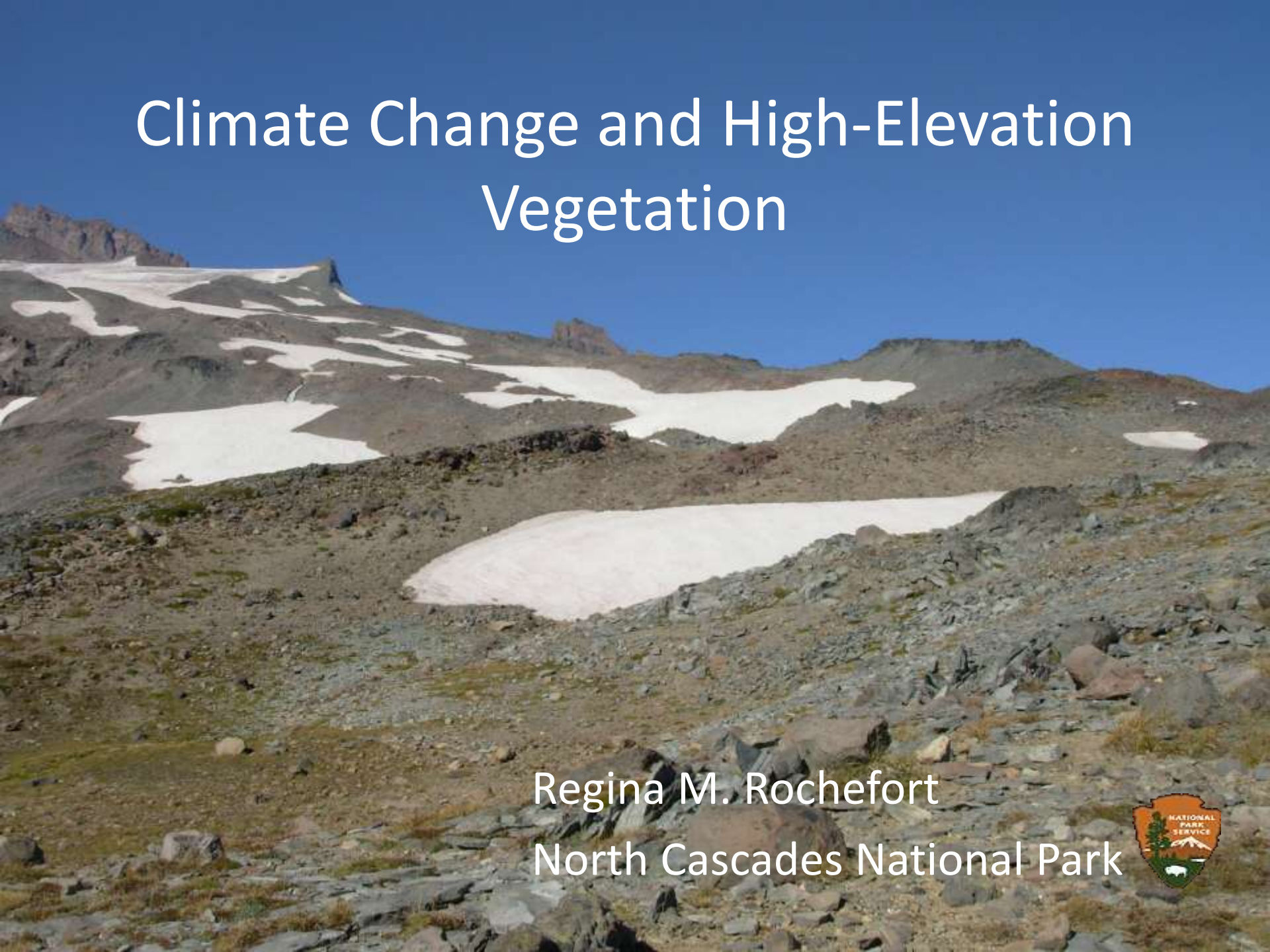
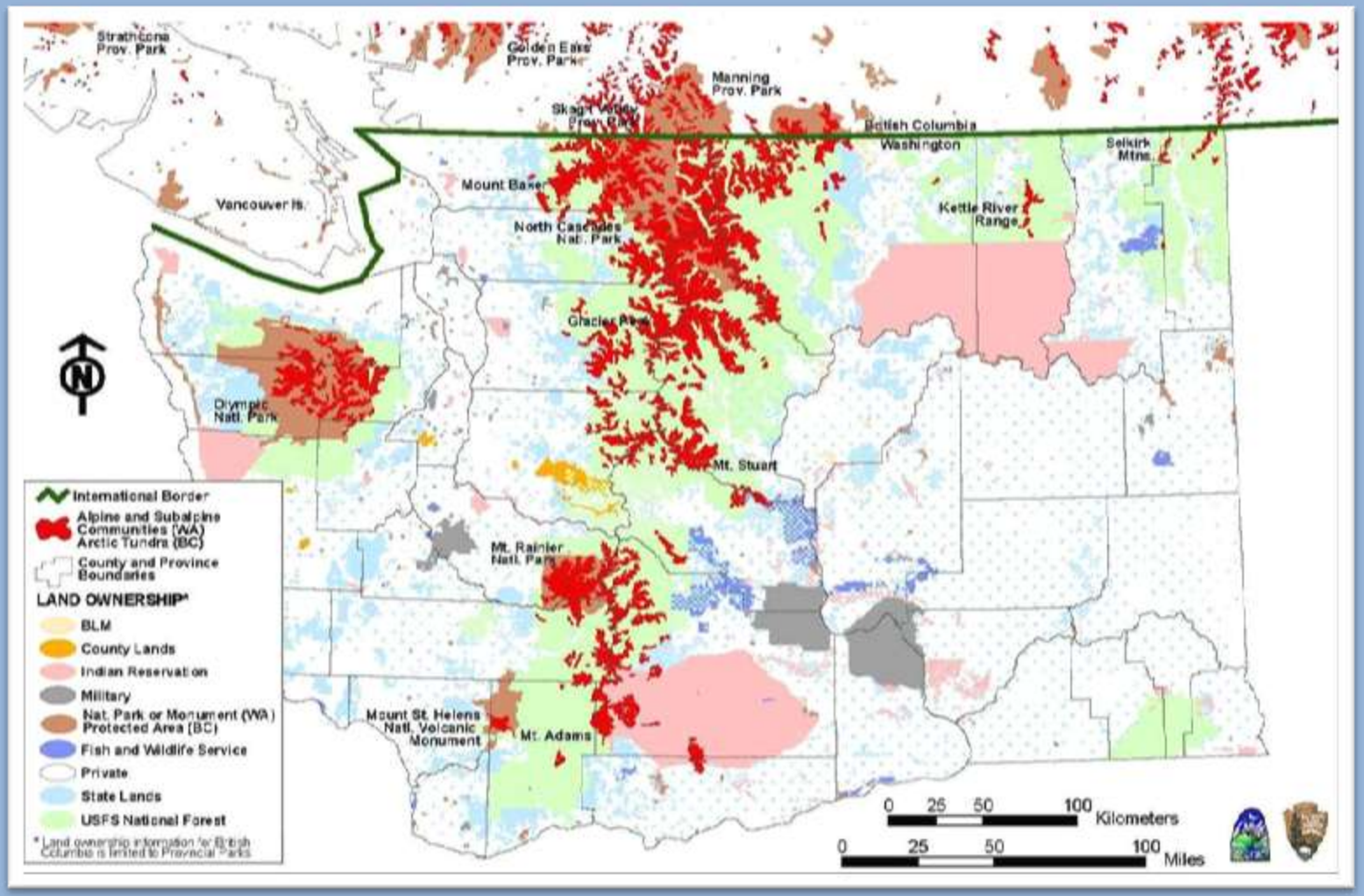
Climate Change and High-Elevation Vegetation



