Effects of Climate Change on Ecological Disturbances

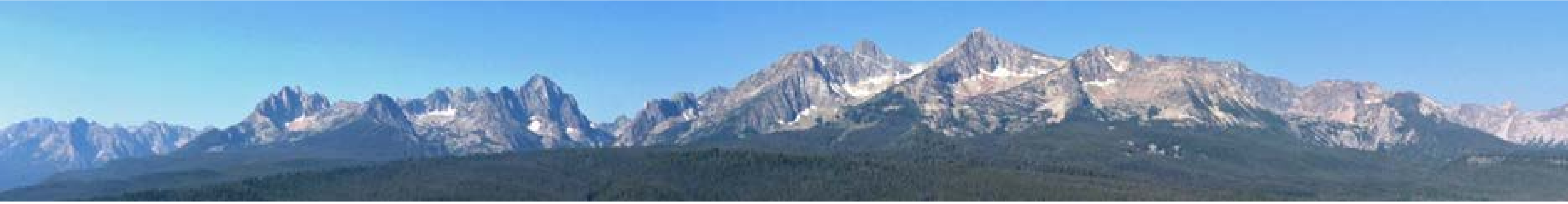
Intermountain Region – Climate Assessment Workshop

May 22, 2018

Danielle Malesky, M.S.F.

Forest Entomologist

State and Private Forestry – USDA Forest Service



Ecological Disturbances Chapter Team

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Barbara Bentz

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Ann Lynch

Marek Matyjasik & **Gordon Keller**

Joel McMillin

Javier Mercado

Jesse Morris

Jose Negron

Wayne Padgett

Rob Progar

Carol Randall

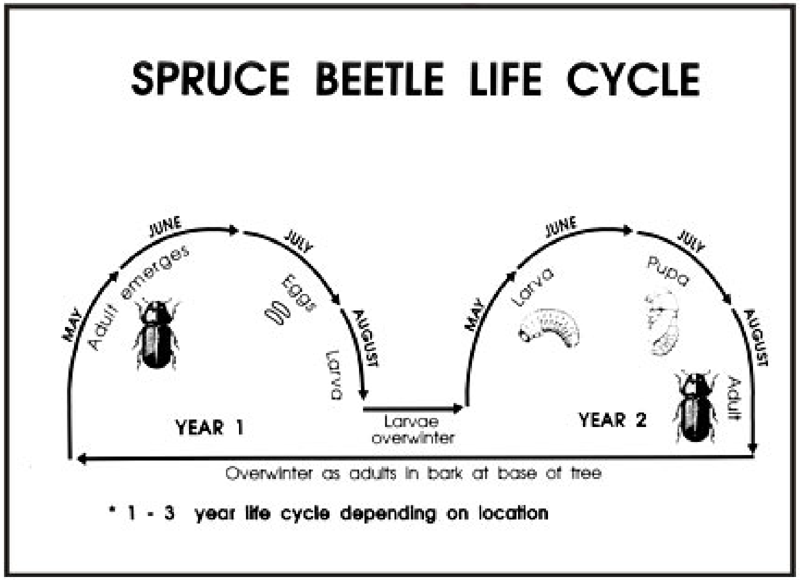
And others

Ecological Disturbances Chapter

- Introduction
- Paleo-ecological background for Region 4
- Wildland fire
- Insects
    - Bark beetles
    - Native defoliators
    - Invasive Insects
- Forest tree diseases
    - Native and non-native
- Invasive Plants
- Geologic Hazards
- Interactions
- Conclusion

Insects: Bark beetles

- Direct and Indirect effects of climate change
  - Direct effects (overwinter survival and generation time)
  - Indirect effects (host tree susceptibility and community associates)

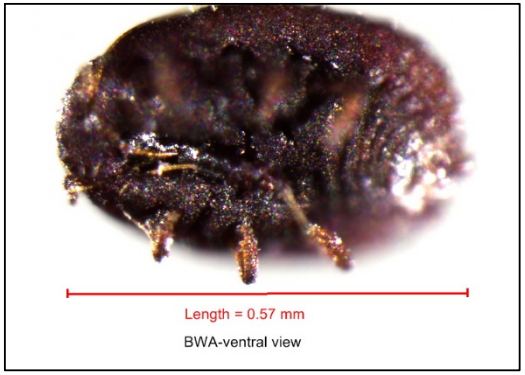


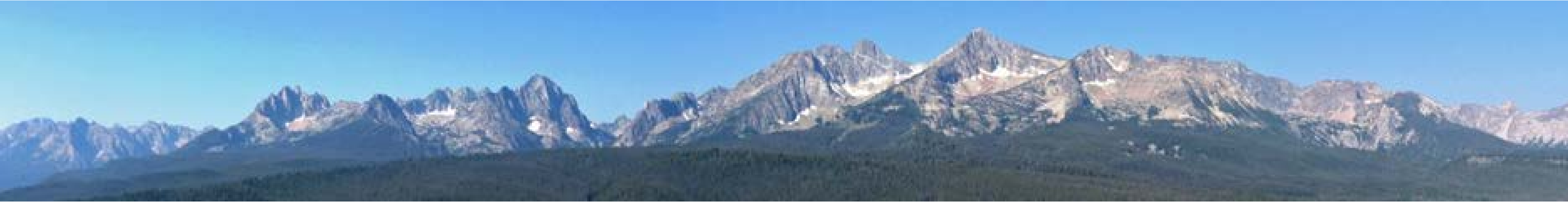
Insects: Defoliators

- Western spruce budworm
- Douglas-fir tussock moth
- Pine butterfly

Insects: Invasive Insects

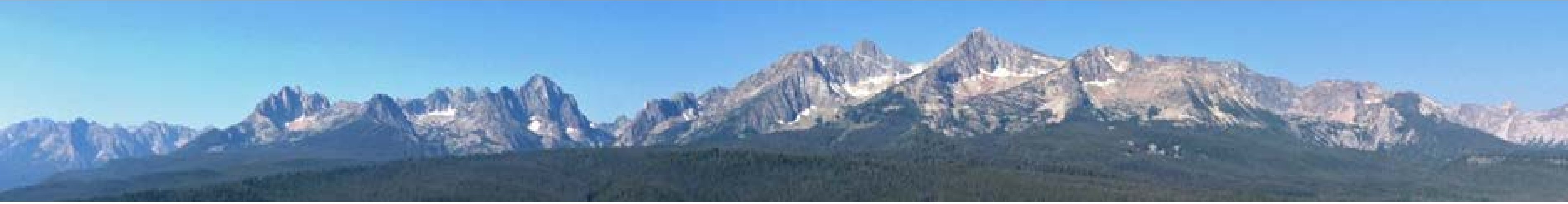
- Larch casebearer
- Spruce aphid
- Balsam woolly adelgid
- Poplar scale





