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Cooling Down Florida's Coast: Saving East Central and Southeast Florida's Sea Turtles From Impacts of Climate Change

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COOLING DOWN FLORIDA'S COAST: SAVING EAST CENTRAL AND SOUTHEAST FLORIDA'S SEA TURTLES FROM IMPACTS OF CLIMATE CHANGE

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INTRODUCTION

Despite the existing legal protections in place for sea turtles, these vulnerable species remain in a precarious situation due to the continual loss of suitable nesting habitat.[1] One of the most certain consequences of climate change is increased erosion rates along nesting beaches.[2] Further, rapidly increasing global temperatures may result in warmer incubation temperatures and highly female-biased sex ratios.[3] In a system of temperature-dependent sex determination, where environmental variability is the primary guarantee of a mixed sex ratio, fixation on a particular nesting site or type of nesting site can lead to extinction.[4]

These results of climate change could affect the basic requirements of a good nest-site for sea turtles, which includes easy accessibility from the sea, a beach platform high enough not to be inundated by high tides or the water table, and beach sand that facilitates gas diffusion[5] but is moist and fine enough to prevent excess slippage during nest construction.[6] Many factors (sand particle size, sand coverage, beach vegetation, and slope) independently influence nest-site selection, and the possibility exists that these characteristics may influence nest-site selection in

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[1] Matthew Rupert, Note, *Beach Nourishment to the Rescue: Through an Extensive Regulatory Review Process, Beach Nourishment Can Restore and Protect Vital Sea Turtle Nesting Habitat*, 19 SE. ENVTL. L.J. 327, 328 (2011).
[2] NAT'L OCEANIC & ATMOSPHERIC ADMIN., NAT'L MARINE FISHERIES SERV., RECOVERY PLAN FOR THE NORTHWEST POPULATION OF THE NORTHWEST ATLANTIC LOGGERHEAD SEA TURTLE CARETTA CARETTA (2008), *available at* http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_loggerhead_atlantic.pdf [hereinafter LOGGERHEAD REPORT].
[3] *Id.*
[4] James R. Spotila & Edward A. Standora, *Temperature Dependent Sex Determination in Sea Turtles*, 1985 COPEIA 711, 720 (1985).
[5] Ralph A. Ackerman, *The Nest Environment and the Embryonic Development of Sea Turtles*, *in* THE BIOLOGY OF SEA TURTLES 99 (Peter L. Lutz and John A. Musick eds., 2015). ("Net diffusion of any gas can only occur when there is a concentration difference for the gas. This means that, in order to supply the oxygen or get rid of the carbon dioxide associated with developmental metabolism, concentration differences must set up between the center and edge of the egg.").
[6] Ahjond S. Garmestani, et al., *Nest-site Selection by the Loggerhead Sea Turtle in Florida's Ten Thousand Islands*, 34 J. HERPETOLOGY 504, 504 (2000).

combination.[7] Overall, a nesting site is important because a nest site affects sex determination in sea turtle embryos because it affects temperature in the nest.[8]

Part I of this paper describes the four species of nesting sea turtles found on east central and southeast Florida's coast, along with the threats they currently face due to climate change. These threats include the warming of beaches; beach erosion; and beach nourishment. Part II discusses the existing federal and Florida laws regarding protections for sea turtles and their nesting habitats. Part III discusses three possible solutions to combat possible extinction of east central and southeast Florida's sea turtles: (1) categorize leatherbacks, green sea turtles, and hawksbills in distinct population segments under the Endangered Species Act ("ESA") and obtain critical habitat; (2) nest relocation to higher dunes or egg hatcheries; and (3) revision of beach management and beach nourishment programs regarding beach nourishment policies, and to include dune restoration and preservation.

I. SEA TURTLES ON THE BRINK OF EXTINCTION ON EAST CENTRAL AND SOUTHEAST FLORIDA'S COAST

A. *Overview of Nesting Sea Turtle Species in Florida*

In Florida, there were 11,924 sea turtle emergences[9] recorded during the 2013 nesting season,[10] with a majority of the sea turtle emergences being loggerheads (73%), green turtles (26.5%), and leatherbacks (0.5%).[11] Of the total number of crawls[12], 6,672 resulted in a nest,

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[7] Garmestani et al., *supra* note 6, at 504.
[8] Spotila & Standora, *supra* note 4, at 716.
[9] SEA TURTLE CONSERVANCY, http://www.conserveturtles.org/ seaturtleinformation.php?page=seaturtle-faq#2 (last visited July 14, 2015) ("When the female sea turtle emerges from the sea at night and ascends the beach, searching for a suitable nesting site.").
[10] RICHARD M. HERREN, U.S. FISH & WILDLIFE SERVS., HABITAT CONSERVATION PLAN A PLAN FOR THE PROTECTION OF SEA TURTLES ON THE ERODING BEACHES OF INDIAN RIVER COUNTY (2013), *available at* http://www.ircgov.com/Departments/Public_Works/Coastal_Engineering_Section/HCP/HCP2013.pdf.
[11] *Id*. at 9-10.

yielding an overall nesting success of 56 percent for all species and all areas combined.[13] Leatherback nesting success was 58 percent, green turtle nesting success was 49.7 percent, and loggerhead had the highest rate of success at 91.9 percent.[14] On Melbourne, Beach, Florida, 17 of 97 loggerhead nests in 1985 were lost to erosion, accretion, and surf action.[15]

With loggerheads, most nesting occurs on Florida beaches, with approximately 90 percent of nesting in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties.[16] Green turtles nest particularly in Brevard, Indian River, St. Lucie, Martin, Palm Beach, and Broward Counties.[17] With leatherbacks, a majority of nesting occurs along the southeast Atlantic coast in Brevard through Broward counties.[18] Hawksbill nesting is restricted to the southeastern coast of Florida (Volusia through Dade counties).[19]

1. Loggerhead

The beaches of east central and southeast Florida from Brevard to Broward Counties are especially prolific nesting areas, accounting for approximately 90 percent of the total nests