Regina M. Rochefort
North Cascades National Park

Distribution of Subalpine and Alpine Area in Washington



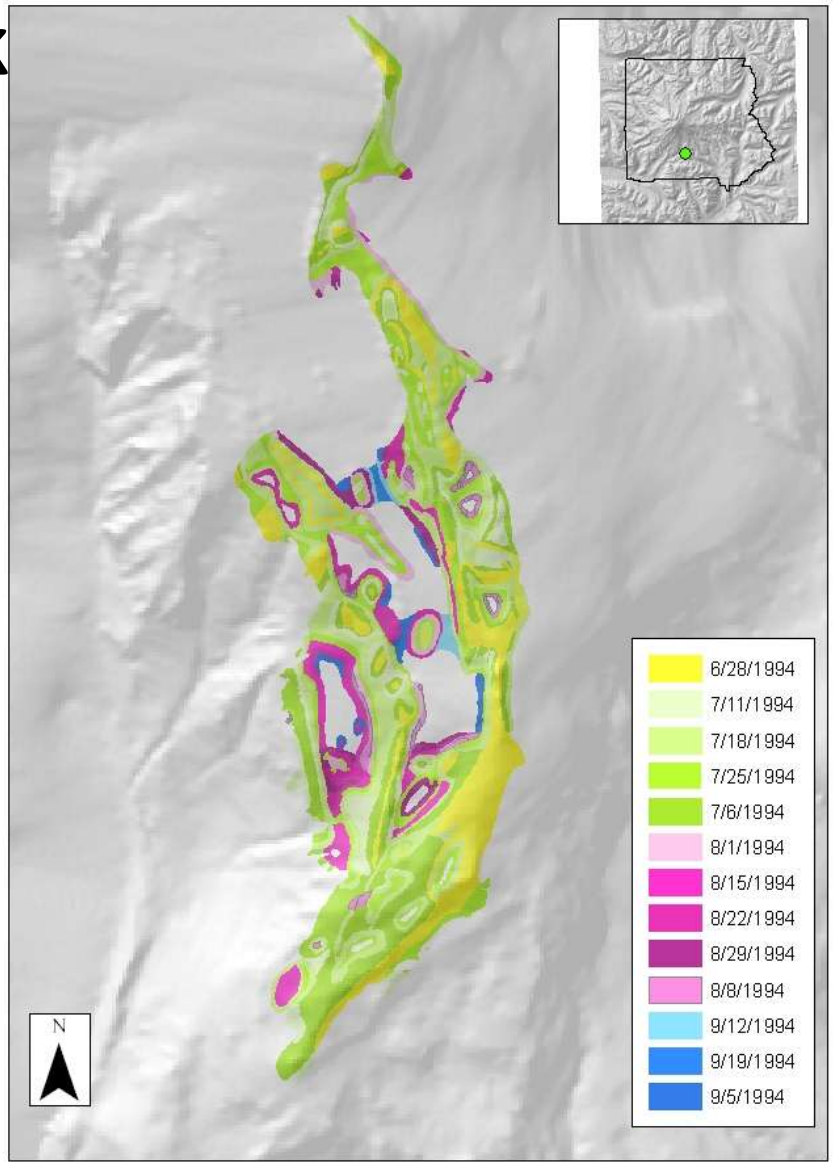
WA : Alpine/subalpine = 850,000 ha 66% USFS & 28% NPS

Factors Influencing Alpine & Subalpine Vegetation

- **Broad scale:**
  - Duration & extent of snow pack
  - Short growing season
  - Low growing season temperatures
- **Local scale**
  - Topography, Aspect
  - Air temperature, soil moisture
  - Air quality
  - Human use

