

# A Shortage of Males: Changing Sex Ratio of Loggerhead Sea Turtles (*Caretta caretta*)

## Rising temperatures producing more female hatchlings

### Introduction

The environment is under severe threat due to anthropogenic climate change. Currently species are dying off at increasing rates, mimicking past mass extinction events (Hawkes et al., 2007).

Sea turtles are no exceptions, they are under treat from bycatch from commercial fishing and hatching interference. As the climate shifts and the oceans continue to warm and acidify sea turtles could face much worse problems.

As a retile, sea turtles lay eggs, doing so on the same beaches they were hatched from year after year. For Loggerhead Sea Turtles (*Caretta caretta*), common in the southern United States, nesting occurs every two to four years after reaching

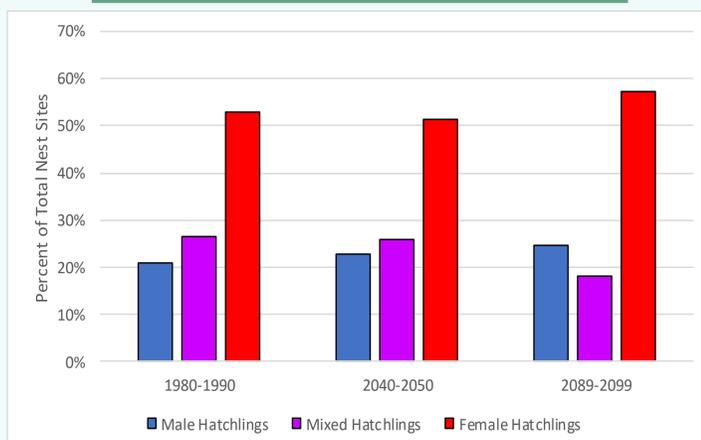


maturity at twenty years old (NOAA Fisheries). In one nesting season, which lasts from April until September, loggerheads can lay three to six nests, each with over 100 eggs (NOAA Fisheries).

Unlike mammals, reptiles do not have sex chromosomes instead their sex is determined by incubation temperatures (Fuentes et al., 2011). Females are usually the result of temperatures over 87 F while males result from temperatures under 82 F, in between the extremes is a mix (Fuentes et al., 2011).

With increasing global temperatures, the ratio of male to female sea turtles should shift as incubation temperatures rise with the climate.

Ratio of Sex Distribution of Loggerhead Sea Turtles Based on Current Nest Sites

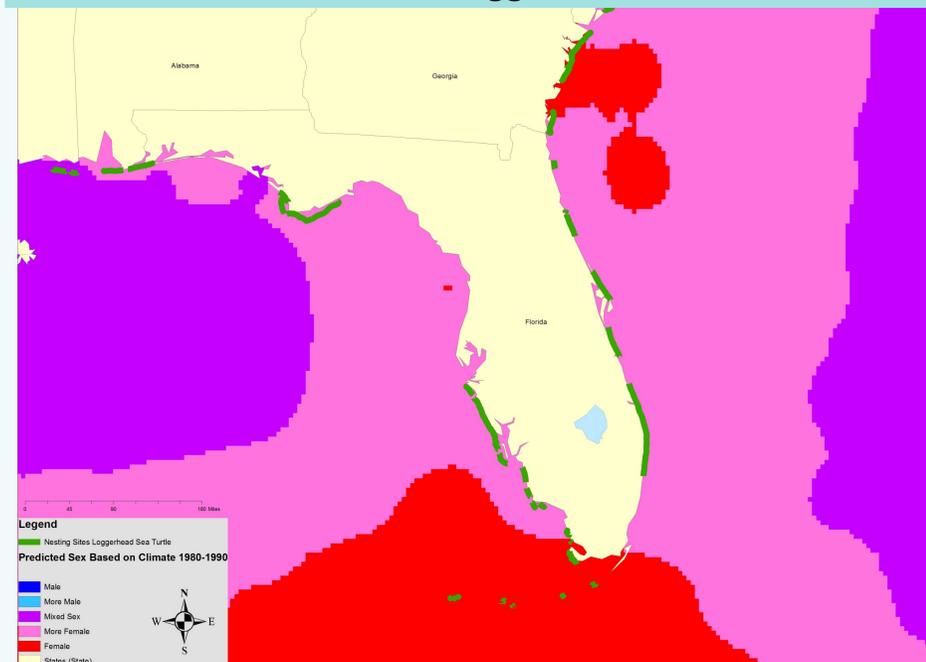


### Questions and Methods

Will the likelihood of male sea turtle hatchlings decline over the three selected time periods using high CO<sub>2</sub> emissions predictions (A2 Climate Scenario)?

GIS data on climate predictions in ten year selections for the United States were gathered from NCPN Climate Change Scenario. Location of loggerhead sea turtles' nesting sites in the southeast United States taken from NOAA Fisheries. Climate predictions were based on IPCC A2 Scenario, which expects delayed development of renewable energy. Climate data was interpolated using inverse distance weighting and exported to a raster. All rasters were reclassified and broken down into five categories signifying likely sex of sea turtle hatchlings. Loggerhead sea turtles' critical nesting sites were mapped over sex distributions. Totals for each sex category were taken to create a graph using Excel.

