (see text for a discussion of this).

1a)



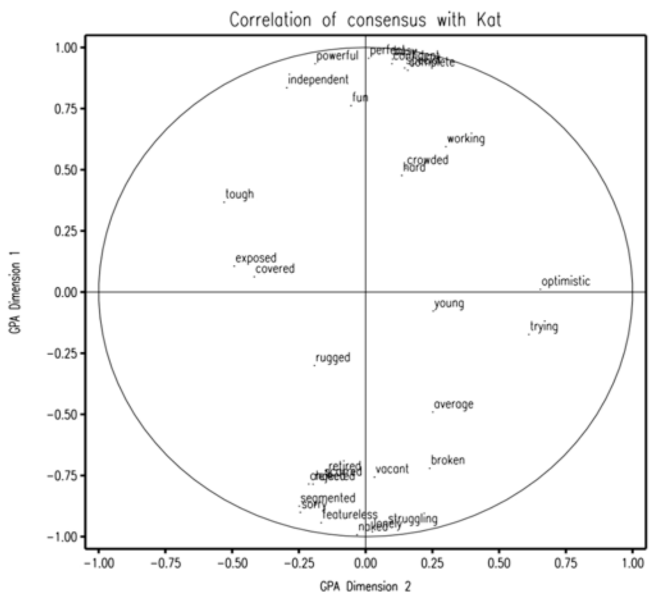
1b)



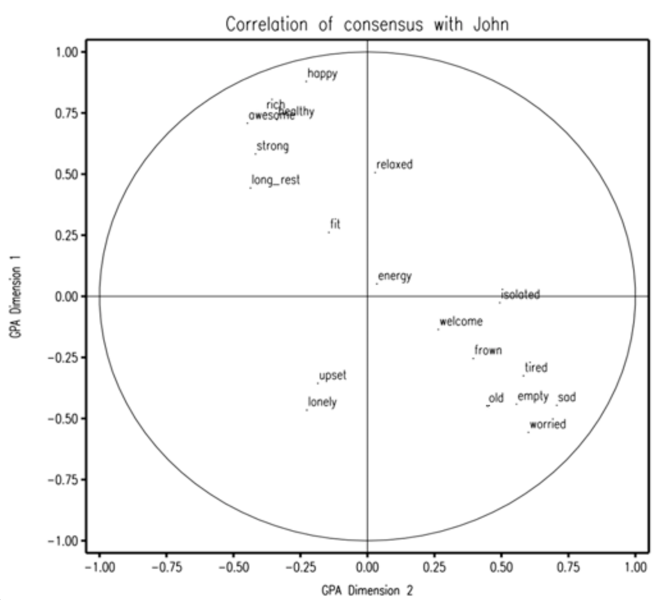
Interpretation of the Consensus Profile

Figure 2 shows an example word chart from each survey (participant 5 for OW and participant 2 for RG). The OW participant characterized dimension 1 as ranging from ‘perfect/busy/confident’ to ‘naked/lonely/struggling’, while the RG participant described it as ranging from ‘happy/rich/healthy’ to ‘worried/lonely/sad’. The OW participant perceived dimension 2 as ranging from ‘optimistic/trying/working’ to ‘tough/exposed/covered’, while the RG participant saw it as ranging from ‘sad/tired/empty’ to ‘awesome/long-rest/strong’.

Figure 2. Example participant word charts of (a) the OceansWatch survey, and (b) the Reef Guardian survey. Axes reflect the correlation of a participant’s terms with dimensions 1and 2 of the consensus profile.



2a)



2b)

It is important to view these examples in the context of all the participants collectively. To allow comparison of all participant word charts the two highest scoring positive and negative terms for each dimension are included from each participant for dimensions 1 and 2 of both consensus profiles (Table 3). From this list it can be seen that there is considerable semantic convergence in the terms used to describe the positive and negative ends of both surveys. Terms are either similar in meaning (e.g. new-growth, growing-fast and new-coral in RG dimension 1), or they indicate complimentary aspects of an emotive atmosphere or mood (e.g. energized, lively and stimulated in OW, dimension 1). In the RG survey there is also substantial use, and similar scoring, of the same terms (e.g. happy, healthy, worried and sick in RG dimension 1).

Table 3. Terms (2 for each participant) showing the highest positive and negative correlations with dimensions 1 and 2 of the consensus profile in each survey. Values in brackets give the number of times a term occurs, unless occurring once.

Reef Guardian Study	
Positive correlation with Dimension 1	**Negative correlation with Dimension 1**
Happy (5), healthy (3), colourful (2), new growth, growing fast, new coral, peaceful fish, shelter, many fish, rich, confident.	Worried (4), sick (3), lonely (2), dead-coral (2), quiet, tired, hungry, coral-covered, shallow, sad, coral-damage.
Positive correlation with Dimension 2	**Negative correlation with Dimension 2**
Clean (2), sick (2), healthy, new-growth, parrot-fish, feel-good, new-coral, trying, small-fish, fine, old, sad, smart, empty, quiet, worried.	Worried (2), happy (2), bored, recovering, shallow, dirty, young, dead-coral, long-rest, surgeon-fish, strong, awesome, suffocating, good-rest, small-fish.
OceansWatch Study	
Positive correlation with Dimension 1	**Negative correlation with Dimension 1**
Energised, gorgeous, hopeful, diverse, generous, attractive, renewing, strong, perfect, busy, homely, independent, lots-of-coral, beautiful, character, healthy, plentiful, stimulated, confident, lively, friendly, alive.	Barren (2), flat, damaged, beaten, dead, injured, scarred, quiet, naked, lonely, brittle, skeletal, staghorn, old, broken, choked, stripped, small, challenged, desolate, strangled.
Positive correlation with Dimension 2	**Negative correlation with Dimension 2**
Vulnerable, protective, grubby, confused, jagged, prickly, sleepy, fighting, optimistic, trying, slimy, patchy, lively, old, isolated, remote, separated, crowded, humble, relieved, happy, smothered.	Clean (2), murdered, crushed, vacant, buried, desperate, rejuvenated, tough, exposed, weary, battered, struggling, dead, basic, predators, open, aged, stretched, naked, variable, quiet.

In the RG survey the first dimension is not as strong as in the OW survey while the second dimension is only slightly stronger meaning that they account for less of the overall variation between reefs than the OW survey.

The first dimension appears to contrast happy, healthy, colourful reefs that are experiencing new growth with worried, sick, tired and damaged reefs. There seems to be a clear correlation between coral growth and fish abundance and the participants' perception of the health of the reef. This also seems to be strongly associated with the participants' perception of the 'mood' of the reef as being happy and confident at the positive end and sad and lonely at the negative end. The second dimension provides a little more subtlety to the qualities of dimension 1. Here the descriptions are more contrasting, distinguishing clean, smart, quiet and old, from bored, suffocating, well-rested and recovering reefs. This contrast can apply to both the positive and negative ends of dimension 1, so terms for dimension 2 can depict a mixture of positive and negative moods. For example, a reef may be old, quiet and have a sense of sadness but at the same time seem well-rested, clean and showing signs of recovery and growth. Conversely a young and colourful reef may appear smart and confident and yet be lacking surgeonfish and other small fish and so also have a feeling of emptiness. These may appear like contradictions but in fact may actually point towards recognition of the complex dynamics inherent in reef ecosystems.

