Received: 9 February 2023 | Accepted: 10 April 2023

DOI: 10.1111/mms.13025

NOTE

Marine Mammal Science

# Observations of southern right whales (*Eubalaena australis*) surface feeding on krill in austral winter at South Georgia

Susannah V. Calderan[1] | Tracey Dornan[2] | Sophie Fielding[2] | Ryan Irvine[3] | Jennifer A. Jackson[2] | Russell Leaper[4] | Cecilia M. Liszka[2] | Paula A. Olson[5] | Martin A. Collins[2]

[1]Scottish Association for Marine Science (SAMS), Argyll, Scotland, UK

[2]British Antarctic Survey, NERC, High Cross, Cambridge, UK

[3]Ryan Irvine Ecology, Churchtown House, St Buryan, Cornwall, UK

[4]International Fund for Animal Welfare, London, UK

[5]Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, La Jolla, California

**Correspondence**
Susannah Calderan, Scottish Association for Marine Science (SAMS), Argyll, Scotland, PA37 1QA, UK.
Email: susannah.calderan@sams.ac.uk

**Funding information**
Darwin Plus Grant, Grant/Award Number: DPLUS149; Friends of South Georgia Island; South Georgia Heritage Trust

Southern right whales (*Eubalaena australis*) occur in the waters around the sub-Antarctic island of South Georgia, where they use the area to feed during the austral summer months (Jackson et al., 2020; Kennedy et al., 2020; Moore et al., 1999; Richardson et al., 2012). Although Antarctic krill (*Euphausia superba*) is known to be an important part of their diet, there have been few descriptions of southern right whale foraging behavior or prey (Argüelles et al., 2016; Hamner et al., 1988; Hoffmeyer et al., 2010; Jackson et al., 2020; Reid et al., 2000; Seyboth et al., 2016; Valenzuela et al., 2018). Southern right whales in the South Atlantic are generally found at lower latitudes over the austral winter on calving grounds, including off Brazil and Argentina (Crespo et al., 2019; Groch et al., 2005). However, here we document observations of southern right whales feeding at South Georgia during austral winter, in July 2022. Whales were observed surface feeding on krill just after sunset on three occasions and, based on these observations, on a fourth occasion at sunset, observers judged that the whales were about to start feeding.

Observations were made from the M/V *Pharos SG* as part of ecosystem research into the South Georgia winter krill fishery (Winter Krill Project; https://www.bas.ac.uk/project/winter-krill-at-south-georgia). Line transect surveys were conducted off the north coast of South Georgia during the austral winter of 2022, with research activities including predator observations, active acoustics, and both scheduled and opportunistic plankton trawls.

Active acoustics surveys were conducted using a Simrad EK80 split-beam echosounder with 38 and 120 kHz transducers hull-mounted at a depth of ~4.3 m. The system was calibrated in Stromness Bay (54°9.60′S, 36°41.90′W) on July 19, 2022, using standard sphere (38.1 mm WC) techniques (Demer et al., 2015). The settings obtained are provided in Table S1. The acoustic data were processed in Echoview (version 13.0.378), and data were calibrated with in situ temperature, salinity, and speed of sound derived from conductivity, temperature, and depth (CTD) measurements. Time-varied gain background noise was removed (De Robertis & Higginbottom, 2007), and intermittent noise was removed and replaced with a 7 × 7 average $S_v$ (Wang et al., 2016). A surface exclusion of 7 m was applied to account for the transducer depth (4.3 m) and nonlinearity in the echo response in the 120 kHz transducer nearfield (2.7 m). Krill swarms were identified using the SHAPES algorithm (Coetzee, 2000), applied to clean 120 kHz acoustic data filtered using a 3 × 3 dilation (Macaulay et al., 2019). The algorithm detected swarms with a minimum length of 15 m and height of 3 m. Adjacent swarms were joined together if they were horizontally <15 m and vertically <5 m apart. The same parameter settings as used during a 2019 large-scale survey for krill (Krafft et al., 2021) were applied. Analysis was focused on swarms with acoustic signatures consistent with Antarctic krill (*Euphausia superba*), and net hauls targeted at some of these swarms confirmed that the catch was almost entirely Antarctic krill. However, when referring to swarms which were not targeted, we refer to "krill" as opposed to "Antarctic krill" as we cannot rule out that other euphausiids or zooplankton were present, although these swarms were nonetheless consistent with those we did target.

