

# The role of research in the management of whale watching

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## ABSTRACT

The commercial whale watching industry has experienced a rapid expansion in Australia in recent years, often outpacing regulatory development. While whale watching has the potential to provide a number of benefits to the community, industry and animals, these benefits come at the risk of over-exploiting the animals and their environment. A management regime can be used to regulate the industry through legislation, a permitting system with associated conditions or voluntary guidelines. Such management relies on a well-developed understanding of the animals, the industry and potential and real impacts so that any regulatory measures are effective. There is a need for sound scientific research incorporating short-term tests and long-term monitoring of the whale watching industry, participants and target species to inform and support management decisions. Research should focus on the behavioural ecology and population biology of the animals, the extent of the industry and the expectations and satisfaction of the participants. This information can then be used to develop a long-term management system that will detect trends and impacts and will be responsive to necessary changes.

**Key words:** whale, dolphin, whale watching, tourism, wildlife management

## Introduction

There has been a change in attitude towards marine mammals, in particular whales and dolphins (or cetaceans) over recent decades. This can be seen in the use of whale and dolphin symbolism, the increasing popularity of marine parks and the burgeoning whale watching industry.

In 1993 the International Whaling Commission (IWC) adopted a resolution declaring its desire “to encourage the further development of whale watching as a sustainable use of cetacean resources” (IWC 1994). This declaration highlights two important points. First, it notes the move from viewing cetaceans as a resource to be harvested to a resource to be appreciated. Second, it recognises whale watching as a sustainable use of a resource. Both points regard cetaceans as a resource and, similar to other resources, some form of management may be required to ensure that this “resource” is not exploited.

As an industry, whale watching has rapidly grown over the past two decades, often outpacing regulatory development. While it is important to develop a management regime for the industry, it is crucial that this regulatory system is established for the right reasons and is grounded and supported by scientific research. This paper will address the growth and management of the whale watching industry in Australia and focus on key research needed to develop and implement a solid management system that will provide benefits to the industry, the public and the animals. While a variety of types of interaction and numerous species of marine mammals have been targeted by tourism worldwide, this paper only addresses well established commercial whale watching operations that target cetaceans in Australia. The term ‘whale watching’ will be used throughout this paper to refer to activities involving any species of whale or dolphin.

## Whale watching in Australia

Whale watching is a growing industry in Australia and worldwide. A recent report noted that in 1998 commercial whale watching occurred in 87 countries with over 9 million participants and that, overall, this industry was worth more than US\$1.5 billion (Hoyt 2001). The same report found that, in Australia alone, 734,962 visitors participated in whale watching and spent \$US11,869 million in direct expenditures during 1998. Hoyt (2001) further noted that the industry in Australia has grown at an estimated rate of 12-16% annually, in terms of visitor numbers and direct expenditure, between 1991 and 1998.

Although there are 43 species of cetacean that occur in Australian waters, commercial whale watching focuses mainly on only three of these species. They are the bottlenose dolphin *Tursiops* sp., humpback whale *Megaptera novaeangliae* and southern right whale *Eubalena australis*. These species have been targeted by the industry because their movements and distribution are somewhat regular and predictable. Thus, they can reliably be sighted either year round where resident populations occur, as is the case for bottlenose dolphins, or seasonally during annual migrations, as is the case for humpback and southern right whales. A variety of other species (e.g. blue whales *Balaenoptera musculus*, minke whales *Balaenoptera acutorostrata*, humpback dolphins *Sousa chinensis*, common dolphins *Delphinus delphis*, sperm whales *Physeter macrocephalus*, killer whales *Orcinus orca*, pilot whales *Globicephala* sp., risso's dolphins *Grampus griseus* and false killer whales *Pseudorca crassidens*) are regularly sighted during whale watching tours, though are less predictable



Land-based viewing of migratory humpback whales from Cape Solander, NSW. (Photograph: Geoff Ross)

and are rarely the target species for commercial operations. One exception is the relatively new operations focusing on the dwarf minke whale *Balaenoptera acutorostrata* in the Great Barrier Reef Marine Park (Birtles *et al.* 2002).

The first commercial development in Australia took place at Monkey Mia, Western Australia in the 1960s where a resident population of bottlenose dolphins began to interact with fishers, then tourists at a beach site (Connor and Smolker 1985). Boat based commercial whale watching initially focused on humpback whales and began on the east coast at Hervey Bay, Queensland in 1987 (Anderson *et al.* 1996) and in Western Australia in 1989 (Coughran and Crawford 1996). Since that time, the interest in marine mammals has grown and the whale watching industry has rapidly expanded to include most states and a variety of experiences. For example, in 1995 there were 223 commercial operators across six states (Anderson *et al.* 1996).

Whale watching in Australia covers a variety of viewing platforms and several types of interaction. People may view marine mammals from land sites, vessels or aircraft. Although the main type of interaction is passive viewing, there is a growing interest in other types, including swimming with and feeding marine mammals. (For a review of activities and the industry see Anderson *et al.* 1996).

Some examples of the extent of the industry and experiences currently available around Australia include:

- Viewing humpback whales on their annual migration from land based cliff sites or boat tours from a number of sites in New South Wales, Western Australia and Queensland;
- Viewing southern right whales in breeding and resting areas from land based sites and boat tours in Victoria and South Australia;

- Dolphin watching tours in Port Stephens, Jervis Bay and Coffs Harbour, New South Wales and Port Phillip Bay, Victoria;
- Swimming with bottlenose dolphins in Rockingham, Western Australia and Port Phillip Bay, Victoria;
- Swimming with dwarf minke whales in the Great Barrier Reef Marine Park, Queensland; and
- Feeding bottlenose dolphins at Monkey Mia and Bunbury, Western Australia and Tangalooma, Queensland.

### Managing whale watching

Whale watching has the potential to provide a number of benefits to the community and industry as well as to the animals and environment. However, these benefits do not come without costs. Managers need to recognise and understand both costs and benefits to achieve a balance that will maximise the benefits while minimising the costs.

Benefits include both economic and educational elements for local communities and the general public. Economic benefits flow from the industry itself to increased tourism and related expenditures in local communities. However, whale watching also provides opportunities for local communities and the general public to have direct experiences and to learn more about marine mammals and the marine environment. At the local level, such experiences may foster local pride and appreciation for the animals and their environment. At a broader level, experiences may bring about a deeper appreciation and understanding of marine life. This may lead to changing attitudes towards marine mammals, marine conservation and the environment, ultimately resulting in positive conservation outcomes (Orams 1996). This broader picture is exemplified in the current push to ban whaling which is, in part, due to a better understanding and appreciation of whales and dolphins now commonly held.



