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'KIA ANGI PUKU TO HOE I TE WAI' OCEAN NOISE AND TOURISM

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ABSTRACT

The overall theme of the 6th Coastal and Marine Tourism congress is "The Spirit of Ubuntu, Connecting Continents, Places and People". "The Spirit of Ubuntu" is a traditional African concept, acknowledging interconnectedness between humans and also between humans and nature. This concept is also central to the worldview of Maori, the indigenous people of Aotearoa/New Zealand where the phrase 'kaitiakitanga' is used to express the duty of care or guardianship responsibilities Maori have with all living things. Indigenous paradigms such as 'ubuntu' and 'kaitiakitanga' are pertinent to the emerging issue of ocean noise. There is a growing concern regarding increasing levels human induced noise in the oceans and its effect on marine mammals. Tourism activities contribute to these rising sound levels, however, few studies have focused on quantifying sound produced by tour boats and assessing their effects on marine mammals. Furthermore, no research has been conducted, thus far, to examine the impacts of deliberate use of sound as a mechanism to create and enhance interactions between tourists and marine mammals. As a consequence, there is little to guide management decisions when considering marine mammal responses to noise levels. We argue here that an alternate approach to management is needed with direct actions taken to minimise any potential effects through a sound understanding of the needs of the marine mammal. This is consistent with the precautionary principle and is also well suited to an adaptive management type of approach. Following the spirit of "ubuntu" and "kaitiakitanga" and ensuring that our acoustic impacts on marine environments and on marine creatures are minimised must be a better way forward.

Keywords: Whale-watching, swim-with-dolphins, noise, sound, management.

INTRODUCTION

In February of this year we attended a public presentation on the issue of noise in our oceans. The talk was given by U.S. based marine acoustics researcher, Dr Chris Clark. Because he was a visitor to Aotearoa/New Zealand, he was given a traditional 'mihi' or greeting from representatives of local indigenous Maori. As part of this mihi, Rawiri Paratene shared a treasured expression his grandfather had gifted him: "kia angi puku to hoe I te wai" which translated means "move your paddle silently through the water". As with many such phrases which are passed down the generations within cultures that have a strong oral tradition, this phrase in Maori has multiple meanings. Rawiri explained that for Maori there are many reasons why paddling your 'waka' (canoe) silently is important. Efficient paddling technique produces little disturbance of the water

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and, therefore, little noise. This was a valuable skill because Maori needed to be able to move through dangerous areas quietly to avoid or to make an attack on rival iwi (tribes). 'Kai-moana' or sea-food is an important component of Maori diet, and when fishing and approaching prey, stealth was a significant contributor to success, thus silent paddling was of considerable assistance. Finally, respect and reverence for the realm of 'Tangaroa', the god of the seas, was considered of paramount importance if one was to remain in his favour and to avoid bad weather or accident. Thus, for Rawiri his grandfather's expression holds great significance and wisdom. It is also pertinent to the emerging issue of noise in our oceans.

THE ISSUE

Because of the acoustic and visual properties of water sound is of great significance to marine creatures (Hildebrand, 2005). More specifically, sound travels faster and further underwater than it does in air and conversely, visible light is compromised underwater and diminished by depth, turbidity and the physical make up of salt-water. Thus, in simple terms, it is far easier and more efficient to produce and listen to sounds underwater than it is to see. The consequence of these phenomena is that sea creatures have evolved to use sound in a wide and complex array of ways. They use it for communication, for navigation, for locating food and for stunning and confusing both prey and predators alike. In particular, for large migratory species, such as the great whales that need to navigate over great distances and to locate one another, sound is fundamentally important (Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, National Research Council, 2003).

The world's oceans are far from "silent" as Jacques Cousteau described them in 1953. Ambient noise in many of the world seas and oceans (especially in the northern hemisphere) has increased by an average of 3dB per decade over the past 50 years (McDonald *et al*., 2006; 2008; Hatch and Wright, 2007). This increase is primarily due to human activities. Shipping and other marine transport, fishing activities, drilling and ocean exploration, construction and land 'reclamation', dredging and spoil dumping, military activity and tourism have all become major sources of underwater noise. Three specific additional activities have also become more commonplace. The use of explosives to assist with removal of rocks and sea-bed areas which are difficult to dredge, the use of passive low-frequency sonar by the military to detect movement of vessels (especially submarines) and the use of sonic 'air-guns' as seismic survey tools to scan for under-sea oil and gas reserves. Ambient noise levels are predicted to increase further due to the significant reduction in ocean's ability to absorb, sound a consequence of climate change induced ocean acidification. As a consequence, sound propagation distances are expected to increase by a minimum of 30% by 2050 (Hester *et al*., 2008).

MARINE MAMMALS AND SOUND

It has long been recognised that human produced under-water sound has impacts on marine mammals (Shevill, 1968) and other marine life (Banner and Hyatt, 1973). As human marine-based activities and the related sound produced have increased, concern has grown regarding potential effects on marine mammals' auditory systems. More specifically, these concerns focus on the effects on marine mammals' navigational, foraging, reproductive, and hearing capabilities (Richardson *et al.*, 1995) as well as their immune functions and overall health (Romano *et al*., 2004). Non-auditory effects of acoustic impacts (see Jepson *et al.*, 2003) are also of concern (Weilgart, 2007). For example, it is possible that noise could affect marine mammals indirectly through their prey. Fish show permanent and temporary hearing loss, stress and behavioural reactions to noise (Pearson *et al*., 1992; Engås *et al.,* 1996; McCauley *et al*., 2003; Sarà *et al*., 2007). It is argued that these impacts, particularly their cumulative, longer-term effects could

contribute to population-level declines in species viability, abundance and distribution (IFAW, 2008).