Following swarm detection, certain properties were exported, including mean swarm depth (m), mean swarm height (m), swarm thickness (m), swarm cross-sectional area (m$^2$), and swarm length (m). The packing concentration of each swarm was then calculated ($N_v$, individuals/m$^3$) following Tarling et al. (2009) according to the following equation:

$$N_v = 10\frac{S_v - TS}{10}$$

where $S_v$ is the mean volume backscatter of the swarm in dB re 1 m$^2$ and $TS$ is the mean target strength of the individual krill obtained from length-frequency data from the sampling area, and calculated using the simplified stochastic distorted-wave Born approximation (SDWBA) model (Conti & Demer, 2006; Demer & Conti, 2003; McGehee et al., 1998).

A description of the southern right whale feeding events observed were as follows, with further details in Table 1 and Figure 1. Due to low light levels and distance from sightings it was not possible to determine the age class of the whales observed, nor were photographs of ID-quality taken (although there were five ID photos taken of other southern right whales during the survey as a whole, which will be compared to other catalogs). No feces were observed during the feeding events (although this could easily have been missed), nor was there an opportunity to record any vocalizations.

**TABLE 1** Southern right whale surface feeding events at South Georgia, July 2022.

| Date | Sighting time UTC | Sighting time local | Local time sunset | Local nautical twilight | Position | Water depth (m) |
|---|---|---|---|---|---|---|
| July 11, 2022 | 18:55 | 16:55 | 15:57 | 17:31 | 54°08.59′S 36°13.72′W | 267 |
| July 12, 2022 | 18:32 | 16:32 | 15:59 | 17:32 | 54°11.93′S 36°14.28′W | 181 |
| July 16, 2022 | 18:15 | 16:15 | 16:04 | 17:37 | 53°44.25′S 37°46.30′W | 95 |
| July 17, 2022 | 18:37 | 16:37 | 16:07 | 17:39 | 54°05.27′S 35°40.94′W | 198 |


FIGURE 1 Sighting on July 12, 2022, showing (a) "banana" posture of foraging whales, (b) pair of whales foraging closely together, (c) and (d) feeding lunges.

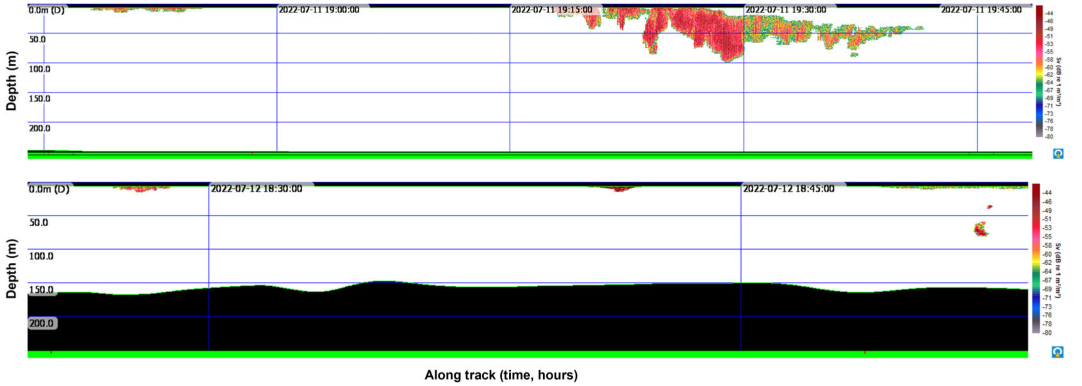


FIGURE 2 Echogram segments from 0 to 250 m depth corresponding to the observed surface feeding events on July 11 (top panel) and July 12 (lower panel). Panels show swarms of krill identified on the 120 kHz echogram following the swarms identification method, with background noise removed, a surface exclusion depth of 7 m (black bar at top of each panel), and a maximum integration depth of 250 m. Units are $S_v$ in dB re 1 $m^{-1}$. The black shaded area at the bottom of the bottom panel represents the seafloor.

