

Unsustainable dolphin-watching tourism in Fiordland, New Zealand

David Lusseau^{1,2}, Liz Slooten¹ & Rohan J.C. Currey³

University of Otago, ¹Department of Zoology and ³Department of Marine Sciences, PO Box 56, Dunedin, New Zealand

²Dalhousie University, Department of Biology, 1355 Oxford Street, Halifax, NS B3H 4J1, Canada
E-mail: d.lusseau@dal.ca

Bottlenose dolphins are a key resource of the tourism industry in Fiordland and are used on a daily basis by the tour operators offering cruises on the fiords. Recent studies have shown that the current levels of dolphin-boat interactions in this region cannot be sustained by bottlenose dolphins. Interactions have both short- and long- term effects on both individuals and their populations. Population models indicate that these effects may be affecting the viability of the three bottlenose dolphin populations living in Fiordland. We are currently observing drastic changes in the bottlenose dolphin population living in Doubtful Sound which can be linked to the level of boat interactions to which they are currently exposed. The creation of a multi-level marine mammal sanctuary would help minimise dolphin-boat interactions and still allow for some further growth in the tourism sector in Fiordland.

Introduction

Fiordland is one of the key destinations for international travellers visiting New Zealand as well as for New Zealanders. In 2002, 450,000 people visited Milford Sound and 41,000 visited Doubtful Sound, nearly all undertaking scenic cruises in those fiords (DoC, 2006). This represented 58% of all visitors to the New Zealand Southland region in that year (TRC, 2005). In 2004, more than 1 million people visited Southland, a 29% increase since 2002 (TRC, 2005). There was no estimate for the scenic cruise component of the industry but the increase in participation was most likely similar or higher. Recent economic analyses show that tourism is one of the strongest assets of Fiordland accounting for 12% of jobs in the Southland region of New Zealand and providing NZ\$368 million/year (US\$ 233 million) for that region (Southland Tourism Strategy 2005). Fiordland is a young tourism destination in New Zealand and is currently undergoing a rapid expansion (only 247,000 tourists visited Milford Sound in 1992) on which the region is understandably eager to capitalise by increasing tourism opportunities (Tourism Resource Consultants, 2005).

People come to Fiordland to experience wilderness and many undertake scenic cruises on the fiords. The scenic cruise industry relies on bottlenose dolphins as one of their key assets (Lusseau, 2005b), it is therefore crucial to

maintain viable populations of this species in the region and prevent any activities that may alter the biology and/or ecology of those populations. Failure to do so, as we argued before (Lusseau, 2004, 2005a; Lusseau & Higham, 2004; Lusseau, Slooten, Dawson, & Higham, 2002), will undermine the sustainability of the scenic cruise industry in this region and taint the “Green Image” of New Zealand which attracts so many visitors to this country.

Fiordland is home to three small populations of bottlenose dolphins (*Tursiops* sp.) which seem to have very restricted social and genetic interactions (Lusseau et al., 2003; Williams, Dawson, & Slooten, 1993) (de Tezanos Pinto, unpublished data 2005). They are the southernmost resident populations of the species and are therefore subjected to higher environmental stress compared to life at high latitudes (Schneider, 1999). All three populations regularly interact with tour boats with varying degrees of intensity. In the period 1999-2002 more than 8500 boat tours per year were offered in Milford Sound, 1700/year in Doubtful Sound and a much lower level, not quantified, occurred in Dusky/Breaksea Sound (Lusseau, 2004). During those years, dolphins spent 11% of their time interacting with boats in Doubtful Sound and, intriguingly, exposure to interactions was similar in Milford Sound (13%). A study was carried out at that time to quantify the effects of boat tours on these populations of dolphins. We present here a short overview of the main

findings of this study, the recommendations that were made to achieve sustainability and an update on the implementation of these recommendations.

Boat interactions affect the biology of Fiordland bottlenose dolphins

In Milford Sound, a large proportion (8-10%) of dolphins in the population were bearing marks of physical injuries caused by boat strikes (Lusseau et al., 2002). One calf was also shown to have been killed by a tour boat in 2002 (Lusseau et al., 2002), this reduced the reproductive success of the population that year by 50% since only two calves were born in the population.