A wide range of studies have confirmed that under-water sounds associated with human activities affect marine mammals. These include: dredging and construction, oil and gas drilling, marine geophysical surveys, military and other sonar, 'pingers' and other acoustic alarms, transportation, seismic explosions and oceanographic research (for reviews see: Richardson *et al.*, 1995; Gordon *et* al., 2003; Nowacek *et al.*, 2007; Weilgart, 2007; IFAW, 2008; AEI, 2008). While it is not been empirically proven, claims have been made that a number of these activities have been associated with mass strandings of marine mammals (Jepson *et al.*, 2003; Jasny *et al*., 2005; Cox *et al.*, 2006; Parsons *et al*., 2008).

In addition to general increases in ambient noise, sound associated with specific activity, which is discrete in terms of time frame and location, is also increasing (AEI, 2008; IFAW, 2008; McDonald *et al.*, 2006). While commercial shipping is the main contributor to ambient noise, recreational watercraft and smaller commercial vessels, such as those used for whale-watching, can contribute to noise on a regional and local scale (AEI, 2008).

A number of studies have shown that cetaceans respond acoustically to noise generated by vessels in a variety of ways. These responses include changes in whistle production rates (e.g., Buckstaff 2004; Van Parijs & Corkeron 2001; Scarpaci *et al.*, 2001; Lemon *et al.*, 2006; May-Collado & Wartzok 2008); vocalisation (Finley *et al.*, 1990; Schiefele *et al.*, 2005; Holt *et al.*, 2008; signal frequency (Lesage *et al.* 1999; May-Collado & Wartzok 2008) and call duration (Lesage *et al.*, 1999; Foote *et al.* 2004; Buckstaff, 2004). Cetaceans have also been shown to increase their swimming speed and move away from the source of sound (Hastie, 1991; Evans *et al.*, 1992; Gordon *et al.*, 1992). It has also been argued that if such noise persists over a long period of time (in some cases several years), cetaceans may abandon an area altogether (e.g. Bryant *et al.*., 1984; Morton and Symonds, 2002).

There is, however, substantial variation in marine mammals' responses to underwater sound. Experiments have shown that a given level of sound can cause a wide range of responses, from no detectable change in behaviour to dramatic avoidance, cessation of feeding or reduced reproductive rates (Southall *et al.*, 2007). In addition, there are also intra- and inter-species variations as well as variability in reactions due to different physical and biological factors. For example, a number of studies have identified that reactions are influences by the volume and type of noise, vessel characteristics and the hearing capability of the animals (Watkins, 1986; Blane, 1990; Kruse, 1991; Lesage *et al.*, 1999). Au *et al.* (2007) showed that in a quiet environment harbour porpoises have a shorter range at which they can detect sound when compared with bottlenose dolphins in the same location. As a consequence, they conclude that it is more difficult for harbour porpoises to inhabit a noisy environment. Thus, the influence of sound on marine mammals is high variable and influenced by a wide range of factors.

Marine mammal tourism and sound

It is widely accepted that understanding and managing the potential impacts of human activities such as whale watching on marine mammals is critical to the long-term conservation of targeted species. Although whale-watching (any commercial tour interacting with cetaceans in the wild) is widely viewed as a viable, sustainable eco-tourism activity, research on a diverse range of species at a wide range of locations clearly identifies that whale-watching is not benign (e.g. Lusseau & Bejder, 2007). Whale-watching (with the exception of land-based observation) does have impacts on the whales or dolphins targeted and these impacts can have long-term detrimental consequences for these animals. The growing body of literature demonstrating these impacts in different locations

and with a range of species has led to some arguing that whale-watching, if not carefully managed, is another form of harmful exploitation of cetaceans (Orams, 1999).

To illustrate, over the past 20 years, the following short-term effects of tourism on cetaceans have been detected: Changes in behavioural state/activity (e.g. Nowacek *et al.*, 2001; Lusseau, 2003; Constantine *et al.*, 2004; Ribeiro *et al.*, 2005; Williams *et al.*, 2006; Stockin *et al.*, 2008); group cohesion (e.g. Bejder *et al.*, 1999; Nowacek *et al.*, 2001; Ribeiro *et al.*, 2005; Miller *et al.* 2008); dive intervals (e.g. Janik & Thompson, 1996; Nowacek *et al.*, 2001; Richter *et al.*, 2001; Lusseau, 2003; Miller *et al.* 2008); direction of travel (e.g. Goodwin & Cotton, 2004; Mattson *et al.*, 2005; Lusseau, 2006; Lemon *et al.*, 2006), and habitat use (Sorensen *et al.*, 1984; Baker & Herman, 1989; Wells, 1993; Ostman-Lind *et al.*, 2004; Lusseau, 2004, 2005; Bejder *et al.*, 2006b). Furthermore, more recent research has linked the short-term effects of tourism with long-term biological consequences for the viability and fitness of targeted animals (e.g. Lusseau, 2005; Bejder *et al.*, 2006; Lusseau *et al.*, 2006; Williams *et al.*, 2006).

This body of research has primarily concentrated on detecting changes in the targeted marine mammals' behaviour as a consequence of the approach and close proximity of tour vessels and, in some cases, tourists swimming in the water nearby. Few of these studies have focused on the specific cause of the disturbance and have tended to measure the speed, approach distance and direction and number and size of vessels. Thus, little is known about whether vessel design, propulsion type, vessel construction or other more specific variables have influence on responses of marine mammals. More specifically, while many studies have pointed to noise produced by marine mammal tour vessels as a potential influential factor, very few have quantified and tested different types and volumes of under-water sound emitted by those vessels (e.g Erbe, 2002; Buckstaff, 2004; Holt *et al.*, 2009). Furthermore, to our knowledge, no studies have specifically examined the deliberate use of sound as a mechanism to create and enhance interactions between tourists and marine mammals.

The deliberate use of underwater sound during cetacean-based tourism

In the 1970s, New Zealand diving and marine exploration pioneer Wade Doak founded an initiative he called Project Interlock (see Doak, 1981; 1988; 1993). He, his family and friends explored opportunities to view and interact with wild dolphins at sea from a sailing catamaran off the coast of northern New Zealand. In exploring these interactions Doak conducted a number of experiments in transmitting sounds to the dolphins. They used a range of mechanisms including using a bell, a whistle, playing musical instruments and broadcasting music through underwater speakers. Doak reported a variety of responses in the dolphins which he interpreted as positive reactions and while these experiments formed a part of his much wider interest in and exploration of cetacean cognitive abilities, he was positive dolphins responded to their use of music and other sound.

