Marine Mammal Science

Notes

MARINE MAMMAL SCIENCE, 31(2): 808–817 (April 2015)

DOI: 10.1111/mms.12188

Evaluating the potential disturbance from dolphin watching in Lovina, north Bali, Indonesia

PUTU LIZA KUSUMA MUSTIKA,[1] College of Marine and Environmental Sciences and College of Business, Law and Governance, James Cook University, James Cook Drive, Townsville, Queensland 4814, Australia; ALASTAIR BIRTLES, College of Business, Law and Governance, James Cook University, James Cook Drive, Townsville, Queensland 4814, Australia; YVETTE EVERINGHAM, College of Science, Technology & Engineering, James Cook University, James Cook Drive, Townsville, Queensland 4814, Australia; HELENE MARSH, College of Marine and Environmental Sciences, James Cook University, James Cook Drive, Townsville, Queensland 4814, Australia.

A global review of tourist visitation and expenditures associated with whale and dolphin watching industries indicated that the industry attracted 13 million tourists in 119 countries and contributed US$ 2.1 billion to the global economy in 2008 (O'Connor *et al.* 2009). O'Connor *et al.* (2009) indicated that nine of the 10 countries with the fastest rate of whale and dolphin watching industries were developing countries.

Whale and dolphin watching is not without risks to targeted populations. In the short-term, the behavior of some dolphin species changes when the number of boats around a school increases (Lusseau 2003, Constantine *et al.* 2004, Christiansen *et al.* 2010). The presence of tour boats may alter the path of travel (Williams and Ashe 2007) and even force the animals to dive to avoid the boats (Schaffar *et al.* 2013). Interactions with dolphin watching boats may also decrease time spent foraging (Christiansen *et al.* 2013). In addition, dolphin watching may eventually partially displace the target population from key habitats, as demonstrated during a 19 yr research study in Shark Bay, Western Australia (Bejder *et al.* 2006).

Marine mammal experts have become increasingly concerned about the need to regulate whale and dolphin watching activities (Orams 2000, Brownell and Oosthuizen 2004, Constantine *et al.* 2004, Corkeron 2004, IWC 2009), leading researchers to attempt to measure the impact of viewing (and swim-with) tourism on cetacean populations. In choosing an appropriate research design (see Bejder and Samuels

[1]Corresponding author (e-mail: putu.liza@my.jcu.edu.au).

2003), researchers must consider whether the measured activities contribute to short-term or long-term changes in the population and possible confounding factors. If such factors are not taken into account, measuring changes becomes extremely difficult and incontrovertible evidence of anthropogenic impacts even harder to obtain.

Measuring both short- and long-term impacts from tourism on dolphin behavior can be challenging. Short-term impacts, *e.g.*, changes in surface times, dive patterns, and behavioral states are easier to measure than longer-term impacts (Williams *et al.* 2002, Bejder and Samuels 2003, Williams *et al.* 2006, New *et al.* 2013). However, long-term data are required to confirm that the anthropogenic activities directly contribute to long-term changes in a cetacean population (*e.g.*, habituation, habitat utilization, changes in vital rates, and reproductive success (Bejder *et al.* 2006, Lusseau and Bejder 2007, Christiansen *et al.* 2013). The influence of confounding factors is difficult to measure, particularly when historical data are not readily available and experimental manipulations are not possible. In addition, the robust experimental designs required to measure the ecological impacts of whale and dolphin watching can be impossible to implement in places where funding, infrastructure, and capacity are limited and baseline data unavailable.

