Tyne, J., Loneragan, N. and Bejder, L. (2014) The use of area-time closures as a tool to manage cetacean-watch tourism. In: Higham, J.E.S., Bejder, L. and Williams, R., (eds.) Whaling-watching, sustainable tourism and ecological management. Cambridge University Press, Cambridge, UK, pp. 242-262.

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The use of area–time closures as a tool to manage cetacean-watch tourism

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Introduction

The world's oceans have been exploited for generations. In some cases, this has led to the removal of top predators from ecosystems, resulting in a cascading effect through trophic levels altering ecosystems and restructuring food webs (Pauly *et al.*, 2002; Myers & Worm, 2003). Cetaceans (whales, dolphins and porpoises) have also been targeted, mainly for their meat and oil, and some populations being driven close to extinction. Fortunately, attitudes towards cetaceans have changed over the past two decades, and rather than harvest them, it is now more desirable to observe them in their natural environment (Bearzi *et al.*, 2010). Today, cetaceans are icons for marine conservation efforts. The USA was the first country to introduce legislation to protect marine mammals through the Marine Mammal Protection Act 1972 (MMPA). The MMPA was designed to minimize the capture or 'take', harassment and disturbance of marine mammals, primarily from fishing operations as by-catch and from cetacean hunting. The MMPA defines the term 'take' as 'hunting, killing, capture and harassment of a marine mammal or the attempt thereof'. Since the declaration of the MMPA, other countries have adopted their own legislation, e.g. The Marine Mammals Protection Act 1978 in New Zealand and the Environment Protection and Biodiversity Conservation Act 1999 in Australia.

Although protection of cetaceans is supported enthusiastically in many countries, only 1.3% of the world's oceans are protected from anthropogenic threats (Hoyt, 2011), and cetacean populations are still vulnerable to a multitude of anthropogenic impacts. These threats fall into two broad categories: *direct* impacts, i.e. those that are readily observable; and *cumulative* impacts, i.e. those that are not readily observable and are likely to cause effects through repeated exposure. Direct impacts are those that cause the death of individuals immediately, such as whaling (Gales *et al.*, 2005), ship strikes (Panigada *et al.*, 2006) and by-catch (Mangel *et al.*, 2010). Although the deaths of individual cetaceans are readily detected, quantifying the effects of direct impacts on the viability of cetacean populations is challenging as it requires information on the population size and the connectivity of populations. Cumulative impacts include sources of disturbance that are likely to affect behaviour and/or physiology and, as a consequence, are more difficult to identify and quantify. Indirect effects include noise pollution (Nowacek *et al.*, 2007; Tyack, 2008), chemical pollution (Reijnders *et al.*, 2009), tourism (Lusseau & Higham, 2004; Bejder *et al.*, 2006a, 2006b; Lusseau *et al.*, 2006), coastal development (Jefferson *et al.*, 2009), prey exploitation (Bearzi *et al.*, 2006), oil and gas exploration (Harwood & Wilson, 2001), shipping (Clark *et al.*, 2009), aquaculture (Watson-Capps

Whale-watching: Sustainable Tourism and Ecological Management, eds J. Higham, L. Bejder and R. Williams.
Published by Cambridge University Press.

& Mann, 2005) and climate change (Alter *et al.*, 2010).

Ironically, cetacean-watch operations, which are often promoted as beneficial, can cause significant impacts on cetaceans if not managed appropriately. Specifically, dolphin-watching can cause biologically significant impacts on exposed communities by causing habitat displacement and reducing the reproductive success of individuals (Lusseau, 2005; Bejder *et al.*, 2006b). As such, the International Whaling Commission (IWC) noted that 'there is compelling evidence that the fitness of individual odontocetes [toothed whales] repeatedly exposed to whale watching vessel traffic can be compromised and that this can lead to population-level effects'. The Whale Watching subcommittee of the IWC has noted that cetacean populations targeted by tourism operations can be divided into four categories: (1) resident populations where breeding, nursing, and feeding occur in the same area; (2) cetaceans on their breeding grounds; (3) cetaceans on their feeding grounds; and (4) cetaceans on their migratory corridors (International Whaling Commission, 2006). Each category is likely to require different levels and types of protection; for example, potentially, it is more important to protect cetaceans on their breeding grounds than on their migratory corridor. In addition, cetacean-watch tourism operates in varying social, cultural, economic and political environments (Higham *et al.*, 2008). Therefore, management frameworks for cetacean-watch operations should be designed based on the overall context in which the activity takes place. This raises the question of which management approach is the most appropriate to protect populations against impact(s) from tourism operations.

In this chapter we discuss area–time closures as a management approach to mitigate the impacts of commercial cetacean-watch tourism. We begin by evaluating the benefits and potential impacts of the cetacean-watch industry; discuss the variety of legislation currently available and then evaluate its effectiveness. We then discuss the development of area–time closures as part of management frameworks to help mitigate threats to cetacean populations. Finally, we identify the important issues for consideration when implementing area–time closures.