Doak is not alone in his attempts to explore options to interact with cetaceans, special relationships between humans and dolphins have been reported over centuries (eg. Pliny the Elder in 70 AD; Pline L'Ancien, 1955) and, in more recent times, interacting with cetaceans has become a booming commercial tourism industry (Hoyt, 2001). As cetacean-based tourism has grown in popularity, so too has the range of techniques and platforms that are used to facilitate these opportunities. 'Whale-watching' is now conducted from vessels of all types and sizes, from ocean-going cruise ships to two metre sea-kayaks. It is undertaken using aircraft, from land-based observation sites and from in the water using snorkels and masks and SCUBA diving apparatus (Orams, 1999). In order to reliably sight dolphins and whales, tour operators have taken advantage of a number of naturally occurring phenomena, such as migratory pathways, feeding, breeding and resting sites. Operators have also deliberately developed mechanisms to locate cetaceans (using spotting air-craft, sighting networks and hydrophones) and techniques to facilitate close approaches (by feeding dolphins,

towing swimmers on 'mermaid lines' and placing swimmers in the water in close proximity to dolphins and whales) (Hoyt, 2001; Samuels *et al*., 2003).

The use of artificial underwater signals or sounds by tour operators and private recreational tourists to interact with cetaceans has also been relatively common. In particular, swim-with-dolphins tour operators have encouraged swimmers to use several techniques to "entertain" the dolphins. These include, singing, squealing, bubble-blowing, rewinding underwater cameras, tapping rings on dive masks, clicking fingers, playing with wetsuit zips and making squeaky sounds around the vessel (personal observations, both authors). The production of such sounds has not, to our knowledge, been empirically investigated with regard to its impact on the dolphins. This is surprising given the relatively common practice of tour operators encouraging tourists to participate in such activities and the widely reported concerns regarding noise pollution and its impacts on cetaceans. Perhaps the production of such sounds by tourists is considered relatively low level, intermittent and of low priority with regard to the range of other potentially harmful impacts resulting from marine mammal tourism. However, such an assumption appears dangerous when the range of impacts that have now been shown is considered.

In New Zealand the issue of tourists deliberately using sound to interact with dolphins has been elevated in priority because, over the past few years, Hector's dolphin (*Cephalorhynchus hectori hectori)* swim tour operators at Akaroa*;* (Canterbury, South Island) have been providing stones to their clients onboard their vessels and encouraging them when swimming to bring them together under the water to create sounds (clicks, bangs and rhythms). Anecdotally, tourists and their onboard guides report sustained and closer interactions between the dolphins and the swimmers. Such activities are problematic in that intuitively most tourists (and indeed many operators) assume that because it is the dolphins 'choosing' to approach and interact that there are no detrimental consequences. The 'if they don't like it they can just leave' response is common and appears rational. However, empirical evidence is clear with regard to vessel and swimmer approaches, even if avoidance is not a consequence, dolphins and whales can be detrimentally impacted by interactions with tourists. Thus, sustaining or enhancing interactions with dolphins by using artificial means such as clicking stones underwater may not be in the best interests of the dolphins. This is particularly of concern at Akaroa because the species of dolphins targeted for swimming with are Hectors dolphins. This species is endemic to New Zealand, endangered and already under significant pressure from other challenges such as by-catch mortality, declining abundance of prey and habitat degradation.

It is important, therefore, to design and undertake empirical research to assess the impacts of deliberate use of sound as a component of tourists' interactions with cetaceans. The swim-with Hectors dolphins tours at Akaroa is a good place to start and we are currently conducting such a study.

ASSESSING IMPACTS OF TOURISM-CAUSED SOUND ON MARINE MAMMALS

Conducting research on impacts of tourism on marine mammals is challenging. However, the use of innovative techniques and good study design can lead to the successful investigation of the issue (Orams, 2004). Bejder and Samuels' (2003) review of research on the impacts of tourism activities on cetaceans indicated that sound scientific evidence can be successfully gathered if a study incorporates: multiple research platforms; appropriate behavioural sampling techniques; simultaneous measurement of multiple responses; supplemented opportunistic sampling with controlled experiments; analysis of both existing and historical data (when available); and innovative technologies (e.g. acoustic tagging, remote monitoring). Thus, a variety of methods and accepted research protocols now exist for studying and assessing the impacts of cetacean-based tourism on the targeted animals.

Defining the real costs of whale-watching on targeted populations is also challenging. Not only is it difficult to determine the biological significance of impacts but it can also take decades to show an impact on the viability of targeted populations. An important consideration is whether short-term behavioural measures are suitable as indicators of long-term biologically and ecologically significant impacts (Gill *et al.*, 2001; Beale and Monaghan, 2004a).

A number of authors have argued that attention needs to be focusing on observing and measuring potential indicators of long-term tourism-induced stress (Orams, 2004; Wright *et al.*, 2007) and interpreting observed behaviours in the context of population-level consequences and, in particular, acceptable noise exposure levels (Nowacek *et al.*, 2007). It is, however, difficult to determine what specific exposure levels (i.e. thresholds) might result in behavioural avoidance or displacement and, therefore to specify what noise levels are acceptable (Nowacek *et al.*, 2007). Nevertheless, it is important to establish baseline data on background noise. This will allow an assessment of changes in cetacean behaviour and an analysis of potential correlations between noise level changes and behavioural changes (Lemon *et al.*, 2006).