Adaptation Strategies & Tactics

- Whitebark Strategy
  - National and Regional efforts ongoing
- Partnerships & Collaboration
  - National and Region 1 / 4 efforts ongoing
  - Data sharing
  - FIA
- Stay flexible (and fiscally aware) with management
  - Reconsider treatment timing
  - Cost : Benefit
  - Reconsider cost : benefit of long-term options versus short term
- Align, communicate and develop a research strategy
  - Funding limited
  - First things first…
- Invest in longer term options
  - Genetic resistance programs
  - Biological control



Summary & Major Results

- "It's complicated"
- "There will be winners and losers"
- Get to know your forest health staffs and funding / services available
- Forest health funding available
    - STDP, EM, and PIAP
    - Western bark beetle
    - Additional funding sources: WWETAC, SERG, and Emerging Pest

Weblinks & Additional Resources

- Forest Health Protection: https://www.fs.usda.gov/main/r4/forest-grasslandhealth
- FHAST, previously FHTET: https://foresthealth.fs.usda.gov/portal
- Forest Inventory and Analysis tools and data: https://www.fia.fs.fed.us/tools-data/
- State Forest Health websites:
  - UT: https://ffsl.utah.gov/index.php/forestry/forest-health
  - NV: http://forestry.nv.gov/forestry-resources/forest-health/
  - WY: http://wsfd.wyo.gov/forest-management/forest-health/forest-health-management
  - ID: https://www.idl.idaho.gov/forestry/forest-health/index.html
- Google search insect names with “FIDL”

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Effects of Climate Change on Ecological Disturbances

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Tim Metzger

Fire Management Planning Specialist

Fire and Aviation Management– USDA Forest Service

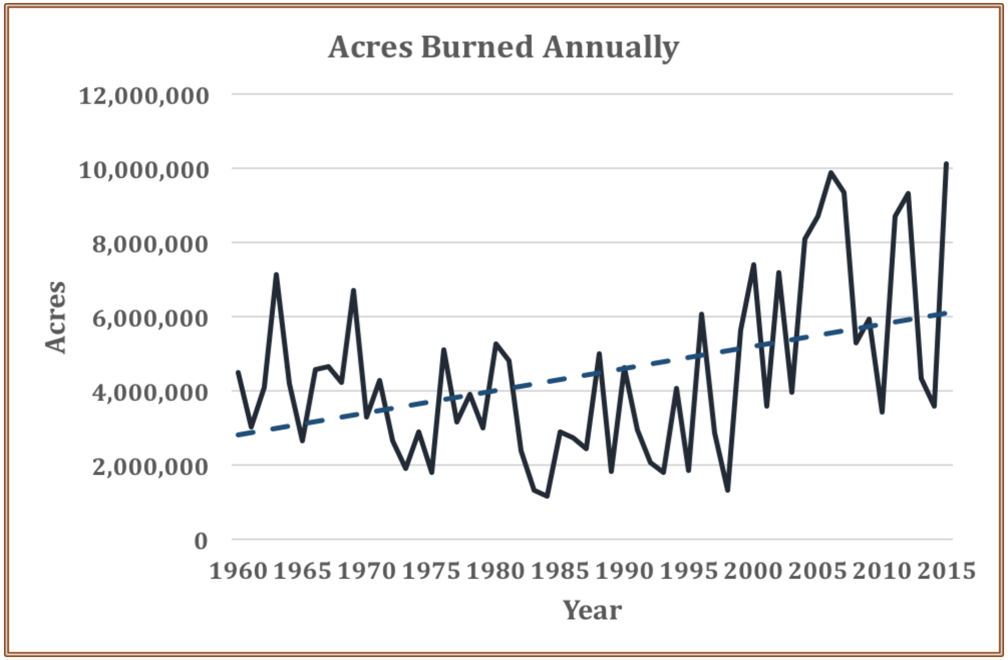
Climate Change and Fire

- Increasing temperature + enhanced precipitation variability =
  - *Warmer and drier springs*
  - *Earlier snowmelt (less snow, more rain)*
  - *Lower soil and fuel moisture*
- Longer fire seasons
- Larger fire size
- Increased likelihood & frequency
  - *Fire initiation and spread*

The annual area burned by fire in parts of western North America is expected to increase by 200-400% for each degree (°C) of warming (NRC 2011).

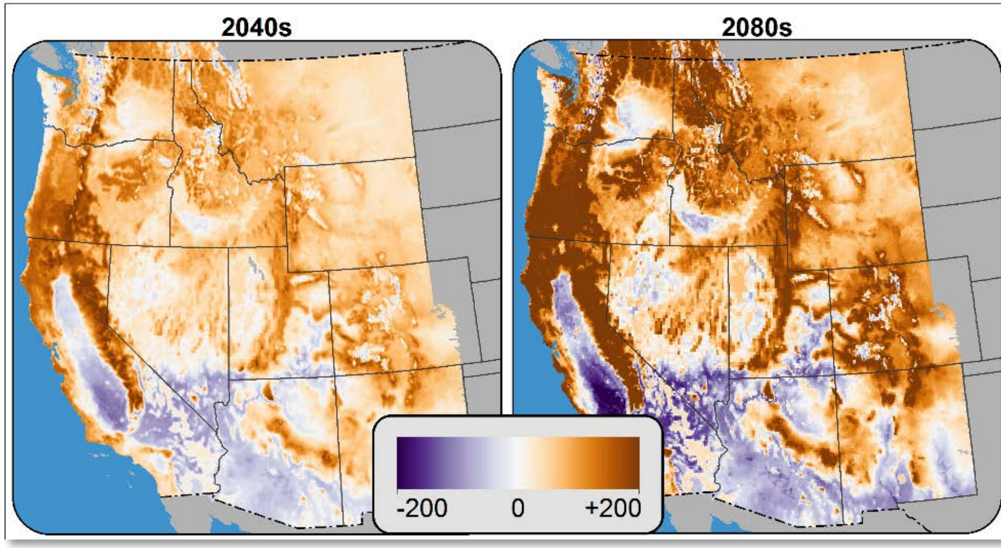
Wildland Fire in West

- Vegetation changes
- Land use legacies
- Temperature increases
- Precipitation variability
- Invasive species



