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SHORT COMMUNICATION

WILEY

First reported observation of an apparent reproductive bottlenose × Risso's dolphin hybrid

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Abstract

1. Bottlenose dolphin photo-identification data were compiled from western Scotland to identify individuals and ultimately investigate population size, demographic parameters, spatio-temporal distribution, and movement patterns.
2. Opportunistic citizen science photographs revealed what appeared to be an adult bottlenose × Risso's dolphin hybrid along with an apparent second-generation hybrid or back-cross calf. Both had atypically short rostra and the dorsal fin of the adult was noticeably taller than is normal for bottlenose dolphins.
3. Based on these characteristics, this case may represent a congenital rostral abnormality or the first intergeneric calf reported for this species combination, either in captivity or in the wild.
4. The previously reported presence of several putative hybrids and mixed-species sightings in the area, in combination with the tall dorsal fin, provide support for the second possibility, i.e. intergeneric hybrids.
5. Although rare, hybridization may have disproportionate conservation consequences, with population-level impacts in very small coastal populations of long-lived, slow-breeding animals.

KEYWORDS
Allee effect, fertile, *Grampus griseus*, intergeneric hybrid, species conservation, *Tursiops truncatus*

1 | INTRODUCTION

The traditional biological species concept is based on reproductive isolation between sympatric populations (Mayr, 1942). However, hybridization, the successful mating between individuals from different species, has been documented among a variety of terrestrial, freshwater, and marine species, and may occur naturally or be anthropogenically promoted (e.g. Gardner, 1997; Scribner, Page & Bartron, 2001; Shurtliff, 2013). In general, the fitness of animal hybrids is low as they are typically sterile or non-viable (stillborn or die shortly after birth). Increasing numbers of putative or confirmed hybridization events among marine mammal species are being reported, with detection based on the assessment of morphological traits (with hybrids typically demonstrating intermediate morphological characteristics compared with the parent species) and/or genetics (for reviews, see: Bérubé, 2009; Crossman, Taylor & Barrett-Lennard, 2016; Syme, Kiszka & Parra, 2021).

Hybridization events may happen at several taxonomic levels: e.g. intrageneric hybridization occurs between individuals from species belonging to the same genus, whereas intergeneric hybridization involves reproduction between individuals of species from different genera. In free-ranging marine mammal populations, natural intra- and intergeneric hybridizations are more common when the separate species have similar life histories, behaviour, morphological traits, and habitat requirements (Bérubé, 2009; Crossman, Taylor & Barrett-Lennard, 2016); in captivity, hybridization is promoted by mixed-species enclosures.

2 | METHODS

As part of a study of common bottlenose dolphins (*Tursiops truncatus*) off western Scotland (van Geel, 2016), photographic images were collated and analysed to identify individual dolphins. In collaboration with the Hebridean Whale and Dolphin Trust, a total of 29,385 images were obtained between 2000 and 2014. These were collected during dedicated research surveys, by platforms of opportunity (especially wildlife tour operators), and through citizen science data provided by members of the public. The overall aims of the research effort were to estimate the population size and demographic parameters (notably survival and calving rates), and to investigate spatio-temporal presence as well as mobility patterns.

3 | RESULTS

Analyses of these data revealed one particularly interesting encounter among the citizen science photographs, on 19 August 2011 at Port of Ness, Isle of Lewis, Scotland (Figure 1). This sighting, one of the few with photographic evidence from the northern part of the Outer Hebrides, included an adult dolphin with an atypically short rostrum (i.e. beak) as well as a relatively tall dorsal fin. In a surfacing sequence captured in three photographs, it was evident that this dolphin was accompanied by a calf that also exhibited this unusual rostrum trait (Figure 2). The photographs were of insufficient quality for photo-identification purposes, which prevented analyses of further encounters of these specific individuals at this location or elsewhere, and the assessment of the long-term survival of the calf.