Detailed monitoring and measurement of animal behavioural responses and ambient noise exposure levels could help resolve many questions about short-term reactions (Erbe, 2002; Nowacek *et al.*, 2007). Tag/telemetry systems could also help gather data on behaviour/stress when underwater and noise level at an individual's specific location (Nowacek *et al*., 2007; AEI, 2008). Sound propagation and impact assessment models could be developed to identify scenarios where noise impacts could be significant (Erbe, 2002; Nowacek *et al.*, 2007). Models could include zone of audibility, masking and responsiveness; exposure levels and likelihood of auditory injury (Erbe, 2002; Holt, 2008). Erbe and Farmer (2000a) created, for example, a software model to estimate zones of impact on cetaceans around anthropogenic noise.

While there are a variety of tools for researchers to explore the impacts of sound resulting from marine mammal tour operations, the lack of basic knowledge about most targeted populations inhibits researchers' abilities to inform management regarding suitable policies to minimise impacts.

MANAGEMENT OF THE INDUSTRY, A WAY FORWARD?

The management of the exponential growth of the whale-watching industry has been a challenge (e.g. Lusseau, 2004; Evans *et al.*, 2008). Although the potential impacts of the industry have been widely flagged, the success (or otherwise) of management regimes to minimise such impacts has not been addressed to the same degree (Higham *et al.*, 2009). Casagrandi and Rinaldi (2002, p 1), for example, argued "that it is difficult, if not impossible, to formulate policies that guarantee that tourism can be maintained for a long time without severely impacting on the environment".

One of the difficulties is to translate observed impacts into effective management guidelines which can minimise or eliminate those impacts. Furthermore, while research may demonstrate short-term effects, it may not be possible to determine whether these effects will result in long-term biologically significant impacts on the observed population (Wright, 2006). Further challenges are related to the difficulties inherent in research on marine mammals, namely whether claimed behavioural responses to disturbance have been interpreted correctly (e.g. Gill *et al.*, 2001; Beale and Monaghan, 2004b; Bejder *et al.*, 2006).

Another problem is that related to the huge variation in management regimes currently being applied around the world. These range from no guidelines or regulation at all to highly regulated, government licensed industries. This variability is inconsistent and highly fragmented (Garrod and

Fennel, 2004). But are management measures effective? Research needs to help and guide managers a) to mitigate harassment and disturbance both in the short and long-term and b) to decide what options really do work. Thus far what is emerging is that voluntary and industry led codes of conduct have limited success (e.g. Scarpaci *et al.*, 2003, 2007; Constantine *et al.*, 2004; Lusseau, 2005; Allen *et al*., 2007; Wiley *et al*., 2008). In addition, even when regulations do exist, there are significant challenges in their implementation, especially in their consistent application and enforcement (Orams, 2004).

As a consequence of the growing recognition of the effects of whale-watching, there has been a push for a shift in attitudes towards management so that the onus of proof is placed on the industry itself to demonstrate it is environmentally sustainable (Mangel *et al.* 1996; Bejder *et al*., 2006b). The precautionary principle is increasingly being advocated as a fundamental basis which should under-pin management regimes for marine mammal tourism in the face of uncertainty (e.g. Principle 15 of the UNCED 1992 – The Rio Declaration). However, Heazle (2006) used the example of the IWC and argued that while the precautionary principle has its benefits, its vagueness (how much precaution is enough) and its openness to interpretation can also result in its application creating, instead of limiting, risks and uncertainty.

Higham *et al.* (2009) identified a lack of a comprehensive integrated management framework for marine mammal tourism and, as a result, proposed an integrated and adaptive management model. They claim that this model not only addresses the current shortcomings in the long-term sustainable management of the whale tourism industry (Higham and Bejder, 2008), but it also responds to the growing recognition of the role of scientists in helping managers to achieve sustainability. They argue that decision analysis models, for example, can be used to investigate the consequences of various management policies to assess the environmental and economic risks incurred when establishing those policies (Lusseau, 2004). Regions where such models can be applied could be used as a baseline for other areas where data on impact assessment is unavailable (e.g. where whale-watching is about to be developed).

In considering this approach to marine mammals' responses to noise levels, there is limited data available and, as a consequence, little to guide management decisions. Wright *et al.* (2007) proposed that the adaptive management of noise impacts could be linked with well-planned long-term studies that take into account uncertainties about the population level impacts of noise on the targeted species. They recommended careful extrapolation of data from other species. The monitoring of ambient noise levels and the use of noise impact assessment models (eg. Erbe, 2002) could also help develop effective mitigation measures.

An alternate approach related to mitigation of potential risk of harm could be used. If it is accepted that minimizing under-water noise is an important objective, then research effort can be directed at measuring sources of noise and devising means of mitigating their effects. More specifically, if we are able to understand the frequency, timing and significance of the use of sound by the marine mammals targeted for tourism we could deliberately seek to reduce the amount of sound produced by tourism operations at those frequencies, at those times and in those locations. For example, we can, through research, gain an understanding of the frequency of communication whistles and clicks from dolphins at a particular location. We can also learn through research when and where these sounds are used for particular tasks, such for foraging. If we understand this we can restrict tourist activity at particular times and in particular locations so as to minimise potential disturbance to the targeted marine mammals.

This kind of approach to research is potentially more cost effective and more likely to mitigate negative impacts on the targeted marine mammals. What we are advocating here is that rather than direct research effort at quantifying and demonstrating an impact and then advocating for

management change, we should direct our research effort at minimising any potential effect through a sound understanding of the needs of the marine mammal. This kind of approach is consistent with the precautionary principle and well suited to an adaptive management type of approach. To give specific examples of how this could work in practice: If we know a particular location and time of day is important for resting then we should ban tourism activity from that location at that time. Conversely, if we know that a particular location and time is typically used for social interaction then let's permit the tourism activity to occur at that place and at that time. Similarly, if we know that a particular species uses a certain frequency range for communication then we should ensure that tour vessels do not emit sounds at that frequency range or at a volume that masks such communication.