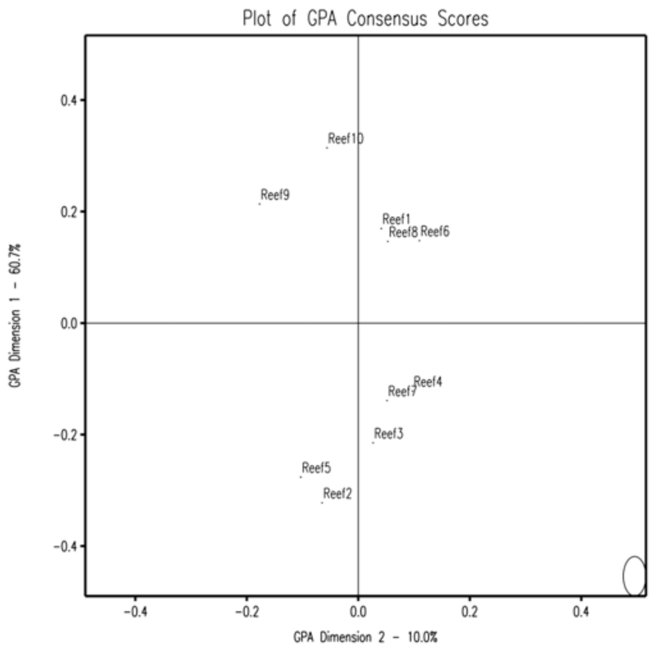
The OW survey is characterized by a relatively larger number of terms scoring highly in both dimensions compared to the RG survey. This doesn't mean that there aren't as many terms shared by participants but simply that each participant has generally produced more terms with similar meanings. For example both happy and healthy were used by five of the eleven participants but only two participants scored them high enough to be represented in Table 3.

The first dimension of the OW survey appears to contrast healthy, diverse, plentiful, stimulated and attractive reefs with barren, damaged, challenged, scarred and lonely reefs. As with the RG survey there seems to be a clear correlation between the perceived abundance and health of the reefs corresponding to positive emotional moods at the positive end and a contrasting association between ill health, scarcity and negativity at the negative end. The second dimension differentiates these qualities further and, like the RG survey, shows more contrast at both ends of the axis. Here the positive end distinguishes optimistic, relieved, confused and isolated reefs from vacant, desperate, open and rejuvenated ones. Once again this contrast can apply to both ends of dimension one, depicting a mixture of positive and negative moods, and may also point towards the participants' recognition of the complex nature of each reef.

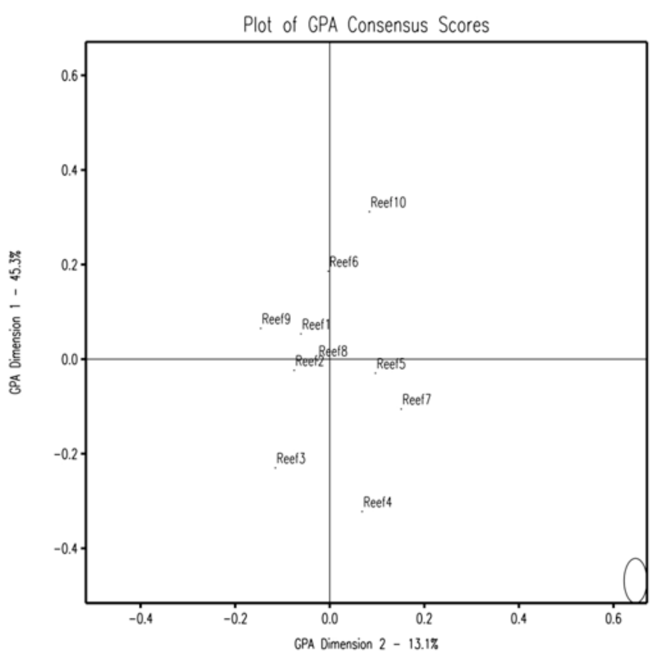
Reef Characteristics

Figure 3 shows the 'reef plots' for the two surveys. In both surveys the standard error of the coordinates of individual reefs is small (see ellipse at bottom right hand corner of plots), and so these coordinates can be assumed to reliably characterize the reefs' position on dimensions 1 and 2. The spread of the reefs over the plots indicates that both axes offer reasonable resolution as independent dimensions of the reefs' expressive qualities.

Figure 3. Reef plots from (a) the OceansWatch study and (b) the Reef Guardian study.



3a)



3b)

Of considerable interest in this study is the amount of correlation between the two surveys. As mentioned earlier there are significant cultural, educational, professional and language differences between the two groups. In addition, the RG group has a long term, survival dependent, relationship with the reefs that includes varied uses and exploitation of a variety of species. In contrast the OW group includes marine scientists, conservationists and divers, motivated and informed by very different interests. As one of the goals of this project is to develop an appropriate monitoring technique for the Reef Guardians to use as an aid to adaptive management decisions, it is relevant to investigate the similarities and differences between the two and how they relate to the perceived qualities of each reef. Statistically this was achieved using a Spearman correlation, which shows significant correlation on dimension 1 ($r=0.73$, $p<0.02$) but not on dimension 2 ($r=0.30$, ns).

The degree of spread between the highest positive and negative scoring reefs is very similar for both surveys although there is a difference in the position of some reefs. In the OW plot there is a definite separation between positive and negative scoring reefs on the first dimension whereas in the RG plot there is a more even spread and a small cluster of reefs close to the mid point of both dimensions. However, in both surveys there is an even split of the same 5 reefs on the positive and negative sides of dimension 1. The reefs positioned most similarly on dimension 1 in both surveys are reefs 3, 6, 7 and 10. Reefs 1, 8 and 9 are not positioned as closely but never the less still show significant correlation. The reefs showing the least correlation are 2, 4 and 5. Interestingly, these reefs all score negatively on dimension 1.

In both surveys, Reef 10 received the highest positive scores on dimension 1. This reef is outside the main lagoon and is characterized by abundant fish life, good hard coral cover and clear water compared to most of the other reefs in the study. Of the four other positive scoring reefs only Reef 9 differs in its overall position between the two surveys (in order, highest first; OW: 9, 1, 6, 8, RG: 6, 9, 1, 8). Reef 9 is also outside the main lagoon, has good hard coral cover and fish life, but is overall less abundant than Reef 10. Despite its different ranking, both groups still characterized this reef as healthy, strong and happy.

