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SWIMMMING WITH AN ENDEMIC AND ENDANGERED SPECIES: EFFECTS OF TOURISM ON HECTOR'S DOLPHINS IN AKAROA HARBOUR, NEW ZEALAND

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The South Island Hector's dolphin (*Cephalorhynchus hectori hectori*) is both endemic and endangered. It is also subjected to commercial ecotourism operations in Akaroa Harbour, Banks Peninsula. The Hector's dolphin is an attractive species for swim-with-dolphin tourism. It is strictly coastal, resident in well-defined areas, has a low migratory range, and is generally attracted to vessels. In Akaroa Harbour, commercial swim-with-dolphin trips began in 1990 and it is the only place where this type of activity is permitted with this species. This study assessed the effects of such activities on Hector's dolphins, in particular vessel approach and swimmer placement. Effects identified here are similar to those previously reported in other coastal species. Furthermore, although Hector's dolphins showed increased tolerance to swimmers over time, they appear to display a temporal shift in their receptivity to swimmers during the austral summer months. To ensure the sustainability of the local tourism industry, it is recommended that the moratorium on the number of swim permits remains in place. In addition, a reduction in the level of exposure of this population of Hector's dolphins to tourism activities should be considered.

Key words: Hector's dolphins; Swim-with-dolphins; Effects; Behavior; Akaroa Harbour, New Zealand

Introduction

Worldwide, the number of cetacean-watching operations (viewing and swimming with whales and dolphins) focusing on dolphins is growing (O'Connor, Campbell, Cortez, & Knowles, 2009). Human fascination for dolphins and the modern belief that interacting with them improves physical and spiritual well-being has led to the rapid expansion of swim-with-dolphin opportunities, not only in captivity but also with free-ranging populations (Curtin, 2006). New swim-with-wild dolphins (swim-with-dolphin hereafter) programs are being initiated on a regular basis (e.g., Hoyt, 2001; O'Connor

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et al., 2009; Samuels, Bejder, Constantine, & Heinrich, 2003). In 2008, 14 out of 119 countries and territories providing cetacean-watching trips offered such programs, some of them on a very small scale (e.g., Fiji, Niue) (O'Connor et al., 2009). The majority of swim-with-dolphin encounters occur from commercial vessel-based tours and involve wild and nonprovisioned populations (Samuels et al., 2003). In a review, Samuels et al. (2003) reported at least 11 species of dolphins being the focus of such tourism activities.

It has been suggested that close encounters with wild dolphins may enhance respect for wildlife (e.g., Orams, 1997) and that animals have a choice as to whether or not they interact with swimmers (e.g., Dudzinski, 1998). The assumption is that if dolphins choose to do so, then interactions are unlikely to be detrimental. The stereotypical response that "if they do not like it, they can just leave" is common and appears to be rational (Martinez & Orams, in press). Concerns have been raised, however, about swim-with-dolphin activities and their potential harmful, beneficial, and/or neutral effects on targeted species (Samuels & Bejder, 2004). Although swimming with wild dolphins can be viewed as an activity of low risk (Perrine, 1998), it can be dangerous for both humans and the animals, resulting in serious injury and even death in extreme cases (Goodwin & Dodds, 2008; Santos, 1997; Shane, 1995; Shane, Tepley, & Costello, 1993).

Empirical research indicates that even if avoidance is not a consequence, dolphins can still be detrimentally affected by swim-with-dolphin operations. Over the past two decades, behavioral changes have been linked to the type of vessel approach (e.g., Barr & Slooten, 1999; Constantine, 2001; Neumann & Orams, 2006; Ransom, 1998; Würsig et al., 1997), the presence of swimmers/vessel(s) (e.g., Barr & Slooten, 1999; Christiansen, Lusseau, Stensland, & Berggren, 2010; Courbis & Timmel, 2009; Danil, Maldini, & Marten, 2005; Lundquist & Markowitz, 2009) or swimmer placement (Constantine, 2001; Weir, Dunn, Bell, & Chatfield, 1996).

In New Zealand, considerable research has been conducted to investigate the effect of swim-with-dolphin tourism on targeted species (Orams, 2004). These include dusky dolphins (*Lagenorhynchus obscurus*) in Kaikoura (e.g., Barr & Slooten, 1999; Markowitz, DuFresne, & Würsig, 2009; Yin, 1999), bottlenose dolphins (*Tursiops truncatus*) in the Bay of Islands (e.g., Constantine, 2001; Constantine & Baker, 1997), common dolphins (*Delphinus* sp.) in the Bay of Islands, Bay of Plenty, and the Hauraki Gulf (e.g., Constantine & Baker, 1997; Leitenberger, 2001; Neumann & Orams, 2006), and Hector's dolphins (*Cephalorhynchus hectori hectori*) in Porpoise Bay (e.g., Bejder, Dawson, & Harraway, 1999; E. Green, 2003), and Akaroa Harbour (e.g., Nichols, Stone, Hutt, & Brown, 2002).

In terms of legislation, few countries have regulations in place to protect free-ranging cetaceans (Carlson, 2008). New Zealand has often been exemplified as a model country (Hoyt, 2001), having both a Marine Mammals Protection Act (MMPA, 1978) and the Marine Mammals Protection Regulations (MMPR, 1992). The MMPR were introduced, as an amendment of the MMPA, to provide for the control and management of all marine mammal tourism activities. However, because research has demonstrated that impacts vary greatly between species, location, and type of tourism activity, generic management regimes are seldom appropriate (Orams, 2004). Therefore, sound management must be based on comprehensive research that provides information regarding the requirements and sensitivities of specific targeted populations (Orams, 2004).

Akaroa Harbour, Banks Peninsula, is the only location in New Zealand where commercial swim-with-dolphin operations have been permitted to target the endemic and endangered Hector's dolphins since 1990. The development and growth of this industry (with currently up to 18 daily permitted swim trips, in addition to 14 dolphin-watching tours) has been built on limited scientific data (Nichols et al., 2002; Nichols, Stone, Hutt, Brown, & Yoshinaga, 2001), although most of the known information on this species is based on the Banks Peninsula population (Martinez & Slooten, 2003). In the late 1990s, permits were renewed on the basis that tourism activities were not having a significant adverse effect on the Hector's dolphins. However, the Department of Conservation (DOC) recommendation to limit the existing level of permits until effects were known, in addition to concern expressed by researchers, resulted in the implementation of an informal moratorium (Allum, 2009). In 2007, new applications for marine mammal permits lodged with DOC for Akaroa Harbour could potentially have increased the current number of swim trips by 78% (Allum, 2009). Consequently, it is vital to determine whether the current levels of swim-with-dolphin trips in Akaroa affect Hector's dolphins' behavior. This is particularly important because, firstly, this type of tour interacts the longest with the dolphins; secondly, it can potentially be more invasive due to the presence of swimmers in the water with the dolphins; and thirdly, there is pressure to expand swim-with-dolphin operations in Akaroa Harbour.

