INTERACTIONS BETWEEN VESSELS AND DOLPHINS IN PORT PHILLIP BAY

FINAL REPORT, September 2002.

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To: Victorian Department of Natural Resources and Environment.

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EXECUTIVE SUMMARY & RECOMMENDATIONS

A draft of this report was given to Port Phillip Bay dolphin tour industry as well as researchers prior to being finalised. Useful suggestions were made by both groups at the outset of the study and in response to the draft report. These suggestions were greatly appreciated and many have been incorporated into the final report. The main finding of the report is that proximity of all kinds of vessel to dolphins must be further restricted in order that adverse impacts on the dolphin population can be minimised. The report presents a number of recommendations as to how this can be best achieved while allowing for a sustainable industry.

The dolphins that inhabit Port Phillip Bay and are the object of the dolphin swim and sightseeing tour industry are inshore bottlenose dolphins (*Tursiops aduncus*). They are a small population resident to the southern part of the bay near its mouth. The current population is probably smaller than prior to European settlement, and prior to intensive development and loss of fisheries habitat in the last 40 years. This review addresses the issue of sustainability in regard to tour, other commercial, and private boat interactions with dolphins. NRE advises that other processes and actions are being undertaken currently to protect the Port Phillip Bay environment and as a consequence to protect dolphin habitat.

The dolphins use their home range for all aspects of their ecology, including their main activities, foraging and feeding, as well as socialising, resting, and the protection and rearing of young. The population of bottlenose dolphins in Port Phillip Bay is vulnerable to extinction due to its size, female natal philopatry, restricted home range and the human activities within the home range that are likely to be having an adverse impact on the dolphins.

Data from several years of research on the Port Phillip Bay dolphins and vessel proximity to them, carried out by the Dolphin Research Institute and Carol Scarpaci *et al.*, was analysed for this report. The research by both groups is generally sound and uses methods that are well recognised in this field (eg, Martin & Bateson 1993). The data has limitations but provides a solid basis for making decisions to improve management for sustainability.

Many types of vessel use the dolphins' habitat; high and low-speed recreational vessels, commercial shipping, passenger ferries, dolphin swim-tours and dolphin sightseeing tours. Their use of the habitat is increasing, as will their interactions with dolphins. Of these dolphin swim-tours present the largest potential impact due to their sustained interaction with (proximity to) the dolphins, especially during daylight hours in the summer months, November to May. Breaches of the Wildlife (whales) Regulations (Victoria) (Anon. 1998) by all types of vessel are evident. Adverse impacts from vessel traffic, both lethal and non-lethal, could lead to a reduction in recruitment of females into the breeding population, in which case the population is likely to die out in the foreseeable future.

The number of dolphins that swim-tour vessels attempt to interact with on a regular basis is most likely no more than 50, although the size of the population is probably about 80. Increasing levels of interaction by swim-tour vessels and to lesser extent recreational vessels, often in contravention of existing regulations, have been associated with an increase in avoidance of swim-tour vessels by dolphins. This avoidance behaviour is seen as indicative of disturbance that constitutes a threatening process. Regulations contravened include approach distances, number of tour vessels in proximity to dolphins at the one time and swim with foetal-fold (newborn) calves

The Victorian regulations governing swim-tour operations and other vessel traffic are comprehensive and in accord with national guidelines. Approach distances to dolphins are less than those recommended (but not as yet regulated) for dolphin and other Odontocete cetacean sightseeing operations in North America, where experience with the cetacean-watch industry spans more than 20 years and is on a larger scale.

It is apparent from the data that tour operators, other commercial vessels and recreational vessels are not only breaching the letter but also the intent of the Wildlife (whales) Regulations (Victoria), those of relevance having been formulated to allow for vessel interactions at the same time as attempting to minimise any impact on dolphins.

After analysis of available data on parameters for the population and the impact of vessel traffic on the Port Phillip Bay dolphins, and consideration of the results of studies overseas, recommendations below (see also Table 5) aim to further protect dolphins as well as give tour operators the opportunity to improve compliance to regulations and recognise the intent of regulations to protect this small and fragile population.

The proposed changes to regulations represent a shift away from the current focus on regulating the number of swimmers to regulating the proximity of vessels to dolphins. It seems reasonable to trial any proposed changes to the regulations, but to be worthwhile the trials must be monitored by independent observers who are trained in the collection of behavioural data in the field. In addition to recommended changes to regulations outlined below and in Table 5, it is proposed that:

- The proximity of vessels to dolphins continues to be monitored, as well as the responses of dolphins to vessels.
- There continue for the present to be no limit on the overall number of swim tours per vessel per season or per day, an aspect of operation that may need to be addressed if dolphin avoidance of vessels and vessel disruption of normal dolphin behaviours, including foraging and feeding, continues to increase.
- The number of dolphin swim permits be maintained at 4 while not at this stage limiting the number of dolphin sightseeing permits, with the consequences for overall vessel proximity to dolphins, and regulations aiming to reduce proximity, being assessed before there is any decision to increase the number of sightseeing permits beyond the present two.
- The use of the Ticonderoga Bay Dolphin Sanctuary Zone and adjacent areas to the west and north by dolphins be investigated with a view to extending the area westwards, northwards or both in order to provide additional area where dolphins

may not be approached by tour vessels closer than 200m, and where approach distances by other commercial and recreational vessels is restricted to 200m.

To regulate the impact of vessels on dolphins:

- Limit to three per tour the maximum number of approaches closer than 100m to dolphins by swim-tour vessels, per tour.
- Limit to 7 minutes the time a swim-tour vessel can be within 100m of a dolphin on each approach.
- Limit to one per tour the number of approaches closer than 100m to dolphins by sightseeing tour vessels.
- Limit to 7 minutes the time a sightseeing tour vessel can be within 100m of a dolphin on each tour.
- Prohibit approaches within 100m to dolphin groups containing foetal-fold calves.
- Increase to 300m the minimum distance that a tour vessel can approach another tour vessel if that tour vessel is within 100m of a dolphin.
- Increase minimum approach distances in the Ticonderoga Bay Sanctuary Zone to 200m for all motorised vessels.
- Consider prohibiting dolphin swims in areas where vessel navigation is restricted.
- Allocate the existing number of swim-tour permits for 2002/2003 and 2003/2004 seasons but not grant any additional permits.
- Consider effectiveness of regulations and issue of permits after 2003/2004 season on the basis of dolphin behaviour monitoring and compliance to regulations by permit holders.

To monitor short-term impacts on dolphins:

- Continue to monitor dolphin responses to approaches from swim-tour, sightseeing tour and recreational vessels. Determine background level of avoidance behaviour through monitoring behaviour in the absence of vessels, and analysis of data.
- Continue to monitor compliance to regulations over 2002/2003 and 2003/2004 seasons, from both shore-based and boat-based (including swim-tour) stations.

- Monitor and analyse data on dolphin and vessel use of Ticonderoga Bay Sanctuary Zone.

To inform the industry and public:

- Conduct training workshops to inform swim-tour operators of existing and new regulations and the reasons for them, and train them to recognise calves.
- Inform the swim-tour and sightseeing industry of results of monitoring operator compliance and dolphin responses to approaches and interactions, on a regular basis.
- Include questions on marine mammal regulations in the test for recreational boating license.
- Conduct extension activities (eg pamphlets, signage, boat-based surveillance) to inform recreational boaters of existing and new regulations and the reasons for them.

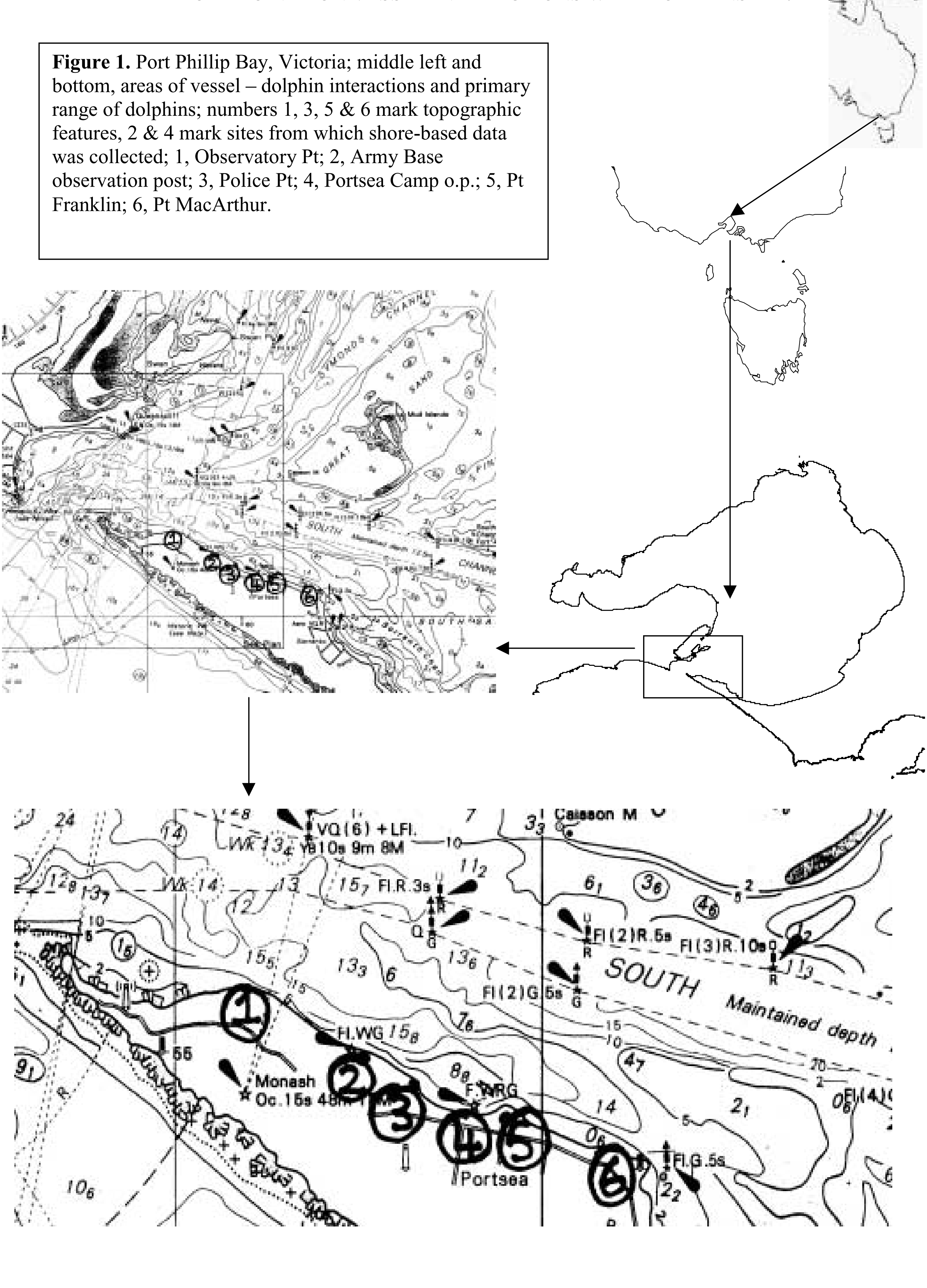
Further research for impact assessment and management:

- Continue to collect demographic information on dolphins to enable variables such as population size, age at first breeding, calving rate and calf and adult survivorship to be determined with greater precision. Carcase recovery and post-mortem to be a priority.
- Conduct population genetic analysis to help identify sex of individual dolphins, size of female breeding population and the geographic range of the population.
- Conduct population modelling, using collected data and data sourced from other populations, to establish confidence levels for population persistence under different parameter values.
- Investigate dolphin use of the Ticonderoga Bay Dolphin Sanctuary Zone and surrounding waters to determine whether an extension to the zone would be effective in providing further sanctuary for dolphins.

Other:

- Remove the limit on the number of swimmers per tour and per day.

Figure 1. Port Phillip Bay, Victoria; middle left and bottom, areas of vessel – dolphin interactions and primary range of dolphins; numbers 1, 3, 5 & 6 mark topographic features, 2 & 4 mark sites from which shore-based data was collected; 1, Observatory Pt; 2, Army Base observation post; 3, Police Pt; 4, Portsea Camp o.p.; 5, Pt Franklin; 6, Pt MacArthur.