Clockwise from top left. Humpback whales during their annual migration. Southern right whale surfacing near a vessel (Photograph: Rob Harcourt). Dolphin research team looking for dolphins (Photograph: Michelle Lemon). Dolphin watching in Port Stephens (Photograph: Simon Allen).

There are costs to these experiences. The positive aspects of whale watching come at the risk of over-exploiting the animals and their environment. The most obvious cost, and one most often cited when discussing the pros and cons of whale watching, is harm to the animals. This may be either direct harm, such as mortality and injury from boat strikes, or indirect harm through disturbance of normal activity patterns and distribution. There is a further risk of harm to the environment through increased pollution and general use. The extent and type of risk varies by location, species and type of interaction. For example, species vary in their response to vessels and while some, like resident bottlenose dolphins, may be familiar with, and readily approach boats, other species may be less familiar or choose to avoid them such that vessel-based whale watching activity may equate to harassment. Further, activities like feeding may result in animals ingesting inappropriate items or consuming an inadequate diet.

One current area of interest to the scientific community and wildlife managers is the impact that vessel-based operations have on marine mammals. This is particularly relevant in Australia where the majority of commercial whale watching activity is vessel-based.

The increase in boat traffic and in interactions with commercial and recreational boaters has led to increased pressure on marine mammals. This increased pressure can result in a number of both short and long-term impacts. There is a need to recognise and identify the potential impacts so that a management system may be developed to detect and minimise such impacts while maintaining the industry. Response to both commercial and recreational vessels that signify, at the very least, short term disturbance has been well documented world wide (for examples see Baker and Herman 1989; Kruse 1991; Corkeron 1995; Richardson 1995; Janik and Thompson

1996; Wells and Scott 1997; Bejder *et al.* 1999; Allen and Read 2000; Erbe 2000; Trites and Bain 2000; Corbelli 2001; Constantine 2001; Nowacek *et al.* 2001; Richter *et al.* 2001). Responses and potential impacts include:

- Changes in respiratory patterns and time spent at the surface in response to vessel proximity or approach;
- Changes in dive behaviour, possibly to avoid vessels;
- Disruption of behaviours and activity patterns, eg. foraging, nursing or resting;
- Changes to group size, formation and cohesion which can include separation of mothers and calves;
- Changed or disrupted acoustic behaviour; and
- Changes to distribution including avoidance of key areas.

These short term changes may have long-term behavioural or physiological consequences, particularly where individuals and populations are subjected to repeated interactions with whale watching vessels either on a daily basis, as is the case for resident dolphin populations, or on a cumulative basis, as experienced by migrating whales. Long-term effects are generally less well understood as they will only be detected through long-term monitoring and can be difficult to quantify for animals with a long life span and low reproductive rate (Findlay 2001). However, over the long-term, repeated short term changes or disturbances can potentially lead to:

- disruption or reduction in key behaviours such as mating and nursing;
- changes in distribution and/or migratory path which may have consequent energetic costs and increased risks of predation;
- avoidance of critical habitat such as feeding grounds and nursery areas; and
- chronic stress with physiological consequences.

These impacts may result in reduced individual health, declining reproductive success and ultimately reduced population fitness. For species such as the humpback and southern right whale, still recovering from commercial whaling, such impacts may be critical.

### How can management help?

Concern over the potential for negative impacts from vessel-based whale watching has become widespread, leading to international conferences, workshops and research to identify threats and make recommendations on how best to monitor and regulate the industry and minimise these impacts (e.g. CMC and NMFS 1988; IWC 1994; Frohoff *et al.* 1995; IFAW *et al.* 1995; ANZECC 1998; Malcolm and Duffus 1998; Spradlin *et al.* 2001).

It is generally agreed that appropriate management should seek to benefit animals by identifying and minimising risks, protecting habitat and improving attitudes towards marine conservation. At the same time, management should also provide benefits to the community by maintaining a viable industry and providing quality experiences and education on marine mammals. A management regime can be used to establish best practice standards for the industry, regulate compliance with these guidelines, and monitor the impacts of the industry, making adjustments to standards when necessary. (For an overview of management concerns in Australia regarding whale watching see Stevens *et al.* 1996)

An important element of a regulatory system is the provision of clear, definable measures that are practical, enforceable and effective (Brix and Nitta 2001). In order to maintain a sustainable industry, wildlife managers should also consider the use of precautionary rules, based on best practice guidelines established elsewhere and adapted to specific circumstances, and the use of research and resultant new information on both short and long-term impacts (IFAW *et al.* 1995; Corkeron 1996; Hoyt 1996).

In areas where whale watching has become established, the initial step in management has typically involved the development of a code of conduct. These codes are often developed in conjunction with industry, community, research and government representatives and usually only require voluntary implementation. However, a number of problems have been identified with this approach, mainly related to the rapid expansion of the industry.

The most common problem is lack of compliance with an agreed code, particularly where the code is voluntary and no agency has the authority to enforce it. Research has found that, where there is no enforcement, there is a high risk of non-compliance (e.g. Grossek 1998; Lalime-Bauer 2000; Allen and Harcourt 2001; Peterson 2001; Scarpaci *et al.* 2001a). This can lead to increased risk to the animals and dissatisfaction and disagreement between operators, particularly where there is a competitive advantage to not following guidelines. Thus, voluntary codes/guidelines often provide insufficient protection.

Additionally, it can be difficult to establish appropriate guidelines on which all operators and stakeholders agree. While consultation is required with all stakeholders so that

all will accept the final outcomes, competing interests, ideas and understanding of marine mammals and their behaviour may lead to disagreements on appropriate guidelines. Further, as species and populations vary in their response to human activity based on local circumstances, habitat and general ecology, guidelines that are sufficient in one location might not prove successful elsewhere. This may lead to inappropriate guidelines, inconsistent use of guidelines and divisions and dissatisfaction within the industry.

Finally, it can be difficult to identify who monitors the use of the guidelines. This too will lead to inconsistent guidelines and generate poor relationships between government agencies and the industry as well as between rivals within the industry.

One accepted solution to these problems has been the development of appropriate legislation so that guidelines and best practice standards become regulations that can be enforced by the relevant government body. Such legislation and regulations have been developed and implemented in many of the countries where commercial whale watching is an established industry, including Australia.

