



Notes

MARINE MAMMAL SCIENCE, 24(1): 202–206 (January 2008)
© 2007 by the Society for Marine Mammalogy
DOI: 10.1111/j.1748-7692.2007.00151.x

Observations of strand-feeding behavior by bottlenose dolphins (*Tursiops truncatus*) in Bull Creek, South Carolina

ERIN E. DUFFY-ECHEVARRIA

Freudenthal & Elkowitz Consulting Group, Inc.,
1757-24 Veterans Memorial Highway,
Islandia, New York 11749, U.S.A.
E-mail: seaturtle1979@hotmail.com

RICHARD C. CONNOR

University of Massachusetts Dartmouth,
285 Old Westport Road,
North Dartmouth, Massachusetts 02747, U.S.A.

DAVID J. ST. AUBIN

(Deceased)

Bottlenose dolphins (*Tursiops truncatus*) are highly adaptable animals capable of exploiting a variety of environments by employing site-specific feeding behaviors (Connor *et al.* 2000). In a behavior called “strand-feeding,” which has been reported in South Carolina and Georgia, bottlenose dolphins surge out of the water in unison onto mud banks to feed on small fish stranded by the dolphins’ surge wave (Fig. 1) (Hoese 1971, Rigley *et al.* 1981, Petricig 1995).

Bull Creek, South Carolina, is a *Spartina* marsh system in the Calibogue Estuary that is well known for the frequency of strand-feeding events (Petricig 1995). Strand-feeding is an apparently cooperative feeding behavior, studied intensively by Petricig (1995), who found that strand-feeding occurs year-round, both day and night, and within 3 h of low tide when mud banks are exposed.

Petricig (1995) identified five distinct phases of strand-feeding: (1) location and approach, (2) setup, (3) charge, (4) landing, and (5) exit. Dolphins patrol the tidal channels in search of fish during the location and approach phase. On locating fish, the dolphins “setup” by facing the shore and assuming a side-by-side orientation. The dolphins simultaneously swim toward and onto the shore during the charge phase, and are stranded and feeding on the shore during the landing phase. Finally, the dolphins move back into the water during the exit phase.



Figure 1. Five dolphins in the “landing” phase of strand-feeding in Bull Creek. Note that the charging dolphins have stranded the fish on shore. Photograph by Erin Duffy (2002).

The dolphins typically strand-feed simultaneously; however, there is some variability regarding individual behavior after the dolphins have initially stranded. Occasionally, a dolphin acting independently of the group may immediately restrand, returning to the shore to feed on fish missed during the first strand-feeding attempt (Petricig 1995). In addition, not all dolphins in a strand-feeding group participate in every event. Some dolphins may remain offshore and others (*i.e.*, calves) may strand without feeding (Petricig 1995).

The apparent importance of group participation in strand-feeding raises interesting questions about individual participation and benefits. Stander (1992) found that lionesses tend to occupy specific positions within hunting groups and that position fidelity correlates with hunting success. Similarly, Gazda *et al.* (2005) reported position fidelity in group-feeding bottlenose dolphins in Cedar Key, Florida. In both the lions and the dolphins, position fidelity was often associated with distinctive behavioral tactics (*e.g.*, “wing” *vs.* “center” position in the lions, “driver” *vs.* “barrier” position in the dolphins).

Similarly, distinctive tactics are not obvious during strand-feeding; nonetheless, position fidelity might be favored if (1) it improves group coordination resulting in more fish stranding, (2) it improves feeding efficiency for individuals, or (3) specific positions yield more rewards. The latter would be indicative of a dominance hierarchy. Treating each strand-feeding event as an independent data point, we determined

strand-feeding group size, whether individual dolphins were found in particular positions exclusively, and made a preliminary assessment of whether dolphins showed a preference for the use of inside or outside positions during strand-feeding events.

Boat-based observations of strand-feeding were conducted in Bull Creek from June through August of 2002. One crew member drove the boat, one photographed dorsal fins, one recorded video, and one recorded written data. Information recorded included the date, time, number of dolphins in the group, the number to strand-feed, and the photo slides that corresponded to all observations. Photographs of dorsal fins and stranding position were taken before, during, and after strand-feeding events.