Like Reefs 9 and 10, Reefs 1 and 6 are similar to each other in that they are both shallow sites within the main lagoon, both with good coral cover and fish life. Reef 8 differs somewhat from the other four, being a reef wall inside the lagoon with perhaps the most diverse physical structure. The reef top is a mixture of large sand patches interspersed with sparsely covered rocky outcrops. The wall however has more soft corals and many rocky overhangs providing ideal habitat for larger fish species such as grouper, sweetlips and parrotfish. Both groups seemed to be influenced by the 'isolated' feeling of this reef but perceived its strength and resilience as well. Overall there is a high degree of consistency in the way the qualities of the positive scoring reefs were perceived and reported. All these reefs are within the two MPAs and are either in relatively healthy states or are showing signs of recovery.

In contrast there is much more variation between the two surveys in the way the reefs were scored on the negative end of dimension 1. What all these reefs have in common is a higher level of degradation and damage compared to positively scored reefs. All of these reefs with the exception of Reef 5 are very shallow (less than 3m deep). Reefs 2, 4 and 5 have a predominance of branching 'staghorn' corals (*Acropora sp*) although Reef 4 has the remnants of other species including massive and encrusting hard corals. Reef 7 also has staghorn growth but comparatively less than the other three. Staghorn corals are generally fast growing species in shallow water and are often amongst the first to re-colonize an area after storm damage (Tkachenko et al, 2007). It is interesting to speculate on the relative positions of Reefs 2 and 4 in each survey. In the OW survey Reef 2 has the highest negative score and Reef 4 the least, while in the RG survey it is the other way around. Reef 2 is highly degraded in some areas but does have substantial staghorn re-growth in other areas. It may be that the OW participants have scored this reef negatively due to the degradation but also its perceived 'prickliness' while the RG participants are perhaps more accustomed to seeing this staghorn re-growth and viewed it a little more positively. Reef 4 on the other hand has very little new growth but is less intimidating and was perceived by the OW participants as vulnerable, shy and un-ambitious while the RG participants perceived it as worried and hungry.

Reef 5 is a highly degraded area of staghorn rubble. There are initial signs of some new coral colonization of various types. This reef is slightly deeper with several of these 'rubble' mounds creating a more undulating topography than the other reefs. This has the effect of aggregating some fish species such as snapper on the 'up-current' sides of the mounds at certain tide states. The fact that some of the RG participants noted this in their terms, as well as the new coral growth, may help to explain the different relative position of this reef between the two surveys.

Despite these differences there is still remarkable similarity in the semantic meaning of the terms used by both groups to describe both the positive and negative ends of dimension 1 in both surveys.

Discussion

The results of this study demonstrate that two very different groups of participants were able to freely generate semantically coherent frameworks of terms to describe the expressive qualities of ten different coral reef habitats. Results also show that there was significant agreement in the perception, assessment and judgment of these qualities within each group, demonstrated by the similarity between individual word charts. In addition, and despite substantial cultural, educational, and professional and language differences, there was significant convergence of terminologies and semantic meaning in the characterization of the reef qualities between the two surveys. This indicates that participants based their assessments on commonly perceived and systematically applied criteria of reef qualities that may not be entirely culturally determined.

This study, and its results, may not be enough to assert unequivocally that the reef is a 'living being' capable of expressing its own 'state' of being through observable qualities that can be perceived by a subjective observer. However it does offer an alternative to the conventional view of the reef as a collection of species living on an inert substrate, open only to objective measurement. By having as its starting premise the assumption of the reef as a 'living, expressive entity' and inviting participants to approach their observation as more an act of 'meeting' the reef through reciprocal interaction, rather than static observation, participants not only produced highly consistent terminologies, but showed equal consistency in the way they applied those terminologies. Further, by accommodating the expressive ability of the reef in this interaction, the significant level of inter-participant reliability also calls into question the notion that what is being perceived is no more than a subjective projection of culturally determined emotional responses. Indeed, in light of the very different cultural backgrounds of the two participant groups, and the significant correlation between their perceptions of the reefs, the above assertion seems valid. At the very least it shows that this approach has strong methodological validity that justifies further exploration.

The cultural difference between the two groups in this study is of particular interest. In their landscape studies using Free Choice Profiling, Harding, Wemelsfelder and Burch noted that all of their 'observers' shared *'similar cultural conditioning'*, potentially influencing the way they experienced the landscapes and biasing the outcomes towards that cultural conditioning (Harding et al, unpublished). They suggested repeating their experiments using observers with different cognitive and cultural backgrounds to test the extent of this bias. This current study has taken a first step in testing this, and even though the subjects were coral reefs rather than terrestrial landscapes, the outcome suggests that, when asked to suspend their cultural conditioning in favour of 'meeting' the expressive qualities of the subject, participants were able to transcend their cultural biases to some extent. It seems unlikely (and perhaps even undesirable) that cultural and cognitive backgrounds can, or should, be completely overridden in our interactions with ecosystems, but in relation to adaptive management strategies, the ability to perceive the intrinsic qualities of ecosystems as distinct (**but not separate**) from our cultural projections seems an important skill.

Treating our perception of '*coral reefs as living beings'* as a skill to be developed fits very well with one of the major goals of this project; namely the development of the Reef Guardian program initiated by OceansWatch. The holistic science approach to developing this direct intuitive perception is based on the work of Johann Wolfgang von Goethe, whose intuitive insights came from '*dwelling in the phenomenon'* (Bortoft, 1996). Free choice profiling offers not only a way of measuring those insights but also, as has been the case in this project, a methodology for developing intuitive perception skills through the presentation of, and training in, these perceptive skills. It would be very interesting to develop this 'Goethean' approach further.

One potential benefit of this approach would be the development of *'intentional intuitive perception'* where the participant uses *'engaged empathy'* (a concept developed in an earlier work) with the reef to seek feedback on specific questions. For example, this might be useful in making an initial assessment about the opening or closing of an area to particular fishing activities. Of course this resonates very well with traditional ecological practices and is indeed one of the goals of the Reef Guardian program. In fact, a first step has already been achieved in this direction with the development of a more qualitative reef-monitoring program for the Reef Guardians of Tuo to trial in the coming year (discussed further in the final conclusions).

A strength of the FCP methodology is that it provides a *'bridge'* between the qualitative world of our direct intuitive perception and the quantitative world of statistical measurement. This not only provides us with a way to rigorously correlate qualitative assessments of ecosystems, but also opens the way for direct comparison between these two supposedly separate worlds. In this study, two very different groups of participants (including local fisherman and professional marine scientists) reached significant agreement on their assessment of reef health. A further step is to determine whether their assessment correlates with the quantitative measurement of the abundance and diversity of selected taxonomic groups in areas of similar habitat.

A part of the overall project in the Reef Islands is the ongoing scientific monitoring of selected reefs, using the Reef Check methodology, developed in the 1990's, to provide a global assessment of coral reef health (Hodgson, 1999). This provided an opportunity to conduct Reef Check surveys on some of the reefs used in the FCP surveys. It is beyond the scope of this thesis to do a full comparative, statistical analysis of the Reef Check and FCP data together but it is hoped this initial *'first look'* will show enough potential to justify further investigation. The following section is a brief exploration of this possibility.