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[12] *What is a Turtle Crawl?*, NETWORK FOR ENDANGERED SEA TURTLES, http://www.nestonline.org/TurtleCrawls.htm (last visited July 14, 2015) ("A turtle crawl is the unique pattern in the sand left by a sea turtle when the turtle crawls to or from the sea.").
[13] HERREN, *supra* note 10, at 10.
[14] *Id.*
[15] *See* NATIONAL RESEARCH COUNCIL, DECLINE OF THE SEA TURTLES: CAUSES AND PREVENTION 66 (1990) [hereinafter NRC].
[16] *Id.* at 29.
[17] *Id.* at 34.
[18] *Leatherback Sea Turtle Fact Sheet*, U.S. FISH & WILDLIFE SERV., http://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/leatherback-sea-turtle.htm (last updated May 21, 2015).
[19] NAT'L OCEANIC & ATMOSPHERIC ADMIN., NAT'L MARINE FISHERIES SERV., RECOVERY PLAN FOR HAWKSBILL TURTLE ERETMOCHELYS IMBRICATA IN THE U.S. CARIBBEAN, ATLANTIC AND GULF OF MEXICO (1993), *available at* http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_hawksbill_atlantic.pdf [hereinafter HAWKSBILL REPORT].

deposited each year in Florida.[20] The contiguous beaches of Brevard, Indian River, St. Lucie, Martin, and Palm Beach counties are the most important loggerhead nursery areas in the Western Hemisphere, attracting more than 15,000 female loggerheads each May through August.[21] The first loggerhead nests begin to appear in late April, and the last nests are deposited in early to mid-September.[22] Mean clutch[23] size varies from about 100 to 126.[24] Natural incubation periods are about 54 days in Florida, and the length of the incubation period is inversely related to nest temperature.[25] The sex of loggerhead hatchlings also depends on temperature.[26]

The loggerhead sea turtle has a threshold temperature of 86°F, where approximately equal numbers of males and females are produced.[27] Loggerheads in Florida produce about 87-100 percent females.[28] The sex of those loggerheads surviving to hatch is determined by a wider range of pivotal temperatures than those for populations of other sea turtle species.[29]

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[20] RICHARD M. HERREN, U.S. FISH & WILDLIFE SERVS., HABITAT CONSERVATION PLAN A PLAN FOR THE PROTECTION OF SEA TURTLES ON THE ERODING BEACHES OF INDIAN RIVER COUNTY (2008), *available at* http://www.ircgov.com/Departments/Public_Works/Coastal_Engineering_Section/HCP/HCP2008.pdf [hereinafter 2008 ANNUAL REPORT].
[21] *The History and Life of a Sea Turtle*, FLA. FISH & WILDLIFE CONSERVATION COMM'N., http://myfwc.com/research/wildlife/sea-turtles/fl-sea-turtles/life-history/ (last visited July 6, 2015).
[22] 2008 ANNUAL REPORT, *supra* note 20, at 29.
[23] SEA TURTLE CONSERVANCY, http://www.conserveturtles.org/ seaturtleinformation.php?page=seaturtle-faq (last visited July 14, 2015) ("A clutch is the number of eggs in a nest.").
[24] NRC, *supra* note 15, at 31.
[25] *Id.*
[26] *Id.*
[27] Spotila & Standora, *supra* note 4, at 712.
[28] JAMES SPOTILA, SEA TURTLES: A COMPLETE GUIDE TO THEIR BIOLOGY, BEHAVIOR, AND CONSERVATION 52 (2004).
[29] *Id.* at 51.

Loggerhead nesting beaches are also warming as temperatures rise.[30] Rising temperatures may result in the northward shift of loggerhead nesting aggregations to cooler climates.[31]

The most significant threat to loggerhead populations in Florida is beach erosion that contributes to the loss and degradation of nesting and foraging habitats.[32]

2. Green Sea Turtle

When nesting, green turtles prefer beaches with wide, sandy offshore approaches free of rock clutter.[33] Green turtles typically do not begin nesting until late May.[34] An estimated several hundred to 8,700 green turtle nests are deposited in Florida each year.[35] The average egg count in a clutch reported for Florida is 136.[36] Due to the location of their nests, many nests are destroyed by tidal inundation and erosion.[37]

Green turtles' sex is determined by incubation temperature.[38] Sand temperatures below 82.4°F produce 90-100 percent males, temperatures between 83.3°F and 86.4°F produce increasing numbers of females, and temperatures of 86.9°F or higher during the middle third of incubation produce 94-100 percent females.[39]

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[30] Jaclyn Lopez, *Sea-Level Rise and Species Survival along the Florida Coast*, *in* CLIMATE CHANGE IMPACTS ON OCEAN AND COASTAL LAW: U.S. AND INTERNATIONAL PERSPECTIVES 561 (Randall S. Abate ed., 2015).
[31] J.S. Reece et al., *Sea Level Rise, Land Use, and Climate Change Influence the Distribution of Loggerhead Turtle Nests at the Largest USA Rookery (Melbourne Beach, Florida)*, 493 MARINE ECOLOGY PROGRESS SER. 259 (2013).
[32] Jane Bongo, *Critical Habitat Designated for Loggerhead Sea Turtles in Atlantic, Gulf of Mexico*, CLEARWATER GAZETTE (July 17, 2014, 9:31 am), http://clearwatergazette.com/cg/news/critical-habitat-designated-for-loggerhead-sea-turtles-in-atlantic-gulf-of-mexico-20140717/.
[33] Garmestani et al., *supra* note 6, at 504.
[34] 2008 ANNUAL REPORT, *supra* note 20, at 44.
[35] *Id.*
[36] Spotila & Standora, *supra* note 4, at 711.
[37] NRC, *supra* note 15, at 34.
[38] *Id*.
[39] Spotila & Standora, *supra* note 4, at 712.