Lovina in Bali (Indonesia) epitomizes many of these problems. There are growing concerns over the likely impacts of dolphin watching at this important site but there are numerous practical difficulties for researchers attempting to measure such impacts. Established in the late 1980s by local artisanal fishers, Lovina (Bali) was the first dolphin watching site in Indonesia (Hoyt 2001, Mustika 2011). This lucrative industry depends on predictable access to coastal dolphins. Between 2007 and 2010, up to 179 colorfully painted, dedicated, traditional fishing vessels (jukungs) were available to take passengers to watch dolphins, particularly dwarf spinner dolphins (*Stenella longirostris roseiventris*). These dolphins are predictably found 3–4 km from shore (Mustika *et al.* 2013). On average, ~35 tour boats from four dolphin associations operated for <3 h each morning; up to ~100 tour boats per day operated during the season of high tourism visitation (June to October). Tour boats generally outnumbered dolphins in an encounter (median dolphin-to-boat ratio = 0.8:1) (Mustika 2011). During the scan samplings, up to 81 boats (median = 16, interquartile range = 8–30) were observed at once in the vicinity of dolphin schools.

We attempted to evaluate the level of disturbance from the dolphin watching industry in Lovina, using conventional techniques including line transect and point surveys (Buckland *et al.* 2004), scan sampling, and focal boat follows (Altmann 1974). However, we could not meet the requirements of an acceptable experimental research design that uses a control group to evaluate the ecological impact of dolphin watching. We could not find a significant cluster of accessible dolphins without tour boats, making controls impossible. We modified the scan sampling design suggested by Altmann (1974) to obtain systematic standardized snapshots of the behavior of the boats in the vicinity of the dolphins. We compared these data with the Australian whale and dolphin watching guidelines (Department of the Environment and Heritage 2005, Carlson 2010).

Sampling started when at least one dolphin was sighted and there was at least one boat responding to the dolphin(s). We scanned the interactions for a maximum of one minute (referred to as one "scan effort") to capture the behaviors of the five tourist boats closest to the dolphin(s) when a dolphin (or a school of dolphins) appeared. The information recorded was encounter fleet size (*i.e.*, the number of boats around a school of dolphins within a 150 m radius), the dolphin species, the observed number of dolphins of each species, the behaviors of the five closest boats (Table 1), and the distances between each of the five closest boats and the dolphins. We also recorded the identity of the five closest boats based on boat name (not always available) or the coloration of the boats (if names were not visible). We estimated the distances between boats and dolphins using the span of the boat's two outriggers (5 m) or boat length (10 m) as the standards. We recorded only one approach per vessel to a particular school of dolphins. However, the same vessel could be recorded multiple times if it engaged in another encounter with a different school of dolphins.

We used a local dolphin tour boat as our research vessel which limited our research to the early morning when the sea was calmest (the boat did not engage in dolphin watching while we were on board). If two encounters occurred simultaneously, our team also recorded the distance of the second encounter from the research vessel, the number of tourist boats and, if possible, the species and the number of dolphins detected. However, the complete scan sampling recording was conducted only on one focal dolphin school at a time. The research vessel typically remained stationary with its engine off during scan sampling, unless the sea state was above Beaufort 3 (7% of total efforts).

We compared our data from Lovina with the Australian standard which accords with 75% of the international best practice standards for whale and dolphin watching tourism (*sensu* Carlson 2010, also see Table 2).[2] The Australian standard bans all vessels from entering a No Approach Zone, defined as all the area within 50 m in front of, parallel to or behind a school of dolphins. The regulation permits up to three boats in the Caution Zone, defined as the zone within 50–150 m on the sides of the dolphin school (Fig. 1).

We grouped our observations into the high tourism visitation season ("High Season," June to October) and the low tourism visitation season ("Low Season," November to May). We used the Australian whale and dolphin watching guidelines

Table 1. Categories of boat behaviors used in the dolphin research off Lovina (modified from Allen *et al*. 2007).

