21st Biennial Conference on the Biology of Marine Mammals
13-18 DECEMBER 2015
HILTON SAN FRANCISCO UNION SQUARE
SAN FRANCISCO, CA USA

Downscaling foraging activity: the impact of Argos-based sampling schemes on movement behavior identification in whale tracking data

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The Argos system remains the primary tool for long-term tracking of large whales. State-space models (SSM) are routinely implemented on whale tracking data to identify simple behavioral modes related to "transiting" and "area-restricted searching" (ARS; i.e., presumed foraging) movement activities, although the validity of these modes remains unverified. The Advanced Dive Behavior (ADB) tag is a new intermediate-duration archival tag capable of collecting high-resolution (1-Hz) dive data along with GPS-quality locations for periods of up to several weeks. ADB tags also transmit location data to the Argos system, providing an opportunity to validate behavioral modes identified by SSMs with the dive data. Here we analyze data from four ADB tags attached to blue whales (Balaenoptera musculus) in Southern California, USA, in August 2014. Tag duration ranged from 18.3 to 20.0 d and tags transmitted an average of 17.3 Argos locations/d (range = 2-26). SSM-derived tracks from the Argos data were generated at 1, 2, 3, and 4 locations/d, and the estimated behavioral modes for these locations were compared with the number of foraging lunges per dive summed over the corresponding periods (24, 12, 8, and 6 h). Transiting and ARS behavioral modes estimated from SSMs generally captured the observed levels of foraging activity at all output resolutions, indicating that the 1-location/d resolution typically generated from Argos tracks is adequate for the characterization of persistent foraging activity over large scales. However, we caution that these estimates were highly sensitive to the number and class accuracy of the input locations, and that low-intensity/brief foraging activity was only captured by the higher resolutions. Finally, we note that "behavioral state," a continuous variable used by SSMs to derive the discrete transiting and ARS modes, also compared favorably with the observed levels of foraging activity, making it a potentially useful quantitative response variable in modeling studies.