The number of strand-feeding dolphins that set up and executed each strand-feeding event was determined using digital video footage. When determining the number of dolphins participating in a strand-feeding event, video proved a more reliable method than field counts. Video analysis revealed that strand-feeding dolphins occasionally left the shore quickly and were not included in the initial observer counts. If the number of dolphins on the shore could not be determined accurately with video, that particular event was excluded from analysis. We also compared the size of the group just prior to strand-feeding and during strand-feeding to determine whether all of the dolphins in a group participated in the event.

Strand-feeding events were reviewed frame by frame to determine dolphin identity and strand-feeding position. Individual strand-feeding position was indicated numerically, with the numbers ascending as feeding position moved from left to right. Slides of strand-feeding events were also examined to determine if any dorsal fins and corresponding stranding positions could be identified. Slides were cross-referenced with video and field notes to ensure accuracy.

Two criteria had to be met for analysis of strand-feeding position: (1) a positive dolphin identification and (2) known strand-feeding position within the group. To calculate the number of times a dolphin was *expected* to strand in a given position, each strand-feeding position was assigned an equal probability regarding whether a dolphin would strand in that position (*e.g.*, each position for a group of three would have a weight of one-third). The expected probabilities for each inside position were added to determine a total probability that an individual would occupy any inside position. Similarly, the probabilities for being in an outside position were added to determine the total probability that a dolphin would occupy an outside strand-feeding position (*e.g.*, two-thirds in a group of three). The probabilities for each event were added to yield the expected frequency of strandings in inside and outside positions for each individual.

Strand-feeding was observed and videotaped 123 times during the season. In 86 of the 123 observations (70%), the entire group executed a strand-feeding event; in the remainder ($n = 37$) some individuals stayed offshore. Twenty-five of the 123 events were excluded from further analysis because the exact number of stranded dolphins could not be determined.

The mean group size of strand-feeding dolphins was 3.6 (SD = 0.28; $n = 95$) dolphins (Fig. 2). When including solitary strand-feeding events, the mean group size was 3.5 (SD = 0.37, $n = 98$). During his 5-yr investigation, Petricig (1995)

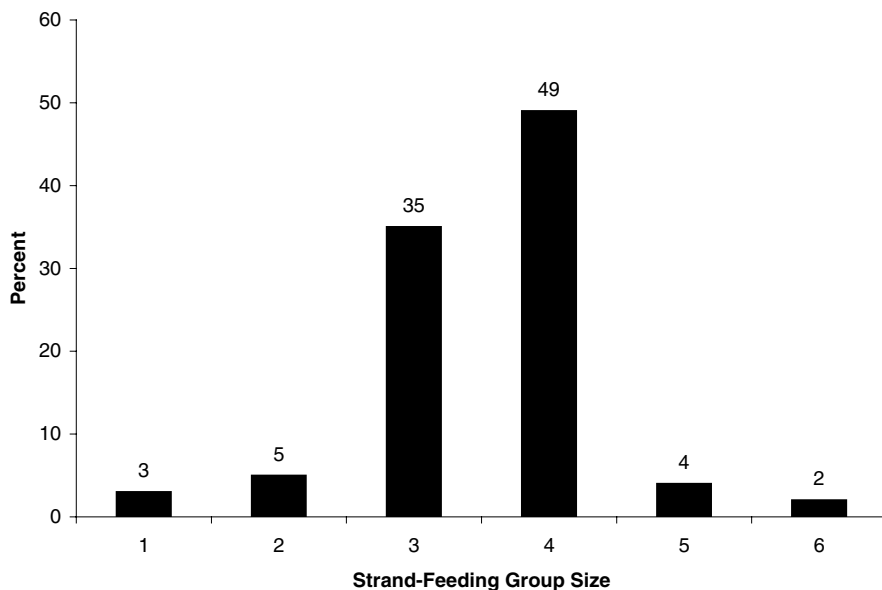


Figure 2. The frequency distribution of strand-feeding group size. The numbers over the bars represent the frequency with which each group size was observed ($n = 98$).

found the mean group size, including solitary strand-feeders, to be 3.6 dolphins per strand-feeding event. Such a consistent result over disparate time periods suggests that a study of optimal strand-feeding group size would be productive.

