

Short Note

Synchronous Swimming and Diving Behaviour in a Group of Fin Whales (*Balaenoptera physalus*)

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The fin whale (*Balaenoptera physalus*) is a Balaenopterid (rorquals) currently listed as “Vulnerable” under the International Union for Conservation of Nature’s (IUCN) *Red List* (Cooke, 2018); however, there is a knowledge gap concerning the behavioural repertoire of this species—for instance, their collective navigation, feeding aggregations, socialisation, and resting (Mann, 1999; Würsig et al., 2017). Lack of this type of information can be problematic as species-specific behaviour and individual behavioural repertoires are important indicators for identifying welfare and conservation priorities (Whitehead, 1999; Nowacek et al., 2016; Atwood, 2017; Clegg & Butterworth, 2017). To build a comprehensive fin whale ethogram, an in-depth description of specific behaviours is essential for understanding behaviour functions and orienting future studies (Burghardt, 1985; Collin & Bekoff, 1999; Bates & Byrne, 2007). In this regard, on 13 July 2021, a focal study approach was used to document a large fin whale group synchronously swimming and diving in the Gulf of St. Lawrence (Québec, Canada).

Observations of fin whale groups have been reported around the world and in the Gulf of St. Lawrence (Edds & Macfarlane, 1987; Kingsley & Reeves, 1998; Herr et al., 2022). For instance, Delarue et al. (2009) reported groups of fin whales in the St. Lawrence ranging from two to 18 individuals (mean of 2.5 ± 2.0); and through photo-identification and biopsy analysis, they evidenced a male-biased sex ratio in larger groups. The associated behaviours included agonistic interactions and female–male positions within groups with females being leaders. Subsequent analysis (Ramp et al., 2016) suggested that fin whales might form groups to target large schools of fast prey.

To our knowledge, travelling behaviours of fin whale groups have been described in two studies (Bacon et al., 2011; Aniceto et al., 2016). Aniceto et al. (2016) analyzed group size, swimming direction, and orientation changes of fin whales found in the Bay of Biscay where high maritime traffic occurs, especially fast ferries that connect France, England, and Spain. Their results showed that groups of fin whales (≥ 3 and ≤ 6) were less responsive to fast ferries than individuals or pairs who systematically changed directions when ferries approached. Bacon et al. (2011) focused on behavioural state (travel, social, surface travel), group size (one whale was considered a group), heading, and inter-individual distancing of fin whales observed during aerial survey transects in summer and fall off the Southern California Bight. Most fin whales were travelling when observed (87%) and had a mean group size of two whales (1.7 ± 0.2) and a mean distance of $16 (\pm 8.7)$ body lengths between individuals; however, groups of more than two fin whales were observed touching (distance less than one body length) during the fall but not in the summer. Interestingly, in both studies, dyads travelled differently from larger groups (≥ 3 fin whales): dyads changed direction more when a ferry approached as compared to groups who were less responsive (Aniceto et al., 2016), and the observed distance between two fin whales (dyads) was always greater than one body length compared to groups of more than three fin whales observed touching (Bacon et al., 2011). These behavioural differences could underline different social functions and mechanisms, highlighting the need to further study fin whales travelling in groups. Herein, we describe the large group of fin whales observed swimming and diving synchronously in the Gulf

of St. Lawrence in the summer of 2021 and discuss potential underlying behavioural functions and mechanisms.

Location, Methods, and Environmental Context

In the North Atlantic, the global fin whale stock is estimated to be around 50,000 individuals distributed across four breeding populations observed in seven feeding (management) areas (Víkingsson et al., 2009; Desportes, 2019). As part of ongoing research on the health and welfare of fin whales found in the Eastern feeding population of the Gulf of St. Lawrence, boat-based, focal animal studies have been conducted in the Sept-Iles area from June to October since 2017. Behavioural data were collected on individuals ($n = 71$), dyads ($n = 7$), trios ($n = 5$), and two groups of five fin whales. The behavioural state of the trios and groups of five were categorized as socialising since they exhibited fission-fusion characteristics, stayed in the same area, and were not observed swimming