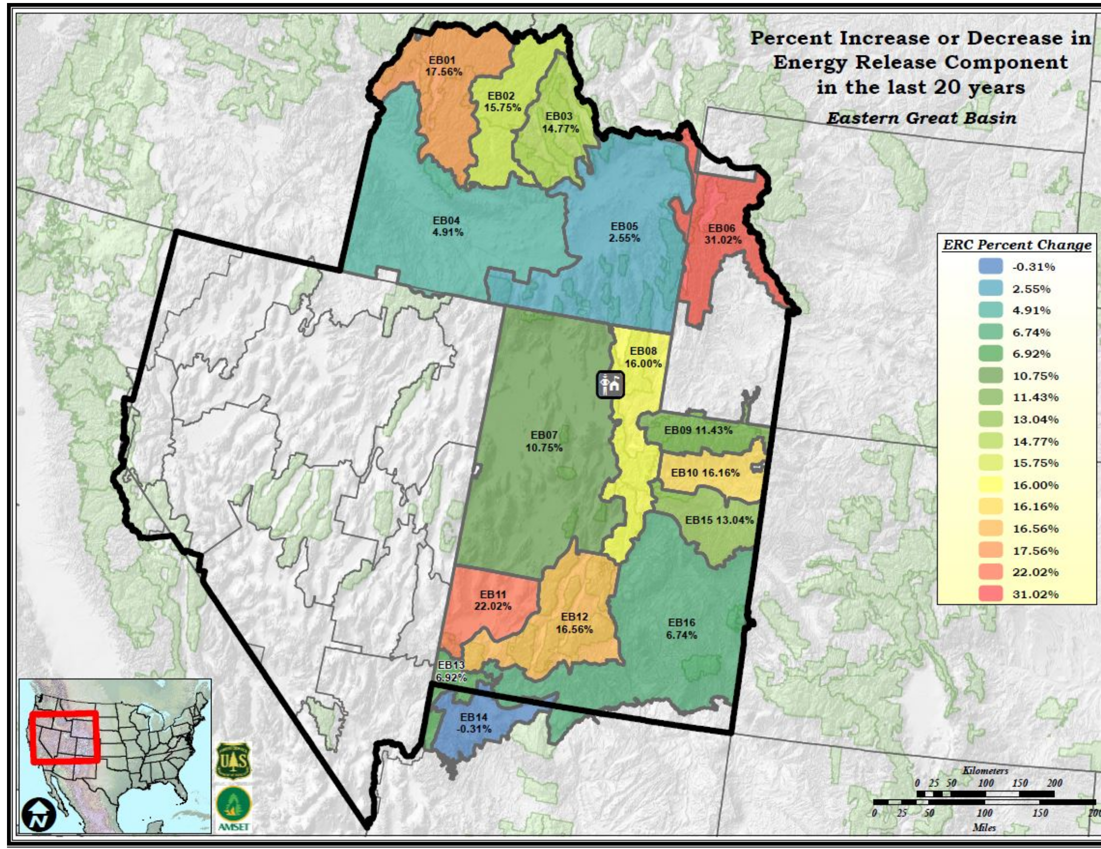
Wildland Fire Projections

- Summer water-balance deficit correlated with area burned and large fires
- Projections for changes in summer water-balance deficit
  - *Exacerbating drought*
  - *Enhanced fuel drying*



Preparedness

- **Energy Release Component (ERC)** - a number related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire. ERC is not affected by wind or slope so is only a measure of the amount of dryness of the fuels. The higher the ERC the more energy released from the flaming front. Higher ERC generally makes direct fire suppression tactics more difficult. (Bradshaw, 2012).



Preparedness

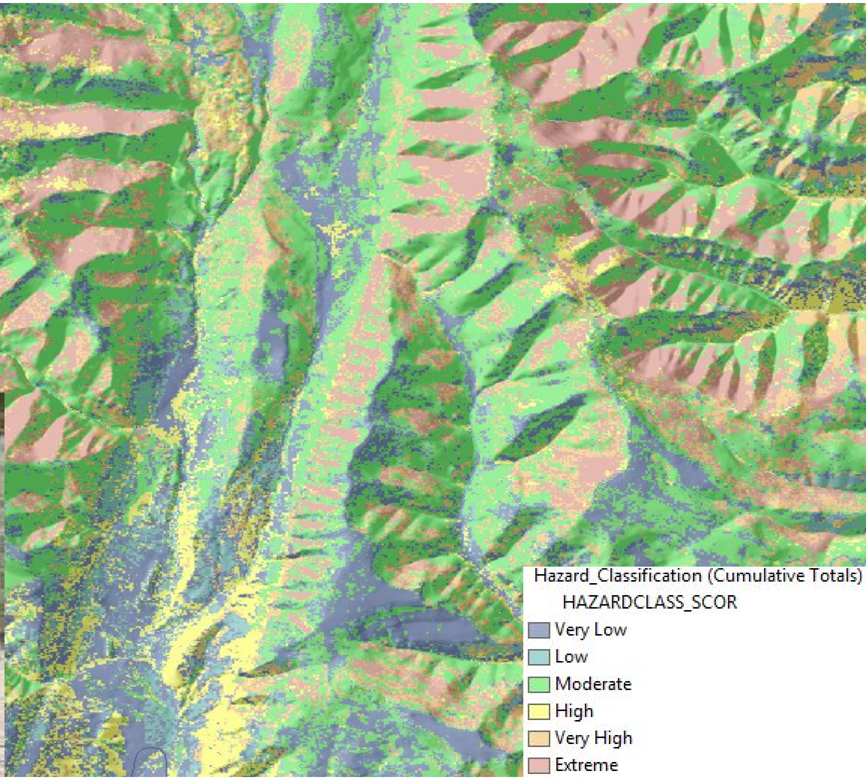
97% Variable	Temp	1000 hr	IC	BI	ERC	SC
1984-1993	Baseline For Comparison					
1994-2003 % change compared to baseline	+3.25%	-20.86%	+8.54%	+5.29%	+12.78%	+0.50%
2004-2013 % change compared to baseline	+2.65%	-19.45%	+11.14%	+5.51%	+11.94%	+0.43%