### Current Management in Australia

In Australia, the various state wildlife management agencies are responsible for the conservation and management of marine mammals in state waters. For example, in NSW the NSW National Parks and Wildlife Service (NPWS) has responsibility for the care and conservation of marine mammals under the *National Parks and Wildlife Act 1974*. Thus, the NPWS is responsible for regulating and managing all activities which might interfere with, disturb or harm marine mammals including vessel-based whale watching and/or other forms of interaction.

Each state with a significant whale watching industry has developed its own management system. Regulation has generally occurred at different times in the various states and has encompassed different systems based on industry growth, expansion and direction. For example, Queensland and Western Australia initiated regulation of the industry through a permit system when vessel-based whale watching first began. Queensland uses a system based on permits, best practice guidelines, regulations, zoning and codes of conduct (Stokes *et al.* 2002) and Western Australia employs a permitting system with associated regulations (Coughran and Crawford 1996). Victoria initially used a voluntary code of conduct to manage a new swim-with-dolphin industry in Port Phillip Bay, then developed a permit system and legislation when the code of conduct proved ineffective (Grossek 1998). NSW is currently exploring a regulatory system for commercial marine mammal operations in consultation with the industry and relevant stakeholders.

Marine mammals can cover extensive ranges that do not correspond with human imposed boundaries. While some species, such as bottlenose dolphins, occur in coastal waters, often resident within a particular jurisdiction, other species, like humpback whales, migrate long distances through various state (within 3 nautical miles (NM) of shore), Commonwealth (3-200 NM) and international

(beyond 200 NM) waters. As whale watching operations occur where animals are most likely to be sighted, there is the potential for animals to come in contact with whale watching operations under a variety of jurisdictions operating under a variety of regulatory systems. Not only will those species that cross jurisdictions face the potential risk of cumulative impacts from whale watching, but differences in regulation between jurisdictions means potentially inconsistent behaviour of whale watching vessels and other human activities.

In recent years, concerns over the impacts of whale watching, and inconsistent regulations between jurisdictions have led to the development of a shared basis for standards and regulations across Australia. In 2000, national guidelines for the observation of cetaceans (ANZECC 2000) were produced in consultation with a variety of stakeholders, scientists and wildlife managers. This document provides guidelines on both appropriate whale watching behaviour and suitable management for the growing industry. Guidelines include such details as recommended caution zones, minimum approach distances and maximum number of vessels in proximity to cetaceans, guidelines on the operation of vessels around marine mammals and management recommendations for various types of activity and species of marine mammal. While the guidelines have been accepted by most states, only certain aspects, such as minimum approach distances, have been incorporated into state legislation. Management recommendations remain, for the most part, voluntary. (Table 1 provides a list of current legislation that addresses activities around marine mammals in Australian waters. For an overview of this legislation, see ANZECC 1998).

**Table 1.** Current Australian legislation that covers activities around marine mammals, including marine mammal tour operations. States marked with an \* currently require tour operators to hold a licence to undertake their activities.

| Jurisdiction       | Legislation  |
|--------------------|--|
| Commonwealth*      | Environmental Protection and Biodiversity Conservation Act 1999<br>Previously <i>Whale Protection Act 1980</i>                           |
| New South Wales    | National Parks and Wildlife Act 1974   |
|                    | National Parks and Wildlife Regulation 2002<br>[DRAFT] National Parks and Wildlife Management (Conservation of Marine Mammals) Bill 2002 |
| Queensland*        | Nature Conservation Act 1992   |
|                    | Nature Conservation (Wildlife) Regulation 1994   |
|                    | Marine Parks Act 1982<br>Conservation and Management of Whales and Dolphins in Queensland 1997-2001                                      |
| Victoria*          | The Wildlife Act 1975  |
|                    | Wildlife (Whales) Regulations 1998   |
| South Australia*   | National Parks and Wildlife Act 1972   |
|                    | National Parks and Wildlife (Whales and Dolphins) Regulation 2000  |
| Western Australia* | Wildlife Conservation Act 1950   |
|                    | Conservation and Land Management Act 1984  |
|                    | Wildlife Conservation (Close Season for Marine Mammals) Notice 1998  |
| Tasmania           | National Parks and Wildlife Act 1970   |
|                    | Whales Protection Act 1988   |
| Northern Territory | Territory Parks and Wildlife Conservation Act 2000   |

## Research: why we need it

Appropriate management of the burgeoning whale watching industry is critical to ensure the risk of impacts to animals are minimised and the industry remains sustainable. However, such management requires a well developed understanding of the animals, the industry and potential and real impacts so that any regulatory measures are effective. It is critical that a scientific basis for the development and regular assessment of regulations and management regime be established so that guidelines and standards will have a biological relevance. In this sense, research has an important role to play for several reasons.

First, it will assist in the development of appropriate legislation, regulations and management decisions by targeting relevant issues and providing the basis upon which to make decisions. Research may be used to identify appropriate minimum approach distances and appropriate types of interaction based on detectable signs of disturbance. Research will also highlight specific impacts upon the animals and the environment, including unforeseen outcomes. Assessment of these impacts will mean that necessary changes to regulatory systems will be identified.

Research is also needed to improve our basic understanding of populations and species of marine mammals. Such information is crucial as these animals and their environment face an increasing number of threats from human development, whale watching and other related activities. Research on behaviour and ecology of target species and populations will demonstrate that populations of each species differ in their biological needs and response to human interaction and that perceived disturbances and impacts will vary based on local circumstances.

Thus, while management will need to address the overarching concerns of the impacts of whale watching, it will have to be developed on a case-by-case basis and be responsive to local needs and circumstances.

Finally, research will help build positive relationships between government agencies, research bodies, operators and other stakeholders, all of whom share a common interest, by giving all an opportunity to participate in, and understand, the process.

### Research categories

The required research falls into three basic categories: baseline information; long-term monitoring; and specific short-term tests. Baseline information is required as a grounding point to establish specific biological and ecological requirements as a basis for comparison. Long-term studies expand on this baseline information to allow for populations and management systems to be monitored over time, detecting significant changes and trends and making changes to management regimes where necessary. Long-term studies are even more critical when dealing with species that are long-lived and have low fecundity rates, such as cetaceans, as changes in population density and habitat use may be subtle and take years or decades to become noticeable (e.g. Wilson *et al.* 1999). Finally, specific studies on the immediate and short-term effects of whale watching are critical to identify specific impacts and test best practice standards.