Category	Explanation
Chase with speed faster than the cetaceans	Boat heads straight at cetacean school at a speed that exceeds that of the cetaceans but stops before the school
Approach with speed slower or the same as the cetaceans	Boat approaches cetacean school but stops before the school, not speeding
Circle to the front of the cetacean school	Boat travels to the front of the cetacean school in a semicircling movement
Parallel with the cetacean school	Boat runs parallel within 150 m of the cetacean school
Driving or cutting through the cetacean school	Boat speeds straight to and then through the cetacean school
Following the cetaceans	Boat follows the cetaceans from behind
Stationary with engine on (neutral gear)	Boat relatively stationary within 150 m of the cetacean school, engine on
Stationary with engine off	Boat relatively stationary within 150 m of the cetacean school, engine off
Searching for cetaceans	Boat searches for cetaceans

[2]Out of 12 countries or territories in Table 2 that provided the minimum distance for dolphin watching, 75% of them used 50 m for the No Approach Zone.

Table 2. A brief description of distance limit for dolphin watching industries *sensu* Carlson (2010).

Country/territory/ group of countries	Minimum distance	Maximum number of boats in Caution Zone	Maximum time spent in Caution Zone (minutes)	Maximum speed around the animals (knots)
ACCOBAMS	50	1	30	6
Australia	50	3	60	5
Dominica	50	2	20	n.a.
Ecuador	50	3	25	5
France	10	2	n.a.	n.a.
Galapagos Islands	n.a.	n.a.	n.a.	3
Hong Kong	100	1	n.a.	10
Indonesia[a]	50	n.a.	n.a.	n.a.
Ireland	100	3	30	7
Mauritius	50	n.a.	n.a.	n.a.
Oman	50	n.a.	n.a.	n.a.
Pacific Islands	50	3	n.a.	n.a.
Philippines	50	n.a.	20	n.a.
Tanzania and Zanzibar	n.a.	2	30	n.a.

[a]Indonesia's distance limit was proposed by Apex Environmental, but has not yet been adopted as a national policy.

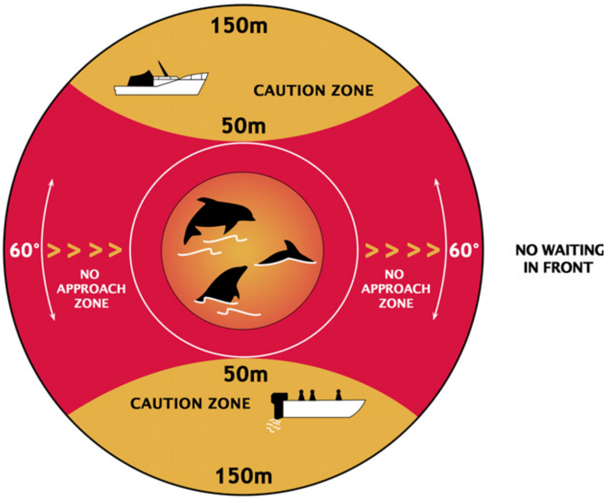

Figure 1. The Australian national guidelines for dolphin watching used as the standard to evaluate dolphin watching off Lovina (Department of the Environment and Heritage 2005; reproduced with written permission).

(Department of the Environment and Heritage 2005, Carlson 2010) to categorize the boats into those that did or did not exhibit "behaviors of concern." A boat exhibiting "behaviors of concern" was one that sped towards the school, cut through or blocked the dolphins' line of travel up to 150 m from the dolphins. Boats that followed the dolphins from behind were excluded in the overall analysis because of the difficulties in measuring the angles between the dolphins and the boats. This omission is likely to have resulted in an underestimation of boat intrusions by an unknown amount.

During 175 scan sampling efforts over 36 d, examination of the boatmen's conduct indicated that the operations at Lovina violated Australian standards. On average, approximately 40% of observed boatmen (2.1 of the five closest boats) deliberately came closer than the recommended 50 m minimum approach distance. A total of 64 boats (64.7% of the 99 identified boats) were observed speeding, cutting through, or blocking the dolphin's route at least once during the scan sampling days.