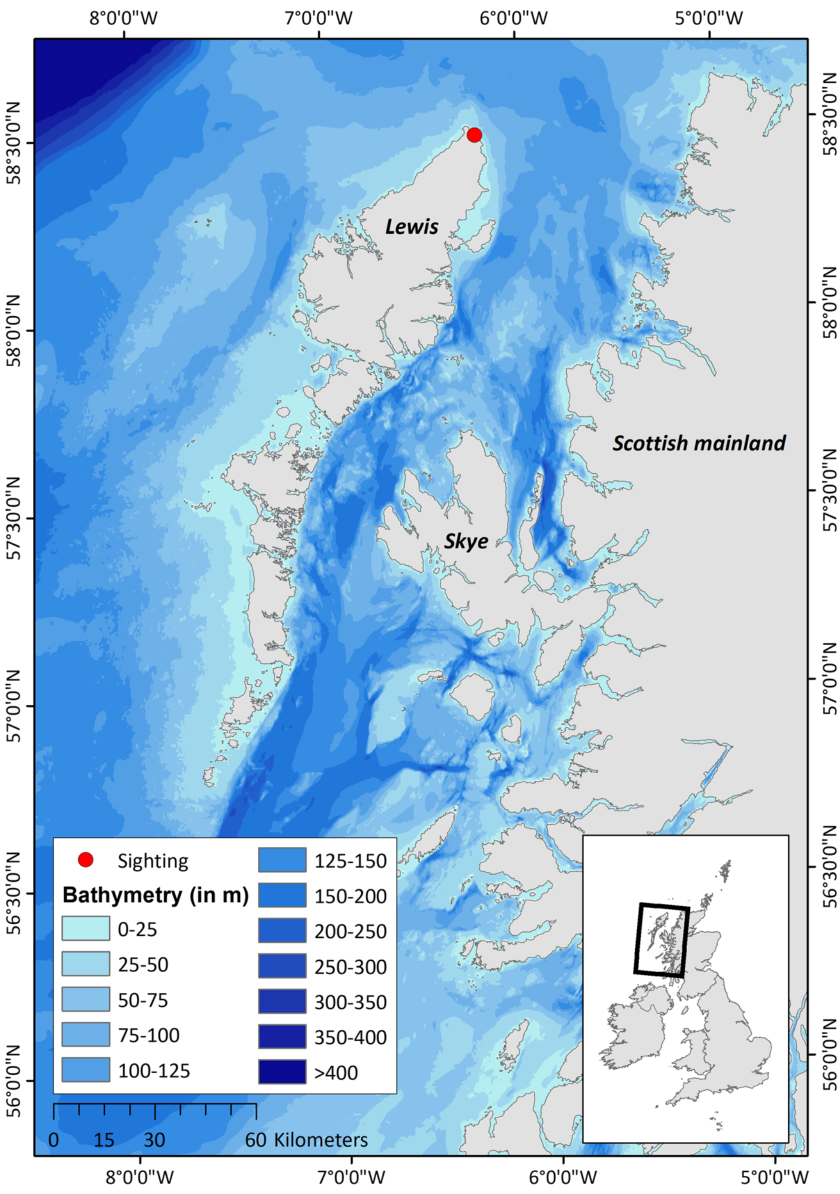

FIGURE 1 Map of western Scotland, marking the location of the encounter with the apparent reproductive hybrid off the Isle of Lewis

FIGURE 2 Surfacing sequence of an apparent bottlenose × Risso's dolphin hybrid (front adult dolphin) with calf, both with atypically short rostra. Also note the tall dorsal fin of the putative adult hybrid. A bottlenose dolphin with a normal rostrum and dorsal fin length is visible in the background. Photographs by Tony Marr.