BACKGROUND

The inshore bottlenose dolphin, *Tursiops aduncus.*

Two morphological forms of the bottlenose dolphin, *Tursiops truncatus*, are recognised in the Indo-Pacific region; an inshore or coastal dwelling form *T. aduncus* and an offshore form *T. truncatus* (Hale *et al.* 2000). *T. truncatus* has a worldwide distribution in tropical and temperate waters but *T. aduncus* is recognised in the Indo-Pacific region only. The two forms are distinguished morphologically by differences in adult body length, skull size and colour patterns. In Eastern Australia, *T. aduncus* inhabits estuarine and coastal ocean waters to about 30m in depth while *T. truncatus* has been identified predominantly in deeper ocean waters, at least to the edge of the continental shelf (Hale *et al.* 1998, Hale *et al*. 2000). There is considerable sympatry in their distributions in this region. Genetic studies have revealed the two morphotypes to be genetically distinct at the level of species within the subfamily Delphininae. Thus when in sympatry, where their ranges overlap, the two forms are reproductively isolated for genes inherited through males and females (nuclear genes) as well as mitochondrial genes, which are inherited through females alone. This is evidence that they are separate species (Hale *et al.* 1997, 1999).

Genetic and morphological tools have enabled inshore and offshore bottlenose dolphins to be distinguished in Australian waters (Hale *et al.* 1997, 1999, 2000). The *T. aduncus* genotype is present around the entire Australian coastline, including Port Phillip Bay (Gratten & Hale 1997). Research investigations carried out prior to this genetic analysis have frequently identified the Port Phillip Bay dolphin population as *T. truncatus* primarily.

Studies of population structure using genetic methods reveal striking population structure for female lineages amongst *T. aduncus*, while for mixed genetic lineages (telling us, by subtraction, what males are doing) the population structure is consistent with a model of isolation by distance (Gratten & Hale 1997, Hale *et al.* 1999). The genetic data reveals female natal philopatry (from G/L philos (love of) & L patria (native land), with males moving about during their lifetime, dispersing genes amongst populations and as a consequence preventing inbreeding in discrete local populations such as the one in Port Phillip Bay.

The consequence of this natal philopatry is that females and their female descendents stay at or close to their natal site throughout their lives. They rear their young within the maternal home range and the female offspring remain with the group. Thus the matriline is site-attached. The integrity of the group within the home range is most likely maintained by related females. Port Phillip Bay appears to be such an area. The small population of dolphins using Port Phillip Bay will most likely comprise related females, their young offspring, and adult males that are moving over a larger home range, which includes the bay, or have taken up residence in the bay. The consequence of this natal philopatry is that if the females in a population go extinct then it will take a very long time for females to move in from elsewhere.

In the past there appear to have been many more dolphins in Port Phillip Bay than at present. The Herald (Melbourne) newspaper from the 1930's reports large groups of dolphins interfering with fishing in northern Port Phillip Bay (McDonald pers. comm.). Many of these would have been common dolphins (*Delphinus delphis*) as this species is, or was, a regular, although most likely seasonal visitor to the bay, and is found in large numbers along the south and east coasts of Australia. Both bottlenose and common dolphins have been found in the bay. Records of cetacean strandings in Victoria over the last 35 years (DNRE 2002) show 28 records of dolphin strandings inside Port Phillip Bay, 18 bottlenose and 10 common dolphins (Fig. 2). The distribution of strandings most likely reflects human population density rather than dolphin density. It is considered a rare event nowadays to see a common dolphin in the bay (Scarpaci *et al.* 1999), perhaps co-incidental with severe reductions in fish biomass in recent decades (CSIRO 1996). Offshore bottlenose dolphins (*Tursiops truncatus*) on the east coast of Australia are seldom seen in estuaries and are unlikely to be found in coastal waters shallower than 30m (Hale *et al.* 2000). It is unlikely that this species is resident to Port Phillip Bay, although it is known to inhabit offshore waters of Southern Australia and seems to have been sighted in the bay. The *T. aduncus* of Port Phillip Bay that are the subject of this review are seldom sighted in the northern part of the bay (DRI pers. comm.), although stranding records indicate their use of the northern bay (Fig. 2).

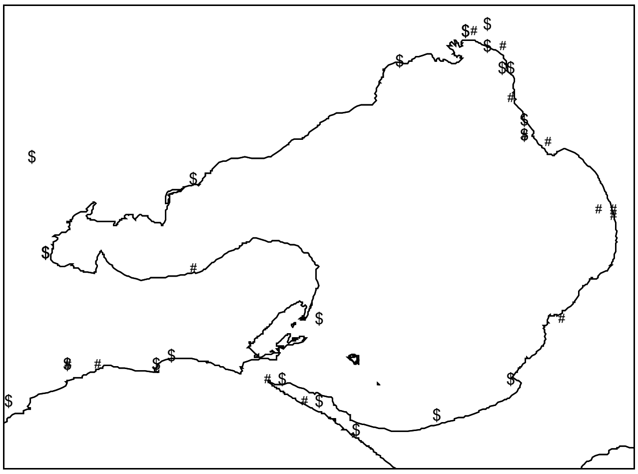


Figure 2. Map of Port Phillip Bay showing the locations of dolphin strandings recorded opportunistically over 35 years; from DNRE database (DNRE 2002); circles, common dolphin (*Delphinus delphis);* triangles, bottlenose dolphin *(Tursiops spp).*

This current population of *T. aduncus* is likely to be fewer than that found at the time of European settlement or even more recently when the bay was in better condition than at present. Large reductions in fish habitat and fisheries in Port Phillip Bay in recent decades (CSIRO 1996) may have led to a reduction in the number of *T. aduncus* in the bay. There has been a clear decline in seagrass in the last thirty years and many species of fish have shown large decreases in abundance over this period (CSIRO 1996).

An interesting consideration for the management of Port Phillip Bay's dolphins is the absence of a resident population of *T. aduncus* in Sydney's Port Jackson / Botany Bay. There are resident populations of *T. aduncus* nearby, in Jervis Bay to the south and Port Stephens to the north of these estuaries. Flannery (1999) and Moorhouse (1999), in their histories of Sydney, make no mention of dolphins in Port Jackson, but it is likely that a population of *T. aduncus* existed in Sydney Harbour and / or Botany Bay because the habitat is appropriate and sufficiently large to support a population, and there are populations nearby to the north and south. Anthropogenic impacts may have led to the extinction of resident population(s) in Port Jackson and Botany Bay, and these most likely include directed killing for food in the 19th (& 20th?) century, killing for bait (once a common practice in Australian waters) in the 19th and 20th centuries and loss or alienation of habitat. The absence of re-colonisation of Port Jackson/Botany Bay by *T. aduncus* from nearby populations suggests that localised population extinction may be long lasting if not permanent.

General consideration of the ecology of *T. aduncus in* Port Phillip Bay.

The bottlenose dolphins (*T. aduncus*) of Port Phillip Bay are a small population that appear to be resident in the area around but mainly on the inside of the mouth of the bay (Fig. 1). They are the only resident population of dolphins in the bay and spend most of their time in the southern area close to the mouth of the bay, rather than in the extensive bay, although they have been observed further north. The likely reason for a ranging area near the mouth of the bay is to exploit feeding opportunities, as migratory species such as squid, mullet and barracouta, on which these dolphins are known to forage, move in and out of the bay through its narrow mouth. They are also likely to forage around seagrass beds in the area.

There is a strong tidal flow on the ebb tide through the deep channels close to the bay mouth that may exceed 8 knots, with a substantial flow rate on the flood tide as well (CSIRO 1996). Dolphins are likely to stay in the deeper water eddies inshore along the Portsea coast, where the tidal flow is weaker, when not feeding and the tide is running, to avoid the need to expend energy swimming against the tide in order to maintain position within their home range. On the Queenscliff coast to the west there are not significant deeper water eddies, as near shore areas are very shallow. The only deep water on the Queenscliff coast is in the Loelia Channel, where the tide runs rapidly. Dolphins certainly feed along the Queenscliff coast, on squid and other prey, but they are not often seen there. In the Portsea / Sorrento area the bottom topography is different, with deeper water close to the shore from Pt Nepean to Portsea and then further east in Capel Sound off Rye

(Fig. 1). Tidal flow in these areas is weaker, and dolphins are often observed feeding, travelling and socialising (Dunn *et al.* 2001, Scarpaci *et al.* in press). Topography, foraging opportunities and food availability may be the reason why these dolphins spend a large proportion of time in this area. This area is also the focus of dolphin swim-tours and much other vessel traffic, including vehicular ferries, commercial shipping moving in and out of the bay as well as fast- and slow-moving recreational vessels.

Most of the dolphin swim-tour interactions occur from Portsea to Blairgowrie, inshore (ie, to the south) of the South Shipping Channel (Fig. 1, Dunn *et al.* 2001). Therefore, most of the interactions occur where the dolphins spend most of their time. Here they forage, feed, rest and socialise. Bottlenose dolphins need to feed regularly, at least every few days, and are on the lookout for food continually. Scarpaci *et al.* (in press) found feeding and travelling behaviours of Port Phillip Bay dolphins to be distributed more or less evenly throughout the year.

REVIEW OF PUBLISHED RESEARCH AND GUIDELINES

This section is a review of published research and guidelines relevant to dolphin swim and dolphin viewing programs, as well as other interactions between vessels and odontocete cetaceans. It does not include the findings of any research on the Port Phillip Bay dolphins, which is dealt with in subsequent sections. Studies involving dolphin groups rather than single animals were reviewed. Lone dolphin interactions have been reviewed (Samuels *et al.* 2000) and are the subject of current studies (Cunningham-Smith *et al.* 2001, Goffman & Kerem 2001). As these studies are concerned with lone dolphins rather than the impacts of humans on dolphin populations they will not be considered further herein.

Dolphin swim and sight-seeing tours

Constantine & Baker (1997) and Constantine (2001) monitored the commercial swim with dolphin and dolphin watch operations in the Bay of Islands, New Zealand. The topography of most of the study area was open ocean, and common dolphins as well as bottlenose dolphins frequent the study area. Neither species studied was considered to be resident in the study area. The 'population' of bottlenose dolphins in this area that is the target of the swim and sightseeing tours is estimated at 450 (Constantine 2001).

Constantine & Baker (1997) considered an interaction distance between tour vessels and dolphins of 400m on the basis of a study by Baker & Herman (1989) of humpback whales. They compared behaviours of bottlenose dolphins at 400m with those at 100m. From 111 instances where behaviours were assessed at both distances, a change was detected in 30% of cases. Of these, 23 were a change from some other behaviour to 'bow-ride', 5 another behaviour to 'travel', 4 another behaviour to 'dive', 1 'travel' to 'mill'. Of these changes only ten (a change to travel, dive or mill; 8%) could be considered as aversion behaviour. The above suggests that there is little interaction between (slow moving) boats and dolphins outside 100m in this area.

The minimum approach distance for swims and sightseeing in New Zealand is 50m. Constantine (2001) found a decrease in resting and an increase in milling behaviour (considered to be an aversion behaviour) with an increasing number of boats. The same behavioural change was found when the swim-tour vessels were present as with dolphin watch and recreational vessels. Between 1994/1995 and 1997/1998 there was an increase in the avoidance response to approach techniques that cut across the dolphins' path and a decrease in the avoidance response to a 'parallel' approach technique. As well, there was a decrease in interactions with swimmers between the two periods.

Barr and Slooten (1999) monitored from shore the responses of dusky dolphins (*Lagenorhynchus obscurus*) to vessels in the waters off Kaikoura, New Zealand. These dolphins rest in shallow inshore waters 1-3 km from shore during the day, returning to deeper offshore waters at night to feed. Groups of up to 600 are sighted. Dolphin responses to vessels over two consecutive summer seasons (1994/1994 & 1994/1995) were monitored. The continual presence of boats throughout the observation period restricted the ability to detect changes in behaviour in response to vessels, as vessel free data was sparse. However the authors concluded that avoidance behaviours by dolphins, in particular a high number of directional changes, were more likely when the direction of travel of vessels was less predictable.

Other odontocete cetacean – vessel interactions.

