



Refugia for Endemic Alpine Plants in the Pacific Northwest

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What are the potential responses of endemic alpine plants to climate change?



Endemic

A native species
with a limited geographic distribution



← *Saxifraga vespertina*

A high-altitude mountain landscape with snow-covered peaks and rocky outcrops under a clear blue sky. The foreground is dominated by a large, smooth snowdrift. In the background, dark, jagged mountain ranges stretch across the horizon, with some snow patches visible on the slopes. The sky is a pale, clear blue.

Alpine:

- Land above tree-line
- Cold, wind & snow
- Short growing season



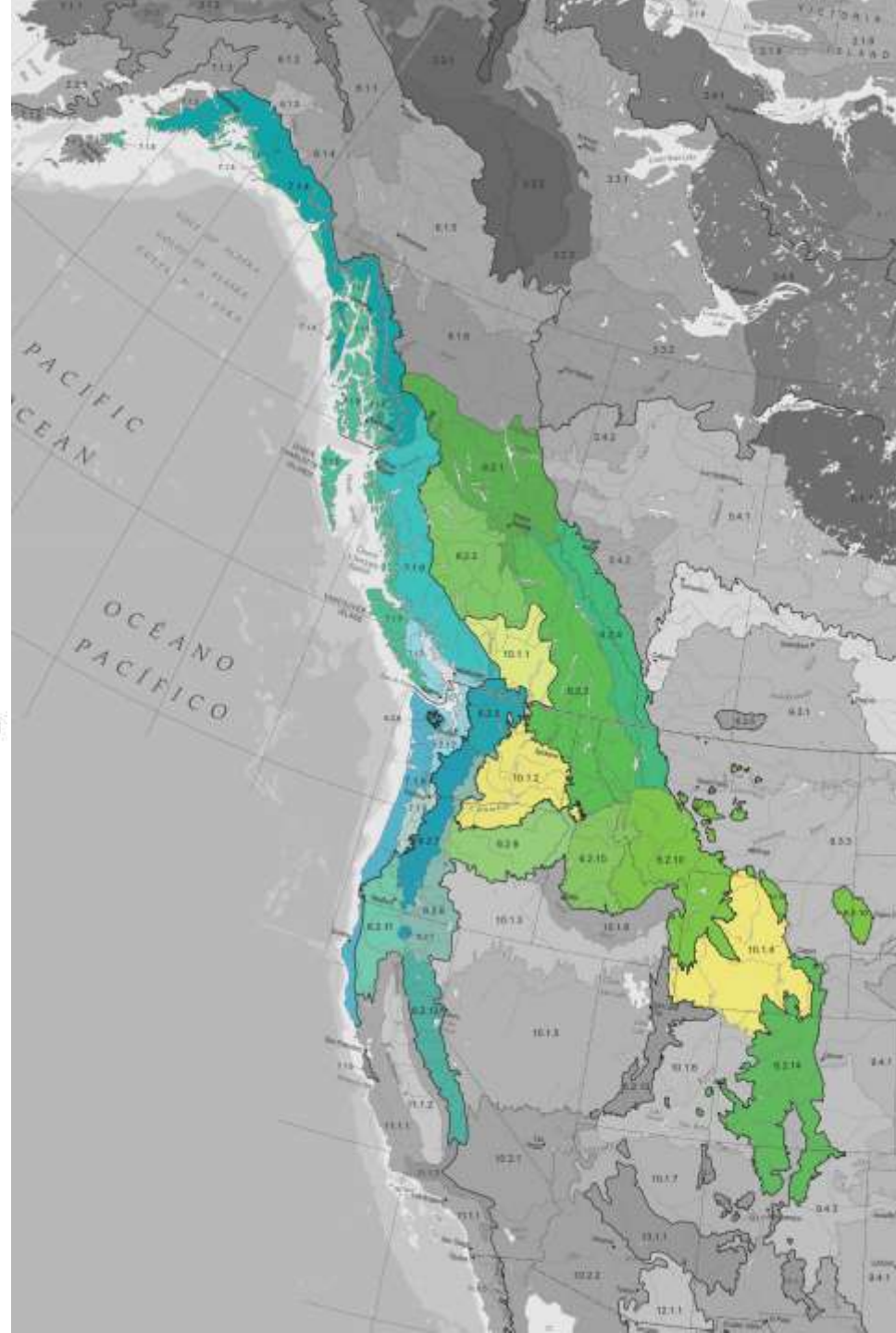
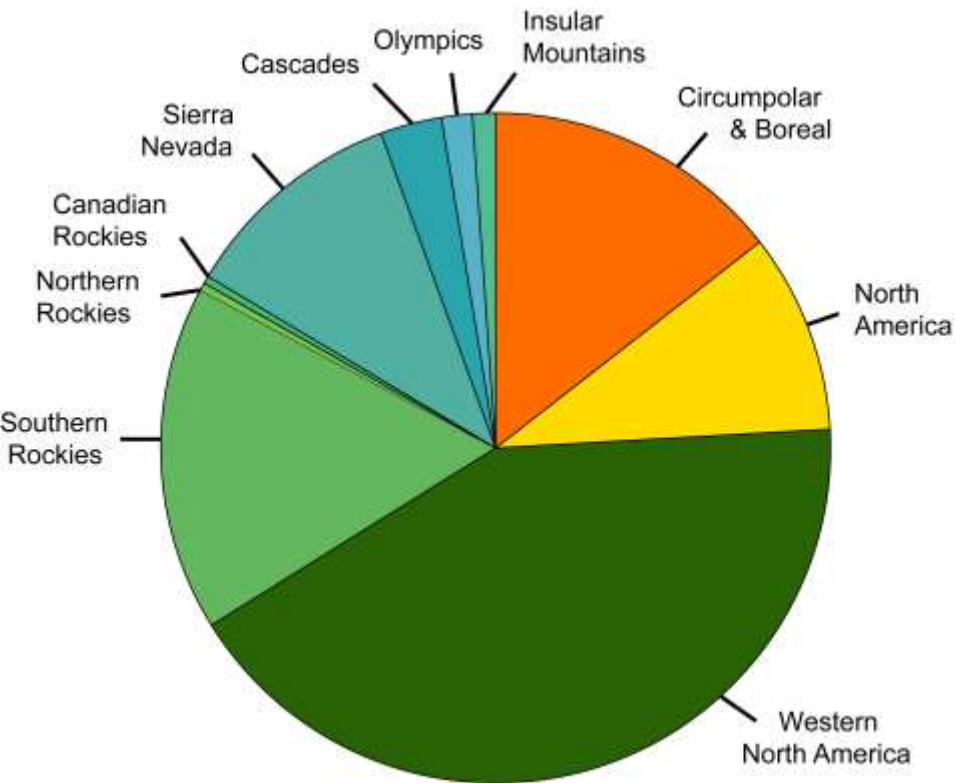
Rocky Mountain Floristic Region