FIGURE 3 Examples of the appearance of a typical common bottlenose dolphin and calf (top) and Risso's dolphin (bottom). The stubby rostra of bottlenose dolphins are clearly demarked from their melons (i.e. bulging foreheads) by a crease, and their dorsal fins are moderately tall and falcate in shape. Risso's dolphins are characterized by their distinct extensive scarring (particularly the mature individuals) and blunt bulbous head without a sharp demarcation of the rostra; instead, there is a smooth transition from the melon to the beak. Their falcate dorsal fins are notably taller and more erect than those of bottlenose dolphins; Risso's dolphins have one of the tallest dorsal fins in relation to body size of any cetacean. Photographs by Barbara Cheney (top left), Nienke van Geel (top right), and IFAW/MCR (bottom).

These two individuals were part of a group of approximately 15 bottlenose dolphins. Likewise, the majority of the bottlenose dolphins photographed could not be reliably identified because of insufficient picture quality. However, one adult female was previously encountered in 2007 between the Isle of Skye and the Scottish mainland, where she was observed associating with a group of approximately 15 Risso's dolphins (*Grampus griseus*) (Thompson et al., 2011). This female was also sighted together with other bottlenose dolphins off the Isle of Lewis in 2012; no other matches were made within the dataset assessed here. She was accompanied by a calf on all three occasions. For comparison, examples of the appearance of normal bottlenose dolphins, including the rostrum of a calf, and Risso's dolphins are shown in Figure 3.

4 | DISCUSSION

Although this mother–calf morphological feature might be an inherited genetic rostrum anomaly, it is also possible that these dolphins are intergeneric hybrids within the Delphinidae family, notably between bottlenose and Risso's dolphins. Supporting the possibility of the presence of intergeneric hybrids, putative bottlenose dolphin hybridization with Risso's dolphins, as well as mixed-species groups containing individuals from both of these species, have been reported in adjacent waters off eastern Lewis and off the west coast of the Scottish mainland (Thompson et al., 2011; Hodgins, Dolman & Weir, 2014; Giulia Bertulli, 2018). These sightings include reports of a female bottlenose dolphin with a calf together with a group of Risso's dolphins (see Results), a single adult bottlenose dolphin sighted with Risso's dolphins, and a single adult Risso's dolphin sighted amongst bottlenose dolphins. Bottlenose dolphin–Risso's dolphin mixed-species groups have also been reported outside of UK waters (reviewed by Syme, Kiszka & Parra, 2021). Additionally, there are documented strandings of three apparent bottlenose × Risso's dolphin hybrids in Ireland (Fraser, 1940). Finally, besides the short rostrum, the adult female in the current study showed an unusually tall dorsal fin, which is considered an additional indicative feature of a bottlenose × Risso's dolphin hybrid (Hodgins, Dolman & Weir, 2014). The photographed calf could be the offspring of two hybrids, as multiple presumed hybrids with various intermediate morphological characteristics have been identified in the area (Hodgins, Dolman & Weir, 2014), or a back-cross between a hybrid and either of the parental species.

If the adult photographed off western Scotland is indeed a reproductive bottlenose × Risso's dolphin hybrid, survival till sexual maturity, and particularly the presence of a calf, represents a very rare observation. In Japan, 14 births of bottlenose (female) × Risso's (male) hybrids were documented in captivity. However, of these, eight were stillborn, four calves died within a year, and one calf died before the age of 7 years (Sylvestre & Tasaka, 1985). The final calf, born in 1993, was still alive 20 years later (Hodgins, Dolman & Weir, 2014); however, none of these hybrids reproduced.