Monitoring the respiration rate of individuals can help in understanding the physiological constraints they are faced with since this physiological parameter is directly linked to metabolic demands. We followed individuals and recorded the time elapsed between surfacings with and without boats present as well as depending on the behaviour of boats (whether the boats violated the New Zealand Marine Mammal Protection Regulations). We observed typical vertical avoidance during interactions with boats and regulation violations had an additive effect for females (D. Lusseau, 2003). The more violations were committed during an interaction, the greater the increase in dive interval for females (Figure 1). By contrast males were not as affected by violations (Figure 1). Moreover, the effect on females was substantial with an 18.6% increase in dive interval when one violation occurred, and 37.1% increase for more than one violation. Following predator avoidance strategy theory, we concluded that the observed extra energetic demand on females, related to their metabolic rate and smaller size, prevented them from vertically avoiding a perceived threat (Howland, 1974). They would have therefore only increased their dive interval when necessary, i.e. when the threat is real (e.g. risk of injuries for example) during intrusive interactions. Males would have more energy available to avoid any potential problem via short-term vertical avoidance. This showed that responses to boat interactions had a significant biological cost that may be difficult to be met by females. Having to meet this cost could result in reduced reproductive success for females (Moberg & Mench, 2000).

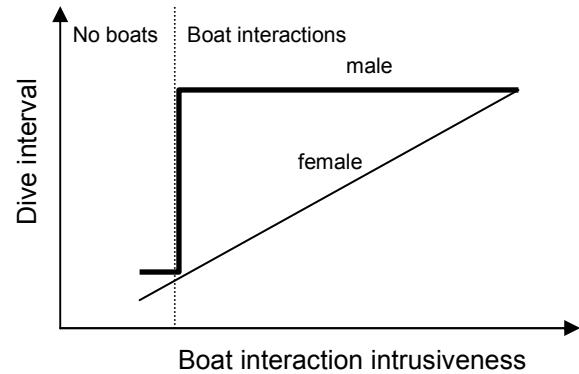


Figure 1. The effects of boat interactions on the surfacing pattern of female and male dolphins in Doubtful Sound. Both sexes increase their dive intervals, that is spend more time underwater, when interacting with boats. However, while male's dive intervals do not change with the intrusiveness of boat interactions (measured as the number of violations of the MMPR during interactions), female's dive intervals increase steadily with the intrusiveness of interactions.

Boat interactions affect the behavioural budget of Fiordland bottlenose dolphin populations

In both fiords the behavioural budget of dolphins changed significantly during boat interactions in a similar fashion (Lusseau, 2004). These interactions disrupted significantly the dolphins' resting behaviour and increased the amount of time they spent travelling, to horizontally avoid boats. These changes did not alter the overall behavioural budget of the populations because schools of dolphins did not spend enough time exposed to boats. However, comparing both fiords showed that this short-term behavioural disruption strategy was no longer advantageous if there was typically less than 68 minutes between two boat interactions (Figure 2). Beyond this threshold the time elapsed between two boat interactions was no longer directly related to the number of boat trips undertaken but remained constant. This shows that dolphins actively avoided boat interactions in order not to exceed this interaction frequency threshold. In order for the behavioural budget of dolphins, and consequently their energetic budget, to not change significantly, dolphins switched to long-term area avoidance when boat interactions were too frequent (Lusseau, 2004, 2005a).

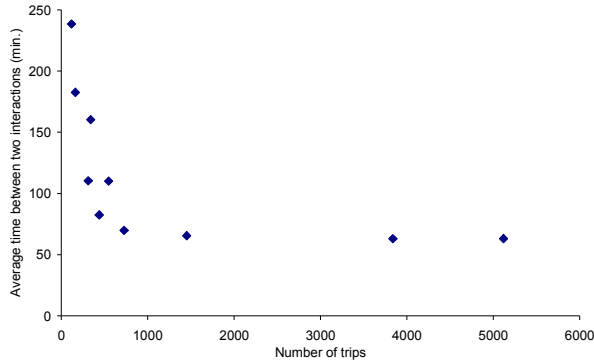


Figure 2. The average time spent between two interactions with boats each season in Fiordland in relation to the number of boat trips offered in the same location during that season. The average time between two interactions is estimated using the likelihood to spend the time between two samples without interactions both in Milford Sound and Doubtful Sound (see Lusseau 2004 for details).

