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Short Note

Comparison of Short-Term Satellite Telemetry and Long-Term Photographic-Identification for Assessing Ranging Patterns of Individual Common Bottlenose Dolphins (*Tursiops truncatus*) in the Waters Around Charleston, South Carolina, USA

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In the southeastern United States (SEUS), common bottlenose dolphins (*Tursiops truncatus*) occur in a complex mosaic of bay, sound, and estuary (BSE) and coastal stocks in which there can be a high degree of stock overlap and boundaries that can be particularly difficult to differentiate on both spatial and temporal scales (Hayes et al., 2020). Along the Atlantic coast of the U.S., there are two migratory coastal stocks that have extended seasonal movements from New York to North Carolina (Northern Migratory Coastal Stock) and North Carolina to Florida (Southern Migratory Coastal Stock), and three additional coastal stocks (South Carolina-Georgia, Northern Florida, and Central Florida) that have more limited ranges. There are also 11 BSE stocks extending from North Carolina to Florida in which animals display long-term (multi-season and year) site fidelity to a localized geographic region.

Telemetry of individual marine mammals has provided valuable input into population-level decisions on stock boundaries and ranging patterns (reviewed in Hart & Hyrenbach, 2009). Over the past 40 years, telemetry has become an increasingly effective tool to track individual movements and provide insights into SEUS bottlenose dolphin stock structure and geographic range (e.g., Irvine et al., 1982; Read et al., 1996; Balmer et al., 2008, 2014a). Initially, radio transmitters were the primary method for electronically tracking dolphins; but as technology advanced and the size of transmitters decreased, satellite telemetry greatly exceeded the capabilities of its predecessor, providing several months of location data without the requirements of intensive, on-water monitoring associated with radio telemetry (Cooke et al., 2004; Balmer et al., 2014b).

During capture-release health assessments along the Atlantic coast, radio and/or satellite tags have been attached to dolphins from several study areas. In Charleston, South Carolina (1999, 2003, 2005; n = 37) and Brunswick/Sapelo, Georgia (2009; n = 28), radio-tagged dolphins were intensively tracked for several months to determine individual ranging patterns and to refine study area sizes to more closely match appropriate stock boundaries (Speakman et al., 2006; Balmer et al., 2013). Radio telemetry data from these studies also identified habitat use of BSE and coastal stocks, which provided insight into parameters, such as the geographic extent of fine-scale movements, that could be used to differentiate stocks with overlapping ranges. Satellite tags deployed during stock assessments along the coast of New Jersey (2002, 2003; n = 8) and North Carolina (2004; n = 4) provided some of the first, fine-scale ranging pattern data to better understand seasonal movements of the Northern and Southern Migratory Coastal Stocks, respectively (Hayes et al., 2020). Similarly, satellite telemetry data (2015; n = 19) from a health assessment in Brunswick provided insight into ranging patterns of dolphins hypothesized to be members of the South Carolina-Georgia Coastal and Southern Georgia Estuarine System Stocks (Balmer et al., 2018). The data collected from this study were also used to evaluate risk of morbillivirus exposure between overlapping BSE and coastal stocks.

In addition to health assessments, dolphin rescues (e.g., entanglements and out-of-habitat scenarios) provide another opportunity for electronic tag deployments. Telemetry data collected from these interventions have been valuable for evaluating individual health post-release and potential population-level stressors (Wells et al., 2013). For example, during 2017, a dolphin along the southern Georgia coast was disentangled from baling twine that was cutting through its dorsal fin (Balmer et al., 2019). Prior to release, a blubber sample was collected for measuring contaminants, and a satellite tag was attached. The subsequent analyses identified extremely high levels of contaminants attributed to a Superfund Site, ~30 km south of where the animal was disentangled. The telemetry data in conjunction with long-term photographic-identification (photo-ID) data provided insights into the geographic scope of site-specific contamination in relation to the animal's movements.

