Quantifying the Dive Behavior of Coastal Sharks

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INTRODUCTION
How can the diving behavior of coastal sharks be quantified?

• High-resolution data-loggers (ADLs) provide depth, temperature, and acceleration data at sub-second sampling intervals.
• Depth is usually sampled once per second, which provides much higher dive profile resolution than has been used in most previous shark studies.
• ADLs can identify individual dives where prior technologies could only transmit data summaries and descriptive.
• This creates new opportunities for understanding shark behavior, but also poses new challenges for quantifying high-resolution dive profiles.

The Effect of Resolution: One Shark, Five Sampling Rates

METHODS

Dive Behavior in Other Species

Sea Turtles

Fig. 2. Dive types and depth trace for sea turtles (Minamikawa et al. 1997, reviewed by Houghton et al. 2002). Dives were typed by surfacing events and distinct profiles.

Whale Sharks

Fig. 3. Whale shark dive types (Gleiss, et al. 2010). Dives lasted at least 30 minutes and profiles were very distinct.

Numerical Classification

Fig. 4. Examples of the four dive types and two behaviors found in the blacktip dive traces. Each segment of the depth trace was identifiable as one type, although there were occasions when multiple seemed appropriate.

Visual Classification

Fig. 5. The process of numerical classification through wavelet analysis and K-means clustering. A) Spectrogram identifying recurrent amplitudes and frequencies in a depth trace. B) K-means clustering criteria derived from a synthetic wave consisting of visually identifiable stretches of each dive type and behavior. C) Division of depth trace into different clusters. D) Percentage of time represented by each cluster.

RESULTS

Fig. 7. Visual and numerical identification was completed for 11 sharks (226 hours). Each 15 minute period was labeled as one dominant dive type or cluster. The percent occurrence shown for (A) dive type and (B) K-means clusters.

CONCLUSIONS

• Blacktip sharks exhibit six main types of dive profile based on visual analysis.
• Results of K-means clustering show incomplete overlap with visual classification.
• Neither classification produced a consistent change in diving behavior over time.
• We recommend the use of numerical classification because it is a more objective measure and roughly ten times faster than visual classification (3.28 min/hr analyzed compared to 0.36).

LITERATURE CITED


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