Almost 30% of the closest boats were stationary, while about 21% of the moving boats exhibited "behaviors of concern" (n = 161 scan efforts). The active (nonstationary) tourist vessels came very close to the dolphins, especially in the High Season (Fig. 2). The median distance of the closest active boat in each scan was 20 m (interquartile range = 10–30 m, range = 0–100 m, n = 83 scan efforts) in the High Season and 30 m (interquartile range = 20–50 m, range = 5–125 m, n = 72 scan efforts) in the Low Season. There was a significant seasonal difference; the closest active boats were much nearer the dolphins in the High Season when there were more boats around (nonparametric median test two-tailed $P = 0.000$, n = 155 scan efforts).

Two other ways of measuring boat crowding were also used. In both seasons, the median distance of the five closest active boats was within the "No Approach Zone" defined by Australian regulations (High Season median = 30 m, interquartile range = 15–40 m, range 0–125 m, n = 83 scan efforts; Low Season median = 50 m, interquartile range = 30–75 m, range 10–150 m, n = 72 scan efforts; Fig. 2). A significant

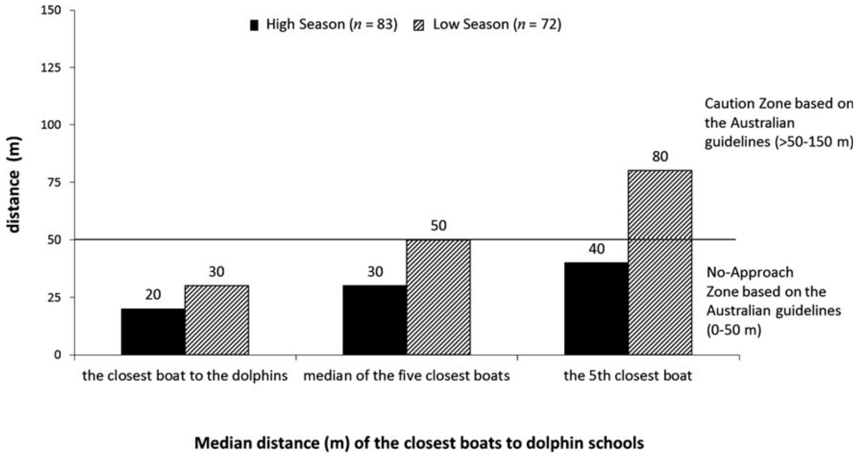

Figure 2. Comparison of the median approach distances of the tourist boats off Lovina with the Australian National Guidelines for Whale and Dolphin Watching 2005. The data are based on scans of the five active tourist vessels closest to dolphins encountered off Lovina. The values above each bar are median distance (m).

seasonal difference was detected (nonparametric median test two-tailed $P = 0.000$, $n = 155$ scan efforts); the median distance of the five closest active boats was significantly closer to the dolphins in the High Season than in the Low Season.

In the High Season, even the furthest of the five closest active boats was typically within the Australian "No Approach Zone" (median = 40 m, interquartile range = 20–50 m, range 1–150 m, $n = 83$ scan efforts). However, the situation was different in the Low Season when the furthest of the five closest active boats was usually outside the "No Approach Zone" (median = 80 m, interquartile range = 50–100 m, range 10–150 m, $n = 72$ scan efforts; Fig. 2). A significant seasonal difference was detected (nonparametric median test two-tailed $P = 0.0005$, $n = 155$ scan efforts) with High Season boats tending to approach the dolphins more closely compared with the Low Season boats.

Most boats were engaged in behaviors recommended by the Australian best practice guidelines, and thus were likely to have little impact on the dolphins; *e.g.*, approaching (48% of such behaviors) or following the dolphins at a speed not greater than that of the dolphins (14%). Nonetheless, some of the five closest boats were seen speeding towards a dolphin school (69.5% of "behaviors of concern"), cutting through (24.2%) or blocking the dolphin's line of travel (6.3%). On almost every occasion, one of the five closest active boats was seen conducting such behaviors (median = 0.8, mean = 0.9, SE $\pm$ 0.16, $n = 36$ d). No significant difference was detected between seasons (two-tailed Mann-Whitney independent sample test $P = 0.188$, $n = 36$ d).