Since 1994, the dolphins in the waters surrounding Charleston have been intensively studied. Initial efforts utilized photo-ID to classify site fidelity, estimate abundance, and determine survival rates for the Charleston Estuarine System Stock (stock area defined in Hayes et al., 2020; see also Zolman, 2002; Speakman et al., 2010). Health assessments in which a subset of animals were radio- or satellite-tagged were conducted in 1999, 2003, 2004, and 2005, with the primary goal of identifying and comparing the individual- and population-level health of Charleston dolphins to dolphins in the Indian River Lagoon, Florida (Reif et al., 2008). An additional health assessment was conducted in 2013 to continue to collect long-term health data on Charleston dolphins. During this project, three dolphins also received satellite tags to provide further insight into fine-scale ranging patterns. The goals of this short note are to report these satellite telemetry data and compare the short-term ranging patterns of the satellite-tagged individuals to their respective long-term photo-ID sighting histories in the Charleston study area (Figure 1).

During August 2013, three adult male bottlenose dolphins (Dolphin IDs 854, 8F4, and 886) were tagged with location-only satellite transmitters (SPOT 299-A; Wildlife Computers, Redmond, WA, USA) (Table 1; Figure 1). The single-pin design of these tags has been refined over the past 10+ y to maximize transmission duration while minimizing impacts to the tagged individual (Balmer et al., 2014a). Tags were attached to the lower third of the dorsal fin and followed attachment protocols detailed in Balmer et al. (2014a). The projected battery life for SPOT 299-A satellite transmitters was 280 d (250 transmissions per day), and tags were programmed to transmit for eight 1-h transmission-window blocks per day to further extend battery life. All three tags were also coated with Propspeed (Oceanmax, Ltd., Auckland, NZ) to reduce biogrowth.

Kernel density estimates (KDEs) were used as a quantitative methodology to determine 95 and 50% utilization distributions (UDs) from the high-quality (Location Class [LC] 3, 2, and 1) satellite location data (Worton, 1989). To calculate UDs in the Charleston study area, which is a complex salt marsh ecosystem, a KDE method for an environment with barriers to movement in "Geostatistical Analyst and Spatial Analyst Tools" (*ArcGIS*, Version 10.4.1; ESRI, Redlands, CA, USA) was used. The selection of bandwidth (or the smoothing parameter) is important because KDE distributions can be over- or underestimated depending on the value that is used (Horne & Garton, 2006). The methodology for bandwidth selection is dependent on the goals of the project, ranging patterns of the target species, and amount of data available for spatial analyses (Rayment et al., 2009). A rule-based ad hoc method (Kie, 2013) was used to determine the appropriate bandwidth. In addition to the satellite telemetry data, all three tagged individuals had extensive sighting histories in the Charleston study area's long-term photo-ID catalog (1994 to 2019; T. Speakman, pers. comm., 1 January 2021). UDs were calculated using the long-term photo-ID sighting histories and then were compared to each individual's respective satellite telemetry UD.

The three tags in this study had a mean transmission duration of 19 d (range: 5 to 28 d). Dolphin 854's satellite tag transmitted for 24 d, provided 144 high-quality locations, and its UDs were 5 km^2 (50% UD) and 24 km^2 (95% UD) (Table 1). The general ranging pattern for Dolphin 854, based upon satellite telemetry, was primarily in the estuarine waters west of Folly and Morris Islands, extending from Stono Inlet to the coastal waters of Lighthouse Inlet (Figure 1). Dolphin 854's photo-ID sighting history included 92 sightings, covering 17 y from 1997 to 2013; its UDs were 2 km^2 (50% UD) and 12 km^2 (95% UD). The general ranging pattern for Dolphin 854, based upon photo-ID, was primarily at the entrance to Charleston Harbor and the estuarine waters west of Morris Island, but also extended as far south as Stono Inlet. Dolphin 8F4's satellite tag transmitted for 28 d, provided 236 high-quality locations, and its UDs were 6 km^2 (50% UD) and 30 km^2 (95% UD) (Table 1). The general ranging pattern for Dolphin 8F4, based upon satellite telemetry, was primarily in the estuarine waters west of Folly Island, including Stono Inlet (Figure 1). Dolphin 8F4's photo-ID sighting history included