Reef Check Surveys

Methods and Design

Reef Check (RC) is the methodology used by OceansWatch to monitor changes in reef health within the MPAs that have been established in the Reef islands. The aim of the project this year was to increase the number of monitoring sites (both within and outside the MPAs) and increase the number of replicates for each site to provide more accurate feedback of changes within the MPAs. This provided the opportunity to coincide some of the monitoring sites with the FCP sites. Sites were selected in accordance with Reef Check guidelines using stratified random sampling, which is preferred when permanent fixed transects aren't feasible (Hodgson et al, 2006). Each site survey included three replicates, conducted on separate days but with the same starting point coordinates to within 5m. In total five FCP sites were surveyed using Reef Check, FCP reefs 1, 2, 3, 7 and 8. Reefs 1 and 2 are within the 5 yr MPA, Reefs 7 and 8 are within the permanent MPA and Reef 3 is outside the 5 yr MPA.

Ideally each survey will include two depth contours; shallow (2 – 6 m) and mid-depth (>6 – 12 m). However, depending on individual reef topography, this is not always possible. Of the five reefs only Reef 8 is a mid depth survey. Each survey consists of three transects; a fish belt transect, an invertebrate belt transect and a substrate line transect. During the invertebrate transect any coral disease, coral bleaching or damage (including anthropogenic) is also recorded. All the transects are 100 m long, split into four 20 m sections with a 5 m gap between each section.

Experimental Procedures

Of the five FCP/RC sites only one, Reef 8 is a medium depth site requiring the use of scuba equipment. The rest of the surveys were conducted using only snorkelling equipment. Surveys were carried out by the marine science team of four qualified Reef Check divers (including myself), all of whom are marine scientists. At the start of each survey, once the start point and direction of transect had been established, one buddy team enters the water and lays the transect line (a 100 m tape marked in centimetres). Once the tape is laid the divers exit the water and wait 15 minutes before the start of the fish belt transect, to allow time for the fish community to settle.

The diver conducting the fish transect swim very slowly along the transect line, stopping every 5 m for one minute before continuing. Indicator species are counted in a belt 5 m wide and 5 m high along the line (see table 4. for indicator species list and substrate types). The next diver follows conducting the invertebrate transect. Again this is done in a belt 5 m wide (2.5 m either side of the line) and in this survey the diver concentrates on investigating every crack and overhang along the belt to ensure that all indicator species are counted. Finally the substrate line transect is completed. Substrate types are recorded every 50 cm so that each 20 m section will have 40 data points. A plumb line is used to avoid bias (Hodgson et al, 2006). Once all three transects have been completed and all data sheets checked for accuracy, the transect line is retrieved.

Table 4. Reef Check indicator species and substrate types.

Substrate type	Fish indicator species	Invertebrate indicator species
Hard coral (HC)	Butterflyfish	Banded coral shrimp
Soft coral (SC)	Sweetlips	Long-spined Diadema sp Urchin
Recently killed coral (RFC)	Snapper	Pencil urchin
Nutrient indicator algae (NIA)	Napoleon Wrasse	Collector urchin
Sponge (SP)	Parrotfish>20cm	Sea cumber (3 sp)
Rock (RC)	Rabbitfish	Crown of thorns starfish
Rubble (RB)	Surgeonfish	Lobster
Sand (SD)	Grouper>30cm	Triton shellfish
Silt/Clay (SI)	Bump head parrotfish	Giant Clam

Data Processing and Statistical Procedures

Data entry is standardised using pre-formatted Excel worksheets provided by Reef Check International. These worksheets contain all the formulas required for attaining the basic statistics needed for interpreting the data. This includes the standard deviation (SD), how widely the distribution of observations is distributed around the mean, standard error (SE), which is decreased with more replicates, as well as the means from each section of a transect (Hodgson et al, 2006) (see figure 4. for a sample of the tables and graphs produced by these worksheets).

	Mean % per segment	SE
HC	29%	0.042542871
SC	0%	0
RKC	0%	0
NIA	6%	0.035903517
SP	0%	0
RC	32%	0.044924706
RB	4%	0.023935678
SD	17%	0.02576941
SI	0%	0
OT	13%	0.027003086

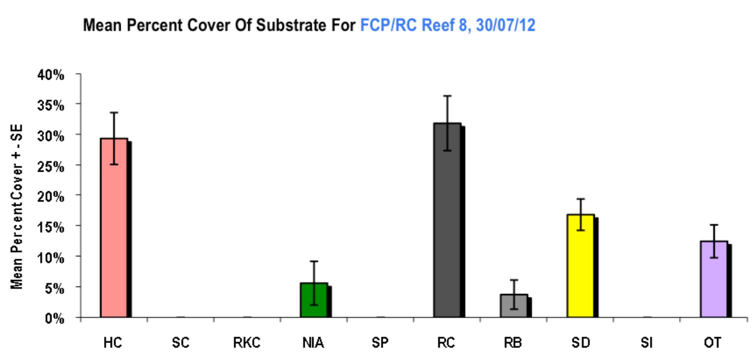


Figure 4. An example of the standard Reef Check data output.

For the purposes of this study additional statistical analysis has been conducted. As mentioned above, this does not represent a full analysis but is aimed at giving a *'first look'* at the potential correlation between the qualitative and quantitative approaches to assessing reef health.

The first step in this process is to find the mean of the three replicates of each site for the indicator species and substrate types. This was achieved by importing the means from each replicate into a new worksheet. The result is one worksheet with the means from all five reefs, listed in rows, with a column for each species and substrate type (some species with very low or no returns were excluded). The next step was to rank the reefs from 1 to 5 for each species and substrate type. Ranking was done on the basis of either a high ranking (1) for positive indicators of reef health (e.g. the reef with the highest % of hard coral cover is ranked (1) and the reef with the lowest is ranked (5)), or a low ranking for negative indicators (e.g. the reef with the highest % of nutrient indicator algae is ranked (5) and the reef with the lowest % is ranked (1)).

It is then possible to determine an overall 'health' ranking for each reef by taking the mean of all the rankings for each reef and running them through an additional ranking process. The result is a single column giving the relative health ranking for each reef. It is important to note that these rankings are only relevant in the context of how they relate to each other as no analysis has been done to compare them to any regional or international reef health indexes. This would be of interest but is beyond the scope of this study.

The purpose for assigning these rankings is to allow a direct comparison to the outcomes of the FCP surveys for the same reefs. Ranking of the FCP surveys was achieved by taking the consensus scores from the first dimension of the consensus profiles for each reef and applying the same ranking process. As discussed in the results from the FCP surveys, dimension 1 has the highest differentiation between the positive and negative ends of the axis and so best represents the participants' assessment of reef health based on their perception of the expressive qualities of each reef.

