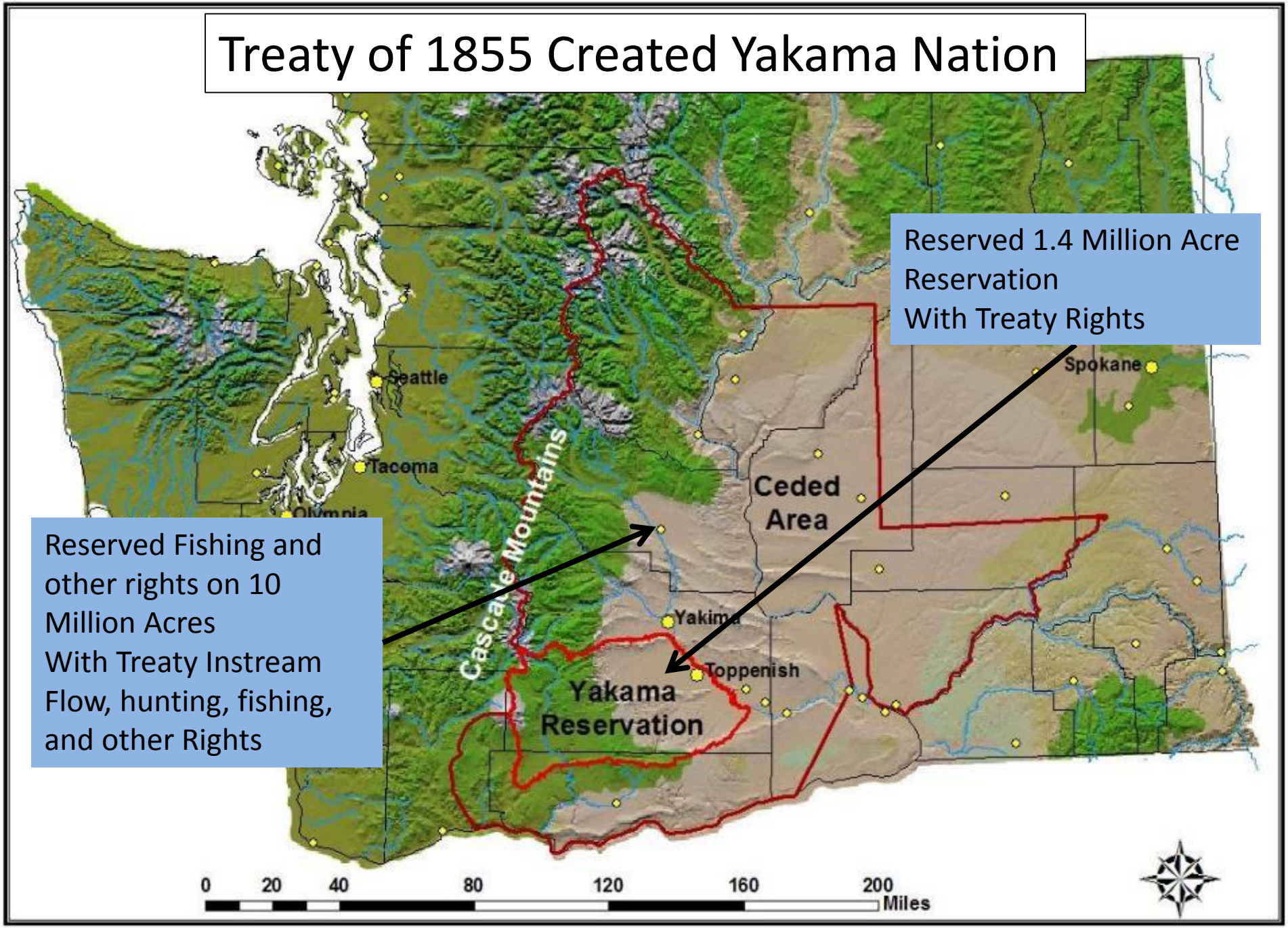
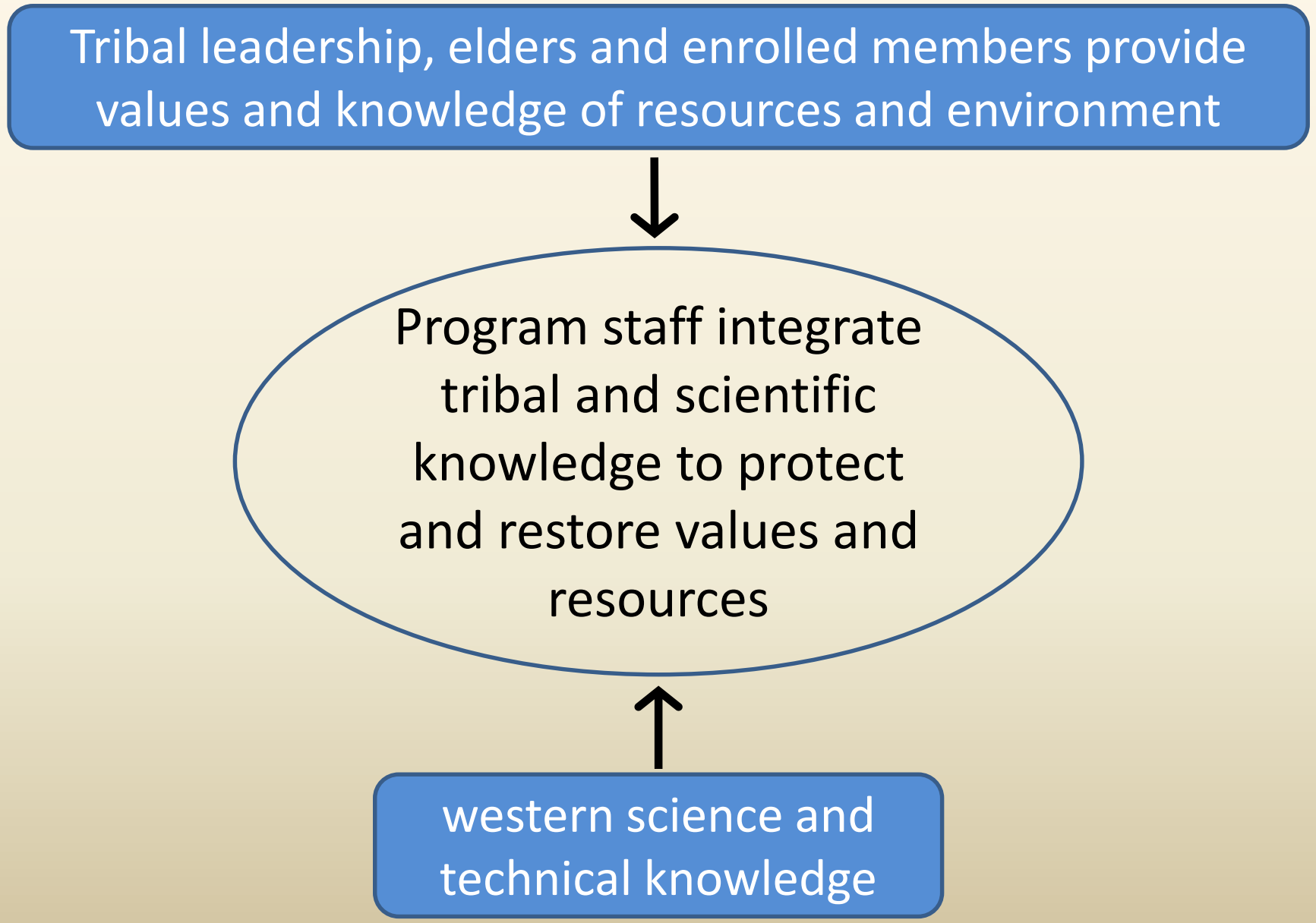
Yakama Nation Meadow Vulnerability Assessment