Boat interactions affect the ecology of Fiordland bottlenose dolphin populations

This long-term area avoidance strategy resulted in the displacement of dolphins from their habitat; dolphins avoiding altogether the fiord when boating intensity was high (Lusseau, 2005a). This meant that the dolphins spent significantly less time in Milford Sound during peak tourism seasons (Figure 3) and their residency pattern was significantly negatively related to boat traffic. When dolphins visited Milford Sound they also avoided being inside the fiord, i.e. where boats cruised, during peaks in traffic. The likelihood that they would be found inside the fiord when present in Milford Sound was also significantly negatively related to boat traffic.

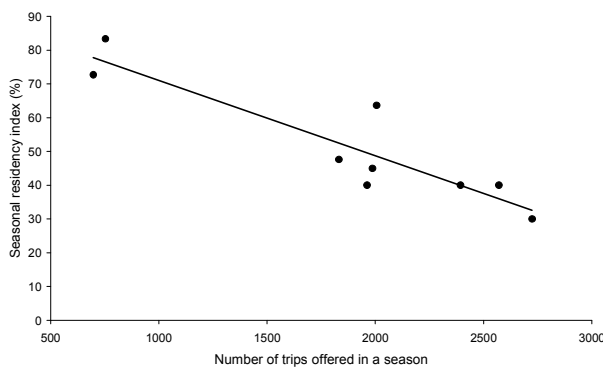


Figure 3. The relationship between the number of boat trips offered each season and the seasonal residency index of bottlenose dolphins in Milford Sound between December 1999 and February 2002 (9 seasons). The residency index is the number of days when dolphins were present in the fiord related to the number of days of field effort each season.

Solutions for sustainable tourism

These findings resulted in a conundrum: how can these impacts be resolved without impeding tourism growth? Interactions between boats and dolphins needed to be limited, especially when dolphins were resting and socialising, but boats that held dolphin watching permits still needed to be able to access this resource. We proposed the creation of a multi-level marine mammal sanctuary (Figure 4) in order to resolve this conflict (Lusseau & Higham, 2004). The idea behind the sanctuary was to provide operators with dolphin-watching permits with more opportunities to encounter dolphins than other operators in the area, and provide dolphins with no-boat zones. This zoning would result in restricting access for only 15% of the fiord, in the case of Doubtful Sound, and provide no-boat zone status to 50-60% of locations where dolphins were observed resting and socialising.

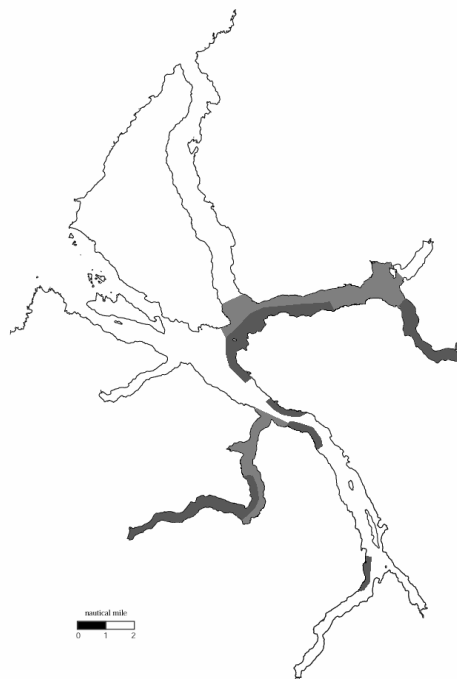


Figure 4. Proposed multi-level marine mammal sanctuary in Doubtful Sound (adapted from Lusseau & Higham 2004). Dark gray areas correspond to no-boat zones. Light gray areas correspond to location where only tour operators that possess a dolphin-watching permit and researchers are allowed. At present this sanctuary would apply to tour operators and researchers only. Non-targeting general traffic needs to be minimised as well in the protected zones. No wake/no interactions corridors can be implemented within the light gray zones to reach safe anchorage.

Conclusions

In 2002, the study reached the following conclusions:

“On a long-term basis, bottlenose dolphins cannot sustain the types of activities undertaken by the scenic cruise industry in Doubtful Sound. The tourism sector is currently at a crossroad in this fjord... Sustainability can be achieved if the results of this study are incorporated in a management framework. If the current development scheme is left unaltered the industry will impact upon both the local natural resources and the local community beyond repair. Moreover, the activities offered in the fjord will not match the expectation of visitors, which will irrevocably compromise the economic sustainability of the tourism operations.” (Lusseau 2004)

“It is necessary to place a limit on the number of trips that can be offered by *all* companies utilising Milford Sound” (Lusseau et al. 2002)