Gordon *et al.* (1992) compared the responses of individual sperm whales (*Physeter macrocephalus*) during recovery from deep dives in the presence and absence of tour vessels. They found no significant change in blow interval. There was no significant changes in blow rates, surface times or numbers of blows with different numbers of boats within 50m of whales. However for a subset of individually identified whales surface times were shorter, blow intervals more erratic and blow numbers lower when boats were present.

Bain (2001) studied the effect of vessel noise on killer whale (*Orcinus Orca*) hearing thresholds. Like other mammals, killer whales experience a masking effect of ambient noise, which is strongest when both ambient noise source and test signal are located in front of the whale. Noise levels at which different species of marine mammal avoid (travel away from) a source appear to be relatively constant (Calambokidis *et al.* 1998), suggesting that bottlenose dolphins would be affected by similar noise types and levels to those reported for killer whales.

Behavioural audiograms have been obtained for a number of odontocete species, including killer whales (Syzmanski *et al*. 1999) and bottlenose dolphins (Johnson 1967, Ljungblad *et al*. 1982). The shape of the audiogram is similar for all species tested, with hearing sensitivity greatest at higher frequencies with the upper limit ranging from 100 to 150kHz.

Williams *et al.* (2002) studied the behavioural responses of killer whales to boat traffic by tracking whale movements in the absence of boats, in the presence of a vessel running parallel at 100m, and normal boat traffic. They found that ‘whales responded to experimental approaches by adopting a less predictable path than observed during the … no boat period’. Killer whales appear not to habituate to vessel traffic, as these responses are present after more than 20 years of whale watching (Williams *et al.* 2002).

The results of the studies mentioned above are directly relevant to management of vessel proximity and dolphin swim-tours in Port Phillip Bay. The findings suggest that:

- Approaches from front-on cause an increased avoidance response; this type of approach is prohibited by regulation in Victoria, an action prompted by anecdotal information that dolphins were showing higher levels of avoidance to front-on than to parallel approaches, subsequently supported by experimental results – see further. The killer whale sound study results give an ecological basis to the finding;
- Parallel approach minimum distances of 50m may be too close, and greater distances may be more appropriate. Killer whales display increased avoidance responses to vessels travelling in parallel at 100m. The minimum parallel

approach distance in Victoria is 50m for permitted vessels, and 100m for non-permitted vessels.

Regulations and guidelines for dolphin swim and sightseeing tourism.

Acts for the purpose of marine mammal protection in Australia, New Zealand, USA and Canada prohibit aspects of 'taking' marine mammals, the term 'take' meaning to harass, hunt, capture, kill, feed, or attempt any of these. In Australia, regulations under the relevant Act seek to define clearly levels of interaction that do not constitute 'take'.

The Wildlife (Whales) Regulations 1998 of Victoria (Anon. 1998) are consistent with the Australian National Guidelines for Cetacean Observation (Anon. 2000). They specify minimum approach distances for different classes of vessel (dolphin tour, other paid tour, recreational), approach distances when other tour vessels are present, restricted approaches to groups with young calves, speeds within prescribed distances of dolphins, placement of swimmers and the need for sanctuary zones. Other States in Australia generally conform to these regulations. State jurisdictions may be more stringent than the national guidelines.

Dolphin (watch) tour vessels at Port Stephens in NSW limit their approach distance to 50m under a voluntary code. The code also limits the number of vessels that can be around a group of dolphins at any one time to two. Each vessel may spend a maximum of 30 minutes with a particular group of dolphins (Allen 2001). Draft regulations for NSW are currently open to public comment. It is proposed in the draft regulations to abolish the current exemption for bottlenose and common dolphins on the NSW minimum cetacean approach distance of 100m.

The U.S. Marine Mammal Protection Act (1972) prohibits the ``take" of marine mammals which includes ``harassment." The Act defines the term 'take' as ``to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The Act defines the term ``harassment'' 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, (Level A harassment), or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment)." Specific regulations prohibit the feeding of wild dolphins and heavy penalties have resulted from contravention of the Marine Mammal Protection Act in respect of feeding. While guidelines are in place for these activities there are no regulations. The National Marine Fisheries Service (NMFS) is considering whether to propose regulations to protect marine mammals in the wild from human activities that have the potential to harass the animals (NMFS 2002). The scope of the proposed regulations encompasses any activity of any person or conveyance engaged in direct interactions with marine mammals in the wild. The proposal has come about as a result of increased activity since regulations were proposed in 1992 and subsequently withdrawn. Regarding dolphin-swim activities, these have significantly increased in the Southeast U.S. and Hawaii in the last decade, and are beginning to expand to other U.S. coastal areas. In Hawaii, swim activities primarily target Hawaiian spinner dolphins (*Stenella* longirostris), taking advantage of the dolphins' use of shallow coves and bays during the day to rest and care for their young. Regarding other vessel-based interactions, the use of motorized or non-motorized vessels (e.g., outboard or inboard boats, kayaks, canoes, underwater scooters, or other types of water craft) to interact with marine mammals in the wild is also a rapidly growing activity in the U.S. “NMFS has received complaints from researchers and members of the public that include:

- Operators of motorized vessels driving through groups of dolphins in order to elicit bow-riding behavior (e.g., bottlenose dolphins in the Southeast, spinner dolphins in Hawaii, Dall's porpoise in the Northwest);
- Kayakers and canoers utilizing the quiet nature of their vessels to closely approach and observe or photograph cetaceans and pinnipeds (e.g., killer whales in the Northwest, large whales and pinnipeds in California and the Northeast);
- Whale watchers attempting to touch and pet gray whales in California;
- People using underwater ``scooters'' to closely approach, pursue and interact with the animals (e.g., dolphins in the Southeast); and

- Operators of personal watercraft tightly circling or crossing through groups of dolphins, often at high speed, to closely approach, pursue and interact with the animals (e.g., dolphins along the mid-Atlantic and Gulf of Mexico)" (NMFS 2002).

"Researchers monitoring the effects of human disturbance on wild marine mammals report boat strikes, disruption of behaviours and social groups, separation of mothers and young, abandonment of resting areas, and habituation to humans" (NMFS 2002).

Guidelines for cetacean sightseeing in British Columbia and Washington specify a minimum approach of 100m, with low speeds (< 5 knots) at less than 400m, moderate speeds (8-10 knots) from 400-800m and unlimited speeds past 800m. Restrictions on approach to cetaceans for sightseeing apply in Canadian waters, with a minimum front-on approach distance of 400m, and 100m from other directions. Speed limits also apply (Koski *et al.* 2001, Pakenham & Fairley 2001).

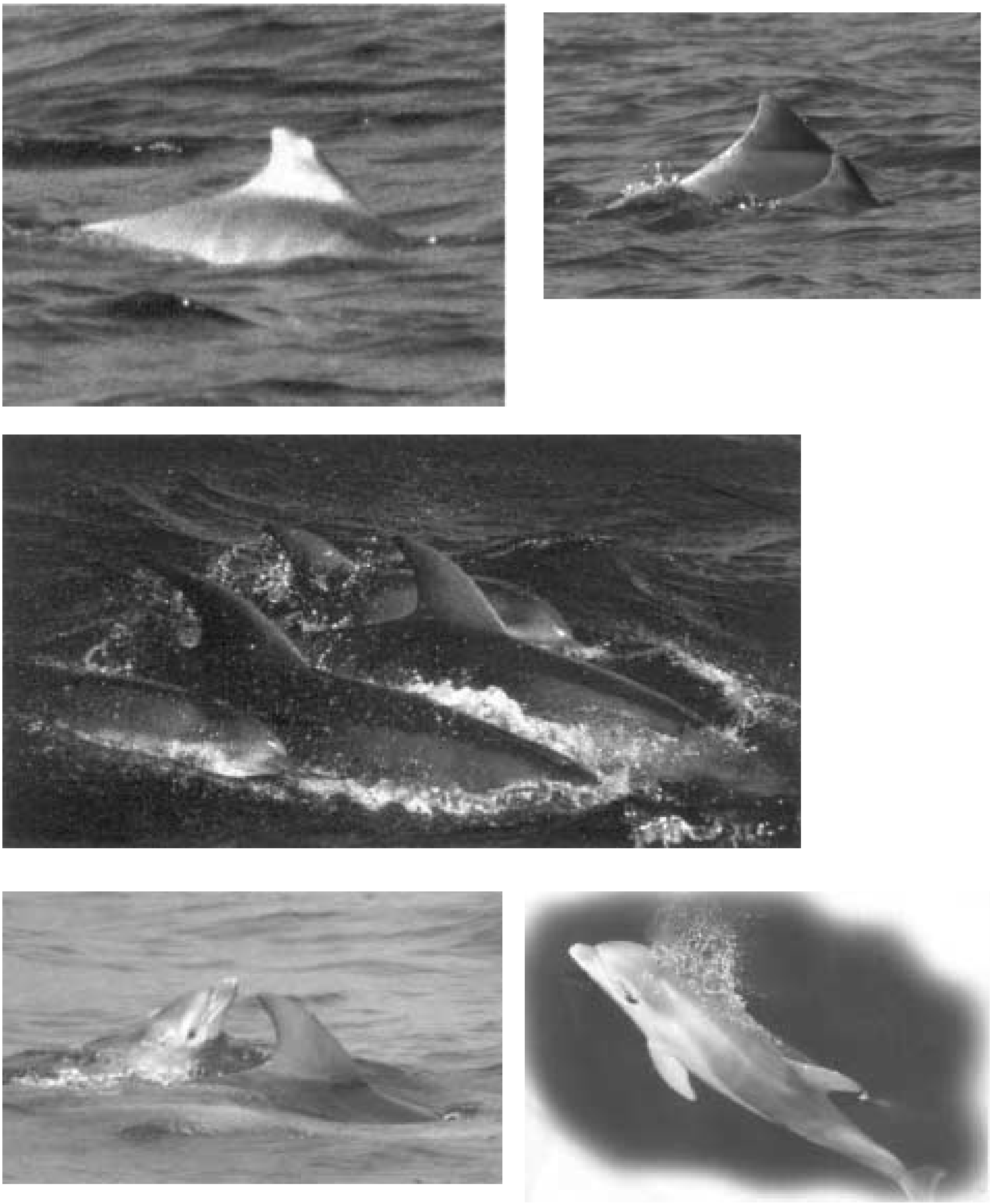


Figure 3. <u>Dolphin calves and adults.</u> Top right, foetal fold *S. chinensis* calf showing foetal fold lines running dorso-ventral below dorsal fin (Hale photo); top left, same calf with mother (Hale photo); middle, group of bottlenose dolphins photographed in Port Phillip Bay (DRI photo); bottom left, *T. aduncus* mother and calf from the bay (DRI photo); bottom right, *T. aduncus* calf from Port Phillip Bay showing feint foetal fold line anterior to dorsal fin (DRI photo).

POPULATION PARAMETERS FOR PORT PHILLIP BAY DOLPHINS

Data for Port Phillip Bay dolphins was taken from the DRI Draft Report (Dunn *et al.* 2001) and Scarpaci *et al.* (2002 etc). The research by both groups is generally sound and uses methods that are well recognised in this field (eg, Martin & Bateson 1993). Information needed but not readily available was sought directly from the authors. Clarification from authors was also sought on aspects of data collection where necessary. The data has limitations but provides a solid basis for making decisions to improve management for sustainability.

Population size estimate from photo-identified dolphins

The population estimate made from the photo-identification (photo-ID) study conducted from 1997-2001 by DRI (Draft Report - Part 2) is 83 marked dolphins. Mistakes in identification of individuals through photography are more likely to result in population estimates that are incorrectly high rather than low because mis-identification usually results in replication rather than pooling (Stevick *et al.* 2001). Thus if the estimate for the population size is inaccurate, is likely to be too high. DRI estimates that 20% of dolphins are not sufficiently well marked to enable identification, and conclude that the population size is therefore about 100. But marked animals will include those who may have been in the area few times only in the 5-year study (transient dolphins, see below). The resident population is then likely to be less than 100 individuals, and a figure of about 80 does not seem unreasonable as an estimate of the resident population size.

