

An update of the conservation status of the bottlenose dolphins of Bocas del Toro Panama: Female calving intervals and calf survivorship.

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Our previous work presented at the IWC 2012-2015 has described the acoustic (e.g., SC/66a/WW5, SC/66a/WW6) and behavioral responses (e.g., SC/66a/WW10, SC/65b/WW06) of bottlenose dolphins at the Archipelago of Bocas del Toro to intense interactions with tour-boats. Here we provide an advance on our research and continue our call to reduce dolphin-watching boat interactions in Bocas del Toro. Using photoID from 2004-2014 we identified 35 females, 23 of which are regular inhabitants of Dolphin Bay where most of the dolphin-boat interactions occur. We found that females in this population had between one and three calves during the study period, with an average calving cycle of 62 months (SD: 21.91 months, Range: 24-97 months). Calf mortality was estimated to be 0.46 with a survival rate of 0.54. These values are lower than other bottlenose dolphin populations. While we are concern about the potential cumulative effects of boat-dolphin interactions on female reproduction, it is important to clarify that these results are based on data collected prior training collaborative efforts between our team and the Government of Panama. Between 2014 and 2018 a total of 117 tour operators in Bocas were trained (e.g. SC/66a/WW/1/rev4). The report by **SC/68A/INFO/55 Sitar and Parsons** report high levels of no compliance by tour-boat operators in 2013. However, is important to highlight that their values do not represent current levels of regulation compliance, and that our results do not represent a response to current numbers of boats or compliance either. Having said that, during the years in which the data was collected for this report boat activity did significantly interrupted dolphins during foraging activities and these interruptions may have had high energetic cost to nursing mothers and their calves (SC/66a/WW10, SC/65b/WW06, SC/66a/WW11, SC/66a/WW12). In addition, since 2014, we have learned that other factors may be impacting the health of this dolphin population, and that boat-activity may had exacerbated these effects. Barragan-Barrera et al. (2019) found that Bocas dolphin's diet is largely based on low calorie prey that may likely require these dolphins to eat more often. They also find that Bocas dolphins have a marginal health risk for mercury bio magnification. An ongoing stress hormone project reveals an overall increase in cortisol levels of Bocas dolphins during the high tour-boat season. Bocas dolphins do not need many boats to respond negatively, in SC/65b/WW06 we reported a 10-fold increase in dolphins' negative reactions to more than three tour-boats. Altogether, boat activity, low compliance by tour-operators, low calorie diet, and stress may have influenced Bocas female dolphin 'reproductive success between 2004 and 2014. Ongoing efforts by our team are assessing if training and education efforts between 2015 and 2019 will reveal a higher level of tour boat compliance, and if

with it there is an increase in calf survivorship rate. Our 15 years of research on this dolphin population highlight the importance of establishing long-term research and partnerships with governmental institutions to secure proactive and preventing conservation actions.

Introduction

The resident bottlenose dolphins of the Archipelago of Bocas del Toro in Panama consist of a small and genetically isolated population (Barragan-Barrera et al. 2017, SC/65a/SM15) that is regularly exposed to interactions with dolphin-watching boats throughout the year (SC/64/WW2). In previous meetings we have shared our research on how dolphins respond acoustically (e.g. May-Collado and Wartzok 2008, May-Collado and Quinones-Lebron 2014, SC/66a/WW5, SC/66a/WW6) and behaviorally (e.g., SC/66a/WW10, SC/65b/WW06) to these interactions. Together our reports to the IWC and IWC letters of recommendations to the Panamanian Government have helped government officials to become more aware of the situation. In addition, there has been an intense effort in training 117 tour operators in Bocas by our team members and by the Panamanian Government (Prof. Jose Julio Casas, UMIP). While we expect tour-operators compliance to have increase, we still see more than recommended numbers of boats interacting in key dolphin habitat, Dolphin Bay (SC/65b/WW06). Dolphin Bay is an area used by females' likely due its semi-close characteristics, which could provide safety from predators and high abundance of sardines a primary food component of their diet (Barragan-Barrera et al. 2019). One of our recent studies showed that foraging is the most interrupted behavior, and that females with calves appeared to be particularly vulnerable to these interruptions, raising concerns about the health status of lactating mothers and their calves (SC/66a/WW11.). In addition, Barragan-Barrera et al. (2019) shows that while mercury concentrations are low in this dolphin population there is a marginal health risk due to bio magnification in their food chain as has been found for other dolphin populations (Harding et al. 2018).

Calf survivorship and female reproductive success are key demographic parameters used to predict population dynamics, viability, and health. In bottlenose dolphin these parameter vary among population likely due to local environmental factors. For example in the Bay of Islands of New Zealand have a population where female have an inter-birth interval of 4.3 years, and a calf mortality ranging from 0.34 to 0.52 (Tezano-Pinto et al. 2015). This same population showed a 7.5% annual rate of decline from 1997-1999 to 2003-2006 (Tezano-Pinto et al. 2013). In this study we provide preliminary estimates of female calving interval and calf survivorship for Bocas del Toro resident bottlenose dolphin population and the possible reasons for the observed patterns based on recent published work and ongoing research efforts.

