Forecasting range expansion of marine turtles and their exposure to coastal development

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Background

Climate change is a major threat to biodiversity.

To adapt to climate change a species may either shift its range by dispersing to newly climatically suitable locations or evolve new adaptive traits in situ.

Several studies have explored whether environmentally suitable habitat will be available for species in a changing climate and what potential range shifts might be

Range shifts may be accompanied by increased exposure to other threats or, more optimistically, to areas where fewer threats exist.

There is the need to couple predictions of species distribution with an assessment of exposure to other threats. Such analysis will indicate whether habitat that is environmentally suitable in the future will provide the necessary buffer for species to redistribute their geographic locations as an adaptive response to deal with environmental changes.

However, studies that explore potential range shifts by species concentrate mainly on identifying areas that will be environmentally suitable for species under a range of climatic scenarios, without exploring the anthropogenic disturbances of these areas.

Objective

To model the geographic distribution of suitable nesting habitat for 3 species of marine turtles in the USA under future climate scenarios (2050) and identify potential range shifts and consequent changes in exposure to coastal development.

Methods

Georeferenced sea turtle nesting areas, as well as their relative importance were obtained from the State of the World's Sea Turtles (SWOT).

Current (1950-2000) climate data was obtained from the WorldClim global climate database.

We selected Bioclim variables that provided the maximum climate information whilst avoiding strongly inter-correlated variables and that were ecological meaningful for sea turtles, including:

- mean diurnal range in temperature (°C),
- isothermality,
- maximum temperature of the warmest month (°C),
- temperature annual range (°C),
- precipitation seasonality (coefficient of variation),
- Precipitation of the wettest quarter (mm), Precipitation of the driest quarter (mm), Precipitation of the warmest quarter (mm),
- Precipitation of the coldest quarter (mm).

Methods cont.

For our future climate data, we obtained data for five different GCMs with in the A2 IPCC SRES scenario for the 2050 time period (average for 2041-2060) from CMIP3 from the International Centre for Tropical Agriculture's

We used maximum entropy modelling to predict the distributions of sea turtle nesting grounds for both our current and future time periods.

To identify where environmental suitability differed significantly between current and future time periods, we applied the SigDiff function in the R package SDMTools.

SigDiff computes the pairwise differences between each grid cell of two species distribution model prediction output maps. We used this to identify where the future distribution predicted significantly higher environmental suitability (SD ≥ 0.975) or significantly less environmental suitability (SD ≥ 0.025) in comparison to the current distribution.

Results to date

We have modelled the current and future habitat suitability for green, loggerhead and leatherback turtles. Initial analysis indicates that some of the current habitat used by turtles will be less suitable in the future (Fig 1.)

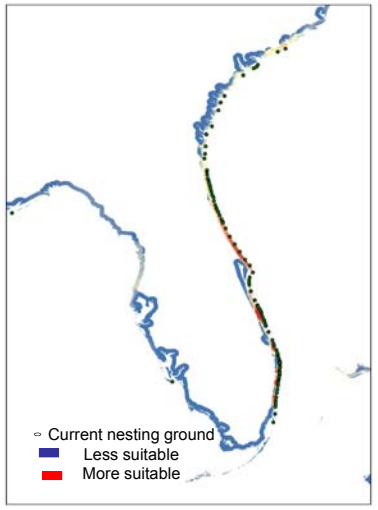

Figure 1. Leatherback distribution and future suitability.

Future work

Determine whether nesting areas more suitable in the future will have higher or lower exposure to coastal development.