We used the scan data to investigate vessels that repetitively exhibited behaviors of concern. We identified 64 vessels that displayed "behaviors of concern" at least once. A total of 37.5% of those vessels (24 boats) were observed exhibiting "behaviors of concern" more than once. One persistent offender exhibited "behaviors of concern" six times in six different efforts on four different days. The number of boats that exhibited "behaviors of concern" was positively correlated with encounter fleet size ($P = 0.000$, Pearson $r = 0.283$), suggesting that the drivers were more likely to compete with each other to gain closer access to the dolphins when more vessels were clustered around a school. Evidence suggests the behavior of the closest boat is related to the behavior of the farthest boat (Pearson chi-square $P = 0.002$, df = 1, Cramer's V $P = 0.245$, n effort = 161). Furthermore, the data suggest that if the closest boat was interfering, the farthest boat was also more likely to interfere. However, if the closest boat was not interfering, then the farthest boat was more likely to not interfere. This finding suggests that competition exists among adjacent vessels to place their passengers close to the dolphins and bad driving behaviors by the closest boatmen could induce this tendency in others.

We examined the scan sampling data to see how many boats actively approached dolphins in the "No Approach Zone" (0–50 m) and "Caution Zone"(50–150 m) of the Australian regulations. Slightly more boats were observed to actively approach the dolphins into the "No Approach Zone" in the High Season (2.3 boats, SE ± 0.17, range = 0–5, $n = 97$ scan efforts) compared with the Low Season (1.9 boats, SE ± 1.66, range = 0–5, $n = 78$ scan efforts), but the difference was not significant at the 5% level (Mann-Whitney independent sample two-tailed test $P = 0.071$, $n_1 = 97$ efforts, $n_2 = 78$ efforts).

The number of High Season boats that deliberately ventured into the "Caution Zone" was significantly different from that in the Low Season (Mann-Whitney independent sample two-tailed test $P < 0.0005$, $n_1 = 97$ efforts, $n_2 = 78$ efforts), with fewer boats in the High Season (0.3 boats, SE ± 0.06, range = 0–3) compared to the Low Season (1.4 boats, SE ± 0.16, range = 0–5). We suspect that this observation was largely due to most of the boats concentrating tightly around the dolphins and in the "No Approach Zone" during the High Season.

Occasionally, one of the five boats sampled was observed to engage in "behaviors of concern" in the "No Approach Zone" (mean 0.6, SE ± 0.07, range = 0–4, $n = 175$ scan efforts). We suspect the low frequency of "behaviors of concern" in the "No Approach Zone" was because of the very restricted space available to maneuver the boats in this zone (50 m radius) without collision. No significant differences were detected between seasons (Mann Whitney independent sample two-tailed test $P = 0.687$, $n = 175$ scan efforts). These data are underestimates as they were based on the five closest boats only.

The mean encounter fleet size at Lovina was 15.6, which makes the total mean observed number of boats (stationary and active) in the "Caution Zone" 10.6 (with the other five in the "No Approach Zone"). Thus, the number of boats in the "Caution Zone" in Lovina was at least three times higher than the Australian standard of three vessels per encounter.

These results demonstrate that the behaviors of the boats at Lovina did not accord with Australian best practices. Although we could not prove the causal effect of this best practice violation, we inferred from other studies that this situation was likely to have adverse impacts on the dolphins at Lovina. For instance, Constantine *et al.* (2004) studied common bottlenose dolphins (*Tursiops truncatus*) in the Bay of Islands in New Zealand. Significantly reduced resting times for dolphin in schools of sizes 2–10 and 11–20 were associated with exposure to four or more tour boats, or less than 17% of the average encounter fleet size at Lovina, even in the Low Season. In 1998 a dolphin watching guideline for Zanzibar was proposed that placed a limit of a maximum of two boats per school of bottlenose dolphins for a maximum 30 min encounter (Stensland and Berggren 2007, Carlson 2010). Surveys had indicated that violations of the guidelines and increased tourism activities resulted in the dolphins spending more time traveling and less time resting, foraging, and socializing (Stensland and Berggren 2007, Christiansen *et al.* 2010).