You are here

Takhtajan 1978

Degree of endemism in alpine plants in the RMFR



Endemic Alpine Plants



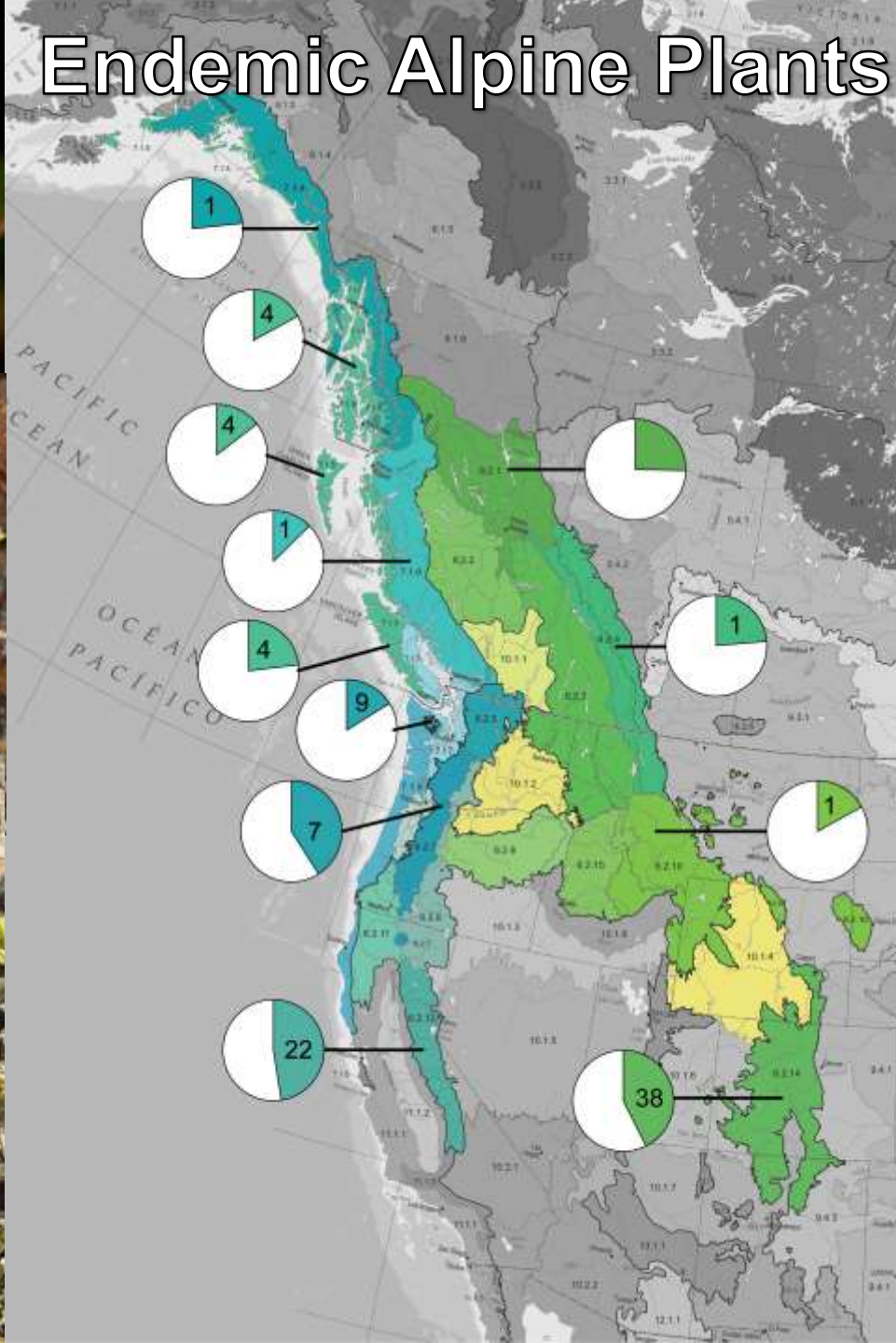
Saxifraga taylorii



Viola flettii



Ivesia muirii



Arnica louiseana

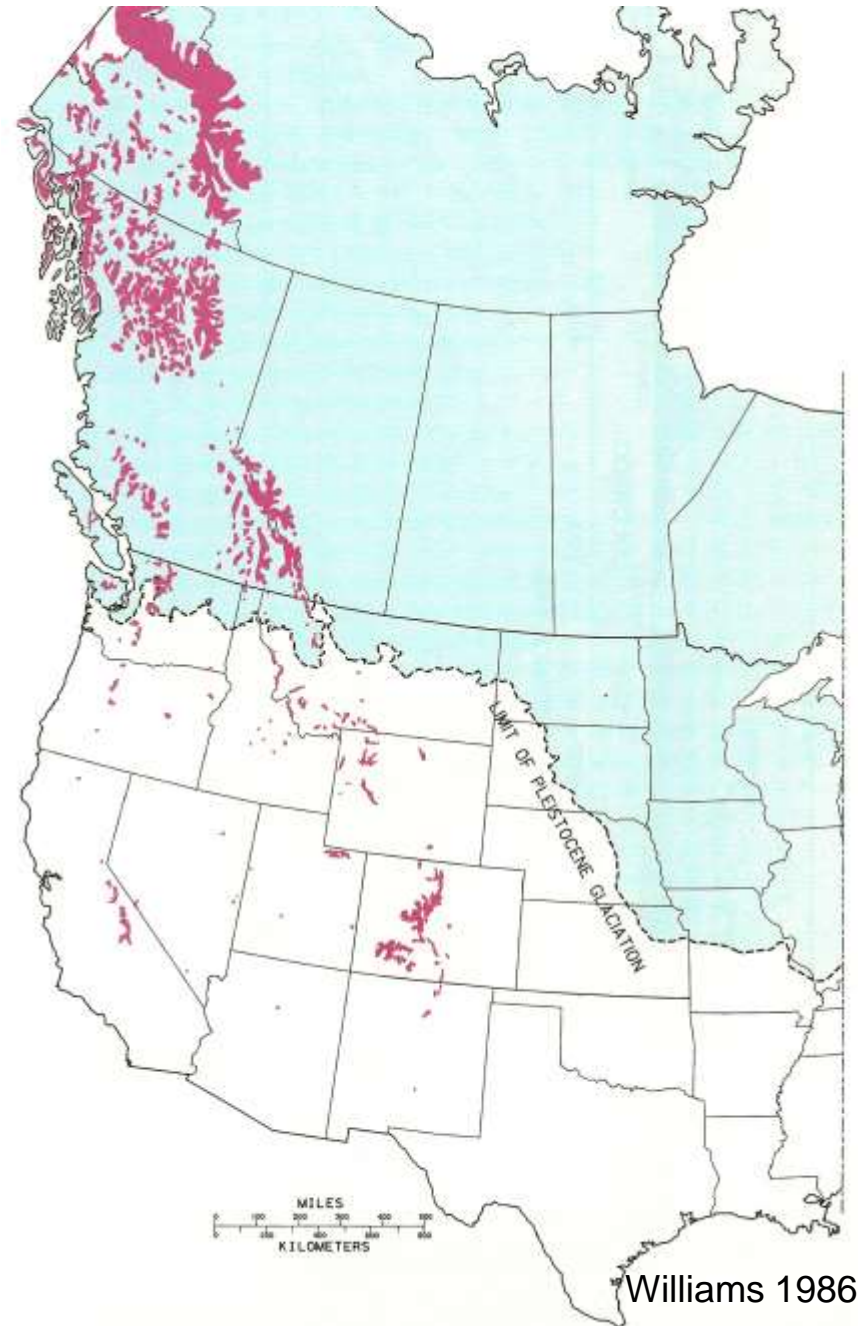
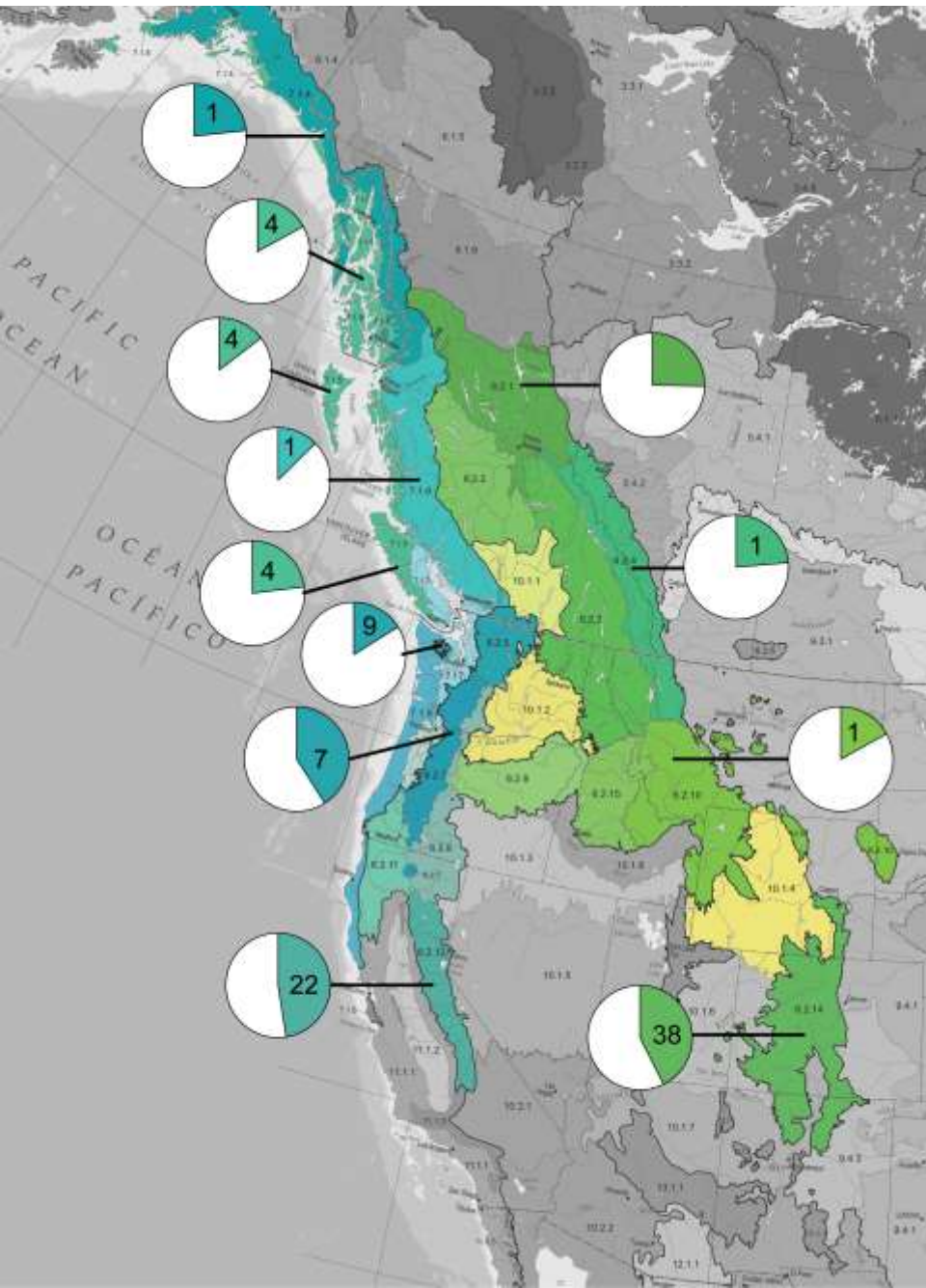


Erigeron evermannii



Rhodiola rhodantha

Distribution of endemics reflects Glacial Refugia



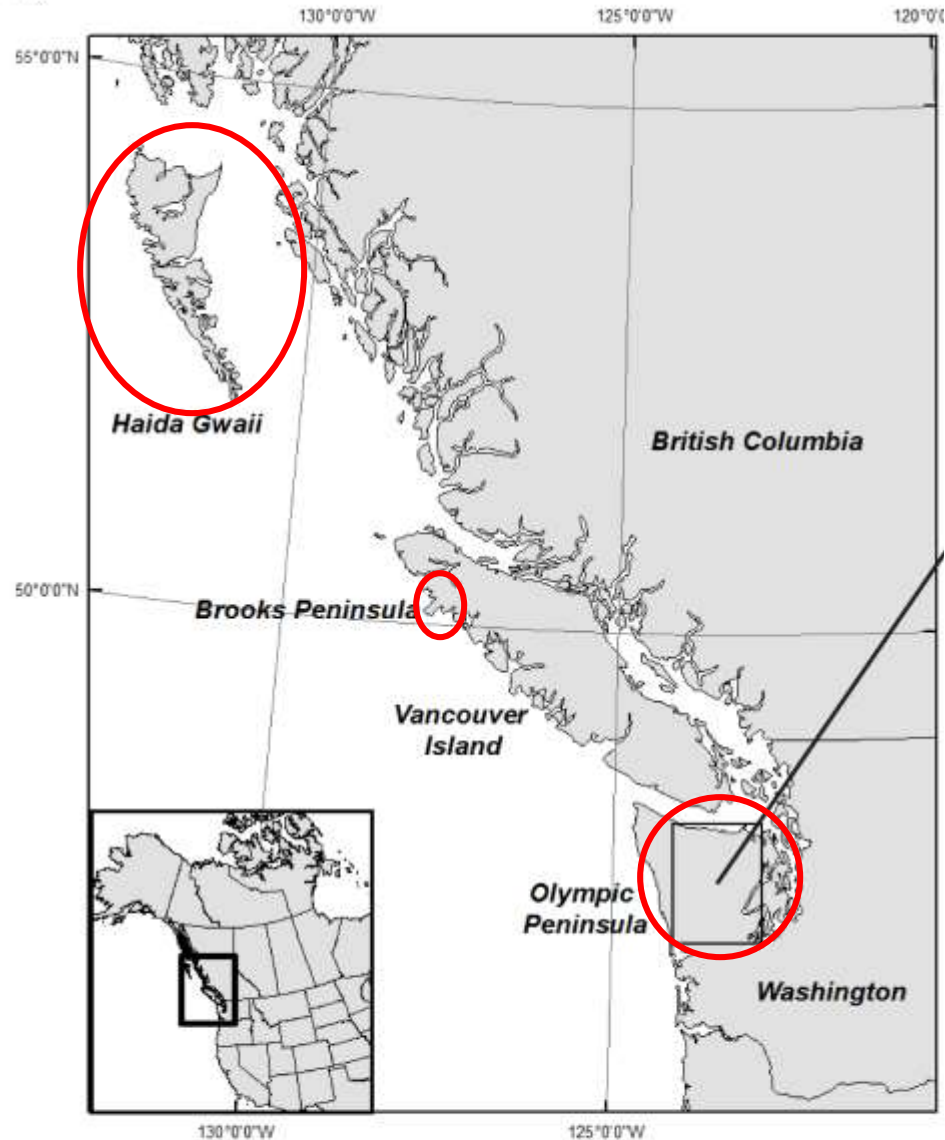
Glacial Refugia



Areas of suitable climate and habitat that allowed species to persist through the Ice Ages

Insular Mountain Refugia

A)



- Continuous geographic isolation throughout warm and cold periods

- Haida Gwaii**
(4 endemic alpine taxa)

- Brooks Peninsula** on Vancouver Island
(4 endemic alpine taxa)

- Olympic Peninsula**
(9 endemic alpine taxa)

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How will endemic alpine plants
of the Olympic Mountains be impacted
by climate change?





