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Arctic Shorebird Habitat Climate Change Resilience Analysis

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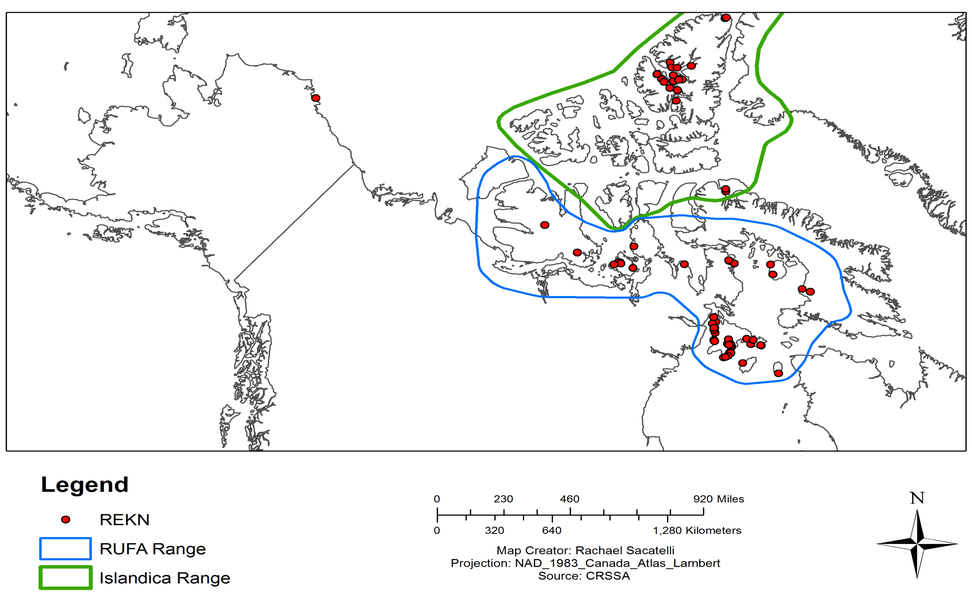
Problem Statement: The objective of this project was to identify likely, high-quality breeding habitat for Arctic-nesting shorebirds that is considered to be resilient to climate change, i.e. has the potential to persist or develop with climate warming. The focus was on two selected shorebird species, the Red knot (*Calidris canutus; REKN*) which were chosen to serve as proxies for a broader suite of Arctic-nesting shorebird species. The *rufa* subspecies of Red knots have been recently listed as a Threatened Species by both the USA and Canada.

The presence points for the Red Knots were collected primarily from the Program for Regional and International Shorebird Monitoring and the Arctic Shorebird Demographic Network.



Project Approach: We have combined existing shorebird population (derived from the literature, established sightings databases and Arctic experts), environmental and modelled climate data (for the present day) with species distribution models (SDM) to identify and map current, high-quality locations for the target species. Once fit, the SDMs were used to map the expected species distribution under a projected future climate in the year 2070 for a range of warming scenarios. Further geospatial analysis to identify landscape-scale sites that are expected to retain suitable or support new suitable shorebird habitat under climate change and to identify the current protective status.

First, Maxent was used to model the baseline situation (i.e. current day) using a suite of environmental and climate data to determine the current and future habitat suitability.

Environmental Parameters
Elevation
Land Cover
Bedrock/Surficial Geology
Distance to Coastal Water
Conservation Lands

Climate Parameters
Annual Mean Temperature
Temperature Annual Range
Annual Precipitation (sum of daily mean rate)
Snow cover duration