Increasing Problematic Fire Behavior

- Recognizing problematic fuels and vegetative conditions to develop strategies and tactics.
- Utilizing fire behavior and effects modeling to create a prioritized landscape to target restoration treatments.

Targeting Potential Problematic Fire Behavior and Forecasting Effects

- Where is the threat?
- Where are the values?
- What are the opportunities?
- Where is there alignment of our partners, neighbors?



Ecological Disturbances-
Geologic Hazards and Some Mitigations

Intermountain Region – Climate Assessment Workshop

May 23, 2018

Gordon R. Keller, PE, GE

Geotechnical Engineer

GENESEE GEOTECHNICAL – Retired USDA Forest Service

Geologic Hazards and Mitigations

Geologic Hazards are Huge–But Some Can be Minimized or Mitigated!!

-Droughts & Bug Kill → Fires → Geologic Hazards (Debris Flows/Flooding)

-Landslides

-Erosion & Gully Formation

-Stream Channel Instability/Changes

Storm Damage Risk Reduction Measures

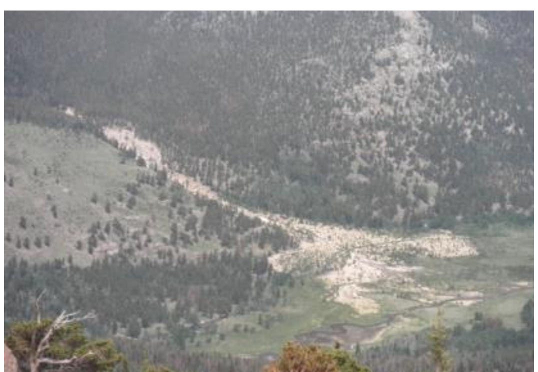
-Assessment Tools-WEPP, ERMiT, GRAIP, USGS
-Measures to Minimize Landscape Changes, Reduce Geologic Hazards, and Reduce Infrastructure Damage

- BAER Efforts
- Improve/Restore Natural Drainage Patterns
- Stream Diversion Prevention
- Pullback Sliver Fills
- Maintain/Restore Vegetative Cover
- Drainage, Drainage, Drainage

Debris Slide Impacts

Penny Luehring, USFS, BAER

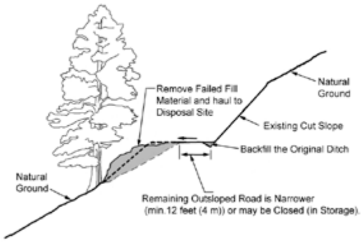
Don Lindsay, CGS



Debris Slide Prevention and Mitigation

- Preventing Drainage Concentration

- Pulling Back Sliver Fills



- Revegetation with Deep Roots

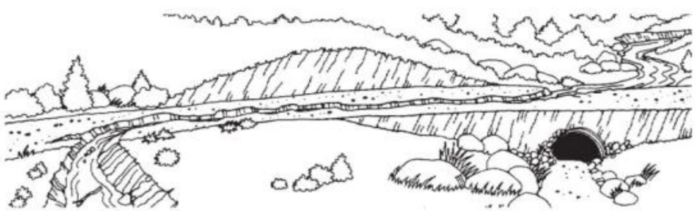
- Containment and Deflection Structures

Flooding and Drainage Issues

- **Local Flooding**

- **Stream Diversion**

Poor Installation



b. Sketch of a stream diverted down the road, forming a new channel. M. Furniss

- **Failed Structures and Washouts**

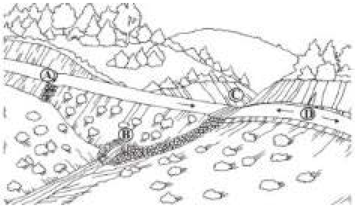
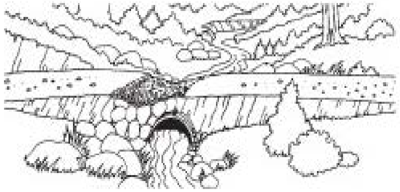
USFS/Volpe

Flooding and Drainage Mitigations

- Flooding

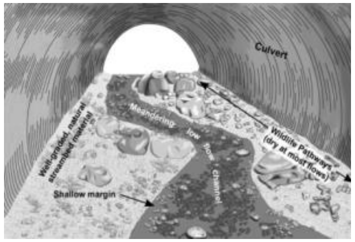
STAY OUT OF HARM'S WAY

- Stream Diversion Prevention

- Stream Simulation Structures





- Drainage Structures

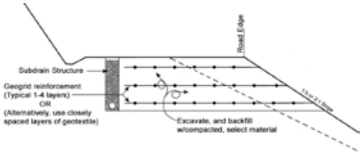



Landslide Impacts

Landslide Prevention and Mitigation

- **Biotechnical Slope Stabilization Measures**

- **Deep Patch Structures**



CROSS-SECTION OF TYPICAL DEEP PATCH
ROAD EMBANKMENT REPAIR

- **Deep Rooted Vegetation**

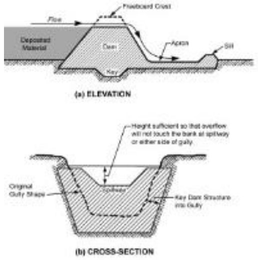
- **Improved Surface Drainage**

- **Other Retaining Structures**

Erosion and Gully Control

- **Vegetative Ground Cover**
  Mix for Fast Growth and Deep Roots

- **Prevent Water Concentration**
  DISPERSE OR REMOVE THE FLOW
- **Check Structures**



