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Sudden seasonal occurrence of humpback whales *Megaptera novaeangliae* in the Firth of Forth, Scotland and first confirmed movement between high-latitude feeding grounds and United Kingdom waters

Katie E. O'Neil¹, Emily G. Cunningham² and Daniel M. Moore^{3*}

Abstract

Here we report on the sudden seasonal occurrence of humpback whales *Megaptera novaeangliae* within the Firth of Forth, Scotland, UK over the winter months of 2017 and 2018. Sightings and photographs collected by citizen scientists of the Forth Marine Mammal Project were inspected and a fluke photograph compared to existing catalogues from all known feeding and breeding grounds across the North Atlantic. No matches to breeding grounds were found but a fluke match to a non-catalogued individual in Svalbard (Norway) constitutes the first confirmed movement of a UK-recorded humpback whale from high-latitude feeding grounds. A different individual was photographed in the Firth of Forth in both 2017 and 2018, providing evidence of a whale returning to the Firth of Forth in consecutive years. Despite year-round observation, the discrete seasonality of sightings suggests that the Firth of Forth may represent a migratory stopover or alternative destination for humpback whales on their southbound migration. Overall, these findings constitute a formalised baseline of information regarding the occurrence of humpback whales in the Firth of Forth and contribute to our understanding of the migration habits of humpback whales in the eastern North Atlantic.

Keywords: Svalbard, Photo-ID, Migration, Citizen science, North East Atlantic, British Isles, Cetacean, Norway, Arctic

Background

Following severe decline due to commercial whaling (Tønnessen and Johnsen, 1982), humpback whale *Megaptera novaeangliae* (Borowski 1781) populations in the North Atlantic region have been undergoing steady recovery during the latter part of the twentieth century (Katona and Beard, 1990; Weir et al. 2001; Leopold et al. 2018). There has been significant variation in recovery rates between different areas of the North Atlantic (Stevick et al. 2003), but the paucity of recent data for the eastern North Atlantic prevents a clear picture from being drawn.

The little information that exists on the historical distribution and abundance of humpback whales in Scottish waters prior to commercial whaling indicates that they were present in low densities. Between 1306 and 1918,

only three humpback whales were reported stranded on the east coast of Scotland: Firth of Forth in 1690, Wick in 1871 and Dundee in 1884 (van Deirse, 1918). Humpback whales feature in whaling records from catches around Scotland in the first half of the twentieth Century, albeit in relatively low numbers (Parsons et al. 2000).

Commercial whaling in Scottish waters ended in 1951 (Parsons, 2012) and in the wider North Atlantic in 1955 (Stevick et al. 2003). Since that time, no humpback whale was reported stranded in Scotland until the first confirmed record in 1985 (MacLeod et al. 2005). Although all records of humpback whale presence, including visual, acoustic and strandings, remain low (Reid et al. 2003), there have been increasing records for this species in Scotland and the wider eastern North Atlantic region since the mid-1980s (Charif et al. 2001; Weir et al. 2001; Ryan et al. 2016; Leopold et al. 2018; Ron Macdonald 2018, pers. comm.). The first confirmed record of a humpback whale in the Firth of

* Correspondence: forthwhale@gmail.com

³Department of Biosciences, Durham University, Durham, UK
Full list of author information is available at the end of the article



Forth, Scotland, occurred in February 2003, with further records from August 2006, October 2012 and August 2017 (Leopold et al. 2018; Ron MacDonald 2018, pers. comm.).

There is a growing awareness of the value of citizen science in cetacean monitoring (Tonachella et al. 2012; Bruce et al. 2014; Embling et al. 2015) and in Scotland there are numerous amateur groups that make observations on cetaceans. Here we focus on data collected by the Forth Marine Mammal Project (FMMP), a grassroots community project established in January 2017. The FMMP was founded and is now led by volunteer citizen scientists who conduct informal landwatches year-round along both coasts of the inner Firth of Forth. The FMMP is largely facilitated by the use of social media, predominantly Facebook (Forth Marine Mammal Project, 2017), and uses these platforms to promote live sightings information to its members. Here we report on the sudden seasonal occurrence of humpback whales in the Firth of Forth and the first confirmed movement between high-latitude feeding grounds and United Kingdom waters using data collected by citizen scientists of the Forth Marine Mammal Project.