Approximately 12 southern right whales were observed in a loose aggregation feeding at the surface just after sunset on July 11, 2022. The whales were seen to be actively lunging, and surface swarms of krill were visible to observers. The acoustic data showed swarms of krill at or near the surface around the time of the encounter (Figure 2, top panel). Immediately prior to the encounter, a thin swarm (~8 m thick) was observed at a mean depth of 9.7 m. During the encounter, a larger swarm was seen with a mean depth of 41.6 m, starting with a thin layer at the surface before deepening to ~100 m at its deepest. It is likely that swarms were closer to the surface than the 7 m surface exclusion applied to the echosounder. Both of these swarms were relatively dense, with packing concentrations of ~100 and ~ 200 individuals/$m^3$, respectively.

A targeted plankton trawl was carried out directly after the sighting using a rectangular mid-water trawl with a 1 $m^2$ mouth opening and a cod end mesh size of 610 μm. The net was towed at 2.5 knots between the surface and 30 m. Catches were sorted and identified to species where possible. Antarctic krill were measured from the anterior of the eye to the posterior of the telson, using standard CCAMLR observer methods (Commission for the Conservation of Antarctic Marine Living Resources, 2011). The trawl almost entirely comprised small Antarctic krill ($n = 25{,}830$, 4,100 g in weight), mostly 25–30 mm in total length (TL) (median = 26 mm; see Figure S1).

In approximately the same location as the previous evening, on July 12, six southern right whales in three subgroups were observed just after sunset. The whales appeared to be feeding at the surface in very close pairs (Video S1). This proximity between pairs together with their "banana" postures (head and tail at the surface; Figure 1a) gave the appearance that one was almost on the other's back (Figure 1b). The whales were moving at an estimated speed of 4–6 knots, with a prominent bow wave and wake, apparently chasing or herding their prey. Their mouths were open, with baleen clearly visible. Some distinct lunges were also observed (Figure 1c,d). Acoustic data showed three dense layers of krill detected during the encounter, with a mean swarm depth of between 8.5 and 9.8 m, and between 71 and 511 m long (Figure 2, bottom panel). Swarms were densely packed, with concentrations ranging from 169 to 1,622 individuals/$m^3$. A plankton trawl was not conducted until approximately an hour and a half after the sighting. This was again almost exclusively Antarctic krill, although in much smaller numbers than on the previous day (median TL = 30 mm).

On July 16, at sunset, earlier than the other sightings described here, two southern right whales were observed spending considerable time at the surface. Active feeding was not seen, but observers judged that they might be about to start, given their behavior and the behavior observed on the previous two occasions. There was no krill visible on the echosounder at the surface, but some dense swarms were detected deeper, at 20–50 m.

Shortly after sunset, on July 17, a single southern right whale was observed feeding at the surface in a similar manner to previous occasions. Some dense krill layers were visible on the echosounder from the surface to around 15 m, with some small, but not dense, swarms at greater depths.

Sightings of both southern right whales and other whale species during the Winter Krill Project surveys and from other projects (e.g., Bamford et al., 2022) demonstrate that South Georgia is an important whale habitat and foraging ground in the austral winter as well as the summer. The southern right whale foraging behaviors observed—rapid and energetic chasing and lunging, sometimes by pairs of animals—suggest a response likely related to the size and mobility of krill. While right whales skim feed on copepods (for example, North Atlantic right whales, *Eubalaena glacialis*, may do so in a slower and more methodical manner; Kraus & Rolland, 2007), the animals observed here were swimming faster and more energetically in order to catch their prey. The observations recorded here are similar to those of Hamner et al. (1988), who observed a single southern right whale west of the Antarctic Peninsula in austral summer feeding on krill "at the surface with its upper jaw lifted above the water, swimming at high speed (estimated at 8–9 knots by the ship's captain) in feeding runs of 15–20 seconds … During these powerful filter-feeding runs enormous amounts of water were displaced, cascading beside and behind the right whale and producing a large wake." Similar feeding behavior was also observed at South Georgia in January 2020 (austral summer), where a single southern right whale was seen surface feeding just after sunset, circling with shallow dives and then surfacing to feed with its mouth open; feces were also observed (P. Olson, personal observation). The pairs of whales observed here also appeared to be in the echelon formations observed in some surface feeding bowhead and southern right whales (Argüelles et al., 2023; Fish et al., 2013; Würsig et al., 1985). It has been hypothesized that this behavior improves feeding efficiency, especially of fast-moving prey, perhaps by allowing the trailing whale to capture prey which has escaped the leading whale, (Würsig et al., 1985), or by the hydrodynamic flow from the leading whale concentrating prey in its wake (Fish et al., 2013).