Benefits of the cetacean-watch industry

Cetacean-watch tourism is a rapidly growing industry with the potential to contribute to economic growth, education, conservation and the collection of scientific data. In 2009, cetacean watch tourism was a US $2 billion global industry with approximately 13 million tourists paying to observe cetaceans in their natural environment employing 13,000 people (O'Connor *et al.*, 2009; Cisneros-Montemayor *et al.*, 2010). Some coastal communities are highly dependent on the income generated by local cetacean-watch operations. For example, in 1986 the local community of Kaikoura, New Zealand, resurrected their ailing economy by developing commercial whale-watch operations (Hoyt, 2007; see Chapter 22). Before whale-watching, approximately 3400 tourists visited Kaikoura annually. Seven years after the commencement of whale-watching, the number of annual visitors increased to 80,000. In 1998, the number of tourists had increased 10-fold to an estimated 873,000 annually (Hoyt, 2007).

Cetacean-watch operations provide a platform to educate and raise awareness of the biology and environment of cetacean populations, population threats and population conservation, and many include an educational and interpretive component (Lück, 2003). Properly developed education programmes can be effective in managing tourist interactions with free-ranging animals in their natural environment (Orams, 1997). Furthermore, cetacean-watch experiences can lead to behavioural changes in tourists by encouraging a more environmentally aware behaviour (Orams, 1997 Ballantyne *et al.*, 2010).

Commercial cetacean-watch operations also offer a platform of opportunity for scientific research by providing frequent and relatively inexpensive access to study animals (Bejder & Samuels, 2003). Research from these vessels may, however, restrict the sampling methods and the type of abundance, distribution and behavioural data that can be collected (Bejder & Samuels, 2003). However, commercial tour vessels were used to study commercial swim-with-dolphin operations in the Bay of Islands, New Zealand (Constantine, 2001), and in controlled-approach experiments to record killer whale behaviours when approached by cetacean-watch vessels in Johnstone Strait, British Columbia (Williams & Ashe, 2007). The presence of researchers on a cetacean-watch vessel can also provide tourists with up-to-date knowledge information on the population of interest.

Costs of the cetacean-watch industry

Cetacean-watch tourism repeatedly seeks out prolonged close encounters with specific communities of free-ranging cetaceans. The cumulative impacts on cetacean populations from repeated encounters have the potential to cause significant biological effects on these populations. However, it is challenging to ascertain whether observed changes in population parameters (e.g. abundance, fecundity, survival rates) are attributable to a tourism operation or whether they are due to natural variation.

The National Research Council (2005) developed the Population Consequences of Acoustic Disturbance (PCAD) model to help identify possible effects of human activity on cetaceans. The PCAD model incorporates five groups of variables: sound, behaviour change, life functions, vital rates and population effect. The conceptual model identifies sound characteristics that may cause a disturbance with a resulting behavioural change (e.g. the sound may cause a change in dive behaviour or movement). It seeks to link behavioural changes to potential alterations in life functions (e.g. feeding and breeding), which can cause changes to vital rates (e.g. survival and reproduction) which, in turn, may have population-level effects (e.g. population growth rate). Although this model was developed specifically for acoustic disturbance, the framework can be applied to evaluating any human-induced impact on cetaceans. For example, repeated disruption to resting dolphins by a tour-vessel could result in a behavioural change from resting to travel behaviour (Lusseau, 2003a), resulting in an altered behavioural budget (i.e. affecting a life function). In turn, this could reduce the amount of available energy for reproduction (i.e. a vital rate), which has the potential to reduce population growth rates (i.e. population effects) (Bejder *et al.*, 2006b). As such, repeated behavioural disruptions, mediated through cetacean-watch vessel disturbance, may cause long-term biologically significant effects on populations.

Behavioural responses of cetaceans to vessels vary greatly, ranging from attraction to avoidance. For example, northern resident killer whales (*Orcinus orca*) on Canada's Pacific coast alter their swimming path from a convoluted pattern to a more direct path with an increase in approaching whale-watching vessels (Williams & Ashe, 2007). In the Bay of Islands and Milford Sound, New Zealand, resting behaviour of bottlenose dolphins decreased as the number of boats increased (Constantine *et al.*, 2004; Lusseau *et al.*, 2006). In Shark Bay, Western Australia, long-term exposure to dolphin-watch vessels caused declines in relative abundance of bottlenose dolphins in an area where boat-based tourism occurred (Bejder, 2005; Bejder *et al.*, 2006b).

The noise from cetacean-watching vessels has the potential to impact populations as anthropogenic noise affects the quality of habitat (Tyack, 2008). Noise pollution has the potential to impact cetaceans as their auditory capabilities are a primary means of communication, foraging and sensing their marine environment. Anthropogenic noise can interfere with cetacean acoustic systems and impair their communication, diminishing their ability to detect natural sounds including sounds generated by conspecifics (Nowacek *et al.*, 2007; Tyack, 2008). Acoustic interference, referred to as acoustic masking (Clark *et al.*, 2009; Jensen *et al.*, 2009), may render cetaceans vulnerable to predation, affect their navigation and communication, and have long-term biologically significant effects. Noise from small vessels masks acoustic communications in bottlenose dolphins (*Tursiops* sp.) and short-finned pilot whales (*Globicephala macroryhnchus*) (Jensen *et al.*, 2009). Furthermore, avoiding sonar frequencies disrupts the swim path, navigation and detection of shallow waters (Zimmer & Tyack, 2007). Currently, we lack long-term data to evaluate the effects of acoustic pollution on cetacean populations (NRC, 2005), which is a significant gap in our knowledge.