Patterns of Snowpack

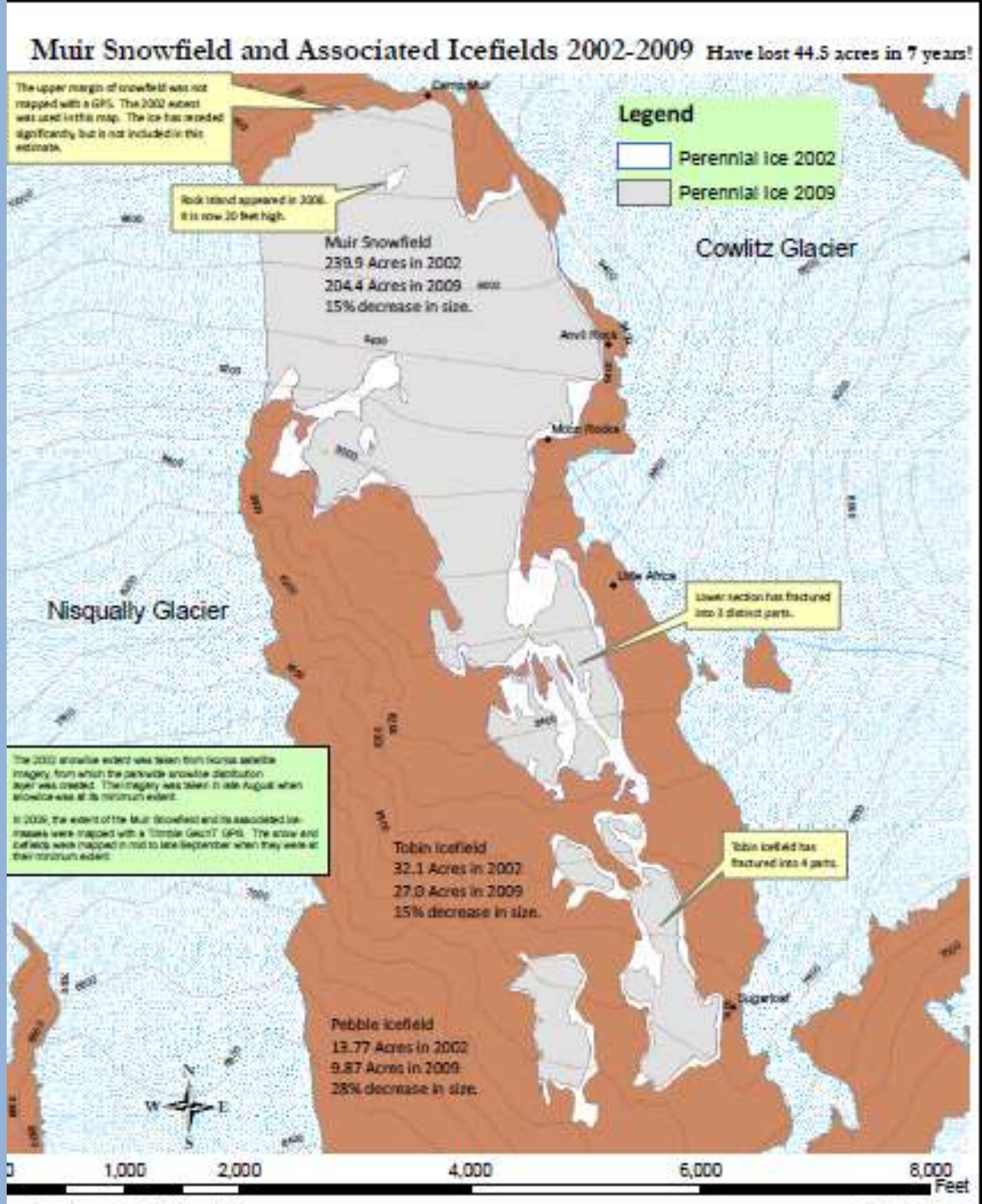
- Duration of snow cover :
  - varies with seasons across landscape
  - varies year to year
- Influences:
  - vegetation composition
  - soil moisture
  - landscape heterogeneity
  - human use



Muir Corridor, 1994: snowmelt June (yellow) through September (blue)

Trends in Snow Cover

- Future climate projections = warmer, wetter winters & warmer, drier summers
- Reduced snowpack
- New areas for vegetation establishment



What Can We Expect?