Methods and results

For this study, FMMP social media accounts were trawled for humpback whale sighting records over the period January 2017–March 2018. Any sighting record which did not have photographic confirmation was disregarded for the purposes of this study. Where details regarding a specific sighting were ambiguous (dates, location, etc.), further clarification was sought from the FMMP member who originally reported the sighting. This provided 15 validated sightings between 14th January and 15th March in 2017 (61 day period) and 36 validated sightings between 3rd January and 23rd February in 2018 (52 day period). No humpback whales were reported in the Firth of Forth outside these time periods, despite year-round observations.

The number of observers more than doubled in the second year, with 15 observers in 2017 and 37 observers in 2018.

In 2017 the maximum number of whales observed at any one time was 2 individuals on 13th March. In 2018, concurrent sightings of 3 individuals was made on a number of dates. On all occasions, individuals were solitary and no interaction was observed. Non-formalised observations of behaviour include reports of surface idling, diving and occasional breaches.

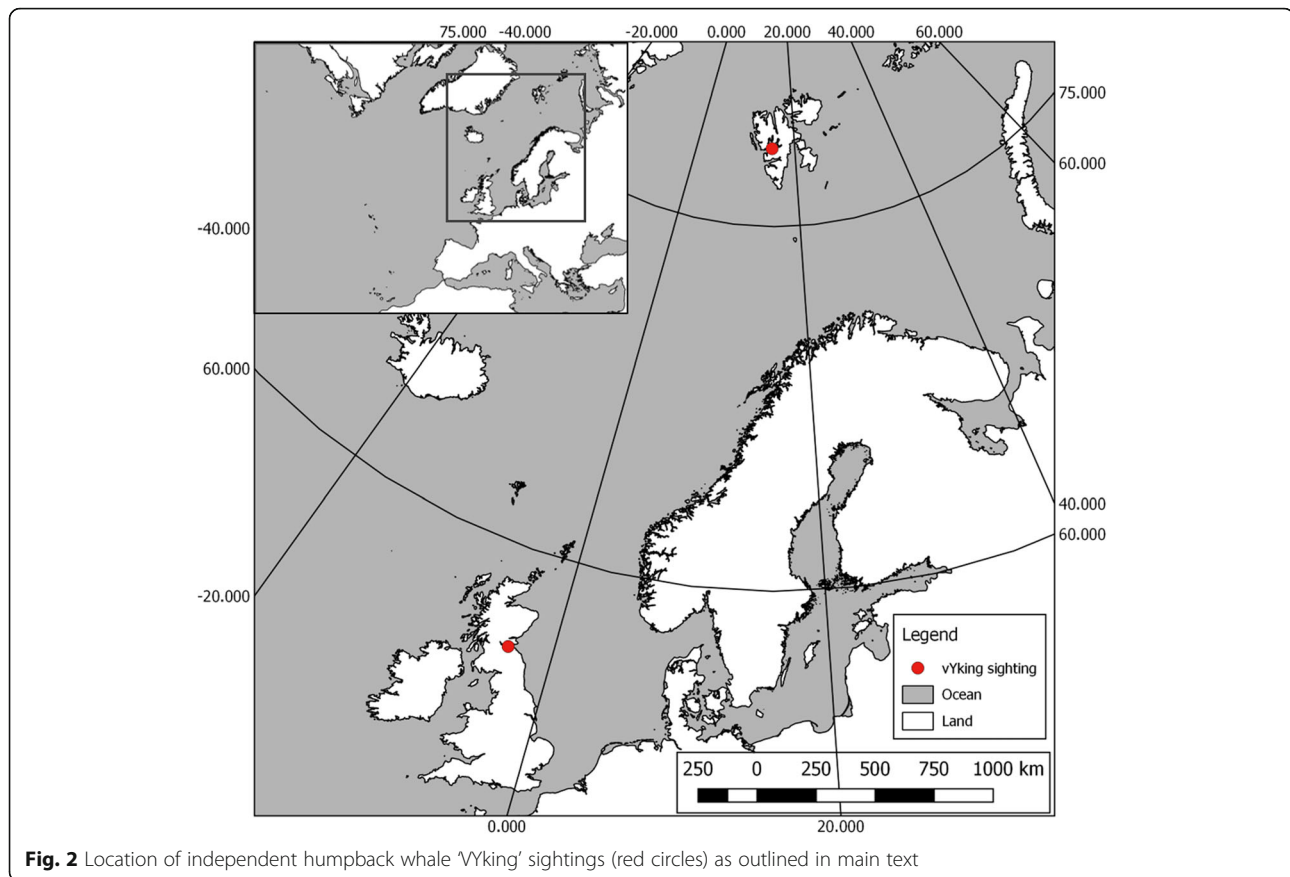
Humpback whales were predominantly sighted in the deep-water channel passing Inchkeith Island and running to Inchmickery. During periods of low tide, sightings were mainly reported in the deeper water found in the eastern reaches of the Forth.