Our results also support parallel investigations into the socio-economic sustainability of the industry at Lovina, which indicated that the passengers were dissatisfied with the boatmen's driving behavior (Mustika *et al.* 2012). Given that the excessive number of boats and extreme proximity to the dolphins is likely to lead to behavioral changes (Constantine *et al.* 2004, Stensland and Berggren 2007, Christiansen *et al.* 2010), our results reinforce the need to engage the boatmen and other stakeholders in improving industry practice. Our discussions with stakeholders suggest that adverse comparison with an example of international best practice was a powerful reason for change (Mustika 2011). The designation of Lovina as a marine park to protect the dolphins in late 2011 has provided a mechanism for further negotiations, because a sustainable management plan is mandatory for park-based tourism in Indonesia (MMAF 2010). Discussions have already occurred between the local government and several NGOs, *e.g.*, Conservation International and Reef Check Indonesia, to better train the boatmen to improve the sustainability of their current tourism practices by reducing the impacts on the dolphins.

The rapid assessment technique described in this note should be applicable to dolphin watching industries in other developing countries/regions, where baseline data are not available, controls are difficult to establish, infrastructure and capacity are limited, and long-term funding unlikely. When these countries/regions develop their guidelines, we suggest that they adapt best practices from other countries to the local context and target species.

Acknowledgments

Our thanks are due to the local boatmen of Lovina for accepting our presence in their villages, Ocean Park Conservation Foundation Hong Kong, AusAID, Mohamed bin Zayed Conservation Fund, Conservation International Indonesia, Rotary Club Lovina Chapter, WWF Indonesia, the Society for Marine Mammalogy, and James Cook University for funding the research in Lovina; our research assistants: Niken Puspita Sari, Juwita A. Pusposari, and Made Sudana; Pak Putu Tastra Wijaya (former Head of the Buleleng Cultural and Tourism Agency) for his patronage, and Pak Bahruddin, Pak Darmayasa, Pak Rudita, Pak Ginantra and Pak Dolphin for supporting our work in their villages. We are grateful for the feedback of the editor and three anonymous reviewers in improving this manuscript. This research was conducted under Animal Ethics Approval #A1247 issued by James Cook University.

Literature Cited

Allen, S., H. Smith, K. Waples and R. Harcourt. 2007. The voluntary code of conduct for dolphin watching in Port Stephens, Australia: Is self-regulation an effective management tool? Journal of Cetacean Resource Management 9:159–166.

Altmann, J. 1974. Observational study of behavior: Sampling methods. Behaviour 49:227–265.

Bejder, L., and A. Samuels. 2003. Evaluating the effects of nature-based tourism on cetaceans. Pages 229–256 *in* N. Gales, M. Hindell and R. Kirkwood, eds. Marine mammals: Fisheries, tourism and management issues. CSIRO Publishing, Melbourne, Australia.

Bejder, L., A. Samuels, H. Whitehead, *et al*. 2006. Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance. Conservation Biology 20:1791–1798.

Brownell, R., Jr., and H. Oosthuizen. 2004. Report of the workshop on the science for sustainable whalewatching. Cape Town, South Africa, 6–9 March 2004. Available at http://iwc.int/document_22.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers and L. Thomas. 2004. Introduction to distance sampling. Oxford University Press, New York, NY.

Carlson, C. 2010. A review of whale watch guidelines and regulations around the world (version 2009). Provincetown Center for Coastal Studies, Provincetown, MA. 195 pp.

Christiansen, F., D. Lusseau, E. Stensland and P. Berggren. 2010. Effects of tourist boats on the behaviour of Indo-Pacific bottlenose dolphins off the south coast of Zanzibar. Endangered Species Research 11:91–99.