Current approaches to managing marine mammal tourism have concentrated on such issues as restricting numbers of vessels, minimum approach distances, maximum approach speeds and approach direction. In considering the potential impacts of sound (deliberate or otherwise) on marine mammals it seems likely that a similar kind of approach will be taken. That is, management will attempt to control vessel types, require certain propulsion systems and ban or curtail the deliberate use of sound. Such an approach seems to us to perpetuate a management model that has not been overly successful in reducing the impacts of marine mammal tourism to date. What we are advocating is that rather than scientists being required to 'prove' tourism activities negatively impact targeted marine mammals before management is designed to address the issue, an alternate approach is needed. Namely, we accept that we need to do all we can to minimise the potential impacts that vessels, tour operations and the sounds they produce can have. Research effort at designing quieter vessels and other actions intended to minimise under-water noise must be a better way forward.

CONCLUSION

For Maori in Aotearoa/New Zealand a number of important concepts are central to their worldview (Cheung, 2008). 'Kaitiakitanga' is the expression which is used to describe the duty of care or responsibility that Maori consider central to their relationship with nature. Translated it means guardianship or stewardship and it implies that there are values (kaupapa) and codes of behaviour (tikanga) that guide this relationship. For Maori, nature and other living things as well as ancestors and spirits and the world are connected and interdependent. This paradigm is not unusual in indigenous cultures (for example, the spirit of ubuntu of the Xhosa of Southern Africa) and it closely aligns with ecological principles of interconnectedness. The wisdom of these approaches is important with regard to the issue of noise. On its own, noise can be viewed as a relatively transient and, perhaps discrete issue for marine resource management. It is not as tangible as extractive activities such as fisheries and whaling. It does not appear to as inherently harmful as dumping, oil spills or dredging. It is, however, one of those chronic insidious human-made influences that can compromise the integrity and viability of the whole. For Maori it can be viewed as an insult to Tangaroa (the god of the sea). It is a potential exploitation of their 'taonga' (culturally significant treasure) and a compromise to their wairuatanga (spirituality).

At the presentation we attended in Tamaki-makau-rau (Auckland), marine acoustics expert Dr Chris Clark graphically and convincingly presented data that showed the scale of the problem of ocean noise. It was sobering and disturbing, but what was more striking was the reaction and korero (speech) of Rawiri Paratene afterwards. It was obvious to us in the audience that he, as Maori, felt deeply insulted by the growing impacts that ocean noise was having. More significant than this, he expressed that he felt diminished by human-kinds collective actions in both producing these sounds and our inaction with regard to trying to reduce them. He expressed, on our behalf, a common deep-seated reaction within each of us present which re-emphasized the great dilemma and challenge:

How do we manage our use of marine environments so that we do not diminish the special values and significance they have for all of us, human, non-human - those who have gone before us - and those who will come after?

REFERENCES

AEI (2008). The Acoustic Ecology Institute Special Report: Ocean Noise 2008. Science, Policy, Legal Developments. Santa Fe, USA: The Acoustic Ecology Institute.

Allen, S., Smith, H., Waples, K., & Harcourt, R. (2007). The voluntary code of conduct for dolphin watching in Port Stephens, Australia: is self-regulation an effective management tool? Journal of Cetacean Research and Management, 9(2), 159-166.

Au, W. W. L., Benoit-Bird, K. J., & Kastelein, R. A. (2007). Modeling the detection range of fish by echolocating bottlenose dolphins and harbor porpoises. The Journal of the Acoustical Society of America, 121(6), 3954-62.

Baker, C. S., & Herman., L. M. (1989). Behavioral responses of summering humpback whales to vessel traffic: experimental and opportunistic observations. U.S. National Park Service.

Banner, A. & Hyatt, M. (1973). Effects of noise on eggs and larvae of two estuarine fishes. Transactions of the American Fisheries Society, 1, 134 -136.

Beale, C. M., & Monaghan, P. (2004). Behavioural responses to human disturbance: A matter of choice? Animal Behaviour, 68, 1065-1069.

Bejder, L., & Samuels, A. (2003). Evaluating the effects of nature-based tourism on cetaceans. In N. Gales, M. Hindell & R. Kirkwood (Eds.), Marine mammals: fisheries, tourism and management issues. CSIRO Publishing, 229-256 pp.

Bejder, L., Dawson, S. M., & Harraway, J. A. (1999). Responses by Hector's dolphins to boats and swimmers in Porpoise Bay, New Zealand. Marine Mammal Science, 15(3), 738-750.

Bejder, L., Samuels, A., Whitehead, H., & Gales, N. (2006a). Interpreting short-term behavioural responses to disturbance within a longitudinal perspective. Animal Behaviour, 72, 1149-1158.

Bejder, L., Samuels, A., Whitehead, H., Gales, N., Mann, J., Connor, R., Heithaus, M., Watson-Capps, J., Flaherty, C., & Krützen, M. (2006b). Decline in the relative abundance of bottlenose dolphins exposed to long-term disturbance. Conservation Biology, 20(6), 1791-1798.

Blane, J. (1990). Avoidance and interactive behaviour of the St. Lawrence Beluga Whale (Delphinapterus leucas) in response to recreational boating. Ontario: University of Toronto.

Buckstaff, K. C. (2004). Effects of watercraft noise on the acoustic behavior of bottlenose dolphins, Tursiops truncatus, in Sarasota Bay, Florida. Marine Mammal Science, 20(4), 709-725.

Bryant, P.J., Lafferty, C.M. & Lafferty, S.K. (1984). Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by gray whales. In: M.L. Jones, S.L. Swartz and S. Leatherwood (eds.). The Gray Whale Eschrichtius robustus. (pp 375-387). Academic Press, Inc., Orlando, Florida.

Casagrandi, R., & Rinaldi, S. (2002). A Theoretical Apporach to Tourism Sustainability. Conservation Ecology, 6(1), 13-27.

Cheung, M. (2008). The reductionist – holistic worldview dilemma. MAI Review, 3, Research Note 5. http://www.review.mai.ac.nz retrieved 16 March 2009.

Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals, National Research Council, 2003 Ocean Noise and Marine Mammals. The National Academies Press, http://www.nap.edu/catalog.php?record_id=10564#description retrieved 9 March 2009.