- **Close Unwanted Roads**

Stream Channel Instability

- Evaluate Natural Meander Potential

- Move Infrastructure Away from Streams



- Armor Stream Channels near Infrastructure



"Storm Damage Risk Reduction Guide for Low-Volume Roads"

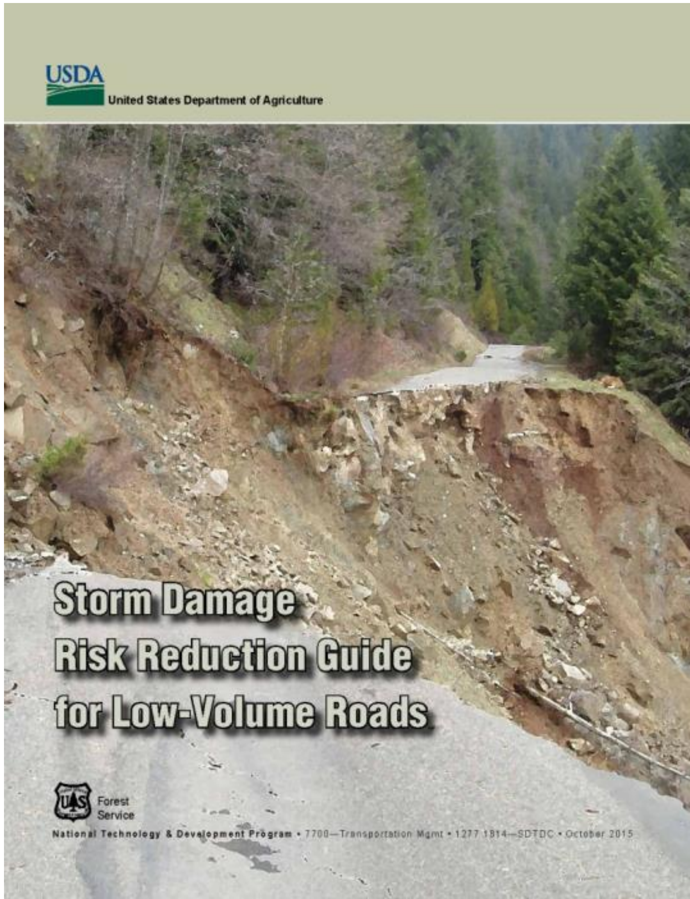
http://www.fs.fed.us/td/pubs/pdfpubs/pdf12771814/pdf12771814dpi100.pdf

or

http://www.fs.fed.us/eng/php/library_card.php?p_num=1277%201814

-US Forest Service Climate Change & Transportation Resiliency Guidebook

-Chapter 10: Effects of Climate Change on Infrastructure



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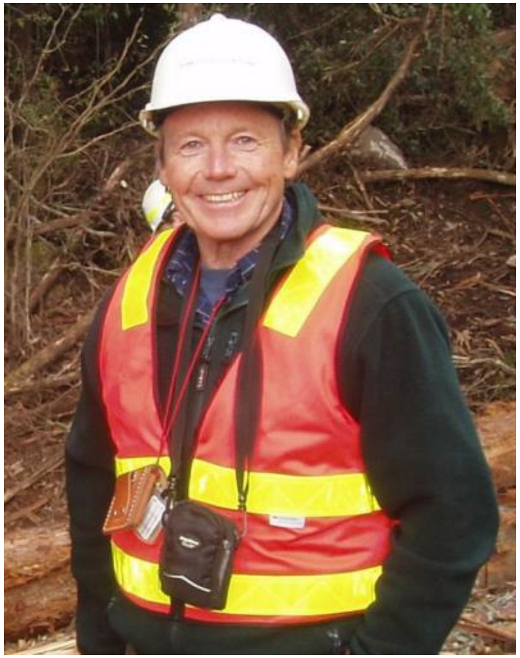


DIALOGUE AND Q&A

Effects of Climate Change on Ecosystem Services

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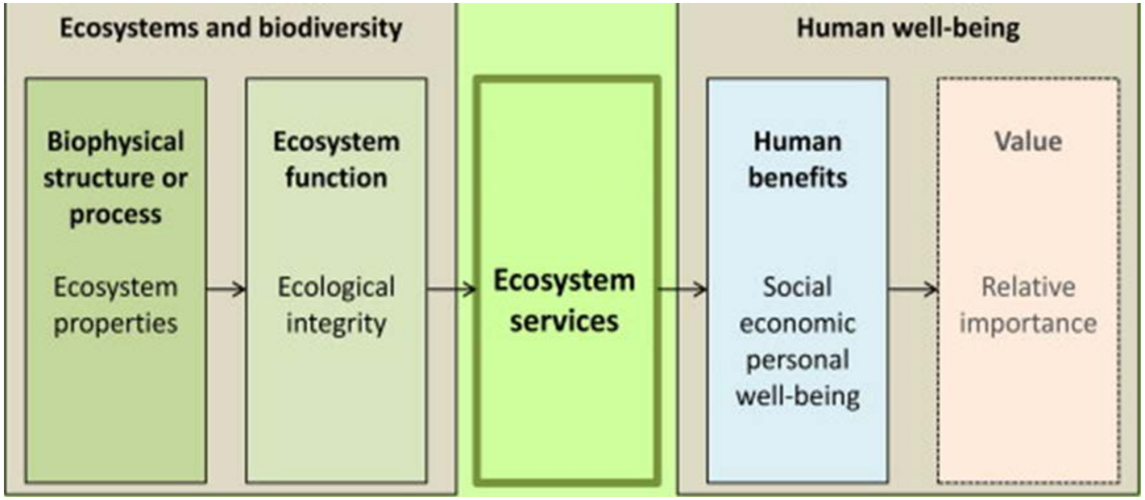