Some tour operators offer swim-with-cetacean activities (Samuels & Spradlin, 1995; Bejder *et al.*, 1999; Constantine, 2001; Courbis, 2007; Kessler & Harcourt, 2010). Methods used to place swim-with customers in the path of wild cetacean groups alters their long-term behaviour (Constantine, 2001); e.g. the magnitude of avoidance response of dolphins to swimmers in the Bay of Islands, New Zealand, increased over time and the tour operator's success with swim-with attempts decreased over a three-year period (Constantine, 2001). It has not been possible to evaluate whether these behavioural changes have had long-term biologically significant impacts on the population.

Strategies for managing the cetacean-watching industry

Due to the rapid growth of the industry and lack of scientific information, management agencies face significant challenges in developing appropriate management strategies to mitigate possible impacts (Higham *et al.*, 2008). Carlson (2009) reviewed the cetacean-watching regulations of 47 jurisdictions worldwide and documented a wide variety of management frameworks for mitigating effects of cetacean-watch operations (Table 17.1). These include: unmanaged and unregulated cetacean-watch operations (Beasley *et al.*, 2010; Mustika *et al.*, 2012a), codes of conduct (Allen *et al.*, 2007), guidelines (Christiansen *et al.*, 2010; Schaffar *et al.*,

Table 17.1 The use of permits/licensing, general legislation and guidelines for cetacean-watch tourism in 47 jurisdictions (adapted from Carlson, 2009).

Jurisdiction	Permit/ licensed legislation	General regulations for the protection of cetaceans	Guidelines
ACCOBAMS*			×
Antarctica			×
Argentina	×		×
Australia	×		×
Azores		×	×
Bahamas			×
Brazil		×	×
British Virgin Islands			×
Canada	×		×
Canary Islands	×		×
Chile	×		×
Colombia			×
Dominica	×		×
Dominican Republic			×
Ecuador	×		×
France			×
Galapagos			×
Guadeloupe			×
Hong Kong			×
Iceland			×
Indonesia			×
Ireland			×
Japan			×
Madagascar			×
Mauritius			×
Mexico	×		×
Mozambique			×
New Caledonia		×	×
Newfoundland and Labrador			×
New Zealand	×		×
Niue	×		×
Norway			×
Oman			×
Pacific Islands Region	×		×
Philippines			×

(*cont.*)

Table 17.1 (*cont.*)

Jurisdiction	Permit/ licensed legislation	General regulations for the protection of cetaceans	Guidelines
Puerto Rico	×		×
South Africa	×		×
St Lucia		×	×
Tanzania			×
Tonga			×
Turks and Caicos			×
United Kingdom		×	×
United States		×	×
Uruguay			×

* Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area.

2010), general legislation (Wiener *et al.*, 2009) and permitting strategies (Bejder *et al.*, 2006b; Lusseau *et al.*, 2006; Notarbartolo di Sciara *et al.*, 2008).

Guidelines/codes of conduct

Few countries implement legislation to protect cetaceans from the effects of human disturbance and fewer countries have legislation that addresses commercial cetacean-watch tourism specifically (Table 17.1). In an attempt to offer some protection, numerous self-imposed voluntary codes of conduct and guidelines have been developed for commercial cetacean-watch operations to mitigate potential impacts (Garrod & Fennell, 2004). However, these agreements lack legislative power and legally binding rules. Often, adherence to codes of conduct is based on ethical obligation and peer pressure, which are often ineffective in reducing impacts on cetaceans (Garrod & Fennell, 2004). In Hawai'i, commercial cetacean-watch operators have been observed flouting voluntary guidelines, by steering bow-riding spinner dolphins (*Stenella longirostris*) directly to clients in the water (Wiener *et al.*, 2009). In Zanzibar, Tanzania, guidelines for dolphin-watching have been violated with increasing frequency as the numbers of cetacean-watch vessels increased, causing detrimental effects on a local population of bottlenose dolphins (Christiansen *et al.*, 2010).

In Port Stephens, New South Wales, Australia, a variety of legislative measures were adopted after voluntary codes of conduct failed to adequately reduce tourism impacts on the local dolphin population (see Allen *et al.*, 2007). Subsequently, the New South Wales government introduced an amendment to National Parks and Wildlife Regulations to include marine mammals, adopting all aspects of the national guidelines as part of the regulations. A marine protected area (MPA) was declared within Port Stephens. This MPA includes different zoning areas, and commercial operations wishing to undertake dolphin-watching tours in the MPA must obtain a licence from the management agency. These amendments provided a mechanism that allows most stipulations within the formerly voluntary code of conduct to be enforced (Allen *et al.*, 2007). Moreover, Allen *et al.* (2007) suggested that dolphins in the MPA could be further protected by the implementation of spatial and temporal dolphin-watching zones. Speed restrictions were introduced in the MPA, as a mitigation measure to minimize boat impacts. However, speed restriction zones were ineffective at minimizing impacts on the local dolphins, and a revision on zone location was recommended (Steckenreuter *et al.*, 2012). Continuously monitoring the performance of a mitigation strategy that attempts to minimize impacts is important. Management agencies must be able to react quickly and adapt existing management measures as information on the effectiveness of management becomes available, an option that would be unavailable without a legislative framework.