### Research areas

Along with these categories defining the scope of research, there are three general areas of research that are critical to establishing and maintaining good management of the whale watching industry. These are behavioural ecology, population biology (particularly health) and socioeconomic issues.

#### *Behavioural Ecology and Habitat Use*

To manage interactions between humans and marine mammals we need to understand their behaviour and recognise their environmental requirements. This understanding will lead to better decisions about processes and interactions that impact on aspects of the animals' lives. Human actions that lead to disturbance of activities, disruption of group dynamics, or displacement, may lead to population decline over the long-term. A developed understanding of species' needs and normal behaviour will lead to appropriate and responsive management systems. As species and populations differ in their basic habitat and behavioural requirements, managers must be sensitive to this variation and investigate specific needs on a case by case basis. Management plans require sound information on habitat use; migratory patterns; activity patterns; and social and group dynamics.

Baseline studies will identify normal patterns of distribution, group dynamics and behaviour and basic habitat requirements. Long-term monitoring can then detect changes in either behaviour or distribution that may be a result of human activities. Specific studies on human/animal interaction will identify short term

responses to potential impacts and be useful in testing appropriate guidelines and best practice standards.

Research has been conducted in Australia in a number of these areas. The growth in interest in marine mammals, which has led to the burgeoning tourism industry, has coincided with a growing interest in scientific aspects of the animals. Populations that have been well studied tend to be those that are also targeted by the whale watching industry. This is in part due to the interest generated in such populations and also to the fact that these populations are usually highly visible and readily accessible to both tourists and scientists. For example, both humpback and southern right whales have a highly predictable seasonal distribution and have exhibited a dramatic recovery from whaling. Further, individuals migrate and rest in near-shore waters, making them not only a focal point for both the general public and the whale watching industry, but also a marine species that is relatively easy to study on a seasonal basis. Thus, extensive research has been conducted on these species over the years. Vang (2001) reviewed the general information on humpback whales and research in Australia, while Corkeron (1996) and ANZECC (1998) reviewed research on this species conducted in Australia across a range of topics. Similar information on southern right whales can be found in Bannister *et al.* (1996) and Burnell and McCulloch (2003).

Generally, there is extensive information on the behaviour and ecology of both species in the resting areas where animals are sighted annually. Studies have included photo-identification of individuals, analysis of behaviour and acoustic elements of behaviour. However, there is little known of the full migratory pathway from Antarctic feeding grounds to breeding areas or on behaviour patterns of travelling animals, because research has focused mainly in tropical breeding and resting areas. Further, the long life span and low fecundity rate of these species mean that population changes in response to human interactions may not be identified for years.

In contrast, bottlenose dolphins occur in most coastal waters of Australia in discrete resident and transient populations. There are numerous local differences in habitat and other ecological attributes that often lead to differences in population behaviour. Thus, while there are some aspects of dolphin biology that are comparable across populations, studies are needed on individual populations to identify local characteristics and habitat requirements. A number of studies have taken place on specific populations, with some studies continuing for 20 years. Populations that have been studied include those at Monkey Mia, Western Australia (e.g. Mann *et al.* 2000, Connor *et al.* 2001), Port Phillip Bay, Victoria (Goldsworthy and Dunn 2000), Jervis Bay, New South Wales (Mandelc 1999; Moller *et al.* 2002), Port Stephens, New South Wales (e.g. Moller *et al.* 2002), Moreton Bay, Queensland (Corkeron 1990, 1997; Chilvers 2000), Bunbury, Western Australia (O'Neil 2001) and Perth, Western Australia (e.g. Waples 1997; Donaldson unpublished data, 2000, Murdoch University). Studies on these populations cover a range of topics, including group dynamics, behaviour and distribution.

While there is a growing body of literature on the impacts of the whale watching industry worldwide, research on specific populations in Australia has been limited. Corkeron (1995) examined humpback whale response to boats. Several studies have been undertaken on the impact of tourist related activities on bottlenose dolphins (e.g., Weir *et al.* 1996; Orams 1997; Dunn and Goldsworthy 2000; Scarpaci *et al.* 2001b). There are several studies underway, including an investigation of humpback whale response to tour boats operating under existing guidelines in NSW waters (Stamation unpublished data, 2002, UNSW), bottlenose dolphin acoustic and behavioural response to tour operations at Monkey Mia (Bejder unpublished data, 2002, Dalhousie University), Port Philip Bay (Scarpaci *et al.* 2001) Jervis Bay (Lemon unpublished data, 2002 Macquarie University) and Port Stephens (Lemon unpublished data, 2002 Macquarie University; Allen unpublished data, 2002 Macquarie University).

Although these examples suggest there is a good deal of information on marine mammal populations around Australia relevant to the management of whale watching, there is still a need for ongoing research to monitor the long-term impacts of the industry. Such research would include baseline information on full migratory pathways, distribution and critical habitat of migratory whales and identification of the habitat requirements and activity of other resident populations facing increasing levels of human interaction. Long-term monitoring is also required to detect deviation from established migratory routes or changes in distribution, general behaviour or habitat use. Finally, more investigation into animal response to vessels and other whale watching activity is required, including testing current guidelines and analysis of the cumulative impact of these activities on migratory animals.

Populations respond differently based on differences in the local environment and the behavioural ecology of each species. While some information is pertinent to whale watching on a global basis, there remains a need for site-specific information. For example, migrating whales may respond differently to human disturbance in areas where they are travelling, compared to areas where they remain to rest and breed. Research is required at a variety of locations where whale watching might occur to ensure that impacts, including cumulative impacts, are minimal. As discrete populations of bottlenose dolphins face varying levels of human interaction, populations must be examined individually, including baseline assessment of population behaviour and distribution.

Baseline information is also required on new populations facing a development of a commercial whale watching industry. ANZECC (2000) recommended that no new activity (e.g. swim programs) begin without initial baseline data on the target population and scope for long-term monitoring to assess impacts. This will allow for appropriate management to be initiated from the start, supported by sound research.

### Population Biology

Research is also required on basic demography. This information will make it possible to assess long-term effects of human activity on population fitness and recovery by highlighting changes in population size, density, recruitment

rate and mortality. Baseline data collection should establish abundance estimates and reproductive and mortality rates for species and populations exposed to whale watching and other human-related activities. Long-term monitoring is required to detect changes in population size and structure, in particular noting changes in reproductive success and in causes of mortality where possible.