For management purposes, it is important to ascertain what the potential long-term effects that swim-with-dolphin activities might have on a targeted population (Samuels et al., 2003). Longitudinal studies are, therefore, essential to ensure an effective protection of Hector's dolphins and the sustainability of the industry. The first provisional assessment of the potential swim-with-dolphin impacts in Akaroa Harbour was only for a single season (2001/2002) (Nichols et al., 2002). However, this research does provide some useful baseline data for comparative purposes. Following on from Nichols et al. (2002) work, the main objectives of the research presented here were to assess the short-term behavioral responses of dolphins in relation to swimming activities, in particular to vessel approach and swimmer placement, and whether Hector's dolphins show any signs of sensitization, or tolerance over time.

Methods

The present study consisted of opportunistic vessel surveys, conducted within the permitted swimming and viewing area of operation for the commercial tour operators based in Akaroa (43.81°S, 172.97°E), which encompasses Akaroa Harbour (Fig. 1). The harbor, situated on the southern side of Banks Peninsula, is approximately 17 kilometers long, with a predominantly north–south orientation (Heuff, Spigel, & Ross, 2005). A total of five vessels, belonging to two different companies, were used as platforms of opportunity.

The research period comprised three consecutive field seasons between November and March, commencing in November 2005. This 5-month period was chosen as it corresponds to the time when Hector's dolphins are found within Akaroa Harbour (e.g., Dawson, 1991; Rayment, Dawson, & Slooten, 2010) and encompasses the high tourism season. During this study period, Hector's dolphins were exposed to nine vessels operating daily up to 18 swim-with-dolphin trips as well as eight dolphin-watching cruises between 0600 and 1800 h. An attempt was made to undertake equal sampling effort between the different departure times so as to cover most of the commercial daily activities.

Observation effort varied and was limited to favorable environmental conditions [no rain and Beaufort Sea State (BSS) of three or less]. Environmental variables such as BSS, wind speed and direction, temperature, percentage glare, and cloud cover were all recorded at the start of each survey or when noticeable change in conditions occurred.

Upon the departure of a trip, date, operator, vessel name, departure time (hh:mm), skipper, crew, and number of passengers (watchers and swimmers) were recorded. Return time (hh:mm) was also noted upon arrival. The route taken for all tours was largely based on the skipper's discretion and influenced by sea conditions and prevailing weather, in addition to previous sightings, when applicable. Vessels typically traveled at speeds of 10–15 knots (kts) until a group of dolphins was encountered. At this point, the skipper would slow the vessel to first observe if the group would approach the boat before the swimmers were placed in the water. Swims were only attempted with dolphin groups in the absence of calves, in compliance with section 20(b) of the MMPR. A calf was defined as an individual that was approximately 50% or less than the size of an adult and was consistently observed in association with an adult, presumed to be the mother (Fertl, 1994).

Characteristics of Swim-With-Dolphin Encounters

A swim encounter was judged to have commenced when the first swimmer entered the water and ended when the last swimmer got back onboard the vessel. For each trip, the start and end

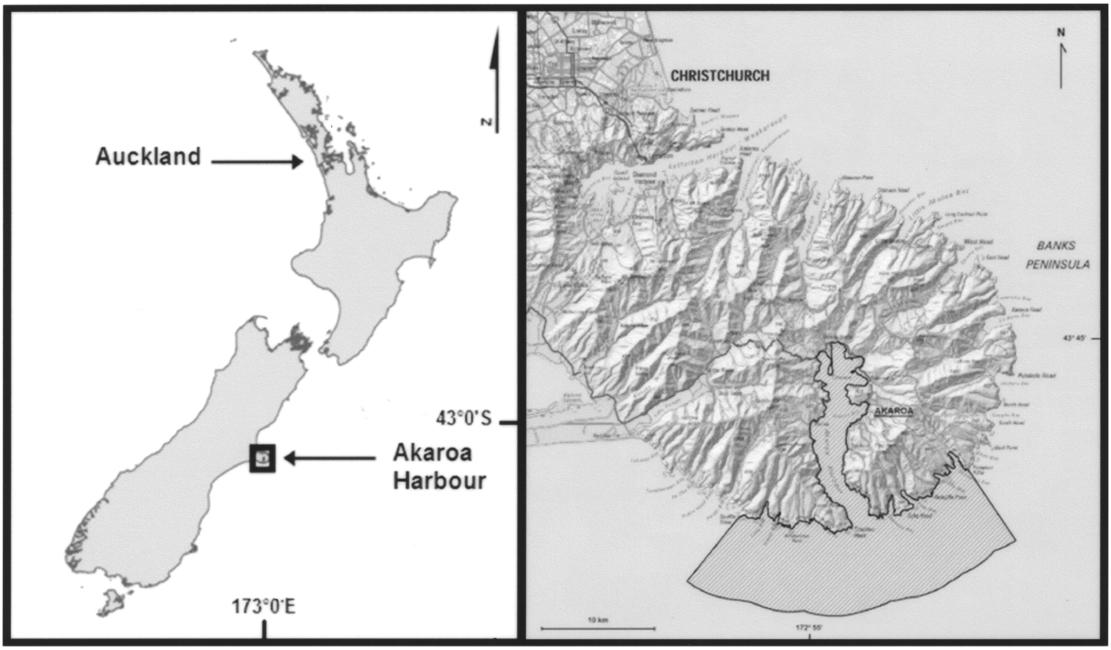

Figure 1. Permitted area of operation for commercial tour operators based in Akaroa, Banks Peninsula, New Zealand (adapted from Allum, 2009, p 35).

time of each encounter were recorded (hh:mm), in addition to the initial dolphin behavioral state, group size, and the number of swim attempts. Behavioral states were grouped into one of the four categories (milling, traveling, diving—inferring foraging, and socializing). Behavior definitions were modeled on Shane, Wells, and Würsig (1986) and Slooten (1994). When more than one swim attempt took place, it was also noted whether it occurred with the same initial group. Under their permits, operators must restrict their number of approaches to a maximum of three when interacting with "reluctant" dolphin groups. Reluctant groups are defined as dolphins that actively avoid a vessel (Permit condition, DOC Canterbury Conservancy). Quality of encounter was also independently rated (Table 1) based on the data sheets commercial operators must complete after each trip (Permit condition, DOC Canterbury Conservancy).