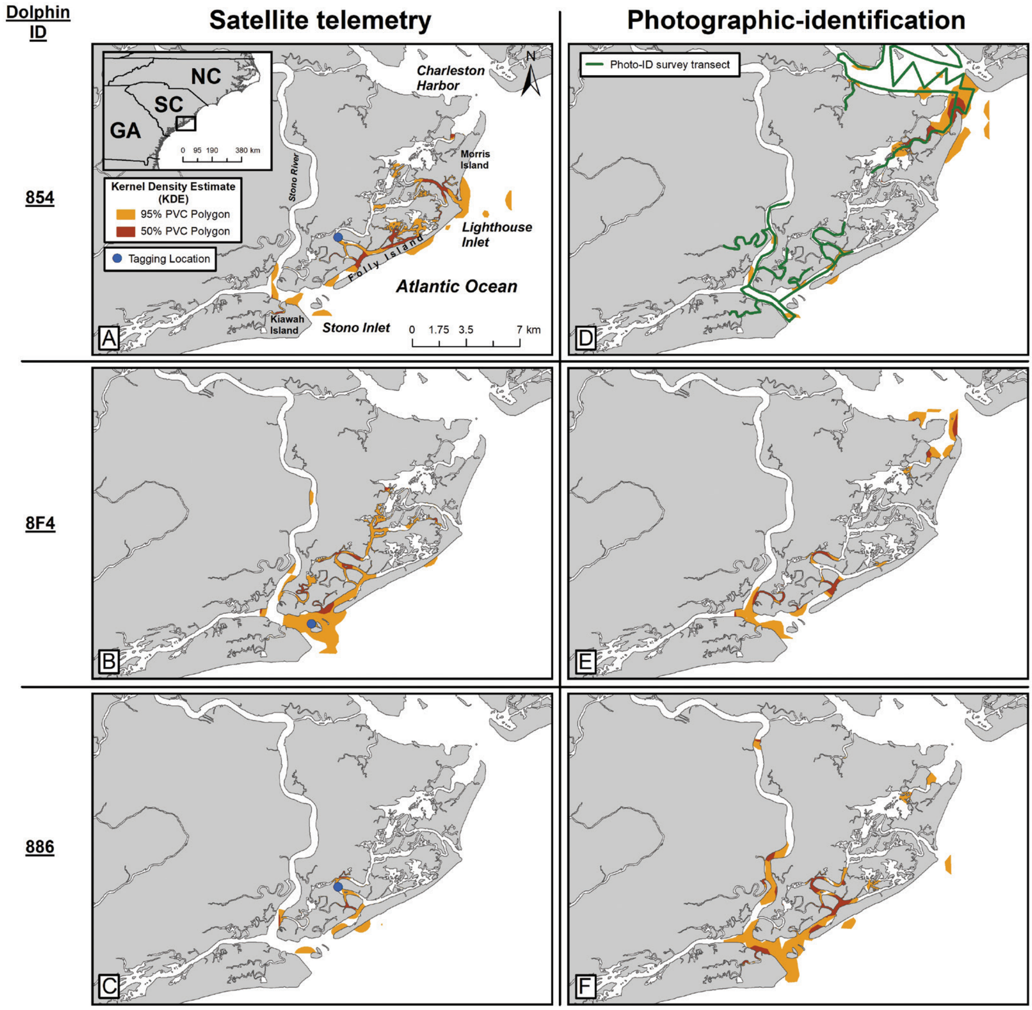

Figure 1. Common bottlenose dolphin (*Tursiops truncatus*) satellite-tagging locations and utilization distributions (50 and 95% UDs) for Dolphins 854 (A – satellite telemetry; D – photographic-identification [photo-ID]), 8F4 (B – satellite telemetry; E – photo-ID), and 886 (C – satellite telemetry; F – photo-ID). The area depicted is within the boundaries of the Charleston Estuarine System Stock as defined in Hayes et al. (2020).