A number of studies have been conducted on humpback and southern right whales including long-term investigations of population size and recovery processes (e.g. Paterson and Paterson 1989; Kaufman *et al.* 1993; Burnell 1999; Bannister 2001; Paterson *et al.* 2001). Such studies have used techniques such as annual counts from shore-based sites (Paterson and Paterson 1984), aerial surveys (e.g. Bannister 1986; Kemper *et al.* 1997; Burnell 1999; Chaloupka and Osmond 1999) and photo identification (Kaufman *et al.* 1993; Burnell 1999) to assess population size and growth over time. These studies have been valuable in noting the slow recovery of both humpback and southern right whales (e.g. Paterson *et al.* 1994, 2001).

Events of cetacean mortality are recorded by each State wildlife agency and information provided annually to Environment Australia. However, there is a wide variation in the detail of accounts and investigation into causes of mortality. Further, there has been no rigorous analysis or application of this information to management practices in most states, nor is there any national review or assessment.

Ongoing monitoring of populations exposed to whale watching and other human activities is critical for management needs. For example, in a study on the long-term management of a bottlenose dolphin population, Wilson *et al.* (1999) found that long-term monitoring over at least 8 years was essential to detect changes. Further effort is needed to establish baseline data on populations exposed to commercial whale watching and to maintain ongoing assessments. Further investigation into mortality events that may involve human actions is also warranted.

### Socioeconomic Issues

The goal of management is not only to ensure the protection and conservation of the target species and environment, but also to provide a sustainable industry which benefits the community. Thus, research is also required on socioeconomic aspects of whale watching to ensure that managers can meet this goal. We need to develop an understanding of the perspective and needs of the stakeholders, commercial operators and participants. This can be used to assess the likely capacity of the industry, identify emerging trends and allow a management system to develop that can take into account the various perspectives and needs of the stakeholders. In this regard, baseline information is needed on the current status of the industry including number of operators, types of operations, number of tours and number of participants. Ongoing monitoring of this type of data will identify trends in the industry. Some research has been undertaken (e.g. Anderson *et al.* 1996; Hoyt 2001). States that regulate these activities have access to this information and occasionally compile reports on industry status and growth (e.g. Coughran and Crawford 1996). However, not all states have such regulatory systems in place, nor do all



have the same requirements for annual reporting. Thus, it is currently difficult to compile this information into an Australia-wide perspective.

One of the stated benefits of whale watching is education and improved attitudes towards conservation. Whale watching is seen as a means of increasing the public's awareness and appreciation of marine mammals and the marine environment and thus their commitment to the conservation of both (Russell 2001). There is a need then to understand the motivations, attitudes and expectations of participants in order to model educational information to reach these desired outcomes. People may hold unrealistically high expectations of wildlife viewing experiences (e.g. Green and Higginbotham *et al.* 2001; Moscardo *et al.* 2001). An understanding of this and appropriate educational material may be used to modify expectations and visitor behaviour both during the activity and in the future (Orams 1994, 1996; Moscardo *et al.* 2001). Research is needed not only on current attitudes and expectations, but also on how educational material can be most effectively used to influence attitudes towards wildlife and conservation.

Research on visitor expectations and satisfaction has been conducted in Queensland (e.g. Orams 1996, Neil *et al.* 1996; O'Neil 2001; Birtles *et al.* 2002) and Western Australia (O'Neil and Lee 2001). Beaumont (2000) reviewed the effectiveness of outdoor education and interpretive programs on knowledge of and attitudes towards conservation. Several studies have addressed the use of education as a management tool in nature based recreational activities (e.g. Neil *et al.* 1996; Green and Higginbotham 2001; Higginbotham *et al.* 2001; Moscardo *et al.* 2001). One current study in NSW is addressing visitor satisfaction and usefulness of interpretive material in watching humpback whales at two coastal areas (K. Stamation, unpublished data, 2002, UNSW).

Specific short-term studies may examine public response to the whale watching experience and test the quality and usefulness of educational material. Such information will be useful in management decisions and on the provision of interpretive material to guide expectations, understanding and appreciation for cetaceans and the marine environment and develop an awareness of the impacts human activities.

## Conclusion

There are benefits for marine conservation from the expanding interest in viewing marine mammals. However, there are potential costs, and appropriate management is needed not only to ensure that whale watching will remain a sustainable industry, but also to protect and conserve the

species targeted by the industry. Such management may be established through regulatory processes governed by legislation and must be grounded in sound scientific research. There are various systems in place throughout Australia for the conservation and protection of marine mammals, with no overall coordination of legislation or regulation. Adoption of the following recommendations would lead to a management system appropriate to the needs of the industry and the environment, sensitive and adaptable to identified impacts, resulting in positive conservation outcomes.

1. Endorsement of the ANZECC guidelines as a minimum standard for best practice of cetacean observation by all States. Not only will this ensure continuity between jurisdictions for marine mammals that may cross state borders, but it will improve public perception and understanding of appropriate behaviour around marine mammals.
2. Adoption of a system of recording commercial whale watching tour operators in all States. This may be done through either a regulatory licensing regime or operator register. Such information will allow for assessment of the industry and its growth across Australia and identify areas where potential and cumulative impacts need to be examined.
3. Establishment of a strong scientific basis for future management decisions. This would include:
  - maintaining ongoing research on population estimates, rate of recovery and behaviour to detect changes in populations that may be related to human activities.
  - developing a national marine fauna stranding database which can be used to record information on marine mammal incidents that occur around Australia, including details of cause of death where identified and location of samples collected. Development of a standard minimum protocol for assessment of incidents and sample collection would also improve our understanding of these incidents and may identify important trends.
  - filling information gaps on distribution and behaviour and research
  - assessing the impacts of boat-based whale watching, including identification and assessment of appropriate best practice guidelines and codes of conduct.
  - assessing the industry and the participants to ensure that conservation benefits are maximised through appropriate education and experience.

## References

- Allen, S.J. and Harcourt, R.G. 2001. Big brother is watching from under-water, above-water and on-land: assessing the behaviour of tour vessels around bottlenose dolphins. Abstract in the *Proceedings of the 14<sup>th</sup> Biennial Conference on the Biology Marine Mammals*. Society for Marine Mammalogy, Vancouver.
- Allen, M.C. and Read, A.J. 2000. Habitat selection of foraging bottlenose dolphins in relation to boat density near Clearwater, Florida. *Marine Mammal Science* 16: 815-824.
- Anderson, G.R.V., Forbes, M.A. and Pirzl, R.M. 1996. A national overview of the development of whale watching in Australia. p 5-16 in *Proceedings of Encounters with Whales*, edited by K. Colgan, S. Prasser, A. Jeffery. Australian Nature Conservation Agency, Canberra.
- ANZECC. 2000. *Australian national guidelines for cetacean observation and areas of special interest for cetacean observation*. Australian and New Zealand Environment and Conservation Council, Canberra, ACT.