The population will include dolphins that remain at the study site for long periods (residents) and those that are present for short periods only or infrequently (transients). Figure 2.3 of the DRI report reveals that a little more than half the 83 dolphins were sighted 5 times or less over the 5 year period, with the remainder sighted more than 5 times to a maximum of 24 times. This is evidence that some of the population is resident and some transient. Whether males or females belong to either category is not known, and will depend on the ability to identify sex. Genetic analysis of skin samples would be the best way to identify sex in a large proportion of the population, although association with newborn calves is allows for identification of adult females.

The question of the number of different dolphins approached by tour vessels is addressed in part 3.3.4 of the report (Figs. 3.8 & 3.9). The proportion of dolphins sighted more than 5 times from tour vessels in 1999/2000 is a little more than half the number of dolphins sighted and identified. This is evidence that those dolphins approached regularly by tour vessels are a subset of the total population.

Other dolphin population parameters.

Wells and Scott (1990) estimated population parameters for coastal bottlenose dolphins in Florida USA as part of a long-term study where many individuals were caught and tagged. From eight consecutive years of data, an average of 26 adult females were identified each year from 83 identified individuals (frequency of .313) where the sex of adults was known. This is about the proportion of adult females one would expect from a stable age distribution. Over this period 37 new calves were identified, and 30 survived to year 1. So the calving rate is about 1 per 6 years, and 20% of the calves did not survive to year 1. Other data analysed by Wells and Scott (1990) suggests that calves become independent of their mothers at age 5-6. Thus both lines of evidence point to females breeding about every 6 years in the Florida population.

The size of the Port Phillip Bay population, from the DRI data, is probably about 80 individuals. Assuming the proportion of adult females to be the same in each population, then there should be 26 adult females in the population. The DRI estimate is 27, from adult dolphin association with very young calves. If the calving rate were 1 / 6 yr, then 4 – 5 (4.5) new calves would be expected in the Port Phillip Bay population each year. DRI estimates from their data on calving interval over a four-year period that the calving interval is greater than 3 years where calves survive to year 1. On average there are 6 new calves per year in the population. The estimate of 6 calves corresponds to a calving interval of 4.5 years, which is a more optimistic value than that calculated from the data of Wells and Scott (1990). A value of 4.5 years will be used in the population viability analysis (PVA, see below) to reflect the DRI estimate.

In the study of Wells and Scott (1990), attrition was calculated from carcasses recovered as well as individuals that disappeared from the population, including newborn calves. In this study it was estimated that 20% of calves do not survive to year 1, and that the mortality rate for dolphins of all other ages was about 4% per year. DRI has kept records of all known dolphin strandings in and near Port Phillip Bay since 1994. In the 8 years, 16 bottlenose dolphin carcases have been recovered, with different amounts of information recorded for each. Carcasses were not identified as *T. aduncus* or *T.truncatus*. Of these, 6 were calves. Where sex was recorded, 4 were female and 7 male. Carcase recovery will depend to a large extent on the number of sharks in the area, accessibility of the coastline, and human population (who may report stranded dolphins).

Behavioral ecology of Port Phillip Bay dolphins

Scarpaci *et al.* (2002) classified the behaviour of dolphins into three categories; travel, feeding and social. Behaviours were recorded in the absence of swim-tour vessels from an observation point on land. Behaviours observed were predominantly travel and feeding, and these were observed in all four seasons. Whether or not there is a significant difference in the two main behaviours among seasons was not clear, but the results suggest that there may not be significant differences.

DRI (Dunn *et al.* 2001) analysed dolphin behavioral state from an observation point on land and found that in the absence of vessels within 400m, traveling (42% of time), travel-feed (18%) and feeding (28%) were the main behaviours observed, the remainder (12%) comprising other social behaviours involving close interaction between dolphins.

Both studies found travel and feeding to be the predominant (daylight) behaviours, comprising around 90% of all observations. The findings demonstrate that these dolphins' forage continually, during the day at least, throughout the year. In the current (2001-2002) swim season, a large proportion of dolphin sightings have been near Pt King

(Fig. 1) and the predominant behaviour observed has been feeding (DRI pers. comm.), perhaps on young snapper.

VESSEL INTERACTIONS WITH DOLPHINS: GENERAL

Data from several years of research on the Port Phillip Bay dolphins and vessel proximity to them, carried out by the Dolphin Research Institute and Carol Scarpaci *et al.*, was analysed for this report. The research by both groups is generally sound and uses methods that are well recognised in this field (eg, Martin & Bateson 1993).

Various vessels interact with the dolphins, intentionally or otherwise. Shipping moving in and out of Port Phillip Bay, ferries moving between Sorrento and Queenscliff, recreational vessels (particularly in the warmer months), dolphin sightseeing vessels (there are two permits current) and dolphin swim-tour vessels (there are four permits current).

The DRI report notes that 'during the period from Oct-May, multiple swim-tours interact with up to three-quarters of the population on a regular basis.' And further: 'data indicate that each tour spent on average 7 hours per day on the water during the peak time (Jan / Feb) and of this 1.5 hours was spent within 400m of dolphins ('in proximity' to dolphins rather than 'interacting with' dolphins), a total of 6 hours per day for all four swim-tour operators combined. Note that where more than one operator was in proximity at the same time, only the operator closer to the dolphins was recorded as being in proximity (DRI pers. comm.).

Ferries interact with dolphins opportunistically. Passenger ferries run every hour between Queenscliff and Sorrento. DRI reports that these ferries will approach and intentionally be in proximity to dolphins for up to 15 minutes per trip, and that this may happen several times per day, potentially up to 20 times.

Time 'in proximity' for swim-tours compared to recreational vessels.

The DRI Draft Report (section 3.3.5, Dunn *et al.* 2001) defines interaction (or approach) by a vessel as 'stopping to view dolphins within 100m or travelling within 100m of dolphins'. Time in proximity to dolphins is time within 400m. Data was collected from the shore or DRI research vessel, for recreational and tour vessels from 1997 – 2001 inclusive. Tour vessels accounted for 95% of the time vessels were in proximity to dolphins (DRI Fig. 3.10, reproduced here as Fig. 4). The important finding here is that the proportion of time recreational vessels (5%) compared to swim-tour vessels (95%) were in proximity to dolphins was small. Further, in most cases recreational vessels did not deliberately approach within 100 metres of dolphins (ie, interact with dolphins) and were therefore complying with Regulations. The main concern with recreational vessels is the high speeds at which they may travel, with little chance therefore of spotting dolphins before they are within the regulated limit (100m). But the data shows that this would occur infrequently.

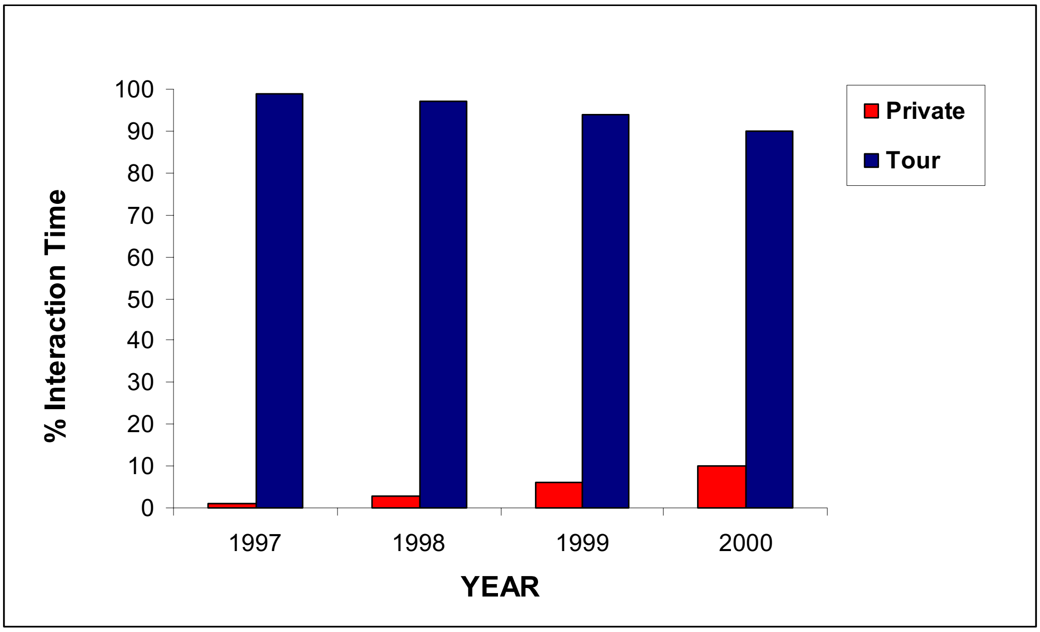


Figure 4. Proportion of time in the vicinity of dolphins for tour vessels and recreational vessels – shore and DRI research vessel data. Large columns are data for swim-tour vessels (tour) while small columns are data for recreational vessels (private). Reproduced, with permission, from Dunn *et al.* 2001.

Scarpaci *et al.* (2002) studied the interaction of recreational and swim-tour vessels with dolphins:
"A total of 125 dolphin groups were observed (during daylight hours) *with a mean group size of 8 (SD = 7.65). Mean observation time was 31.4 min (SD =31.7; N=125; Range = 5-230min) from December 1996 - December 1998. All data presented are from land-based observations in the study area. Dolphin groups were observed 47.4% of the time in the presence of boats within 300m* (in proximity to vessels). *The proportion of time dolphins were observed with boats varied depending on boat type. Commercial dolphin-swim tour operations accounted for 38.2% of these observations followed by recreational boats and tour operators together (4.9%) and recreational boats alone (4.3%)'.* That is, recreational vessels alone were observed within 300m of dolphins on 4.3% (9% of vessel

– dolphin interactions) and swim-tour vessels on 43% (91% of vessel – dolphin interactions) of observations.

‘48.9% of the adult-calf observations were in the presence of boats and 41.2% of these observations were in the presence of dolphin-swim tour operations. Tour operators accounted for the majority of boating interactions observed for every season except Winter. In Autumn '98 dolphins were observed 54.9% of the time with dolphin-swim tour operations followed by Summer '97 (42.1%)’.

COMPLIANCE BY TOUR OPERATORS TO WILDLIFE REGULATIONS.

DRI monitoring

Compliance to Wildlife Regulations (1998) was monitored during 711 approaches by swim-tour vessels over 2 swim seasons, 1998/1999 and 1999/2000 (DRI Draft Report – Part 4). Compliance was monitored from the tour vessels. Overall compliance rate was 51% in 1998/1999 and 63% in 1999/2000 (DRI Fig. 4.1). Regulations monitored for compliance included: placing vessel in path of dolphins (5.2.h.i-iv, Anon. 1998), approach within 100 metres in the Ticonderoga Bay Sanctuary Zone (5.2.j), approaching within 50 metres (5.2.b), swim distance and approach (6.2.f & h). All were breached, particularly the first two, which were breached 32% and 26% of the time respectively.

Another breach of regulations observed by DRI concerned Regulation 5.2.a; ‘tour vessel must not approach or remain within 200m of another tour vessel if that tour vessel is within 100m of a dolphin’. The DRI report notes that more than one tour was interacting with the same group of dolphins in 68% of all sightings in the 1999/2000 swim season and 51% in the 1998/1999 season’.

Scarpaci *et al.* (2002) ‘Compliance with regulations …’

The article aims to assess compliance with regulations by swim-tour vessels. Four regulations were examined; approach type (Regulation 5.2.h.i-iv, Anon. 1998), swim time (6.2.b, c; 6.3), time in proximity to dolphins (for dolphin sightseeing permit holders this is regulation 7.2.e, but there does not appear to be a similar regulation for dolphin swim-tour permit holders), swim with foetal-fold calf (6.2.i,j).

Observations were made from the swim-tour vessels, which provided opportunity to assess compliance of that observation platform and other vessels, as vessels are often in close proximity when attempting swim-tours. A total of 128 swim-tours were studied during the 1998-1999 and 1999-2000 swim-tour seasons. Findings for the four regulations examined are summarised below.

Approach type. Analysis of a sample of 564 swim-tour approaches found that the parallel approach (permitted) occurred 64% of the time while direct and J-approaches (not permitted) occurred 36% of the time. DRI also reported non-compliance with this regulation.