Christiansen, F., M. H. Rasmussen and D. Lusseau. 2013. Inferring activity budgets in wild animals to estimate the consequences of disturbances. Behavioral Ecology 24:1415–1425.

Constantine, R., D. H. Brunton and T. Dennis. 2004. Dolphin-watching tour boats change bottlenose dolphin (*Tursiops truncatus*) behaviour. Biological Conservation 117:299–307.

Corkeron, P. J. 2004. Whale watching, iconography and marine conservation. Conservation Biology 18:847–849.

Department of the Environment and Heritage. 2005. Australian national guidelines for whale and dolphin watching. Department of the Environment and Heritage Australia, Canberra, Australia.

Hoyt, E. 2001. Whale watching 2001: Worldwide tourism numbers, expenditures, and expanding socioeconomic benefits. International Fund for Animal Welfare, Yarmouth Port, MA.

IWC. 2009. Report of the intersessional correspondence group on whalewatching (Argentina, Australia, Brazil, Mexico and South Africa), submitted to the IWC61 Conservation Committee. International Whaling Commission (IWC\61\CC9). 6 pp. Available at http://http://iwc.int/document_1746.

Lusseau, D. 2003. Effects of tour boats on the behavior of bottlenose dolphins: Using Markov Chains to model anthropogenic impacts. Conservation Biology 17:1785–1793.

Lusseau, D., and L. Bejder. 2007. The long-term consequences of short-term responses to disturbance experiences from whalewatching impact assessment. International Journal of Comparative Psychology 20:228–236.

MMAF. 2010. Reg. 30/MEN/2010 on the Management and Zoning Plan of Aquatic Protected Areas (Rencana Pengelolaan dan Zonasi Kawasan Konservasi Perairan). Ministry of Marine Affairs and Fisheries, Jakarta, Indonesia.

Mustika, P. L. K. 2011. Towards sustainable dolphin watching tourism in Lovina, Bali, Indonesia. Ph.D. thesis, James Cook University, Townsville, Australia. 261 pp.

Mustika, P. L. K., A. Birtles, R. Welters and H. Marsh. 2012. The economic influence of community-based dolphin watching on a local economy in a developing country: Implications for conservation. Ecological Economics 79:11–20.

Mustika, P. L. K., A. Birtles, Y. Everingham and H. Marsh. 2013. The human dimensions of wildlife tourism in a developing country: Watching spinner dolphins at Lovina, Bali, Indonesia. Journal of Sustainable Tourism 21:229–251.

New, L. F., J. Harwood, L. Thomas, *et al*. 2013. Modelling the biological significance of behavioural change in coastal bottlenose dolphins in response to disturbance. Functional Ecology 27:314–322.

O'Connor, S., R. Campbell, H. Cortez and T. Knowles. 2009. Whale watching worldwide: Tourism numbers, expenditures and expanding economic benefits. Economist at Large and IFAW, Melbourne, Australia.

Orams, M. B. 2000. Tourists getting close to whales, is it what whale-watching is all about? Tourism Management 21:561–569.

Schaffar, A., B. Madon, C. Garrigue and R. Constantine. 2013. Behavioural effects of whale-watching activities on an endangered population of humpback whales wintering in New Caledonia. Endangered Species Research 19:245–254.

Stensland, E., and P. Berggren. 2007. Behavioural changes in female Indo-Pacific bottlenose dolphins in response to boat-based tourism. Marine Ecology Progress Series 332:225–234.

Williams, R., and E. Ashe. 2007. Killer whale evasive tactics vary with boat number. Journal of Zoology 272:390–397.

Williams, R., A. W. Trites and D. E. Bain. 2002. Behavioural responses of killer whales (*Orcinus orca*) to whale-watching boats: Opportunistic observations and experimental approaches. Journal of Zoology 256:255–270.

Williams, R., D. Lusseau and P. S. Hammond. 2006. Estimating relative energetic costs of human disturbance to killer whales (*Orcinus orca*). Biological Conservation 133:301–311.

Received: 26 January 2014
Accepted: 17 October 2014