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OCURRENCE OF TIGER SHARK (*GALEOCERDO CUVIER*) SCAVENGING ON AVIAN PREY AND ITS POSSIBLE CONNECTION TO LARGE-SCALE BIRD DIE-OFFS IN THE FLORIDA KEYS

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ABSTRACT: *The tiger shark, Galeocerdo cuvier, is the largest predatory fish in tropical waters. Due to its wide-ranging movements, diverse diet and perceived potential threat to humans, the feeding behavior of this species has received significant attention in the scientific literature for over 40 years. Such studies have identified various prey items and feeding strategies for tiger sharks worldwide, and new insights into the life-history (i.e. movement, diet, reproduction) of this currently threatened predator are useful in conservation and management initiatives. Here we describe observations of tiger shark scavenging on a terrestrial avian species off the Florida Keys and its potential connection to several large-scale bird die-offs within the region.*

Key Words: bird, movement, diet, elasmobranch, conservation

THE tiger shark (*Galeocerdo cuvier*) is a large semi-coastal/oceanic species, which populates temperate and tropical waters (Compagno, 2005). Due to its wide-ranging diet, the tiger shark has long been regarded as a generalist predator in various ecosystems (e.g., Springer, 1960; DeCrosta et al., 1984; Lowe et al.; 1996). Studies assessing the dietary breadth of tiger sharks have identified several prey items, with the most commonly consumed being teleost fishes, marine reptiles, marine mammals, and sea birds (Heithaus, 2001; Simpfendorfer et al., 2001; Meyer et al., 2010). Additionally, the discovery of foreign, non-digestible items inside tiger shark stomachs has further supported this predator's reputation as an opportunistic forager/scavenger (Linaweaver and Backus, 1969; Lowe, 1996). While there is a wealth of studies describing tiger shark life history characteristics such as diet, the most descriptive accounts of such have been conducted in the Indian and the Pacific Oceans

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(e.g., Simpfendorfer et al., 1992; Heithaus, 2001; Heithaus et al., 2002; Papastamatiou et al., 2006).

Here we describe a rare observation involving a tiger shark scavenging on a terrestrial species of avian prey in the Atlantic Ocean. We combine movement data collected from the satellite-tagged tiger shark to examine the scavenging event in relation to various large-scale bird die-offs in the Florida Keys.

MATERIALS AND METHODS—As part of a larger study on the abundance and life histories of large coastal sharks in the subtropical Atlantic, we initiated a satellite tagging study of tiger sharks off the Florida Keys (USA). Sharks were captured using baited drumlines as described by Hammerschlag et al. (2011). Drumlines were deployed for 1 h before being checked for shark presence. On November 13, 2010, we captured a 255 cm (TL = total length) female tiger shark in US federal waters, off the reef edge in the middle Florida Keys (N 24.69, W 80.85). While gathering tissue samples and taking measurements, the shark regurgitated a large collection of partially digested primary and secondary contour feathers held together by shorn ligaments and digestive juices (Figure 1A). The regurgitated specimen was immediately frozen and brought back to the laboratory for later identification. Prior to release, the shark's dorsal fin was affixed with a SPOT5 satellite tag to provide high-resolution information on its migratory behavior, providing geolocation data each time tag breaks the surface. Over the next two weeks, the tiger shark moved approximately 200 km in a northerly direction, displacing a tight affinity for the southeast coastline of Florida (Figure 2).

The avian specimen was photographed and sent to various specialists and bird experts. Tom Webber, Bird Collection Manager of the Florida Museum of Natural History, positively identified the specimen as the left wing from an American Coot (*Fulica americana*; Tom Webber, pers comm; Figure 1B). In addition to positive photographic identification, the physical specimen was similarly identified as a coot by a staff of veterinarians specializing in avian rehabilitation from the Miami Museum of Science (S. Montgomery and G. Mealey, pers comm.).