Measuring Responses of Hector's Dolphins to Swim-With-Dolphin Encounters

Responses and changes in response over time were collected using focal group scan sampling methods (Altmann, 1974; Mann, 1999). Several strategies were used to approach a dolphin group, with vessel headings considered as: a) *in path*—when in the on-coming path of travel of a dolphin group, b) *rear*—when behind a dolphin group, or c) *line abreast*—when parallel or to the side of the group. Another technique included *drifting*, which was defined as putting the engine(s) in neutral to let the vessel move with the wind and/or current. Finally, when dolphins initiated the approach by moving directly towards the vessel while underway, it was referred to as *dolphin first*.

Strategies to place swimmers in the water with dolphins, derived from Constantine (2001) and Neumann and Orams (2005), described the swimmers' entrance in relation to the position of the focal dolphin group. These included: a) *line abreast*—swimmers entered the water to the side and slightly ahead of the dolphin group, b) *in path*—swimmers were placed in the dolphins' path of travel, and c) *around the vessel*—dolphins were milling around the wake of the stationary vessel when swimmers entered the water. The response to swimmers by the focal dolphin group was also adapted from Constantine (2001) as follows: a) *avoidance*—the dolphin group moved away from the swimmers and/or vessel or dived before resurfacing away from them; b) *neutral*—no apparent change in the behavior of the dolphin group, which remained at a distance of two to three dolphin body length from swimmer(s) (or less than 5 meters); and c) *interaction*—at least one dolphin from the group remained within 5 meters of a swimmer for a minimum of 10 seconds.

Analysis

Whenever possible, methods previously used in other studies (e.g., Bejder et al., 1999; Constantine, 2001) were selected to allow inter- and intraspecies comparisons. Statistical tests were performed using the statistical package SPSS version 18 (SPSS, 2009), unless specified. All continuous response variables were initially tested for normality and homoscedasticity using Anderson-Darling and Bartlett's and Levene's tests, respectively (Zar, 1996). A series of post hoc (Bonferroni or Dunn's multiple comparison tests) was run when applicable. Significance was accepted at the alpha (0.05) level.

To measure dolphin affinity for the swimmers, the proportion of time Hector's dolphins spent actively in the presence of swimmers (or interaction time) was calculated. The independent sampling unit was taken to be interaction time during an entire swim attempt. To determine if a relationship existed between interaction time and several variables a Generalized Linear Model (GLZ) was run using R version 2.10.0 (R Development Core Team, 2009). The initial saturated model was of the form:

$$Y \sim X_1 + X_2 \ldots X_i \text{ (family = binomial)}$$

where the response variable Y is the probability of dolphins to interact with swimmers and X_i the following explanatory variables: number of swimmers, month, departure time, group size, and dolphin behavioral state. The model was then rerun excluding nonsignificant explanatory variables. Percentage changes were subsequently calculated. Only the number of swimmers was treated as continuous variables; the relationships were assumed to be linear. Errors are assumed to follow a binomial distribution. Departure time was categorized as either discrete or staggered. Discrete departure time was defined as tours departing Akaroa concurrently. In this study, 0600 and 0900 h swim-with-dolphin trips were considered discrete because both companies operated at that time. From 1015 h onwards, there was an overlap between dolphin-watching and -swimming trips. Consequently, trips offered past 1015 h were deemed staggered. Months were categorized as early austral summer (November and December), midaustral summer (January and February), and late austral summer (March) due to a small sample size. Group size was categorized as 1–2, 3–5, 6–10, or >10 individuals.

The effect of successive swim attempts (considered here as the sampling unit) with a same dolphin group on encounter duration was tested using one-way analysis of variance (ANOVA) with a

Table 1
Definitions of the Encounter Ratings Between Hector's Dolphin Groups and Commercial Swim-With-Dolphin Vessels in Akaroa Harbour, New Zealand

Rating	Definition
Very good	Sustained swimming interactions with swimmers. Dolphins stay with swimmers for most of the duration of an encounter (i.e., a minimum of 20 minutes).
Good	Dolphins initially interested in interacting with swimmers but lost interest after a period of between 10 and 20 minutes into an encounter.
Average	Dolphins come and go and occasionally interact with swimmers. Encounters last between 5 and 10 minutes.
Poor	Dolphins showing no interest in interacting with swimmers. Encounters last less than 5 minutes.

Derived from DOC Canterbury Conservancy data sheet for commercial operators.

Bonferroni's post hoc test for multiple comparisons. Data were log-transformed to satisfy normality and homoscedasticity assumptions.

Pearson's chi-square tests were applied to detect whether a relationship existed between vessel approach type and dolphin responses (here defined as a behavioral change) and whether swimmer placement affected dolphin responses and the duration of a swim encounter. For purposes of analysis, some grouping was necessary. Encounter duration was categorized, using the definition of encounter ratings (Table 1), as <5 minutes, 5–10 minutes, and >20 minutes, corresponding to short (poor), medium (average to good), and long (very good) encounters, respectively. Freeman-Tukey cell deviates were also calculated to identity which cells contributed to the significance of the chi-square.

Results

Over the research period, a total of 581 commercial tours were monitored, including 420 swim-with-dolphin trips and 161 wildlife cruises. In addition, from December 2006, a total of 278 swim-with-dolphin trips were recorded using the standardized data sheet provided to all operators.

Characteristics of Swim-With-Dolphin Encounters

Swims with Hector's dolphins were attempted on 93.8% ($n = 320$) of the trips observed in 2006/2007 and 2007/2008. The majority of these (44.9%, Fig. 2) were conducted with dolphin groups of 6–10 individuals, with an overall mean of 7.5 dolphins (SE = 0.24, range = 1–27). Swimmers were seldom placed in the water with groups of less than three individuals (Fig. 2).

Monitoring parameters of swim-with-dolphin trips are presented in Table 2. The number of swimmers onboard averaged 8.5, with as many as 19 swimmers aboard at any one time. A limit of 10 swimmers per trip is imposed under the tour operators' permit. As not all of the swimmers actually entered the water (i.e., they decided not to swim although they were booked as "swimming"); a mean of 7.6 swimmers were present in the water with the dolphins during all swim attempts. Only 3.4% of the swim attempts ($n = 513$) exceeded the legal limit of 10 persons.

The majority of trips (55.6%, $n = 320$) consisted of only one swim attempt (Fig. 3), with a mean of 1.6 attempts (Table 2) over the course of this study. Overall, 62.2% of swim attempts recorded on DOC data sheets ($n = 278$) were considered *good* to *very good*. Only 11.6% were deemed as poor (i.e., dolphins showed no interest in the swimmers). The remaining trips (26.2%) were considered as *average*.

The duration of swim-with-dolphin trips varied from 61 to 168 minutes, with a median of 105 minutes (interquartiles: 97–114 minutes, $n = 320$). The total trip duration differed significantly between months [Kruskal-Wallis: $H(4) = 11.028$, $p = 0.026$] (Fig. 4). Trips in March were significantly longer than in both November and January (Dunn's multiple comparison test, $p < 0.05$). Departure time (Fig. 4) had no significant effect of the duration on swim-with-dolphin trips [$H(4) = 6.276$, $p = 0.180$].