3. Leatherback

Nesting by leatherbacks in Florida typically begins and ends earlier in the season than other species, with the first nests in late February or early March and the last nests in July.[40] Leatherbacks' clutch size average 101 eggs.[41] Eggs incubate averaging 64 days in Florida.[42] Eggs that have not been relocated have a 66 percent hatch success for nests surviving to term.[43] Due to the nesting locations of leatherbacks, eggs are lost to erosion as a result of the high energy of the beaches favored by the species.[44]

Leatherbacks have a small range of incubation temperature (also known as the transitional range of temperature or "TRT") relative to other sea turtles, regarding the production of all male or all female hatchlings.[45] For leatherbacks, the TRT is between 84.2°F and 86.0°F; above and below these temperatures, all female and male hatchlings are produced, respectively.[46] Eggs can be transferred to hatcheries, but they need more careful handling than those of other sea turtles, if viability is to be maintained during the transfer.[47]

4. Hawksbill

Hawksbill nesting on the east coast of Florida may well be underestimated due to the scarcity of observers qualified to recognize the species and the masking effects of the thousands

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[40] 2008 ANNUAL REPORT, *supra* note 20, at 50.
[41] NAT'L OCEANIC & ATMOSPHERIC ADMIN., NAT'L MARINE FISHERIES SERV., RECOVERY PLAN FOR LEATHERBACK TURTLES IN THE U.S. CARIBBEAN, ATLANTIC, AND GULF OF MEXICO (1992), *available at* http://www.nmfs.noaa.gov/pr/pdfs/recovery/turtle_leatherback_atlantic.pdf [hereinafter LEATHERBACK REPORT].
[42] *Id.* at 8.
[43] *Id.*
[44] NRC, *supra* note 15, at 41.
[45] R. Barreto, et. al., *Metabolically-generated Heat of Developing Eggs and Its Potential Effect on Sex Ratio of Sea Turtle Hatchlings*, 31 J. HERPETOLOGY 616, 618-19 (1997).
[46] *Id.* at 618.
[47] NRC, *supra* note 15, at 41.

of loggerhead turtles sharing these nesting beaches.[48] Hawksbills nest on low- and high-energy beaches in tropical oceans, frequently sharing the high energy beaches with green turtles.[49] The females often nest in low densities[50] and, unlike other sea turtle species, dig many of their nests behind the sandy beach.[51]

In Florida, clutch size is approximately 140 eggs.[52] Eggs take about 60 days to hatch.[53] Hatching success at nesting beaches in the United States is approximately 80 percent.[54] Nests laid in vegetation have significantly longer incubation durations than nests laid in other beach zones.[55]

B. *Threats from Climate Change and Beach Restoration Affecting Central and Southeast Florida's Coast Sea Turtles*

1. Warming Beaches and Impacts to Sea Turtles' Reproduction

The temperature of nest incubation influences the sex of sea turtle hatchlings.[56] The warmer the temperature of the sand surrounding the egg chamber, the faster the embryos develop.[57] If the egg incubates at a low temperature, usually below 82 – 84°F, the embryo develops as a male.[58] If the egg incubates at a high temperature, usually about 86 – 88°F, the

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[48] P. Frank Lund, *Hawksbill Turtle (Eretmochelys imbricate) Nesting on the East Coast of Florida*, 19 J. HERPETOLOGY 164, 165 (1985).
[49] HAWKSBILL REPORT, *supra* note 19, at 4.
[50] *Statewide Atlas of Sea Turtle Nesting Occurrence and Density*, FLA. FISH & WILDLIFE CONSERVATION COMM'N., http://myfwc.com/research/wildlife/sea-turtles/nesting/nesting-atlas/ (last visited July 14, 2015) ("Density is divided into four quartile ranks, each containing a quarter of the density values. Low-density beaches are the lowest 25 percent.").
[51] Stephanie Jill Kamel and N. Mrovsovsky, *Deforestation: Risk of Sex Ratio Distortion In Hawksbill Sea Turtles*, 16 ECOLOGICAL APPL. 923, 923 (2006).
[52] HAWKSBILL REPORT, *supra* note 19, at 6.
[53] *Id.*
[54] *Id.*
[55] Kamel & Mrovsovsky, *supra* note 51, at 928.
[56] LEATHERBACK REPORT, *supra* note 41, at 32.
[57] 2008 ANNUAL REPORT, *supra* note 20, at 32.
[58] SPOTILA, *supra* note 28, at 51.

embryo develops as a female.[59] When turtle eggs are kept at a constant temperature, incubation temperature is longer at cooler temperatures; over the range of 78.8-89.6°F, a 1°F change decrease adds about five days to incubation.[60] The range of incubation temperatures in which both sexes are produced is centered around the pivotal temperature.[61] Pivotal temperatures are those defined as those over which the sex ratio changed greatly.[62] At these temperatures the ratio is highly sensitive to temperature with even 1°F making a considerable difference.[63] Incubation temperatures outside the TRT result in 100 percent male or female hatchlings.[64] Sediment temperatures prevailing during the middle-third of the incubation period also determine the sex of sea turtles.[65] Moisture conditions in the nest similarly influence incubation period, hatching success, and hatchling size.[66] It is predicted that males were more likely to be produced early in the season (March – April nests), while later nests (June) may produce nearly 100 percent females.[67]

Some scientists are now suggesting that global climate change has the potential to eliminate the production of male turtle offspring if mean global temperatures increase 7.2°F.[68] Hatchlings from Florida beaches tend to be female.[69] However, one surprising human influence

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[59] SPOTILA, *supra* note 28, at 171.
[60] N. Mrosovsky, *Thermal Biology of Sea Turtles*, 20 AMER. ZOOL. 531, 531 (1980).
[61] Barreto, *supra* note 45, at 616.
[62] Mrosovsky, *supra* note 60, at 532.
[63] *Id*.
[64] Barreto, *supra* note 45, at 616.
[65] 2008 ANNUAL REPORT, *supra* note 20, at 32.
[66] *Id.*
[67] *Climate Change and Sea Turtles*, GLOBAL GREENHOUSE WARMING, http://www.global-greenhouse-warming.com/climate-change-and-sea-turtles.html (last visited July 6, 2015).
[68] *Id.*
[69] SPOTILA, *supra* note 28, at 171.