Travis Warziniack, PhD
Research Economist, Rocky Mountain Research Station

Francis Kilkenny, PhD
Research Geneticist, Rocky Mountain Research Station

Terry Padilla
Regional Range Director, USFS Region 4

John Proctor
Regional Botanist, USFS Region 4

Ecosystem Services covered

- TIMBER, WOOD PRODUCTS, AND BIOMASS
- CARBON SEQUESTRATION
- POLLINATOR SERVICES AND NATIVE VEGETATION
- GRAZING FORAGE FOR LIVESTOCK AND WILDLIFE
- MUNICIPAL DRINKING WATER QUALITY AND QUANTITY

Management Priorities in a Changing Climate

Intermountain Region – Climate Assessment Workshop

May 23, 2018

Terry Padilla

Regional Range Director

Intermountain Region – USDA Forest Service

Habitat Restoration in a Changing Climate

Intermountain Region – Climate Assessment Workshop

May 23, 2018

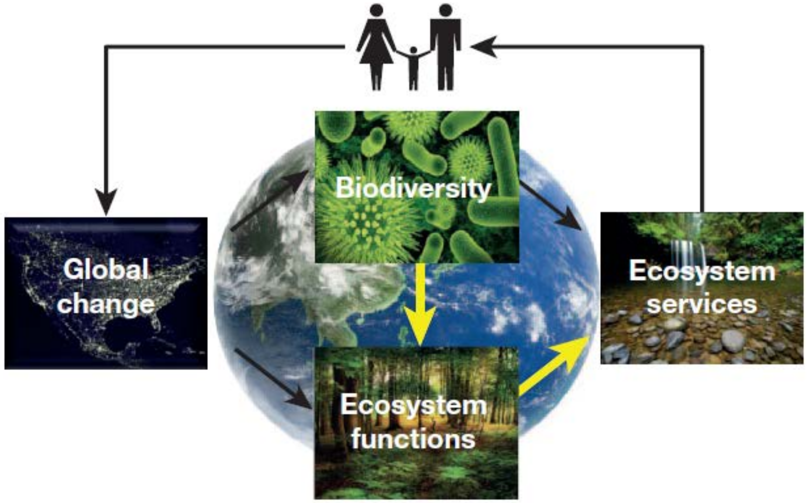
Francis Kilkenny, PhD

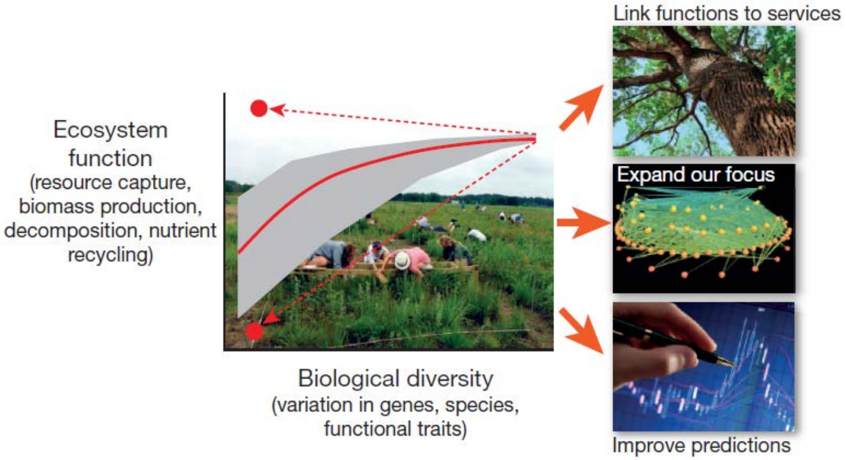
Research Biologist

Rocky Mountain Research Station – USDA Forest Service

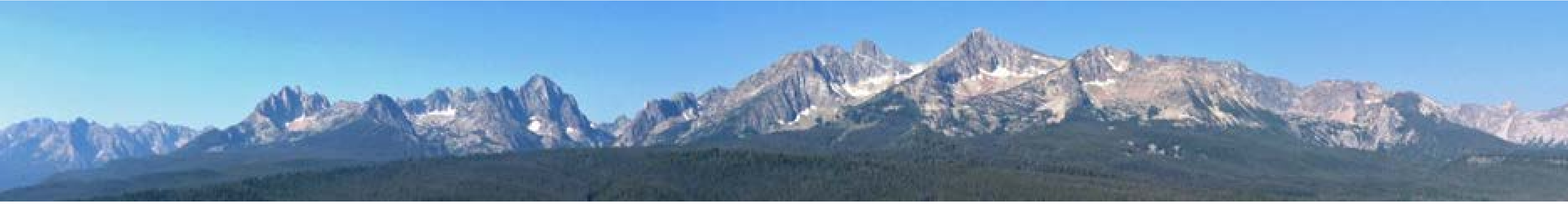
Biodiversity, ecosystem services, global change

- Biodiversity forms the basis of ecosystem function, leads to ecosystem services
- Global change affects biodiversity and ecosystem functions
- Link functions to services, expand focus of conservation, improve predictions and tools