in a straight-line direction. However, on 13 July 2021, at 1103 h, we observed a different behaviour in a large group. We observed multiple tall spouts south of Research Area 1, so we headed in their direction and stopped where we estimated the fin whales would surface to breathe (see observation location in Figure 1). Approximately 20 s after the boat engine was turned off, the group of fin whales ($n \approx 13$) surfaced close to the research vessel, leaving no time to collect the usual video/photos; therefore, an iPhone 11 was used to capture the event, with two observers logging notes in a journal. The first respiratory event lasted 1 min and 41 s (see supplementary video on the *Aquatic Mammals* website), after which the group was observed diving for 7 min and 32 s. No other whales were observed in the area (visually or acoustically [hearing any spouts]). The subsequent surfacing of the group was ≈ 1.5 nmi farther east. By the time our boat arrived close enough to document the behaviour, the group was diving. We turned off the engine and waited for the group to come up for the next breathing sequence.

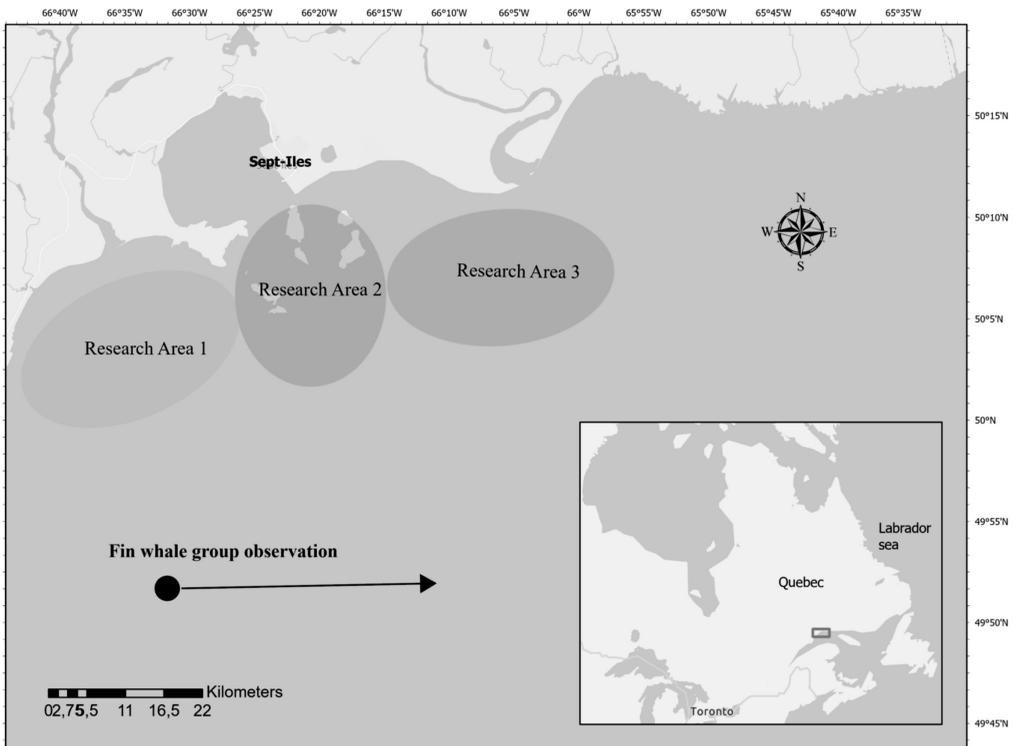


Figure 1. Map of typical research areas (1, 2, and 3) monitored by our research team near Sept-Iles, Québec, Canada. The black dot and line, farther from shore, represent the location and direction of the fin whale (*Balaenoptera physalus*) group observed swimming and diving synchronously.

Again, no other fin whales were observed in the area (visually or acoustically). After 6 min and 49 s, the group resurfaced once again ≈ 1.5 nmi farther east, so it was decided not to attempt additional boat approaches in case the rapid swimming of the group was in reaction to our approach. For this third breathing sequence, we observed the spouts for 2 min and 7 s before the animals engaged in a diving sequence, again in synchrony. After 7 min and 21 s with no other observation of fin whales in the area (visually or acoustically), the group resurfaced at a distance farther east. We decided to leave the area since maritime conditions were changing rapidly.