- ANZECC. 1998. *Humpback Whale Research and Conservation Seminar*. Department of Environment and Heritage, Brisbane, Qld.
- Baker, C.S. and Herman, L.M. 1989. *Behavioral responses of summering humpback whales to vessel traffic: experimental and opportunistic observations*. Final report to the United States Department of the Interior National Park Service Anchorage Alaska. Technical report NPS-NR-TRS-89-01.
- Bannister, J.L. 1985. Southern right (*Eubalaena australis*) and humpback (*Megaptera novaeangliae*) whales off Western Australia: some recent aerial survey work. Pages 105-113 in *Studies of Sea Mammals in South Latitudes*, edited by J.K. King and M.M. Bryden. South Australian Museum, Adelaide, SA.
- Bannister, J.L. 1986. Southern right whales status off Australia from twentieth century 'incidental' sighting and aerial survey. *Report to the International Whaling Commission. Special issue 10*: 153-157.
- Bannister, J.L. 2001. Status of southern right whales (*Eubalaena australis*) off southern Australia. *Journal of Cetacean Research and Management (Special Issue 2)*.
- Bannister, J.L., Kemper, C.M. and Warneke, R.M. 1996. *The Action Plan for Australian Cetaceans*. Australian Nature Conservation Agency, Canberra
- Bannister, J.L. and Hedley, S.H. 2001. Southern hemisphere Group IV humpback whales: Their status from recent aerial survey. *Memoirs Of The Queensland Museum 47*(2):587-598.
- Beaumont, N. 2001. Ecotourism and the conservation ethic: recruiting the uninitiated or preaching to the converted? *Journal of Sustainable Tourism 9*:317-341.
- Bejder, L., Dawson, S.M. and Harraway, J.A. 1999. Response by Hector's dolphins to boats and swimmers in Porpoise Bay, New Zealand. *Marine Mammal Science 15*: 738-750.
- Birtles, R.A., Arnold, P.W. and Dunstan, A. 2002. Commercial swim programs with dwarf minke whales on the Northern Great Barrier Reef, Australia: some characteristics of the encounters with management implications. *Australian Mammalogy 24*: 23-38.
- Brix, K. and Nitta, E.T. 2001. Whale watching and humpback whale protection in Hawaii and Alaska. Pages 50-51 in *Viewing Marine Mammals in the Wild, a workshop to discuss responsible guidelines and regulations for minimizing disturbance*, edited by T. Spradlin, E. Nitta, J. Lewandowski, L. Barre, K. Brix and B. Norberg. NOAA Fisheries. Vancouver, BC.
- Burnell, S.R. and McCulloch, R.E. 2003. *Draft Recovery Plan for the Southern Right Whale in Australian Waters*. Unpublished report. Environment Australia, Canberra, ACT.
- Burnell, S.R., 1999. The population biology of southern right whales in southern Australian waters. Ph.D. Thesis. University of Sydney. Sydney, Australia; 227pp.
- Chaloupka, M. and Osmond, M. 1999. Spatial and seasonal distribution of humpback whales in the Great Barrier Reef Region. *American Fisheries Society Symposium 23*:89-106.
- Chilvers, B.L. 2000. The apparent dependence of some bottlenose dolphins on trawler discard within Morton Bay, SE. Queensland. Abstract in the *Proceedings from the Southern Hemisphere Marine Mammal Conference*. Phillip Island, Vic.
- CMC and NMFS. 1988. *Proceedings of the Workshop to Review and Evaluate Whale Watching Programs and Management Needs*. Sponsored by the Center for Marine Conservation and National Marine Fisheries Service. November 14-16, 1988, Monterey, California. 53pp.
- Coleman, G. and Hunter, I. 2002. Proposed regulation of the commercial marine mammal observation tour industry. *NSW Government Discussion Paper*. NSW National Parks and Wildlife Service, Hurstville, NSW.
- Connor, R.C. and Smolker, R.S. 1985. Habituated dolphins (*Tursiops sp.*) in Western Australia. *Journal of Mammalogy 66*:398-400.
- Connor, R.C., Heithaus, M.R. and Barre, L.M. 2001. Complex social structure, alliance stability and mating access in a bottlenose dolphin 'super-alliance'. *Proceedings of the Royal Society of London 268*:263-267.
- Constantine, R. 2001. Increased avoidance of swimmers by wild bottlenose dolphins due to long-term exposure to swim-with-dolphin tourism. *Marine Mammal Science 17*:689-702.
- Corbelli, C. 2001. An evaluation of the impact of whale watching vessels on humpback whales in Newfoundland, Canada and an evaluation of voluntary codes of conduct to minimize impact and ensure passenger benefits. p 83-85 in *Viewing Marine Mammals in the Wild, a workshop to discuss responsible guidelines and regulations for minimizing disturbance*, edited by T. Spradlin, E. Nitta, J. Lewandowski, L. Barre, K. Brix and B. Norberg. NOAA Fisheries. Vancouver, BC.
- Corkeron, P. 1990. Aspects of the behavioural ecology of the inshore dolphins *Tursiops truncatus* and *Sousa chinensis* in Moreton Bay, Australia. Pages 285-293 in *The Bottlenose Dolphin*, edited by S. Leatherwood and R. Reeves. Academic Press Inc, San Diego, California.
- Corkeron, P.J. 1995. Humpback whales in Hervey Bay, Qld: behavior and responses to whale -watching vessels. *Canadian Journal of Zoology 73*: 1290-1299.
- Corkeron, P.J. 1996. Research priorities for whale watching in Australia: a scientist's viewpoint. p 133-136 in *Proceedings of Encounters with Whales*, edited by K. Colgan, S. Prasser and A. Jeffery). Australian Nature Conservation Agency, Canberra.
- Coughran, D. and Crawford, S. 1996. Marine mammal interaction: an overview of the whale watching industry in Western Australia 1989-1994. p 161-166 in *Proceedings of Encounters with Whales*, edited by K. Colgan, S. Prasser and A. Jeffery. Australian Nature Conservation Agency, Canberra.
- Dunn, W. and Goldsworthy, A. 2000. Behavioural responses of bottlenose dolphins (*Tursiops truncatus*) to dolphin swim tour vessels in southern Port Phillip Bay, Victoria. Poster Presentation *Australian Marine Science Association Conference*, Sydney, Australia.
- Erbe, C. 2000. Underwater noise of whale watching boats and its effects on marine mammals. *International Whaling Commission. SC/2/WW11*.
- Findlay, K. 2001. Can we watch whales and not disturb them? Abstract in the *Proceedings from the Southern Hemisphere Marine Mammal Conference*. Phillip Island, Victoria, Australia.
- Frohoff, T.G., Herzig, D.L. and Santos, M. 1995. Report from the workshop Human-interactions with small cetaceans: research and management. Convened at the 11<sup>th</sup> Biennial conference on the Biology of Marine Mammals, December 1995, Orlando FL.
- Goldsworthy, A. and Dunn, W. 2000. Residency status of a population of bottlenose dolphins (*Tursiops truncatus*) in southern Port Phillip Bay, Victoria 1997-1999. Poster Presentation. *Australian Marine Science Association Conference*, Sydney, Australia.