This was done for both the OW and RG surveys so that we now have three separate rankings, from 1 to 5 for the five FCP/RC reefs. The final step is to determine the degree of correlation between these rankings. Because the relationship between the rankings is now linear we can use a Pearson correlation coefficient to achieve this. Thus we can explore (from a quantitative perspective) the merits of both qualitative and quantitative methods for assessing reef health.

Results

Table 5 shows the substrate mean percentages produced from the three replicate surveys at each site. Of note is the relatively close percentage of hard coral cover on each reef, with the exception of Reef 7, which shows a considerably lower percentage and a correspondingly high percentage of bare rock. Also of note are much higher percentages of rubble on Reefs 7 and 2.

Table 5. Mean substrate percentages from the 3 replicate surveys on each reef.

	HC	NIA	RB	RC	SD	OT
Reef 1	29%	7%	4%	31%	18%	11%
Reef 2	24%	4%	20%	28%	18%	6%
Reef 3	26%	5%	4%	39%	20%	5%
Reef 7	17%	2%	17%	50%	7%	6%
Reef 8	24%	4%	5%	42%	19%	2%

Figure 5 shows the mean populations of fish indicator species for each reef. Overall Reef 2 shows the least abundance of most species. Apart from Reef 2 there are healthy populations of the herbivorous surgeonfish and the corrallivorous butterflyfish. Not surprisingly Reef 1, with the highest percentage of hard coral cover also has the highest mean population of butterflyfish. Reef 8 shows higher populations of parrotfish and snapper, which is likely to be associated with its location on the reef front and its greater depth. This may also explain the slightly higher mean for grouper at this site. It should be noted here that the only invertebrate species included in these results are giant clams due to the total or near total absence of other indicator species.

Figure 5. Mean populations (3 replicates) of fish indicator species for each reef.

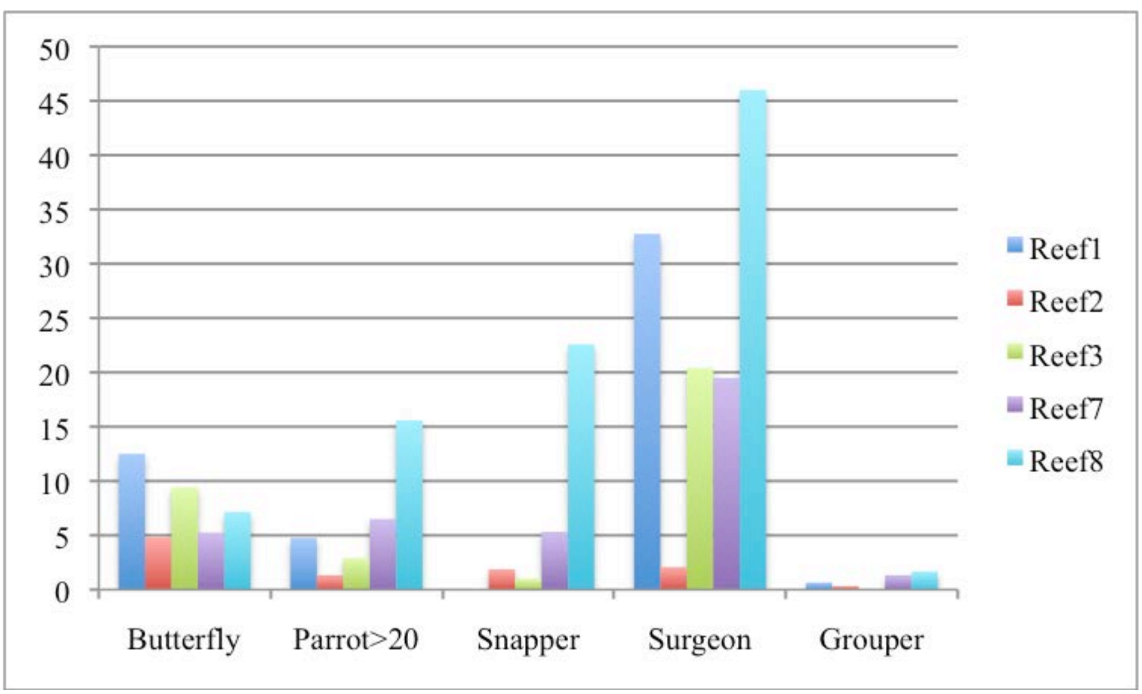


Table 6 shows the combined ranking totals for each reef from the individual substrate and indicator species rankings as well as the means from those rankings. From this the overall ranking for each reef is calculated. The ranking represents the health of that reef relative to the other reefs in the survey. As mentioned above, it does not provide an overall health ranking on a regional or global scale, which would require further analysis.

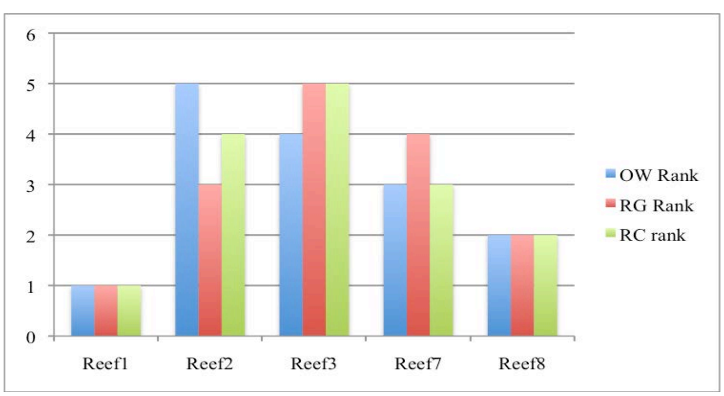
Table 6. Combined total and means of individual rankings and overall reef ranking.

	Combined totals from individual substrate and indicator species rankings	**Mean from combined substrate and indicator species rankings**	**Overall ranking**
Reef 1	27	2.25	1
Reef 2	39	3.25	4
Reef 3	42	3.5	5
Reef 7	36	3	3
Reef 8	31	2.58	2

Table 7 (and Figure 6) shows the RC rankings alongside the OW and RG rankings, taken from the dimension 1 consensus scores for each reef. There is strong correlation between both the OW and RG rankings and the RC ranking ($r=0.9$, $p<0.02$). This indicates that the assessment of the reefs' expressive qualities by the FCP participants significantly corresponds to the quantitative measurement of key indicators of reef health. It is interesting to note that the two highest ranking reefs, 1 and 8, were also the only reefs with positive consensus scores from the FCP surveys. These reefs shared the same ranking from all three surveys with Reef 1 ranked first and Reef 8 second.

Table 7 & Figure 6. Correlation of reef rankings between FCP and RC surveys.

	OW ranking	**RG ranking**	**RC ranking**
Reef 1	1	1	1
Reef 2	5	3	4
Reef 3	4	5	5
Reef 7	3	4	3
Reef 8	2	2	2
Pearson correlation to RC Ranking	$r = 0.9$ $p<0.02$	$r = 0.9$ $p<0.02$	



Reef 1, with the highest percentage of hard coral cover and consistently high fish means was perceived by the FCP participants as busy, varied and optimistic, but was also characterized as smothered and slimy, which correlates to the relatively high percentage of NIA measurement from the substrate transects. Reef 8 was characterized as strong, resilient, isolated and well populated with fish in the FCP surveys, which also coincides with the Reef Check transects.