Wildlife Resource Management Program

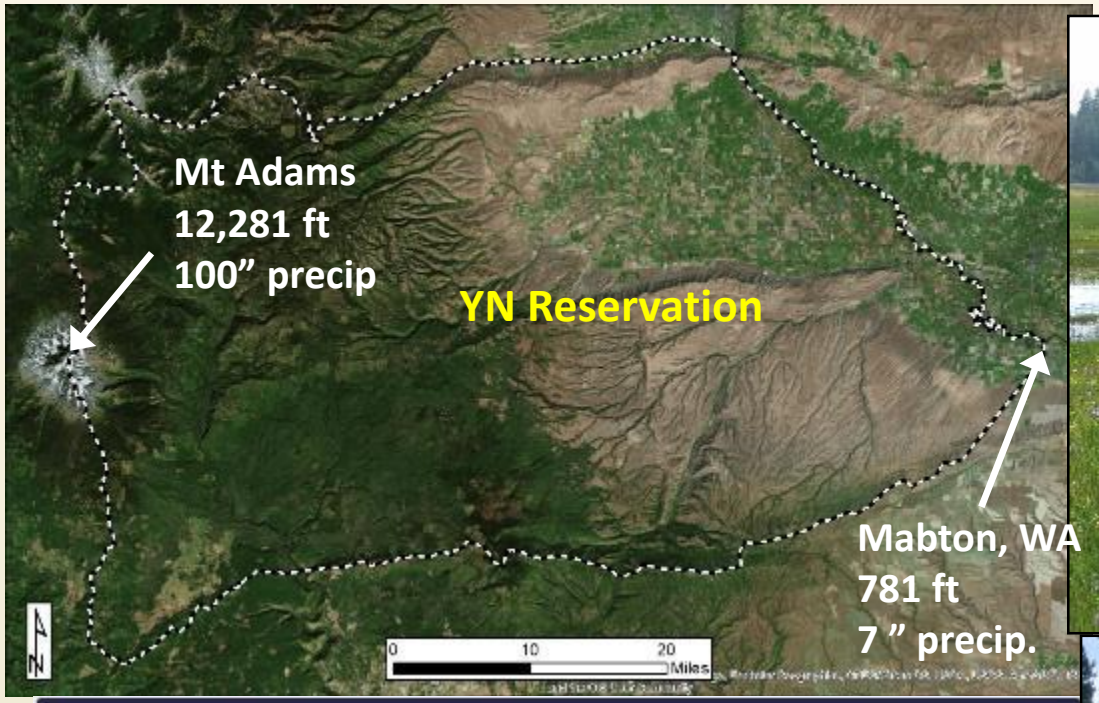
Treaty of 1855 Created Yakama Nation



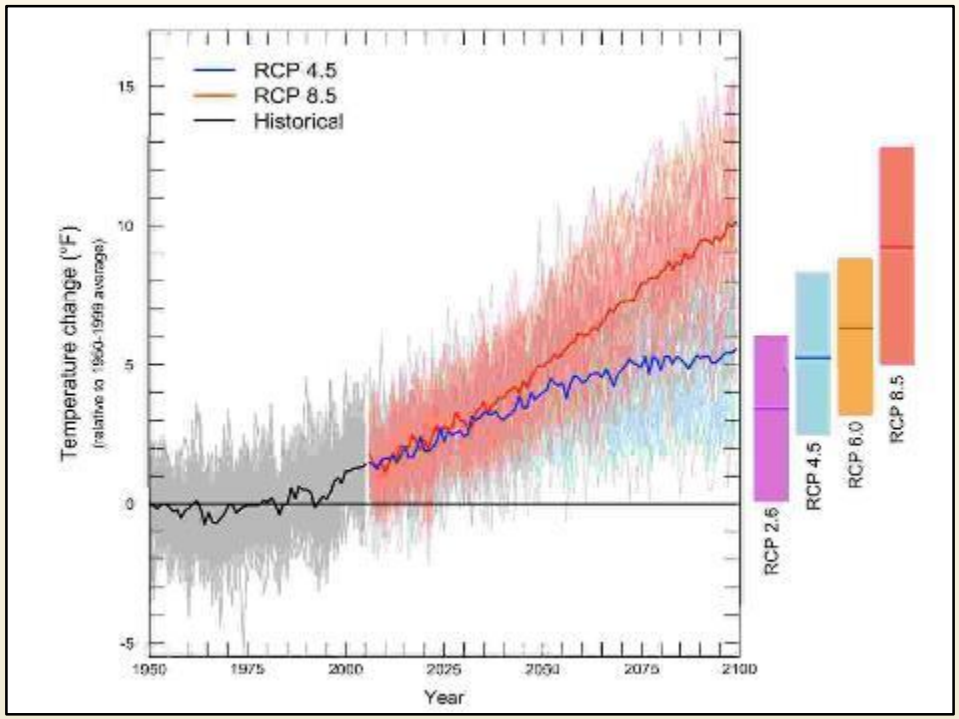
Integration of tribal values and knowledge, and science



YN Reservation-strong moisture gradients drive vegetation



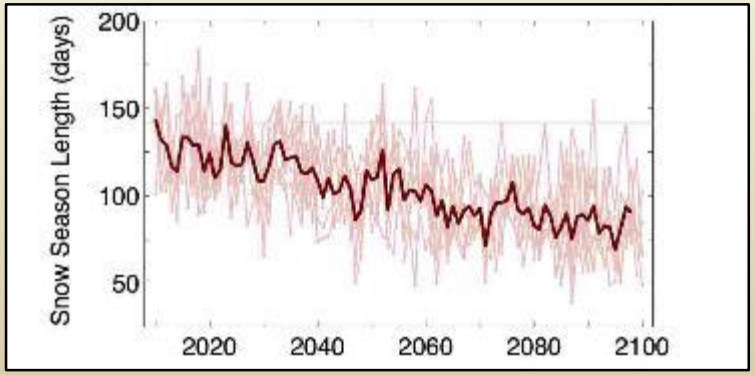
Pacific Northwest Climate Change-past and future



