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Perspective

Long-term impacts of fish provisioning on the behavior and survival of wild bottlenose dolphins

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ABSTRACT

To promote close encounters with wildlife, humans sometimes provision wild animals with food. However such practices can be harmful, and the impacts of human provisioning on wild animals can be difficult to determine, especially indirect effects such as those on the offspring of provisioned animals. In Shark Bay, Australia, a small subset of the resident population of bottlenose dolphins is regularly provisioned with fish handouts under the supervision of the West Australian Department of Environment and Conservation (DEC). Previous studies have shown that calves born to provisioned females experienced reduced care and higher mortality relative to calves of non-provisioned mothers. These results led to changes in the management practices in 1994, which we assessed the efficacy of by comparing (1) calf mortality before and after the intervention and (2) behavior of provisioned with non-provisioned dolphins in the population. Although calves born to provisioned females exhibited higher survivorship (86.7%) than before the intervention (23.1%, $\chi^2 = 9.05$, $df = 1$, $p = 0.003$, $N = 28$), group differences in maternal and calf activity budgets were still observed over the course of calf development. Provisioned mothers provided less care to their calves and their calves appeared to compensate by foraging more and separating more from their mothers compared to their non-provisioned counterparts ($N = 114$ calves). Our study shows that careful regulation and reduced wildlife provisioning can increase calf survivorship, but behavioral development continues to be affected.

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Contents

Abbreviations: DEC, West Australian Department of Environment and Conservation; BACI, Before-After-Control-Impact.

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1. Introduction

Wildlife conservation efforts often have a complex dynamic with ecotourism ventures. Ecotourism can offer vital economic support for wildlife protection and promote public awareness, but can also degrade wildlife and their habitat (Krüger, 2005), especially as tourism increases (Duffus and Dearden, 1990). Though their motives differ, conservationists and tour operators often share the objective of maintaining ecosystem health. Tourism contributes to economic stability, particularly for those in developing countries or in poor communities (Andam et al., 2010; Ferraro et al., 2011). Habituation to humans also facilitates close monitoring of animals for basic research (Asquith, 1989; Connor and Smolker, 1985) and health assessment (e.g., Robbins et al., 2011).

Though cetacean tourism is often cited as an ecologically preferred and economically viable alternative to more consumptive practices such as whaling (Cisneros-Montemayor et al., 2010), its growth has prompted an emerging body of research on potentially negative impacts (Constantine et al., 2004; Stamation et al., 2010; Visser et al., 2011). Cetacean tourism is especially popular in Australia, involving over 1.6 million whale-watchers that support a 172 million dollar industry and hundreds of jobs each year (O'Connor et al., 2009). In addition, Australia permits feeding of wild dolphins at four locations, Tin Can Bay, Tangalooma, Bunbury, and Monkey Mia (Orams, 1995; Samuels et al., 2000), although unregulated feeding occurs at these and several additional sites (Finn et al., 2008; Garbett and Garbett, 1997). Western Australia prohibited feeding of wild marine mammals in 1998 under the Wildlife Conservation Notice, but the bottlenose dolphin provisioning program based at Monkey Mia in Shark Bay was grandfathered in since it is the oldest provisioning site in Australia.

Shark Bay provides an ideal dolphin population for examining the costs and benefits of tourism, particularly wildlife provisioning, because (1) basic research preceded the growth in tourism; and (2) anthropogenic impacts are relatively small. While Shark Bay as a whole is a relatively low-recreation area, two boats currently operate wildlife viewing tours in the eastern gulf, with one specifically licensed for dolphin-watching operations in a zoned area near shore. In addition, only a very small subset (<0.002%) of the resident population of about 3000 dolphins participates in the daily provisioning program managed by the West Australian Department of Environment and Conservation (DEC), enabling comparisons between provisioned and non-provisioned dolphins. Approximately 100,000 people visit Monkey Mia annually, supporting a multi-million dollar industry and an estimated 20–42% of the local Shark Bay economy (Stoeckl et al., 2005). The reliability of observing provisioned dolphins and their proximity to shore facilitates research efforts as well (Connor and Smolker, 1985; Mann and Kemps, 2003), and both provisioned and non-provisioned dolphins have been intensively studied since 1984. Although dolphins have large home ranges, longitudinal study of individuals is feasible because both sexes remain in their natal areas for life (Tsai and Mann, 2013). The long-term study of individually known dolphins over periods with different management protocols and between provisioned and non-provisioned groups allows us to apply the powerful 'BACI' (Before-After-Control-Impact) design (Underwood, 1991).