DISCUSSION—Birds have previously been documented as a prey item of tiger sharks in the Pacific (e.g., Papastamatiou et al., 2006; Whitney et al., 2007). For example, off Hawaii, tiger sharks instinctively forage on juvenile fledging albatross at the French Frigate Shoals (e.g., Lowe et al., 1996). Our observation, although just one event, is relatively rare and provides additional evidence for tiger shark and bird predator-prey interactions in the Atlantic Ocean. To our knowledge, there have been only four previous scientific reports describing avian remains in the stomachs of tiger sharks in the Atlantic Ocean, this being the second documented occurrence of a terrestrial avian prey eaten by a tiger shark (Gudger, 1949; Saunders and Clarke, 1962; Dodrill and Gilmore, 1978; Carlson et al., 2002). All previous reports have discovered feathers and bones from terrestrial and other marine birds through stomach dissection. In this study, the tiger shark regurgitated an American Coot, a freshwater swimming rallid that is found in temperate wetlands and marsh systems across the Southeastern North America (Brisbin et al., 2002). The regurgitation and non-digested status of this prey item may signify recent consumption due to the early stages of physical and chemical digestion.

Three days prior to our observation reported here, forty large birds were discovered floating dead, moribund, or stressed in the waters of Biscayne Bay, Florida (N 25.59, W 80.26, marked "X" in Figure 2). The mass of birds



FIG. 1. (A) Largely undigested remnants of a left wing of an American Coot, regurgitated from our 255 cm tiger shark. (B) American coot wing from the Bird Collection of the Florida Museum of Natural History (photo: Tom Webber).

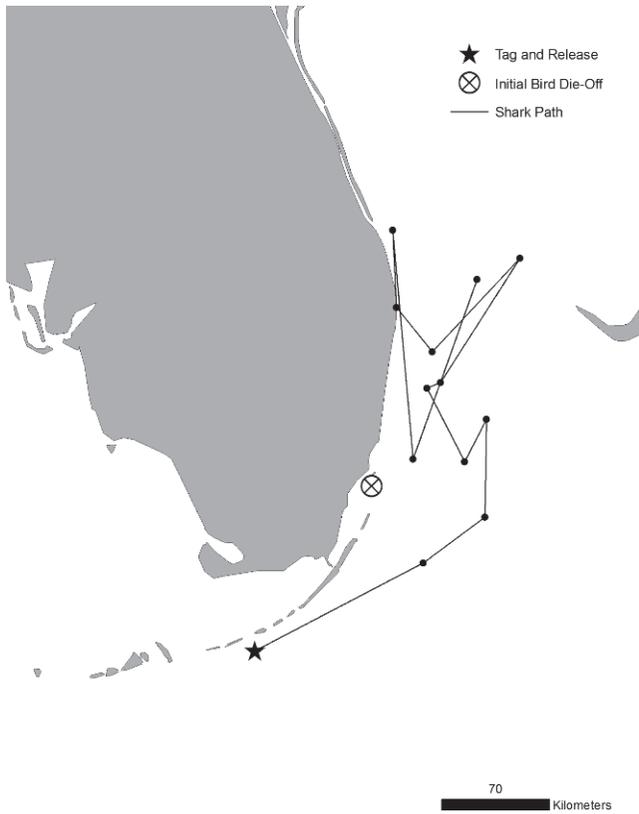


FIG. 2. Two-week movement path from our satellite tagged shark starting on November 13, 2010 (marked with star). Location of initial bird die-off also noted.

included turkey vultures (*Carthartes aura*), hawks (*Buteo spp.*) and American Coot (*Fulica Americana*; Florida Keys Wild Bird Center). Satellite-tag data from this tiger shark show a direct northerly movement past the region where the above bird die-off occurred, followed by several highly tortuous movements in a restricted area from Ft. Lauderdale to Miami (Figure 2). These types of convoluted, back-and-forth movements of sharks have been previously thought to occur in response to areas of high resource availability and/or a change in habitat quality (Sims et al., 2006; Weng et al., 2008). Moreover, any scavenging by tiger sharks on dead or moribund floating birds would occur at the surface. It is likely that the deposit and outflow of the strong uropygial and sensory cues emitted from the mass of dead and/or dying birds could change the movement of local marine predators and attract sharks (acute sensory predators) to opportunistically scavenge on the birds. Interestingly, over the next 10 days, an estimated 400–500 additional terrestrial bird carcasses were also found floating in the waters of Florida Bay and Everglades National Park (V. Nograd, pers. comm.). These locations are within close

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