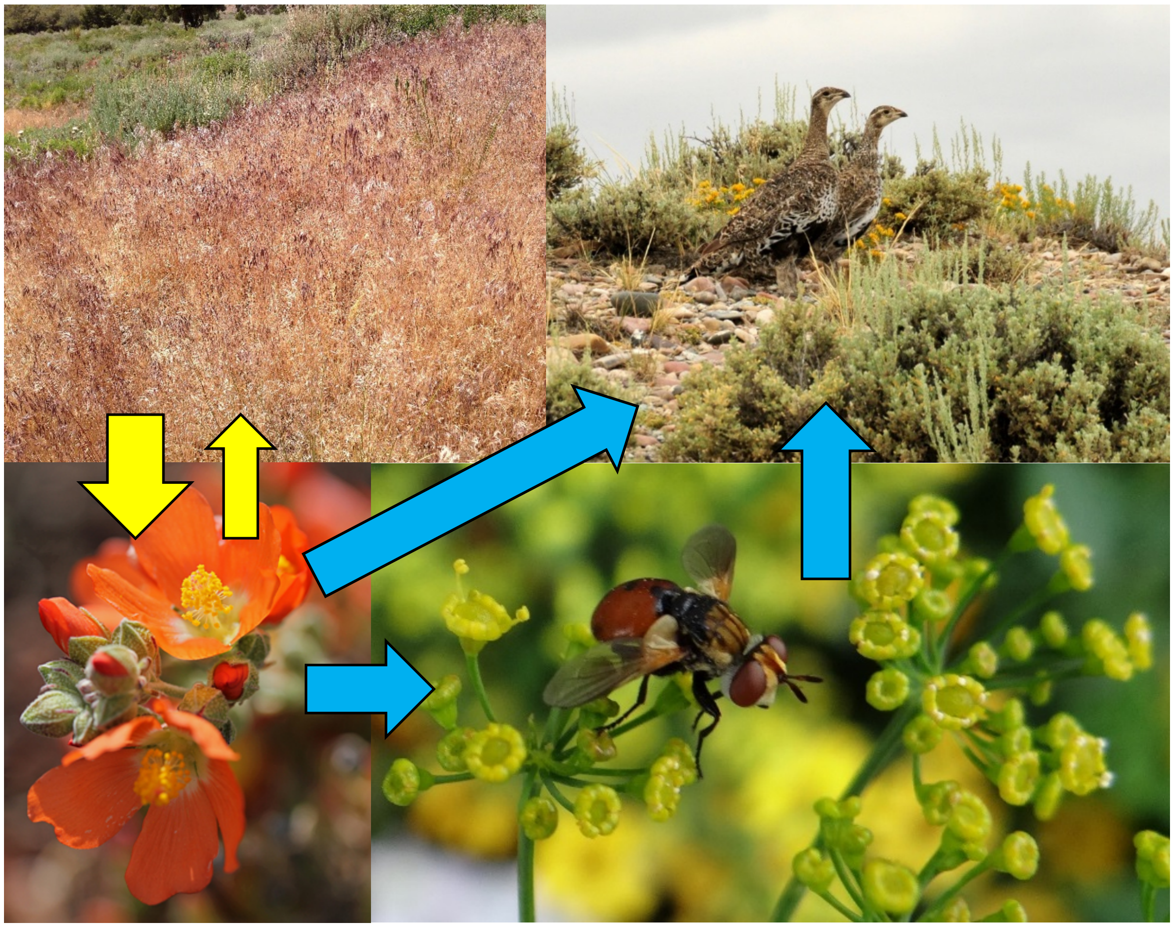


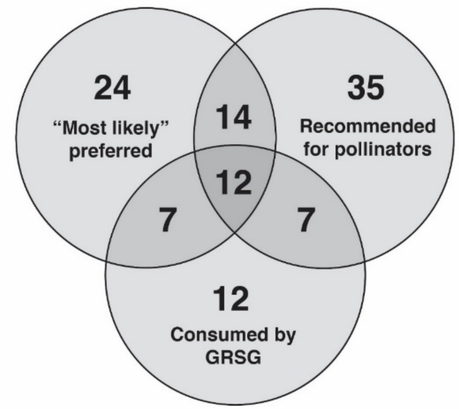


Cardinale et al. 2012. Nature 486:59-67



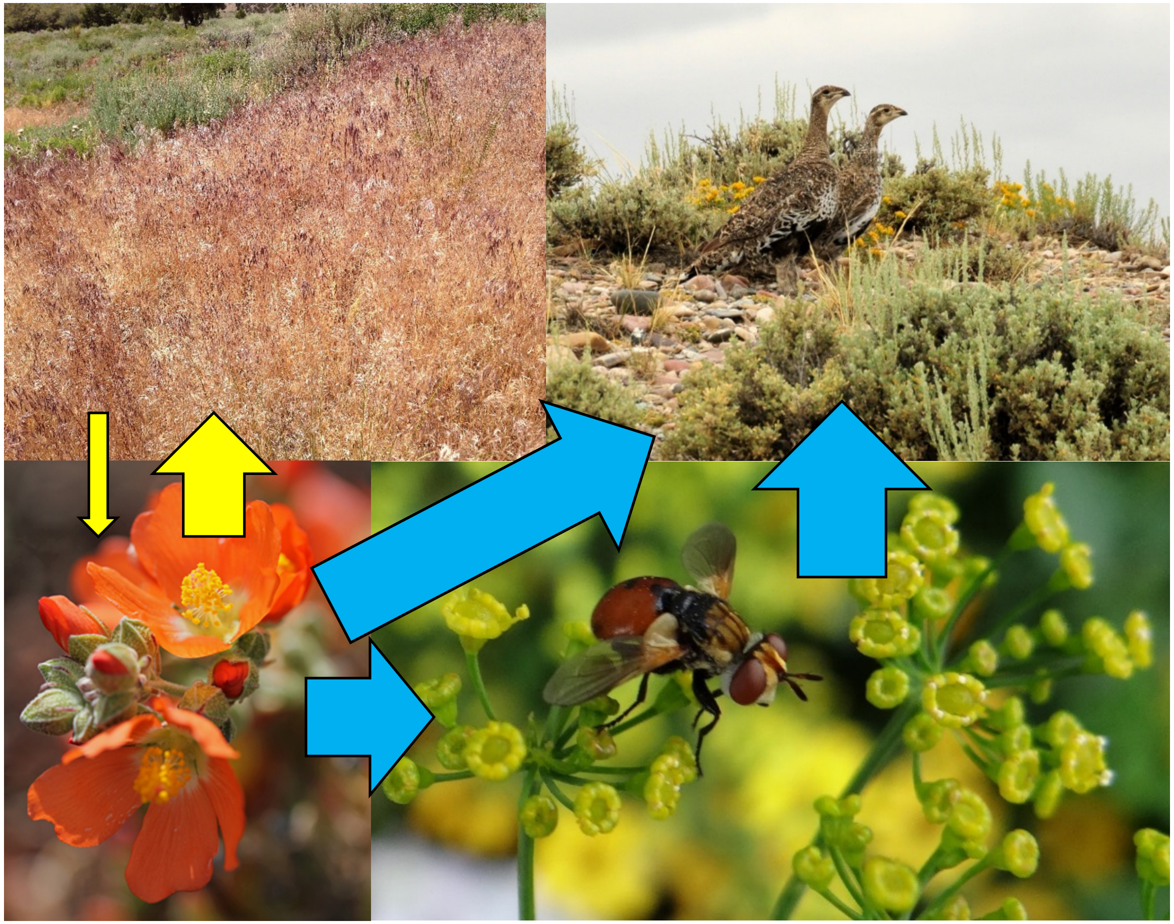
Biodiversity in the sagebrush steppe – targeting habitat restoration using native plants