is the effect of tall buildings in Boca Raton, Florida, where shade from the buildings blanket the beach during the day and cools nest temperatures by 2 – 4°F, resulting in more males.[70]

2. Impacts of Beach Nourishment on Sea Turtles and Their Nests

Almost 40 percent of Florida's sandy beaches are in a state of "critical erosion."[71] Beach nourishment is often proposed when beach erosion threatens to remove an existing beach or make it too narrow to be used.[72] Beach nourishment consists of pumping, trucking, or otherwise depositing sand on the beach to replace what has been lost to erosion.[73] Beach nourishment can disturb nesting turtles and even bury turtle nests during the nesting season.[74] In Florida, much beach nourishment occurs in the summer, and nests must be moved from the beach before nourishment.[75] Nourished beaches develop steep escarpments in the mid-beach zone that can hamper or prevent access to nesting sites.[76] Heavy machinery and pipelines associated with beach nourishment projects can also cause false crawls[77] and entrapment of nesting females and hatchlings.[78] Nourishment project activities are normally conducted on a twenty-four hour basis and can create barriers to nesting females emerging from the surf and crawling up the beach, causing a higher incidence of false crawls.[79]

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[70] SPOTILA, *supra* note 28, at 171.
[71] Gary Appelson, *Beach Nourishment and Turtles – Can They Get Along?*, SEA TURTLE CONSERVANCY, http://www.conserveturtles.org/velador.php?page=velart50 (last visited July 6, 2015).
[72] Don Barber, *Beach Nourishment Basics*, BRYN MAWR COLL., http://www.brynmawr.edu/geology/geomorph/beachnourishmentinfo.html (last visited Apr. 20, 2015).
[73] NRC, *supra* note 15, at 78.
[74] *Id.*
[75] *Id.* at 121.
[76] Katherine R. Butler, Comment, *Coastal Protection for Sea Turtles in Florida*, 13 J. LAND USE & ENVTL. L. 399, 411 (1998).
[77] *Id.* at 408 ("A 'false crawl' occurs when a female ascends the beach but returns to the sea without nesting.").
[78] *Id.* at 411.
[79] LEATHERBACK REPORT, *supra* note 41, at 12.

An element of beach nourishment is the depositing of new sand on the affected area.[80] However, the sand deposited on the nesting beach may be different from native beach sediments.[81] Additionally, larger sand grain size can also result in difficult digging conditions for the female turtles.[82] A variation in grain size from the native sand can also affect the moisture content of the sand and the moisture content of the sand on the nesting beach sand can affect hatchling success.[83] Sand color can influence the temperature of the sand which plays a role in "[n]est site selection, incubation duration, sex ratio, and the hatchling emergence."[84] Therefore, the quality of nourishment material must be acceptable to nesting sea turtles.[85]

Transporting the sand onto the beach and the nourishment itself often results in severe compaction of the beach, significantly reducing nesting success.[86] High compaction can affect nest excavation, incubation time, and the success of hatchling emergence from the nest.[87] One study evaluated compaction on ten nourished east coast Florida beaches and concluded that five were so compacted that nest digging was inhibited and another three might have been too compacted for optimal digging.[88] In general, beaches nourished from offshore borrow sites are harder than natural beaches and can remain hard for ten years or more.[89]

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[80] Butler, *supra* note 76, at 411.
[81] *Id.* at 411-12.
[82] BRYANT C. COONEY ET AL., BEACH NOURISHMENT: GLOBAL PERSPECTIVES AND LOCAL APPLICATIONS TO THE NORTH CAROLINA COASTLINE 39 (2003) ("[Too great a composition of silt, shell, or rock fragments that harden and making digging difficult").
[83] Rupert, *supra* note 1, at 347.
[84] *Id.*
[85] NRC, *supra* note 15, at 121.
[86] *Id.*
[87] Rupert, *supra* note 1, at 348.
[88] NRC, *supra* note 15, at 78.
[89] *Id.*

Constructed beaches tend to differ from natural beaches in they are typically wider and flatter than natural beaches.[90] Even though constructed beaches are wider, nests deposited there may experience higher rates of washout than those on relatively narrow, steeply sloped beaches.[91] Nests laid closest to the waterline on constructed beaches may be lost during the first year or two following construction as the beach undergoes an equilibration process during which seaward portions of the beach are lost to erosion.[92]

Beach nourishment projects require continual maintenance as beaches erode and hence their negative impacts to turtles are repeated on a regular basis.[93]

II. EXISTING LEGAL PROTECTION FOR SEA TURTLES

There are several existing Federal and state laws that if are changed to revise climate change mitigation measures to adaptation measures instead, would greatly benefit sea turtles in their recovery. Federally, the ESA protects the sea turtles, their habitat, and develops recovery plans in hopes to delist the species. On a state level, Florida has two laws: Marine Turtle Protection Act, which enforces regulations to protect sea turtles, their habitat, and their nests, as well as implement the recovery plans; and the Beach and Shore Preservation Act, which regulates beach and shore projects such as beach nourishment and erosion control measures.