- Green, R. and Higginbotham, K. 2001.** The Negative Effects of wildlife tourism on wildlife. Wildlife Tourism Research Report No. 1. *Status Assessment of Wildlife Tourism in Australia Series*. CRC for Sustainable Tourism, Gold Coast, Qld.
- Grossek, G. 1998.** Regulatory Impact Statement: Wildlife (Whales) Regulations 1998. Department of Natural Resources and Environment, Melbourne, Victoria.
- Higginbotham, K. Northrope, C.L. and Green, R.J. 2001.** Positive effects of wildlife tourism on wildlife habitats. Wildlife Tourism Research Report No. 6. *Status Assessment of Wildlife Tourism in Australia Series*, CRC for Sustainable Tourism.
- Hoyt, E. 1996.** Whale watching: a global overview of the industry's rapid growth and some implications and suggestions from Australia. p 31-36 in *Proceedings of Encounters with Whales*, edited by K. Colgan, S. Prasser and A. Jeffery. Australian Nature Conservation Agency, Canberra.
- Hoyt, E. 2001.** Whale watching 2001: *Worldwide tourism numbers, expenditures and expanding socioeconomic benefits*. International Fund for Animal Welfare, Yarmouth Port, MA USA. 158pp.
- IFAW, Tethys Research Institute and Europe Conservation. 1995.** *Report of the workshop on scientific aspects of managing whale watching*. Sponsored by International Fund for Animal Welfare and Tethys Research Institute and Europe Conservation Montecastello di Bivio, Italy. IFAW, Crowborough, UK. 40 pp.
- International Whaling Commission. 1994.** *Forty-fourth report of the International Whaling Commission*. Cambridge: IWC.
- Janik, B.M. and Thompson, P.M. 1996.** Changes in surfacing patterns of bottlenose dolphins in response to boat traffic. *Marine Mammal Science* 12: 597-602.
- Kaufman, G.D., Lagerquist, B.A., Forestell, P.H. and Osmond M.G. 1993.** *Humpback whales of Australia: A catalogue of individual whales identified by fluke photographs*. Queensland Department of Environment and Heritage. Brisbane.
- Kemper, C.M., Mole, J., Warneke, R.M., Ling, J.K., Needham, D.J. and Wapstra, J.E. 1997.** Southern Right Whales in south-eastern Australia - aerial surveys during 1991-93 and incidental information from 1904. p 40-55 in *Marine Mammal Research in the Southern Hemisphere, Volume 1: Status, Ecology and Medicine*, edited by M. Hindell and C. Kemper. Surrey Beatty and Sons, Chipping Norton, Melbourne, Australia.
- Kruse, S. 1991.** Interactions between killer whales and boats in Johnstone Strait, BC. p 149-159 in *Dolphin Societies: Discoveries and Puzzles*, edited by K. S. Norris and K. Pryor. University of California Press, Berkeley.
- Lalime-Bauer, J. 2000.** Operator compliance to Australian whale watching regulations and guidelines. International Whaling Commission. SC/52/WW4.
- Lear, R.J. and Bryden, M.M. 1980.** A study of the bottlenose dolphin *Tursiops truncatus* in eastern Australian waters. Australian National Parks and Wildlife Service Occasional Paper No. 4. 23pp.
- Malcolm, C. and Duffus, D. 1998.** *Whale-watching workshop report summary*. World Marine Mammal Science Conference. Monaco, January 19-26.
- Mandelc, F. 1997.** Ecology and conservation of the bottlenose Dolphin *Tursiops truncatus* in Jervis Bay, NSW. Doctoral Dissertation. Macquarie University. 202 pp.
- Mann J., Connor, R.C., Barre, L.M. and Heithaus, M.R. 2000.** Female reproductive success in wild bottlenose dolphins (*Tursiops* sp): Life history, habitat, provisioning and group size effects. *Behavioural Ecology* 11:210-219.
- Moller, L.M., Allen, S.J. and Harcourt, R.G. 2002.** Group characteristics, site fidelity and seasonal abundance of bottlenose dolphins *Tursiops aduncus* in Jervis Bay and Port Stephens, south eastern Australia. *Australian Mammalogy* 24:11-21.
- Moller, L.M. and Harcourt, R.G. 1998.** Social dynamics and activity patterns of bottlenose dolphins, *Tursiops truncatus*, in Jervis Bay, Southeastern Australia. *Proceedings of the Linnaean Society of NSW*. 120: 181-189.
- Moscato, G., Woods, B. and Greenwood, T. 2001.** Understanding visitor perspective's on wildlife tourism. Wildlife Tourism Research Report No. 2. *Status Assessment of Wildlife Tourism in Australia Series*. CRC for Sustainable Tourism, Gold Coast, Qld.
- Neil, D., Orams, M. and Baglioni, A. 1996.** Effect of previous whale watching experience on participants knowledge of, and response to, whales and whale watching. Pages 182-1888 in *Proceedings of Encounters with Whales*, edited by K. Colgan, S. Prasser and A. Jeffery. Australian Nature Conservation Agency, Canberra.
- Noad, M. J. and Cato, D.H. 2001.** combined acoustic and visual survey of humpback whales off southeast Queensland. *Memoirs of the Queensland Museum* 47(2):507-523.
- Nowacek, S.M., Wells, R.S. and Solow, A.R. 2001.** Short-term effects of boat traffic on bottlenose dolphins in Sarasota Bay, Florida. *Marine Mammal Science*. 17:673-688.
- O'Neill, F. 2001.** Ecologically sustainable management of tourist-minke whale interaction: visitor experiences with dwarf minke whales in the far Northern Region of the Great Barrier Reef, Queensland. p 97-99 in *Viewing Marine Mammals in the Wild, a workshop to discuss responsible guidelines and regulations for minimizing disturbance*, edited by T. Spradlin, E. Nitta, J. Lewandowski, L. Barre, K. Brix and B. Norberg. NOAA Fisheries. Vancouver, BC.
- O'Neill, F. and Lee, D. 2001.** Dolphin interaction: Tourism management and best practice. p 34-38 in *Viewing Marine Mammals in the Wild, a workshop to discuss responsible guidelines and regulations for minimizing disturbance*, edited by T. Spradlin, E. Nitta, J. Lewandowski, L. Barre, K. Brix and B. Norberg. NOAA Fisheries. Vancouver, BC.
- Orams, M.B. 1994.** Creating effective interpretation for managing interaction between tourists and wildlife. *Australian Journal of Environmental Education* 10:21-34.
- Orams M. 1996.** Cetacean education: can we run tourists into 'greenies'? p 167-177 in *Proceedings of Encounters with Whales*, edited by K. Colgan, S. Prasser, A. Jeffery. Australian Nature Conservation Agency, Canberra.
- Orams, M.B., Hill, G.J.E. and Baglioni, A.J. Jr. 1996.** "Pushy" behavior in a wild dolphin feeding program at Tangalooma, Australia. *Marine Mammal Science* 12:101-117.
- Paterson, R.A. and Paterson, P. 1984.** A study of the past and present status of humpback whales in east Australian waters. *Biological Conservation* 47: 33-48.
- Paterson, R.A. and Paterson, P. 1989.** The status of the recovering stock of humpback whales (*Megaptera novaeangliae*) in east Australian waters. *Biological Conservation* 47: 33-48.
- Paterson, R.A., Paterson, P. and Cato, D.H. 1994.** The status of humpback whales *Megaptera novaeangliae* in east Australia thirty years after whaling. *Biological Conservation* 70: 135-142.