66 sightings, covering 16 y from 2003 to 2019; its UDs were 2 km^2 (50% UD) and 8 km^2 (95% UD). The general ranging pattern for Dolphin 8F4, based upon photo-ID, was primarily in the estuarine waters west of Folly Island, including Stono Inlet, and extending into the entrance to Charleston Harbor and the estuarine waters west of Morris Island. Dolphin 886's satellite tag transmitted for 5 d, provided 31 high-quality locations, and its UDs were 1 km^2 (50% UD) and 8 km^2 (95% UD) (Table 1). The general ranging pattern for Dolphin 886, based upon satellite telemetry, was primarily in the estuarine waters west of Folly Island and Stono Inlet (Figure 1). Dolphin 886's photo-ID sighting history included 92 sightings, covering 17 y from 1995 to 2013; its UDs were 3 km^2 (50% UD) and 15 km^2 (95% UD). The general ranging pattern for Dolphin 886, based upon photo-ID, was primarily in the estuarine waters west of Folly Island, including Stono Inlet, and extending farther into the Stono River.

Short-term satellite telemetry and long-term photo-ID data identified that the three tagged dolphins had localized (95% UD: $\leq$ 30 km^2) ranging patterns and high (sighted across multiple seasons and years) site fidelity to the Charleston study

Table 1. Satellite telemetry and photographic-identification (photo-ID) data for each satellite-tagged common bottlenose dolphin (*Tursiops truncatus*). Satellite telemetry data include deployment and last transmission dates, number (#) of days transmitting, number (#) of quality locations (Location Class [LC] 3, 2, and 1), and 50 and 95% utilization distributions (UDs). Photo-ID data include initial and last sighting dates, number (#) of sightings, and 50 and 95% UDs.

			Satellite telemetry						Photo-ID				
Dolphin ID	Sex	Age	Deployment date (d/mo/y)	Last transmission date (d/mo/y)	# of days transmitting	# of quality locations (LC 3, 2, 1)	50% UD (km^2)	95% UD (km^2)	Initial sighting date (d/mo/y)	Last sighting date (d/mo/y)	# of sightings	50% UD (km^2)	95% UD (km^2)
854	M	25	28/8/13	20/9/13	24	144	5	24	9/4/97	28/8/13	92	2	12
8F4	M	16	23/8/13	20/9/13	28	236	6	30	22/4/03	2/7/19	66	2	8
886	M	39	23/8/13	28/8/13	5	31	1	8	2/11/95	23/8/13	92	3	15

area suggesting that they are all members of the Charleston Estuarine System Stock. These results complement photo-ID data collected and analyzed from previous survey effort in the Charleston study area (Zolman, 2002; Speakman et al., 2010). Similar limited ranging patterns and long-term site fidelity have been observed for other BSE stocks along the Atlantic coast of the U.S., including the Northern South Carolina Estuarine System Stock (Sloan, 2006), Northern Georgia/Southern South Carolina Estuarine System Stock (Gubbins, 2002), Central and Southern Georgia Estuarine System Stocks (Balmer et al., 2013), Jacksonville Estuarine System Stock (Caldwell, 2001), and Indian River Lagoon Estuarine System Stock (Mazzoil et al., 2008).

Several bottlenose dolphin studies in the SEUS have evaluated how study area size and sampling methodology can greatly influence determining ranging patterns and bias site fidelity classifications. For example, Nekolny et al. (2017) identified that ranging patterns can be significantly underestimated when animals have movements outside a study area's boundaries. Similarly, Balmer et al. (2014b) determined that ranging patterns and site fidelity classifications can vary greatly across different sampling methodologies (photo-ID, radio telemetry, and satellite telemetry). Although a very limited sample size, the three dolphins in this study further confirm that perceived ranging patterns can differ between short-term satellite telemetry and long-term photo-ID data. For example, the 95% UD for Dolphin 854 had minimal spatial overlap between the two sampling methods (Figure 1A & D), and the overall UD size was two times larger for 24 continuous days of satellite telemetry than 92 d of sightings spaced out over 17 y (Table 1). Similarly, although the general ranging patterns for the satellite telemetry and photo-ID had some overlap for Dolphin 8F4 (Figure 1B & E), the 95 and 50% UDs were over three times larger for the satellite telemetry dataset (Table 1). One hypothesis for these observed differences are that the long-term photo-ID sighting histories, which cover 17 and 16 y for both Dolphin 854 and 8F4, respectively, include ranging patterns from when these animals were subadults to adults. In other estuarine dolphin populations throughout the world, ranging patterns have been identified to potentially shift depending on age class (e.g., Hung & Jefferson, 2004; McHugh et al., 2011).