A. *Endangered Species Act*

The ESA was enacted in 1973 to provide for the conservation of endangered or threatened species and their ecosystems.[94] The text of the Act as well as its legislative history

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[90] LOGGERHEAD REPORT, *supra* note 2, at I-36.
[91] *Id.*
[92] *Id.*
[93] LEATHERBACK REPORT, *supra* note 41, at 12.
[94] 16 U.S.C. § 1533 (2014).

unequivocally demonstrates that Congress intended that protection of endangered species be afforded the highest level of importance.[95] Congress made it clear that the Act seeks to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved."[96]

Currently, the ESA lists and protects all six species of sea turtles that live or swim within the Atlantic Coast of the United States: the green, leatherback, loggerhead, hawksbill, olive ridley, and Kemp's ridley sea turtle.[97] The responsibility of conservation and protection of the listed sea turtles is shared by the U.S. Fish and Wildlife Service ("FWS") and the National Marine Fisheries Service ("NMFS") because the migratory behavior of the sea turtles encompasses both the marine environment (NMFS jurisdiction) and the dry beach (FWS jurisdiction).[98] FWS and NMFS combat the major threats to sea turtles, which are the "destruction and alteration of nesting and foraging habitats."[99]

The goal of the ESA is to protect endangered species by protecting the ecosystems around them.[100] In creating the ESA, Congress started from the finding that a major cause of extinction is destruction of critical habitat.[101] Critical habitats are those lands that are essential to the listed species' conservation[102] and areas in which physical and biological features essential to the conservation of the species are found or which may require special management

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[95] Animal Welfare Inst. v. Beech Ridge Energy, LLC, 675 F. Supp. 2d 540, 543 (D. Md. 2009).
[96] Federico Cheever, *Critical Habitat, in* ENDANGERED SPECIES ACT: LAW, POLICY, AND PERSPECTIVES 1, 41 (Donald C. Baur and William Robert Irvin ed., 2d ed. 2010).
[97] NRC, *supra* note 15, at 16.
[98] *Sea Turtles, Nat'l Marine Fisheries Serv.*, NAT'L MARINE FISHERIES SERV., http://www.nmfs.noaa.gov/pr/species/turtles/ (last updated Jun. 11, 2015).
[99] *Id.*
[100] Palila v. Hawaii Dep't of Land and Natural Resources, 852 F.2d 1106, 1108 (9th Cir. 1988).
[101] Tenn. Valley Auth v. Hill, 437 U.S. 153, 179 (1978).
[102] 16 U.S.C. § 1532(5)(A) (2014).

considerations or protection.[103] NMFS rules require the agency to "focus on the principal physical and biological constituent elements within the defined area that are essential to the conservation of the species."[104] Accordingly, the Service is also required to make a determination to designate – "to the maximum extent prudent and determination" – the listed species' critical habitat.[105]

Congress expressed its concern for habitat conservation most plainly in the Act's provisions for (1) the designation of critical habitat and (2) the prohibition against federal agency actions that destroy or adversely modify designated critical habitat.[106] Section 4(a)(3)(A) provides that "[the Secretary . . . to the maximum extent prudent and determinable . . . shall, *concurrently* with making a determination . . . that a species is an endangered species or threatened species, designate any habitat of such species which is then considered to be critical habitat."[107]

FWS and NMFS are charged with developing recovery plans for each species, indicating how the threats to the species will be removed so that it can be delisted.[108] Pursuant to Section 4(f)(1) of the ESA, the Secretary is required to "develop and implement plans . . . for the conservation and survival of endangered species . . . unless he finds that such a plan will not promote the conservation of the species.[109] Although the ESA does not mandate a timeline for

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[103] Blake Armstrong, Note, *Maintaining the World's Marine Biodiversity: Using the Endangered Species Act to Stop the Climate Change Induce Loss of Coral Reefs,* 18 HASTINGS W.-N.W. J. ENVTL. L. & POL'Y 429, 435 (2012).
[104] *Id*.
[105] 16 U.S.C. § 1533(a)(3)(A) (2014).
[106] Cheever, *supra* note 96, at 41.
[107] *Id*.
[108] Sara Gersen, Note, *Who Can Enforce the Endangered Species Act's Command for Federal Agencies to Carry Out Conservation Programs?* 36 ECOLOGY L.Q. 407, 414 (2009).
[109] Ctr. For Biological Diversity v. Kempthorne, 607 F. Supp. 2d 1078, 1087-8 (D. Ariz. 2009) (citing 16 U.S.C. § 1533(f)(1) (2014)).

completing the plans, FWS policy is to attempt to complete a plan for a species within three years of its listing.[110]

The Ninth Circuit has affirmed that Congress did not intend the ESA merely to forestall the extinction of species (i.e. promote a species survival) but to allow a species to recover to the point where it may be delisted.[111] The recovery plan, once prepared, provides this basic road map to recovery, *i.e.*, the process that stops or reverses the decline of a species and neutralizes threats to its existence.[112]

NMFS regulates beach nourishment projects on behalf of sea turtles and requires mitigation measures through the consultation of Section 7 of the ESA.[113] Section 7 of the ESA requires a federal agency "[to] confer with the Secretary on any agency action which is likely to jeopardize the continued existence of any species proposed to be listed under Section 4 . . . or result in the destruction or adverse modification of critical habitat proposed to be designated for such species."[114] If the Secretaries find that the proposed project would result in adverse consequences, known as takings,[115] to either the species or the critical habitat, "the Secretary shall suggest those reasonable and prudent alternatives which . . . can be taken by the Federal agency or applicant in implementing the agency action."[116] After consultation is complete, the federal agency will only be allowed to move forward with the proposed project if the Secretary

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[110] Gersen, *supra* note 108, at 414.
[111] Gifford Pinchot Task Force v. U.S. Fish and Wildlife Serv., 378 F.3d 1059, 1070 (9th Cir. 2004).
[112] Defenders of Wildlife v. Babbitt, 130 F. Supp. 2d 121, 131 (D.D.C. 2001).
[113] NRC, *supra* note 15, at 121.
[114] 16 U.S.C. § 1536(a)(4) (2014).
[115] *Id.* § 1532(19) ("The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct [relating to an endangered or threatened species]").
[116] *Id.* § 1536(b).

finds the "agency action"[117] and any "taking of an endangered species or a threatened species incidental to the agency action"[118] will not violate 16 USCS § 1536(a)(2).[119] This Section 7 consultation process is designed to ensure federal agencies comply with the ESA's substantive provisions.[120]

B. *Florida Laws*

Florida's two laws that have the most impact on the conservation of sea turtles are the Marine Turtle Protection Act ("MTPA"), which protects sea turtles, their nesting sites, and nests; and the Beach and Shore Preservation Act ("BSPA"), which protects sea turtles and their nesting sites in regards to any beach and shore restoration and preservation projects.