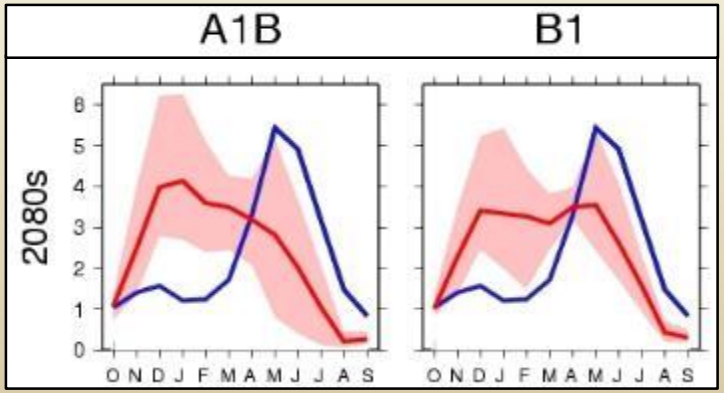
From Snover et al 2013

Mountain Hydrology

- Warming will continue, ~ 5 deg F
- Snowpack will decline
- Timing of spring run-off will advance
- Plant phenology will shift
- Timing of cultural plants is already showing change
- Changes in meadows not known



From Snover et al 2013



From PNW Hydroclimate Scenarios

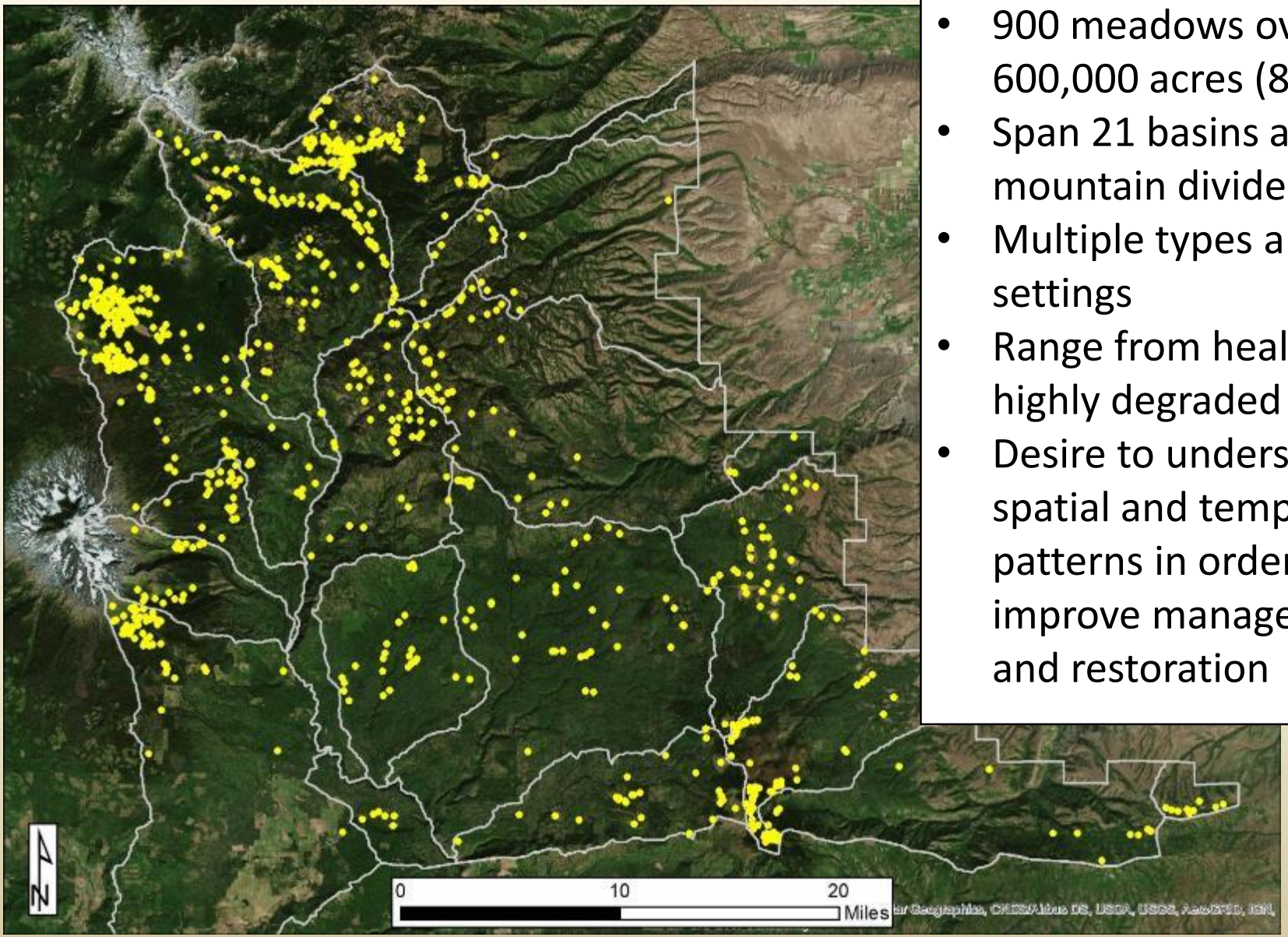
Importance of meadows-habitat islands and ecotones

- Traditional use by tribal members
- Wildlife habitat, game and non-game
- Support beavers, ecosystem engineer
- Culturally important and special status plants
- Function as natural water storage areas

Stressors in YN Reservation meadows

- Overgrazing-trampling, compaction, loss of vegetation
- Harvest practices-soil and veg. damage
- Roads, culverts-channel incision, drying of meadow
- Conifer encroachment-type conversion
- Noxious weeds-loss of native vegetation and function

Need for Assessment: manage at watershed scale



- 900 meadows over 600,000 acres (8,600 ac)
- Span 21 basins and a mountain divide
- Multiple types and settings
- Range from healthy to highly degraded
- Desire to understand spatial and temporal patterns in order to improve management and restoration

Goals and objectives

Goal: Develop new data and synthesis to support accelerated protection and restoration of Yakama resource values in Reservation meadows

Objectives:

1. Integrate tribal knowledge and on-the-ground rapid assessment with historic remote sensing and climate vulnerability modelling to assess threat for each meadow
2. Develop decision tool to provide a flexible means of sequencing actions using variable criteria
3. Provide means of managing meadows by watershed and geographic zone

Methods - Overview

Rapid assessment
-condition and stressors (YN staff)

Remote sensing
-historic changes in greenness and soil moisture (CSP)

Climate modelling
-future trends in hydroclimate (UW CIG)

Tribal knowledge (YN staff)

Synthesis of present, past, and future condition, changes, and trends in soils moisture and climate for each meadow (sampled in rapid assessment)

**CSP Conservation Science Partners*
**UW CIG University of Washington Climate Impacts Group*

Methods 1- Rapid Assessment

- Meadows assessed 2007-2011
- Primary goal to understand function and condition of Reservation meadows
- 368 meadows (46%) and 4,905 acres (57%) assessed
- Datasheet developed, information stored in database
- Threat Summary by meadow and watershed

BOLD BOXES INDICATE GIS ANALYSIS

MEADOW / WETLAND RAPID ASSESSMENT DATASHEET

GENERAL INFORMATION

Meadow No. / Assess. Unit No. (AU):	Date (m/d/y)
Common Name (Meadow, River, etc.):	Investigators:
Elevation (ft.):	Basin:
T / R / S / 1/4 S:	County:
If meadow not previously mapped, give GPS coordinates (UTM) of AU:	**Riverine** Upstream limit: Downstream limit: **Non-Riverine** Center:
Assessment Unit Acreage:	Precipitation zone (inches):
Land Ownership (circle all that apply): Tribal Trust / Private Allotment / Other:	
Do you have previous experience with this site, excluding work done during the office assessment? (circle one): Yes / No If yes, elaborate:	
If other than USFWS Wetlands layer and YN Wildlife GIS, describe how the boundaries of the AU were created:	
Were boundaries modified in GIS during / after field visit? Y / N	GIS Track Name:

HYDROGEOMORPHIC CLASS[1] (Check ALL wetland types present within the meadow and answer associated questions.)