Another hypothesis for the differences in UDs between the two sampling methodologies is that systematic survey effort for the long-term photo-ID data did not include a large amount of the estuarine waters to the west of Lighthouse Inlet and Morris Island as a result of this area being difficult to navigate at low tide (Figure 1D). The satellite telemetry data may have provided additional insight into dolphin habitat use that was not accessible for observations by small vessel-based surveys. In addition to estuarine waters that may not be accessible during certain tides, satellite telemetry data can also be advantageous over small vessel-based surveys in coastal waters that can be more limited as a result of marine conditions. For example, Balmer et al. (2018) used satellite telemetry in addition to photo-ID data to better understand habitat use for dolphins in the estuarine and coastal waters of Georgia. In the current study, satellite tag data from Dolphin 854 identified locations for this animal several kilometers off Lighthouse Inlet which is an area that was not routinely covered during photo-ID surveys. These results suggest that a combined approach of both satellite telemetry and photo-ID methodologies can provide a more comprehensive evaluation of habitat use and ranging patterns for dolphins in this region.

A confounding factor in comparing the short-term satellite telemetry and long-term photo-ID data is that all three individuals were males. In other bottlenose dolphin studies, ranging patterns have significantly differed by sex with males having variable, extended ranges and females having smaller, localized ranging patterns (Owen et al., 2002; Urian et al., 2009; Sprogis et al., 2016). The differences in ranging patterns between the two sampling methodologies may not be as large for females as was observed for the three males in this study in that photo-ID surveys have a greater likelihood of covering all of a female's range. Future studies that compare telemetry and photo-ID data for both males and females may provide further insight into any potential sampling biases across the sexes.

The transmission durations for the tags in this study were much lower than other studies in which similar single-pin satellite tags have been deployed. For example, Wells et al. (2017) and Balmer et al. (2018) deployed satellite tags that transmitted for a mean of 148 d (n = 44; range: 48 to 260 d) and 125 d (n = 19; range: 52 to 181 d), respectively. Unfortunately, due to logistical challenges, follow-up monitoring was not conducted post-tagging to assess why the tags in the current study failed prematurely. In previous tagging efforts, follow-up monitoring has identified that tags primarily fail as a result of battery life cessation, breakage/corrosion of the attachment pin/nut, or damage to the tag antenna (Balmer et al., 2014a). There are also additional variables that influence tag transmission duration such as tag attachment methodology, tag programming, interactions with conspecifics, and other behaviors that may cause tags to be more susceptible to premature failure. Tags were programmed and attached following protocols similar to those detailed in Balmer et al. (2014a). There was also no evidence of electronic and/or battery issues prior to all tags ceasing transmission. During follow-up monitoring in Brunswick, Georgia, Balmer et al. (2018) noted fresh rake marks on the dorsal fin of one satellite-tagged male (Z40) and suggested that Z40's male associate (Z42) may have been interacting with the tag, which, in turn, caused transmissions to prematurely cease, either by damage to the tag's antenna or removal of the tag from the dorsal fin. All three tagged dolphins in this study were adult males with known male associates; thus, one hypothesis for the shorter transmission durations could be a result of interactions with conspecifics.

Another hypothesis for the low transmission durations involves a unique foraging strategy that dolphins inhabiting the salt marsh estuaries of the SEUS perform called strand-feeding. This behavior occurs when a dolphin or group of dolphins temporarily strand on sand or mud banks to capture prey before returning to the water (Petricig, 1995; Fox & Young, 2012), which has also been observed in the coastal ecotype of bottlenose dolphins residing in tropical mangroves from the inner estuary of the Guayaquil Gulf, Ecuador (Jiménez Veintimilla & Alava, 2015). The tagging locations for all three dolphins were in an area known for strand-feeding, and two of the tagged individuals (886 and 8F4) have been observed using this foraging strategy. This behavior may not be conducive for maximizing tag retention as dolphins thrash on their sides against potentially abrasive substrate (i.e., oysters, rocks, etc.) and, in many instances, in close proximity to other dolphins performing the same behavior. The uncertainty as to why these tags failed emphasizes the importance of follow-up monitoring, whenever possible, to continually improve on tag designs with the goals of increasing the data collected while reducing impacts to the tagged individual.

