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SPATIAL DISTRIBUTION OF GREEN SEA TURTLE (*CHELONIA MYDAS*) NESTS AT FRENCH FRIGATE SHOALS, HAWAII: IMPLICATIONS FOR CARRYING CAPACITY?

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ABSTRACT: :: The Hawaiian green sea turtle population (i.e., the Central North Pacific population) is functionally a closed population, meaning that turtles primarily breed, nest, and forage all within the Hawaiian archipelago. Ninety six percent of nesting occurs within a single low-lying, remote atoll - French Frigate Shoals (FFS). Annual nesting surveys are conducted on two islands within FFS, East and Tern Islands. Prior to October 2018, East Island had an area of 35,853 m^2, with sandy beach along the entire perimeter, allowing turtles to emerge from the water on any side of the island. Tern Island had an area of 105,276 m^2, and contained remnant manmade structures, which have created barriers confining turtles to three separate nesting beaches. Both islands have shifting sands, tidal inundation, vegetation, and nesting seabirds. A study based on nesting data from East Island (2005-2009) concluded that the beach could successfully support increased nesting activity, thereby suggesting that carrying capacity for the recovering population was more limited by coastal foraging habitat than nesting habitat. The analysis, however, assumed that turtle nests are randomly distributed over the entire area of East Island. In 2017, we collected GPS data on nest locations to test the hypothesis that nest distribution on both islands was random. Using the nearest neighbor spatial statistic tool in ArcGIS, we found that the nests laid on East and Tern Islands were significantly clustered [East Island nearest neighbor ratio: 0.617822 (z-score: -17.363461, $p << 0.001$); Tern Island nearest neighbor ratio: 0.304501 (z-score: -18.957266, $p << 0.001$)]. Using kernel density analysis methods, we found that 95% of nests on East Island were located within 35% of the total area, and 50% of the nests were located within 10% of the island area. On Tern Island, 95% of nests were located within 8% of the total island area, and 50% of nests were located within 2% of the island area. Our results demonstrate that nesting females use only a small portion of the available area of each island, with most nests occurring in barren spaces along the periphery of the islands. Research in other regions has shown that nest location directly impacts hatching success due to differences in environmental conditions (i.e., microbial activity, temperature, water inundation, or substrate salinity). A clustered nesting pattern may result in higher microbial activity within nests and an increased probability of turtles digging up other nests, directly decreasing hatching success. The previous study estimated that the nesting population at FFS was far below carrying capacity, but our finding of clustered nest distributions combined with the increasing trend in the number of nesting females per year, suggests that the nesting beaches at FFS may soon reach carrying-capacity. We plan to

revisit the models used to calculate nesting beach carrying capacity to incorporate a clustered distribution pattern, and further examine relationships between environmental factors and nest locations.

Session: 4. Population Biology and Monitoring (Status, modeling, demography, genetics, nesting trends, in-water trends)