Swim time. From analysis of 77 swims, the average time swimmers were in the water was 3 minutes (s.d 1.8 min.). The average time mermaid lines were in the water was 31.9 minutes (s.d. 20.1 min.). The authors make the distinction between the time for which swimmers were in the water and the swim duration according to regulations, which is the time the mermaid lines are in the water. With regard to regulations, 61% of swims were outside regulations. The DRI study found a similar proportion of swims breached regulations.

Proximity to dolphins. Regulation 7.2.e (Anon. 1998) concerns the behaviour of dolphin sightseeing vessels, not to be within 100 metres of dolphins for more than 20 minutes. The average time dolphin swim vessels were within 100m of dolphins was 34.8 min. (n=107, range 3-151min, s.d.=28.7 min); 62% of swim tour vessels remained within 100m of dolphins for longer than 20min.

Swim with foetal-fold calves. The study found that 31% of swims were conducted with dolphin groups containing foetal-fold calves (contrary to regulations), from a total of 77 swims analysed (see example of a foetal-fold calf in Fig. 3). The DRI report did not present as a specific item their analysis of compliance with this regulation. However, there data indicates that swims with newborn calves in contravention of regulations constituted less that 10% of overall breaches in the 1998/99 and 1999/00 seasons combined. DRI (pers. comm.) notes that 4.5% of total breaches of regulations constituted swims with foetal-fold calves, and deliberate swim attempts were made with foetal-fold calves during 12% of sightings where foetal fold calves were present.

It is interesting that such a degree of non-compliance occurred even though tour operators were aware of being monitored. Both DRI and Scarpaci *et al.* (2002) report similar findings for compliance monitored from swim-tour vessels. Allen (2001) notes that compliance to regulations by dolphin tour vessels in Port Stephens, NSW is less when tour operators are not aware they are being monitored. However DRI (pers. comm.) notes that compliance by swim-tour operators in Port Phillip Bay is similar whether observed from tour vessels or other vessels.

RESPONSES OF DOLPHINS TO VESSELS

This section of the report analyses dolphin responses to tour vessel approaches and compares the dolphin swim-tour seasons of 1998/1999 and 1999/2000 (DRI Draft Report - Part 3). An approach was defined as an approach by a swim-tour vessel within 100m. Dolphin behaviours at the time of vessel approaches were placed into one of three categories; interaction, avoidance and neutral. These categories record the direction and position of the dolphins relative to the tour vessel. Behaviours were recorded from the tour vessel.

- Interaction; dolphins either approaching, on bow, swimming alongside or in wake of vessel to a distance of <10m.
- Avoidance; dolphins dove and surfaced at a greater distance from the vessel than that when they dove, or changed direction away from the vessel.
- Neutral; dolphins showed no obvious change in direction (with respect to the vessel) or swam past at a distance >10m.

A total of 711 approaches and 300 swims were monitored over the two seasons of the study. Clarification provided by DRI was:

- The same two observers, working together, collected the data (therefore unlikely to be observer bias between years);
- the proportion of trips and approaches for the different vessels was almost identical between years (therefore unlikely to be any vessel bias between years);
- there were no large differences in response by dolphins between tour vessels (therefore vessel bias unlikely);
- surveys were conducted over the same period (Summer / Autumn) for each swim season (therefore results unlikely to be affected by any seasonal bias in dolphin behaviour).

Table 1. Dolphin responses to parallel and intercept approaches by operators; numbers estimated from Figures 3.4 and 3.5 of DRI draft report.

	total	interact	avoid	neutral
1998/1999 intercept	57	10	25	22
1999/2000 intercept	60	22	24	14
Intercept total	117	32	49	36
1998/1999 parallel	177	50	46	81
1999/2000 parallel	358	115	132	111
Parallel total	535	165	178	192

For about the same observation time there were more approaches by tour vessels to dolphins in 1999/2000 than in 1998/1999 (426 v. 285, DRI Table 3.4), for 49 v. 51 hours of observation, but proportionally fewer swims (40% v. 46%, DRI Table 3.4). A test of significance for the percentages shown in DRI Figure 3.2 reveals the difference to be significant (2-sided t-test, $p = 0.018$).

The question addressed by DRI was whether there had been any significant change in frequency of the different response types. In 1999/2000 there was a higher proportion of avoidance responses to the dolphins than in 1998/1999. Values in Tables 1-4 below were estimated from text figures in the DRI report, and appropriate statistical tests applied.

A test of significance for the response by dolphins to the parallel approach by tour vessels between swim seasons showed the difference to be significant (Table 2).

Possible explanations for the increase in avoidance response are:

- Variation in dolphin pod composition (eg, fewer dolphins in the “pool” approached by tour operators in 1999/2000, different dolphins in the ‘pool’, more new calves in 1999/2000 than in 1998/1999),
- The increased number of approaches by tour vessels,
- Dolphins had become sensitised to vessel approaches.

- Variation in dolphin behaviour (eg, foraging for different prey, change in behaviour to more foraging as a result of less food).

D.R.I points out (pers comm) that:
"… swim tours have been underway for ten years but at nowhere near the current level. In 1994 there were only two vessels conducting swims and neither of them was at the level they are running currently. (one operator)did not really start running (swim tours) with much regularity until 1996/97 and (another operator) only started occasional tours in 1997. Both of these companies have slowly expanded over the past three years. (A third operator) also replaced a smaller vessel with a larger one in late 1998."

With further analysis of the photo-identification data it should be possible to determine whether or not there was a substantial change in dolphin group composition between the years. DRI data (DRI Fig. 3.9) suggests that the resighting rate of dolphins from the tour vessels increased markedly in 1999/2000, and that the proportion of dolphins resighted from multiple research platforms increased as well (DRI Fig. 3.8). Together these findings suggest that a smaller group of dolphins was involved in the interaction in 1999/2000 than 1998/1999, as suggested in the DRI draft report (p. 35). A higher frequency of approaches on a smaller number of dolphins in 1999/2000 could explain the increase in avoidance behaviour by dolphins in that year. It is reasonable to conclude that a smaller 'pool' of dolphins and increased tour activity would have compounding effects and lead to increased avoidance. Reasons for a possible smaller pool are not known at this stage.

Table 2. Test for difference between 1998/1999 and 1999/2000, parallel approach, avoid versus other [neutral or interact] responses; data from Table 1.

	avoid	**other**
1998/1999	46	131
1999/2000	132	226

Chi-squared test, df=1, p=0.012

The 1998 regulations (5.2.h.i-iv, Anon. 1998) restrict the way in which swim-tour vessels can approach to within 50m of dolphins to commence a swim. The parallel approach is then the most likely permitted option. DRI reports that the most frequent breach of regulations was placing the vessel in the path of dolphins (36% in 1998/1999, 30% in 1999/2000, DRI Fig. 3.3), a breach of regulations 5.2.h. i & ii. Dolphin responses were compared for the parallel and intercept approaches in 1998/1999 and 1999/2000 separately. In 1998/1999 the intercept approach led to significantly more avoidance responses than the parallel approach (Table 3). In 1999/2000 there was no significant difference between the two approaches, due to the increased proportion of avoidance responses with the parallel approach (Table 4).

Table 3. Test for difference between parallel and intercept approaches, 1998/1999; avoid versus other [neutral or interact] responses; data from Table 1.

1998/1999	avoid	other
Intercept	25	32
Parallel	46	131

Chi-squared test, df=1, p=0.011

Table 4. Test for difference between parallel and intercept approaches, 1999/2000; avoid versus other [neutral or interact] responses; data from Table 1.

1999/2000	avoid	other
Intercept	24	36
Parallel	132	226

Chi-squared test, df=1, p=0.643

Impacts of swimmer placement on dolphins

Scarpaci (unpublished) analysed the response of dolphins to the placement of swimmers in the water. Data was recorded in the four minutes after placement. Response was recorded as avoid, neutral or approach (within the definition of these terms used above). By this time, if dolphins have avoided the boat, then they will have done so, and therefore the response to the vessel will be either ‘neutral’ or ‘interact’. The predominant behaviour observed in the four minutes after placement was also ‘neutral’. This data suggests that dolphins are not responding to the placement of swimmers in the water. Compare this finding to that in the previous section where dolphins are showing a high proportion of avoidance responses to vessel approaches.

Changes in dolphin behaviour in the presence of swim vessels

Scarpaci monitored dolphin behaviour in response to swim-tour vessels from an observation point on land: *The proportion of time dolphins were feeding and travelling was greatest in the absence of boats. Proportions of time dolphins were observed feeding was 19.7% in the absence boats and 9.5% with tour operators. Proportion of social behaviour observed was highest in the presence of tour-operators."*

The findings suggest that social behaviour increases and feeding behaviour decreases in the presence of swim-tour vessels. Social behaviour can constitute an aversion response to vessels (Constantine 2001). As feeding and travelling are the predominant behaviours throughout the year, it is unlikely that season is a covariate in the relation between behaviour and presence / absence of swim-tour vessels.

DRI analysed behavioural state of dolphins in the presence / absence of swim-tour vessels from an observation point on land (Dunn *et al.* 2001). Their data suggest that feeding and social behaviour decrease while travel behaviour increases in the presence (ie, within 400m) of swim-tour vessels. Both studies report a decline in feeding behaviour in the presence of tour vessels.

Dolphin whistles and swim tours

Scarpaci et al. (2000) compared whistle production by dolphins in the presence and absence of swim-tour vessels. The authors found an increase in the frequency of whistles in the presence of vessels. The link between increased whistle behaviour and an adverse impact of swim-tour vessels needs to be explored. It has been proposed that dolphins use whistles as a 'cohesion call' (McCowan & Reiss 2001). Whistles are also likely to be used in other behaviours involving group cohesion; protection against natural predators, co-operative feeding and other feeding behaviour for example. If increased whistle frequency can be associated with behaviours involving avoidance of vessels, and if analytical procedures can be automated successfully, then the monitoring of whistles could provide an objective measure of impact of vessel traffic on dolphins.

APPROACH AND INTERACTION TIMES FOR SWIM-TOUR VESSELS.

DRI (Dunn *et al.* 2001) monitored the time that swim-tour operators were approaching dolphins within 100m (interacting with dolphins) in the 1998/1999 and the 1999/2000 swim seasons. In the first season the average approach time where there was an approach only (no swim) was 2.97min, and in the second season 2.20min. Where a swim was attempted, the interaction times were 2.90 min. in the first season and 3.11 min. (s.d.=2.75, n=242).

Several approaches were attempted at each sighting, in the first season about 4.8 and in the second season 6.1 per sighting. There was about 1 siting per tour. In the peak season 9 tours per day are running. Therefore on average the time within 100m for swim-tour vessels with dolphins is 3 min./approach x 5.5 approaches/tour x 9 tours/day, which is 2.5 hours per day when swim-tour vessels are within 100m of dolphins.

For the same dataset, the DRI report (Dunn *et al.* 2001) defines a vessel interaction as being within 400m of dolphins. This is herein defined as 'in proximity to dolphins', as discussed earlier. In this case, then swim-tour vessels are 'in proximity to' dolphins in peak season for about 6 hours per day.

Scarpaci's results for swim-tour vessel interaction with dolphins differ from the DRI results above. They show the average time swim-tour vessels were within 100m of dolphins as 34.8 min per tour (n=107, range 3-151min, s.d.=28.7 min), compared to about 16.5 min. for the DRI results. The difference in results between the two datasets could relate to the estimation of distance over water. DRI estimated time in proximity to dolphins (within 400m) at about 42 min. per tour, for 1998/1999 & 1999/2000 seasons combined. Regardless, the data discussed above for dolphin responses show a large proportion of avoidance responses for current interaction times.

Herding of dolphins by swim-tour vessels

Scarpaci *et al.* (2002) note that *'the mean time(for which observations were conducted) between boat approaches was found to be 5.5 min (s.d. = 4.2, range = 1-25) for 107 dolphin groups … during the months of Dec 1999 - April 2000. The mean time includes recreational boats and commercial dolphin swim operations'*.