☐**Riverine Wetland**	Dominant / Subdominant wetland (circle one)
1) Which best describes the gradient[2] of the reach you are assessing (circle one): High / Low	
2) What is the gradient of the meadow?	
3) What is the apparent hydrologic flow regime[3] of river? (circle one): Perennial / Intermittent-Seasonal / Ephemeral	
4) If applicable, best describe the current flow condition of the stream (circle one): Low flow (base flow) / High flow / Dry / Disconnected and/or Stagnant	
☐**Depressional Wetland**	Dominant / Subdominant wetland (circle one)
1) Which best describes the type(s) of wetland(s)[4]: Marsh / Bog / Fen / Other.	
2) Which best describes the hydrologic state of the wetland(s) at the time of assessment (circle one): Ponded / Inundated saturated soil, but no surface water / Dry	
3) What is the apparent hydrologic regime[5] of the wetland(s) (circle one): Long-duration / Medium-duration / Short-duration / Don't know	
4) Do these wetlands connect with the floodplain of a nearby stream? (circle one) Yes / No	
5) Is the topographic basin[6] of the wetland / meadow either (circle one): Distinct / Indistinct	
☐**Seep / Spring Wetland**	Dominant / Subdominant wetland (circle one)
1) Does the spring/seep occur on a discernible slope? (circle one) Yes / No	
2) Are there any distinct channels associated with the wetland (e.g. a visible outflow?) (circle one) Yes / No	
3) If yes, briefly describe the channel(s):	
☐**Lacustrine Wetland**	Dominant / Subdominant wetland (circle one)
1) Is the lake (circle one): Natural / Man-made 2) Is the lake impounded by a dam? (circle one) Yes / No	
3) Which situation best describes the hydrologic connectivity of the lake? The lake is (circle one): In channel / Within a floodplain / Disconnected or Isolated	

Assessed damage from:

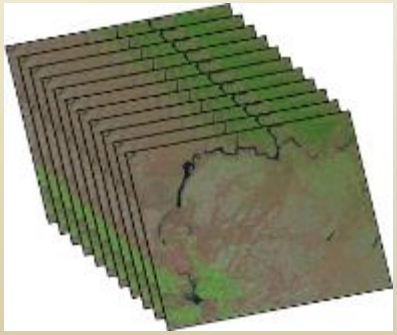
- Overgrazing by cattle
- Conifer encroachment
- Invasive plants
- Hydrologic degradation
- Roads, culverts, harvest practices

Methods 2- Historic Remote Sensing

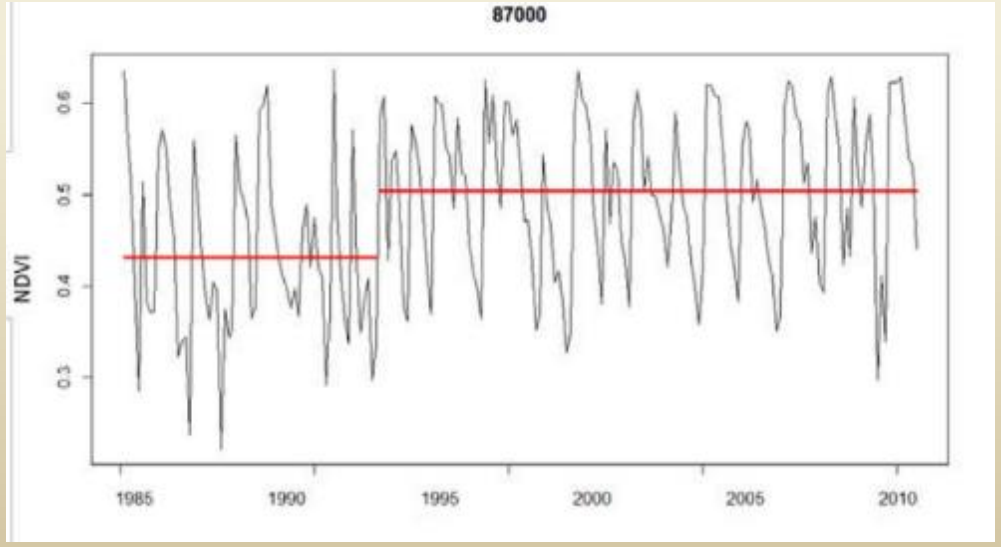
- Model Normalized Vegetation Difference Index (NVDI), a good proxy for **soil moisture**, using Landsat archive on Google Earth Engine, 1984 to 2011
- Generate time series of NVDI, which show trends and abrupt changes
- **Wet** and **dry** meadows were distinguishable, mesic were variable
- Analysis conducted with and without **tree and water pixels**, potentially confounding elements
- Maps produced of results