Forty-five dolphins were identified photographically during the field season. Of the 45 dolphins identified, 27 were observed strand-feeding. Four of the 27 dolphins observed strand-feeding were identified within strand-feeding groups at least five times. None of these dolphins exclusively used any one strand-feeding position within a group. Furthermore, neither of the two dolphins observed in at least 12 strand-feeding events exhibited a preference for either inside or outside strand-feeding positions (Dolphin 1, $n = 13$, $\chi^2 = 1.0637$, $P = 0.3$; Dolphin 2, $n = 12$, $\chi^2 = 1.384$, $P = 0.3$).

We found that the entire foraging group stranded in only 70% of cases. Petricig (1995) observed that young calves would remain offshore, whereas their mother and the group moved onto the shore to feed. There were a number of very young calves observed during the study season; however, they were not associated with any groups of strand-feeding dolphins. In only one instance did we have a juvenile in a strand-foraging group; this individual participated in strand-feeding. Hence, in our observations, the dolphins remaining offshore were not calves that were too young to strand-feed, but adults remaining offshore for other reasons.

We found that individual dolphins do not exclusively occupy particular strand-feeding positions. In a limited sample, we found no evidence for position preference. Petricig (1995) had also suggested that individuals do not occupy preferred strand-

feeding positions, based on his observation that calves stranded in multiple positions. This may relate to the lack of clearly differentiated roles in strand-feeding compared to the “barrier-wall” feeding described by Gazda *et al.* (2005). However, this conclusion is obviously tentative and a larger sample on more individuals might reveal preferences for interior or exterior stranding positions.

In summary, we (1) used video analysis to confirm Petricig’s (1995) estimate of stranding group size (3.5), (2) found that some adults do not strand (in 30% of groups), and (3) established that adults do not exclusively occupy particular stranding positions (inside or outside).

ACKNOWLEDGMENTS

This research was made possible by Mystic Aquarium and the Worthington Family Foundation and was carried out under the General Authorization for Scientific Research, file number 569-1631-01, issued to Richard C. Connor by the National Marine Fisheries Service. A special thank-you is necessary for the late Dr. David J. St. Aubin from Mystic Aquarium. Before his passing, he was an integral part of this research project. His experience, input, and continual support were an essential part of the success of the field season. We would like to thank the Palmetto Bluff Company based in Bluffton, South Carolina, for providing the research team with wonderful living quarters and dock space for the field season. Finally, thank you to James and Elizabeth Duffy, Luis Echevarria, Jr., Katie Durham, Carolyn Margolin, and Barbara Pitera.

LITERATURE CITED

- CONNOR, R. C., R. S. WELLS, J. MANN AND A. J. READ. 2000. The bottlenose dolphin: Social relationships in a fission-fusion society. Pages 97–126 in J. Mann, R. C. Connor, P. L. Tyack and H. Whitehead, eds. *Cetacean societies: Field studies of bottlenose dolphins and whales*. University of Chicago Books, Chicago, IL.
- GAZDA, S. K., R. C. CONNOR, R. K. EDGAR AND F. COX. 2005. A division of labour with role specialization in group-hunting bottlenose dolphins (*Tursiops truncatus*) off Cedar Key, Florida. *Proceedings of the Royal Society B: Biological Sciences*. 272:135–140.
- HOESE, H. D. 1971. Dolphin feeding out of water in a salt marsh. *Journal of Mammalogy* 52:223–224.
- PETRICIG, R. O. 1995. Bottlenose dolphins (*Tursiops truncatus*) in Bull Creek, South Carolina. Ph.D. dissertation, University of Rhode Island, Kingston, RI. 298 pp.
- RIGLEY, L., V. G. VANDYKE, P. CRAM AND I. RIGLEY. 1981. Shallow water behavior of the Atlantic bottlenose dolphin (*Tursiops truncatus*). *Proceedings of the Pennsylvania Academy of Science* 55:157–159.
- STANDER, P. E. 1992. Cooperative hunting in lions: The role of the individual. *Behavioral Ecology and Sociobiology* 29:445–454.

Received: 13 June 2006

Accepted: 18 May 2007