The approximate number of fin whales in the group was determined by visual analysis of the supplementary video, which was segmented with *Adobe Premier*, Version 2018. None of the whales were positively identified since we could only observe their left side (Agler et al., 1993), but since we did not observe any other whales in the area, we categorized this observation as one group. Respiratory metrics (total number of respiratory events and synchronized respiratory bouts) were determined via a spectrogram analysis of the supplementary video's audio track. We used *Raven*

Pro, Version 1.6 software, which can slow down the audio for fine-scale respiratory metric analysis.

Swimming Behaviour

The fin whale group ($n \approx 13$ individuals) moved in a coordinated way in proximity to each other (less than one body length) in a straight-line route, with body motion, respiratory events, and diving events synchronized between some group members, seemingly as a social unit. First observation duration was 1 min 41 s (see supplemental video), and total duration of observation (from afar after the video recording) was 27 min 34 s. The group included three individuals surfacing to breathe first as “leaders” (see Observations 1, 3, and 6 in Table 1), positioned in parallel within one body length of each other. The rest of the group was close behind the first three, also in parallel with a maximum width of six individuals (Figure 2a). When the fin whales initiated their dive, it was impossible to confirm which animal(s) led the others (Table 1). In the last 10 s of the event, eight whales dove in synchrony at approximately the same location as the first three divers: three at

Table 1. Description of key behaviours from the fin whale (*Balaenoptera physalus*) group navigation event (2021) analysis (see supplementary video; duration: 1 m 41 s). Timestamps are associated with specific observations.

Observation	Timestamp of observed behaviour (h:min:s)	Descriptions
1	00:00:04	Camera turns to the left; three fin whales are at the head of the group and are navigating east with coordinated body motion and respiratory events. No more than one body length between the individuals.
2	00:00:05	Camera pans to the right where the rest of the group is navigating in the same direction heading east ($n \approx 10$) and also with coordinated body motion and respiratory events. No more than one body length between individuals.
3	00:00:18-20	Camera pans back to the left; three fin whales surface at the head of the group.
4	00:00:22	Camera pans right, and 11 fin whales can be observed.
5	00:00:27	Camera stays right, and the last fin whale of the group is observed and not synchronized with any other whale.
6	00:00:30	Camera pans back to the left; three fin whales surface at the head of the group.
7	00:00:32-00:01:22	Camera pans back and forth; the group is navigating in a direct course east with coordinated body motion and respiratory events. No more than one body length between individuals.
8	00:01:23-00:01:25	Camera pans left, and one individual initiates the diving sequence with two others diving almost simultaneously but not in parallel.
9	00:01:24-00:01:30	At the same time as the first three individuals initiate a diving sequence, other fin whales are observed in the same area; the camera pans right so total number of diving behaviours cannot be confirmed.
10	00:01:31-00:01:41	The rest of the group, comprised of eight fin whales, dive with synchronous motions and respiratory events.