The other feature of note of the foraging events described here is that they occurred between sunset and nautical twilight, when there was a layer of krill at or near the surface. The surface feeding events were first observed between 30 and 58 min after sunset whereas the whales observed on July 16, 2022, that were judged to be just about to start feeding were observed earlier, 11 min after sunset. Antarctic krill employ a range of behavioral strategies to reduce their risk of predation. While swarming is likely to be the primary antipredation strategy (Tarling et al., 2018), previous acoustic observations suggest that krill swarming inshore at South Georgia also exhibit a degree of diel vertical migration behavior, with swarms occurring at shallower depths at night (Klevjer et al., 2010). The krill swarms in this survey occurred at shallow depths at twilight. As has been observed in other zooplankton in response to predation (Tarling et al., 2002), krill are likely to use antipredation windows (Clark & Levy, 1988), exploiting sufficient light to hunt while reducing their own risk of predation by visually guided predators. We observed whales surfacing feeding at dusk when the need to feed was likely to have driven krill to the surface. We were not able to determine for how long surface feeding continued into the hours of darkness.

Collisions with ships are a significant source of mortality for southern right whales (Schoeman et al., 2020), and surface feeding during periods of poor light or darkness results in whales spending time at the surface where they are vulnerable to ship strikes and unlikely to be seen by approaching vessels (Caruso et al., 2021). These observations add further support for the measures taken by the Government of South Georgia and the South Sandwich Islands to encourage reduced vessel speeds in South Georgia waters in order to reduce ship strike risks.

## ACKNOWLEDGMENTS

We thank the captain and crew of the M/V *Pharos SG* for their enthusiastic support of the ship-based survey work, and the Government of South Georgia & the South Sandwich Islands for logistical support. We thank the British Antarctic Survey team at the King Edward Point research station on South Georgia, in particular Kate Owen and Meghan Goggins, for their hard work and dedication in enabling the collection of these data. Thank you to Amy Kennedy for comments which greatly improved this manuscript, and to Jim Carretta and two further reviewers for reviewing this manuscript.

## AUTHOR CONTRIBUTIONS

**Susannah Calderan:** Conceptualization; formal analysis; investigation; methodology; writing – original draft; writing – review and editing. **Tracey Dornan:** Formal analysis; methodology; writing – original draft; writing – review and editing. **Sophie Fielding:** Conceptualization; formal analysis; methodology; writing – original draft; writing – review and editing. **Ryan Irvine:** Investigation; writing – review and editing. **Jennifer Jackson:** Conceptualization; funding acquisition; project administration; writing – review and editing. **Russell Leaper:** Conceptualization; formal analysis; investigation; methodology; writing – original draft; writing – review and editing. **Cecilia Liszka:** Formal analysis; methodology; project administration; writing – original draft; writing – review and editing. **Paula Olson:** Conceptualization; formal analysis; investigation; methodology; writing – original draft; writing – review and editing. **Martin Collins:** Conceptualization; formal analysis; funding acquisition; investigation; methodology; project administration; writing – original draft; writing – review and editing.

## FUNDING STATEMENT

This work was supported with funding from the Darwin Plus grant DPLUS149., South Georgia Heritage Trust, and Friends of South Georgia Island.