1. Marine Turtle Protection Act

In 1995, the Florida Legislature passed the MTPA, giving the Department of Environmental Protection ("DEP") the authority to enforce regulations protecting sea turtles.[121] DEP was instructed to implement its responsibilities under the FWS recovery plans for the five species of sea turtles.[122] The MTPA states that "no person may take, possess, disturb, mutilate, destroy, cause to be destroyed, sell, offer for sale, transfer, molest, or harass any marine turtle or its nest or eggs at any time."[123] "Take" is defined as an act which kills or injures sea turtles, including "significant habitat modification or degradation that kills or injures marine turtles by significantly impairing essential behavior patterns, such as breeding, feeding, or sheltering."[124]

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[117] 16 U.S.C. § 1536(b)(3)-(4).
[118] *Id.* § 1536(b)(4).
[119] *Id.*
[120] Forest Guardians v. U.S. Bureau of Reclamation, 462 F. Supp. 2d 1177, 1180 (D.N.M. 2006).
[121] FLA. STAT. § 370.12(1)(b) (2014).
[122] *Id.*
[123] FLA. STAT. § 370.12(1)(c) (2014).
[124] *Id.*

Under the MTPA, a permit application to DEP for any activity that affects sea turtles, their nests, or habitat is subject to conditions and requirements for sea turtle protection.[125] DEP must recommend denial of a permit if an activity would result in a "take," unless the taking is incidental under the federal ESA.[126] [127] However, on the Atlantic Coast, DEP cannot restrict the timing of a beach restoration, beach nourishment, or inlet sand transfer project when the applicant already has a sea turtle nest relocation program or has agreed to administer such a program.[128] In this situation, DEP can only require the applicant to successfully relocate and monitor all turtle nests that would be affected by the permitted activity.[129] The MTPA instructs DEP to give special consideration to beach preservation and nourishment projects that restore sea turtle habitat and requires the consideration of nest relocation for all such projects in urbanized areas.[130]

2. Beach and Shore Preservation Act

The BSPA[131] regulates beach and shore preservation projects such as beach restoration and nourishment and erosion control projects.[132] Protection of sea turtles and their nesting sites must also be addressed under this section when DEP grants permits.[133]

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[125] FLA. STAT. § 370.12(1)(d) (2014).
[126] FLA. STAT. § 370.12(1)(f) (2014).
[127] 16 U.S.C. § 1539(a)(1)(B)(iv) (2014) (Section 10 of the ESA authorizes the FWS and NMFS to permit "incidental" takings by non-federal, private actions if the action "will not appreciably reduce the likelihood of the survival and recovery of the species in the wild."). 16 U.S.C.A. § 1539(a)(1)(B) (2014) (An incidental take is one otherwise prohibited by the ESA but which is "incidental to, and not for the purpose of, the carrying out of an otherwise lawful activity.").
[128] FLA. STAT. § 370.12(1)(e) (2014).
[129] *Id.*
[130] FLA. STAT. § 370.12(1)(g) (2014).
[131] See also MARTIN CNTY., FLA., LAND DEV. CODE § 4.111(G) (Feb. 18, 2015) ("restored beaches shall, to the maximum extent possible, resemble the characteristics of pre-existing or adjacent natural beaches in terms of sediment grain size, compaction, refractivity, and beach slope."); and MARTIN CNTY., FLA., LAND DEV. CODE § 4.111(G)(2) (Feb. 18, 2015) ("restabilized dunes shall, to the maximum extent possible, be similar in appearance to the pre-existing or adjacent natural dunes in terms of profile, vegetation, and sediment characteristics.")

The BSPA requires consideration of sea turtle protection[134] in conjunction with state funding for beach restoration and nourishment projects and navigation inlet improvement.[135] When prioritizing projects that can receive up to 75 percent state funding, the state considers, among other criteria, the impact of the project on sea turtle nesting and the extent of local government legislation that protects sea turtles and preserves their habitat.[136] In order to receive any state funds, such a project must provide for protection of sea turtles and their nesting habitat.[137]

III. PROPOSAL TO EXPAND THE PROTECTION AND SURVIVAL OF SEA TURTLES ON EAST CENTRAL AND SOUTHEAST FLORIDA'S COAST

The most beneficial measures to accomplish the protection and survival of sea turtles on east central and southeast Florida's coast would be to research the nesting beaches regarding erosion and to secure additional critical habitat land under the ESA to promote nesting. Because of the warming beaches and level of erosion on many beaches, it will be necessary for additional egg hatcheries to be created or to move nests from the beach and onto a higher level dune to ensure hatching success and non-skewed sex ratios. Finally, the laws and requirements of beach nourishment need to be revised to include when the beach is nourished and implementing dune restoration in order to allow for more nesting area and vegetation for sea turtles to nest.

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[132] FLA. STAT. §§ 161.011-.45 (2014).
[133] FLA. STAT. § 161.053(19) (2014).
[134] FLA. STAT. § 161.161(1)(i), (2)(j) – (k) (2014).
[135] FLA. STAT. § 161.111 (2014).
[136] FLA. STAT. § 161.053(2)(j)-(k) (2014).
[137] FLA. STAT. § 161.161(2) (2014).

A. *Securing Additional Critical Habitat Land Under the ESA*

It has been shown that species with critical habitat protected under the ESA are twice as likely to show signs of measurable recovery compared to those without.[138] However, there is much reluctance in designating additional critical habitat as there is uncertainty as to which areas will undergo the most land loss and erosion. One of the biggest obstacles to overcome in obtaining critical habitat would be determining which stretches of beach are less eroded. As such, research should be conducted regarding what beaches should be deemed as critical habitat, designate critical habitat along beaches that are not currently in a severe state of erosion, and go forward with beach nourishment and dune preservation and nourishment projects in areas that are severely eroded.

