Modeling the distribution of rare plants in Southwest Alaska:

Identifying rarity hotspots and guiding future floristic inventory efforts

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Introduction

The southwest region of Alaska is floristically diverse. Elements of the low arctic, interior-boreal, Aleutian, and Pacific coastal floras converge here, and approx. 60 percent of Alaska's vascular plants occur in one or more of the SWAN* National Park units.

Using the baseline inventory data compiled during the 2001-2004 SWAN* Inventory & Monitoring plant surveys we examine patterns of floristic distribution and to identify hotspots of plant endemism across this region.

* The Southwest Alaska Network (**SWAN**) consists of five units: Alagnak Wild River (WR), Aniakchak National Monument & Preserve (NMON), Katmai National Park & Preserve (NPP), Kenai Fiords NP, Lake Clark NPP

Research objectives

The data collected during the 2001-2004 Inventory & Monitoring surveys is being used to model the potential distributions for 22 plant species of conservation concern that occur in southwest Alaska. The results will be used to address the following questions:

1. Which sites in southwest Alaska are likely to have the **greatest concentrations of rare plant species**?
2. How **well represented** is southwest Alaska's plant diversity within the five SWAN units?
3. Which areas should be **prioritized for future botanical fieldwork**, based on their likelihood of containing greater numbers of plant species that are uncommon (rare or under-collected)?

Methods (I)

Input data:

- **bioclimatic** layers (Table 1)
- **point data** for 14 rare species (Table 2).
- Species were selected on the basis of:
  (1) their conservation rank
  (2) the number of distinct collection localities available within the study region (minimum 5 unique records/species)

Table 1. List of environmental layers that will be used in the final analyses.

Layer name	Information on:
PRISM	Climate (derived from monthly temperature and precipitation data)
National Land Cover Dataset	Land cover
AK National Elevation Dataset (NED)60m	Elevation (Digital Elevation Model)
Aspect♣	Identifies he steepest down-slope direction from each cell to its neighbors
Slope ♣	Measure of slope steepness
Relative Slope Position ♣	position on slope relative to ridge line and stream
Terrain Shape Index ♣	measures local convexity or concavity
Beer's Heat Load Index ♣	Solar insolation
Topographic Relative Moisture Index modified ♣	Soil moisture

♣ Indicates layers the will have to be derived/calculated from the other layers

Table 2. List of 14 plant species of conservation concern whose distributions will be modeled in this project.

Species name	Global rank	State rank
Aphragmus eschscholtzianus	V	V
Arnica x diversifolia	S	CI
Botrychium alaskense	V-I	V-I
Douglasia alaskana	V	V
Draba ruaxes	V	V
Potamogeton subsibiricus	V	V
Primula tschuktschorum	V-I	V-I
Ranunculus pacificus	V	V
Romanzoffia unalaschcensis	V	V
Rumex beringensis	V	V
Smelowskia pyriformis	I	I
Stellaria alaskana	V	V
Stellaria dicranoides	V	V
Thlaspi arcticum	V	V

CI = Critically imperiled, I = Imperiled, V-I = vulnerable to imperiled, V = Vulnerable; AS = apparently secure, S = Secure (NatureServe 2009, http://www.natureserve.org/explorer/ranking.htm)

Methods (II)

Species distribution modeling tool

- **MaxEnt *v.2.2*** **(Phillips et al. 2006,** http://www.cs.princeton.edu/~schapire/maxent/): ecological niche-modeling program that **calculates** expected levels of species presence. Results can be transformed into **probability of occurrence values** for each pixel (cell) in the study area (not just presence-absence data).

MaxEnt runs (Fig. 1)

- Spatial analysis cell size = 60 meters
- For all runs, **jackknife tests will be conducted** to determine which **biophysical variables** are most important to the model.