### Historic Sex Distribution of Loggerhead Turtles 1980-1990



#### Data Sources:

Loggerhead Sea Turtle Critical Habitat in the Northwest Atlantic Ocean : NOAA Fisheries from <http://www.nmfs.noaa.gov/pr/species/turtles/criticalhabitatloggerhead.htm>

GIS Climate Change Scenarios from <https://gisclimatechange.ucar.edu/gis-data>

#### References:

Fuentes, M. M. P. B., Limpus, C. J., & Hamann, M. (2011). Vulnerability of sea turtle nesting grounds to climate change. *Global Change Biology*, 17(1), 140-153.

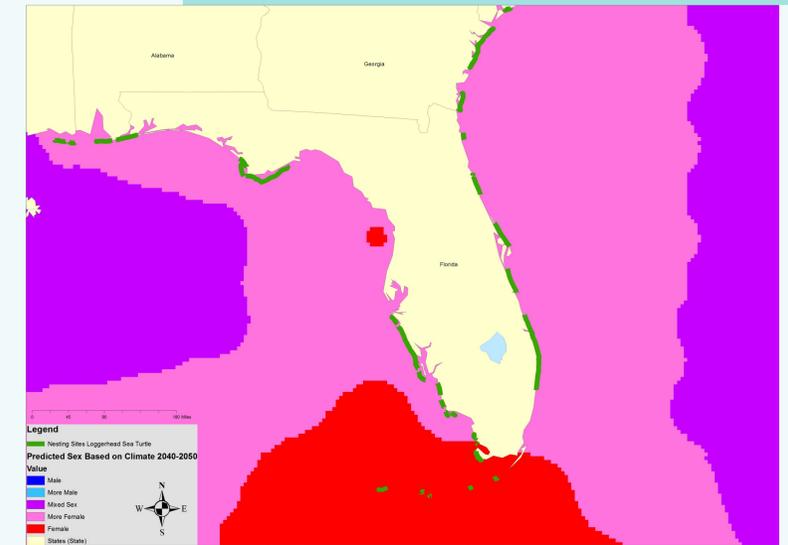
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Listing status and biological information of Loggerhead sea turtles | North Florida ESO Jacksonville. (n.d.). Retrieved April 30, 2018, from <https://www.fws.gov/northflorida/SeaTurtles/Turtle%20Factsheets/loggerhead-sea-turtle.htm>

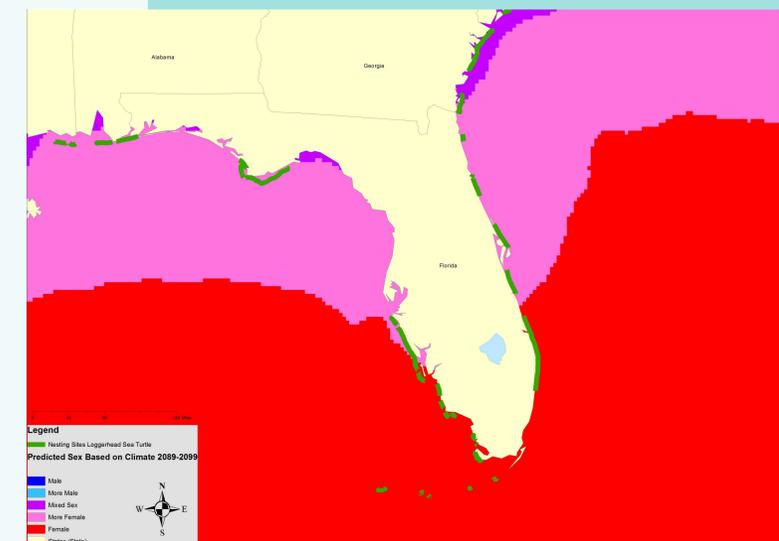
Matsuzawa, Y., Sato, K., Sakamoto, W., & Bjorndal, K. (2002). Seasonal fluctuations in sand temperature: effects on the incubation period and mortality of loggerhead sea turtle (*Caretta caretta*) pre-emergent hatchlings in Minabe, Japan. *Marine Biology*, 140(3), 639-646.

NOAA Fisheries. (n.d.). Loggerhead Turtle (*Caretta caretta*) :: NOAA Fisheries. Retrieved April 30, 2018, from <http://www.nmfs.noaa.gov/pr/species/turtles/loggerhead.html>

### Predicted Sex Distribution 2040-2050



### Predicted Sex Distribution 2089-2099



### Results and Discussion

Southern Florida populations of Loggerhead turtles will produce fewer male turtles by the year 2099 if CO<sub>2</sub> emissions continue to increase. As temperatures rise the range that produces female hatchlings will move north. The mixed sex range of hatchlings will also decrease over time, leaving the male population at high risk of survival. This will effect the turtles genetic diversity likely leading to a population crash due to increasing fatal mutations. Loggerheads could start to nest further north if not action is taken to reduce emissions. Future studies could look at the lethal temperature limit of nests to determine when loggerhead populations in the Florida area are likely to crash and cause species extinction.

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