On September 22, 2011, loggerhead sea turtle populations were protected as nine separate species under the ESA.[139] This triggered the requirement to propose critical habitat protections concurrently with the listings.[140] In 2012, the Center for Biological Diversity filed a notice of intent to sue the Obama administration seeking to protect critical habitat for imperiled loggerhead sea turtles on Florida's nesting beaches and marine waters in the Atlantic.[141] On January 8, 2013, conservation groups filed a lawsuit against the NMFS and FWS for the agencies' failure to protect critical habitat areas for threatened and endangered loggerhead sea

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[138] Anita Shirreffs, *A Win for Sea Turtles! 739 Miles of U.S. Coastline Protected for Loggerhead Sea Turtles*, SOUTH FLA. GREEN NEWS, http://southfloridagreennews.com/tag/sea-turtles-florida/ (last visited Apr. 20, 2015).
[139] Press Release, Ctr. for Biological Diversity, Lawsuit Launched to Protect Habitat for Florida's Loggerhead Sea Turtles (Apr. 16, 2012) (on file with author).
[140] *Id.*
[141] *Id.*

turtles on their nesting beaches.[142] On July 9, 2014, in response to the lawsuit filed, Federal and state officials created a new federal rule designating 300 miles of Florida coastline "critical habitat" for threatened loggerhead sea turtles.[143] One of the most successful gains of critical habitat for a species listed under the ESA was this critical habitat obtained for the loggerhead sea turtles after they were relisted as nine distinct population segments (DPS) in 2011. Therefore, green sea turtles, hawksbills, and leatherbacks should be relisted as DPS to force the government to designate critical habitat for each DPS.

Many green sea turtles as well as a few hawksbill sea turtles nest on the same beaches as loggerheads; however, these two species have different needs in regards to their nesting sites, as they nest under vegetation. These species do not have habitat to benefit and promote their continued existence without placing vegetation on the beaches and dunes that is suitable for them to nest. Planting dense vegetation also helps to alleviate the problem of skewing the sex-ratio of hatchlings, as the vegetation will provide shade that will allow for the opportunity to produce males. After listing the remaining species of sea turtles into DPS, additional critical habitat with vegetation and dunes that are not currently severely eroded or in need of renourishment in the near future should be obtained specifically for the green sea turtles and hawksbills.

B. *Implementing Sea Turtle Nest Relocation and Egg Hatcheries in Recovery Plans Under Section 4 of the ESA and Florida's Marine Turtle Protection Act to Protect Sea Turtle Nests from Erosion*

Clutch relocation is a common management tool used by marine turtle conservation programs, whereby clutches are moved from a threatened site to a safer location, be it to an

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[142] Press Release, Ctr. for Biological Diversity, Lawsuit Filed to Protect Loggerhead Sea Turtle Habitat, (Jan. 18, 2013) (on file with author).
[143] Jennifer Portman, *Federal 'Critical Habitat' for Sea Turtles is Set*, TALLAHASSEE DEMOCRAT (July 20, 2014, 12:16 am), tp://www.tallahassee.com/story/news/local/2014/07/20/federal-critical-habitat-sea-turtles-set/12904371/.

enclosed hatchery area or simply to another section of beach.[144] Relocation projects are authorized under state and federal permits.[145] Eggs are removed from the natural nest either during or shortly after oviposition,[146] placed in buckets or bags, and transported to a protected corral on the beach for incubation.[147] One option now available to those interested in conserving and managing sea turtle populations is the ability to produce hatchlings of a chosen sex ratio by controlling incubation temperatures.[148] Ideally, time in transport and handling is kept to a minimum to mitigate the effects of movement-induced mortality.[149] After the hatchlings emerge from the nests, the hatchlings are taken to the sea to ensure their safety as they enter the waters.[150] It is imperative that the nests at egg hatcheries and hatchling farms closely mimic the natural nest on the nesting beach in terms of depth, size, temperature, and sand, as these factors are important to ensure the highest hatchling success rate. Alternatively, some nesting beaches have higher dunes that have not been and will not be exposed to beach erosion and nests are able to be relocated these higher-level dunes. However, the most viable and realistic alternative would be to create low cost egg hatcheries and hatchling farms to ensure the highest rate of success and non-skewed sex ratios.

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[144] Annette C. Broderick, et al., *Impact of Clutch Relocation on Green Turtle Offspring*, 73 J. WILDLIFE MGMT. 1151, 1151 (2009).
[145] NRC, *supra* note 15, at 121.
[146] OXFORD DICTIONARIES, http://www.oxforddictionaries.com/us/definition/american_english/oviposit (last visited July 14, 2015) ("To lay eggs.").
[147] Steven R. Beissinger & Joanna Grade, *When Relocation of Loggerhead Sea Turtle (Caretta caretta) Nests Becomes a Useful Strategy*, 31 J. HERPETOLOGY 428, 429 (1997).
[148] Karen A. Bjorndal, et al., *Sex Ratio and Sex-specific Growth Rates of Immature Green Turtles, Celonia Mydas, in the Southern Bahamas*, 1992 COPEIA, 1098, 1099 (1992).
[149] Beissinger & Grade, *supra* note 147, at 429.
[150] Mari Mae, *Sea Turtle Nest Relocation and Egg Hatchery Program*, SEA TURTLE RESCUE (Apr. 14, 2012), http://www.seaturtlerescue.org/sea-turtle-nest-relocation-egg-hatchery-program/.