The DRI report notes that, during the swim-tour season, tour vessels are almost continually within 400m of dolphins between the first and the last tour of the day. Breaches of regulation 5.2a ('ensure that the tour vessel does not approach or remain within 200m of another tour vessel if that tour vessel is within 100m of a dolphin', Anon. 1998) were commonplace, occurring in 100% of sightings where more than one operator was present, which was 68% of sightings in the second season and 51% in the first season (see Fig. 6). In the peak season, vessels are within 400m of dolphins for about 6 hours per day. DRI (pers. comm.) describe vessels as 'waiting in line' for a turn to attempt a swim with dolphins, associated with vessel 'herding' of dolphins in a particular direction.
A question with regard to proximity to other vessels is raised where vessels are interacting with dolphins in navigation channels where it is not feasible for another vessel to keep clear of a vessel that is within 100m of dolphins.

POPULATION VIABILITY ANALYSIS FOR PORT PHILLIP BAY DOLPHINS

The likelihood of persistence of the Port Phillip Bay dolphin population (population viability analysis) was simulated using an individual-based age structured model used elsewhere to assess population viability in small populations (Lacy 1989, 1992). The model is incorporated into the VORTEX program (Lacy 1992), which is a Monte Carlo simulation of demographic events in the history of a population. This exercise was conducted to establish the effect on population viability of mortality additional to natural mortality that which may be caused by anthropogenic impacts. These impacts could include reduced birth rate and calf survivorship due to lack of condition in females due to decreased food availability. They could include direct mortality from vessel strikes, which has been observed in this population. Parameters used for the population in this analysis are based on those discussed beforehand and were as follows:

- Females reproduce at age 12, males at age 15;
- maximum breeding age is 35;
- sex ratio is 50 / 50;
- 23% of adult females reproduce each year (ie, females reproduce every 4.5 years);
- litter size = 1;
- 20% mortality of young of year (age 0-1, 50% female, 50% male);
- 4% mortality of adults per year (2% females, 2% males), which is equivalent to about 1 male and 1 female (per year) in the population apart from young of year. More precise modelling would include a mortality estimate for each age class more than 1 year old, but this would not alter the outcome of the simulation significantly.

The carrying capacity of the habitat was set at 500 with a 2% yearly increase. The simulation was run for 100 years. The results of the simulation are shown in Figure 5 below.

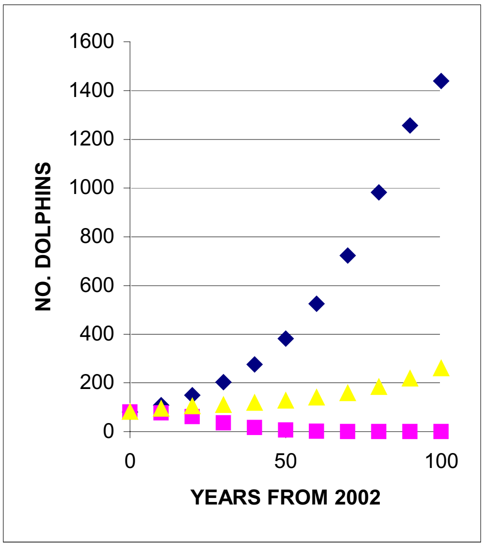
The population parameters used in the simulation can be considered conservative. An important factor for the population is that there is no female immigration, or emigration, so recruitment of females into the breeding population depends on fecundity and survivorship. Neither the habitat nor numbers of males were rate limiting in the simulation. If no additional females are lost then the population increases exponentially to asymptote at carrying capacity (Fig. 5). If one additional female is lost each year the population will remain at low levels similar to what it is at the start but with zero probability of extinction. If two additional females are lost each year the population remains stable for 10 years but by 25 years has a greater than 50% chance of extinction, which is nearly 100% by 40 years (Fig. 5).

Survivorship for young of year is within reasonable expectations. If the birth rate were lower than that used in the simulation, and similar to that found in the Florida study, then the outlook for population viability from the simulation would be more pessimistic.

Increased male mortality makes little difference to population viability because males can mate with more than one female. Severe reductions in the number of males would be necessary before adverse genetic impacts were seen in the population

The simulation demonstrates the vulnerability of small, discrete (for females) populations with low fecundity, and the importance of females for population persistence.

A



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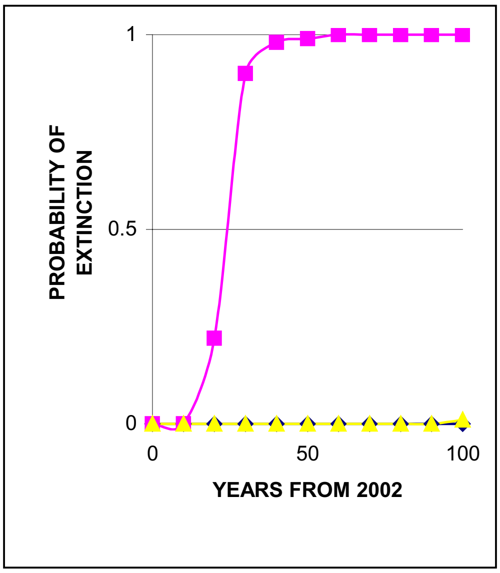

Figure 5. Estimates for extinction of dolphin population from a starting population of 80 individuals, parameter values discussed in text above. **A**, numbers of dolphins surviving; **B**, probability of population surviving. A probability of extinction of 0 is a probability of survival of 1. **Diamonds**, no additional female mortality; **triangles**, additional mortality of 1 female greater than 1 y.o. per year; **squares**, additional female mortality of 2 per year.

CONCLUSIONS FROM ANALYSIS OF RESEARCH

Dolphin ecology

Studies of population structure using genetic methods reveal striking population structure for female lineages amongst *T. aduncus*, while for mixed genetic lineages (telling us, by subtraction, what males are doing) the population structure is consistent with a model of isolation by distance. Thus the genetic data reveals female natal philopatry, a consequence of which is that females and their female descendents stay at or close to their natal site throughout their lives. They rear their young within the maternal home range and the female offspring remain with the group. Thus the matriline is site-attached. The small population of dolphins using Port Phillip Bay will most likely comprise related females, their young offspring, and adult males that are moving over a larger home range, which includes the bay, or have taken up residence in the bay. The consequence of this natal philopatry is that if the females in a population go extinct then it will take a very long time for females to move in from elsewhere.

The size of the Port Phillip Bay dolphin population is about 80 individuals. The species is likely to be *T. aduncus*. The swim-tours interact with about 50 of these on a regular basis. The predominant observed behaviour of dolphins, at least during daylight hours, is travel (when they are most likely foraging) and feeding. These dolphins appear to depend on the area of Port Phillip Bay near its mouth for all aspects of their ecology.

Population viability analysis.

The results of the simulation for the projected population are based on current estimates for the size of the population, the number of adult females, mating behaviour, fecundity for inshore bottlenose dolphins and mortality from natural causes. The simulation was run for a population with no additional mortality, then one additional female per year and two additional females per year. The results show that increased female mortality of two per year beyond what could be considered natural could push an otherwise increasing population to one with a greater than 50% probability of extinction within 25 years.

Avoidance behaviour in response to swim-tour approaches.

DRI (Dunn *et al.* 2001) reports that avoidance behaviour in response to swim-tour vessel approaches increased in 1999/2000 over 1998/1999 swim-tour seasons. This could be attributed to a change in operator behaviour (the frequency of approaches increased markedly in the second season) affecting dolphin behaviour, or dolphins becoming sensitised to vessel approaches, or random fluctuation. It is reasonable to conclude that a smaller 'pool' of dolphins (see section on DRI Draft Report Part 3 above) and increased tour activity would have compounding effects and lead to increased avoidance.

A baseline level for avoidance behaviour is not available. Dolphins would certainly be expected to make sudden changes in direction under natural conditions, and these changes might be towards or away from an observer. The relative frequency of these changes is not yet known. DRI (pers. comm.) think that directional changes are not common in the absence of vessels. Killer whales are less likely to make directional changes in their travel when vessels are absent (Williams *et al.* 2002). Directional changes that are not directly linked to foraging or feeding will be energetically costly (Williams *et al.* 2002). In lieu of any reports of the baseline level of avoidance-type behaviour in dolphins, the 1998/1999 level could serve as a baseline. In that season 26% of behavioural responses to the approach of a vessel were avoidance, compared to 37% in 1999/2000.

An avoidance level of 26% is likely to be well above any natural baseline, which would be the level in the absence of vessels. If this were the natural baseline, then in a situation without boats, a clear change of direction away from an observer would be evident in the dolphins' behaviour from one sounding to the next in 26% of observations. Work with killer whales suggests that in the absence of vessels this species changes direction infrequently (Williams *et al.* 2002). D.R.I. and Scarpaci (pers. comm.) have data that might be useful in answering such a question but it has yet to be analysed. They consider that when travelling, dolphins tend to maintain their direction and speed. Travel forms a large part of dolphin behaviour in the absence of vessels. The 1998/1999 level of avoidance behaviour is likely to be well above any true baseline, which would realistically be less than 10%.

The extent to which avoidance behaviour indicates a state of physical or mental stress in dolphins at the time of occurrence is not clear. What is clear is that where these behaviours - changes in direction, diving and deep diving - occur at levels significantly higher than when boats are not present then a disturbance of natural behaviours is occurring. The most likely impact of this disturbance is on feeding behaviour. Bottlenose dolphins spend most of their time either foraging for food or feeding. Feeding opportunities are especially important for breeding females, which have a metabolic load while lactating that is about twice the normal level. Disturbance to natural feeding behaviours - in this case reduction in the time available for feeding due to boat proximity - is therefore a significant threat to the ongoing viability of the population.

In recognising avoidance behaviour as a key indicator to be monitored the reliability of the indicator should continue to be reviewed and where possible improved.

Noise from engines and propeller cavitation are likely to be the largest factors driving avoidance behaviour. The acquisition of primary data on these noises from vessels interacting with dolphins in Port Phillip Bay was not feasible within the scope of this review. This could be a topic for future research. Mechanical measures (such as above water mufflers) are possible to reduce engine noise. These could be investigated as an adjunct to the primary strategy of reducing prolonged boat proximity to dolphins

Compliance with regulations.

The studies analysed find clear breaches in compliance with existing regulations; swimming with foetal-fold calves (6.2.d.i&j, Anon. 1998), placing vessel in path of dolphins (5.2.h.i-iv), approach within 100 metres in the Ticonderoga Bay Sanctuary Zone (5.2.j), approaching within 50 metres (5.2.b), swim distance and approach (6.2.f & h).

Compliance with regulations will be an important component of any revised management of Port Phillip Bay dolphins. In the past there has clearly been a problem with compliance to regulations, and monitoring of compliance should continue. It should be conducted by independent observers who have been trained in the collection of behavioural field data.

Swims with foetal-fold (newborn) calves

Most calves are born in the summer months, which is the peak time for swim-tours and recreational vessel traffic. Scarpaci *et al*. (2002) found that swims were conducted in 24/31 (77%) of observations where foetal-fold calves were present in the group. DRI (Dunn *et al.* 2001) found that swims with foetal-fold calves constituted less that 10% of overall breaches in the 1998/99 and 1999/00 seasons combined, in fact 4.5% (DRI pers. comm.) of total breaches. DRI (pers comm.) found that deliberate swim attempts were made with foetal-fold calves during 12% of sightings where foetal fold calves were present. The discrepancy between the results of the two groups might have arisen if Scarpaci *et al*. (2002) recorded as breaches swims commenced in the presence of foetal fold calves, and then discontinued when the presence of a newborn calf was detected (in compliance with Regulation 6.2.j). The DRI study only recorded as a breach swims that were continued even after it was discovered that a newborn calf was present in the dolphin group. In considering this discrepancy, it is concluded that the lower level of breaches (12% rather than 77%) is an appropriate value to use.

It could be difficult to identify a newborn calf in a group when the group is first approached, and the industry has attested to this difficulty. However, time needs to be spent outside the 100m-proximity zone, observing a pod so that operators are very certain that a group of dolphins does not contain young calves. All tour vessels are sufficiently high out of the water that a group of dolphins can be observed clearly from the vessel at distances greater than 100m. Visual aids such as binoculars can be of help here.

Newborn calves are vulnerable and mortality of young of year is high, about 20%, under natural conditions (Wells & Scott 1990). Foetal-fold lines (see Fig. 3), which are pigment patterns resulting from folding of the foetus in-utero, are no longer obvious within a few weeks of birth, but calves continue to be vulnerable for years after birth. The finding that calves become independent of their mothers at age 5-6 (Wells & Scott 1990) is indication of their dependence on mothers in the early years and the slow development process in bottlenose dolphins and other odontocete cetaceans. Calves are vulnerable for years after birth as they develop the 'life skills' necessary to survive independently.