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Literature Cited

Balmer, B. C., Wells, R. S., Howle, L. E., Barleycorn, A. A., McLellan, W. A., Pabst, D. A., Rowles, T. K., Schwacke, L. H., Townsend, F. I., Westgate, A. J., & Zolman, E. S. (2014a). Advances in cetacean telemetry: A review of single-pin transmitter attachment techniques on small cetaceans. *Marine Mammal Science*, *30*(2), 656-673. https://doi.org/10.1111/mms.12072

Balmer, B. C., Wells, R. S., Nowacek, S. M., Nowacek, D. P., Schwacke, L. H., McLellan, W. A., Scharf, F. S., Rowles, T. K., Hansen, L. J., Spradlin, T. R., & Pabst, D. A. (2008). Seasonal abundance and distribution patterns of common bottlenose dolphins (*Tursiops truncatus*) near St. Joseph Bay, Florida, USA. *Journal of Cetacean Research and Management*, *10*(2), 157-167.

Balmer, B. C., Schwacke, L. H., Wells, R. S., Adams, J. D., George, R. C., Lane, S. M., McLellan, W. A., Rosel, P. E., Sparks, K., Speakman, T., Zolman, E. S., & Pabst, D. A. (2013). Comparison of abundance and habitat usage for common bottlenose dolphins between sites exposed to differential anthropogenic stressors within the estuaries of southern Georgia, U.S.A. *Marine Mammal Science*, *29*(2), E114-E135. https://doi.org/10.1111/j.1748-7692.2012.00598.x

Balmer, B. C., Wells, R. S., Schwacke, L. H., Schwacke, J. H., Danielson, B., George, R. C., Lane, S. M., McLellan, W. A., Pabst, D. A., Sparks, K., Speakman, T. R., Townsend, F. I., & Zolman, E. S. (2014b). Integrating multiple techniques to identify stock boundaries of common bottlenose dolphins (*Tursiops truncatus*). *Aquatic Conservation: Marine and Freshwater Ecosystems*, *24*(4), 511-521. https://doi.org/10.1002/aqc.2357

Balmer, B., Zolman, E., Bolton, J., Fauquier, D., Fougeres, E., George, R. C., Goldstein, T., Gowen, M., Kolkmeyer, T., Le-Bert, C., Mase, B., Norton, T., Peterson, J., Rowles, T., Saliki, J., & Ylitalo, G. (2019). Ranging patterns and exposure to cumulative stressors of a *Tursiops truncatus* (common bottlenose dolphin) in Georgia. *Southeastern Naturalist*, *18*(1). https://doi.org/10.1656/058.018.0112

Balmer, B., Zolman, E., Rowles, T., Smith, C., Townsend, F., Fauquier, D., George, C., Goldstein, T., Hansen, L., Quigley, B., McFee, W., Morey, J., Rosel, P., Saliki, J., Speakman, T., & Schwacke, L. (2018). Ranging patterns, spatial overlap, and association with dolphin morbillivirus exposure in common bottlenose dolphins (*Tursiops truncatus*) along the Georgia, U.S.A. coast. *Ecology and Evolution*, *8*(24), 12890-12904. https://doi.org/10.1002/ece3.4727

Caldwell, M. (2001). *Social and genetic structure of bottlenose dolphins (*Tursiops truncatus*) in Jacksonville, Florida* (Master's thesis). University of Miami, Miami, FL.