Real meadow

Digitized on aerial photo

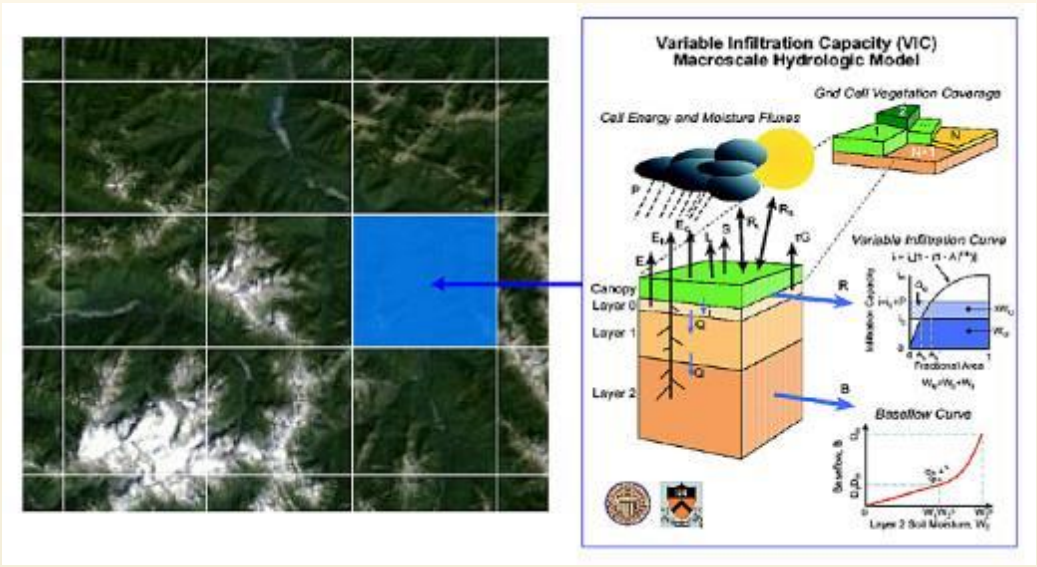


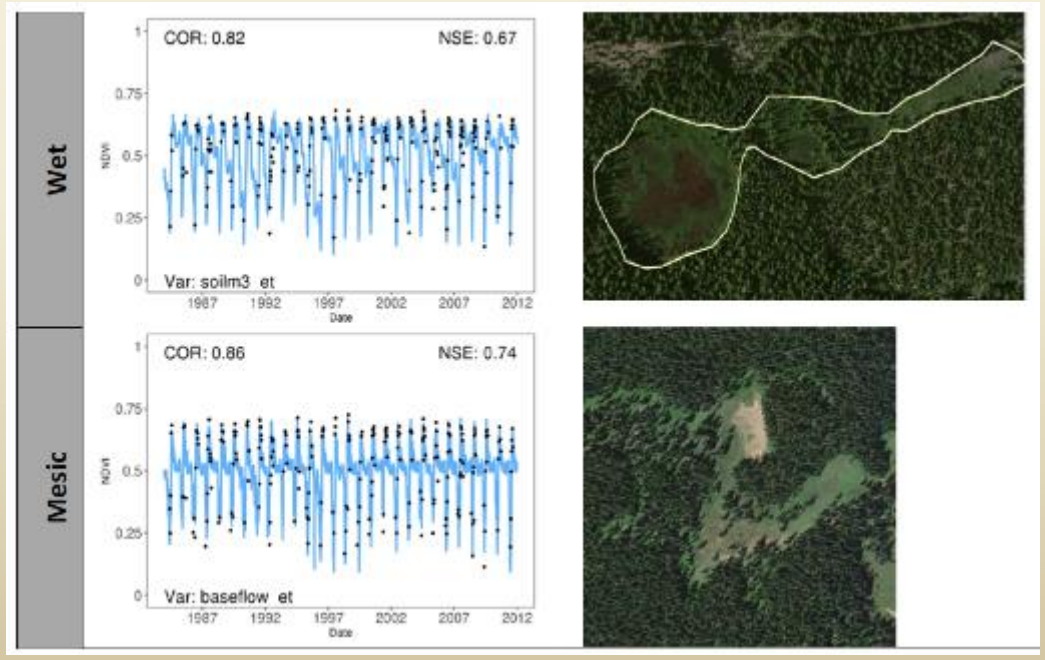
model of NVDI/soil moisture



Methods 3- Future Climate Modelling

- Variable Infiltration Capacity (VIC) hydrological model used
- Historical and future climate time series as inputs (daily temp, precip., wind speed)
- Output daily water balance variables (soil moisture) until year 2100
- Identified future changes in hydroclimate (timing, quantity) for each meadow
- changes in type of meadow (wet to mesic, mesic to dry e.g.)
- Models <u>only</u> changes due to climate, cannot see land use





Methods 4- Incorporate Tribal Knowledge

- Interviews with willing participants
- Informed consent form and structured questions
- Asks about significance, resources, and changes in meadows
- Purpose is to help prioritize meadow protection and restoration according to local knowledge


Meadow with bull thistle

Research Interview Questions (Meadow/Plant Knowledge – Ethnographic Inventory)

After introducing the project, with Tribal approval and support, after reviewing the possible risks and benefits and having the interviewee read and sign the Informed Consent Form, and after securing use of an audio recorder for the interview, the following semi-structured questions could be asked:

A. Demographic Information:

What is your age, gender, and family affiliation? (If applicable)

B. Inventory Information: what is your knowledge of meadows within the closed area?

Possible follow-up questions:

1. How have the meadows you have visited changed over the years?

2. When was the last time you visited some of the meadows?

3. What significance does this meadow or meadows in general have for you?

Nutrition (food source)

Potential medical uses

Cultural Heritage

Other

4. Do you have information, from remembrances or personal experiences, on meadows you used frequently growing up?

Are they still areas that you and your family visit?

If no, what has changed? Has it been a victim or tree encroachment? Is the meadows hydrology changing? Or other?

5. Do you have information, from remembrances or personal experiences, on the changes over time within meadows that are important to you?

Results-Overview

Rapid assessment
-condition and stressors (YN staff)

- 46% overgrazed, 22% affected by roads, 22% channel degradation, 16% conifer encroachment, 15% invasive plants, 9% harvest impacts.
- 58% have threat rating of M, H, or VH

Remote sensing
-historic changes in greenness and soil moisture (CSP)

- 23% of meadows showed a trend or abrupt change
- Abrupt changes: 15% wetter, 6% dryer
- Trends: 15% wetter, 9% dryer
- Surprising! Tree encroachment? Less grazing?

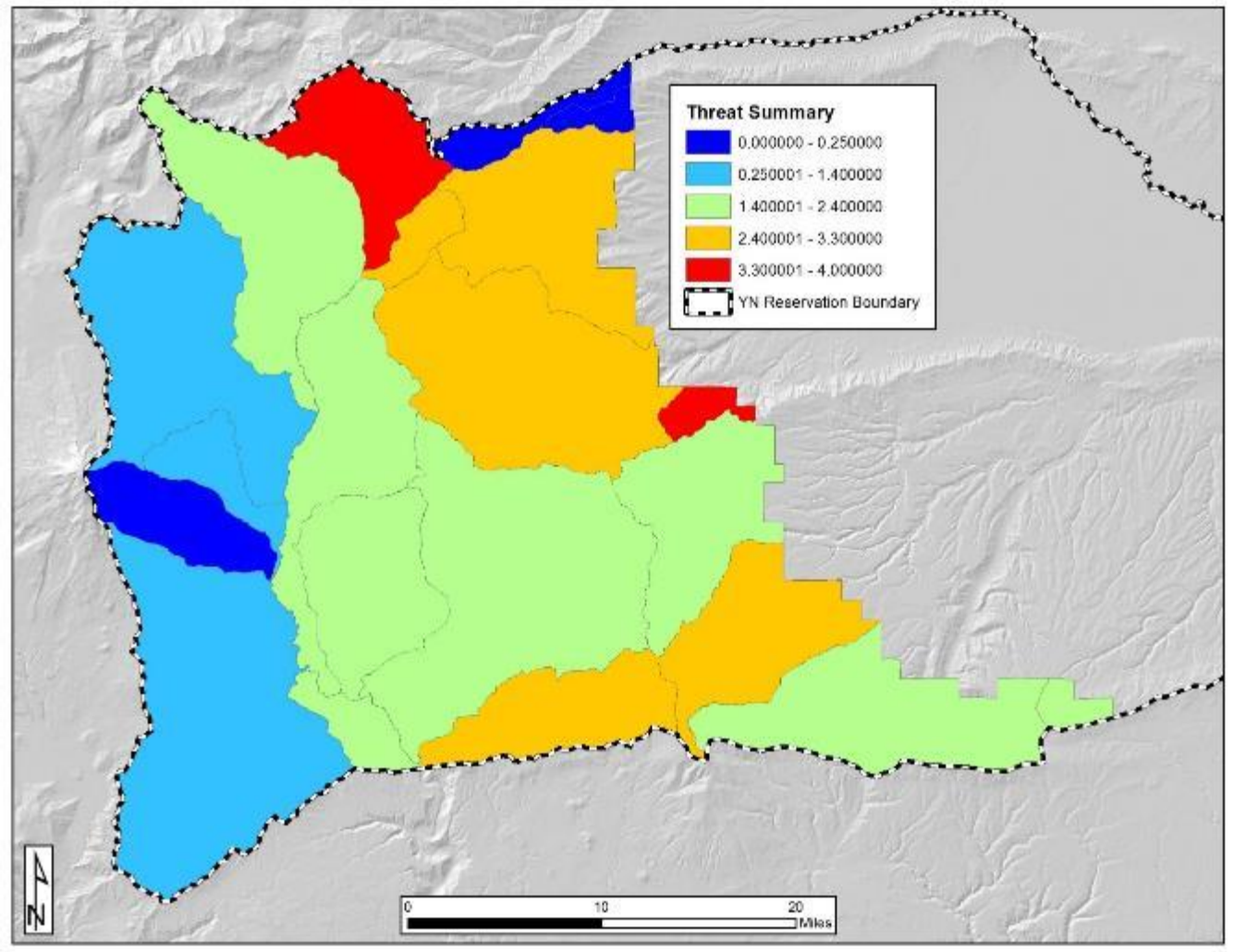
Climate modelling
-future trends in hydroclimate (UW CIG)