## ORCID

*Susannah V. Calderan* https://orcid.org/0000-0002-5838-5041
*Tracey Dornan* https://orcid.org/0000-0001-8265-286X
*Sophie Fielding* https://orcid.org/0000-0002-3152-4742
*Jennifer A. Jackson* https://orcid.org/0000-0003-4158-1924
*Russell Leaper* https://orcid.org/0000-0002-8712-8925
*Cecilia M. Liszka* https://orcid.org/0000-0003-1309-4045
*Paula A. Olson* https://orcid.org/0000-0002-4447-8730
*Martin A. Collins* https://orcid.org/0000-0001-7132-8650

## REFERENCE


Argüelles, M., Fazio, A., Fiorito, C., Pérez-Martínez, D., Coscarella, M., & Bertellotti, M. (2016). Diving behavior of southern right whales (*Eubalaena australis*) in a maritime traffic area in Patagonia, Argentina. *Aquatic Mammals*, *42*(1), 104–108. https://doi.org/10.1578/AM.42.1.2016.104

Argüelles, M., Fiorito, C., Coscarella, M., Fazio, A., & Bertellotti, M. (2023). Short note: First observations of cooperative circle feeding in southern right whales (*Eubalaena australis*). *Aquatic Mammals*, *49*(1), 1–6. https://doi.org/10.1578/AM.49.1.2023.1

Bamford, C. C. G., Jackson, J. A., Kennedy, A. K., Trathan, P. N., Staniland, I. J., Andriolo, A., Bedriñana-Romano, L., Carroll, E. L., Martin, S., & Zerbini, A. N. (2022). Humpback whale (*Megaptera novaeangliae*) distribution and movements in the vicinity of South Georgia and the South Sandwich Islands Marine Protected Area. *Deep Sea Research Part II: Topical Studies in Oceanography*, *198*, Article 105074. https://doi.org/10.1016/j.dsr2.2022.105074

Caruso, F., Hickmott, L., Warren, J. D., Segre, P., Chiang, G., Bahamonde, P., Espanol-Jiminez, S., Li, S., & Bocconcelli, A. (2021). Diel differences in blue whale (*Balaenoptera musculus*) dive behavior increase nighttime risk of ship strikes in northern Chilean Patagonia. *Integrative Zoology*, *16*(4), 594–611. https://doi.org/10.1111/1749-4877.12501

Clark, C. W., & Levy, D. A. (1988). Diel vertical migration by juvenile sockeye salmon and the antipredation window. *The American Naturalist*, *131*(2), 271–290. https://doi.org/10.1086/284789

Coetzee, J. (2000). Use of a shoal analysis and patch estimation system (SHAPES) to characterise sardine schools. *Aquatic Living Resources*, *13*(1), 1–10. https://doi.org/10.1016/S0990-7440(00)00139-X

Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). (2011). *Scientific observers manual (Observation guidelines and reference materials)*. North Hobart, Australia.

Conti, S. G., & Demer, D. A. (2006). Improved parameterization of the SDWBA for estimating krill target strength. *ICES Journal of Marine Science*, *63*(5), 928–935. https://doi.org/10.1016/j.icesjms.2006.02.007

Crespo, E. A., Pedraza, S. N., Dans, S. L., Svendsen, G. M., Degrati, M., & Coscarella, M. A. (2019). The southwestern Atlantic southern right whale, *Eubalaena australis*, population is growing but at a decelerated rate. *Marine Mammal Science*, *35*(1), 93–107. https://doi.org/10.1111/mms.12526

De Robertis, A., & Higginbottom, I. (2007). A post-processing technique to estimate the signal-to-noise ratio and remove echosounder background noise. *ICES Journal of Marine Science*, *64*(6), 1282–1291. https://doi.org/10.1093/icesjms/fsm112

Demer, D. A., Berger, L., Bernasconi, M., Bethke, E., Boswell, K., Chu, D., Domokos, R., Dunford, A., Fassler, S., Gauthier, S., Hufnagle, L., Jech, J., Bouffant, N., Lebourges-Dhaussy, A., Lurton, X., Macaulay, G., Perrot, Y., Ryan, T., Parker-Stetter, S., … Williamson, N. (2015). *Calibration of acoustic instruments* (ICES Cooperative Research Report No. 326). International Council for the Exploration of the Sea.

