Tourism in Marine Environments, Vol. 19, Nos. 3/4, pp. 147–158
Printed in the USA.

1544-273X/25 $60.00 + .00
DOI: https://doi.org/10.3727/216901925X17364076067648
E-ISSN 2169-0197
www.cognizantcommunication.com

This article was originally published in Volume 1, Number 1, pages 17–28, 2004

WHY DOLPHINS MAY GET ULCERS: CONSIDERING THE IMPACTS OF CETACEAN-BASED TOURISM IN NEW ZEALAND[1]

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The growth of tourism based upon cetaceans (whales, dolphins, and porpoises) has been relatively recent—but spectacular. Thus, these marine mammals have now become valuable as a tourism resource. Accompanying this growth are concerns regarding the potential impacts on "target" species. In New Zealand, marine mammal tourism has grown rapidly and a variety of studies have shown that dolphins and whales are affected by these activities. However, these impacts vary greatly with the species, location, and type of tourism activity. Thus, these studies show, not surprisingly, that generic management regimes are seldom appropriate. It can be concluded from what has been learned in the New Zealand situation that sound management of marine mammal tourism must be based on solid research that provides information regarding the needs and sensitivities of specific species and particular locations. A conservative approach is essential given the difficulties in accurately assessing the long-term implications of this growing industry for cetaceans.

Key words: Cetaceans; Dolphins; Whale watching; Ecotourism; Stress

Introduction

The rapid growth of whale and dolphin watching as a tourism activity over the past decade has been widely reported in the literature (e.g., Baxter, 1993; Beach & Weinrich, 1989; Duffus, 1996; Duffus & Dearden, 1993; International Fund for Animal Welfare, 1995; Orams, 1997a). Whale and dolphin watching now takes place in every continent and from countries as diverse as Argentina, South Africa, Japan, Norway, New Zealand and Tonga. Hoyt's (2000) review of the industry illustrates its spectacular growth. He claims that in 1983 whale and dolphin watching occurred in only 12 countries, but by 1995 it had expanded to 295 communities and 65 countries and that by 1998 nearly 500 communities and almost 100 countries or territories were involved in dolphin- and whale-based tourism. He also estimates that the worldwide economic impact derived from whale- and dolphin-watching activities in 1998 totaled more than US$1 billion. As a consequence, there appears to be widespread optimism about the

[1]Title derived from Robert Sapolsky's (1994) *Why Zebras Don't Get Ulcers. A Guide to Stress, Stress Related Diseases, and Coping*.
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future potential of this industry and predictions are that it will continue this rapid growth rate (Hoyt, 2000).

Many view whale and dolphin watching as viable, sustainable "ecotourism" and a more desirable "use" of these animals than the lethal harvesting of them for products (International Fund for Animal Welfare, 1995). However, there is widespread concern about the impacts that tourism activities have on whales and dolphins (Beach & Weinrich, 1989; Forestell & Kaufman, 1990; Jeffery, 1993; International Fund for Animal Welfare, 1995; Phillips & Baird, 1993). Many of the species of whales and dolphins that are popular for tourism are classified as endangered, and the potential for disturbance of their natural behavioral patterns has attracted much research effort in recent times. Examples include Baker and Herman (1989), Briggs (1991), Corkeron (1995), DeNardo (1996), and Gordon, Leaper, Hartley, and Chappell (1992). Some of this research has suggested that close approach by tourist boats for watching and, in some cases, swimming with dolphins and whales, has altered the behavior of the animals and it has been suggested that this could be detrimental (Beach & Weinrich, 1989). This has lead to the view that the "use" of whales and dolphins as a tourist attraction could be seen as another form of harmful exploitation of these marine mammals (Orams, 1999).