A calf, especially a foetal-fold calf, can easily be recognised in a group of dolphins because they are obviously smaller than most other individuals in the group. A group of dolphins should not be approached within 100m until it is determined with certainty that the group does not contain a young calf. With some practice, calves can quickly be recognised in a group: they are noticeably smaller than the largest animals in the group (male and female adult T. aduncus are about the same size; Hale *et al.* 2000), foetal-folds may be visible, in very young individuals the dorsal fin is flaccid, they surface and dive in very close proximity to the accompanying adult, and the rostrum and melon protrude noticeably from the water when the calf surfaces.

Number of vessels interacting with (in proximity to) dolphins.

One result of regulation breaches is an increased herding behaviour by tour vessels on dolphins. At least one tour vessel is within 400m of dolphins for about 6 hours per day during the swim-tour season. In addition there are interactions with other commercial vessels and recreational vessels occurring during these times and at other times at lower frequency. Constantine (2001) did not find marked changes in behaviour of bottlenose dolphins in the presence of vessels between 400m and 100m. The dolphins that were the subject of that study were in the open ocean and deep water, where there was little other vessel traffic at any time. The dolphins in Port Phillip Bay are usually in shallow water surrounded by sandbanks and there is considerable other vessel trafficin the area in addition to tour vessels (other commercial traffic and recreational vessels).
Recommended approach distances on killer whales in North America are 400m front-on and 100m when in parallel (Koski *et al.* 2001, Pakenham & Fairley 2001), because a response by whales to approaches within these distances has been found, and explained on the basis of a masking effect of vessel noise on hearing thresholds (Bain & Dalheim

1994, Bain 2001). The whales do not appear to habituate (Williams *et al.* 2002). As mentioned above, parallel approach minimum distances of 50m may be too close, and greater distances may be more appropriate. Minimum approach distances of 100m for non-tour motorised vessels and tour vessels when not approaching for a tour, as currently specified in the Wildlife (whale) Regulations (Victoria) (Anon. 1998) may also be too close. Further behavioural monitoring should enable the maximum distances at which bottlenose dolphins in Port Phillip Bay react to vessels to be clarified.

Impacts of swimmer placement on dolphins

The finding of Scarpaci that that dolphins are not responding significantly to the placement of swimmers in the water suggests that it is proximity of vessels rather than swimmers that cause avoidance behaviours. The Wildlife (whales) Regulations (Victoria) restrict the number of swimmers that can be in the water at any one time. Ten swimmers are allowed in the water on two 'mermaid lines'. If swimmer placement is not having a negative impact on dolphins, this suggests that the number of swimmers in the water would not have a negative impact on dolphins. Restrictions on the number of swimmers therefore do not serve to lessen the impact on dolphins. There may be safety considerations in the number of swimmers in the water, but if the ratio of dive masters (1) to mermaid lines (1) to swimmers (5) is maintained, there is no reason why 15 or 20 swimmers in the water at any one time would not be just as safe as 10 swimmers, the current upper limit.

VESSEL-DOLPHIN INTERACTIONS AND SUSTAINABILITY.

What is the sustainable level of activity and how should it be measured?
A measure of the sustainable level of activity could be the persistence of the dolphin population at its present size. But the population is already small and likely to have been reduced from its size at the time of European settlement, and in the more recent past. We do not know if in fact the Port Phillip Bay population is slowly but surely on the way to extinction, a process likely to be exacerbated by dolphin-based tourism and general vessel traffic.

Dolphins are long-lived animals with low reproductive rates. From experience and modelling of other populations (eg, see Clancy 1994, Marsh 1994), by the time a significant trend downwards in population size is detected, it may be too late for any actions to reverse the trend. Perhaps yearly calf production could be monitored accurately as a measure of recruitment, but what would be acceptable limits to fluctuations in this variable? Calf survivorship or recruitment of females into the breeding population could be monitored but the same concern applies, plus the difficulty of monitoring individuals in even a small wild population of dolphins. On the other side of the argument, the persistence of other small populations of inshore bottlenose dolphins should also be considered; in Jervis Bay, NSW where the population is thought to be about 90 individuals (Mandelc pers. comm.); in Port Stephens, NSW where the population is thought to be about 120 individuals (Allen 2001). Like the PPB population, these populations face threats from human activities, yet so far they have persisted, although we know little about original population sizes. The decline to extinction predicted in one simulation shown in Figure 5 could be facing all three populations as a consequence of additional mortality from both direct and indirect anthropogenic sources. Note (Fig. 5) that the decline to extinction in such a long-lived animal takes many years.

When considering the responses of killer whales to vessels over 20 years, there has not been habituation to vessel proximity, which suggests that vessels restrict Odontocete cetaceans' ability to forage, feed or pursue some other aspect of their ecology. As much of dolphin behaviour is foraging and feeding, then these activities are likely to be disrupted by vessels, providing an indirect impact on population viability, through for example reduced food intake, poorer condition, longer calving intervals and reduced calf survivorship.

It would be worthwhile to take a cautious approach and monitor some aspect of dolphin behaviour in response to the perceived impacting influence (vessel approaches) that might be an early precursor to a decrease in calf production, juvenile survivorship, or breeding female recruitment. Monitoring the level of avoidance by dolphins when swim-tour vessels approach seems appropriate.

What approaches to defining the sustainable level of activity could be considered?
There are two possible approaches; set the quantum of activity (eg; swims or swimmers per season) or identify a condition indicator and set a desired value for it (eg; percentage of avoidance responses), or both. In 1998/1999 26% of the parallel approaches resulted in avoidance behaviour. In 1999/2000 it was 37%. It is likely that a level of avoidance-type behaviours in the absence of vessels would be much less than 26%. Both DRI and Scarpaci (pers. comm.) have data that could provide an assessment of avoidance-type behaviour in the absence of vessels.

The sustainable level of activity could be defined in terms of the dolphins' response to swim-tours, which provide a very large proportion of the close proximity of vessels on dolphins. Therefore it would be desirable to attempt to set a limit on the number of avoidance responses by setting a quantum of activity, aiming to bring avoidance responses to an acceptable level. Setting a limit on swims would not be desirable because it can take several approaches to achieve a swim, and it is the proximity of a vessel underway rather than the swimmers in the water that the dolphins are avoiding. It cannot be assumed of course that the approach / swim ratio would remain constant if regulations were changed. A limit on the number of swimmers is also not relevant to decreasing vessel proximity, as dolphins do not change behaviour significantly when swimmers are placed in the water. Therefore a limit on the number of approaches should be set, which has the advantage of limiting what is considered a key 'threatening process' from vessels, being in too close proximity to dolphins while underway.

Regulating proximity through number of approaches within 100m.

The proposal is to limit the number of approaches to be made by swim-tours and sightseeing tours on dolphins in an attempt to limit the total time vessels are in close proximity to dolphins and reduce avoidance behaviour by dolphins. The maximum number of approaches to be made each tour is proposed as 3 for swim tour vessels and 1 for sightseeing tour vessels (ie, vessels holding a sightseeing tour permit only), where a tour is defined as the time interval between leaving and returning to the wharf. 'Tour' could also be defined in terms of a particular group of clients, if operators were able to offload and load clients without returning to the wharf. If the number of tours per day were increased substantially, then the number of approaches per tour would need to be reconsidered in the light of the overall time in proximity to dolphins. The proposed number of approaches per swim tour is less than the average number of approaches per tour in the 1998/1999 season.

This figure of 3 approaches per tour has been identified partly on the consideration that it will be sustainable for the industry over the 2-year period of the new permits, and on the consideration that it will not lead to any increase in avoidance behaviour (and hopefully a decrease) by dolphins.

A second option for regulating proximity is to increase the minimum approach distance from 50m to 100m. The reason not to propose this at this stage is that swim-tour operators argue they would get few if any 'successful swims' from this distance. This is supported by the observation that tour operators rarely attempt swims in the Ticonderoga Bay Dolphin Sanctuary Zone, where the minimum approach distance is 100m.

A third option for regulating proximity is to increase the minimum approach distance for all vessels from 100m to 200m, and then for permitted vessels to be allowed within 200m to 50m, for a limited time and for a limited number of approaches per tour. This would be worth considering if proposed changes to regulations to reduce vessel proximity do not result in a decrease in avoidance behaviour over the next two years.

Regulating proximity by regulating interaction time.

The DRI data show the average time within 100m in the 1999/2000 season, where swims were launched, to be 3.11 min. More than 90% of these approaches were completed within 7 min. (assuming approach times follow a normal distribution, which is a reasonable assumption). Therefore it is proposed that the maximum time for which permitted vessels are to be within 100m from dolphins is 7 min. Comparing this to the 1999/2000 average level of interaction within 100m: for 3 approaches per tour, with 9 tours per day it is 189 min. per day (3 approaches x 7 min. x 9), while the 1999/2000 average level of interaction within 100m is 148 min (6.1 approaches per tour x 2.7 minutes overall approach average x 9). However, with fewer approaches per tour (6.1 reduced to 3), if the average approach time remains the same at 2.7 min., then the time within 100m will be reduced from 148 to 73 min. per day.

Swim-tour operators may to respond to the proposed regulation by remaining within 100m for the maximum time allowed, which would be 7 minutes (because the number of approaches has been restricted). Time spent within 100m (ie, interacting) would need to be monitored and the time limit proposed above reviewed after a period, say one season. There is no intention here to restrict the overall swim time to 7 minutes, only to restrict the time within 100m to 7 minutes. If dolphins move or are more than 100m away from the vessel, then there is no limit on the swim time.

At present there is no number available for the proportion of avoidance-type behaviours in the absence of vessels. When a number is available, together with the results of monitoring for a further two seasons, the number of approaches within 100m per tour and the time within 100m should be re-assessed.

Dolphin groups containing foetal-fold calves should not be approached within 100m.

Regulating proximity through approach distance in the presence of another vessel
Regulation 5.2.a states that 'the permit holder must ensure that the tour vessel does not approach or remain within 200m of another tour vessel if that tour vessel is within 100m of a dolphin'. An increase in this distance to 300m is proposed in an attempt to restrict the opportunity for herding behaviour of tour vessels on dolphins, thereby giving dolphins more room and opportunity to move out of proximity with vessels.

It would also be worthwhile considering a ban on swims in areas where vessel navigation is restricted, for example in channels used for navigation between sandbanks. This would allow tour vessels to maintain the proposed 300m (or even the existing 200m) approach distance as well as navigate safely if a swim were being conducted by another vessel.

Sightseeing permits
If additional sightseeing permits were to be considered, then the overall level of proximity to dolphins by permitted motorised vessels would increase. The regulation of proximity of sightseeing vessels through number of approaches, approach distance and approach time must then be reconsidered.

Removing limit on the number of swimmers
A limit on the number of tours each day is set currently by regulations 6.2.g and 6.2.p, because a maximum of 10 swimmers per swim and 50 swimmers per day is specified. The number of swimmers in the water at any one time hanging on to mermaid lines is seen as being of little relevance to the aim of reducing impact on dolphins, as dolphins were shown not to respond significantly to swimmers behind the tour vessel on the mermaid lines. It is suggested therefore that the limit of 10 swimmers in the water at any one time and the limit of 50 swimmers per day be removed. There are safety considerations if the number of swimmers in the water at any one time is increased, but if the ratio of dive-masters to swimmers to mermaid lines remains the same, then this should not be a problem.

Is it possible to discriminate between the impacts of tours versus private boat use?
DRI and other data provided evidence that most (more than 90%) of the interactions of vessels with dolphins is from tour vessels. Although swim-tour vessels are few in number, their target is the dolphins, while most recreational vessels are in proximity to dolphins or interact with dolphins incidentally. Recreational vessels moving at high speed or on an erratic course are likely to impact the dolphins more than those moving at low speed on a steady course. There are regulations in place (9.1, 9.2, Anon. 1998) to govern aspects of vessel behaviour within 300m of dolphins. Persons in control of recreational vessels need to become well acquainted with these regulations. Questions on regulations concerning marine mammals should be included in the test for a recreational boating license.