Demer, D. A., & Conti, S. G. (2003). Validation of the stochastic distorted-wave Born approximation model with broad bandwidth total target strength measurements of Antarctic krill. *ICES Journal of Marine Science*, *60*(3), 625–635. https://doi.org/10.1016/S1054-3139(03)00063-8

Fish, F. E., Goetz, K. T., Rugh, D. J., & Brattström, L. V. (2013). Hydrodynamic patterns associated with echelon formation swimming by feeding bowhead whales (*Balaena mysticetus*). *Marine Mammal Science*, *29*(4), E498–E507. https://doi.org/10.1111/mms.12004

Groch, K. R., Palazzo, J. T., Jr., Flores, P. A. C., Adler, F. R., & Fabian, M. E. (2005). Recent rapid increases in the right whale (*Eubalaena australis*) population off southern Brazil. *Latin American Journal of Aquatic Mammals*, *4*, 41–47. https://doi.org/10.5597/lajam00068

Hamner, W. H., Stone, G. S., & Obst, B. S. (1988). Behavior of southern right whales, (*Eubalaena australis*), feeding on the Antarctic krill, (*Euphausia superba*). *Fishery Bulletin*, *86*(1), 143–150.

Hoffmeyer, M. S., Lindner, M. S., Carribero, A., Fulco, V. K., Menéndez, M. C., Fernández Severini, M. D., Diodato, S. L., Berasategui, A. A., Biancalana, F., & Berrier, E. (2010). Planktonic food and foraging of *Eubalaena australis*, on Peninsula Valdés (Argentina) nursery ground. *Revista de Biologia Marina y Oceanografia*, *45*, 131–139. https://doi.org/10.4067/S0718-19572010000100013

Jackson, J. A., Kennedy, A., Moore, M., Andriolo, A., Bamford, C. C. G., Calderan, S., Cheeseman, T., Gittins, G., Groch, K., Kelly, N., Leaper, R., Leslie, M. S., Lurcock, S., Miller, B. S., Richardson, J., Rowntree, V., Smith, P., Stepien, E., Stowasser, G., … Carroll, E. L. (2020). Have whales returned to a historical hotspot of industrial whaling? The pattern of southern right whale *Eubalaena australis* recovery at South Georgia. *Endangered Species Research*, *43*, 323–339. https://doi.org/10.3354/esr01072

Kennedy, A. S., Carroll, E. L., Baker, S., Bassoi, M., Buss, D., Collins, M. A., Calderan, S., Ensor, P., Fielding, S., Leaper, R., MacDonald, D., Olson, P., Cheeseman, T., Groch, K., Hall, A., Kelly, N., Miller, B. S., Moore, M., Rowntree, V. J., … Jackson, J. A. (2020). *Whales return to the epicentre of whaling? Preliminary results from the 2020 cetacean survey at South Georgia (Islas Georgias del Sur)*. Report SC/68B/CMP22 presented to the Scientific Committee of the International Whaling Commission.

Klevjer, T. A., Tarling, G. A., & Fielding, S. (2010). Swarm characteristics of Antarctic krill *Euphausia superba* relative to the proximity of land during summer in the Scotia Sea. *Marine Ecology Progress Series*, *40*, 157–170. https://doi.org/10.3354/meps08602

Krafft, B. A., Macaulay, G. J., Skaret, G., Knutsen, T., Bergstad, O. A., Lowther, A., Huse, G., Fielding, S., Trathan, P., Murphy, E., Choi, S.-G., Chung, S., Han, I., Lee, K., Zhao, X., Wang, X., Ying, Y., Yu, X., Demianenko, K., … Hoem, N. (2021). Standing stock of Antarctic krill (*Euphausia superba* Dana, 1850) (Euphausiacea) in the Southwest Atlantic sector of the Southern Ocean, 2018–19. *Journal of Crustacean Biology*, *41*(3), Article ruab071. https://doi.org/10.1093/jcbiol/ruab071

Kraus, S. K., & Rolland, R. R. (2007). *The urban whale: North Atlantic right whales at the crossroads*. Harvard University Press.

Macaulay, G., Skaret, G., Knutsen, T., Bergstad, O. A., Krafft, B. A., Fielding, S., Choi, S., Chung, S., Demianenko, K., & Podhornyi, V. (2019). *Biomass results from the International Synoptic Krill Survey in Area 48, 2019* [Meeting report]. CCAMLR SG-ASAM-2019/08 Rev. 1. Commission for the Conservation of Antarctic Marine Living Resources.