Responses of Hector's Dolphins to Swim-With-Dolphin Encounters

Time Hector's Dolphins Actively Spent in the Presence of Swimmers. The optimal GLZ for interaction time was: Interaction time ~ (Month, $df = 4$) + (behavior, $df = 4$) + (group size, $df = 3$). Adding swimmers number, placement, and departure time did not improve the model ($p > 0.05$). Effects of month ($p < 0.001$), behavior ($p < 0.0001$), and group size ($p < 0.001$) were all significant.

In the presence of large dolphin groups (6–10 individuals), interaction time increased significantly ($p = 0.015$) by 214.7% (range: 22–709%) compared to small groups (1–2 individuals). Behavior also had a strong effect on encounters. Interaction time increased significantly ($p < 0.001$) with milling dolphin groups rising by 480.5% (range: 135–1,332%), 615.1% (range: 151–1,938%), and 702.2% (range: 230–1,848%) compared to diving, socializing, and traveling groups, respectively. Finally, in the *midaustral summer* (January and February) there was a significant ($p < 0.001$) decrease of 71.7% (range: 45–85%) in the amount of time dolphins engaged in the presence of swimmers compared to the *early austral summer* (November and December).

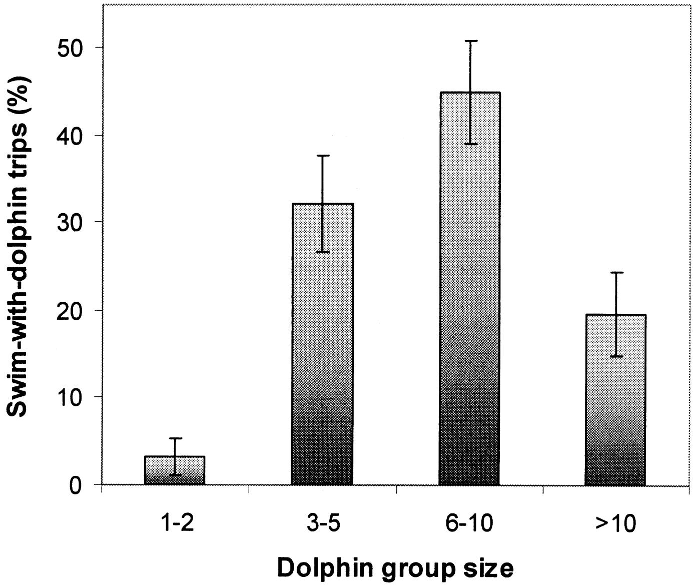

Figure 2. Distribution (percentage) of dolphin group size during swim-with-dolphin trips n Akaroa Harbour, New Zealand. Bars represent the 95% confidence intervals.

Swim Encounter Length According to the Number of Swim Attempts With a Same Group. During the vast majority of swim-with-dolphin trips (91.6%; $n = 285$) in 2006/2007, commercial operators did not interact with the same group for the duration of a trip. From the 22 multiple swim attempts with a same group that were monitored, swim duration decreased after two attempts (Fig. 5).

The second swim attempt was the longest with a mean of 18.8 minutes (SE = 2.046, range = 3–41 minutes, $n = 22$). In contrast, by the third attempt, duration of swims lasted less than 10 minutes (mean = 9.9 minutes, SE = 2.100, range = 3–19 minutes, $n = 9$), although this difference was not significant [ANOVA: $F(2) = 2.394$, $p = 0.102$]. The same trend was apparent when taking into consideration the time that dolphins spent actively in the presence of swimmers (Fig. 5), which was significant [$F(2) = 3.552$, $p = 0.036$]. A Bonferroni's post hoc test indicated that two or more attempts were significantly shorter than a second swim attempt with a same group ($p = 0.043$).

Table 2
Statistics of Swim-With-Dolphin Trips ($n = 320$) and Swim Attempts ($n = 513$) in Akaroa Harbour, New Zealand

Parameters	Mean	SE	Range
Swimmers per trip	8.5	0.137	1–19
Observers per trip	3.1	0.184	0–18
Swimmers per swim attempt	7.6	0.106	1–13
Swim attempts per trip	1.6	0.045	1–5
Swim encounter duration	25.3	0.639	1–70

Responses to Vessel Approach Type. Hector's dolphins initiated the approach in 38.5% of encounters ($n = 1{,}132$). For the remaining 61.5% of approaches, vessels came near a dolphin group predominantly from the side (or *line abreast*, 66.2%). *In path*, *drifting*, and *rear* approaches represented 18.0%, 10.6%, and 5.2% of approaches, respectively. Due to small sample sizes, *rear* and *in path* approaches were pooled as no significant difference was detected (*Z*-test: $z = 1.000$, $p = 0.350$).

Overall, Hector's dolphins' initial behavioral state had a significant effect on any subsequent behavior changes irrespective of the method of vessel approach [$\chi^2(3) = 33.853$, $p < 0.001$]. Diving groups changed behavior less often when ap-

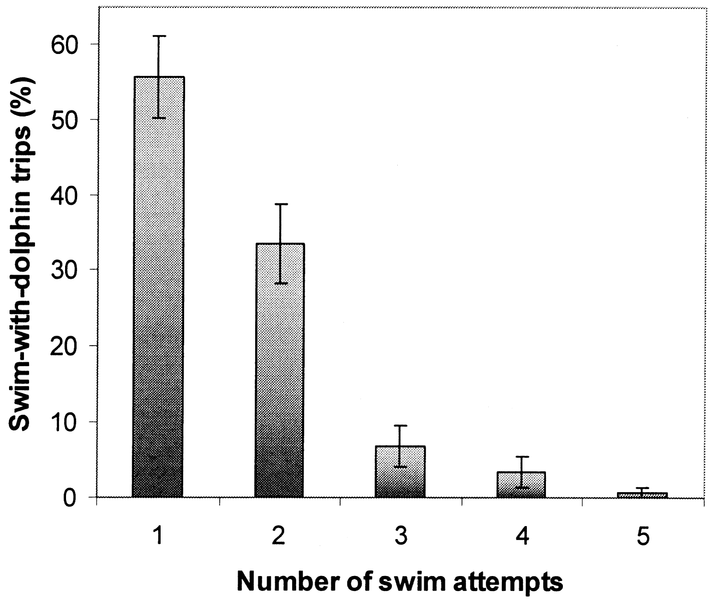

Figure 3. Distribution (percentage) of the total number of swim attempts per swim-with-dolphin trip in Akaroa Harbour, New Zealand. Bars represent the 95% confidence intervals.