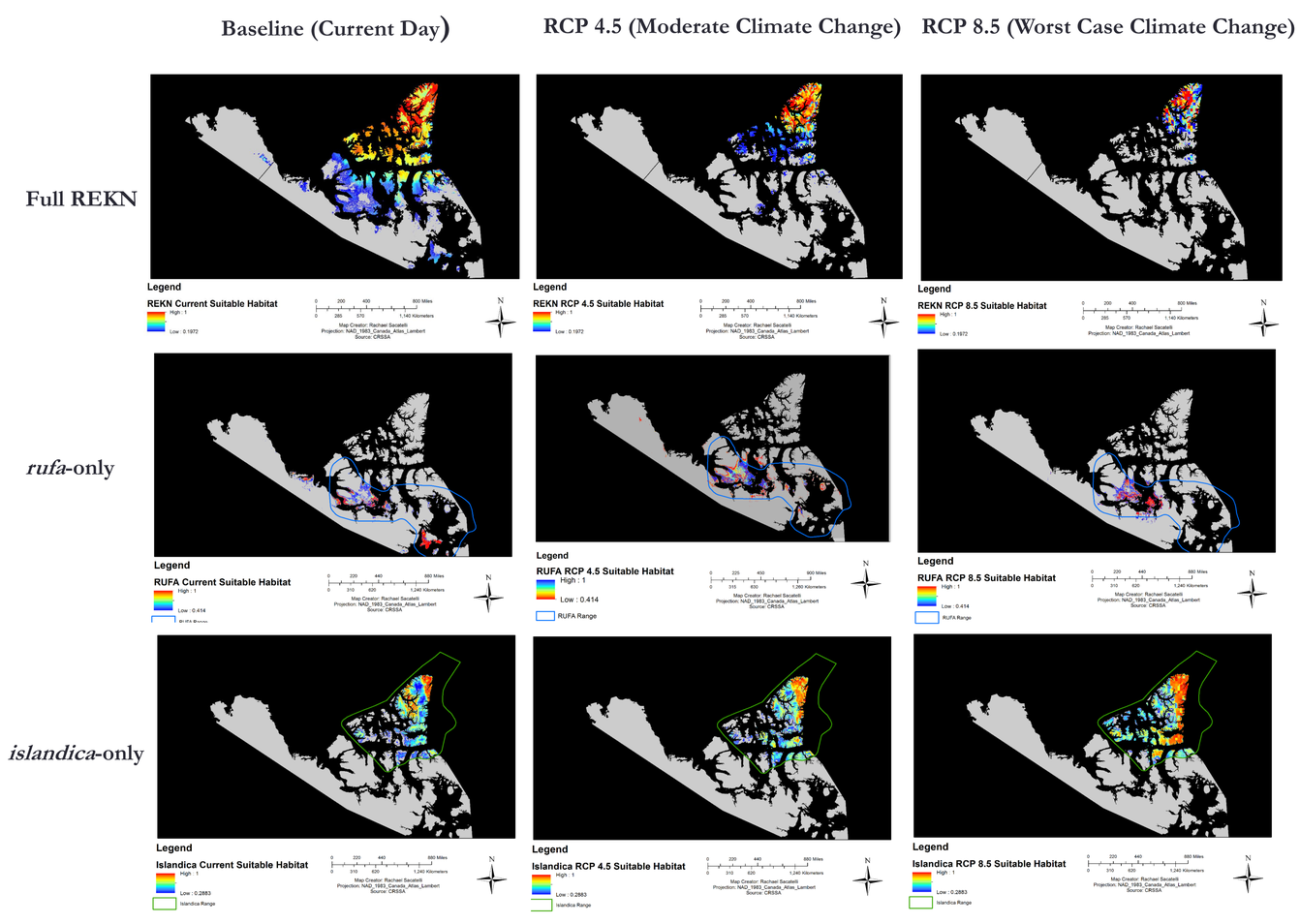
Second, once the Maxent model had been satisfactorily parameterized for the baseline situation, we substituted in the same climate variables for the projected future climate scenarios as of the year 2070: 'moderate-case' (Representative Concentration Pathway (RCP) 4.5); and, 'worst case' (RCP 8.5).

Because of concerns that the individual subspecies of Red knot (*rufa* and *islandica*) might display different model behaviors, we fit a full REKN model (sample size = 80) as well as separate *rufa-only* (n= 50) and *islandica-only* (n = 29) models.

Major Findings

- The full REKN and the *rufa*-only modelling results predict a wholesale decrease in predicted breeding habitat suitability in the southern section of the *rufa* subspecies breeding range while the *rufa*-only model suggests increasing habitat suitability in selected locations in the central section of the *rufa* range under future climate change.
- The *islandica*-only model suggests an increase in suitable habitat area for a broad swath extending across the southern section of the High Arctic Islands.
- In both cases, a significant portion of the new habitat areas predicted by the individual subspecies models under both climate change scenarios occur at the spatially distant end of the subpopulation breeding ranges requiring each subspecies population to travel farther distances to utilize the potential new habitat.
- A comparatively small percentage of the retained and new Red knot breeding habitat under both climate change scenarios is in protected lands, and this primarily in the *islandica* range, not the *rufa* range.
- Our results suggest that the *rufa* subpopulation of Red Knots is more vulnerable to future climate change than *islandica*.

The Maxent model parameterized for the baseline situation (i.e. current Day), then projected results across the entire Arctic study region. The resulting mapped model outputs were used predict habitat areas that are likely to be effected and conversely to identify those areas most likely to persist under RCP 4.5 and 8.5 climate change scenarios (to 2070):



The habitat suitability maps developed were combined to identify locations that support persisting (i.e., qualifies as suitable under Current and Future conditions) or new (i.e., qualifies as suitable under Future conditions only) shorebird habitat under the 2070 climate change scenarios. The Protected Areas GIS data were overlaid to identify the current protective status, if any, of all sites that are identified as new or persisting habitat.

Habitat Category	Current	RCP 4.5	RCP 8.5
Not Habitat Ever	Unsuitable	Unsuitable	Unsuitable
Habitat Loss All	Suitable	Unsuitable	Unsuitable
Retain RCP4.5	Suitable	Suitable	Unsuitable
Retain RCP8.5	Suitable	Unsuitable	Suitable
Retain All	Suitable	Suitable	Suitable
New RCP4.5	Unsuitable	Suitable	Unsuitable
New RCP8.5	Unsuitable	Unsuitable	Suitable
New All	Unsuitable	Suitable	Suitable