Campanula piperi



Viola flettii



Erigeron flettii



Senecio neowebsteri

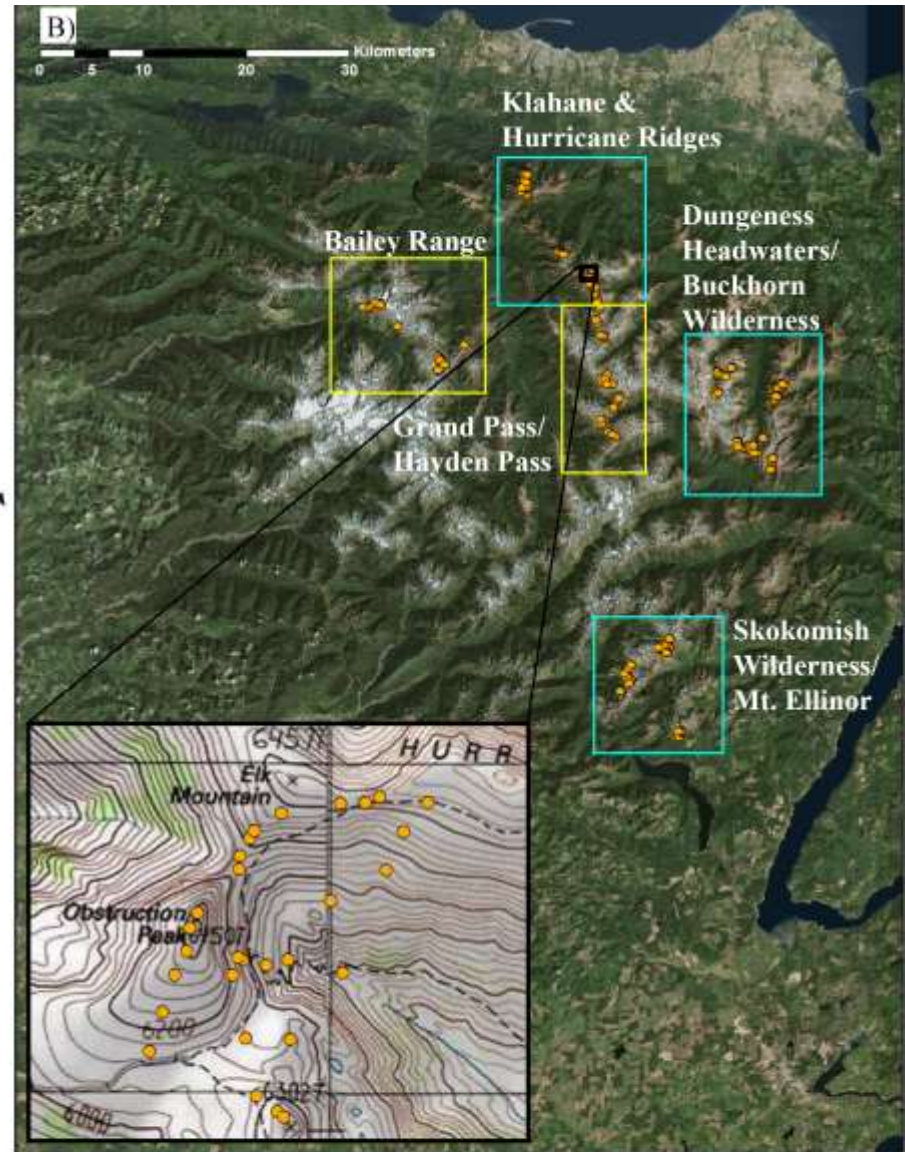
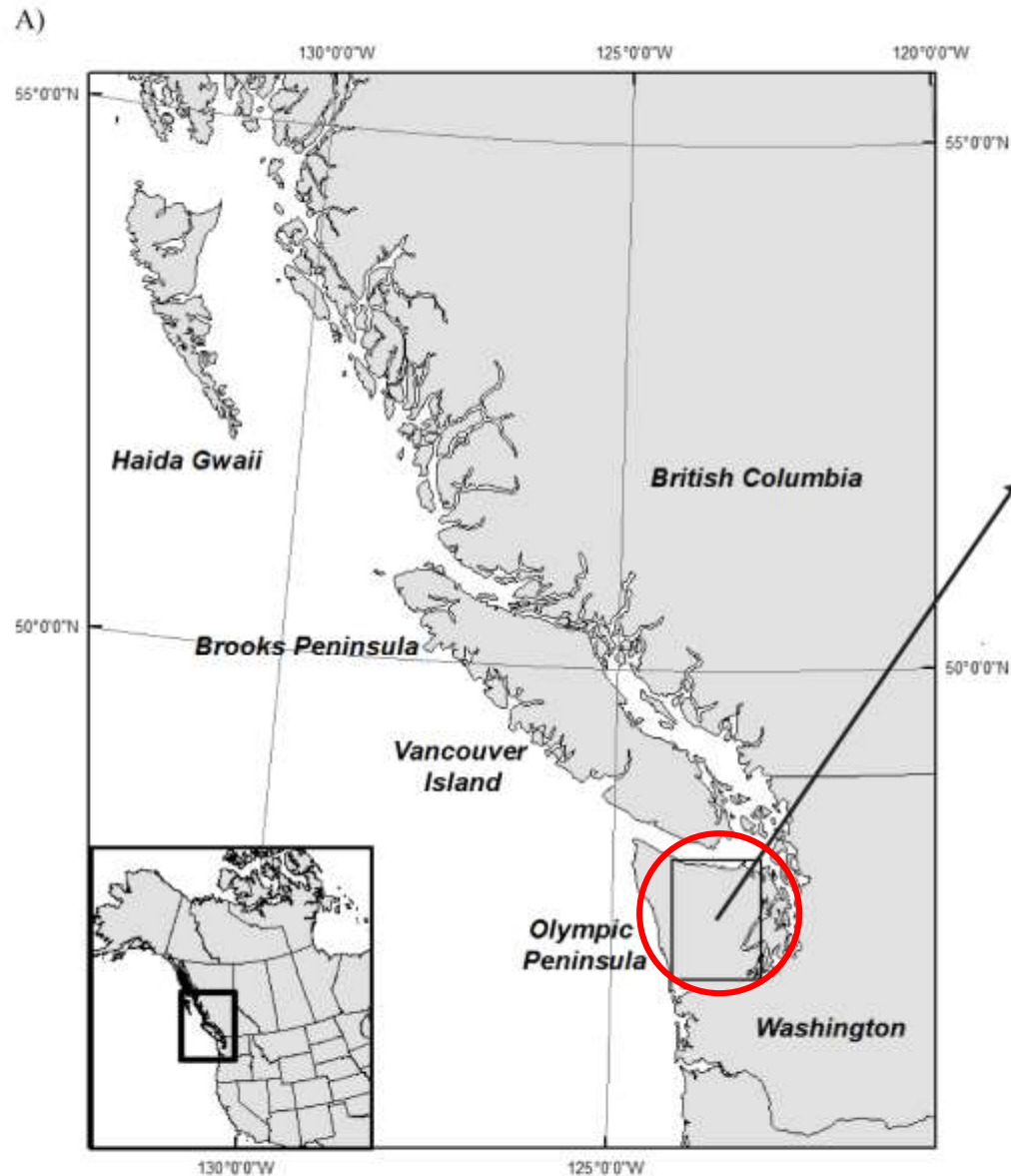