Photographs of observed humpback whales submitted to FMMP social media accounts by citizen scientists were utilised to identify individuals using natural variation in the dorsal fins and ventral flukes (Wells, 2017). As all photos were taken from land and were of low quality, a combination of fluke, dorsal fin and ventral images were used to identify individuals. Four individual humpback whales have so far been identified in the Firth of Forth, with all matches confirmed by two independent experts.

Although photo quality was poor, one individual (nicknamed 'VYking') had a distinct Y-shaped marking on the ventral surface of the fluke and so attempts were made to cross-check the best image with existing humpback whale catalogues from across the North Atlantic region. As no matches were made, FMMP members then conducted Google image searches and made a successful match to an image taken of a non-catalogued individual in Svalbard, Norway (Fig. 1). 'VYking' was photographed in the Firth of Forth ($56^{\circ}02'19''\text{N}$, $3^{\circ}11'36''\text{W}$) on 23rd February 2018 and the Norwegian photograph was taken the previous year on 31st May 2017 at Isfjorden near Longyearbyen in Svalbard (approximately $78^{\circ}15'\text{N}$, $15^{\circ}04'\text{E}$) (Fig. 2). This represents a minimum at-sea distance movement of 2610 km.



Fig. 1 Humpback whale 'VYking' as sighted in the Firth of Forth, Scotland (a) and Svalbard, Norway (b). (Image credits: Sandy Morrison/Forth Marine Mammal Project - A, Iain Rudkin/Iain Rudkin Photography - B)



Of the remaining three animals identified, one individual was positively identified from photographs taken in both 2017 and 2018; providing the first confirmed record of an individual humpback whale returning to the Firth of Forth in consecutive years. Additionally, this individual, nicknamed 'Sonny', was present in the Firth of Forth for nearly a two-month period in 2017 having been sighted regularly between the 16th January and 13th March of that year. 'Sonny' was present for at least a month in 2018, having been sighted regularly between the 3rd January and 4th February.

Discussion

Given the timing and relatively short duration of sightings in the Firth of Forth each year, it is possible that this area represents a migratory stopover, a feeding or recovery opportunity en route of a longer migration, rather than an ultimate destination. It is well documented that humpback whales cover large distances travelling between high-latitude summer feeding grounds and low-latitude winter breeding grounds (Baker et al. 1990, Katona and Beard, 1990; Kennedy et al. 2013; Stevick et al. 2011) and eastern North Atlantic humpback whales are known to make seasonal migrations to winter breeding grounds in the West Indies and Cape Verde (Jann et al. 2003, Stevick et al. 2016,

Wenzel et al. 2009). Humpback whale migration is largely pelagic in the North Atlantic, aside from migratory stopovers where whales make short stops to forage in coastal waters (Stone et al. 1987). Recent satellite tracking data from eastern North Atlantic humpback whales tagged off Norway has shown substantial individual variation in southbound migration route, with some individuals choosing a direct pelagic route and others making visits to coastal waters off Iceland, Shetland or the Azores (Whaletrack, 2018). Recent photo-identification analysis indicates that the Azores constitute a migratory stopover for a small number of the humpback whales migrating between Cape Verde and Norway on both northbound and southbound journeys (Cucuzza et al. 2015).