- Forest line & treeline move up
- Expansion of tree islands

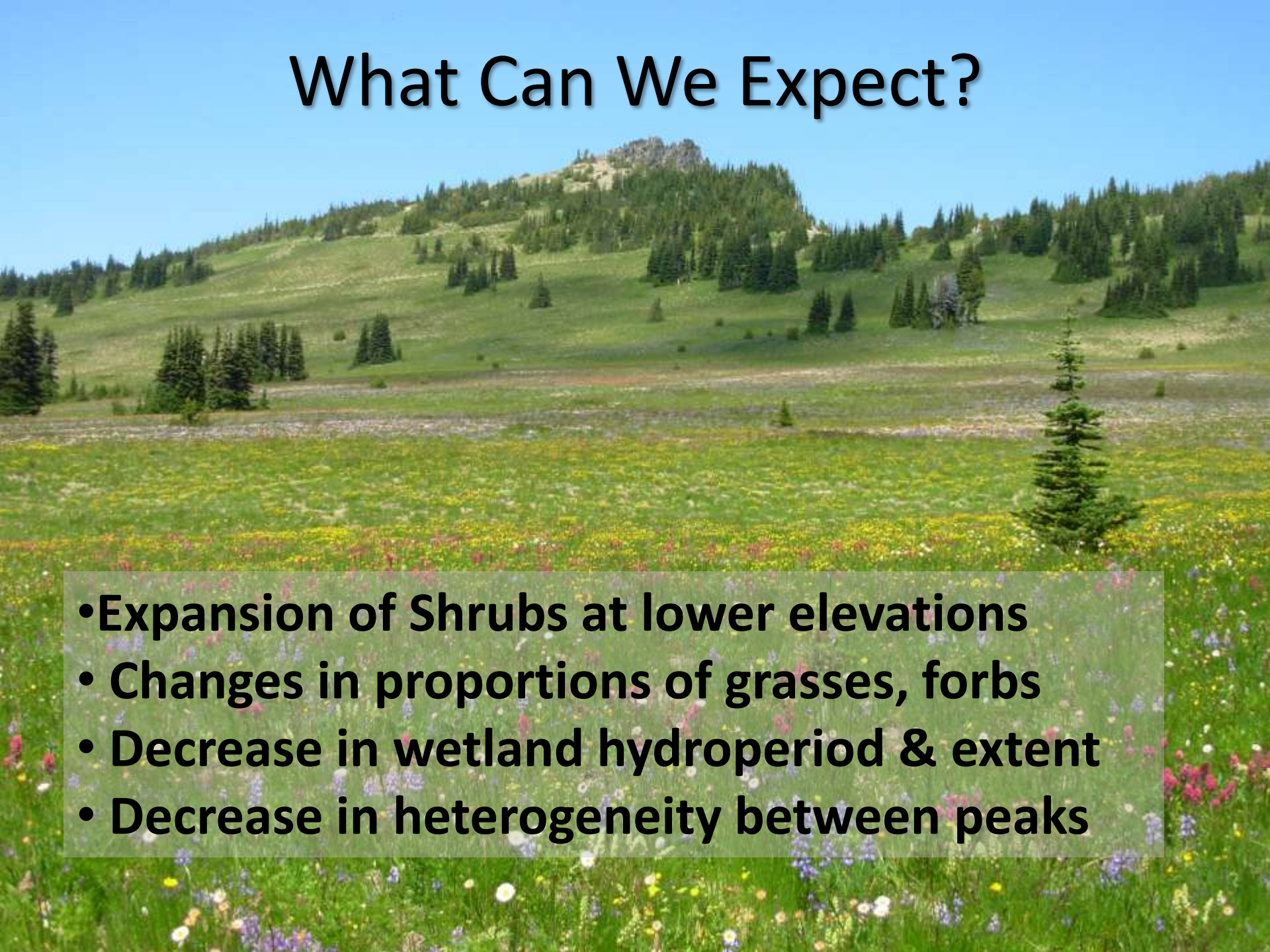
Specifics of Tree Movement

- Landscape location & substrate
  - Nonrandom – associated with topography and shelter: convexities, boulders, terraces
  - Substrate: role of downed logs (A. Johnson 2011)
  - Mycorrhizae
- Species differences – spatially & temporally
  - Olympics: Mtn Hemlock wet habitats, subalpine fir dry (Woodward et al 1995)
  - Mount Rainier: tree establishment on west side during warm, dry periods; east side during cool wet periods