Additionally, the presence of the calf would then indicate that intergeneric Delphinidae breeding can produce fertile offspring, which themselves can successfully give birth to live calves. Successful reproduction has previously been reported for intrageneric Delphinidae hybrids between captive common and Indo-Pacific (*Tursiops aduncus*) bottlenose dolphins (Gridley et al., 2018). Data on the reproductive success of intergeneric Delphinidae hybrids, however, are extremely limited. In captivity, where the survival probability may differ from natural scenarios, a hybrid between a female bottlenose × male long-beaked common dolphin (*Delphinus capensis*) gave birth to a live-born back-cross calf sired by a bottlenose dolphin. However, the calf died shortly after birth (Zornetzer & Duffield, 2003). Likewise, media reports suggest that a captive-born hybrid between a female bottlenose × male false killer whale (*Pseudorca crassidens*) gave birth to three back-cross calves; at least one of these lived for 9 years (NBC News, 2005). Less evidence for second-generation occurrences exists for free-ranging dolphin populations, where rates of hybridization may differ, compared with captive environments. Additionally, it is conceivable that many wild hybrids are not recognized as such in the field (Crossman, Taylor & Barrett-Lennard, 2016). Nevertheless, genetically verified examples of free-ranging striped dolphins (*Stenella coeruleoalba*) and short-beaked common dolphins (*Delphinus delphis*) second-generation hybrids and back-crosses with either parental species have been described (Antoniou et al., 2018).

From a conservation perspective, the occurrence of hybridization is important because of its potential to lead to the emergence of new biodiversity (e.g. genetic variation and species differentiation), as well as being a cause for biodiversity loss (Todesco et al., 2016; Quilodrán, Montoya-Burgos & Currat, 2020). Despite reports of hybridization events accumulating, little is known about past and current hybridization rates and the long-term species-level consequences of hybridization in wild marine mammals. However, viable and reproductive hybrids may ultimately lead to the breakdown of reproductive barriers between species. Introgression, the gradual diffusion of genes between species through repeated back-crossing with individuals from the parent species, is one such potential evolutionary consequence (Bérubé, 2009). Additionally, in hybrid speciation, hybridization leads to a new species that is reproductively isolated from the parent species. An example of hybrid speciation in marine mammals was recently described in the Clymene dolphin (*Stenella clymene*), which differentiated from its putative parental species, the spinner dolphin (*Stenella longirostris*) and the striped dolphin (Amaral et al., 2014). Over shorter time periods, hybridization may increase genetic diversity in populations, in turn enhancing the adaptation potential to changing environmental conditions. Conversely, especially when combined with anthropogenic pressures (e.g. habitat modification, climate change), hybridization may lead to biodiversity loss when hybrids demonstrate reduced fitness, or through increased presence of mal-adaptive genes (Todesco et al., 2016; Quilodrán, Montoya-Burgos & Currat, 2020). It can equally be argued that a congenital rostral deformation alone has the potential to have similar positive or negative fitness impacts.

For bottlenose dolphins, it has been suggested that habitat-driven genetic structuring took place in the north-east Atlantic, where coastal populations have resulted from historical founder events in oceanic population(s), with subsequent niche differentiation and high site fidelity driven by adaptation to these coastal habitats and natal philopatry (e.g. Natoli, Peddemors & Hoelzel, 2004; Louis et al., 2014a; Louis et al., 2014b). These studies indicated that coastal populations are genetically differentiated from the Atlantic offshore population, estimated to be >118,000 individuals during the summer of 2016 (ObSERVE programme, Rogan et al., 2018; SCANS-III survey, Hammond et al., 2021). Evidence is lacking for genetic connectivity between individuals from the coastal west Scotland population and individuals originating from other UK and Irish coastal populations, despite the presence of a limited number of photographic matches between geographic regions (Robinson et al., 2012). However, in general, coastal bottlenose dolphin populations along the western European seaboard have small population sizes, low genetic diversity, and low demographic and genetic connectivity (Nykänen et al., 2018; Nykänen et al., 2019 and references therein). As such, the occurrence of several hybrids and the presence of second-generation hybrids or back-cross calves (Hodgins, Dolman & Weir, 2014; current study) may be particularly consequential (positively or negatively) to the small (estimated to be approximately 45 individuals), slow breeding coastal bottlenose dolphin population off western Scotland (Cheney et al., 2013; van Geel, 2016).