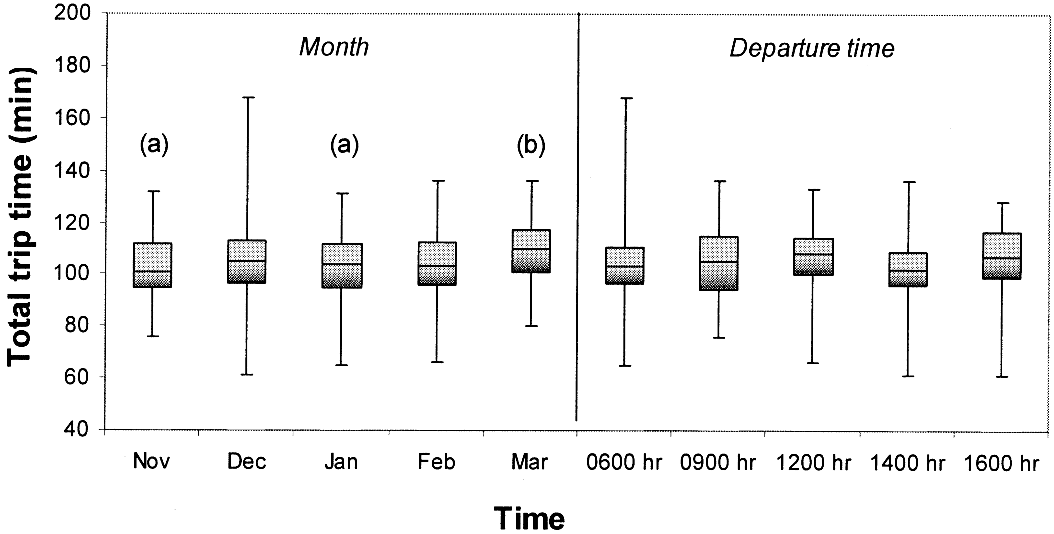

Figure 4. Trip duration (min) of commercial tours according to month and departure time in Akaroa Harbour, New Zealand. Lines represent the median, boxes the 25th and 75th interquartile range, and bars the minimum and maximum values.

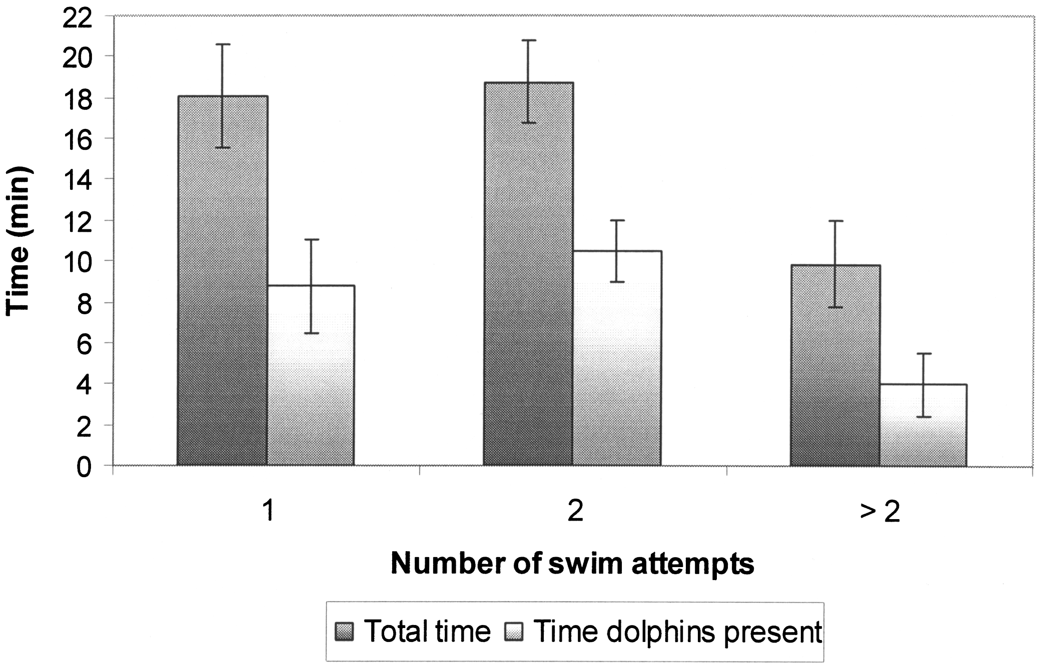

Figure 5. Encounter duration (minutes) of successive swim attempts with a same group of Hector's dolphins in Akaroa Harbour, New Zealand. Bars represent the SEM.

proached (Freeman-Tukey deviates <–1) compared to socializing or traveling groups (Freeman-Tukey deviates >1). *In path/rear* approaches led to a higher proportion of behavior change (Freeman-Tukey deviates >1), although differences between approach types were insignificant [$\chi^2(2) = 4.635$, $p = 0.099$].

Dolphin responses to the different vessel approaches also varied according to their initial behavior when first sighted (Fig. 6). However, in all initial behavioral states, approach type had no significant effect on dolphin response ($p > 0.05$), with the exception of diving [$\chi^2(2) = 7.263$, $p = 0.026$]. When diving, dolphins were less likely to switch behavior when approached from the side or *line abreast* (Freeman-Tukey deviates <–1) and more likely to do so when a vessel was *drifting* (Freeman-Tukey deviates >1).

Responses to Swimmer Placement Style. Dolphin responses to swim encounters varied significantly with swimmer placement [$\chi^2(4) = 19.775$, $p < 0.001$]. *Line abreast* placement resulted in a significant decrease in avoidance of swimmers (Freeman-Tukey deviates <–1). In contrast, when swimmers were placed *in path*, dolphins were more likely to avoid the swimmers or stay neutral rather than interact (Freeman-Tukey deviates >1) (Fig. 7). Swimmer placement also significantly affected encounter duration between Hector's dolphins and swimmers [$\chi^2(4) = 19.775$, $p = 0.002$]. An *in path* placement resulted in an increase (Freeman-Tukey deviates >1) in the likelihood of a short swim encounter (less than 5 minutes) and a decrease in both medium and long encounters (Freeman-Tukey deviates <–1) (Fig. 8).