Synthyris pinnatifida
var. *lanuginosa*



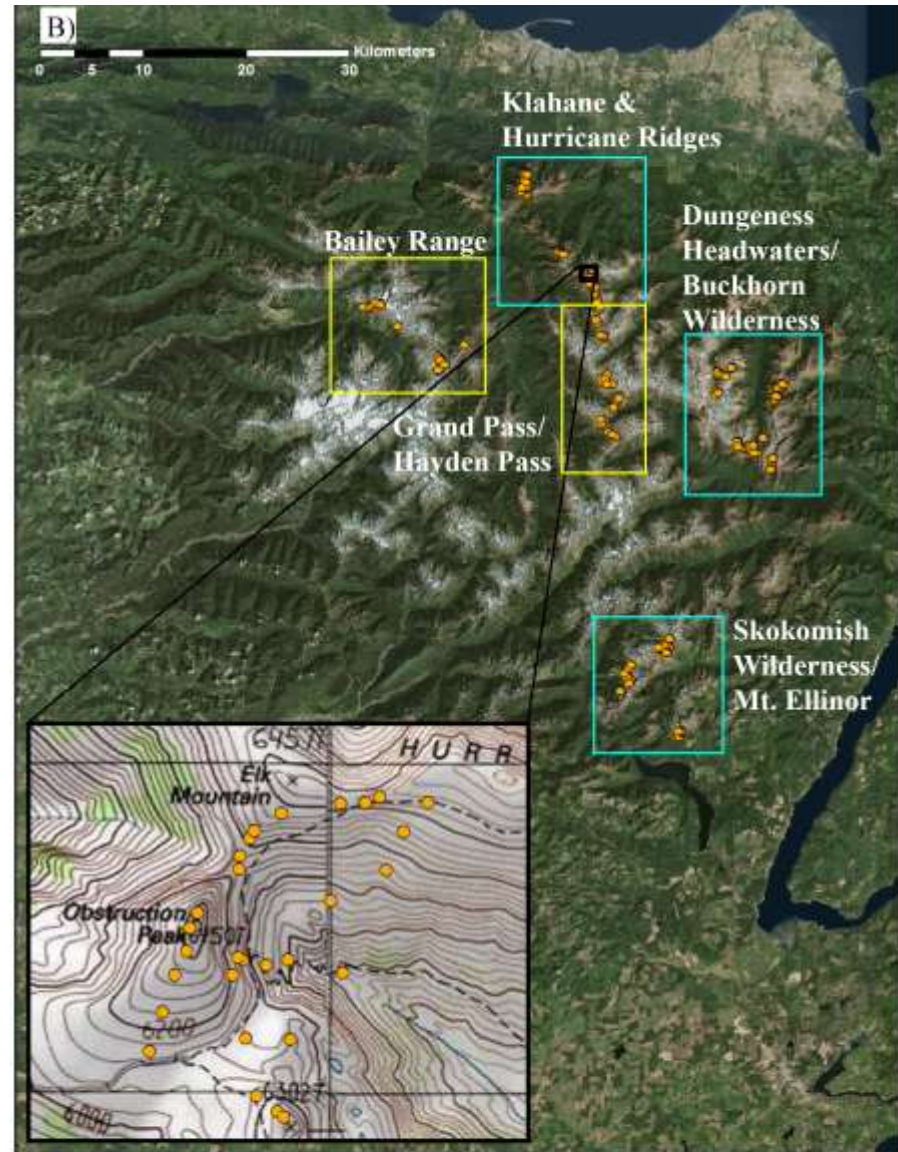
Sam Wershow

Iterative Sampling Approach



Iterative Sampling Approach

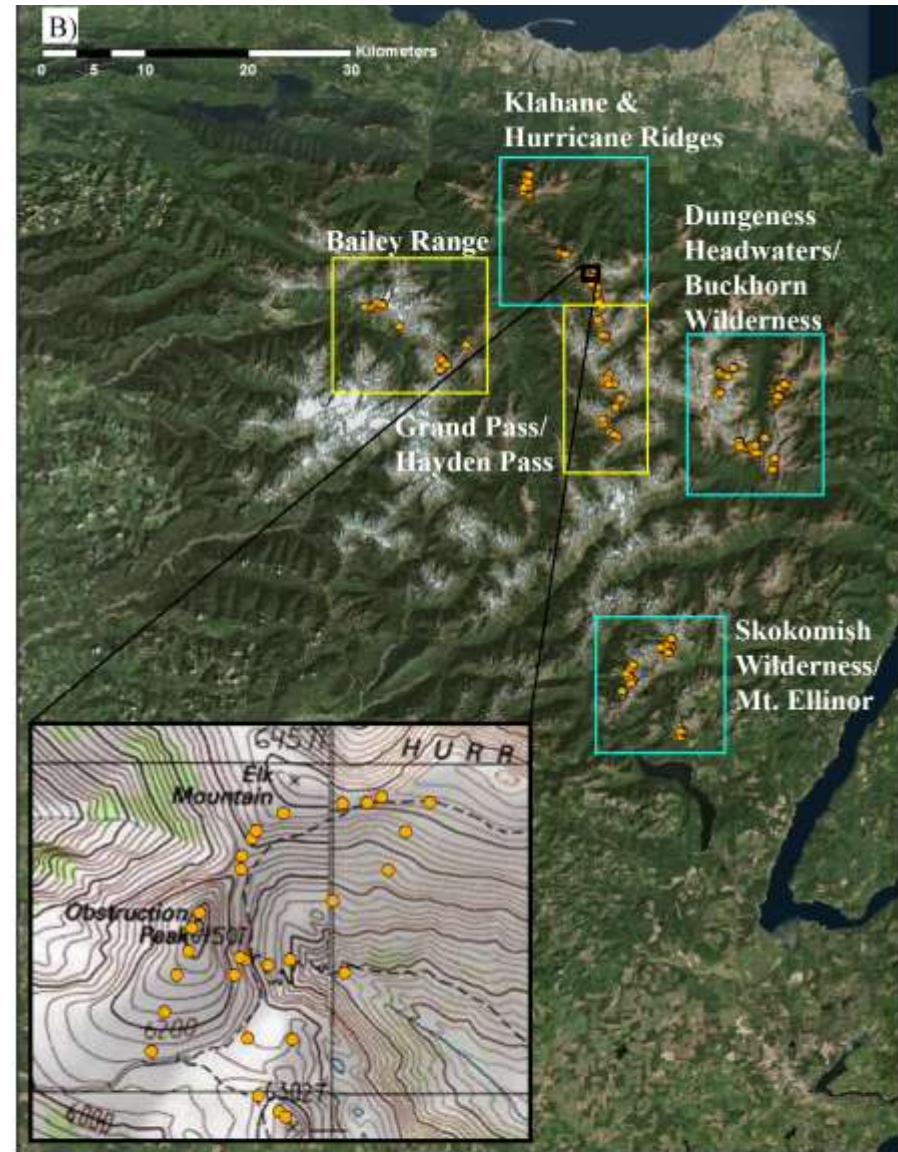
1. Model current distribution based on occurrence records
2. Perform surveys to groundtruth models and acquire new location data
3. Revise models with new location data



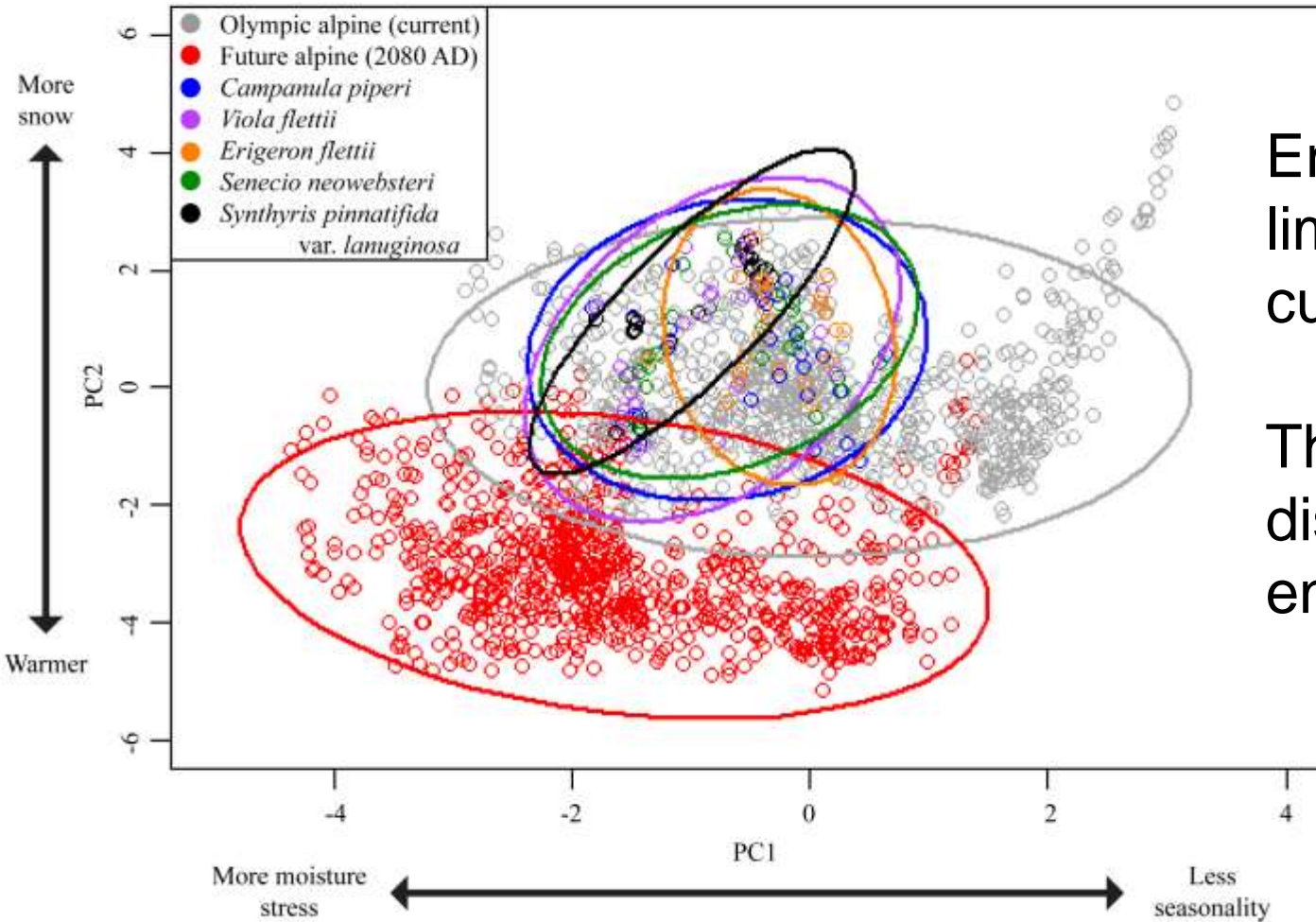
Iterative Sampling Approach

Climate conditions modeled for each taxon and the Olympic alpine in general, using 4 variables:

1. Climate Moisture Deficit
2. Mean Annual Temperature
3. Precipitation as Snow
4. Continentality



Climate Space for Alpine and Focal Taxa



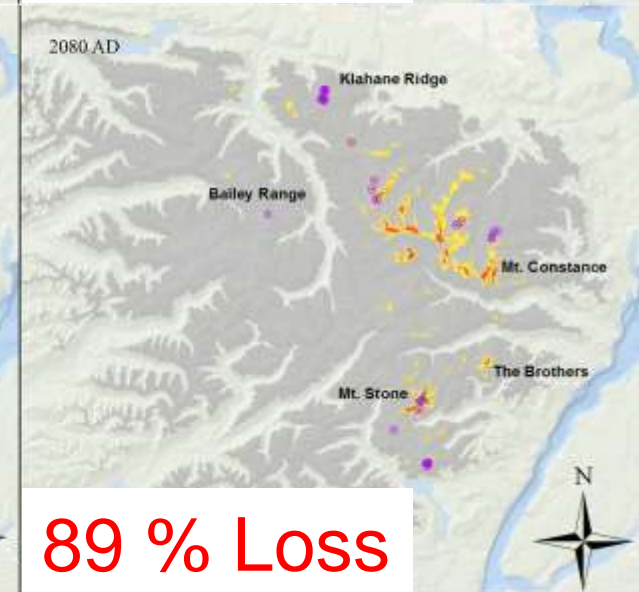
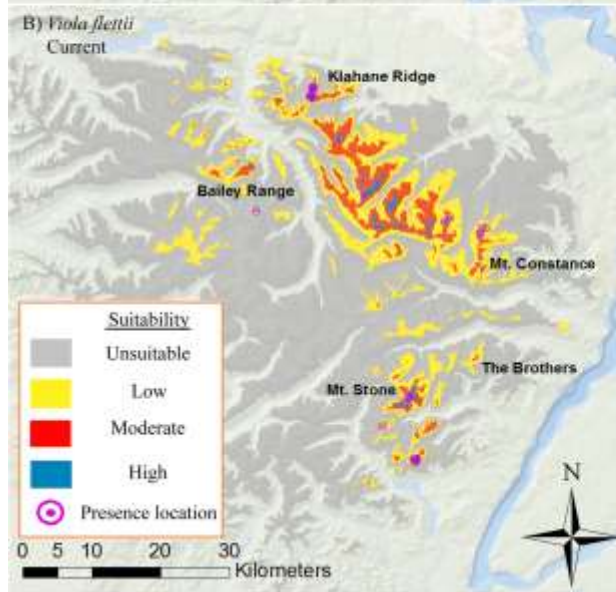
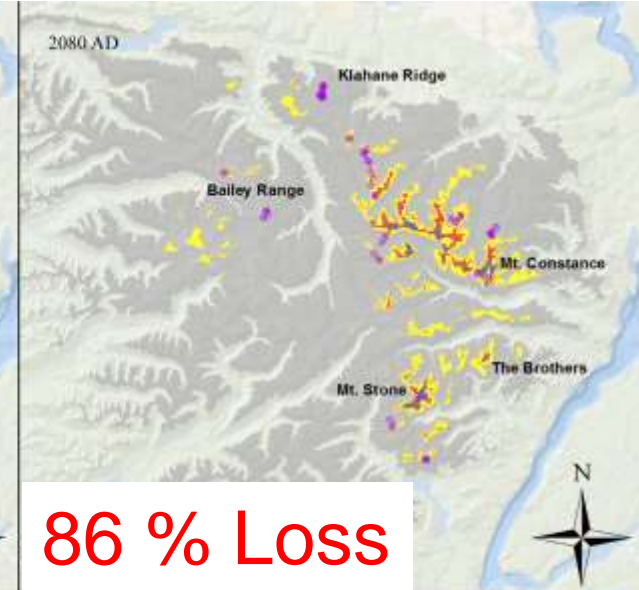
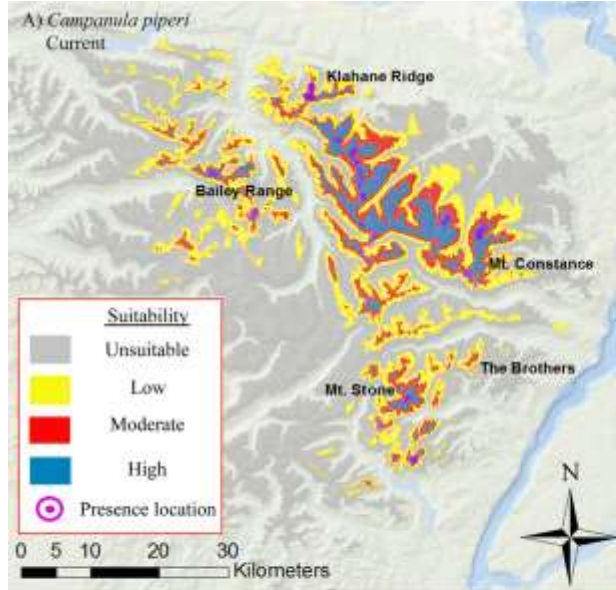
Endemics inhabit a limited subset of current alpine