Cooke, S. J., Hinch, S. G., Wikelski, M., Andrews, R. D., Kuchel, L. J., Wolcott, T. G., & Butler, P. J. (2004). Biotelemetry: A mechanistic approach to ecology. *Trends in Ecology and Evolution*, *19*, 334-343. https://doi.org/10.1016/j.tree.2004.04.003

Fox, A. G., & Young, R. F. (2012). Foraging interactions between wading birds and strand-feeding bottlenose dolphins (*Tursiops truncatus*) in a coastal salt marsh. *Canadian Journal of Zoology*, *90*(6), 744-752. https://doi.org/10.1139/z2012-043

Gubbins, C. (2002). Use of home ranges by resident bottlenose dolphins (*Tursiops truncatus*) in a South Carolina estuary. *Journal of Mammalogy*, *83*(1), 178-187. https://doi.org/10.1644/1545-1542(2002)083<0178:UOHRBR>2.0.CO;2

Hart, K. M., & Hyrenbach, K. D. (2009). Satellite telemetry of marine megavertebrates: The coming of age of an experimental science. *Endangered Species Research*, *10*, 9-20. https://doi.org/10.3354/esr00238

Hayes, S. A., Josephson, E., Maze-Foley, K., & Rosel, P. E. (2020). *U.S. Atlantic and Gulf of Mexico marine mammal stock assessments – 2019* (NOAA Technical Memorandum NMFS-NE-264). National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Horne, J. S., & Garton, E. O. (2006). Likelihood cross-validation versus least squares cross-validation for choosing the smoothing parameter in kernel home-range analysis. *Journal of Wildlife Management*, *70*(3), 641-648. https://doi.org/10.2193/0022-541X(2006)70[641:LCVLSC]2.0.CO;2

Hung, S. K., & Jefferson, T. A. (2004). Ranging patterns of Indo-Pacific humpback dolphins (*Sousa chinensis*) in the Pearl River Estuary, People's Republic of China. *Aquatic Mammals*, *30*(1), 159-174. https://doi.org/10.1578/AM.30.1.2004.159

Irvine, A. B., Wells, R. S., & Scott, M. D. (1982). An evaluation of techniques for tagging small odontocete cetaceans. *Fishery Bulletin*, *80*, 135-143.

Jiménez Veintimilla, P. J., & Alava, J. J. (2015). Strand-feeding by coastal bottlenose dolphins (*Tursiops truncatus*) in the Gulf of Guayaquil, Ecuador. *Latin American Journal of Aquatic Mammals*, *10*, 33-37. https://doi.org/10.5597/lajam00191

Kie, J. G. (2013). A rule-based ad hoc method for selecting a bandwidth in kernel home-range analyses. *Animal Biotelemetry*, *1*(1), Article 13. https://doi.org/10.1186/2050-3385-1-13

Mazzoil, M., Reif, J. S., Youngbluth, M., Murdoch, M. E., Bechdel, S. E., Howells, E., McCulloch, S. D., Hansen,

L. J., & Bossart, G. D. (2008). Home ranges of bottlenose dolphins (*Tursiops truncatus*) in the Indian River Lagoon, Florida: Environmental correlates and implications for management strategies. *EcoHealth*, *5*(3), 278-288. https://doi.org/10.1007/s10393-008-0194-9

McHugh, K. A., Allen, J. B., Barleycorn, A. A., & Wells, R. S. (2011). Natal philopatry, ranging behavior, and habitat selection of juvenile bottlenose dolphins in Sarasota Bay, Florida. *Journal of Mammalogy*, *92*(6), 1298-1313. https://doi.org/10.1644/11-MAMM-A-026.1

Nekolny, S. R., Denny, M., Biedenbach, G., Howells, E. M., Mazzoil, M., Durden, W. N., Moreland, L., Lambert, J. D., & Gibson, Q. A. (2017). Effects of study area size on home range estimates of common bottlenose dolphins *Tursiops truncatus*. *Current Zoology*, *63*(6), 693-701. https://doi.org/10.1093/cz/zox049

Owen, E. C., Wells, R. S., & Hofmann, S. (2002). Ranging and association patterns of paired and unpaired adult male Atlantic bottlenose dolphins, *Tursiops truncatus*, in Sarasota, Florida, provide no evidence for alternative male strategies. *Canadian Journal of Zoology*, *80*(12), 2072-2089. https://doi.org/10.1139/z02-195

Petricig, R. O. (1995). *Bottlenose dolphins (*Tursiops truncatus*) in Bull Creek, South Carolina* (Ph.D. dissertation). Graduate School of Oceanography, University of Rhode Island, Kingston.