Discussion

Characteristics of Swim-With-Dolphin Encounters

Hector's dolphins are an attractive target for swim-with-dolphin trips in Akaroa Harbour as they are easily located within the permitted area of commercial tourism operation. Compared to other species in New Zealand that support this type of tourism (e.g., common dolphins; Neumann & Orams, 2006), Hector's dolphins are very receptive

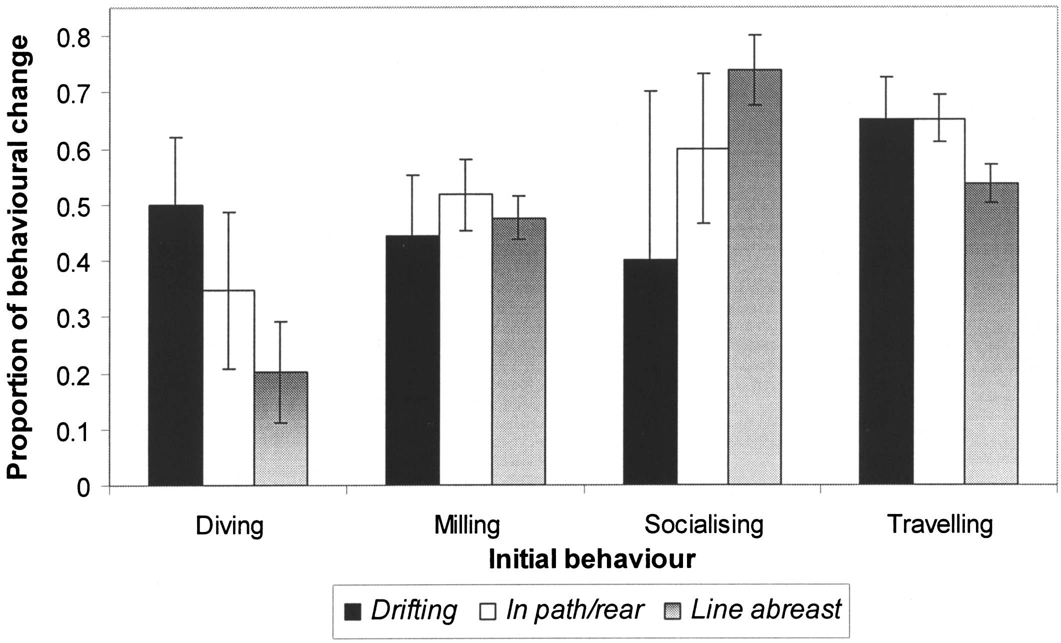

Figure 6. Proportion of behavioral change in Hector's dolphin groups observed in relation to vessel approach type, when considering the initial behavior of dolphins in Akaroa Harbour, New Zealand. Bars represent the SE of the sample proportion.

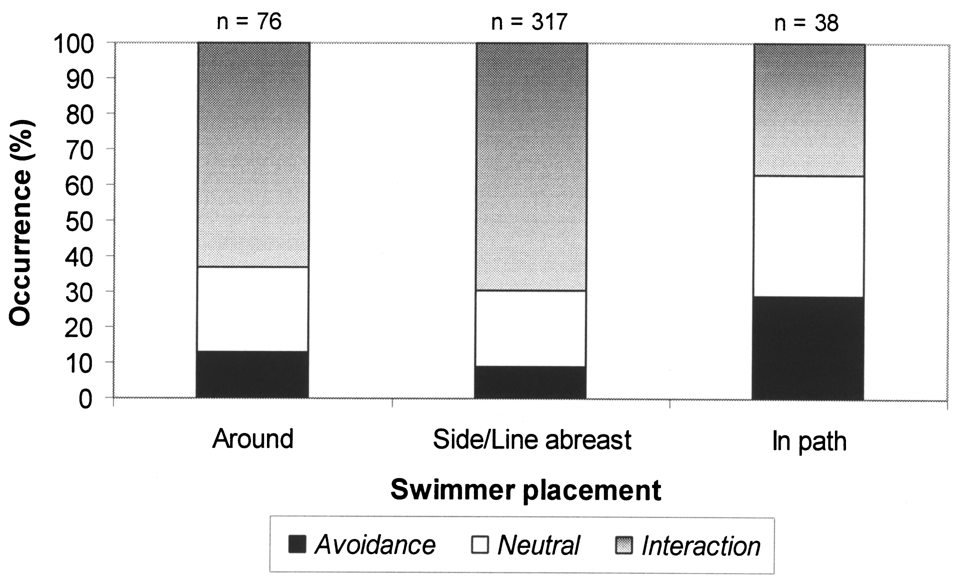

Figure 7. Hector's dolphin responses to swimmers (percentage) as a function of swimmer placement in Akaroa Harbour, New Zealand.

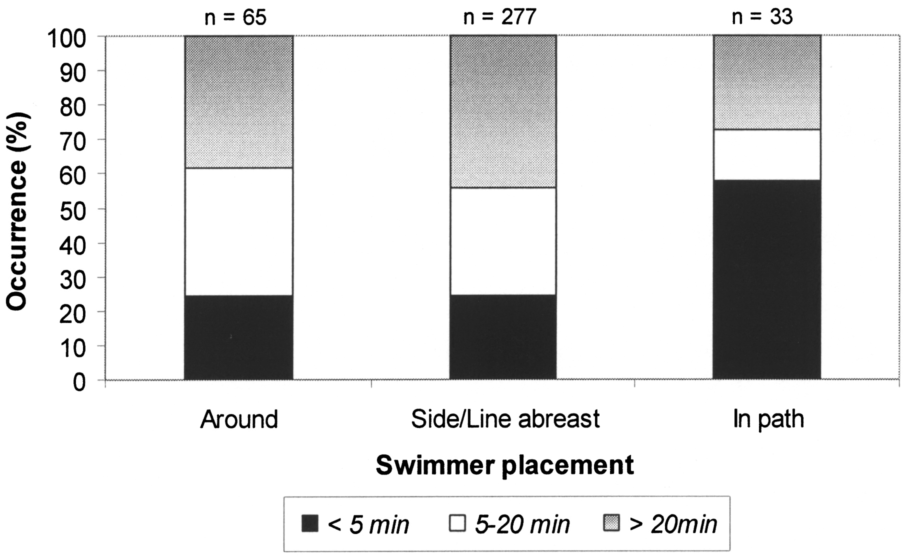

Figure 8. Encounter duration between Hector's dolphins and swimmers (percentage) as a function of swimmer placement, in Akaroa Harbour, New Zealand.

to contact with swimmers. This is shown in the high proportion of sustained and successful swim attempts (only 11.6% were poor encounters).

The receptivity of Hector's dolphins is also evident in the low number of attempts needed to obtain a satisfactory swim encounter, in addition to the relatively long duration of each swim attempts (25.3 minutes). A swim was attempted during 93.8% of the trips monitored with an average of 1.6 attempts per trip, which is less than for both common dolphins observed in Mercury Bay (2.6) (Neumann & Orams, 2006) and dusky dolphins off Kaikoura (4.0) (Markowitz, Markowitz, & Lundquist, 2009). In terms of duration, common dolphins appear to be the least receptive, with swim attempts lasting on average 3 minutes in Mercury Bay (Neumann & Orams, 2006) and 5 minutes in the Bay of Islands (Constantine & Baker, 1997). Swims off Kaikoura with dusky dolphins were slightly prolonged, with an average of 9 minutes (Markowitz, Markowtiz, & Lundquist, 2009). The duration of swim encounters with delphinids outside New Zealand, appear to confirm this trend, with 12 and 14 minutes reported for rough-toothed dolphins (*Steno bredanensis*; Ritter, 2002) and short-finned pilot whales (*Globicephala macrorhynchus*; Scheer, Hofmann, & Behr, 2004), respectively in the Canary Islands.