There was some variance in how the other three reefs were ranked with Reef 3 ranked 5th by RG and RC, but 4th by OW. Reef 7 found agreement between OW and RC at 3rd while RG ranked it 4th. Only Reef 2 received a different ranking from all three surveys with OW ranking it as the least healthy at 5th, RG in the middle at 3rd and RC at 4th. A look at the FCP consensus scores for these reefs (table 8) is useful here. Reef 3 has a very similar consensus score for both FCP surveys and only has a different ranking due to the very low score given to Reef 2 by OW. Likewise Reef 7 received relatively similar scores from both FCP surveys but was again influenced by the substantially different scoring of Reef 2. The possible reasons for the different scoring of Reef 2 in the FCP surveys were discussed in the previous section but it is worth noting again that despite the different ranking there was significant semantic convergence in the descriptive terms used by both groups.

Table 8. Consensus score and rankings for OW and RG FCP surveys.

	OW dimension 1 consensus scores	**OW Rank**	**RG dimension 1 consensus scores**	**RG Rank**
Reef 1	0.178	1	0.063	1
Reef 2	-0.314	5	-0.014	3
Reef 3	-0.207	4	-0.22	5
Reef 7	-0.131	3	-0.096	4
Reef 8	0.155	2	0.007	2

Discussion

These results show that, in this study, there is significant correlation between the quantitative assessment of reef health, using the Reef Check methodology, and the qualitative assessment of the same reefs by two separate groups of participants. This *'first look'* seems to indicate that the expressive qualities of the *'living reef'*, as perceived by naïve observers and marine scientists alike, are a reliable way to assess the overall health of the reef and provides a potentially valid, and complimentary, alternative to purely quantitative monitoring. The small sample size of this study limits the reliability of the results in terms of extrapolating them into a wider context. However, the significance of the correlation ($r=0.9$, $p<0.02$) is at least consistent with the idea that our subjective experience of the ecosystems we interact with can provide us with reliable and useful insights that are compatible with information gained through quantitative monitoring.

Interestingly, the founders of the Reef Check methodology noted a similar correlation in the first global assessment of coral reef health conducted in 1997. Survey teams in 31 countries were asked to make a subjective assessment of the level of overall impacts, including anthropogenic, they believed were affecting the survey sites. These assessments were then plotted against a coral reef health index (CRHI) with a correlation of ($r=0.98$, $p<0.001$) (Hodgson, 1999).

Of particular interest to this study are the ramifications for validating traditional ecological knowledge and associated management strategies employed by the communities in the Reef Islands. As discussed previously these communities have experienced significant decline in the health of their reef systems in the past four decades, with a corresponding loss of confidence in the ability of their traditional practices to cope with this rapid change. Showing that their qualitative assessment is valid and indeed compatible with a modern, scientific approach may contribute to a re-building of confidence and perhaps lead to a higher level of trust and sense of equality with the scientific approach of the 'outside' organizations they come in contact with. The feedback from the Reef Guardian participants in the FCP surveys was overwhelmingly positive, in part due to the perception (and reality) of the scientific nature of the overall study, and its compatibility with TEK. I believe this may have contributed to an increased awareness and understanding of the Reef Check surveys and desire to incorporate this 'new' knowledge into their TEK.

A final observation concerning the comparative study of the two methodologies is worth making. So far (in my reporting of this research) I have defaulted to the standard scientific approach, which asserts the primacy of the quantitative over the qualitative. The assumption here is that the Reef Check results are the benchmark against which the FCP surveys should be measured for significance and validity. But from a holistic science perspective this assertion should be challenged and instead we can ask how well the quantitative data and results fit into our sensed experience of meeting the reefs as living entities.

A valid question we can ask is: does the information about specific species improve our overall understanding and does it inform our intuitive sense of the health of this reef? This approach puts the *'whole'* reef first and leads us to '*move upstream'* (Bortoft, 1996) into a deeper relationship with the reef where we use the empirical data, not to compartmentalize, then unify with a generalised theory of reef health, but rather to meet and understand the whole reef through its diversity. The significant correlation between the RC results and the FCP surveys suggest that the quantitative data can indeed be useful when used in this context.

The marine science team conducting a substrate survey.

Conclusions and Outcomes

The original aims of this project were to make a comparative study between qualitative and quantitative ways of assessing coral reef health. Despite a year immersed in holistic science at Schumacher College, my **initial** approach was still one of seeing the qualitative as secondary (and somewhat subservient) to the quantitative. Perhaps this is understandable to a degree, as we are still scientifically enslaved to the myth of objectivity, and so the onus is on us to 'prove' the reliability of the qualitative approach to a largely skeptical scientific community. Francoise Wemelsfelder has spent the past fifteen years doing just that in the field of animal sentience and welfare. Her courageous work epitomises the holistic science approach of re-instating the qualitative without compromising scientific rigor.

However, as the project progressed and I delved deeper into my exploration of Traditional Ecological Knowledge, the realization came to me that to apportion the most importance to making the quantitative-qualitative comparison was really just playing it safe. By doing so I was missing the opportunity to fully appreciate the potential of investigating the lived experience inherent in our interaction with the qualities of the living reef. For this is exactly what FCP gives us the ability to do. By utilizing GPA to quantify the level of convergence between participants, while keeping the semantic meaning of descriptive terms intact, we have a robust process for the critical assessment of that lived experience. This seems to me to be an entirely appropriate use of quantification as a tool in the service of genuine and open scientific enquiry where the emphasis is not on proving or disproving a theory but on seeking understanding through meeting the subject in its wholeness. Or, as Goethe put it, *'Don't look for anything behind the phenomena, they themselves are the theory'* (Goethe in Bortoft, 1996 Pg, 71).

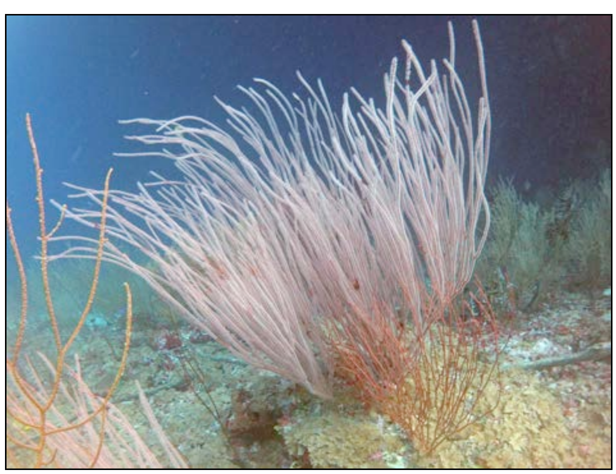
The results of the two FCP surveys conducted in this study seem to indicate that it is entirely possible for us to discern the qualities of a coral reef ecosystem in a manner that gives us reliable information about the health, or as I prefer to describe it, the well being, of that reef. More importantly from an adaptive management perspective, it places us in relationship with the ecosystem, not as an observer, but as a participant, with the ability to affect and be affected by the other's well being.