General legislative framework

Legislation is often developed to allow the organizers of activities that have the potential to be

Figure 17.1 Tour boats and swimmers interact with Hawaiian spinner dolphins in their resting bays off the Kona Coast of the Hawai'i Island. Image taken under permit number GA LOC 15409.

detrimental to cetaceans to be prosecuted. However, general legislative frameworks are not specific to the cetacean-watch industry. For example, the US Marine Mammal Protection Act (MMPA) was designed to minimize harassment and disturbance to marine mammals, primarily for takes from commercial fishing operations as by-catch and from cetacean hunting. However, the interpretation of 'harassment' in the MMPA is a grey area and it is not clear how activities of the cetacean-watch operators fall within this Act. Under the MMPA, harassment is defined as 'any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.' This leads to confusion and difficulty in determining when cetacean-watch activities are deemed to be harassing a cetacean(s). Under these circumstances, voluntary codes of conduct and voluntary guidelines are often agreed upon and implemented to help mitigate impacts as well as the general legislative framework. For example, in addition to the general protection legislation and codes and guidelines, specific legislation is being considered to further limit impacts on the local spinner dolphin population on Hawai'i Island (NOAA, 2005).

Due to growing concerns about the potential impact of cetacean-watch operations on the Hawaiian spinner dolphin (Figure 17.1), the Fisheries Service Pacific Islands Regional Office of NOAA is developing a legislative framework to reduce the exposure of resting spinner dolphins to human activity in Hawaiian waters (see Chapter 19). Hawaiian spinner dolphins display a highly predictable diurnal behaviour. At night they venture off shore to feed on shrimp, squid and fish that migrate towards the surface from the mesopelagic zone (Beniot-Bird & Au, 2003). During the day they move into coastal areas to socialize and rest (Norris & Dohl, 1980; Norris *et al.*, 1994). This predictable behaviour and their daytime reliance on sheltered bays that are easily accessible by people (see Figure 17.1) render them more exposed and more susceptible to human disturbance compared with other dolphin species. Recent studies suggest that the resting periods for Hawaiian spinner dolphins may be interrupted or truncated by exposure to human activity, but the biological significance of these impacts requires further investigation (Danil *et al.*, 2005; Delfour, 2007; Courbis & Timmel, 2009). Furthermore, the population of spinner dolphins along the Kona Coast of Hawai'i Island, which is the target for large-scale cetacean-watch operations, is genetically distinct from all other spinner dolphin populations in the Hawaiian Archipelago (Andrews *et al.*, 2010). Consequently, this population may be one of the most vulnerable to anthropogenic disturbance (Figure 17.1).

Permitted/licensed legislation framework

Some management frameworks exist where a legislative system requires a permit/license to engage in cetacean-watch activities (Table 17.1). This provides management agencies with the opportunity to regulate the level of tourism exposure of a cetacean population by, for example, having the option to revoke a licence should the cetacean-watch industry be shown to have a detrimental effect. For example, an unprecedented decision was made to reduce the number of dolphin-watch operators from two to one within a 'tourism zone' in Shark Bay, Western Australia, in response to research findings showing a decline in relative abundance of bottlenose dolphins (Bejder, 2005; Bejder *et al.*, 2006b; Higham & Bejder, 2008).

Management agencies rarely have sufficient scientific basis to determine the number of permits to allocate at the onset of a local industry. Thus, a conservative allocation of initial licences is important because of the difficulties in revoking licences once they have been issued (Higham *et al.*, 2008). The appropriate number of licences to be allocated is site-specific as each cetacean population is exposed to tourism under differing circumstances. For example, some areas are more important to cetaceans than others (critical habitats). Also, the susceptibility of individual animals to impacts varies with age (Stalmaster & Newman, 1978; Constantine, 2001; Müllner *et al.*, 2004), sex (Williams *et al.*, 2002; Lusseau, 2003b), previous experience (Bejder *et al.*, 2006a, 2009) and reproductive condition (Culik & Wilson, 1995; Nellemann *et al.*, 2000; Parent & Weatherhead, 2000; Beale & Monaghan, 2004). Some argue that cetaceans on breeding grounds are potentially more susceptible to the effects of cetacean-watch operations than on their migration corridor. Thus, it is important to gain appropriate insight into the specific characteristics of a targeted population in order to appropriately determine the number of tourism permits that is both biologically and economically sustainable.

Legislation, however, does not guarantee operator compliance, particularly when the laws are not well-known or not enforced (Keane *et al.*, 2011). For example, in Port Phillip Bay, Victoria, Australia, cetacean-watch tours that violate permit conditions, including: approach type, swim time, time in proximity of dolphins and interaction with new-born calves, were documented frequently (Scarpaci *et al.*, 2003). Improvements in operator compliance with regulations requires operator education, tourist education, enforcement of the regulations or a combination of these measures (Scarpaci *et al.*, 2003). Thus, legislation needs to be explicit for the protection of cetacean populations from cetacean-watch activities and it needs to be enforced and supported by programmes to ensure public awareness of the programme, to ensure compliance.