In Akaroa Harbour, the mean duration of swim encounters increased from 22 to 25 minutes over the 5-year period since Nichols et al. (2002). As this change has not been tracked consistently (annually) over this time period, it may be that this increase is due solely to differences in methodologies between the studies. However, it may also suggest that tolerance to swimmer presence may be slowly increasing over time, an indication of potential habituation. Tolerance is defined as the intensity of disturbance that an individual tolerates without responding in a defined way (Nisbet, 2000), while habituation is described as the relative persistent waning of a response as a result of repeated stimulation, which is not followed by any kind of reinforcement (Thorpe, 1963).

While a 3-minute increase in encounter duration may not indicate long-term increases in dolphin tolerance, associated changes in dolphin behavioral responses may lend evidence to the possibility of habituation. Stone and Yoshinaga (2000) provided anecdotal information on the change in Hector's dolphin behavior responses to swimmers over the past 15 years (i.e., becoming less wary with time). In 2008, it was not uncommon to observe dolphins approaching very close to swimmers (within an arm length) and circling around them (Martinez, Orams, Pawley, & Stockin, in press). An increase in tolerance levels has also been demonstrated in other species. In Kaikoura, the duration of swim encounters with semiresident dusky dolphins increased from 8.3 to 9.1 minutes between 1997–1999 and 2007–2009 (Markowitz, Markowitz, & Lundquist, 2009). Ransom (1998) reported a rise in encounter duration from 7 to 11 minutes with Atlantic spotted dolphins (*Stenella frontalis*) in the Bahamas over a 6-year period. Sensitization to swimmers over time has also been demonstrated in some species, like the bottlenose dolphins in the Bay of Islands, New Zealand (Constantine, 2001).

Finally, in nearly a quarter of swim attempts (23.8%; Martinez, 2010) the operators had to end an encounter due to a legally imposed time limit (60 minutes until 2007 and 45 minutes thereafter). This implies that Hector's dolphins, if given the opportunity, could potentially interact with swimmers for fairly prolonged durations, hence the importance of determining whether such activity may have any detrimental effects on the dolphins.

Responses of Hector's Dolphins to Swim-With-Dolphin Encounters

Bejder, Samuels, Whitehead, Finn, and Allen (2009) indicated that the inappropriate application of the term habituation could mislead managers to conclude that tourism activities have neutral, or even benign, consequences on dolphin populations, when their effects are actually detrimental. Individual Hector's dolphins that use the Akaroa Harbour as part of their home range may have prolonged opportunities to become habituated as first suggested by Stone (1992). To determine whether Hector's dolphins in Akaroa met the criteria to be classified as habituated, it was first necessary to ascertain the proportion of time Hector's dolphins spend actively engaging with swimmers and the factors affecting it, as it gives a more precise measure of the affinity of dolphins for swimmers than the overall encounter duration (i.e., total time swimmers were in the water).

Unlike in Kaikoura, where approaching and dropping swimmers in front of a group of dusky dolphins decreased the duration of swim interactions (Markowitz, Markowitz, & Lundquist, 2009), both swimmer placement and the number of swimmers did not appear to be the primary factors affecting the time dolphins interacted with swimmers in Akaroa. However, other variables did affect this, with dolphins interacting significantly longer when in larger groups (six or more individuals) and when previously engaged in milling behavior. Groups engaged in such behavioral state tend to be naturally larger than when diving or traveling (Martinez, 2010). In other species in New Zealand waters, group size and dolphin behavioral activity also influence the swim duration or the success of swim attempts. When in larger groups, common dolphins were more tolerant of the swimmers in both the Hauraki Gulf (Leitenberger, 2001) and Mercury Bay (Neumann & Orams, 2006). Leitenberger (2001) suggested that the observed increase in avoidance rate in common dolphins in the Hauraki Gulf was a function of small group sizes, supporting the notion that dolphins find safety in numbers. This could also be the case for Hector's dolphins given that they are the smallest marine delphinid (Dawson, 2002). Constantine (2001) also indicated that age class might be a factor influencing the success of a swim, with juvenile bottlenose dolphins more likely to interact than adults. In terms of behavior, common dolphin groups were also more interactive when the predominant group activity was socializing and less so when traveling or milling (Neumann & Orams, 2006). Similar observations were made with dusky dolphin groups in Kaikoura (Markowitz, Markowitz, & Lundquist, 2009).

Interaction time was also shorter in midaustral summer (i.e., January and February) than in early austral summer (i.e., November and December). Nichols et al. (2002) also reported that Hector's dolphins were more interactive during the mornings. It may be that the operators' tendency to head to the same area where they had a good previous encounter and/or to "hand-over" a receptive dolphin group is increasing the likelihood of repeatedly targeting the same group of dolphins over the course of a day. An increased number of approaches made towards the same group was found to reduce swim duration or dolphin affinity for swimmers in both Hector's and dusky dolphins (Markowitz, Markowitz, & Lundquist, 2009). Alternatively, differences in interaction time might be a reflection of diel behavioral patterns. In Kealakekua Bay, Hawaii, spinner dolphins were found to be more interactive in early mornings when few local people swam, yet avoided swimmers around midday, when many tourists and vessels were present (M. Green & Calvez, 1999). Spinner dolphins enter bays in early morning to socialize and rest before moving further offshore in the late afternoon or early evening to forage (Norris et al., 1994). Lammers (2004) indicated that time of day, rather than location, appeared to be a greater influence on the activity level of spinner dolphins in Oahu, Hawaii. The behavior state and the manner in which spinner dolphins are approached in Hawaii also appear to be the main factors that determine how the dolphins will react to vessels and swimmers (Lammers, 2004; Norris et al., 1994). Socially active groups were often tolerant of a human presence unless actively pursued (Lammers, 2004). When resting, however, they usually avoided engaging with swimmers and sometimes left an area if forced to interact (Norris et al., 1994).