This advice was delivered in 2002. However since then levels of activities have continued to increase, offering a natural experiment to test our predictions. In 2006, a new company was granted consent to operate in Milford Sound. Facilities at the harbour have also been expanded in 2005-2006 in order to accommodate more tourists. The growth of the cruise industry in Doubtful Sound has also continued, with several tour operating companies increasing their level of activities since 2002. While many of these companies are not planning to target dolphins within their tours, since they did not apply for dolphin-watching permits, we clearly showed in the 2002 study that non-permitted operators were still significantly interacting with dolphins (D Lusseau, 2003; Lusseau, 2005b) in Fiordland. Therefore despite our advice the increase of dolphin-boat interactions in both fiords has been allowed.

The occurrence of stillbirths significantly increased in the population. Tourism activities increased in Doubtful Sound from 1994 to 2006. The number of boats operating in the fiord in 2000-2006 more than doubled in comparison to the number of boats operating in 1994-1999

(Lusseau, 2005b). From 1994 to 1999 stillbirths occurred only in two of the five years surveyed while they occurred in five out of the six surveyed years from 2000 to 2006 (randomisation test to compare these two proportions: $p=0.037$, 1000 randomisations iterated 200 times. All simulations had $p\leq 0.05$). The stillbirth rate, that is the number of stillbirths observed in a given year in relation to all births in that year, also increased from 0.13 on average from 1994 to 1999 to on average 0.34 from 2000 to 2006. This represented a marginally significant increase (randomisation test to compare means between the two time periods: $p=0.058$, 1000 randomisations iterated 200 times. 20% of those iterations had $p<0.05$ and 96% had $p<0.07$, for all simulations $p<0.08$). The population abundance has drastically decreased from 67 individuals in winter 1997 (coefficient of variation: 1.8%) to 56 individuals in autumn 2005 (coefficient of variation: 1.7%) (Currey submitted). For the first time in 2003 individual dolphins from the Doubtful Sound population were observed in Dusky Sound (Boisseau, 2004) and they have been recorded several time since then in this other fiord (Currey unpublished data). All of these observed effects on the population dynamics were predicted from the impacts observed during the 1999-2002 study. While tourism exposure may not be the only factor affecting the current trends of the population, we demonstrated that it could play a key role in the population dynamics observed since 2002. Other potential impacts on this population include recreational fishing (Lusseau & Wing, 2006) and freshwater input from a hydro-electricity station (Rutger & Wing, 2006; Tallis, Wing, & Frew, 2004), most likely through indirect effects on prey availability rather than direct impacts on the dolphins.

Preliminary individual-based modelling work (Lusseau, Lusseau, Bejder, & Williams, 2006), based on the results of the 2002 study and recent studies (Bejder, 2005; Bejder et al., 2006), show that the current levels of boat-dolphin interactions are highly likely to jeopardise the viability of the dolphin population within the next 30 to 70 years. That is, the population is highly likely to go extinct within the next 50 years if current trends remain. The modelling work shows that this decline can be attributed to the impact of tourism on individuals repeatedly exposed to boat interactions.

While the New Zealand government advocates the precautionary principle in the management of natural resources this is not

being applied in the context of the development of boat-based tourism activities in Fiordland. We are urging the New Zealand government to take actions to protect the small and isolated populations of bottlenose dolphins in Fiordland. We re-iterate our recommendation to establish multi-level marine mammal sanctuaries in Doubtful Sound and Milford Sound to minimise dolphin-boat interactions in these fiords and still allow the tourism industry to flourish there.

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Biographical notes

David Lusseau is currently the Killam postdoctoral fellow in Dalhousie University, Department of Biology, Nova Scotia, Canada. He obtained his PhD from the University of Otago in 2002 studying the effects of tourism activities on bottlenose dolphins in Fiordland.

Liz Slooten is Senior Lecturer at the University of Otago, Department of Zoology, New Zealand. She focuses her studies on the conservation biology of marine mammals, working especially with Hector's dolphins. In 2004 she was co-recipient, with Steve Dawson, of the New Zealand Royal Society's Sir Charles Fleming Award for outstanding contribution to conservation science.

Rohan Currey is PhD student at the University of Otago, Department of Marine Sciences, New Zealand. His work concentrates on the conservation biology and behaviour of bottlenose dolphins in Doubtful Sound, Fiordland, New Zealand.

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