An alternative explanation for their presence in the Firth of Forth over the winter months may be that these are juvenile individuals that are either (a) required to make multiple feeding stops before full migrations owing to their much-reduced capacity to sustain long periods without feeding (Bortolotto et al. 2016; Craig et al. 2003) or (b) do not make complete migrations to breeding grounds but rather migrate only to continue feeding in mid-latitudes during winter and spring, as has been suggested for humpback whales observed off the mid-

Atlantic states of the U.S. (Swingle et al. 1993). There is also acoustic and molecular evidence that a proportion of the eastern North Atlantic adult population may not make complete migrations, although the reasons for this are currently unknown (Brown et al. 1995; Charif et al. 2001; Palsbøll et al. 1995). The maturational status of the individuals sighted within the Firth of Forth in 2017 and 2018 is not known.

This sudden seasonal occurrence of humpback whales in the Firth of Forth follows a slow increase in sightings over the past two decades and is possibly driven by wider population recovery. The North Atlantic humpback whale population as a whole is known to be slowly increasing, but recent abundance data for the eastern North Atlantic are lacking with the most recent assessment using data from 2001 (Øien, 2009). Nevertheless, humpback whale sightings are increasing annually around Scotland (Ron Macdonald 2018, pers. comm.) and in the North Sea (Leopold et al. 2018). It is possible that their sudden appearance in the Firth of Forth could be related to an increase in population size, with their appearance representing a re-occurrence in areas utilised prior to whaling such as has been seen in other regions (e.g. Pallin et al. 2018; Rossi-Santos et al. 2008).

Alternatively, the sudden appearance of humpback whales in the Firth of Forth could be driven by changes in prey distribution or abundance, as has been observed in the Norwegian Sea (Nøttestad et al. 2015). In any case, a better understanding of fish community composition and dynamics along the east coast of Scotland, and in particular for the Firth of Forth, alongside a modern assessment of humpback whale stocks in the eastern North Atlantic may help to elucidate the true drivers of their sudden appearance in the Firth of Forth.

The confirmed return of an individual whale ('Sonny'), recorded in both 2017 and 2018, suggests that its presence in the Firth of Forth is intentional. That 'Sonny' was sighted regularly over a two-month period in 2017 and a one-month period in 2018 suggests that the Firth of Forth offers a suitable habitat for foraging or recovery, either as a migratory stopover or as an alternative destination for whales not making a full migration. In order to better understand why the whales remain in the area for prolonged periods, the collection of behavioural data should be a priority in future years. It is plausible that other individuals may have returned to the Firth of Forth during the two-year study period but as the majority of images submitted to the Forth Marine Mammal Project were of low quality, this was unascertainable. It is only due to identified individuals having such distinctive markings that they qualified to be used in this study. Should humpback whales continue to visit the Firth of Forth in future years, high quality identification images will be needed to clarify an exact number of individuals and better understand their wider migration habits.

Citizen science can be a very useful tool for information gathering, as evidenced by this record. Going forwards, the training of observers in the use of a standardised effort-based methodology for landwatches is recommended. This would provide robust year-round data, enabling reliable monitoring of temporal patterns in humpback whale presence within this area. This, together with formalised observations on humpback whale behaviour, the assessment of fish community composition and updated information on eastern North Atlantic humpback whale stocks, may provide clearer evidence for their purpose of visiting the Firth of Forth.

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Authors' contributions

All authors contributed equally in the preparation of this manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

All images used during the current study are freely accessible on the Forth Marine Mammal Project Facebook page - <https://www.facebook.com/groups/377706222613082/>

Ethics approval and consent to participate

Not applicable.

Consent for publication

Consent for use of images contained in this manuscript has been obtained and copies of consent forms are available upon request.

Competing interests

The authors declare that they have no competing interests.

Author details

¹Independent Researcher, Edinburgh, UK. ²Independent Researcher, Durham, UK. ³Department of Biosciences, Durham University, Durham, UK.

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