Rayment, W., Dawson, S., Slooten, E., Bräger, S., Du Fresne, S., & Webster, T. (2009). Kernel density estimates of alongshore home range of Hector's dolphins at Banks Peninsula, New Zealand. *Marine Mammal Science*, *25*(3), 537-556. https://doi.org/10.1111/j.1748-7692.2008.00271.x

Read, A., Westgate, A., Urian, K., Wells, R., Allen, B., & Carr, W. (1996). *Monitoring movements and health status of bottlenose dolphins in Beaufort, NC using radio telemetry* (NMFS Contract No. 40-GENF-500160). National Marine Fisheries Service.

Reif, J. S., Fair, P. A., Adams, J., Joseph, B., Kilpatrick, D. S., Sanchez, R., Goldstein, J. D., Townsend, F. I., McCulloch, S. D., Mazzoil, M., Zolman, E. S., Hansen, L. J., & Bossart, G. D. (2008). Evaluation and comparison of the health status of Atlantic bottlenose dolphins from the Indian River Lagoon, Florida, and Charleston, South Carolina. *Journal of the American Veterinary Medical Association*, *233*(2), 299-307. https://doi.org/10.2460/javma.233.2.299

Sloan, P. E. (2006). *Residency patterns, seasonality, and habitat use among bottlenose dolphins,* Tursiops truncatus, *in the Cape Romain National Wildlife Refuge, SC* (Master's thesis). University of North Carolina Wilmington, Wilmington.

Speakman, T. R., Lane, S. M., Schwacke, L. H., Fair, P. A., & Zolman, E. S. (2010). Mark-recapture estimates of seasonal abundance and survivorship for bottlenose dolphins (*Tursiops truncatus*) near Charleston, South Carolina, USA. *Journal of Cetacean Research and Management*, *11*(2), 153-162.

Speakman, T., Zolman, E. S., Adams, J., Defran, R. H., Laska, D., Schwacke, L. H., Craigie, J., & Fair, P. A. (2006). *Temporal and spatial aspects of bottlenose dolphin occurrence in coastal and estuarine waters near Charleston, South Carolina* (NOAA Technical Memorandum NOS-NCCOS-37). National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Sprogis, K. R., Raudino, H. C., Rankin, R., MacLeod, C. D., & Bejder, L. (2016). Home range size of adult Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) in a coastal and estuarine system is habitat and sex-specific. *Marine Mammal Science*, *32*(1), 287-308. https://doi.org/10.1111/mms.12260

Urian, K. W., Hofmann, S., Wells, R. S., & Read, A. J. (2009). Fine-scale population structure of bottlenose dolphins (*Tursiops truncatus*) in Tampa Bay, Florida. *Marine Mammal Science*, *25*(3), 619-638. https://doi.org/10.1111/j.1748-7692.2009.00284.x

Wells, R. S., Fauquier, D. A., Gulland, F. M. D., Townsend, F. I., & DiGiovanni, R. A., Jr. (2013). Evaluating post-intervention survival of free-ranging odontocete cetaceans. *Marine Mammal Science*, *29*(4), E463-E483. https://doi.org/10.1111/mms.12007

Wells, R. S., Schwacke, L. H., Rowles, T. K., Balmer, B. C., Zolman, E., Speakman, T., Townsend, F. I., Tumlin, M. C., Barleycorn, A., & Wilkinson, K. A. (2017). Ranging patterns of common bottlenose dolphins (*Tursiops truncatus*) in Barataria Bay, Louisiana, following the Deepwater Horizon oil spill. *Endangered Species Research*, *33*, 159-180. https://doi.org/10.3354/esr00732

Worton, B. J. (1989). Kernel methods for estimating the utilization distribution in home-range studies. *Ecology*, *70*(1), 164-168. https://doi.org/10.2307/1938423

Zolman, E. S. (2002). Residence patterns of bottlenose dolphins (*Tursiops truncatus*) in the Stono River Estuary, Charleston County, South Carolina, U.S.A. *Marine Mammal Science*, *18*(4), 879-892. https://doi.org/10.1111/j.1748-7692.2002.tb01079.x