# A history of dramatic successes at protecting endangered sea turtle nests by removing predators

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Five species of sea turtle, all listed on the IUCN Red List as endangered or critically endangered (IUCN, 2004), nest on Florida beaches. The nesting aggregation of loggerhead turtles is of global significance as it is the second largest nesting aggregation in the world, with the largest concentration in a middle-eastern region vulnerable to the effects of war, political upheaval, and severe oil spills (Meylan et al. 1995). The highest productivity for sea turtle nesting in Florida takes place on beaches protected as Florida State Parks or National Wildlife Refuges. Unfortunately, reproductive success is greatly hindered by nest predation, making human intervention necessary to insure sea turtle conservation.

Racoons (*Procyon lotor*) are the most destructive of a wide variety of sea turtle nest predators in Florida (e.g., Stancyk 1982, Engeman et al., 2003, 2005, Garmestani and Percival 2005). A diverse assortment of other animals, mostly invasive predators, join raccoons as destructors of sea turtle nests (e.g., Lewis et al. 1994, 1996, Woolard et al. 2004, Martin et al. 2005, Helmstetter and Atencio 1997, Northwest Florida Partnership 2000). Nevertheless, the pervasiveness and severity of raccoon predation on sea turtle nests in Florida prompted a leading sea turtle conservation organization to identify raccoons as the single greatest source of sea turtle mortality in Florida (Caribbean Conservation Corporation/Sea Turtle Survival League, N.D.). Coastal development has greatly reduced sea turtle nesting habitat, but raccoon populations thrive at artificially high abundances in association with human development (e.g., Smith and Engeman 2002), reaching astounding densities as great as 238 raccoons/km$^2$. Predation is a critical threat to many endangered or even locally rare species (Hecht and Nickerson 1999) and its deleterious impact is compounded through habitat loss and altered predator communities (Reynolds and Tapper 1996), such as artificially high raccoon populations and invasive predators. Reduction of nest predator populations has been widely recommended (Bain et al., 1997, Mroziak et al. 2000), and widely-practiced, to protect sea turtle nests (Stancyk 1982, U.S. Fish and Wildlife Service and National Marine Fisheries Service 1991, U.S. Fish and Wildlife Service 2000, Engeman et al. 2003, 2005, Garmestani and Percival 2005).

If imperiled sea turtles are to successfully reproduce on Florida beaches, nest predation must be at low levels. Effective programs to remove nest predators have been highly successful at accomplishing this. One of the most outstanding and well-documented examples has taken place on the high-density nesting beach on Jupiter Island within the protected confines of Hobe Sound National Wildlife Refuge and St. Lucie Inlet Preserve State Park. Along this 5.3 km stretch of beach the number of sea turtle nests deposited each year can range to nearly 2000, with the usual number around 1500. Historically, as

many as 95% of the nests on the beach had been depredated, primarily by raccoons, but more recently also by invasive armadillos (*Dasypus novemcinctus*). Some predator removal reduced depredation to around 50%, but the implementation of an agreement with predator management experts and the use of predator monitoring to optimize the timing and placement of management efforts reduced nest predation to under 28% (Engeman et al. 2003). Further application and improvement of the monitoring methods brought nest predation under 10% (Engeman et al. 2005). The net result of these low predation figures was the production of many tens of thousands of additional hatchling sea turtles each year. However, the destructive influence of predators was demonstrated in a later year when a funding shortfall caused a reduction in predator management during turtle nesting season, resulting in an immediate rise in nest predation (Engeman et al. 2006).

Similar results have taken place in Florida's panhandle where the removal of raccoons as well as invasive coyotes (*Canis latrans*), red foxes (*Vulpes vulpes*) and feral swine (*Sus scrofa*) have not only greatly improved turtle nesting results, but also improved nesting results for listed shorebirds and the survival of beach mice (Northwest Florida Partnership 2000, Lewis et al. 1994, 1996). On Cayo Costa Island on Florida's west coast there was a dramatic upturn in sea turtle nesting success as well as nesting success for listed shorebirds resulting from the removal of raccoons and invasive feral swine (Florida Dept. Environmental Protection and USDA/ Wildlife Services unpublished data). During the same time span, neighboring similar islands had turtle and shorebird nesting success remain at or near zero. Subsequent raccoon removal at nearby islands motivated by this success also resulted in dramatically improved nesting success.

There are few practical alternatives to removing predators if sea turtles are to successfully nest. The translocation or release of invasive species in Florida is illegal (multiple violations, Chap. 39 F.A.C.), and the translocation of native species is similarly prohibited. In particular, translocation of raccoons can be particularly harmful when one considers its potential role in rabies transmission among high-density raccoons, which has been a periodic problem in Florida and along the rest of the east coast of the U.S. (Winkler and Jenkins

A green sea turtle. Photo credit: U.S. Fish and Wildlife Services.

1991). An alternative, such as nest caging to place a barrier between predator and nest is not only impractical on high density nesting beaches, but often does not reduce predation, and may even facilitate raccoon depredation of nests in some situations (Mroziak et al. 2000). Moreover, an extensive economic analysis was conducted for predator removal strategies for the Jupiter Island beach and found that the predator removal methods applied had extraordinary, but conservatively calculated monetary benefit-cost ratios accruing from over $8 million in benefits for producing approximately 84,000 additional hatchling turtles in a year from predator removal costing under $10,000 (Engeman et al. 2002). Given the seriousness of the need to assist nesting success of endangered sea turtles and the efficacy and economical practicality from predator removal, we have to ask ourselves, how can we not afford to remove predators when necessary to protect the turtle nests?

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