While whale watching worldwide has a history that dates back to the 1960s, the growth of whale watching in New Zealand is relatively recent. Watching sperm whales in Kaikoura (the only location where exclusively whale-based tourism operations exist in New Zealand) did not start until 1987 (Donoghue, 1996). The 1990s saw the advent of dolphin watching and swimming with dolphins at a wide variety of locations in New Zealand. Internationally, dolphin-based tourism has been less significant and has a shorter history than whale watching. New Zealand, however, has been at the forefront of the development of this new tourism industry. The first permit was issued in the late 1980s and by June 2001 75 permits had been issued (Neumann, 2001). The New Zealand Tourism Board (1996) estimated that 14% of visitors to New Zealand (currently estimated at 2 million visitors per annum) participated in dolphin-watching and -swimming activities. Similarly, there are now large numbers of private recreational boats operated by New Zealanders who seek to watch and interact with dolphins in the wild (personal observation). Thus, in New Zealand, there is an "ecotourism" industry that has grown rapidly and that potentially can cause significant impacts on the natural attraction. More significantly, as Constantine (1999a) points out:

> We know little about the long-term, or even short-term, effects of humans interacting with marine mammals in the wild. More specifically, issues such as the impacts of noise produced by vessels, boat handling practices, numbers and proximity of boats and humans, effects of swimmers in the water, continual disturbance versus sporadic disturbance, differences in responses of different species, age classes, sexes, individuals, or seasonal changes are not known. Research, therefore, has an important role in the future management of this industry. (p. 8)

Unfortunately, as is often the case in the development of ecotourism, research on impacts has occurred after the industry has become established. Recently, however, there have been a number of important studies completed that have provided valuable information regarding the impacts of tourism practices on specific species in New Zealand. This article will provide a brief review of these studies and consider the implications of their results for management. This review is preceded by a consideration of the challenges inherent in the study of small cetaceans. This is necessary to understand the context of the findings of impact studies and has important implications for the future research and management priorities proposed later in this article.

Research on Impacts

Challenges in Studying Cetaceans

The key challenge in studying cetaceans in the wild is that they are wide ranging and that they spend the great majority of their lives under water. In addition, cetacean populations are complex and dynamic; individuals are usually difficult to recognize; and their behavior is often subtle and always multifaceted and contextual (Mann, 2000). An accurate analogy is that cetacean behavioral ecologists are attempting to create or visualize a complete picture from only a few small pieces of the puzzle. When you add the considerable challenges provided by weather, waves, and working from small boats (of-

ten far from shore), this kind of research requires considerable determination. Fortunately, there have been a number of individuals who have persisted despite these challenges and who have contributed to a growing understanding of accepted research protocols and methods that render useful results (Mann, Connor, Tyack, & Whitehead, 2000). However, while methods have advanced significantly over the past three decades and understanding of the behavioral ecology of a variety of species has increased (Perrin, Würsig, & Thewissen, 2002), difficulties in interpreting what is observed remains. With regard to assessing the impacts of tourism, one of the greatest problems is determining cause and effect.

Cause and Effect Issues

Because cetacean behavior is complex and dynamic, and also because observation of behavior is difficult, determining the causal factors that drive observed behavior is problematic. Most often researchers infer or make an estimate of the probable cause on the basis of experience with the species (both their own and others reported in literature), and on the basis of context and repetition. Thus, for example, if repeated and coordinated movement away from a vessel that is attempting to approach dolphins closely is observed, it is inferred that dolphins are attempting to flee from the vessel and that the vessel is the cause of this behavior. However, most observable behavior is seldom as obvious or uniform. Movement, for example, is not always coordinated amongst a group. Within a group of dolphins, some individuals may flee an approaching boat, others may be attracted to it to "bow-ride" for a period, while others may appear unaffected by the boat's presence. In another circumstance, coordinated movement away from an area where a boat is present could be due to the presence of a predator (such as a large shark) or some other factor undetected by researchers and not due to the presence of a vessel at all. Thus, it is difficult for researchers to draw conclusions about the cause of behavior with absolute confidence. This is, of course, problematic when researchers are attempting to assess the impact of tourism activities. The question, seldom able to be answered with absolute certainty, is whether the observed change in behavior would have occurred irrespective of the presence of tourism activity. These issues are further complicated by the fact that most (but not all) research on small cetaceans is carried out from a vessel—and thus the researchers themselves may influence behavior.