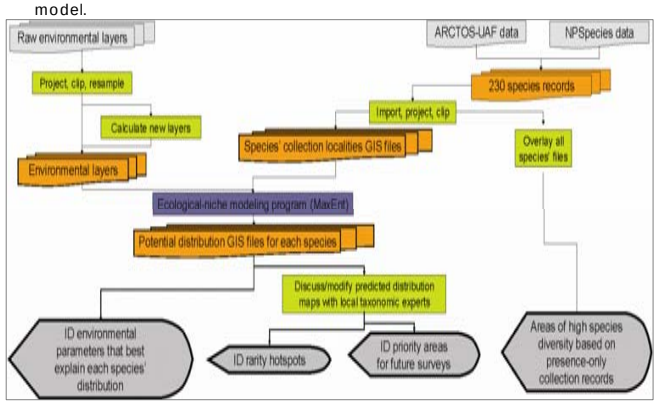
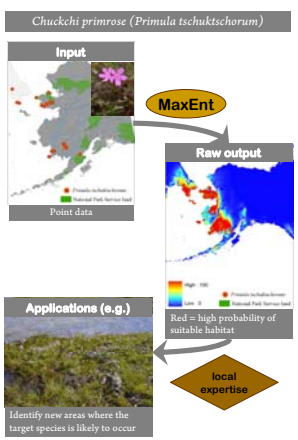
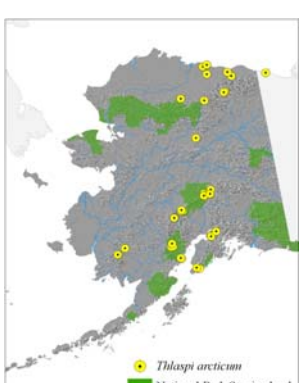


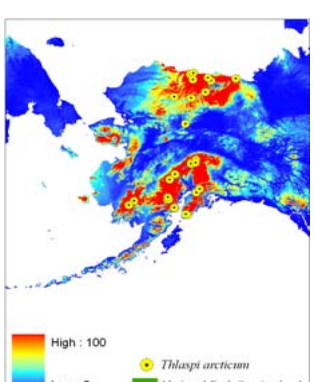
Figure 1. Flow-chart summarizing the main steps involved in modeling the distribution of 22 rare plant species that have been recorded in southwest Alaska, including the main deliverables that will result from this work.



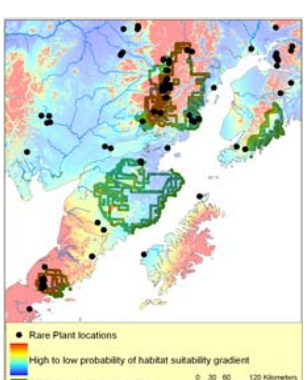
Sample MaxEnt results



Thlaspi arcticum collection localities



Thlaspi arcticum MaxEnt raw output using 1km DEM and PRISM data only



Results of overlaying MaxEnt raw outputs for 14 species (listed in Table 1)

- Some caveats:
  1. Under-collected species: distributions for species with < 5-10 unique data points cannot be effectively modeled
  2. The coarse scale resolution of the DEM (60 instead of 30m) and climate data (PRISM, 1km) limits the programs ability to detect variations due to micro-topography. A good soils layer indicating areas of high/low pH would be especially useful as many AK rare plants are restricted to calcareous substrates.

Accomplishments II

1. Collections dataset for 203 plant species of conservation concern/ with notable range extensions following I&M surveys (sources: NPSpecies and ARCTOS-UAF)
2. Compilation of information on the biology and conservation status for 15-25 rare plant taxa to be used in MaxEnt (sources: experts, publications, collections database, BIOTICS – Rare Plants databse)

Next steps

1. Complete production of 'derived' environmental layers from 60m resolution NED
2. Run MaxEnt for all species of conservation concern w. >5 unique location points/study area
3. Discuss results of modeled distributions with local plant experts and modify accordingly

Aphragmus eschscholztianus collection site, Katmai NP. SWAN I&M surveys.

Expected Management and Conservation Implications

1. MaxEnt detects which biophysical variables were most useful in determining a species' distribution. Results may allow us **identify some key environmental parameters that drive each species' current distribution**
2. There is a current lack of information on the ecology and distribution of rare plants in Alaska. Combining predicted distribution maps with local plant expertise allows us to **better predict which areas may harbor rare or notable plant species**. This information can be used help guide future survey efforts
3. This should lead to an increase in
4. If additional rare plant populations are found as a result of this effort, this could result in the **re-evaluation of many species' conservation status**

References

Phillips, S. J., R. P. Anderson, and R. E. Schapire. 2006. Maximum entropy modeling of species geographic distributions. Ecological Modelling, 190: 231-259. Url: http://www.cs.princeton.edu/~schapire/maxent/.

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