Ticonderoga Bay Dolphin Sanctuary Zone

Is the existing Ticonderoga Bay Sanctuary (TBS) Zone effective?

Perhaps there are two questions here. First, what is the function of the zone? Second, is the zone effective? Currently the zone extends from Police Point to the Cattle Jetty ruins and 500m from shore (Fig. 1).

The deeper water close to the coast in the Sorrento (Pt MacArthur) – Observatory Pt area is likely to be a significant component of the dolphins' habitat because it is outside the main tidal flow, which is strongest in the shallow water further offshore and in the South Channel (Fig. 1). Travelling fish on which the dolphins forage will be more easily herded and caught near the shore if the water there is sufficiently deep (for example around Pt King). Swim-tour and other vessels remain close to dolphins for a large proportion of daylight hours in the Summer and Autumn. A portion of the 'home range' where they are away from tide, tour vessels and recreational vessels is appropriate as a sanctuary from vessels. There is no data available yet to determine precisely the proportion of time dolphins spend inside versus outside the sanctuary zone, but it appears that a significant proportion of their time during daylight hours is within the zone.

The DRI analysis shows a high level of regulation breaches within the TBS. If the zone is to be effective, vessels must keep well clear of dolphins. The minimum approach distances that currently apply are inconsistent if the aim is to provide respite for dolphins; they vary depending on the type of operation. Therefore, for all motorised vessels the minimum approach distance in the sanctuary zone should be 200m, for non-motorised vessels the distance to remain at 100m, and for swimmers, divers, surfboards a distance of 50m is suggested (from 30m) to provide consistent distance multiples in the regulations and ensure that vessels of all types, both motorised and non-motorised, keep clear of dolphins.

Side-on approach distances are thought to be of less concern than front-on approach distances, where 400m is the recommended distance elsewhere. Recognising the difficulty for vessel captains to ascertain dolphin movements and judge distances, a minimum approach distance is needed that can ensure vessels stay well clear of dolphins in this zone. As well, the proposed distance of 200m for all motorised vessels is closer to a distance (400m) that is considered a suitable minimum approach distance from studies elsewhere.

Are there alternative sanctuary zones?

For the purpose of identifying additional or alternative sanctuary zones, an attempt should be made to identify areas used preferentially for feeding, if they exist. Sometimes areas used for feeding will be in navigation channels, such as the common feeding behaviour near Pt King, Sorrento, in the 2001/2002 season. Even in these situations care should be taken to avoid approaching dolphins, as per regulations. Swims should not be attempted in areas where it will not be possible for other vessels to keep clear as per regulations due to restricted navigation.

Extent of Ticonderoga Bay Sanctuary Zone

An extension to the Ticonderoga Bay Sanctuary Zone from 500m to 1000m seawards, and / or to the west would provide a larger sanctuary for dolphins from vessels (in close proximity) in the deeper water close to the coast. The proposed new seaward boundary of the zone is a little more than half way to the South Channel, the main shipping channel (Fig. 1). The zone extends along only 2.5km of coastline, while swims take place along at least 10km of coastline. An extended zone therefore would not restrict unduly access to dolphins by swim and sightseeing tour operators.

The decision on where to extend the zone should rest on an evaluation of existing data of use of the zone by dolphins compared to use of areas outside the zone.

Number of permits for 2002-2004.

The number of permits for 2002-2004 is proposed to remain at present levels. A reduction in interaction time per vessel with dolphins is considered to be a more equitable path to sustainability than that of reducing the number of permits.

Regulations after 2003/2004 season on the basis of results of monitoring.

After the 2003/2004 season, before permits come up for renewal, DNRE should assess analyses of data on dolphin responses and compliance to regulations. The approach distances (for swim-tours, sightseeing tours and recreational vessels) and number of approaches allowed (for swim-tour vessels) for the 2004/2005 and 2005/2006 seasons should be based on the analysis of data available now and that from the next two seasons.

Issue of permits after 2003/2004 season on the basis of results of monitoring.

Monitoring of dolphin responses should allow an assessment as to whether the level of avoidance response has changed. Monitoring of operator compliance and assessment of compliance rate is seen as an important dis-incentive to swim-tour operators who do not comply with regulations.

Monitor impacts on dolphins.

Ongoing monitoring of dolphin responses to vessels and use of the area of high vessel traffic is considered important for ongoing management. For example, if avoidance responses continue to rise, even with additional regulations, then further restrictions on vessel access to dolphins may be necessary.

Informing the industry and public.

Extension activities are a key aspect of encouraging compliance to regulations. The industry it seems does not understand the regulations or the reasons for them because breaches of compliance when being knowingly monitored are high. Training workshops are necessary to further industry understanding of the eco-tourism activity of which they are a part. The recreational boating public would also have little knowledge or understanding of dolphin behaviour and ecology. Ways of getting the message across are needed and those suggested in this section are a start.

Further research for impact assessment and management

There is some data available on population parameters for this and other populations of coastal bottlenose dolphins. It is reasonable to assume that the population is closed for females and open for males. Good estimates for variables such as female population size, calving rate, calving interval, calf and adult survivorship and age at first breeding are needed as inputs to population viability modelling. From this it is possible to predict the impact on the dolphin population of anthropogenic (human-induced) impacts such as reduced food through habitat destruction, reduced feeding opportunities through interference by vessel traffic, and additional mortality from boat strikes, especially on females (Fig. 6).

PROPOSED CHANGES TO REGULATIONS AND MANAGEMENT.

The following are proposed changes to regulations and other management measures that will lead to a greater likelihood of sustainability for the dolphin population and therefore the dolphin swim-tour and sightseeing industry. The aim is to regulate dolphin swim-tours, sightseeing tours and the recreational boating public to ensure a sustainable dolphin population and therefore a sustainable industry; ie; an eco-tourism industry where the wildlife population that is the focus of the industry is likely to persist in perpetuity. These proposals are made in consideration of the other two components of ESD (Ecologically Sustainable Development); social and economic equity. The proposals are presented having considered their likely impacts on the existing dolphin swim-tour and dolphin sight-seeing industry as well as on the dolphins.

The proposed changes to regulations represent a shift away from the current focus on regulating the number of swimmers to regulating the proximity of vessels to dolphins. It seems reasonable to trial any proposed changes to the regulations, but to be worthwhile the trials must be monitored by independent observers who are trained in the collection of behavioural data in the field. In addition to recommended changes to regulations outlined below and in Table 5, it is proposed that:

- The proximity of vessels to dolphins continues to be monitored, as well as the responses of dolphins to vessels.
- There continue for the present to be no limit on the overall number of swim tours per vessel per season or per day, an aspect of operation that may need to be addressed if dolphin avoidance of vessels and vessel disruption of normal dolphin behaviours, including foraging and feeding, continues to increase.
- The number of dolphin swim permits be maintained at 4 while not at this stage limiting the number of dolphin sightseeing permits, with the consequences for overall vessel proximity to dolphins, and regulations aiming to reduce proximity, being assessed before there is any decision to increase the number of sightseeing permits beyond the present two.

- The use of the Ticonderoga Bay Dolphin Sanctuary Zone and adjacent areas to the west and north by dolphins be investigated with a view to extending the area westwards, northwards or both in order to provide additional area where dolphins may not be approached by tour vessels closer than 200m, and where approach distances by other commercial and recreational vessels is restricted to 200m.

To regulate the impact of vessels on dolphins:

- Limit to three per tour the maximum number of approaches closer than 100m to dolphins by swim-tour vessels, per tour.
- Limit to 7 minutes the time a swim-tour vessel can be within 100m of a dolphin on each approach.
- Limit to one per tour the number of approaches closer than 100m to dolphins by sightseeing tour vessels.
- Limit to 7 minutes the time a sightseeing tour vessel can be within 100m of a dolphin on each tour.
- Prohibit approaches within 100m to dolphin groups containing foetal-fold calves.
- Increase to 300m the minimum distance that a tour vessel can approach another tour vessel if that tour vessel is within 100m of a dolphin.
- Increase minimum approach distances in the Ticonderoga Bay Sanctuary Zone to 200m for all motorised vessels.
- Consider prohibiting dolphin swims in areas where vessel navigation is restricted.
- Allocate the existing number of swim-tour permits for 2002/2003 and 2003/2004 seasons but not grant any additional permits.
- Consider effectiveness of regulations and issue of permits after 2003/2004 season on the basis of dolphin behaviour monitoring and compliance to regulations by permit holders.

To monitor short-term impacts on dolphins:

- Continue to monitor dolphin responses to approaches from swim-tour, sightseeing tour and recreational vessels. Determine background level of avoidance behaviour through monitoring behaviour in the absence of vessels, and analysis of data.

- Continue to monitor compliance to regulations over 2002/2003 and 2003/2004 seasons, from both shore-based and boat-based (including swim-tour) stations.
- Monitor and analyse data for dolphin and vessel use of Ticonderoga Bay Sanctuary Zone.

To inform the industry and public:

- Conduct training workshops to inform swim-tour operators of existing and new regulations and the reasons for them, and train them to recognise calves.
- Inform the swim-tour and sightseeing industry of results of monitoring operator compliance and dolphin responses to approaches and interactions, on a regular basis.
- Include questions on marine mammal regulations in the test for recreational boating license.
- Conduct extension activities (eg pamphlets, signage, boat-based surveillance) to inform recreational boaters of existing and new regulations and the reasons for them.

Further research for impact assessment and management:

- Continue to collect demographic information on dolphins to enable variables such as population size, age at first breeding, calving rate and calf and adult survivorship to be determined with greater precision. Carcase recovery and post-mortem to be a priority.
- Conduct population genetic analysis to help identify sex of individual dolphins, size of female breeding population and the geographic range of the population.
- Conduct population modelling, using collected data and data sourced from other populations, to establish confidence levels for population persistence under different parameter values.
- Investigate dolphin use of the Ticonderoga Bay Dolphin Sanctuary Zone and surrounding waters to determine whether an extension to the zone would be effective in providing further sanctuary for dolphins.

Other:

- Remove the limit on the number of swimmers per tour and per day.

Table 5. Recommended changes to existing regulations (Anon. 1998) governing dolphin-swim and dolphin sightseeing tours in Victoria.

	Regulation	Current	Proposed
A	NEW	No. approaches within 100m not regulated	Swim tours allowed a total of 3 approaches within 100m, per tour.
B	NEW	No. approaches within 100m not regulated	Sightseeing tours allowed a total of 1 approach within 100m, per tour.
C	7.2.e	Sight-seeing tours remain closer than 100m for no longer than 20 min.	Sight-seeing tours remain closer than 100m for no longer than 7 min.
D	NEW		Swim-tours remain closer than 100m for no longer than 7 min.
E	6.2.i	Not attempt swim if foetal-fold calf present.	Not approach within 100m if foetal-fold calf present.
F	6.2.j	Discontinue swim if foetal-fold calf detected.	Discontinue swim and withdraw beyond 100m if foetal-fold calf detected.
G	5.2.a	'ensure that the tour vessel does not approach or remain within 200m of another tour vessel if that tour vessel is within 100m of a dolphin;'	Increase distance to 300m.
H	6.2.b	Dolphin swim not to continue more than 20 min.	DELETE, 7 min. time limit within 100m proposed.
I	NEW		Motorised vessel not to approach within 200m in sanctuary zone
J	5.2.j	Swim- & sightseeing-tours not to approach within 100m in sanctuary zone	Swim- & sightseeing-tours not to approach within 200m in sanctuary zone
K	6.2.p	No more than 50 swimmers per day	DELETE, no limit on swimmers
L	6.2.g	No more than 10 swimmers in a swim	DELETE, no limit on swimmers
M	4.b.iii	Distance if swimming or diving not less the 30m.	Distance if swimming or diving not less than 50m.
N	4.b.v	Distance if using a surfboard not less the 30m.	Distance if using a surfboard not less than 50m.

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Figure 6. <u>Vessel - dolphin interactions.</u> Clockwise from top left; family boating (DRI photo), jet ski (DRI photo), female dolphin calf euthanased after tail stock nearly cut through by propeller strike (Hale photo), dolphin swim with second vessel in close attendance (DRI photo), swimmers in the water looking for dolphins (DRI photo), vehicular ferry (DRI photo).