These challenges are not always insurmountable, however. With careful experimental design and comparison of the normal behavioral repertoire (such as through a comparison of activity budgets) with behavior when tourism activities are under way, inferences can be made regarding the impacts of those tourism activities. A growing number of studies are being reported in the literature (see later examples, this article) that demonstrate cetacean-based tourism can and often does affect the behavior of the animals targeted. However, it is important to recognize that a change in behavior as a result of tourism is not necessarily harmful.

Is Impact Always Detrimental?

Findlay (2001) draws the important distinction between a "response"—when an animal shows a reaction to the presence of vessels or swimmers (e.g., rapid movement away from a vessel), an "impact"—the resultant effect of the response (e.g., increased respiration rate), and "disturbance"—an assessment that the impact is detrimental (e.g., an observed injury resulting from a boat strike). This classification is helpful because it counters the common conclusion that any observed response by animals targeted by tourism activities is detrimental. This is often not the case. Dolphins and whales have been exposed to human activities for centuries (but at no time more so than at present). They are extremely adaptable organisms, as evidenced by the wide variety of habitats and situations where they survive in close proximity to human activities. Thus, in many situations, cetaceans have become "habituated" to human activities (i.e., they have adapted to and become tolerant of human influence) (Lockyer, 1990; Orams, 1999). Therefore, responses observed to tourism activities may be adaptive, but not necessarily detrimental.

Despite the significant challenges associated with research on wild cetaceans and tourism, a number of studies in New Zealand have recently been completed. This research provides valuable insights into the potential impacts of tourism on cetaceans. While this work seldom provides absolute answers to ques-

tions surrounding the issue of impacts, these reports represent an important first step towards improving management of this growing industry in New Zealand.

A Brief Review of Impact Studies in New Zealand

Bottlenose Dolphins (Tursiops truncatus)

Bottlenose dolphins are the most well-studied and understood cetacean (Connor, Wells, Mann, & Read, 2000). They are also the most frequently studied cetacean with regard to tourism: over half of published studies focus on this species (Richter, 2002). They are present in New Zealand in what appears to be several discrete areas: the northeast coast of the North Island (Constantine, 2002), the northern and northwestern coasts of the South Island (including the Marlborough Sounds) (Brager & Schneider, 1998), and Fiordland (southwest of the South Island) (Schneider, 1999).

Constantine's work from the Bay of Islands (1995; 1999b; 2001; 2002) has a number of important findings with regard to the impacts of tourism. First, she found that the method of placement of swimmers into the water had a significant influence on dolphin responses. When swimmers were placed in the water directly in the path of the dolphins' travel, or directly within the dolphin group while they were "milling," significantly higher rates of "avoidance" were observed than when swimmers were placed "line-abreast" (adjacent to the dolphins' path of travel). Another important finding has been that Bay of Islands' bottlenose dolphins appear to have become "sensitized" to swimmers in the water. That is, they have shown increasing levels of avoidance behavior as tourism levels have increased over time (Constantine, 2001).

Lusseau's recent work (Lusseau, 2003; Lusseau, in press; Lusseau & Higham, in press) on bottlenose dolphins in Doubtful Sound (Fiordland) also reveals disturbance as a result of tourism operations. In particular, Lusseau found that the dolphins resident in the Sound were sensitive to disturbance from vessels when the dolphins were resting or socializing.

Dusky Dolphins (Lagenorhynchus obscurus)

In New Zealand, dusky dolphins are typically found in large aggregations close to shore off the Northeastern coast of the South Island (Würsig et al., 1997). They are most reliably sighted off the town Kaikoura where the continental shelf is found close to the coast (Orams, 2002).

At Kaikoura, Yin (1999) found that dusky dolphins' "whistle rate" (underwater vocalizations) increased when swimmers entered the water close by. In addition, she reported that dusky dolphins were more active and traveled more when boats were present during the early afternoon, a time period usually used for resting by the dolphins. Barr (1997) also carried out research on dusky dolphins' reaction to tourism activities at Kaikoura. She found that they were accompanied by vessels during 72% of her observations (daylight hours, summer seasons). She observed an increase in aerial activity when vessels were present and also noted that the dolphins formed "tighter" groups (distance between individuals reduced) when boats were present during the early afternoon time period when dusky dolphins often rested.