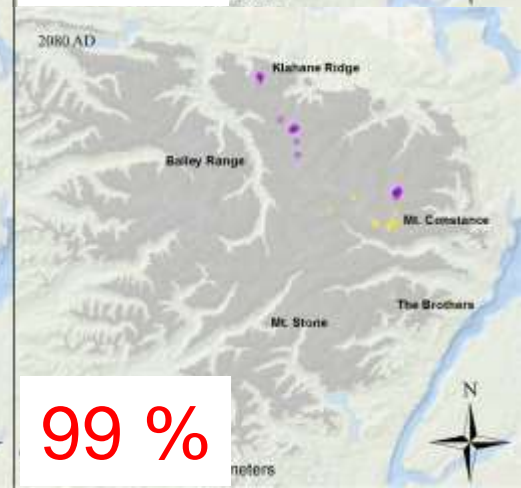
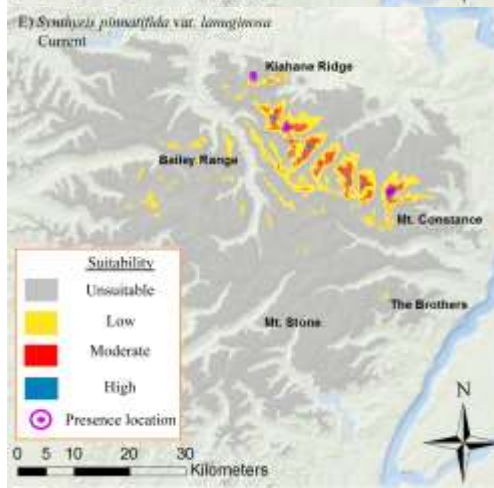
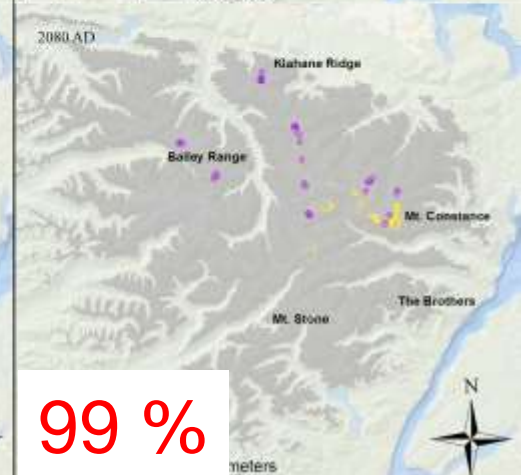
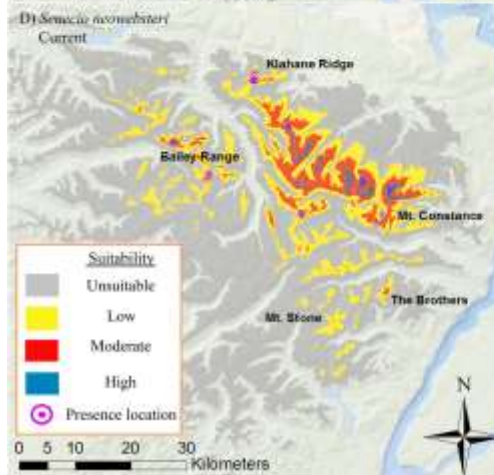
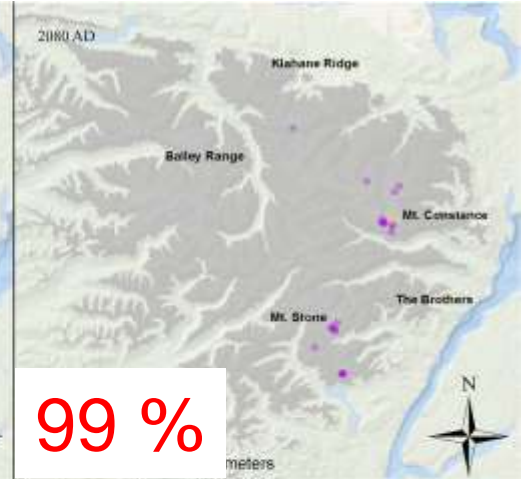
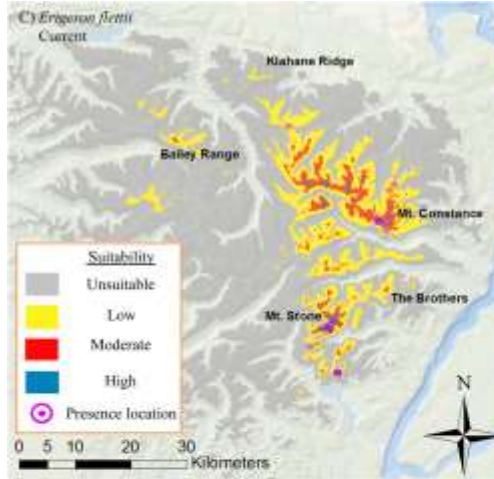
Their conditions will disappear almost entirely