This of course fits very well into the understanding of traditional ecological knowledge as a lived experience, or more precisely, the experience of living as part of an ecosystem. This is a qualitative experience where knowledge is neither static, nor a separate by product, but a living and ever changing dimension of the lived experience. In the third edition of his book *Sacred Ecology* Fikret Berkes makes the point that we should view traditional ecological knowledge '…*as process, rather than content'* (Berkes, 2012, Pg xxiii). He could just as easily be describing the ideal of true scientific discovery. He goes on to suggest that the scientific vs. traditional knowledge debate should be reframed instead as a dialogue and partnership that can work, not so much to synthesize the two, but rather to generate new ecological knowledge through the synergy of combining what is already known to science and to local and traditional knowledge (Berkes, 2012). I would add that we could also combine the different **ways** of knowing as the **process** towards a new understanding of our place in the ecological community.

In a small way this is exactly what is being attempted with the Reef Guardian program. The original concept of this program, as developed by OceansWatch, was to train local villagers in basic monitoring techniques so they could track changes in the MPAs set up within their customary marine areas. This involved swimming along a transect line, counting key indicator species. There are obvious benefits in doing this in terms of measuring the success of the MPAs as a conservation and management tool. However, to date it has been difficult to quantify any of the data collected due in part to the lack of continuity in the surveys and the difficulty in verifying the data collected.

An outcome of the FCP training with the Reef Guardians was the development of a qualitative aspect to their ongoing reef surveys. The new monitoring program, developed in partnership with the Reef Guardians themselves, now includes, as it's main component, a qualitative assessment of reef health using some of the terms generated during their FCP study. Out of the combined terms of all the participants, twelve were chosen as the most representative of the expressive qualities of all the reefs. These terms will now be used by the Reef Guardians to 'score' the reefs in the same way as they did in phase two of the FCP study. In addition to this qualitative assessment they will also conduct a modified, quantitative survey of locally appropriate key indicator species at the same sites. The Reef Guardians will record all the results from each survey, providing them with an ongoing record of their own process in meeting and assessing the wellbeing of the reefs, that are so important to their lives. Four reefs from the FCP studies have been chosen to conduct these bi-monthly surveys, two in each of the MPAs. These four reefs are also Reef Check survey sites so will be surveyed again next year by the OceansWatch marine science team, providing another opportunity to assess any correlation between the two.

Adapting to changing ecological conditions through the careful and considered use of knowledge gained from experience is the hallmark of many traditional cultures. Understanding knowledge as a dynamic process that is embedded in the participatory experience rather than objective measurement of that from which we can never be truly separate seems to be a necessary step for the scientific exploration of our ecological home to truly progress beyond a purely physical dimension. This does not exclude quantification but rather, places it in its rightful position, as just one of many tools available to us on our journey. This, to me, is the path of the holistic scientist.



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Appendix i

Pidgin Instructions for Reef Guardian FCP Study, Tuo, Reef Islands, July 2012.

- Hem ia wan part blong training blong Rif Guardian long yufala, be hem i different lelbet from training wea yu bin complitem finis.
- Bifo yu bin lanem hao blong lukaotem plante kain fis mo hamas korel i stap long rif. Naoia bae yumifala traiem lanem hao blong luk long korel rif sapos hem i wan samting nomoa.
- From wanem blong mekem samting ia hem i traiem understand wanem rif save tellim long yumifala hao hem i harem sapos health blong hem i gud o no gud. Yumifala traiem blong understand mo describem wanem korel rif save tellim long yumifala baot hem.
- Hem ia wan nufala way blong study korel rif mo yufala olketa stap representem nambawan taem wea ol Rif Guardian bin makem samting ia.
- Bae yumifala stap usum wan method blong science nem blong hem Free Choice Profiling, blong luk sapos hem i wan gudfala way blong measurem mo lukaotem korel rif blong yumi.
- Taem yumifala stap usum FCP, bae yumi save luk sapos wan, two o plante blong yufala luk sem samting blong health mo kwaliti blong rif.

Describem kwaliti blong rif

Ol kwaliti hem i wanem?

1. Korel rif hem i wan samting wea hem i stap alive. Olsem yumifala, rif i gat fulap part. Olsem yumi gat foot, leg, head mo plante nara samting, rif i gat fis, korel, bis-de-mer mo plante samting. Sapos yumi wantem meetim mo lanem wan man, yumi mas luk long evrisamting blong hem. Yumi save evri man i different lelebit o bigwan, i gat plante different kwaliti, mo sapos yumi stap smoltaem witem hem, bae yumi save luk heo hem i stap mo wanem hem i mekem. Bae yumi meetim mo save hem gud. Sapos health blong wan man i gud, bae i harem glad mo mekem plante samting, be sapos health blong hem i no gud, bae i harem sori mo bae i stap kweet nomoa.

2. Sapos yumi stap smoltaem witem wan korel rif bae yumi save mitim hem mo luk haoia hem i mekem plante samting. Olsem yumi save usum sam words blong describem olketa kwaliti blong wan man, bae yumi traiem usum words blong descibem olketa kwaliti blong rif wea yumi luk. Mifala wantem tingting blong yufala olsem sapos wan rif hem i stap toktok long yufala baot hem wan nomoa.

3. Olsem taem yu toktok long wan man, taem yufala toktok long korel rif bae yufala harem samting. Hem ia olsem sapos wan fren i tellim wan samting long yu wea yu harem samting, glad o sori or olsem wanem. Hem ia gud be hem i nambawan sapos yu save describem olketa kwaliti blong rif.

4. Hem ia wan example. Sapos yumi luk wan bigfala sark, mebi bae yumi harem fraet long hem. Be hem ia harem blong yumi, hem ia no harem blong sark o blong korel rif. Mebi sark hem I harem hangri mo hem I stap lukaot long kaikai nomoa. From mebi sark hem I ting se yumi wan gudfela kaikai, hem ia from wanem yumi harem fraet. Se, sapos yumi wantem describem kwaliti blong rif, mebi yumi save writim "hangri".
5. Samtaem mebi bae yu luk wan rif wea kwaliti blong rif mo harem blong yu, tufala sem samting. Hem I orait. For example, sapos yu luk wan rif wea I no gat fulup samting, mebi bae yu harem "empty".

6. Remember, mifala no wantem describem rif nomoa, mifala wantem describem kwaliti mo harem blong rif. Mifala wantem describem health blong rif.

7. Wan example bakagen. Sapos yumi luk sanbij nomoa long solwota, yumi no save putum "sanbij". Yumi mas traiem describem kwaliti mo harem blong sanbij. Sapos sanbij I clin, yumi save putum "clin" or "fres" be sapos sanbij I no clin tumus, sapos hem I robis o doti, yumi save putum "taed" o "sori".