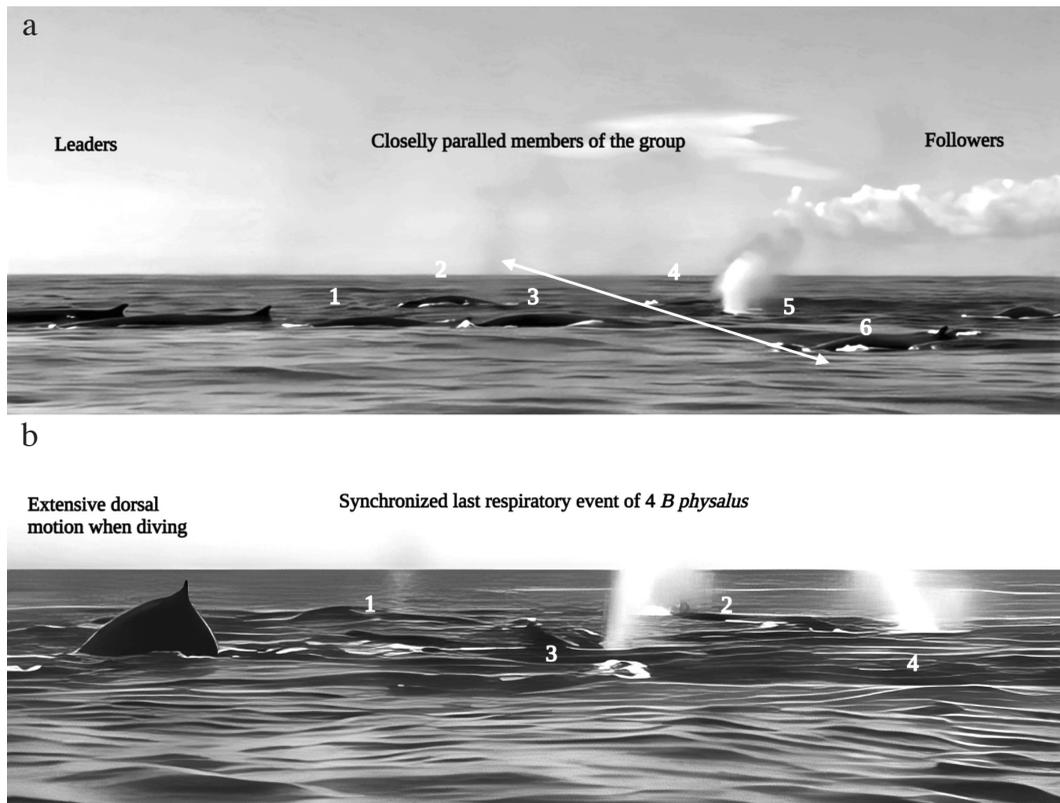


Figure 2. Fin whale group swimming synchronously: (a) composition of the group with leaders, six individuals navigating behind in a parallel manner, and followers; and (b) extensive dorsal motion before diving and last respirations synchronized in four group members before the diving sequence.

timestamp 00:01:31-34, three at 00:01:36-37, and two at 00:01:39-41 (Figure 2b). All individuals appeared to be adults or subadults.

Respiratory Behaviour

In total, 67 individual respiratory events were recorded. Validated respiratory metrics for travelling fin whales have been established at 7.00 ± 3.58 (mean and SD) respiratory events per breathing sequence (Keen & Qualls, 2018), which is consistent with the number of individuals estimated visually (67 respiratory events/13 individuals \approx 5 respiratory events per whale). The total breathing sequence was delimited into six *group respiratory events* with no individuals breathing for 3 s ($n = 4$) or 7 s ($n = 1$), showing synchronized breathing bouts at the group level (see Figure 3a & b and supplementary video).

This observation of synchronized locomotor and potentially associated respiratory behaviour in a large group of fin whales might suggest collective navigation, which is defined as “travelling

within a social context” (Berdahl et al., 2018, p. 2). Though it is possible that the animals were behaving in a coordinated manner for other reasons (e.g., mating competition), collective animal navigation has been extensively studied, both theoretically and empirically, across different taxa such as birds (Bergman & Donner, 1964; Rabol & Noer, 1973; Nesterova et al., 2014), fish (Ward et al., 2011; Shaw et al., 2014; Irisson et al., 2015), land mammals (Ramseyer et al., 2009; Torney et al., 2018), and marine mammals (Lusseau & Conradt, 2009; Lewis et al., 2011; Brent, 2015).

Animals engaging in navigational behaviours, either for short- or long-distance travel, use a wide range of environmental cues, sensory abilities, and neural processing to determine distance and direction. Nonetheless, some imprecisions in orientation and sensory processing will naturally occur at the individual level, suggesting that the function of collective navigation is an adaptive behavioural response to these challenges (Guttal & Couzin, 2011; Bode et al., 2015; Berdahl et al.,