As part of a recovery plan for sea turtles under Section 4 of the ESA, egg hatcheries or nest relocation programs should be created for the nests to be monitored and kept safe. Specifically in regards to Florida, under the MTPA, the DEP ensures that the recovery plans created for each species of sea turtles is implemented. Therefore, the MTPA should require that the DEP relocate any nests in danger to egg hatcheries or higher level dunes. Insofar as funding for these programs in Florida, they should be funded through the Florida Sea Turtles Grants Program. The Florida Sea Turtle Grants Program is entirely sponsored by the sales of Florida's special sea turtle license plates.[151] The money from the sales of these plates gets awarded as grants to a number of organizations and local governments that are looking to work towards improving the sea turtles' odds.[152]

C. *Beach Management Proposal Utilizing Florida's Beach and Shore Preservation Act*

Two of the biggest issues with sea turtle nesting are the severe erosion of beaches, as well as the severe erosion of and lack of vegetation on beach dunes. Two of the most common criticisms of beach nourishment are the use of heavy machinery, which causes compaction to the sand, and the timing of beach nourishment. To reduce the compaction of sand, the most viable and cost effective solution is using beach tilling to fluff and soften the newly placed sand.[153] Beach tilling should be conducted so that the sand is softened to a depth that ensures the sand is softened for an adequate nesting depth.[154] Under the BSPA, it should be required that any beaches nourished should be tilled immediately after nourishment. Regarding the timing of

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[151] Carl Evangelista, *Sea Turtle Grants*, EVOLUTIONARY GRANT SERV., http://governmentgrantss.com/sea-turtle-grants (last visited Apr. 20, 2015).
[152] *Id.*
[153] Rupert, *supra* note 1, at 351-52.
[154] *Id.* at 352.

beach nourishment, which, in Florida, usually occurs during the summertime, the BSPA should be revised to include the timing of beach nourishment. As some turtles start nesting as early as late February until November, it could be required that all beach nourishment projects take place during the months of December through early-February in order to decrease the chances of nests being buried and destroyed during the nourishment process.

Further, the largest problem associated with beach nourishment is the characteristics of the sand brought in matching the characteristics of the natural sand. Most beaches along the Florida east central and southeast coast have the same sand texture. However, the problem is finding sand from offshore borrow sites that match the natural sand characteristics as many beaches are too heavily eroded to borrow from one beach to bring to another. It is even more of an issue now that Broward and Dade counties have depleted their offshore sources of sand that can be used for renourishment projects.[155] An alternative to offshore sources could be to research creating manmade sand that is comparable to and resembles the sediments and moisture levels found in the natural beach sand.

A good model for the BSPA to incorporate regarding beach nourishment is the Brevard County Shore Protection Project ("BCSPP"). In the BCSPP, close attention was paid to the selection of the offshore borrow areas where sand was obtained to ensure that the sand was compatible with native beach sand and suitable for turtle nesting.[156] The county monitored the constructed beach for excessive sand compaction and scarp formation that could be problematic

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[155] *Sand Shortage Leaves South Florida Beaches Vulnerable to Erosion,* TAMPA BAY TIMES, http://www.tampabay.com/news/environment/sand-shortage-leaves-south-florida-beaches-vulnerable-to-erosion/2136553 (last updated Aug. 14, 2013).

[156] Don Barber, *Beach Nourishment Basics,* BRYN MAWR COLL., http://www.brynmawr.edu/geology/geomorph/beachnourishmentinfo.html (last visited Apr. 20, 2015).

for nesting.[157] Because of the high level of success in beach nourishment with the BCSPP in correlation with the effect on nesting sea turtles, the process that the BCSPP used to nourish their beaches should be regulated and made mandatory under the BSPA.

As discussed previously, green sea turtles and hawksbill sea turtles nest in and under vegetation, which is located on beach dunes. Dune restoration will help with the severe erosion and create additional nesting area for green sea turtles and hawksbills. The BSPA should require that dunes be nourished, as well as restored with native vegetation, and invasive vegetation removed, during the times beaches are being renourished. Dunes should be restored each time beach renourishment is conducted so that the sand is the same within the beach and dune, and as to minimize the heavy machinery on the beach during the restoration. Funding for dune restoration should come from the same funding that is used for beach nourishment projects.

An alternative method of funding for dune preservation and restoration projects would be from funds generated through Florida's Amendment 1. Florida's Amendment 1, which was passed in November, 2014, is where the state, for the next twenty years, dedicates 33 percent of the documentary taxes on real estate sales to the purchase and care of environmental lands and other programs meant to benefit the state's natural resources.[158] Therefore, if funding is not available using the same funding resources as beach restoration projects, an alternative would be to preserve and restore the dunes with the funding made available through Florida's Amendment 1.

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[157] Barber, *supra* note 156.
[158] FLA. CONST. art. X, § 28 (2014).

CONCLUSION

Florida is facing new threats to sea turtles due to climate change that were not previously recognized due to the effects taking hundreds, if not thousands, of years to occur. The measures previously taken in an effort to delist sea turtles from the endangered and threatened species lists have only been able to simply maintain their status as endangered or threatened. Therefore, if we only continue to mitigate the effects of climate change instead of finding a way to adapt, it will not be long before the sea turtles will have no nesting beaches and will be unable to reproduce.

The first step is to relist green sea turtles, hawksbills, and leatherbacks into DPS and designate critical habitat. Secondly, for nesting beaches that are already facing extreme erosion and warming, nests need to be moved to higher level dunes, where possible, and to egg hatcheries if not. Lastly, beach nourishment needs to have better implementation measures to include the timing of beach nourishment, as well as to incorporate dune preservation and restoration, both of which should occur outside of the nesting season.

Overall, Florida has successfully implemented many laws protecting sea turtles, their nesting habitats, and their nests. With the current information regarding climate change, those laws need to be adjusted to take into consideration the current state of the climate. Due to the irreversible effects of climate change, global warming, warming beaches, and erosion, it is imperative that Florida now shifts from mitigating the effects of climate change to the mindset of adaptation in order to avoid extinction of Florida's nesting sea turtles. With Florida playing such an integral part in the continued reproduction of sea turtles, there is no other option but to take immediate measures before sea turtles nesting in Florida becomes irreversible too.