Hector's Dolphins (Cephalorhyncus hectori)

Hector's dolphins are endemic to New Zealand and are distributed in several discrete areas, primarily around the coast of the South Island at Porpoise Bay, Southland, around the Banks Peninsula in Canterbury, and in a number of places off the West Coast. Because Hector's are a small, near-shore dwelling dolphin they do not appear to move great distances (Bejder et al., 2002). As a consequence, there appears to be little genetic interchange between these geographically separated populations (Pichler et al., 2001). Recent research has revealed that the small (<100 individuals) populations found off the West Coast of the central North Island are genetically distinct from all others and they have been designated as a separate subspecies that is vulnerable to extinction (Dawson, Pichler, Slooten, Russell, & Baker, 2001; Pichler, 2002).

Bejder's (1997) research on Hector's dolphins at Porpoise Bay, Southland, found that the dolphins used a preferred area less frequently when swimmers were present. He also found that the presence of vessels and swimmers increased the probability of the dolphins being observed in "tighter" groups (i.e., swimming in closer proximity to one another). However, dolphins were not displaced from the area

due to the presence of boats. In fact, initially they were attracted to boats (for bow-riding) but after 50–70 minutes their behavior did not appear affected by the presence of vessels.

Nichols, Stone, Hutt, Brown, and Yoshinaga (2001) found that Hector's dolphins increased their active swimming behavior with increasing numbers of boats in the Akaroa Harbour area. In the same location, Stone (1999) observed short-term changes from interacting with conspecifics (one another) to interacting with boats. Stone and Yoshinaga (2000) also reported on a potential increase in boat strike on calves that could be correlated with increasing tourism and interest in Hector's dolphins in this area.

Common Dolphins (Delphinus delphis)

Common dolphins are typically a pelagic species found in large aggregations far from shore (Gaskin, 1992). However, in New Zealand they can be found relatively close to shore off the northeastern and central eastern coasts of the North Island (Neumann, 2001) and off Kaikoura in the northeast of the South Island (Würsig et al., 1997).

Common dolphins have been examined from a tourism impact perspective for the Bay of Islands (Constantine, 1995), the Hauraki Gulf (Leitenberger, 2001), and the east coast of the Coromandel Peninsula and Bay of Plenty (Neumann, 2001). Neumann found that common dolphins typically showed patterns of initial attraction to vessels (for bow-riding) for around 10 minutes, followed by around an hour of "neutral" response (neither attracted or avoided), then avoidance. Smaller groups of dolphins exhibited avoidance behavior earlier than larger groups. Interaction with swimmers was in all cases brief (around 2 minutes) and dolphins maintained a "safety distance" (greater than 3 meters). He also found that larger groups (more than 50 dolphins) were more likely to interact with swimmers than smaller groups.

Sperm Whales (Physeter macrocephalus)

In New Zealand, sperm whales are only reliably sighted off Kaikoura (northeast coast of the South Island). At this location the continental shelf is close to shore and a bathymetric feature known as the "Kaikoura canyon" is a favored foraging location for the species (Jacquet, Dawson, & Slooten, 2000). Sperm whales at Kaikoura are almost exclusively males; there is little social interaction, and a reasonably predictable surfacing, reoxygenation, and diving pattern exists for the whales (Richter, 2002). This predictability and near-shore location has formed the basis of a considerable whale-watching industry in the area (Orams, 2002).