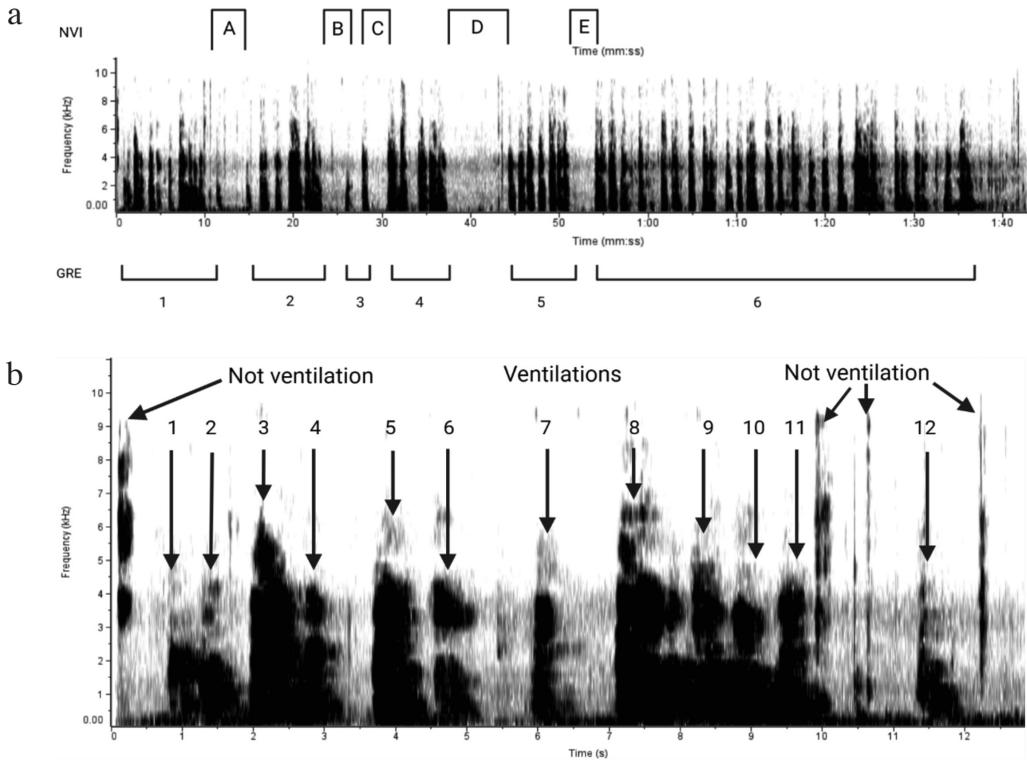


Figure 3. (a) Total group breathing sequence spectrogram showing visually synchronized respiratory bouts (Group Respiratory Events GRE 1-6) and no ventilation intervals (NVI A-E): duration of GRE 1 was 12 s and included 12 respirations from 12 individuals. An interval of 3 s with no ventilation was observed (NVI A) before the subsequent bouts: GRE 2 = 8 s/9 respirations, NVI B = 3 s, GRE 3 = 2.5 s/2 respirations, NVI C = 3 s, GRE 4 = 6.3 s/5 respirations, NVI D = 7 s, GRE 5 = 7 s/7 respirations, NVI E = 3 s, and last, GRE 6 = 42 s/32 respirations; and (b) detailed analysis of GRE 1 showing each ventilation compared to nonventilation visual spectrogram lines.

2018). In this regard, the fin whale group observed synchronously swimming and diving in the Gulf of St. Lawrence could be related to enhancing navigational accuracy and efficiency that might orient the group towards higher prey density areas as suggested by Ramp et al. (2016).

The function of collective navigation is supported by a range of underlying mechanisms with multiple studies suggesting that copying the direction and movements of close neighbours is an effective strategy (Elgar, 1989; Codling & Bode, 2014, 2016; Irsson et al., 2015). However, Codling & Bode (2014) showed that the benefits of such a copycat mechanism would decrease when more than seven individuals are positioned adjacently. This could explain the composition of the fin whale group we observed, where a maximum of six individuals were identified moving in parallel (Figure 2a). To be an efficient navigational strategy, copying neighbours implies that each group member will favour relying on

local cues (e.g., movement of others) in addition to personal knowledge of a route (Berdahl et al., 2018), which is also suggested in our observation of fin whales positioned in parallel within one body length of each other. In this species, the white asymmetrical colouration found on the right-side jaw might help enhance visual cues for copying the movement(s) of neighbouring whales as Caro et al. (2011) suggested for cetaceans in general. Finally, one of the most important characteristics of a copycat dynamic is the high level of synchronization between group members (i.e., maintaining cohesion), which we observed between these fin whales—not only in body motion but also in respirations (Figures 2b & 3; Nagy et al., 2018; Henry et al., 2021). In conclusion, further studies of fin whale movements in groups are needed to assess the possibility of collective navigation, as well as to fully understand how group cohesion and copycat mechanisms during navigation might lower

the sensory processing of other environmental cues like ships, which could have a detrimental impact on the welfare and conservation of this endangered species.

Note: A supplemental video for this short note is available in the “Supplemental Material” section of the Aquatic Mammals website: https://www.aquaticmammalsjournal.org/index.php?option=com_content&view=article&id=10&Itemid=147.

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