Important considerations for implementing time-area management strategies

Effective, long-term management strategies to monitor cetacean-watch operations need to establish thresholds of human–cetacean interactions and respond adaptively to operation impacts and natural phenomena (Higham *et al.*, 2008). Spatial management, including the use of protected areas or closures to commercial operations or no-take/no-watch areas, at the appropriate scale, is an effective approach in protecting both terrestrial and marine ecosystems (Pauly *et al.*, 2002; Hoyt, 2011). Protected areas have been implemented as precautionary measures when managing marine ecosystems to reduce the risks of over-exploitation, especially when scientific knowledge about the ecosystem is lacking (Hoyt, 2011). As a precaution where scientific knowledge is limited, the spatial range of a protected area might be increased to account for uncertainty in the available information. Spatial management has been used to conserve biodiversity, protect fish and cetaceans, and delineate areas for specific use to mitigate anthropogenic threats, enhance productivity and provide public focus for marine conservation (Lauck *et al.*, 1998; Hooker & Gerber, 2004; Hoyt, 2011). Recently, spatial management to reduce gillnet mortalities has improved the survival probability of Hector's dolphins (*Cephalorhynchus hectori*), an endangered cetacean species endemic to New Zealand (Gormley *et al.*, 2012). Spatial management is also a major part of fisheries management to protect spawning aggregations, immature individuals and critical habitats. In addition to spatial closures, limiting access to cetacean-watching in time, i.e. temporal closures, can be introduced to prohibit access to cetaceans during specific times that are critical to animals/populations (Constantine *et al.*, 2004; Notarbartolo di Sciara *et al.*, 2008).

The IUCN (1994) definition of a protected area is '[a]n area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means'. Six categories of protected area, based on the main management purpose and the primary objective of the protected area have been defined (Table 17.2). Several of these categories are significant for the conservation of cetaceans, particularly areas that protect the habitat as well as the target species, such as: Nature Conservation Reserves, which are established to maintain, conserve and restore species and habitats; and Resource Reserves that are designed to protect natural ecosystems and use natural resources sustainably (Table 17.2; Dudley, 2008).

Protected areas for cetaceans are growing in number worldwide (Hoyt, 2011; Notarbartolo di Sciara *et al.*, 2008; Williams *et al.*, 2009; Table 17.3). Currently, the greatest number of protected areas are found in Australia and New Zealand (75), the Wider Carribean (65) and the South Atlantic (56), while the number of reserves is likely to almost double in the Mediterranean and Black Seas should proposed protected areas be approved (Table 17.3). International boundary agreements between countries have been established to protect cetaceans. For example, a 'sister-sanctuary' relationship has been established to protect the North Atlantic humpback whale, *Megaptera novaeangliae*, and is situated between the US Stellwagen Bank National Marine Sanctuary (SBNMS), located between Cape Ann and Cape Cod in the southwest of the Gulf of Maine in the north, and Santaurio de Mamiferos Marinos de la República Dominicana (SMMRD), 3000 miles to the south (Table 17.3). The SBNMS (2181 km^2) protects the feeding and nursery areas of this population, while the SMMRD (2500 km^2) protects its mating and calving areas (Ward & MacDonald, 2009).

Area–time management frameworks have been developed to intervene when unregulated and unmanaged cetacean-watch tourism has been identified as a potential threat to cetacean populations. For example, Samadai Reef, on the coast of the Red Sea, Egypt, is an important area for spinner dolphins (Notarbartolo di Sciara *et al.*, 2008). In 2000, unregulated swim-with-dolphin tours began and

Table 17.2 Protected area categories, descriptions and primary objectives as determined by the International Union for the Conservation of Nature (IUCN) (Dudley, 2008).

Category	Managed for	Description	Primary objective
Ia. Scientific reserve	Strict nature reserve	Strictly protected areas set aside to protect biodiversity and also possibly geological/ geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring	To conserve regionally, nationally or globally outstanding ecosystems, species (occurrences or aggregations) and/or geodiversity features: these attributes will have been formed mostly or entirely by non-human forces and will be degraded or destroyed when subjected to all but very light human impact
Ib. Scientific reserve	Wilderness area	Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition	To protect the long-term ecological integrity of natural areas that are undisturbed by significant human activity, free of modern infrastructure and where natural forces and processes predominate, so that current and future generations have the opportunity to experience such areas
II. National park	Ecosystem conservation and protection	Are large natural or near-natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities	To protect natural biodiversity along with its underlying ecological structure and supporting environmental processes, and to promote education and recreation
III. National monument/ National landmark	Conservation of natural features	Are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value	To protect specific outstanding natural features and their associated biodiversity and habitats
IV. Nature conservation reserve	Conservation through active management	Aim to protect particular species or habitats and management reflects this priority. Many category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category	To maintain, conserve and restore species and habitats

Table 17.2 (*cont.*)

Category	Managed for	Description	Primary objective
V. Protected landscape	Landscape/ seascape conservation and recreation	Where the interaction of people and nature over time has produced an area of distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values	To protect and sustain important landscapes/seascapes and the associated nature conservation and other values created by interactions with humans through traditional management practices
VI. Resource reserve	Sustainable use of natural resources	Conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area	To protect natural ecosystems and use natural resources sustainably, when conservation and sustainable use can be mutually beneficial.