In contrast, more than 200 Risso's dolphins have been identified locally in various UK coastal studies, with indications that these individuals are part of a more open population (with individuals showing varying degrees of intra- and interannual site fidelity, matches between areas, and discovery curves that have not plateaued) (e.g. Atkinson, Gill & Evans, 1999; Baines & Evans, 2012; de Boer et al., 2013; Stevens, 2014; Eisfeld-Pierantonio & James, 2018; Weir et al., 2019, and references therein). Furthermore, the total Risso's dolphin population in European continental shelf waters has been estimated at >15,000 individuals for the summer of 2016 (Rogan et al., 2018; Hammond et al., 2021). With the lack of genetic analyses throughout their north-eastern Atlantic distributional range, little is known about the population structuring of Risso's dolphins. Nevertheless, there is currently no evidence to suggest population substructuring within this region (Evans, 2012). Collectively, this suggests that localized hybridization events may be less consequential to Risso's dolphins than to the local coastal bottlenose dolphins.

Within a species, insights into distributions and ranging behaviour may contribute to assessing the probability of reproductive encounters with dolphins from neighbouring populations. With regards to maintaining genetic diversity and the prevention of inbreeding in particular, the frequency of such interactions may be important, especially for small populations (see below). As outlined above, the potential for this appears higher for Risso's dolphins than for bottlenose dolphins. Influxes of individuals from offshore areas or calves born through coastal dolphins temporarily venturing into offshore waters or other coastal regions may mitigate hybridization effects.

For species conservation, it is important to determine how frequent hybridizations occur, whether they positively or negatively influence individual survival and reproductive success, and what the scale of the impact may be on the parent species. This information is currently lacking for the species of concern here. Mixed-species groups have been reported in the wider western Scotland area for over two decades. Although such interactions do not necessarily lead to successful reproduction, the presence of the four putative hybrids observed in a small area off Lewis (Hodgins, Dolman & Weir, 2014) indicates that this can be the case. Continued interspecies reproduction results in the presence of hybrids and back-cross dolphins at the cost of individuals being born in the parent species' populations. The bottlenose dolphin is a protected species under the EU Habitats Directive (transposed into UK law), and the presence of hybrids and back-crosses may, ultimately, have implications for the conservation status of small groupings of coastal bottlenose dolphins of the West Coast Scotland Assessment Unit (status currently uncertain/unknown; DEFRA, 2019). Continued population monitoring will help to understand the scale of hybridization currently present and to assess population-level consequences.

In general, the viability of small populations is a conservation concern; as population size decreases, extinction risk increases through demographic and environmental stochasticity, natural catastrophes, and the loss of genetic diversity and/or accumulation of unfavourable mutations (e.g. Shaffer, 1981; Lacy, 1987; Harmon & Braude, 2010). Small populations may also be subject to Allee effects, which could dramatically increase the probability of extinction (Courchamp, Clutton-Brock & Grenfell, 1999; Stephens & Sutherland, 1999; Stephens, Sutherland & Freckleton, 1999). Allee effects refer to situations where the population growth rate (through impacts on reproduction and survival) is negatively affected as a result of reduced interactions associated with this low density or small group size, and may also be relevant to small populations of marine mammals (e.g. Wade & Slooten, 2020). Hybridization may add to the aforementioned concerns, especially for the small local bottlenose dolphin population.

Future genetic sampling may verify the occurrence of hybridization, or rule this out and instead indicate that the described traits are a genetic rostral anomaly. In addition, investigating whether altered or atypical vocalizations are produced by these individuals may be useful. Long-term passive acoustic data are currently being collected (EU INTERREG VA COMPASS project; https://compass-oceanscience.eu/) and could be analysed to investigate the presence of unusual call types. For instance, the 52-Hz call (Watkins et al., 2004) is hypothesized to be transmitted by blue whale (*Balaenoptera musculus*) × fin whale (*Balaenoptera physalus*) hybrids (Stafford et al., 2007). If such hybrid-specific vocalizations exist, they may provide insights into the occurrence of bottlenose × Risso's dolphin hybrids.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest associated with this work.

DATA AVAILABILITY STATEMENT

The data that supports the findings of this study are available within this article.

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