Methods

We used nine years of photo-ID data collected between 2004 and 2014. The current dorsal fin catalog for this dolphin population consists of roughly 140 dolphins. Females have been identified using genetic and reproductive hormone information, and association patterns with calves. Calves were classified into age classes based on body length. Neonates (0-3months old) were identified as those that were less than half the size of an adult and had paler coloration (Mann and Smuts 1998). Calves (3 months -3 years old) measured roughly half the size of an adult. Juveniles (3-9 years old) measured 2/3 the size of an adult (Kasuya et al. 1997; Tezano-Pinto et al 2015). Calf

mortality was estimated by recording the initial sighting of the individual mother and her calf. If the mother was sighted without the calf for two consecutive years, when the calf is less than 24 months old, the calf is presumed dead (Wells and Scott 1990, Mann et al. 2000). The calving interval was estimated by calculating the difference in months between the first sighting of a mother-calf pair and the first time the same mother was seen with a different calf. This number was rounded to the nearest quarter-month. Reproductive success and calf mortality were determined by the number of calves that survived/died respectively, divided by the total number of calves produced in the overall population.

Results

We identified 35 females and their calves, 23 of which are regular inhabitants of Dolphin Bay where tour-boat activity is high. The average female calving interval was 62.08 (± 21.91) months and ranged between 24 and 84 months. During the study period 24 females had only one calf and 11 have between 2 to 3 calves. Collectively, these 35 females produced a total 49 calves, of which 20 survived the first two year, 17 did not, and for 12 we have not yet determined their fate, as five more years of data remains to be analyzed. Overall, calf survivorship was 0.54 and mortality 0.46.

Discussion

The average calving interval of the females in this bottlenose dolphin populations is significantly long ~ 5.17 years and calf survivorship is relatively low 54% compared to other populations. In the North Sea female calving interval is 3.8 years and calf survivorship is (Robinson et al. 2017). In this North Sea dolphin population mothers will give birth to their next calf if her previous calf did not survive or if her previous calf became a juvenile and separated from her (Robinson et al. 2017). Several factors may favor longer maternal care before separation including life history, habitat, provisioning and group size (Mann et al. 200). Calves stay with their mothers because their mothers teach them valuable skills such as how where to hunt and how to avoid predators. High boat traffic in key mother-calf habitat may drive females to stay longer with their calves teaching them how to cope with them. In Bocas between 2004 and 2014 dolphin interactions with boats often resulted on increasing avoidance behaviors and mother-calve separation (SC/66a/WW10, SC/65b/WW06). Unfortunately, if females are investing more time per calf, this may not had pay off. Bocas dolphin calf survival rate of 54 % compared to other populations is low. For contrast, in Sarasota Bay, the calf survivorship rate is of 81% and in Doubtful sound and in Bay of Islands, New Zealand calf survivorship ranges between 48% and 66% and (Robinson et al. 2017; Wells et al. 1990; Currey et al. 2008; Tezano-Pinto et al. 2015).

We do not have evidence that low survivorship is due to boat traffic or low boat compliance, however, we have in the past reported dolphin mortality due to boat collision (SC/66a/WW7). Indirectly, tour-boat interruptions during foraging may come with high energetic cost to nursing mothers and their calves. Our recent findings on diet indicates these animals feed on low calorie diet that may require these dolphins to eat more often; and although Bocas dolphins have low mercury concentrations, they showed a marginal health risk for mercury bio magnification (Barragan-Barrera et al. 2019). In addition our preliminary results on stress hormones indicate that during high tour-boat season dolphins show higher levels of cortisol (Betzi Perez pers.comm 2019). Our previous work suggest that it only takes three boats to increase a 10-fold the negative

responses to boat presence (SC/65b/WW06). Thus, boat presence even if low may be already exacerbating the effects of a low-calorie diet and health overall.

Altogether, boat activity, low compliance by tour-operators, low calorie diet, and stress may had influence Bocas female dolphin 'reproductive success between 2004 and 2014. Ongoing efforts by our team are assessing if training and education efforts between 2015 and 2019 will reveal a higher level of tour boat compliance, and if with it there is an increase in calf survivorship rate. Our 15 years of research on this dolphin population highlight the importance establishing long-term research alongside proactive and preventing conservation actions.

Disclaimer: We want to stress to the IWC that while we are concern about the potential cumulative effects of boat-dolphin interactions on female reproduction, we also want to be clear about the described patterns in this report. Our results are based on data collected prior tour-boat training efforts by our team and the Government of Panama, and so they do not represent a response to **current** numbers of boats or compliance. Similarly, we think the report by **SC/68A/INFO/55 Sitar and Parsons** reporting high levels of no compliance by tour-boat operators in 2013, should also be taken with caution. Their values do not represent **current** levels of boat compliance. This is very important for two reasons: (1) we have invested significant efforts in training and education and (2) the whale-watching regulations have been revised and updated since these studies (**Resolution No. DM0530-2017, October 13, 2017**). Next SC IWC meeting my team, International Maritime University of Panama UMIP and Enviromental Ministry cetacean team research will be presenting a report on boat compliance and tour-boat fleet.

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