the number of tourists increased dramatically. More than 800 swimmers were reported to be interacting with spinner dolphins in the small 1.5 km^2 lagoon in a single day (Notarbartolo di Sciara *et al.*, 2008). Spinner dolphin sightings decreased and concerns were raised about the effects on the local dolphin population (Notarbartolo di Sciara *et al.*, 2008). Management authorities suspended all tourist visits until a suitable management plan was developed. In 2004, an area–time management regime was introduced that included zoning the area into four different use areas: no tourist zone; diving and snorkelling zone; boat mooring zone; and dive sites zone. Interactions with people were confined to four hours each day and the number of visitors was restricted to 100 divers and 100 snorkellers per day. Visitor entrance fees were introduced, visits were allowed only under the supervision of trained and certified guides, and monitoring and enforcement programmes were introduced (Notarbartolo di Sciara *et al.*, 2008).

A number of development steps are needed to successfully implement an area–time management plan for cetacean-watching, including consultation with commercial tour operators, social science communities and natural scientists (Higham *et al.*, 2008). Management agencies are responsible for establishing and coordinating the development of the legislative framework, which should proceed prior to commencing commercial operations (Higham *et al.*, 2008). The size, location and access restrictions to these areas where the cetacean population is most vulnerable to disturbance should be identified as part of the management framework. Regulations for the allocation/revocation of permits and legislation to

Table 17.3 The number of existing and proposed protected areas with cetacean habitat across 18 marine regions. Adapted from Hoyt (2011).

	MPA or PA (marine protected area or protected area for river dolphins on land)			High seas MPA (marine protected area outside national waters of EEZ)		National EEZ Sanctuary (no hunting zone within national waters or EEZ)		
Marine region	Existing	Proposed	Existing with proposed expansion	Existing	Proposed	Existing	Proposed	Total
1. Antarctica	4	0	0	3	1	0	0	8
2. Arctic	29	8	4	0	4	0	0	45
3. Mediterranean and Black Seas	45	38	11	1	17	0	0	112
4. North West Atlantic	9	2	1	0	1	1	0	14
5. North East Atlantic	14	27	8	0	1	2	0	52
6. Baltic	6	6	0	0	0	0	0	12
7. Wider Caribbean	65	4	2	0	0	4	1	76
8. West Africa	40	4	1	0	0	0	1	46
9. South Atlantic	56	7	3	0	1	3	0	70
10. Central Indian Ocean	17	7	8	0	0	1	0	33
11. Arabian Seas	20	4	1	0	0	0	0	25
12. East Africa	22	2	2	0	1	1	0	28
13. East Asian Seas	23	8	1	1	0	0	1	34
14. North and South Pacific	21	3	4	0	0	12	0	40
15. North East Pacific	20	3	5	0	0	1	0	29
16. North West Pacific	21	3	0	0	0	0	0	24
17. South East Pacific	30	5	2	0	1	4	0	42
18. Australia – New Zealand	75	7	0	0	0	2	0	84
Total	517	138	53	5	27	31	3	774

control tourism operations, including restrictions on engine noise, speed of approach, distance, time with dolphins, and a visitor interpretation programme. The likely response of tour operators to restrictions of access to cetaceans should also be considered, as this may lead to increased interactions in other areas, which may have unforeseen detrimental effects on the population. As an example, if an area–time management framework was introduced in resting bays used by Hawaiian spinner dolphins, human–dolphin interactions might increase outside the resting bays.

Understanding the cetacean population of interest

Critical habitats are areas where a species executes behaviours essential to the viability of the population, and include foraging, breeding, nursing, socializing or resting habitats (Hoyt, 2011). Repeated disturbance of cetaceans within critical habitats has been implicated as a factor in reducing the viability of the population (Bejder, 2005; Bejder *et al.*, 2006b; Lusseau *et al.*, 2006). Understanding the abiotic and biotic environment and behaviour and biology of the focal population, particularly identifying critical areas, and the time of their use, prior to developing a management plan is important (Lusseau, 2003a; Lusseau *et al.*, 2009). Sampling programmes should be developed that incorporate methodologies to collect comprehensive data on the population, and its habitat, that can be used to estimate population size, population structure, reproductive rates and behavioural budgets (Lusseau, 2004). These data provide the basis for developing models to identify critical areas and habitat use and assessing the potential threats to the population.

The NOAA initiated research programme on the spinner dolphins and their interactions with cetacean-watching activities along the west coast of Hawai'i Island, which provides an example of an integrated programme (NOAA, 2005). A suite of modern visual and acoustic techniques are being used and a systematic photographic identification sampling regime has been developed to study spinner dolphin populations in the study area. Group focal follows are undertaken to observe behaviours and human interactions outside resting bays. Land-based theodolite tracking of spinner dolphins, their behaviours and human interactions within resting bays are also undertaken (Tyne *et al.*, 2011). Cetaceans can display sequences of behaviour, or transitions between behaviours, such as foraging behaviour followed by socializing behaviour, which may be followed by resting behaviour. When cetaceans are disturbed, however, the probability of transitioning from one behavioural state to another is altered (Lusseau, 2003a), resulting in a change in their overall behavioural budget. Calculating the probability of transition from one behavioural state to another in the absence of cetacean-watch tourism, may provide an indicator for assessing the impact of tourism operations: changes in the transition probability may be an early warning of a deleterious effect of cetacean-watching tourism (Lusseau, 2004). Furthermore, 'show stoppers', or limit reference points, such as a decline in reproductive success or declines in abundance, should be identified as immediate evidence of a significant impact resulting in an immediate management intervention, such as a 50% reduction of tourism on bottlenose dolphins in Shark Bay (Bejder *et al.*, 2006b).