- 47% of meadows (73% by area) drying by 2080s
- 15% shift to dryer type (wet to mesic or mesic to dry)
- Meadows above 1000 meters get wetter

Tribal knowledge (YN staff)

- Still in process

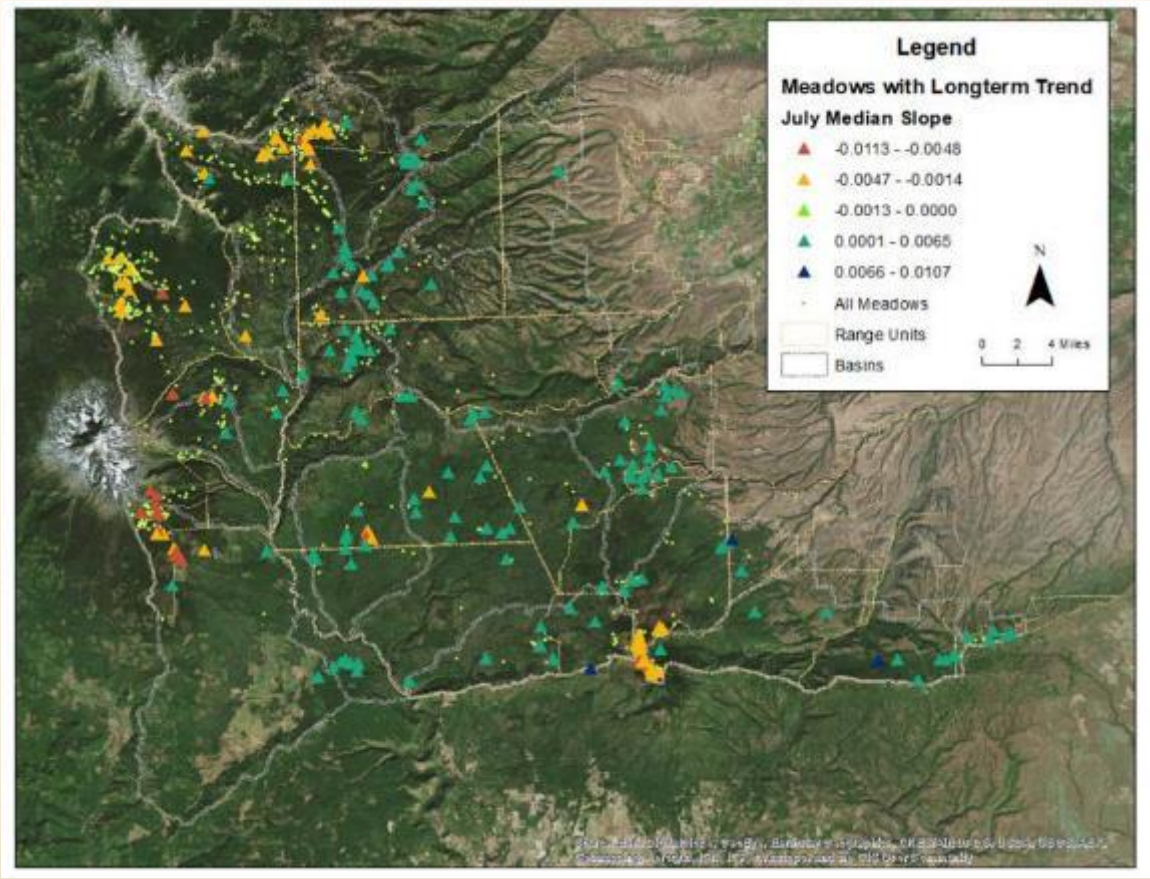
Results-Rapid Assessment example



Combined threat summary for all meadow basins, by number of meadows

- Combine all threats by watershed to see broad patterns
- Similar maps can be produced of all threat types
- Can be broken down by numbers of meadows or meadow area