MacGibbon (1991) found that sperm whales off Kaikoura responded to the presence of whale-watching boats by having shorter respiratory intervals (less time between blows) and by spending less time at the surface. He also noted that sudden changes in boat speed, high-speed approaches, and proximity to whales all produced responses from the whales—usually by submerging without "fluking" (conducting a short shallow dive, presumably to avoid the boat). Gordon and colleagues (1992) showed that individual whales responded differently to the presence of whale-watch vessels; some were tolerant, others not. Richter (2002) showed that "resident" sperm whales (those that were regular visitors to Kaikoura) were more tolerant of vessels than "transients" (whales not recorded more than once at Kaikoura). He also found that respiratory intervals were decreased in the presence of vessels, and an increase in the frequency and amount of heading changes (direction the whale was swimming) in the presence of boats. There was also a decrease in time to "first click" (first echolocation signal) after the whale had dived.

Other Species

While the above species of cetaceans are those explicitly targeted for tourism in New Zealand, there are a number of other species that are encountered opportunistically or, in some cases, periodically, that form part of the "tourism attraction" on a variety of marine tours (including those specifically focused on marine mammals but also including other more general marine tours). There are no currently completed studies that assess the impacts of tourism on these species. There are, however, a number of studies that have addressed more fundamental questions surrounding the species distribution, abundance, biology, and behavioral ecology of these species in New Zealand waters. Species and studies include: humpback whales (Gibbs & Childerhouse, 2000), killer whales (Visser, 2000), southern right whales

(Patenaude, 2000), North Island Maui's (Hector's) dolphins (Russell, 1999), Brydes whales (O'Callaghan & Baker, 2002), and a variety of species of beaked whales (Dalebout, 2002). Species that are sometimes encountered but for which no studies have been currently completed include minke whales and pilot whales (see Childerhouse & Donoghue, 2002, for a summary of cetacean research in New Zealand).

While the findings of all the above reviewed studies identify some impact and disturbance as a result of tourism activities, in many cases (but not all) the behavioral changes reported are not statistically significant (at the alpha = 0.05 level). While scientists dwell excessively on this issue of statistical significance, the issue of greater relevance here (as Richter, 2002, quite rightly points out) is whether such behavioral changes are *biologically* significant. This is extremely difficult to assess given the wide-ranging behavior, habitat, and situational-specific issues that exist in cetacean-based tourism scenarios. What appears logical is that recorded responses and impacts are considered in terms of the known biological parameters of a species at a certain location. Thus, a fundamental understanding of the biology and behavioral ecology of a species is essential in making judgments regarding "disturbance" resulting from tourism activities. A related and extremely important issue, not addressed in any detail in any of these studies, is the issue of stress.

The Important Issue of Stress

It is well recognized that stress has a significant influence on the physical health of human beings. For example, Sapolsky (1994) states that "stress can make us sick, and a critical shift in medicine has been the recognition that many of the damaging diseases of slow accumulation can either be caused or made far worse by stress" (p. 3). It is also being increasingly recognized that other social mammals show similar physiological responses to long-term stress (Moberg & Mench, 2000). Recently, there has been much attention given to issues surrounding the ethics of animal welfare including the influence of stress (Broom & Johnson, 1993; Moberg & Mench, 2000). Examples of long-term captive animals that exhibit what is described by staff as "depression" when a companion dies illustrate a growing understanding that social and psychological phenomena can impact an animal's physiological health. It is also well understood that "intellectual" stimulation, activity, and social relationships are critical to the long-term health and survival of captive marine mammals (Goldblatt, 1993; Kleiman, Allen, Thompson, & Lumpkin, 1996). Thus, the potential effects of stress are relevant when considering the impacts of tourism on marine mammals, including cetaceans.

In his consideration of human stress and stress-related diseases, Sapolsky (1994) divides stress into three main types. The first is acute physical stress, such as that induced by immediate threats to life. The second is chronic stress, such as that produced by long-term difficulties and challenges like famine, disability, or parasite infestation. The third is psychological and social stress, those things that are perceived to be challenges or difficulties and for which the human body reacts as if they were. Acute physical stressors have been well studied in humans and other species and the physiological responses (such as the release of the hormone adrenalin in humans) are widely understood.