Baseline data on cetacean populations, prior to the start of tourism operations, should be used to develop monitoring programmes and management plans (Higham *et al.*, 2008) and establish population parameters prior to or during the onset and growth of tourism activities (Bejder & Samuels, 2003). Reference points can be developed from the baseline data to provide target reference points and limit reference points, at which management actions are initiated, i.e. when predetermined acceptable thresholds have been exceeded. Target and limit reference points are commonly used in fisheries to monitor and manage the health of fish stocks and their ecosystems, e.g. spawning biomass at Maximum Sustainable Yield, percent of Virgin Biomass, and Spawning Potential Ratio. Similarly, the Potential Biological Removal (PBR; Wade, 1998) assesses the allowable limits of mortality on cetacean populations from anthropogenic disturbance (Williams *et al.*, 2009). The PBR is calculated as the product of a minimum population estimate (N_{min}), one half of the maximum theoretical net productivity rate (R_{max}) and recovery factor (Fr) ($PBR = N_{min} \times 0.5R_{max} \times Fr$; Wade, 1998).

Area–time management systems require an understanding of why and when specific habitats/areas are critical to a population. Critical habitats encompass areas of high animal density, and areas essential to the viability of the population, e.g. a nursing area where only mothers and calves are present. Quantifying the importance of an area to a cetacean population by assessing habitat preference, and the behaviours in these habitats, is an important tool in the development of area–time management systems (Higham & Lusseau, 2007). A high proportion of the population of northern resident killer whales (*Orcinus orca*) in Johnstone Strait, Canada, uses a small proportion of their habitat for a rare behaviour called beach-rubbing, where individuals rub their bodies on the smooth pebble beaches, a behaviour thought to remove parasites or have some social significance (Williams *et al.*, 2009). This renders the population vulnerable due to the high proportion of the population that uses this small area, coupled with the heavy human use of Johnstone Strait by large ships (Williams *et al.*, 2009).

Bottlenose dolphins in Fiordland, New Zealand, are particularly sensitive to boat interactions while resting, and to a lesser extent, while socializing (Lusseau, 2004). Using behavioural state observations, Lusseau and Higham (2004) identified critical areas for dolphin resting and socializing in Doubtful Sound. Subsequently, a voluntary code of conduct for tour operators was developed which included some elements of zoning (unregulated). Similarly, the commercial dolphin-swim/watch industry in the Bay of Islands, New Zealand, altered the behaviour of bottlenose dolphins (Constantine *et al.*, 2004). Resting behaviour decreased significantly as the number of commercial vessels increased. Constantine *et al.* (2004) suggested that the local legislation was ineffective in protecting the dolphin population and recommended measures to minimize tour-boat impacts by restricting the number of boat trips, trip durations and limiting dolphin exposure to tour boats. In late 2004, The Department of Conservation (DOC) implemented changes to the dolphin-watch and swim-with-dolphin operations, some based on the findings of Constantine *et al.* (2004), others of their own making (Constantine, 2010, University of Auckland, pers. comm.).

Identifying critical habitat should also consider both the abiotic and biotic characteristics of the habitat, and link these characteristics to the focal cetacean population's behaviour within the area. These characteristics may include prey abundance, characteristics of the bathymetry, and substratum, temperature, salinity, turbidity, tide and currents. For example, Hawaiian spinner dolphins prefer to rest in sheltered sandy bays during the day (Norris & Dohl, 1980; Thorne *et al.*, 2012) and, as a consequence, any changes to this habitat may have significant biological consequences for the population.

Oceanographic features have also been used to identify critical cetacean habitats. Johnston and Read (2007) highlighted an ecological link between a predictable oceanographic feature in time and space that attracts cetaceans to the Bay of Fundy, Canada. In the summer and during flood tides, the Grand Manan Island wake attracts foraging fin whales (*Balaenoptera physalus*), minke whales (*Balaenoptera acutorostrata*) (Johnston *et al.*, 2005a) and harbour porpoise (*Phocoena phocoena*) (Johnston *et al.*, 2005b). Oceanographic observations provided an understanding of the spatial and temporal variability in the physical forces controlling the island wake (Johnston & Read, 2007). Secondary flows in the wake aggregate prey to predictable locations where the cetaceans focus their foraging efforts. These ecological links between the foraging habitats and foraging behaviour over space and time are therefore important factors when considering the spatial boundaries of a marine protected area in this region. Johnston and Read (2007) recommended that a proposed protected area at the Grand Manan Island encompass the island wake. The predictable nature of this oceanographic feature also allows human activities to be controlled within the area during the tidal flows that generate the island wake when mega fauna are foraging in the wake.