Species-Specific Consequences

Current

2080



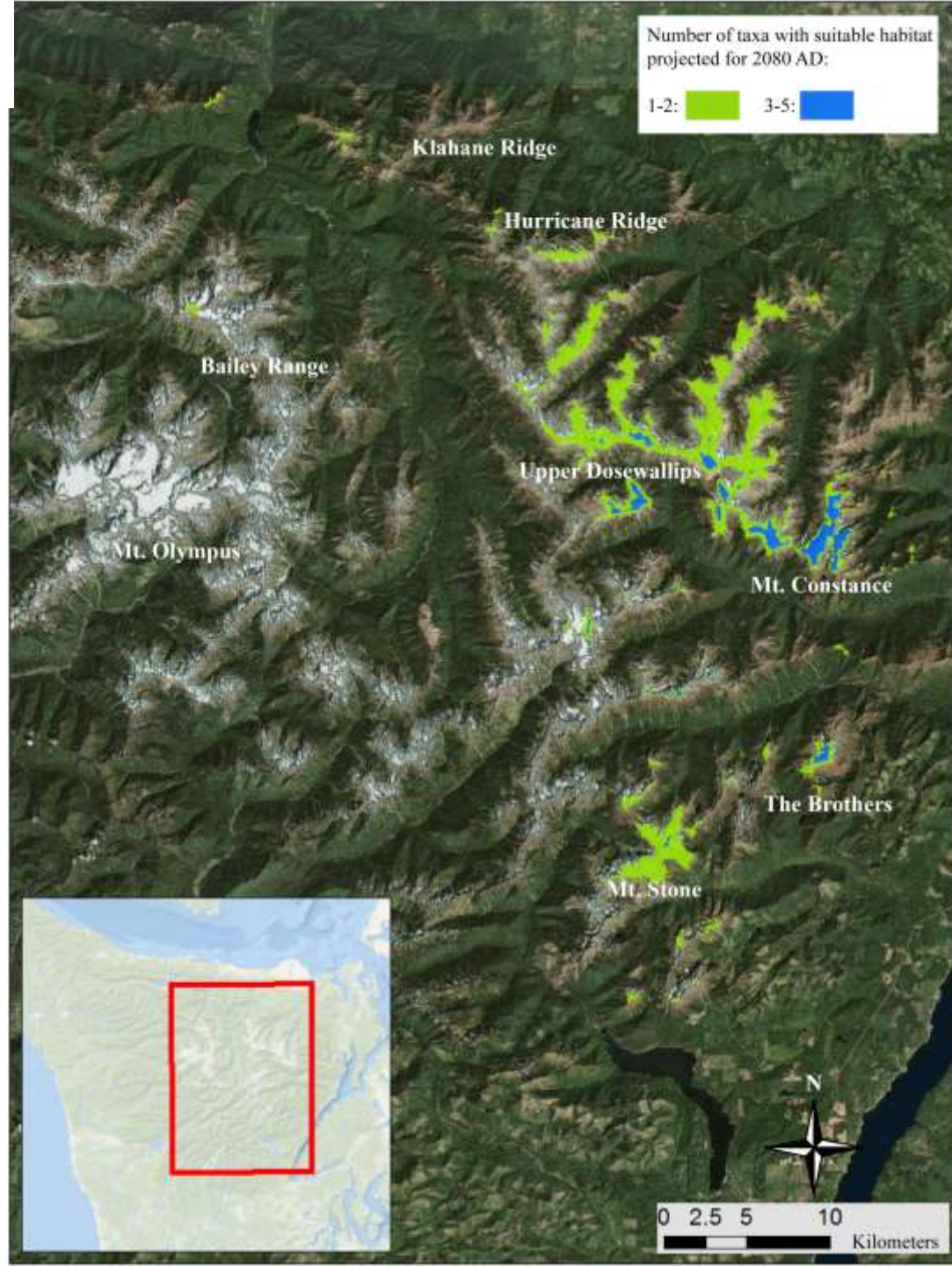


Thermal Refugia

Cold microhabitats

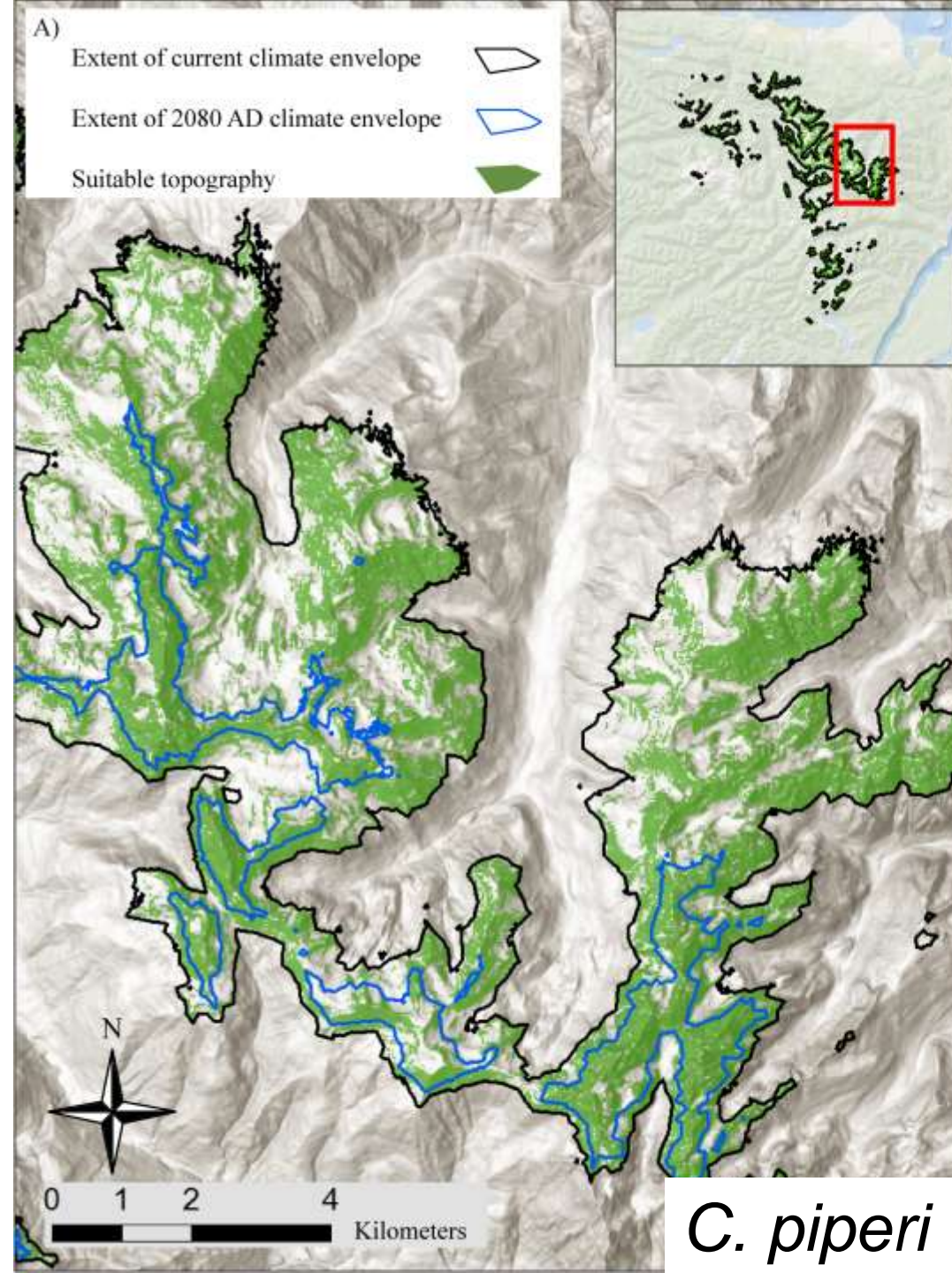
Locations where populations may persist as warming diminishes habitat elsewhere

Restricted to the highest peaks of the eastern Olympics



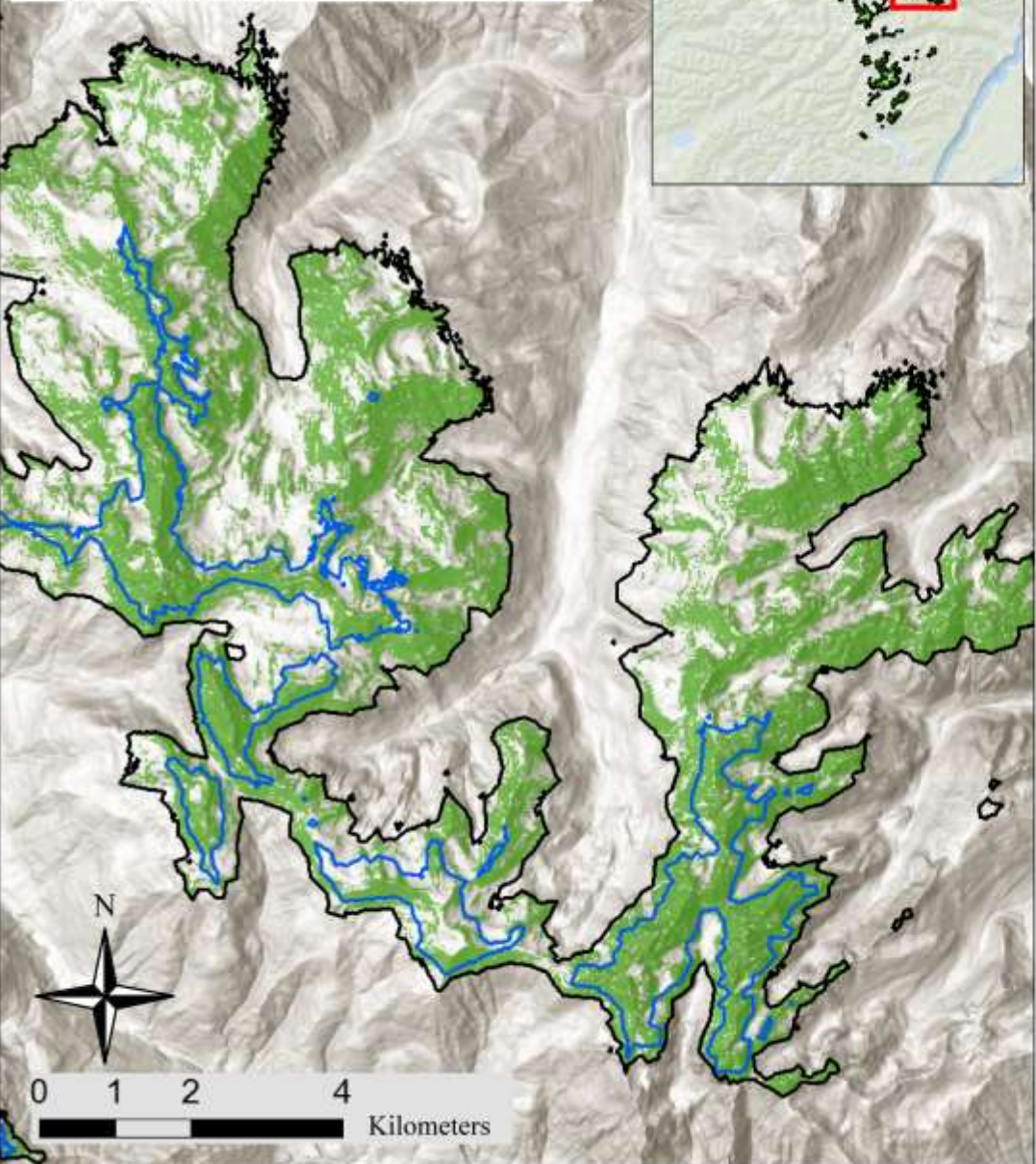
Integrating Climate and Topography

- Climate defines extent of potential habitat
- Suitable topographic is nested within that



A)

- Extent of current climate envelope
- Extent of 2080 AD climate envelope
- Suitable topography



Topography within Climate % loss by 2080

	<u>Current</u>	<u>2080</u>	<u>C</u>	<u>C+T</u>
<i>Campanula piperi</i>			86	81
<i>Viola flettii</i>			89	83
<i>Erigeron flettii</i>			99	99
<i>Senecio neowebsteri</i>			99	99
<i>Synthyris pinnatifida</i> var. <i>lanuginosa</i>			99	99



Olympic alpine endemics are stranded
on ever-shrinking habitat islands

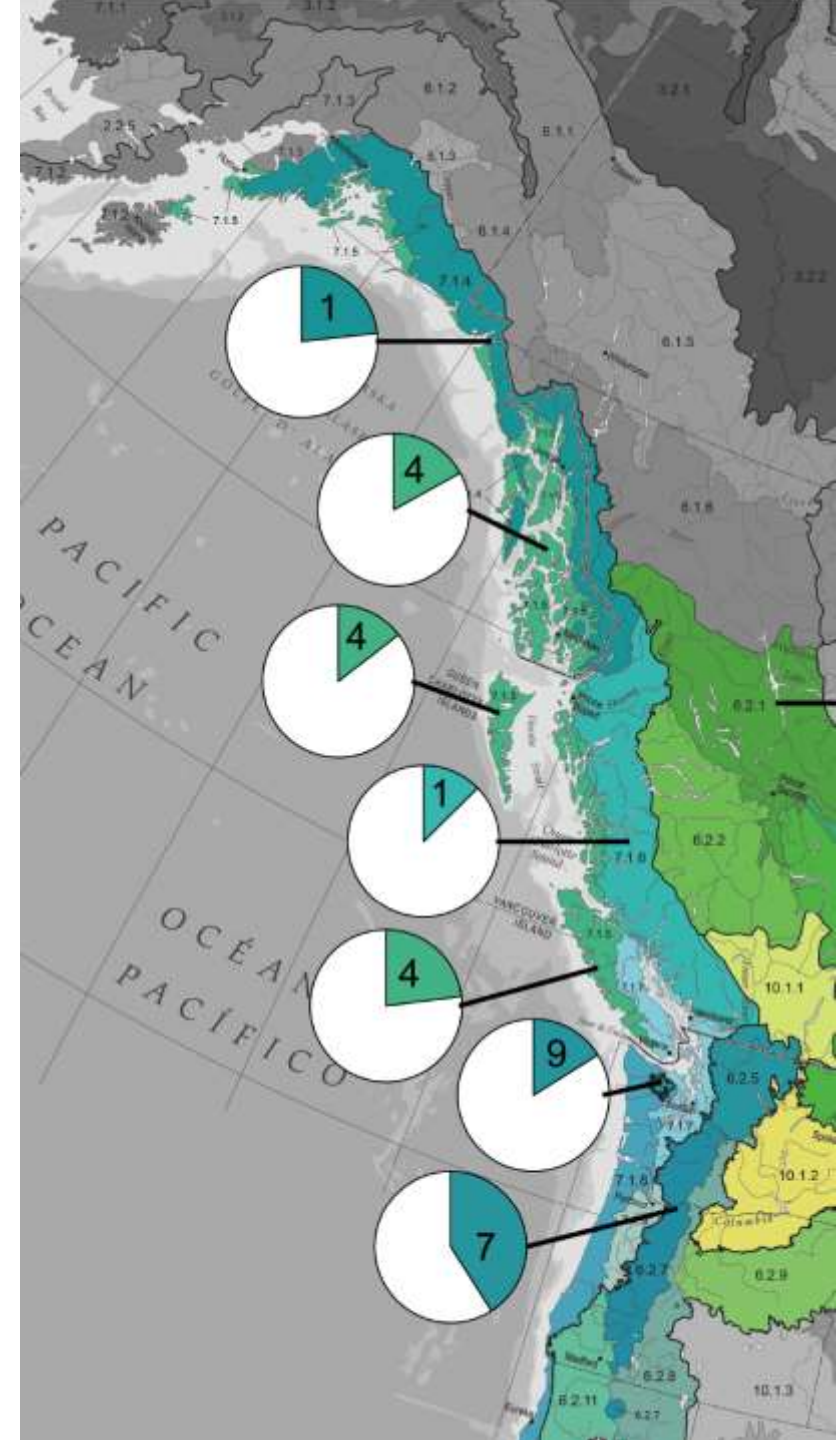


Within isolated thermal refugia, the distribution of microtopography is critical for determining long-term survival

Implications:

These findings are generalizable to all the island-peninsula alpine systems of the Pacific Northwest:

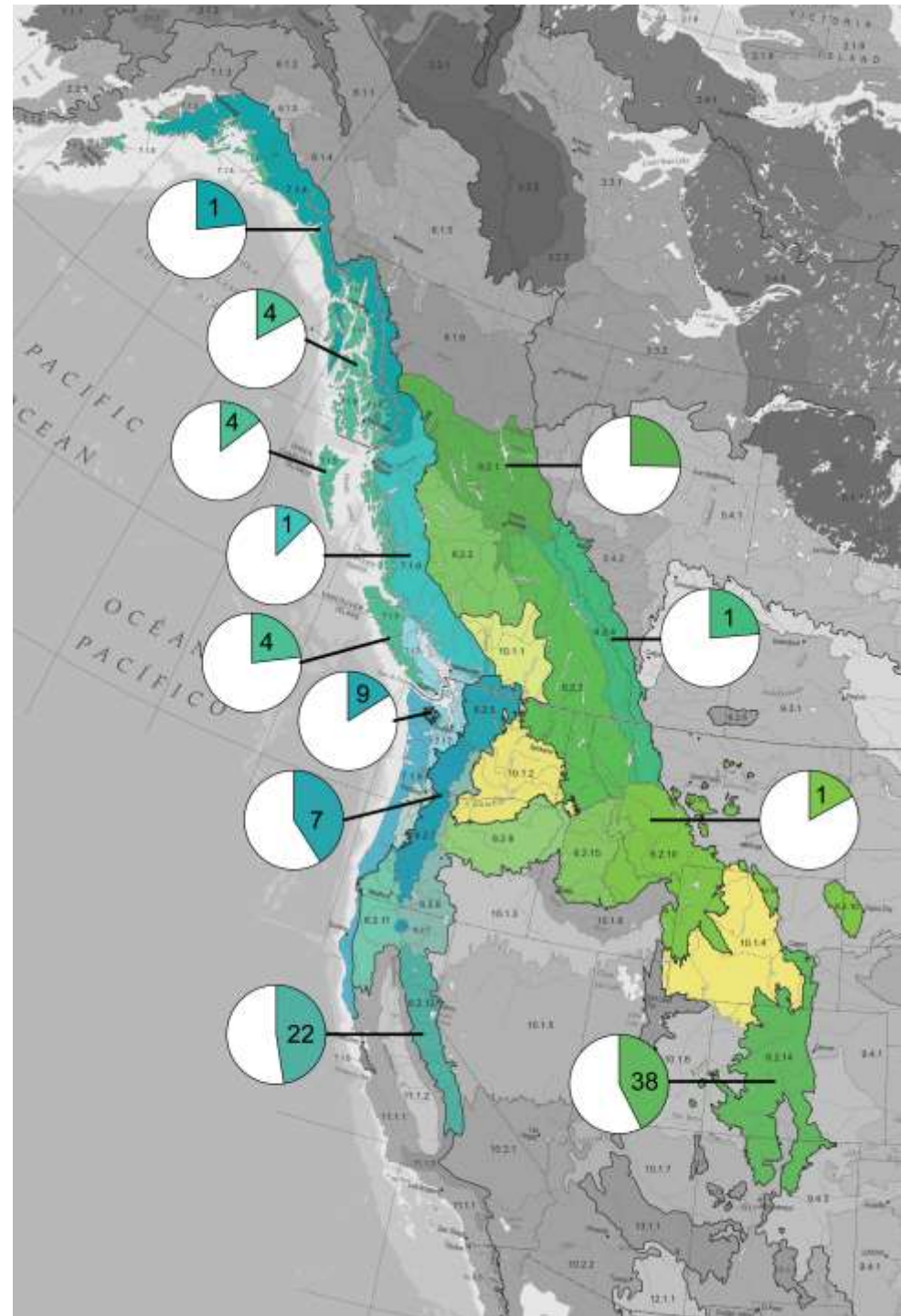
- Olympic Peninsula
- Vancouver Island
- Haida Gwaii
- Alexander Archipelago

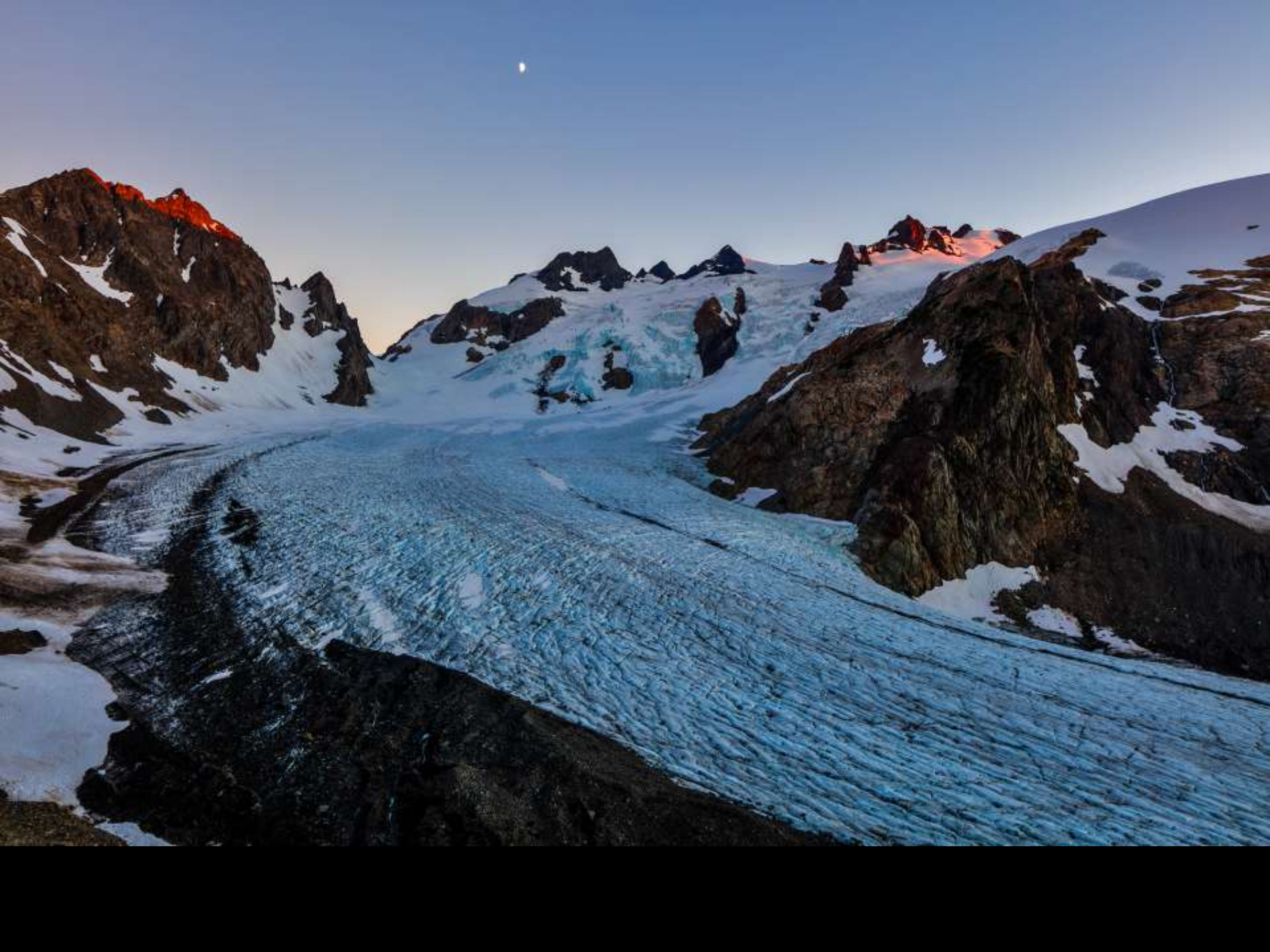


Implications:

And more broadly
throughout the
Rocky Mountain
Floristic Region...