McGehee, D., O'Driscoll, R. L., & Traykovski, L. M. (1998). Effects of orientation on acoustic scattering from Antarctic krill at 120 kHz. *Deep Sea Research Part II: Topical Studies in Oceanography*, *45*(7), 1273–1294. https://doi.org/10.1016/S0967-0645(98)00036-8

Moore, M. J., Berrow, S. D., Jensen, B. A., Carr, P., Sears, R., Rowntree, V., Payne, R., & Hamilton, P. K. (1999). Relative abundance of large whales around South Georgia (1979–1998). *Marine Mammal Science*, *15*(4), 1287–1302. https://doi.org/10.1111/j.1748-7692.1999.tb00891.x

Reid, K., Brierley, A. S., & Nevitt, G. A. (2000). An initial examination of relationships between the distribution of whales and Antarctic krill *Euphausia superba* at South Georgia. *Journal of Cetacean Research and Management*, *2*(2), 143–149.

Richardson, J., Wood, A. G., Neil, A., Nowacek, D., & Moore, M. (2012). Changes in distribution, relative abundance, and species composition of large whales around South Georgia from opportunistic sightings: 1992 to 2011. *Endangered Species Research*, *19*, 149–156. https://doi.org/10.3354/esr00471

Schoeman, R., Patterson-Abrolat, C., & Plön, S. (2020). A global review of vessel collisions with marine animals. *Frontiers in Marine Science*, *7*, Article 292. https://doi.org/10.3389/fmars.2020.00292

Seyboth, E., Groch, K. R., Dalla Rosa, L., Reid, K., Flores, P. A. C., & Secchi, E. R. (2016). Southern right whale (*Eubalaena australis*) reproductive success is influenced by krill (*Euphausia superba*) density and climate. *Scientific Reports*, *6*(1), Article 28205. https://doi.org/10.1038/srep28205

Tarling, G. A., Jarvis, T., Emsley, S. M., & Matthews, J. B. L. (2002). Midnight sinking behaviour in *Calanus finmarchicus*: a response to satiation or krill predation? *Marine Ecology Progress Series*, *240*, 183–194. https://doi.org/10.3354/meps240183

Tarling, G. A., Klevjer, T., Fielding, S., Watkins, J., Atkinson, A., Murphy, E., Korb, R., Whitehouse, M., & Leaper, R. (2009). Variability and predictability of Antarctic krill swarm structure. *Deep Sea Research Part I: Oceanographic Research Papers*, *56*(11), 1994–2012. https://doi.org/10.1016/j.dsr.2009.07.004

Tarling, G. A., Thorpe, S. E., Fielding, S., Klevjer, T., Ryabov, A., & Somerfield, P. J. (2018). Varying depth and swarm dimensions of open-ocean Antarctic krill *Euphausia superba* Dana, 1850 (Euphausiacea) over diel cycles. *Journal of Crustacean Biology*, *38*(6), 716–727. https://doi.org/10.1093/jcbiol/ruy040

Valenzuela, L. O., Rowntree, V. J., Sironi, M., & Seger, J. (2018). Stable isotopes ($\delta^{15}N$, $\delta^{13}C$, $\delta^{34}S$) in skin reveal diverse food sources used by southern right whales *Eubalaena australis*. *Marine Ecology Progress Series*, *603*, 243–255. https://doi.org/10.3354/meps12722

Wang, X., Zhang, J., & Zhao, X. (2016). A post-processing method to remove interference noise from acoustic data collected from Antarctic fishing vessels. *CCAMLR Science*, *23*, 17–30.

Würsig, B., Dorsey, E. M., Fraker, M. A., Payne, R. S., & Richardson, W. J. (1985). Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: A description. *Fishery Bulletin*, *83*, 357–377.

## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**How to cite this article:** Calderan, S. V., Dornan, T., Fielding, S., Irvine, R., Jackson, J. A., Leaper, R., Liszka, C. M., Olson, P. A., & Collins, M. A. (2023). Observations of southern right whales (*Eubalaena australis*) surface feeding on krill in austral winter at South Georgia. *Marine Mammal Science*, *39*(4), 1306–1312. https://doi.org/10.1111/mms.13025