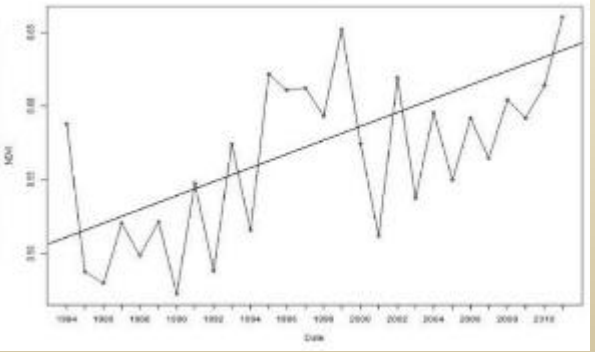
Results-Historic Remote Sensing Example



Meadows with long term trend

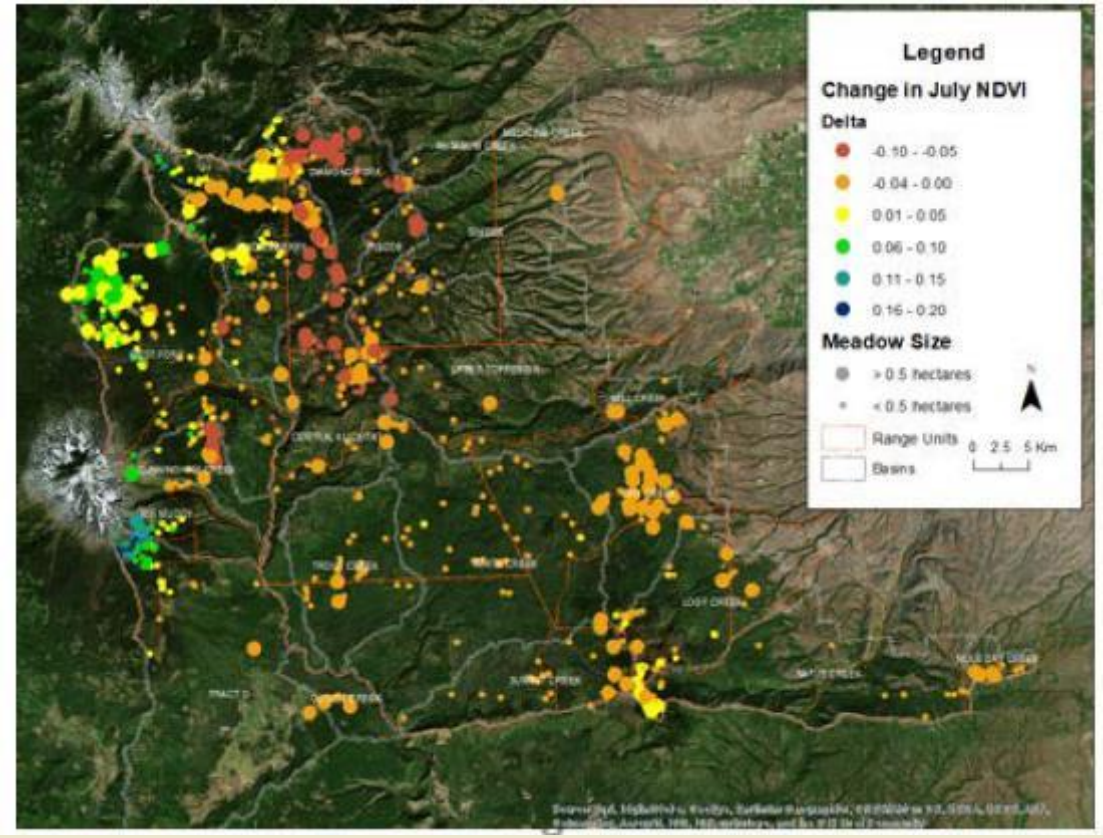
- Shows mostly slight trends, does not explain them
- Local knowledge or further analysis would be necessary
- "Wetter" trend could be tree encroachment, recovery from mid-century heavy grazing
- Suggests directions for future work

Central Klickitat – AU# 52000



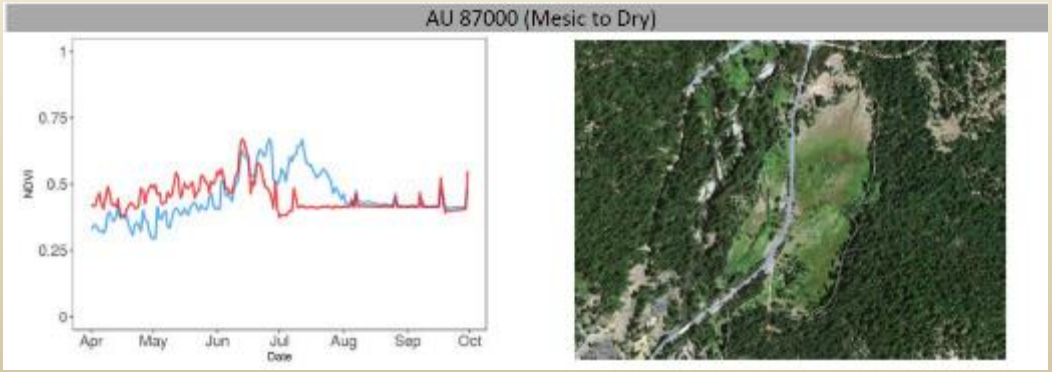
Example of tree encroachment

Results-Climate Model Example



Projected change in July NVDI for 2080s

- Projected future shifts will aid in long-term planning
- Strong elevation and longitudinal patterns
- Shifts in timing
- Projections align with regional climate forecasts
- Potential effects on meadow plant species

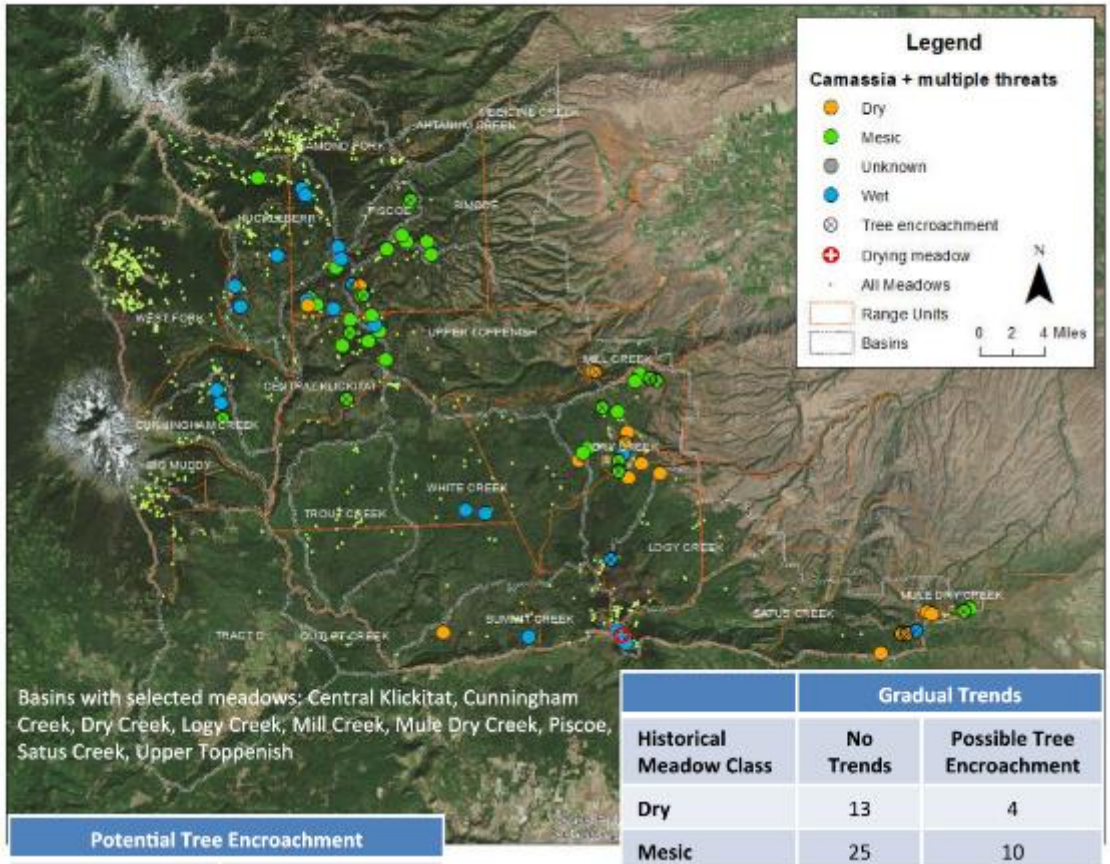


Example of projected shift mesic to dry

Synthesis and decision tool

- Brings together the different data sources
- Allows for flexible criteria, e.g. plant species, beaver activity
- Can incorporate future data, e.g. cultural or wildlife habitat
- Will be tested against local knowledge for a reality check