- Paterson, R.A., Paterson, P. and Cato, D.H. 2001.** Status of humpback whales, *Megaptera novaeangliae*, in east Australia at the end of the 20th century. *Memoirs Of The Queensland Museum* 47(2):579-586.
- Peterson, H. 2001.** Studying and mitigating disturbance to humpback whales near Juneau, Alaska. p 99-103 in *Viewing Marine Mammals in the Wild, a workshop to discuss responsible guidelines and regulations for minimizing disturbance*, edited by T. Spradlin, E. Nitta, J. Lewandowski, L. Barre, K. Brix and B. Norberg. NOAA Fisheries. Vancouver, BC.
- Richardson, W.J. 1995.** Documented disturbance reactions. p 241-576 in *Marine Mammals and Noise*, edited by W. Richardson, C. Greene, C. Malme and D. Thomson. Academic Press, San Diego, CA.
- Richter, C., Dawson, S. and Slooten, E. 2001.** Sperm whale watching off Kaikoura, NZ: current research, impacts and education. In *Viewing Marine Mammals in the Wild, a workshop to discuss responsible guidelines and regulations for minimizing disturbance*, edited by T. Spradlin, E. Nitta, J. Lewandowski, L. Barre, K. Brix and B. Norberg. NOAA Fisheries. Vancouver, BC.
- Scarpaci, C., Corkeron, P.J., Nuggeoda, D. 2001a.** Compliance with regulations by swim-with-dolphins operations in Port Phillip Bay, Victoria Australia. p 30-31 in *Viewing Marine Mammals in the Wild, a workshop to discuss responsible guidelines and regulations for minimizing disturbance*, edited by T. Spradlin, E. Nitta, J. Lewandowski, L. Barre, K. Brix and B. Norberg. NOAA Fisheries. Vancouver, BC.
- Scarpaci, C., Corkeron, P.J. and Nuggeoda, D. 2001b.** Monitoring whistles produced by bottlenose dolphins (*Tursiops truncatus*) during approaches by commercial dolphin-swim charters: A new perspective to managing cetacean based eco-tourism. *Proceedings of the Southern Hemisphere Marine Mammal Conference*. Phillip Island, Vic.
- Spradlin, T.R., Nitta, E.T., Lewandowski, J.K., Barre, L.M., Brix, K. and Norberg, B. 2001.** *Viewing Marine Mammals in the Wild: a Workshop to Discuss Responsible Guidelines and Regulations for Minimizing Disturbance*. NOAA Fisheries. Vancouver, BC.
- Stevens, T., Jeffery, A. and Coughran, D. 1995.** Whale watching in Australia- an agency view. *Proceedings of Encounter with Whales*, edited by K. Colgan, S. Prasser and A. Jeffery. Australian Nature Conservation Agency, Canberra. ACT.
- Stokes, T., Dobbs, K. and Recchia C. 2002.** Management of marine mammal tours on the Great Barrier Reef. *Australian Mammalogy* 24:39-49.
- Trites, A. and Bain, D.E. 2000.** Short and long-term effects of whale watching on killer whales in British Columbia. International Whaling Commission. SC/52/WW18.
- Vang, L. 2002.** Distribution, abundance and biology of Group V humpback whales *Megaptera novaeangliae*: a review. Conservation Management Report to the Environmental Protection Agency, Brisbane, Qld. 20 pp.
- Waples, K.A. 1997.** The rehabilitation and release of bottlenose dolphins from Atlantis Marine Park, Western Australia. Doctoral Dissertation. Texas A&M University. 211pp.
- Weir, J., Dunn, W., Bell, A. and Chatfield, B. 1996.** An investigation into the impact of dolphin swim ecotours in southern Port Phillip Bay. Report to the Department of Tourism, Federal Government, Australia.
- Wells, R.S. and Scott, M.D. 1997.** Seasonal incidence of boat strikes on bottlenose dolphins near Sarasota, Florida. *Marine Mammal Science* 13: 475-480.
- Wilson, B., Hammond, P.S. and Thompson, P.M. 1999.** Estimating size and assessing trends in a coastal bottlenose dolphin population. *Ecological Applications* 9(1): 288-300.