Vessel traffic and tourism activities peaked around midday and in January (Martinez, 2010). The generally lower tourism activity in the mornings and earlier in the austral summer could explain the tendency for dolphins to interact longer with swimmers during these time periods. Markowitz, Markowitz, and Lundquist (2009) also recorded a shorter swim duration in the summer, coinciding with a peak in tourism, potentially indicating some level of sensitization of dusky dolphins to seasonally high levels of vessel interaction. In the Bay of Islands, New Zealand, bottlenose dolphins exhibited long-term sensitization to swim-with-dolphin tourism as their avoidance response increased over a 5-year period (Constantine, 2001). Although Hector's dolphins in Akaroa Harbour may have developed an increased tolerance to swimmers over time, they appear to display a temporal shift in their receptivity to swimmers during the austral summer months. This is yet another example illustrating how tourism activities may affect species differently, and why management needs to focus at the species, and more importantly, at the local population level.

Responses to Vessel Approach Type

National and international research suggests the strategies employed to approach a group of dolphins affect the way dolphins respond to a vessel, and presumably the level of disturbance to the group (e.g., Lusseau, 2006; Neumann & Orams, 2006). It has been suggested that dolphins are able to detect and localize incoming vessels and adapt their behavior accordingly (Lemon, Lynch, Cato, & Harcourt, 2006; Nowacek, Wells, & Solow, 2001). Invasive approaches (e.g., *in path*) leave dolphins two choices, interaction or avoidance (Constantine, 2001). This type of approach could be perceived by dolphins as threatening, which may more likely result in a behavioral change. For that reason, it is prohibited to intercept the path (swimming direction or course) of a dolphin group in New Zealand under the MMPR (1992, section 18k). In the present study, Hector's dolphins also had a tendency to change their behavioral state more often, when vessels used an *in path/rear* approach. When vessels are driven in a manner which is consistent with the provisions of the MMPR, common, bottlenose, and Hector's dolphins showed fewer behavior changes (Lusseau, 2006; Neumann & Orams, 2006; this study).

Reactions to approaching vessels may also be related to the dolphin behavioral state. Hector's dolphins were more likely to change behavior when engaged in social or travel states and least likely to do so when diving, especially if approached from the side (a less invasive approach). This is consistent with other studies, although interspecies differences are apparent. In the Bay of Islands, socializing was the most likely disrupted behavior for both common and bottlenose dolphins, while resting common and foraging bottlenose dolphins were less likely to change their behavior (Constantine & Baker, 1997). In contrast, disruption was less likely to occur when Atlantic spotted dolphins in the Bahamas (Ransom, 1998) and bottlenose dolphins in Florida (Shane, 1990) were socializing. A lower probability of a behavioral change occurring when diving Hector's dolphins were initially approached potentially denotes the importance of this behavior in terms of energy intake for this species.

Effects of Swimmer Placement Style

Previous research has demonstrated that swimmer placement can also affect dolphin response to swimmers (e.g., Constantine, 2001; Constantine & Baker, 1997; Markowitz, Markowitz, & Lundquist, 2009). In Akaroa Harbour, operators have a high compliance level with the MMPR in terms of swimmer placement (as they do with vessel approach types). Swimmers entered the water to the side of the dolphin groups (*line abreast* placement) on 73.5% of all water entries and a further 17.6% of swim attempts were initiated when dolphins were milling around stationary vessels. *In path* placement was least observed, accounting for just 8.8% of approaches. Despite a low sample size, it is clear that an *in path* approach resulted in the highest rate of avoidance response and the shortest encounter times. This type of reaction is consistent with that observed for other species within New Zealand waters, namely common (Constantine & Baker, 1997), dusky (Markowitz, Markowitz, & Lundquist, 2009), and bottlenose dolphins (Constantine, 2001). A *line abreast* placement offers dolphins the choice to approach swimmers or maintain their current behavioral activity. Conversely, with an *in path* vessel approach dolphins must choose to continue on their course and come into close proximity with swimmers or actively change course to avoid the swimmers (Constantine, 2001). An *around vessel* placement resulted in a significant increase in avoidance response of bottlenose dolphins in the Bay of Islands (Constantine, 2001). There is no evidence, however, to suggest that this is also the case for Hector's dolphins. Unlike bottlenose dolphins, Hector's dolphins that remain once a vessel approached appeared willing to interact with the vessel as well as the swimmers. Some skippers and guides in Akaroa Harbour (usually those more experienced) tend to use that cue as an indicator of a group's receptivity prior to deploying swimmers (Nichols et al., 2002; personal observation, first author).

Conclusions

There is a large market for swim-with-dolphin activities, which represents a long-standing desire to interact with dolphins based upon their image and popular representations in the media (Curtin & Wilkes, 2007). Dolphin tourism has a great potential for altering dolphin behavior due to the extended time tourists and tour vessels spend with the dolphins. This is particularly true for swim-with-dolphin encounters with Hector's dolphins, a species that appears to be very receptive to contact with vessels and swimmers, compared with other species targeted by this type of activity in New Zealand. The Hector's dolphin is also an attractive species to target, especially in Akaroa Harbour, where its seasonal distribution means tour operators are able to reliably and quickly locate dolphins within ca. 15 minutes of their departure point when Hector's dolphins tend to be found further inside the harbor (i.e., in January) (Dawson, 1991; Martinez, 2010). These characteristics mean that operators can provide multiple trips, with as many as five different departure times throughout the day during the peak tourism season.

With up to 18 daily swim-with-dolphin trips between November and March, in addition to 14 dolphin-watching trips, pressure on Hector's dolphins is very high. Many individual dolphins can be subject to repeated swim attempts between November and March (Martinez, 2010) and, to a lesser extent the rest of the year, in particular individuals exhibiting a high degree of site fidelity. Over a 5-year period, Hector's dolphins have become more tolerant to the presence of swimmers. However, within an austral summer season, some level of sensitization to seasonally high levels of tourism activities and vessel traffic is evident. Hector's dolphins are therefore not yet habituated (as defined by Samuels et al., 2003). This study also confirms that adherence to the MMPR and permit conditions is effective in minimizing the effects of tourism activities on Hector's dolphins in Akaroa Harbour.

It is important not to overrely or emphasize the statistical significance of the results presented here, but to consider whether changes found in this study are biologically meaningful for this population (Orams, 2004; Richter, Dawson, & Slooten, 2006). There is a common misconception that because dolphins choose to approach and interact, there are no detrimental consequences. However, rven apparently positive interactions can have long-term effects on populations by detracting from important behavior such as foraging or resting. Tourism activities in Akaroa Harbour, whether commercial or recreational, are disrupting the Hector's dolphin behavioral budget (Martinez, 2010). An increased tolerance of human interactions linked with a disruption of diving, which is important in terms of energy uptake, could potentially have long-term detrimental consequences for this population, already vulnerable to other human activities (e.g., by-catch: Slooten, 2007; pollution: Stockin et al., 2010).

This study provides sufficient evidence to support the following management recommendations that: a) no further swim-with-dolphin permits within Akaroa Harbour should be granted (i.e., maintain the moratorium in place), and b) a reduction in the level of exposure of this population to tourism activities should be considered.

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