Constantine, R., D.H. Brunton, T. Dennis (2004). Dolphin-watching tour boats change bottlenose dolphin (Tursiops truncatus) behaviour. Biological Conservation, 117, 299-307.

Cousteau, J.Y. & Dumas, F. (1953). The silent world. New York: Harper.

Cox, T. M., Ragen, T. J., Read, A. J., Vos, E., Baird, et al. (2006). Understanding the impacts of anthropogenic sound on beaked whales. Journal of Cetacean Research and Management, 7(3), 177 - 187.

Doak, W. (1981). Dolphin, dolphin. Auckland, New Zealand: Hodder and Stoughton, 245 pp.

Doak, W. (1988). Encounters with whales and dolphins. Auckland: Hodder and Stoughton.

Doak, W. (1993). Swimming with dolphins in New Zealand. Auckland, New Zealand: Hodder and Stoughton.

Engås, A., Løkkeborg, S., Ona, E. & Soldal, A.V. (1996). Effects of seismic shooting on local abundance and catch rates of cod (Gadus morhua) and haddock (Melanogrammus aeglefinus). Canadian Journal of Fisheries and Aquatic Sciences, 53, 2238-2249.

Erbe, C. (2002). Underwater noise of whale-watching boats and potential effects on killer whales (Orcinus orca), based on an acoustic impact model. Marine Mammal Science, 18(2), 394-418.

Erbe, C., & Farmer, D. M. (2000). A software model to estimate zones of impact on marine mammals around anthropogenic noise. The Journal of the Acoustical Society of America 108(3 Pt 1), 1327-1331.

Evans, P. G. H., Canwell, P. J. & Lewis, E. J.. (1992). An experimental study of the effects of pleasure craft noise upon bottle-nosed dolphins in Cardigan Bay, West Wales. In P. G. H. Evans (ed.). European research on cetaceans. (pp 43–46). European Cetacean Society, Cambridge.

Evans, P. G. H., Panigada, S., & Pierce, G. J. (2008). Integrating science and management for marine mammal conservation. Journal of the Marine Biological Association of the United Kingdom 88(6), 1081-1083.

Finley, K.J., Miller, G.W., Davis, R.A. & Greene, C.R. (1990). Reactions of belugas, Delphinapterus leucas , and narwhals, Monodon monoceros , to ice-breaking ships in the Canadian High Arctic. In T.G. Smith, D.J. St. Aubin & J.R. Geraci (eds.), Advances in research on the beluga whale, Delphinapterus leucas, (p97-117). Canadian Bulletin of Fisheries and Aquatic Sciences, 224.

Foote, A. D., Osborne, R. W., & Hoelzel, A. R. (2004). Whale-call response to masking boat noise. Nature, 428, 910.

Garrod, B., & Fennell, D. A. (2004). An analysis of whalewatching codes of conduct. Annals of tourism research, 31(2), 334-352.

Gill, J. A., Norris, K. S., & Sutherland, W. J. (2001). Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation, 97, 265-268.

Goodwin, L., & Cotton, P. A. (2004). Effects of Boat Traffic on the Behaviour of Bottlenose Dolphins (Tursiops truncatus). Aquatic Mammals, 30(2), 279-283.

Gordon, G., Leaper, R., Hartley, F. G., & Chappell, O. (1992). Effects of whale-watching vessels on the surface and underwater acoustic behaviour of sperm whales off Kaikoura, New Zealand. Science and Research Series. Wellington, New Zealand: New Zealand Department of Conservation.

Gordon, J., Gillepsie, D., Potter, J., Frantzis, A., Simmonds, M.P., Swift, R. & Thompson, D. (2003). A review of the effects of seismic surveys on marine mammals. Marine Technology Society Journal, 37 (4), 16-34.

Hatch, L.T. & Wright, A.J. (2007). A Brief Review of Anthropogenic Sound in the Oceans. International Journal of Comparative Psychology, 20, 121-133.

Heazle, M. (2006). Lessons in precaution: The International Whaling Commission experience with precautionary management. Marine Policy, 30, 496 - 509.

Hester, K.C., Peltzer, E.T., Kirkwood, W.J. & Brewer, P.G. (2008). Unanticipated consequences of ocean acidification: A noisier ocean at lower pH. Geophysical Research Letters, 35, L19601.

Higham, J. E. S., & Bejder, L. (2008). Managing Wildlife-based Tourism: Edging Slowly Towards Sustainability? Current Issues in Tourism, 11(1), 75-83.

Higham, J. E. S., Bejder, L., & Lusseau, D. (2008). An integrated and adaptive management model to address the long-term sustainability of tourist interactions with cetaceans. Environmental Conservation, 35(4), 294-302.

Hildebrand, J. A. (2005). Impacts of anthropogenic sound. In J. E. Reynolds, III, W. F. Perrin, R. R. Reeves, S. Montgomery, & T. J. Ragen (Eds.), Marine Mammal Research: Conservation Beyond Crisis (pp. 101-124). Baltimore: Johns Hopkins University Press

Holt, M. M., Noren, D. P., Veirs, V., Emmons, C. K., & Veirs, S. (2009). Speaking up: Killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. Journal of the Acoustical Society of America, 125(1), EL27-EL32.

Hoyt, E. (2001). Whale Watching 2001-Worldwide Tourism Numbers, Expenditures and Expanding Socioeconomic Benefits. International Fund for Animal Welfare (IFAW) and the United Nations Environmental Program (UNEP), Welfare, Yarmouth Port, MA, USA.

IFAW (2008). Ocean Noise: Turn it down. A report on ocean noise pollution. IFAW.

IWC (2004). Workshop on the Science for Sustainable Whalewatching. Cape Town: International Whaling Commission.

Janik, V. M., & Thompson, P. M. (1996). Changes in the surfacing patterns of bottlenose dolphins in response to boat traffic. Marine Mammal Science, 12(4), 597-602.

Jasny, M., Reynolds, J., Horowitz , C. & Wetzler, A. (2005). Sounding the Depths II: The rising toll of sonar, shipping and industrial ocean noise on marine life. A Natural Resources Defense Council.