Box 1. Meadows with *Camassia* and impacted by multiple threats



Basins with selected meadows: Central Klickitat, Cunningham Creek, Dry Creek, Logy Creek, Mill Creek, Mule Dry Creek, Piscoe, Satus Creek, Upper Toppenish

Potential Tree Encroachment	
Basin	Selected Meadows
Central Klickitat	2
Cunningham Creek	2
Dry Creek	6
Logy Creek	1
Mill Creek	1
Mule Dry Creek	1
Piscoe	1
Satus Creek	3
Upper Toppenish	2

	Gradual Trends	
Historical Meadow Class	No Trends	Possible Tree Encroachment
Dry	13	4
Mesic	25	10
Wet	19	4
Unknown	1	

	Future Projections			
Historical Meadow Class	NDVI Decrease	NDVI Increase	Shift to Drier Class	Shift to Wetter Class
Dry	17	0	1	0
Mesic	35	0	11	0
Wet	18	2	5	0
Unknown	1	0	0	0

Synthesis and decision tool

- Can drill down to each meadow
- Incorporate historical air photos
- Evaluate potential remedial actions

Box 8. Meadow 187000 – Possible tree encroachment (selected under Scenarios 2, 4, and 10)

- ✧ Example of a mesic meadow, showing variability across it; it may be a meadows where parts are wet (north) and parts are dry (south).
- ✧ The current image shows small trees in the drier (southern) portion of the meadow that were not there in 1996.
- ✧ The NDVI time series, both with all pixels and with tree-free pixels, show significant seasonal variability, and there appears to be a longer-term positive trend, suggesting tree encroachment.
- ✧ Tree encroachment appears to be important. Could meadow drying be a driver of this trend? Could tree removal be an effective restoration strategy? A field visit could be very helpful.

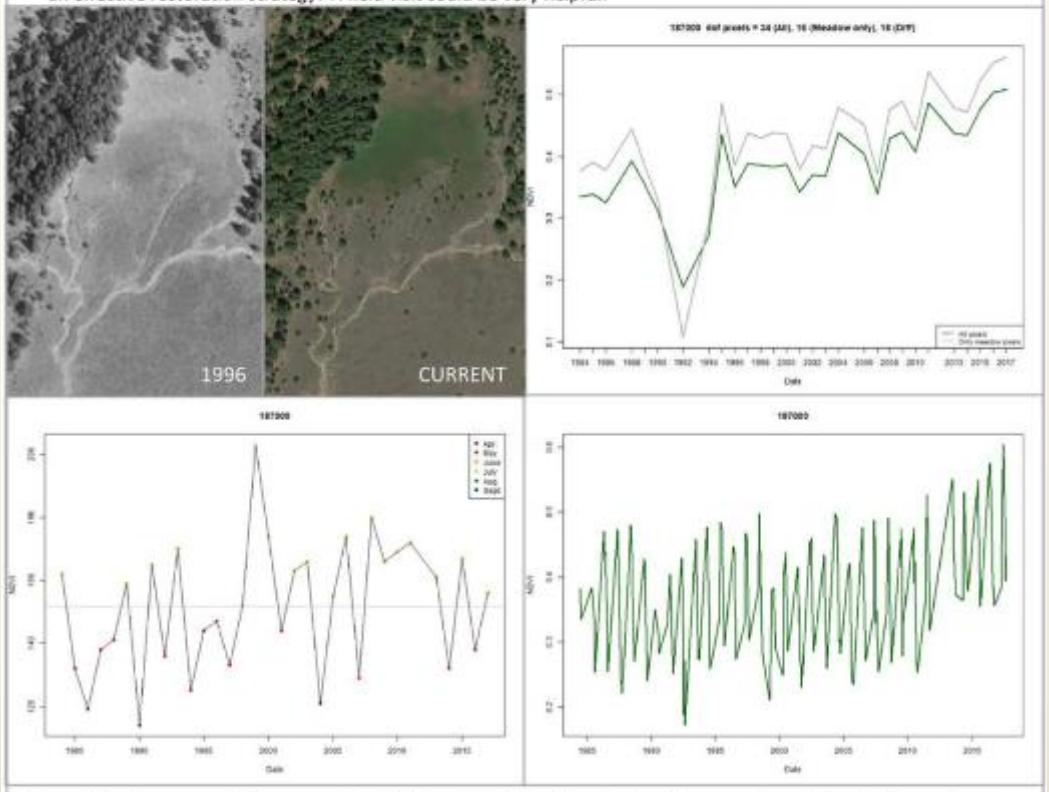


Figure 38. Exploring the data on meadow 187000. Top left panel is a side-by-side comparison of two high-resolution images of the meadow: 1996 and current. Top right panel shows the median July NDVI, and how it varies year by year from 1984 to 2011, for all pixels within the polygon (green) and for only those pixels without trees or open water (gray). Bottom right panel shows all NDVI observations from 1984 to 2011 for all pixels. Bottom left panel shows the year-to-year variations in the date of maximum NDVI.

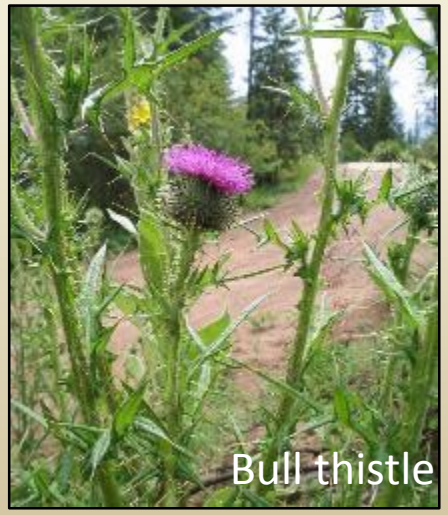
Table 8. Summary of threats and remedial actions, obtained from the habitat assessment (King, 2011).

	Grazing Threat	Roads Threat	Channel Threat	Encroach Threat	Logging Threat	Weed Threat	Threats Index
Impacting the meadow			✔				**MEDIUM**
Remedial actions exist			✔	✔			

Conclusion and Takeaways

1. Historic land use, existing threats are of great immediate concern, overgrazing is a leading cause of degradation
2. Past trends in NVID/moisture are surprising and challenge assumptions
3. Tree encroachment emerged as a big concern, could gradually eliminate meadows (Sierra report)
4. Climate change is a threat to YN meadows, should help focus management efforts and clarify priorities

Figure 26. Conifer encroachment in Camas Patch meadow (AU #183).



Protection and Restoration Measures

1. Manage grazing with fences and movement of cattle
2. Restore channel function
3. Re-introduce fire and cut trees down
4. Target meadows for invasive plant management
5. Remove/replace roads and culverts
6. Follow forest management guidelines

Next steps

1. Continue efforts to interview enrolled members
2. Compare model and remote sensing results with reality through site visits
3. Use decision tool to plan and sequence watershed restoration
4. Engage partners in Ceded Territories to broaden the scope of assessment
5. Find some funding, get to work!

Thank You!

- Yakama Tribal Council
- Wildlife Program colleagues
- Bureau of Indian Affairs
- Environmental Protection Agency
- U.S. Fish and Wildlife Service
- Bonneville Power Administration
- Yakama Nation Fisheries
- Yakima Basin restoration community