Specifics of Tree Movement

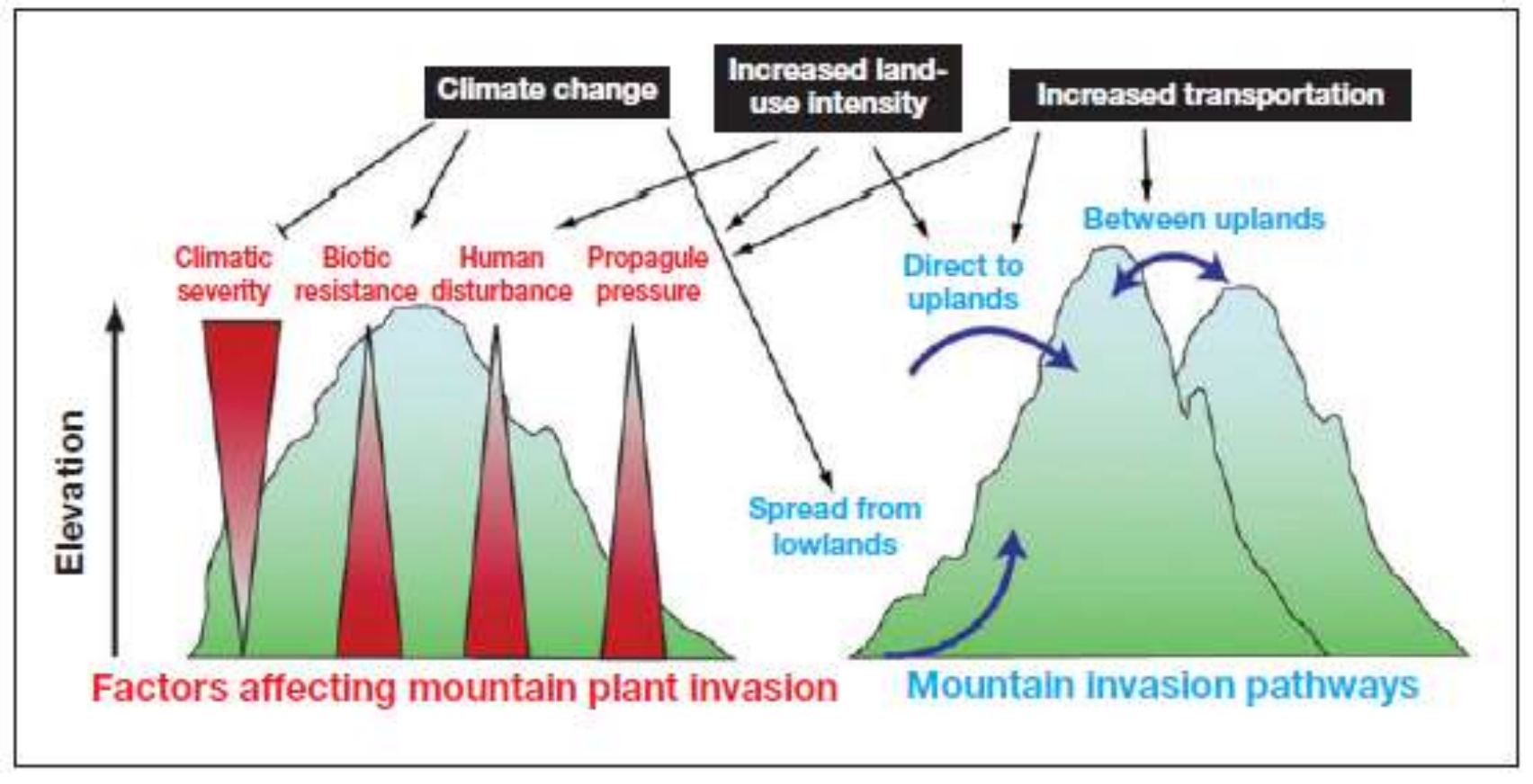
- Associated species
  - Whitebark pine first species to establish (Resler & Tomback 2008)
- Rates of movement
  - Stueve – 150 m between 1970 – 2003
  - Brookman – forest line up 127m and treeline 25m (1958-2009)

What Can We Expect?



- **Expansion of Shrubs at lower elevations**
- **Changes in proportions of grasses, forbs**
- **Decrease in wetland hydroperiod & extent**
- **Decrease in heterogeneity between peaks**

Potential Increase of Non-Native Species into High-Elevation Areas



From Pauchard et al. 2009. Ain't no mountain high enough: plant invasions reaching new elevations. Front Ecol Environ 2009; 7(9): 479–486

Why is it Difficult to Predict Future Conditions?

Limiting Factors Vary with:

- **species**
- **elevation**
- **slope**
- **topography**
- **plant functional group**
- **species growth strategies**

Limiting Factors may change over time as:

- **warmer temperatures increase nutrient availability**
- **alter community structure & dynamics (e.g. light availability)**

Conclusion

- We can make some general projections on climate change influences on vegetation

- But, applications to our specific landscape, rare species, disjunct populations will need local research and science-based application