Jepson, P.D., Arbelo, M., Deaville, R., Patterson, I.A.P., Castro, P., Baker, J.R., Degollada, E., Ross, H.M., Herraez, P., Pocknell, A.M., Rodriguez, F., Howiell, F.E., Espinosa, A., Reid, R.J., Jaber, J.R., Martin, V., Cunningham, A.A. & Fernández, A. (2003). Gas-bubble lesions in stranded animals: Was sonar responsible for a spate of whale deaths after an Atlantic military exercise? Nature, 425(6958), 575-76

Kruse, S. (1991). The interactions between killer whales and boats in Johnstone Strait, B.C. In K. Pryor & K. S. Norris (Eds.), Dolphin societies: Discoveries and puzzles (pp 149-159). Berkeley: University of California Press.

Lemon, M., Lynch, T. P., Cato, D. H., & Harcourt, R. G. (2006). Response of travelling bottlenose dolphins (Tursiops aduncus) to experimental approaches by a powerboat in Jervis Bay, New South Wales, Australia. Biological Conservation, 127(4), 363-372.

Lesage, V., Barrette, C., Kingsley, M. C. S., & Sjare, B. (1999). The effect of vessel noise on the vocal behavior of Belugas in the St. Lawrence River estuary, Canada. Marine Mammal Science, 15(1), 65-84.

Lusseau, D. (2003a). Male and female bottlenose dolphins Tursiops spp. have different strategies to avoid interactions with tour boats in Doubtful Sound, New Zealand. Marine Ecology Progress Series, 257, 267–274.

Lusseau, D. (2003b). Effects of tour boats on the behavior of bottlenose dolphins: Using Markov chains to model anthropogenic impacts. Conservation Biology, 17(6), 1785-1793.

Lusseau, D. (2004a). Directions in the scientific aspects of whale watching management. (p. 8): Paper submitted to the IWC workshop on the science for sustainable whalewatching.

Lusseau, D. (2004b). The hidden cost of tourism: Detecting long-term effects of tourism using behavioral information. Ecology and Society, 9(1), 15p.

Lusseau, D. (2005a). Residency pattern of bottlenose dolphins Tursiops spp. in Milford Sound, New Zealand, is related to boat traffic. Marine Ecology-Progress Series, 295, 265-272.

Lusseau, D. (2005b). The state of the scenic cruise industry in Doubtful Sound in relation to a key natural resource: bottlenose dolphins. In M. Hall & S. Boyd (Eds.), Nature-based Tourism in Peripheral Areas: Development or Disaster? (pp 246-262) London: Channelview Publications.

Lusseau, D., & Higham, J. E. S. (2004). Managing the impacts of dolphin-based tourism through the definition of critical habitats: The case of bottlenose dolphins (Tursiops spp.) in Doubtful Sound, New Zealand. . Tourism Management, 25, 657-667.

Lusseau, D. & Bejder, L. (2007). The Long-term Consequences of Short-term Responses to Disturbance Experiences from Whalewatching Impact Assessment. International Journal of Comparative Psychology, 2007 (20), 228-236.

Lusseau, D., Lusseau, S. M., Bejder, L., & Williams, R. (2006). An individual-based model to infer the impact of whalewatching on cetacean population dynamics. International Whaling Commission. SC/58/WW7.

McCauley, R. D., Fewtrell, J. & Popper, A. N. (2003). High intensity anthropogenic sound damages fish ears. Journal of the Acoustical Society of America, 113,638–642.

McDonald, M.A., Hildebrand, J.A. & Wiggins, S.M. (2006). Increases in deep ocean ambient noise in the Northeast Pacific west of San Nicolas Island, California. Journal Acoustical Society of America, 120(2), 711-718.

McDonald, M.A., Hildebrand, J.A., Wiggins, S.M., Ross, D. (2008). A 50 year comparison of ambient noise near San Clemente Island: a bathymetrically complex coastal region off Southern California. Journal of the Acoustical Society of America, 124(4), 1985-1992.

Mangel, M., Talbot, L. M., Meffe, G. K., Agardy, M. T., Alverson, D. L., et al. (1996). Principles for the conservation of wild living resources. Ecological Applications, 6(2), 338-362.

Mattson, M. C., Thomas, J. A., & St. Aubin, D. (2005). Effects of Boat Activity on the Behavior of Bottlenose Dolphins (Tursiops truncatus) in Waters Surrounding Hilton Head Island, South Carolina. Aquatic Mammals, 31(1), 133-140.

May-Collado, L. J., & Wartzok, D. (2008). A comparison of bottlenose dolphin whistles in the atlantic ocean: factors promoting whistle variation. Journal of Mammalogy, 89(5), 1240-1240.

Miller, L. J., Solangi, M., & Kuczaj II, S. A. (2008). Immediate response of Atlantic bottlenose dolphins to high speed personal watercraft in the Mississippi Sound. Journal of the Marine Biological Association of the United Kingdom, 88(6), 1139-1143.

Morton, A.B. & Symonds, H.K. (2002) Displacement of Orcinus orca (L.) by high amplitude sound in British Columbia, Canada. ICES Journal of Marine Science, 59, 71-80.

Nowacek, D. P., Thorne, L. H., Johnston, D. W., & Tyack, P. L. (2007). Responses of cetaceans to anthropogenic noise. Mammal Review, 37(2), 81 - 115.

Nowacek, S. M., Wells, R. S., & Solow, A. R. (2001). Short-term effects of boat traffic on bottlenose dolphins, Tursiops truncatus, in Sarasota Bay, Florida. Marine Mammal Science, 17(4), 673-688.

Orams, M. B. (1999). The economic benefits of whale watching in Vava'u, the Kingdom of Tonga. North Shore, Auckland, New Zealand: Centre for Tourism Research, Massey University at Albany.

Orams, M. B. (2004). Why do dolphins get ulcers: Considering the impacts of cetacean based tourism in New Zealand. Journal of Tourism in Marine Environments, 1, 17-28.