Socioeconomic considerations

Cetacean-watch operations are important for the economy of many coastal communities (Hoyt, 2007). Access restrictions to protect cetacean populations from tourism operations may have implications for the economic status of these communities. Therefore, it is important to highlight the benefits of sustainable cetacean-watch management and the significance of area–time management systems to local businesses and the wider community. The aim of these operations should be to maximize the economic viability of the local cetacean-watch industry, while sustainably managing the target cetacean population.

Raising awareness among visitors on cetacean biology and conservation is an important component in the development of any long-term management framework for cetacean-watching.

Many commercial cetacean-watch operations provide educational information on the target cetacean population, its environment, the associated conservation efforts, and to some degree the plight of cetaceans worldwide (Orams, 1997; Higham & Carr, 2002; Christensen *et al.*, 2007). In New Zealand, tourism operations must provide an educational component of the cetacean-watch experience, a condition for obtaining a cetacean-watch permit (Carlson, 2009). However, the effectiveness of educational programmes in raising environmental and conservational awareness and ultimately changing human behaviour is still being debated (Orams, 1996; Higham & Carr, 2002; Ballantyne *et al.*, 2010). Carefully designed educational nature-based programmes that incorporate strategies to facilitate behavioural change can instil greater environmental and conservational awareness in tourists and lead to changes in their behaviour and attitudes to interactions with marine fauna (Orams, 1997; Higham & Carr, 2002; Ballantyne *et al.*, 2010). The continued collection of visitor data and their perceptions of cetacean-watch operations enable the effectiveness of education programmes to be assessed and adapted if necessary.

Management considerations

Reliable and detailed scientific data on the critical habitat of cetaceans can provide management agencies with the information needed to establish protected areas. The spatial scale of the protected area should be large enough to be biologically relevant and small enough that cetacean-watch operations can be effectively managed within its boundaries (Ashe *et al.*, 2010; Ross *et al.*, 2011). Furthermore, the time when the critical behaviour occurs should inform management agencies when to restrict human access to the protected area. Population estimates, reproductive rates and changes in behavioural budget (Lusseau, 2004; Bejder *et al.*, 2006b) should provide management agencies with the information necessary to establish quantifiable Limits of Acceptable Change (LAC) in the target cetacean population (Higham *et al.*, 2008). Spatial and temporal scales of habitats and cetacean presence in the region, and the LAC criteria should then be used to establish clearly defined legislation for operators and enforcement within the protected area boundaries.

The preceding discussion has demonstrated that rules and regulations are only part of the solution to minimizing impacts on cetacean populations from cetacean-watch operations. For a successful management plan, rules and regulations must also be supplemented with educational and enforcement programmes (Keane *et al.*, 2008) to help ensure compliance with regulations. Moreover, clearly defined legislation must have significant authority, including that to revoke operator licences (Bejder *et al.*, 2006b; Higham & Bejder, 2008). Without enforcement or legislation, management plans may fail to meet their goals and, ultimately, fail to protect cetacean populations and the long-term viability of the cetacean-watch tour operations.

Conclusions

Despite the rapid increase in cetacean-watch tourism since the 1970s and its recent expansion into developing countries, it continues to be perceived as a benign activity. However, in 2006, the International Whaling Commission noted that 'there is compelling evidence that the fitness of individual odontocetes [toothed whales] repeatedly exposed to whale-watching vessel traffic can be compromised and that this can lead to population-level effects' (International Whaling Commission, 2006).

In the absence of management regulations, tour operators have been observed overcrowding and encroaching extremely close to cetacean groups (Mustika *et al.*, 2012a, 2012b). Moreover, there are growing concerns for critically endangered cetacean species exposed to unmanaged cetacean-watching (Beasley *et al.*, 2010). In some areas voluntary codes of conduct have been employed; however, they are regularly flouted and often ineffective in providing cetaceans with adequate protection (Allen *et al.*, 2007; Wiener *et al.*, 2009). Where management legislation is in place, operator compliance is not guaranteed, particularly when the laws are not communicated or adequately enforced (Keane *et al.*, 2008). Spatial management has been shown to be effective in protecting cetaceans (Gormley *et al.*, 2012). In this chapter we argue that area–time management systems should be considered an important tool to manage cetacean-watch tourism and ensure its long-term viability.

The challenge for scientists and managers is to develop studies of appropriate temporal and spatial scales that quantify the population dynamics of tourism-exposed cetacean populations. When achievable, knowledge from such studies can help tease apart possible effects of anthropogenic disturbance of exposed populations from natural variability. By obtaining robust estimates on population size, identifying critical habitat and baseline population parameters, coupled with information on behavioural changes in response to cetacean-watching operations, scientists will be able to identify when and where cetacean populations are most vulnerable. Management agencies can use this information as a basis to develop appropriate legislative management frameworks to protect cetacean populations from disturbance when they are most vulnerable. The efficacy of a management strategy must be continuously monitored and should be able to adapt quickly when necessary. A management framework must also provide management agencies with a sufficient mandate to change operator conditions when rules have been violated repeatedly. As such, we argue that a licensing system should be considered more widely, so that management agencies have the authority to change and/or revoke a licence should it be deemed necessary.

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