Sapolsky's important point is that the body of humans, and other animals, is well adapted to handling acute stressors. Homeostasis, or physiological balance, is reattained quickly after such "acute" events with little or no long-term impact on an animal's health and functioning. This is why "Zebras Don't Get Ulcers" (the title of Sapolsky's book): simply put, they don't spend their days thinking about what the lion might do to them, they only react when the lion is trying to do something to them. It is when an animal continually turns on the "physiological stress response" over an extended period in reaction to a situation (or even in anticipation of a situation) that long-term physiological problems can occur. [It should be noted that acute stress has been shown to be fatal in some circumstances with regard to small cetaceans. For example, Bearzi (2001) reported that a common dolphin died after a strike from a small biopsy dart.]

Long-term chronic problems can occur in mammals because physiological responses are adapted to maximize an animal's chances of survival in a short-term acute stress situation (e.g., escaping the pursuing lion). In this situation, a mammalian body rapidly mobilizes energy from storage sites (and inhibits further storage); heart rate, blood pressure, and breath-

ing all increase in order to transport nutrients and oxygen to muscles; digestion, growth and the immune system are inhibited; reproduction is curtailed, sex drive decreases, pain is blunted, and perception sharpened. All of these physiological responses are adaptive to short-term "life-threatening" scenarios.

When these physiological responses to stress occur continuously over long periods, health problems result. The fact that there is widespread concern in modern human societies regarding issues such as high blood pressure, elevated heart rates, depressed immunity, peptic ulcers, etc., illustrates that it is now understood that stress has a significant impact on human health. Simply stated, if humans continually "turn on" the stress response they significantly increase their chances of getting sick.

An important question is whether the psychological and social stress that so clearly has health impacts in humans is also manifested in other animals. There is strong evidence to support this contention with regard to highly social mammals such as dolphins (Thomson & Geraci, 1986). Long-term captive situations show that dolphins can experience stress of a social nature and that physiological responses result (McBain, 1999). The measurement of "stress"-related hormones from blood samples is now standard husbandry practice in dolphinaria (Dierauf & Gulland, 2001). However, this kind of physiological indicator of stress is seldom available in the study of wild populations. The great majority of cetacean–tourism impact studies focus, almost exclusively, on observed changes in behavior over relatively short time frames. Thus, any conclusion that wild dolphin-based tourism has little impact on dolphins because there are few observed changes in behavior may well be incorrect. Many long-term impacts may indeed occur as a result of low-level, long-term chronic stress that an animal or group of animals may be experiencing but that is not able to be detected from observational studies. This long-term stress could potentially reduce reproductive rates, reduce immunity, and thus increase mortality and morbidity, and it could reduce the biological viability of an individual or group of cetaceans (Broom & Johnson, 1993; Lay, 2000). There have been no studies on New Zealand cetaceans that have addressed this (nor were they able to) and there has been no explicit acknowledgement of this issue, other than admitting the short-term nature of studies and by advocating the use of the precautionary principle.

There are, therefore, significant challenges in quantifying impacts of tourism activities on cetaceans, particularly with regard to the potential detrimental effects of long-term chronic stress. As a consequence, there is a need for a management regime that recognizes this potential and provides opportunities for managers to take a conservative approach in managing the industry. New Zealand's legal framework for protecting marine mammals is considered one of the strongest in the world; nevertheless, challenges remain in implementing the protective intent of the legislation. It is worthwhile reviewing the management regime utilized in New Zealand because it is often held up as a "model" for the industry worldwide (Baxter, 1993) and because the variety of completed studies reviewed above allows for a consideration of the "model's" effectiveness in managing the industry.

Management of Marine Mammal Tourism in New Zealand

Marine mammals in New Zealand waters are afforded complete protection under the Marine Mammals Protection Act (New Zealand Government, 1978). Marine mammal tourism is regulated under the Marine Mammals Protection Regulations (New Zealand Government, 1992). Responsibility for administering these laws and regulations falls to the Department of Conservation (DoC). DoC's primary mechanism for doing this is via the issuing of marine mammal tourism permits. A permit is required for any commercial enterprise wishing to offer and promote interaction opportunities (observing, swimming, snorkeling, etc.) with marine mammals. Permits can have a variety of conditions attached to them; however, all permits require the operator to have no significant adverse effect on the species targeted, to be in the interests of conservation, management or protection of marine mammals, and to have sufficient educational value. Operators are also required to have experience with marine mammals and the local area. These explicit requirements go beyond any other nation's legal framework for managing cetacean-based tourism and allow for DoC to set additional permit conditions.