Ostman-Lind, J., Driscoll-Lind, A., & S.H., R. (2004). Delphinid abundance, distribution and habitat use off the western coast of the Island of Hawaii. A NMFS Southwest Fisheries Science Center Administrative Report.

Parsons, E.C.M., Dolman, S.J.; Wright, A.J., Rose, N.A. & Burns, W.C.G. (2008). Navy sonar and cetaceans: Just how much does the gun need to smoke before we act? Marine Pollution Bulletin, 56(7), 1248-1257.

Pavan, G. (2002). Effects of underwater noise on marine mammals. Bulletin ACCOBAMS, 4(February), 11-14.

Pearson, W. H., Skalski, J. R. & Malme, C. I. (1992). Effects of sounds from a geophysical survey device on behavior of captive rockfish (Sebastes spp.). Canadian Journal of Fisheries and Aquatic Sciences, 49, 1343–1356.

Pline L'Ancien. (1955). Histoire Naturelle, Livre IX, French translation by E. de Saint-Denis. Société d'Edition les Belles Letters. Paris : Collection des Universités de France.

Ribeiro, S., Viddi , F. A. & Freitas, T. R. O. (2005). Behavioural responses by Chilean dolphins (Cephalorhynchus eutropia) to boats in Yaldad bay, Southern Chile. Aquatic Mammals, 31(2), 234-242.

Richardson, W. J., Green Jr, C. R., Malme, C. I., & Thomson, D. H. (1995). Marine mammals and noise. London: Academic Press.

Richter, C., Dawson, S., & Slooten, E. (2006). Impacts of commercial whale watching on male sperm whales at Kaikoura, New Zealand Marine Mammal Science, 22(1), 46 - 63.

Romano, T. A., Keogh, M. J., Kelly, C., Feng, P., Berk, L., Schlundt, C. E., Carder, D. A., & Finneran, J. J. (2004). Anthropogenic sound and marine mammal health: measures of the nervous and immnue systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Sciences, 61(7), 1124-1134.

Sarà, G., Dean, J.M., D'Amato, D., Buscaino, g., Oliveri, S., Genovese, S., Ferro, S., Buffa, G., Lo Martire, M. & Mazzola, S. (2007). Effect of boat noise on the behaviour of bluefin tuna Thunnus thynnus in the Mediterranean Sea. Marine Ecology Progress Series, 331, 243-253.

Samuels, A., Bejder, L., Constantine, R., & Heinrich, S. (2003). Swimming with wild cetaceans in southern hemisphere. In N. Gales, M. Hindell & R. Kirkwood (Eds.), Marine mammals: Fisheries, tourism and management issues. (pp 265-291). Victoria, Australia: CSIRO Publishing.

Scarpaci, C., Bigger, S. W., Corkeron, P. J., & Nugegoda, D. (2001). Bottlenose dolphins (Tursiops truncatus) increase whistling in the presence of "swim-with-dolphin" tour operations. Journal of Cetacean Research and Management, 2(3), 183-185.

Scarpaci, C., Dayanthi, N. & Corkeron, P.J. (2003). Compliance with regulations by "Swim-with-dolphins" operations in Port Phillip Bay, Victoria, Australia, Environmental Management, 31, 342–347

Scheifele, P. M., Andrew, S., Cooper, R. A., Darre, M., Musiek, F. E., & Max, L. (2005). Indication of a Lombard vocal response in the St. Lawrence River beluga. Acoustical Society of America Journal, 117(3), 1486-1492.

Schevill, W. E. (1968). Quiet power whaleboat. Journal of the Acoustical Society of America, 44, 1157-1158.

Sorensen, P.W., Medved, R.J., Hyman, M.A.M. & Winn, H.E. (1984). Distribution and abundance of cetaceans in the vicinity of human activities along the continental shelf of the northwestern Atlantic. Marine Environmental Research, 12, 69–81.

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene Jr., C. R., Kastak, D., Ketten, D. R., Miller, J. H., Nachtigall, P. E., Richardson, W. J., Thomas, J. A., & Tyack, P. L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Special Issue of Aquatic Mammals, 33(4), 412-522.

Stockin, K. A., Lusseau, D., Binedell, V., Wiseman, N., & Orams, M. B. (2008). Tourism affects the behavioural budget of the common dolphin Delphinus sp. in the Hauraki Gulf, New Zealand. Marine Ecology Progress Series, 355, 287-295.

Van Parijs, S. M., & Corkeron, P. (2001). Boat traffic affects the acoustic behaviour of Pacific humpback dolphins, Sousa chinensis. Journal of the Marine Biological Association of the United Kingdom, 81(3), 533-538.

Watkins, W. A. (1986). Whale reactions to human activities in Cape Cod waters. Marine Mammal Science, 2(4), 251-262.

Weilgart, L.S. (2007). The impacts of anthropogenic ocean noise on cetaceans and implications for management. Canadian Journal of Zoology, 85, 1091–1116.

Wiley, D. N., Moller, J. C., Pace, R. M., & Carlson, C. (2008). Effectiveness of Voluntary Conservation Agreements: Case Study of Endangered Whales and Commercial Whale Watching. Conservation Biology, 22(2), 450-457.

Williams, R., Lusseau, D., & Hammond, P. S. (2006). Potential energetic cost to killer whales of disturbance by vessels and the role of a marine protected area. Biological Conservation, 133, 301-311

Williams, R., Bain, D. E., Ford, J. K. B., & Trites, A. W. (2002). Behavioural responses of male killer whales to leapfrogging vessel. Journal of cetacean research and management, 4(3), 305-310.

Wright, A. J. (2006). A review of the NRC's 'Marine mammal populations and ocean noise: determining when noise causes biologically significant effects' Report. Journal of International Wildlife Law and Policy, 9, 91-99.

Wright, A. J., Aguilar Soto, N., Baldwin, A. L., Bateson, M., Beale, C., et al. (2007). Anthropogenic noise as a stressor in animals: A multidisciplinary perspective. International Journal of Comparative Psychology, 20, 250-273.