Although wildlife feeding is popular with tourists, provisioned animals experience altered behavior patterns and population dynamics (Laroche et al., 2007; Unwin and Smith, 2010; Villanueva et al., 2012), physiological costs (Semeniuk et al., 2009), and increased intra- and inter-specific aggression (Hodgson et al., 2004; Orams et al., 1996; Smith et al., 2008). Previous studies in Shark Bay have shown that dolphin calves born to provisioned females received less care and had higher mortality rates than calves of non-provisioned females (Mann et al., 2000; Mann and Kemps, 2003). In response to research, DEC implemented specific protocols designed to reduce time that females spent at the provisioning site with the hope that this would lessen calf mortality (Mann and Kemps, 2003). The current study examines the effectiveness of this intervention.

For long-lived, socially-complex species such as bottlenose dolphins, evaluating the long-term impacts of tourism and provisioning can be complicated by many issues (Bejder et al., 2006; Samuels and Bejder, 2003). First, species with slow life histories may not show significant demographic changes for many years, making survival or reproductive rates alone an impractical metric. Second, baseline data or control data from comparable populations are rarely available. Third, short-term effects are difficult to interpret and often affect long-term changes non-linearly (Higham et al., 2008). Fourth, social transmission of behaviors can influence animals that are not directly exposed to tourism (Donaldson et al., 2012). Finally, the long-term social bonds and fission–fusion nature of bottlenose dolphin societies, where groups change frequently in size and composition (Connor et al., 2000), makes it challenging to detect key changes in social dynamics.

Shark Bay dolphin calves nurse for an average of 4 years and occasionally as late as age 8 (Mann et al., 2000). Altered maternal activity budgets and care are likely to affect calf experience and skill development, and because dolphins are not in stable groups, weaned juveniles face a range of social and ecological challenges on their own (Stanton and Mann, 2012). Although several studies have examined the impacts of human provisioning on wildlife, behavioral development has received little attention, perhaps because immature animals, such as the dependent offspring of provisioned animals, are affected only indirectly. Using the BACI design we investigated whether (1) management changes resulted in increased calf survival and, (2) maternal and calf behavior and development in the provisioned group differs from mother-calf pairs that had no involvement in the program.

2. Methods

2.1. Study site

Monkey Mia, located in Shark Bay, Western Australia (26°S, 114°E), was historically a small seasonal fishing camp that became a resort in 1991 and has served as a field base for dolphin researchers since 1984. Shark Bay contains a population of about 3000 resident bottlenose dolphins (Preen et al., 1997), with about 600 dolphins residing within our 250 km^2 study site. Research on demography, genetics, life history, and behavior of the resident population has been ongoing since 1984, with information on approximately 1500 individuals collected.

Since the 1960s, several dolphins have received fish handouts from humans at Monkey Mia (Connor and Smolker, 1985). The feeds were originally unregulated; fishermen often fed baitfish or some of their catch to dolphins, and tourists could purchase buckets of fish to feed to the dolphins ad libitum while standing in knee-deep water. In 1989, DEC began regulating feeds, limiting them to members of three well-known matrilines. Unregulated shore- and boat-based feeding were discouraged and park rangers selected individual tourists to feed each dolphin up to 60 kg of fish per month, or more if the female had recently calved (up to 120 kg of fish per month, although this total amount was rarely fed). In response to elevated calf mortality (Mann et al., 2000), protocols were revised in late 1994 to further limit each dolphin to 2 kg of fish per day, rather than averaged over the month, with feeds occurring for a maximum of three times and only between the

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