In a number of situations DoC has set conditions of a permit to require an operator to provide support

for research, in terms of a direct financial contribution or, in some cases, by providing a "platform" (i.e., passage onboard a boat) for research activities. The flexibility provided in the permitting and related permit condition procedures has allowed DoC to "tailor make" management regimes to suit particular locations, species, and, in some cases, vessel types. A variety of conditions have been utilized including restrictions on species targeted, animal status (such as no approaches for mothers with calves), locations, minimum depths, minimum approach distances, maximum number of vessels within a specified range, vessel types, vessel speed, vessel propulsion types, time spent with animals, and maximum number of trips.

A real advantage has been the ability to require operators to provide support for research. The majority of marine mammal tourism impact studies conducted in New Zealand to date have received support via this mechanism and many have been published in DoC's "Science for Conservation" series (see http://www.doc.govt.nz/Publications/004~Science-and-Research/index.asp). Furthermore, the permit renewal procedures have allowed DoC to update permit conditions when research has revealed the need for differing approaches to reduce potential impacts.

The system is not without criticism, however. Many marine mammal tourism permit applicants find the application procedure frustrating and too long (personal observation) and some operators find the conditions arduous. Probably of greater significance is that DoC has, at times, found it difficult to enforce permit conditions as a result of ambiguous wording in the regulations (e.g., what is "sufficient educational value"?) or when transgressions of regulations or permit conditions are difficult to prove (e.g., in assessing minimum approach distances). Also of relevance is the large number of permits that have been issued in New Zealand (as of June 2001 there were 75 issued for cetacean-based tourism) while the long-term impacts of such operations is not known. Of particular concern must be the issue of stress and its long-term implications, especially for endangered species such as the Hector's dolphin, an endemic animal that currently supports significant tourism activity. While the regulation is clear that tourism based on marine mammals is "to have no significant adverse effect," accurately establishing whether such adverse effect could or has occurred is difficult.

An additional challenge provided by such a flexible system is the lack of consistency around the country. While permitted operators are aware of, and for the most part obey, permit conditions, nonpermitted marine tour operators and private recreational vessels are seldom aware of such restrictions. As a consequence there is, understandably, considerable frustration amongst permitted operators who do the best they can to minimize impacts, provide educational services, and support research (as per their permit conditions) while some nonpermitted operators and private "boaties" flout such conventions and impose themselves on the animals in an inappropriate way (personal observation). Thus, there is considerable scope for DoC and permitted operators (and other interested parties) to educate the public about appropriate codes of conduct when in the proximity of marine mammals.

Priorities for the Future

In New Zealand, there has been a rapid and widespread growth of cetacean-based tourism (particularly based on dolphins). There is also a framework that attempts to provide a mechanism for the careful and sustainable management of the industry. However, a number of studies have identified that tourism activity is having a variety of impacts on the targeted cetacean populations. What is frustrating (but not unusual) is that "despite the obvious need, no New Zealand cetacean population has received detailed study before being targeted by commercial whale or dolphin-watching operations" (Bejder & Dawson, 1998, p. 2) and thus, "before and after" comparisons have not been possible. It is also extremely difficult (and too early) to reach conclusions regarding the long-term effects of tourism on dolphins and whales in New Zealand.

As a result of the above review of completed studies and a consideration of pertinent issues surrounding the effects of stress, cause and effect determination and impact assessment, the following research priorities and approaches are suggested for the future.

1. That understanding the fundamental behavioral ecology of a species at a specific location is a prerequisite for any impact assessment.