8. Plis, yumifala no save tellim ol kwaliti wea yumi bin putum long eni nara man kasem yumi komlitem study blong yumi. Yu no save tellim long vlej o rif guardian.

Appendix ii

Instructions for Reef Guardian FCP Study, Tuo, Reef Islands, July 2012

Phase 1

1. We have 10 reefs to visit. They are all different, but are all part of the Tuo customary marine area.

2. At each site we will float on the surface of the water and use masks and snorkels to look at the reef for 5 minutes. Let the reef tell you about itself. Look carefully but don't look just at the coral or the fish. See the reef as one living being with everything connected.

3. When I signal to stop looking (loud slapping on the surface of the water), write down the words that you think best describe what the reef has told you about itself. You can write as many words as you want to but only write the words that fit what the reef is telling you. There is no right number of words. You might write a lot of words for some reefs but not many for others. This is ok.

4. You will have 5 minutes to find the right words but don't worry if you are having trouble finding the words. Just relax, don't think too much and let the reef flow into your senses.

5. It is ok to use some of the same words for different reefs as long as they are the best words for that reef. Do not tell anyone else the words you have written.

6. In between each reef we can talk to each other but it is **very important that you don't tell each other the words you used to describe the reefs.** When we have finished both parts of the training we can tell each other about the words we used. It will be fun to see how many of the same words you all use. This will help us as Reef Guardians to understand if the reef is healthy or not.

Phase 1 Form

Name: **Reef Qualities Study**

1. Float on the top of the water and look at the reef for 5 minutes. Let the reef tell you about itself. Look carefully but don't look just at the coral or the fish. See the reef as one living being with everything connected.
2. When I signal to stop looking (loud slapping on the surface of the water), write down the words that you think best describe what the reef has told you about itself.
3. It is ok to use some of the same words for different reefs as long as they are the best words for that reef. Do not share the words with anyone else.

Reef: 1

Reef: 2

Reef: 3

Reef: 4

Reef: 5

Reef: 6

Reef: 7

Reef: 8

Reef: 9

Reef: 10

Instructions for Reef Guardian FCP Study, Tuo, Reef Islands, July 2012

Phase 2

- The second part of the training will take place a few days after we finish the first part.
- We are going to visit the same 10 reefs but this time you are going to give a score to all the words you have written. This is **not** a test and there are no right or wrong scores. The scores you give for each word at each reef we visit will come from what you see and feel and what the reef tells you about itself.
- The reason for scoring each word is to see how much we all agree about what we are seeing and feeling about how healthy the reef is.
- I will show you how to do it and we can practice before we visit the reefs.

How do we score the words?

I will give you a printed sheet of waterproof paper for each reef. It will have all the words you used to describe all 10 reefs on it. The only words that won't be on it are words that mean exactly the same as another word already on the paper or words that are the opposite of another word like *happy and unhappy.* In this case we would only use the word *happy.*

Each word will have a line next to it. All the lines are exactly the same length. (I will show you what they look like)

The lines have the words min (minimum) and max (maximum) at each end. We will use the lines to score the words.

When we look at the reefs again we want to look at each word and decide how much we think this word describes the reef we are looking at. If you don't think the word describes the reef very well then you should score it towards the minimum end of the line. If you think the word does describe the reef very well then you should score it towards the maximum end of the line. We can score each word at any point along the line depending on how well we think it describes that reef. The scores aren't good or bad or pass and fail. They are just what we sense from the reef.

It is very important to score every word for every reef. It is very important not to compare your scores for each word. You should score each word separately.

To score each word we just make a single mark vertically through the line where we think is the right place for that reef. Try not to think about it too much, just try to sense where you should mark each word, but don't worry if it takes you a while to decide, we have plenty of time.

Phase 2 Form

Reef Quality Assessment

NAME: **Reef:**

TERMS:

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Min. Max.

Sample Excel work sheet of terms and scores from Phase 2

Subject$	empty	sad	tired	energy	long-rest
Reef1	13	31	23	77	115
Reef2	34	17	50	79	87
Reef3	25	17	32	55	88
Reef4	50	71	61	88	89
Reef5	33	52	32	79	73
Reef6	15	7	17	82	115
Reef7	100	50	75	67	83
Reef8	34	47	32	97	86
Reef9	35	15	34	79	103
Reef10	24	39	55	70	94

Appendix iii

Article about the Pelowe (dolphin tribe) reported in the Solomon Star newspaper on April 29th 2011 by Ernest Laky, University of the South Pacific, Suva, Fiji.

What amazes me was the animal's behaviour during the death of its human tribe. I am not sure if science can explain why these dolphins behave the way they do. But in the case of Reef Islands only tradition provides the answers. The dolphins can come ashore only under two conditions:

1. *When someone from the dolphin tribe (Pelowe) died*

2. *Someone had whispered to the corpse requesting the dolphins to come ashore. In short, number one is the prerequisite and number two is the catalyst.*

Having grown up in Tuo Village in the 70s and 80s, I was only able to witness the tradition this year 2010 and managed to take some shots. On the 2nd of January 2010, at about 4pm in the afternoon, a shoal of dolphins was spotted by Tuo villagers coming towards shore. This was believed to be related to an elderly man from Nopali Village belonging to the dolphin tribe who died in late December 2009.

As usual, the men folk pushed their dugout canoes off to lead the animals ashore. By tradition those with pregnant wives were not allowed to join the team. They form a c-shape around the animals and perform rituals to bring them to shore. They uttered dolphin songs; wave their paddles in the air and beat the side of their canoes as the animals head to shore.

Simultaneous on the shore, women belonging to the dolphin tribe perform ritual by singing and showing their breast (susu) as a sign for the animals to come and breast feed. Usually elderly women perform this role. The beach was a no go zone only 2-3 women of the dolphin tribe were allowed to perform the ritual.

The rest of the villagers hid behind beach shrubs in anticipation of the animal's arrival. The whole village went into pin drop silence except for those who perform the rituals. Half way through the proceedings, the men leading the animals ashore would have someone from the dolphin tribe to jump and swim with the dolphins before their final journey ashore.

A white coloured dolphin who leads the procession, circles the historic dolphin stone and heads back into the ocean. The rest of *the animals head straight to the beach in what the villagers believed and described to be a suicide mission.*

It was a spectacular moment lining up with the animals and children swimming and playing with them. Totally magnificent. On this occasion, 50 dolphins were beached and slaughtered for food. Village children swam in the sea of blood believed to make them healthy and strong.

It was my first time to witness this tradition and even touching these intelligent animals. But the ending was too emotional, some elderly women shed tears and seeing the animal's tears coming from their eyes was disheartening. Within 2 days all the 50 dolphins were gone- killed and distributed to the rest of Fenualoa as far as villages on Lomlom Island. The villagers believed the animals will not survive if released back into the ocean. They will be killed by sharks and other predators.

Their mission is very clear- suicide in honour of the loss of one of their human tribe.