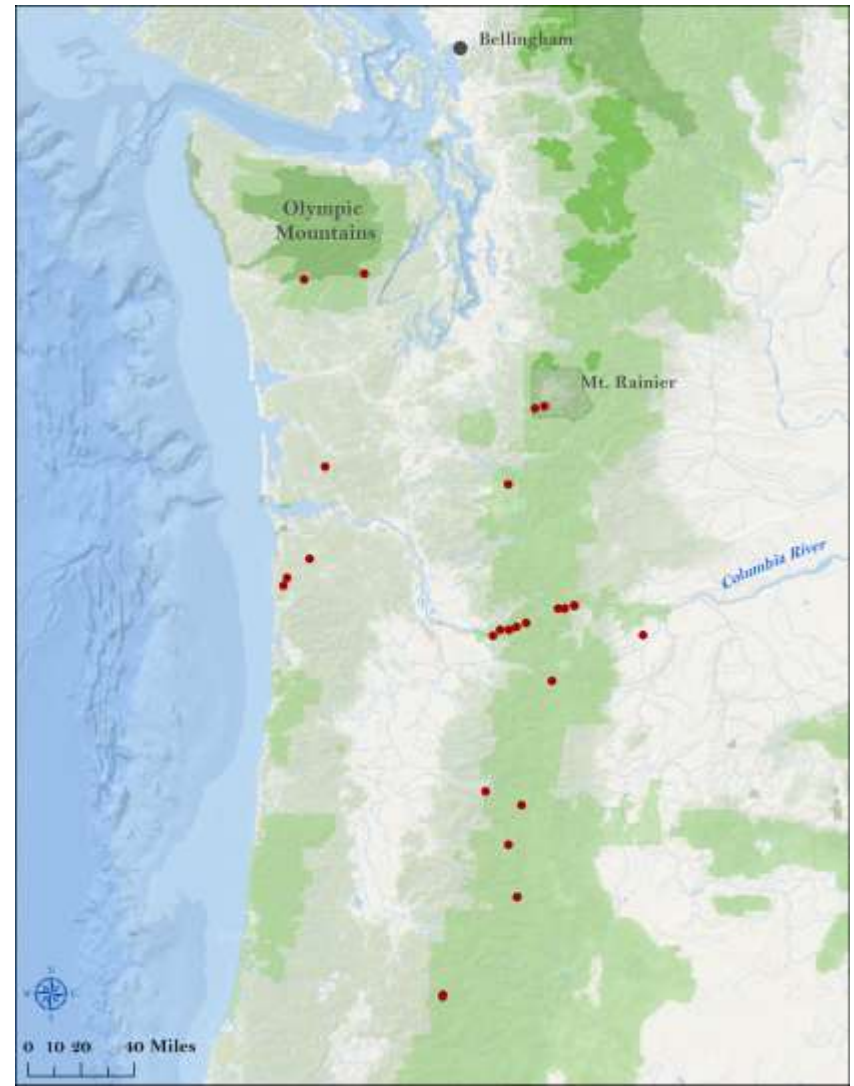
And worldwide





S. vespertina

- Endemic to WA/OR
- Basalt talus and cliff bands
- Alpine & Gorge Waterfalls

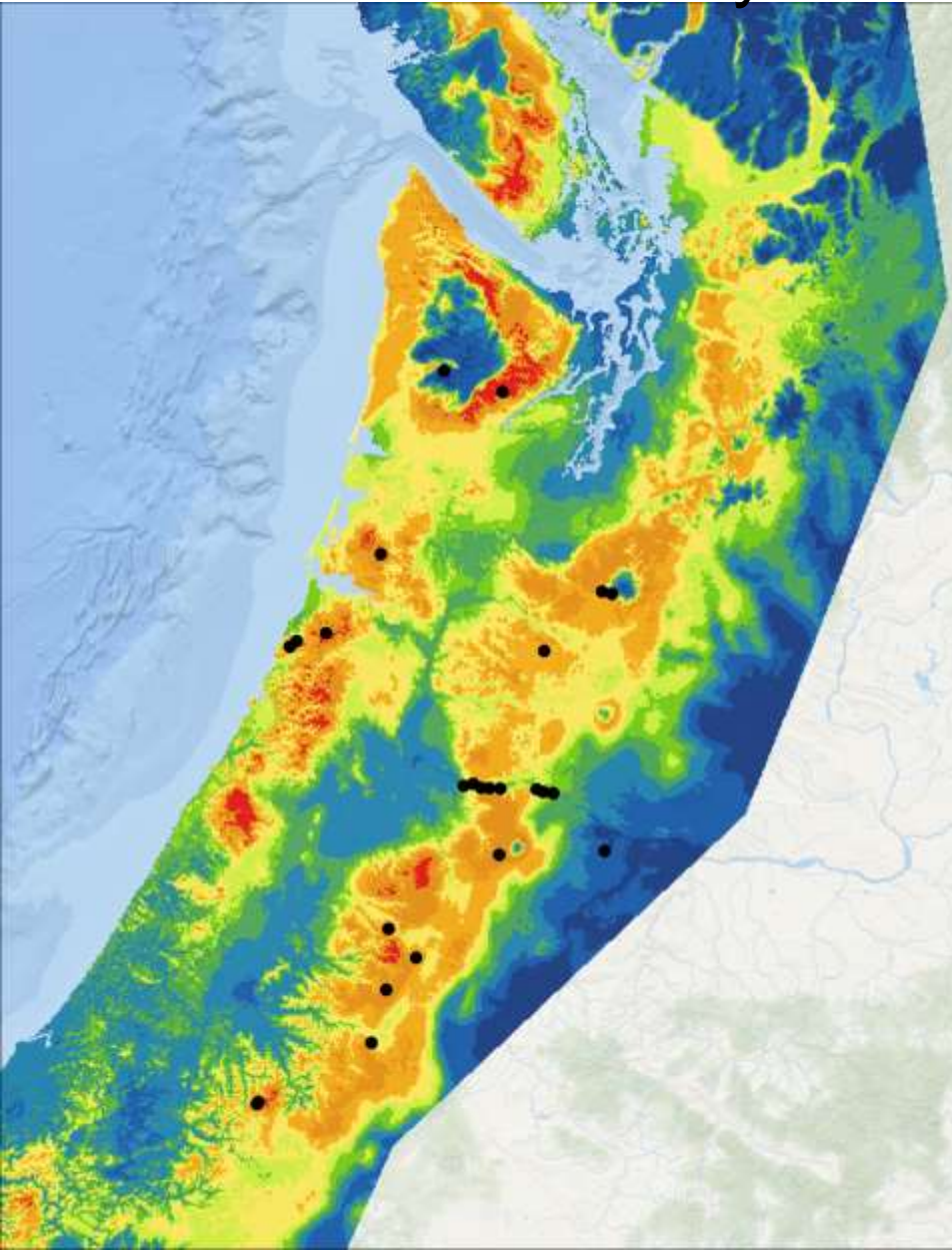




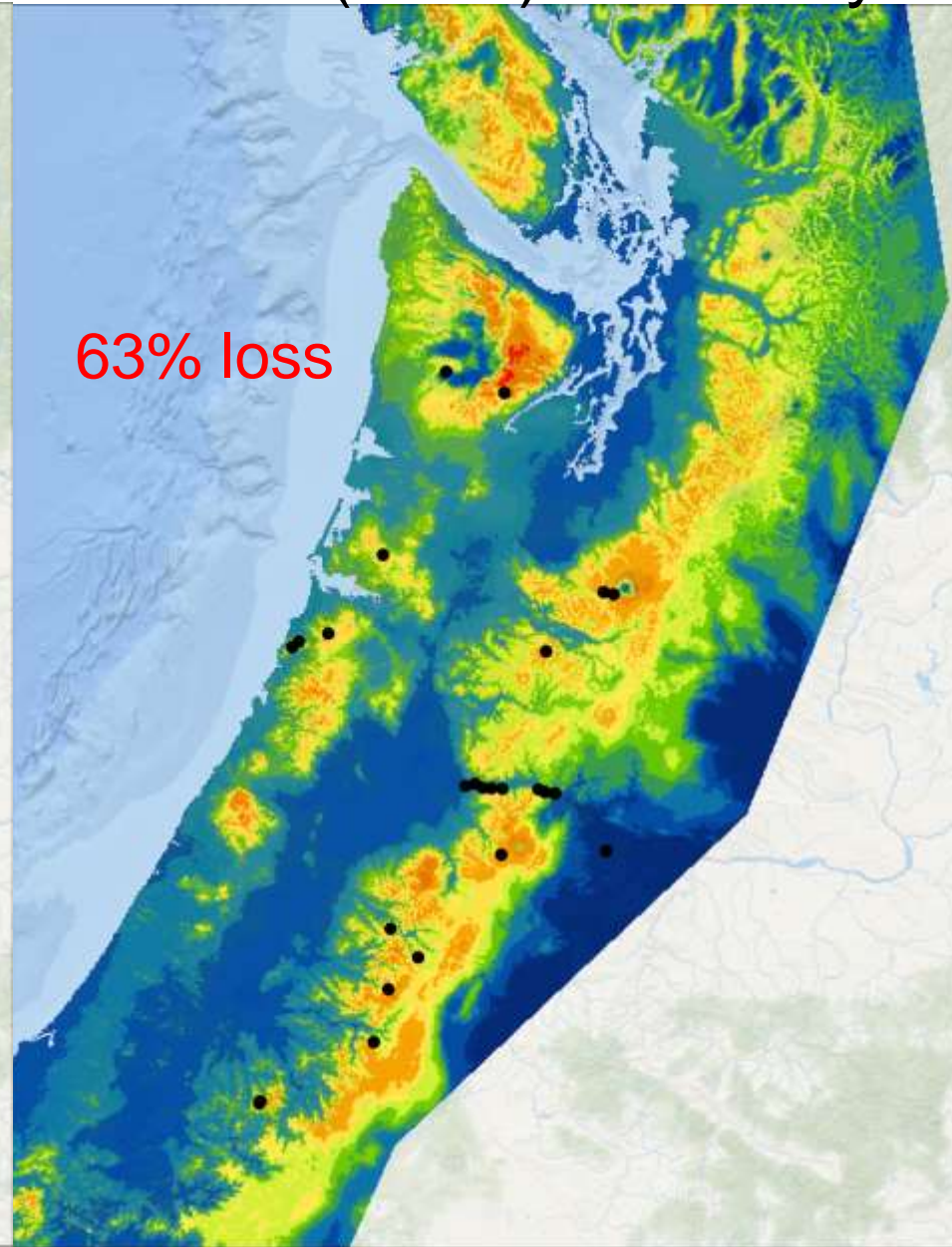
Saxifraga vespertina
(Small) Fedde



Projected
Current Suitability



Projected
Future (2080) Suitability

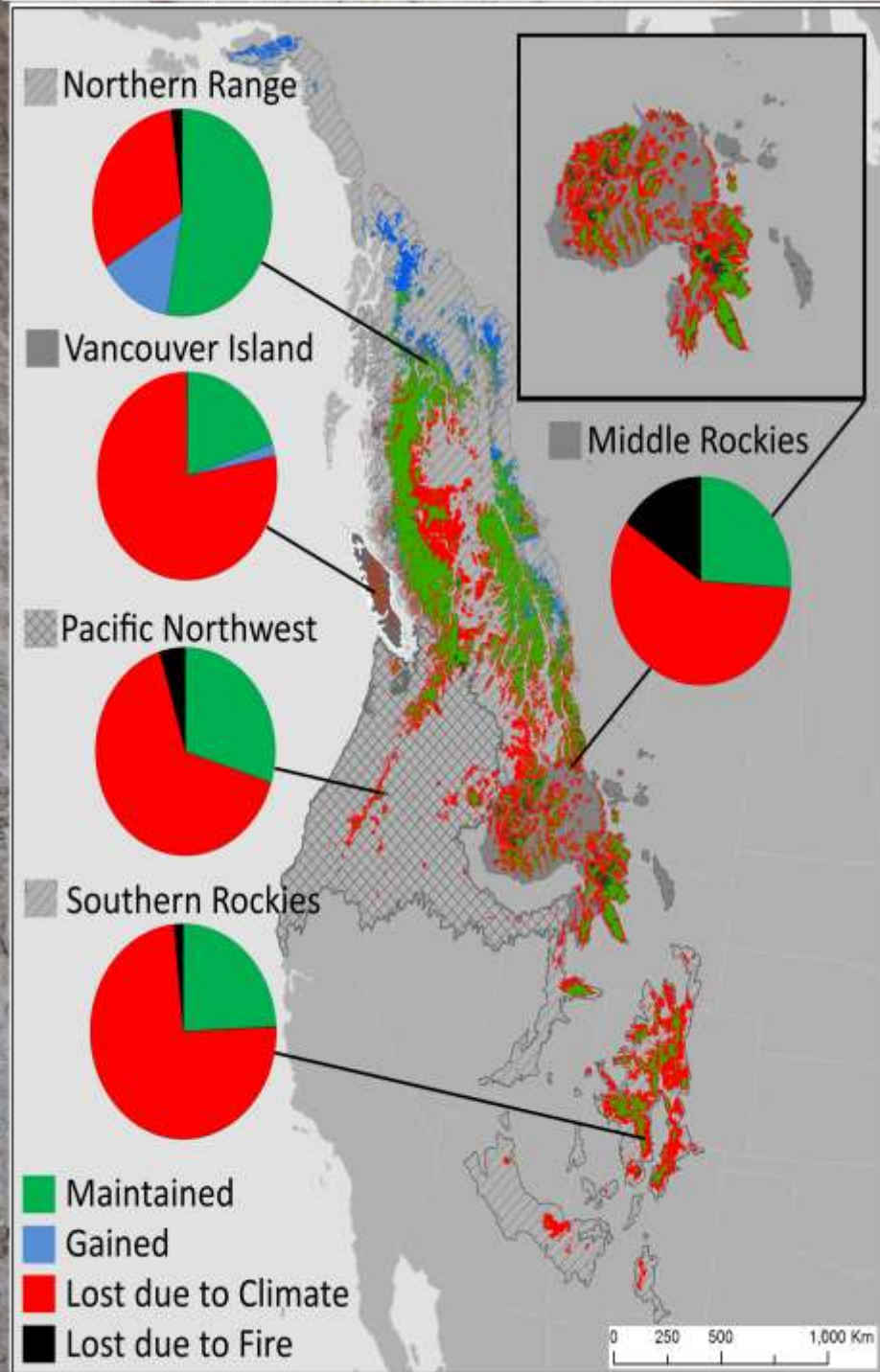






Eagle Creek Fire, Columbia Gorge 2017





Saxifraga austromontana