2. Control and experiment design formats are often useful, allowing comparisons of data collected in the presence of tourist (and other) vessels with data collected in the absence of vessels.
3. It is important for researchers to identify parameters that are both relevant to the species and location and that are measurable from a practical standpoint. Parameters could include: respiration rates, interanimal distance (separation), animal swim heading and speed, behavioral states (e.g., traveling, resting, foraging, socializing, milling), behavioral events (e.g., breach, leap, tail-slap, head-slap, spy-hop, blowhole "chuff", etc.), and acoustic activity.
4. Activity budgets can be a useful tool to measure and compare in the presence and in the absence of vessels.
5. Attention needs to be given to observing and measuring potential indicators of stress. These indicators could include, changes (elevation) in respiration rates, boat avoidance behavior, erratic and unpredictable behavior, decreased interanimal distance (separation), increased prevalence of external parasites, decreased reproductive rates (calf number decrease), change in activity budget (less time feeding, resting, socializing; more time milling and traveling), increased stranding rates, and increased mortality.
6. Particular attention and a careful approach needs to be given to those species/locations where the population is already under stress and/or is small in number. For example, North Island Hector's (Maui's) dolphin, South Island Hector's dolphin, Fiordland bottlenose dolphins, and Hauraki Gulf Bryde's whales.

It is recognized that the above list is rather general and not comprehensive; however, research into the impacts of tourism on cetaceans is in its infancy. A good start has been made over the past decade, but more work is needed. All species of cetaceans targeted for tourism in New Zealand live for over 10 years (some much longer); it is possible that detrimental impacts may not become apparent for some generations. Thus, a long-term, continued careful approach to research and management is essential if the worthy requirement of the New Zealand Marine Mammals Protection Regulations of "no significant adverse effect" is to be met.

Conclusion

All interested parties hope that marine mammal tourism can be a sustainable economic activity with few adverse effects on the targeted animals. Also, perhaps through experiencing marine mammals in the wild and by learning about them tourists can be changed to become more environmentally responsible citizens (Orams, 1997b). Certainly, the marine mammal tourism industry provides an economic value to these animals that adds an incentive to ensure that healthy and abundant populations exist into the future. This appears to be the aim of the New Zealand marine mammal management approach. However, significant challenges exist in its implementation. In particular, the issue of long-term tourism-induced stress deserves much greater attention in terms of research and more careful consideration in terms of management. While the legal framework that provides the base for managing the industry in New Zealand has been (quite rightly) applauded, the application and enforcement of the system has been difficult. In addition, the growth of the industry has naturally induced an increase in attention from private recreational "marine tourists." This group appears to be growing rapidly in some areas popular for commercial marine mammal tourism, and management of these activities is a significant challenge for the future. What is certain is that research has a critical role to play in the long-term sustainability of the marine mammal tourism industry in New Zealand.

Acknowledgments

This article was derived from a presentation given to the "Ecotourism, Wilderness and Mountain Tourism: Issues, Strategies and Regional Development Conference" hosted by the Department of Tourism, University of Otago, Dunedin, New Zealand, in August 2002. The author also wishes to acknowledge the work of students, scientists, and managers in the field in New Zealand, particularly (but not limited to), C. Scott Baker, Kirsty Barr, Andrew Baxter, Lars Bejder, Stefan Brager, Simon Childerhouse, Rochelle Constantine, Merel Dalebout, Steve Dawson, Aaron Donaldson, Mike Donoghue, Padraig Duignan, Nadine Gibbs, David Lusseau, Dirk Neumann, Franz Pichler, Cristof Richter, Kirsty Russell, Aline Schaffar-Delaney, Karsten

Schneider, Liz Slooten, Karen Stockin, Greg Stone, Rob Suisted, Ingrid Visser, Bernd Würsig, and Suzanne Yin. The author would also like to acknowledge the work of marine mammal tour operators in New Zealand, the great majority of whom are very supportive of research and who are doing their best to do the "right thing" by the animals that form the basis of their industry. The author also wishes to thank the three anonymous referees who provided comments that have helped to improve the article. Acknowledgment should also be given to Janet Mann, who first drew the author's attention to the issue of chronic stress and recommended the excellent book of Robert Sapolsky that provided the inspiration for this article and its title.

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