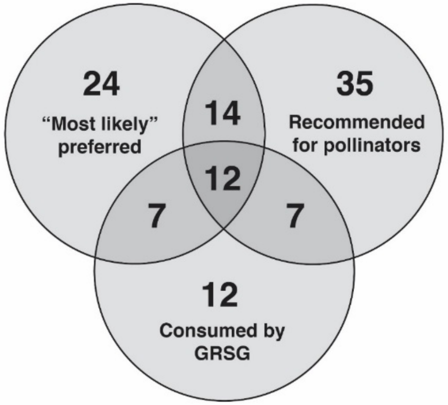




Dumroese et al. 2016. Natural Areas Journal 36:499-511

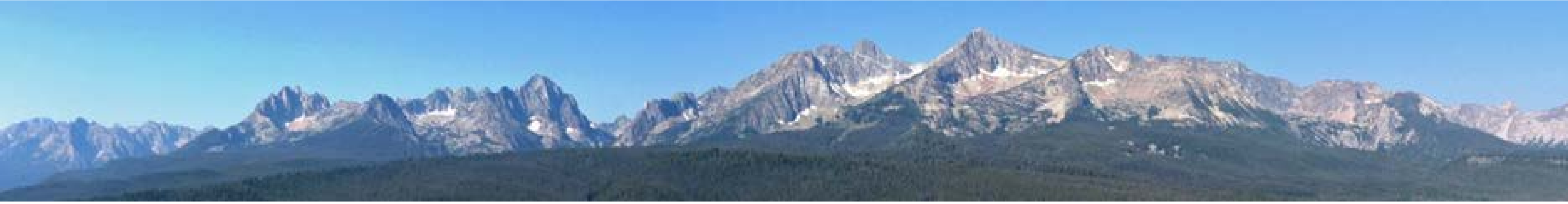
Biodiversity in the sagebrush steppe – targeting habitat restoration using native plants





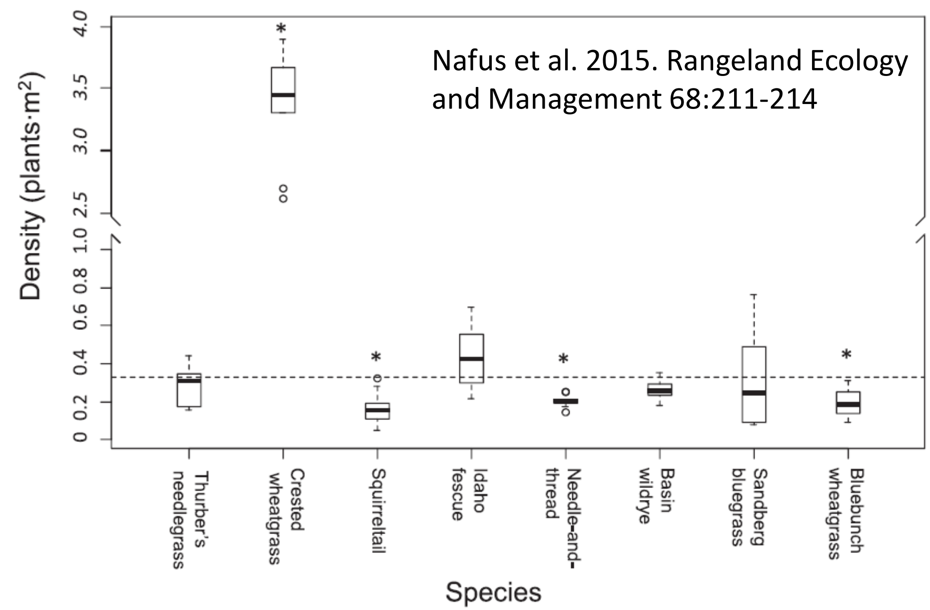
Dumroese et al. 2016. Natural Areas Journal 36:499-511

Right seed in the right place at the right time

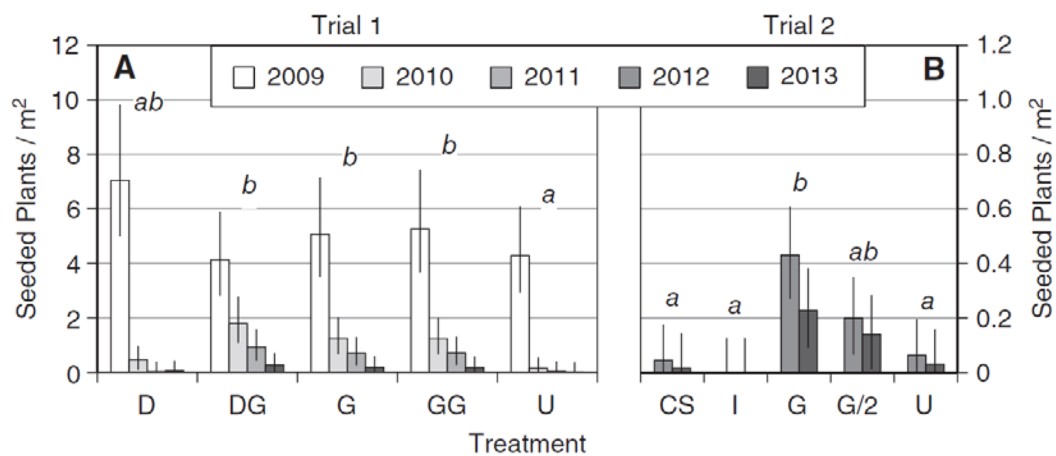


Seed mixes matter!

- Conventional mixes can adversely affect long-term biodiversity
- Introduced grasses outcompete both exotic ***and*** native species
- Stands of introduced grasses can be difficult to diversify



Nafus et al. 2015. Rangeland Ecology and Management 68:211-214

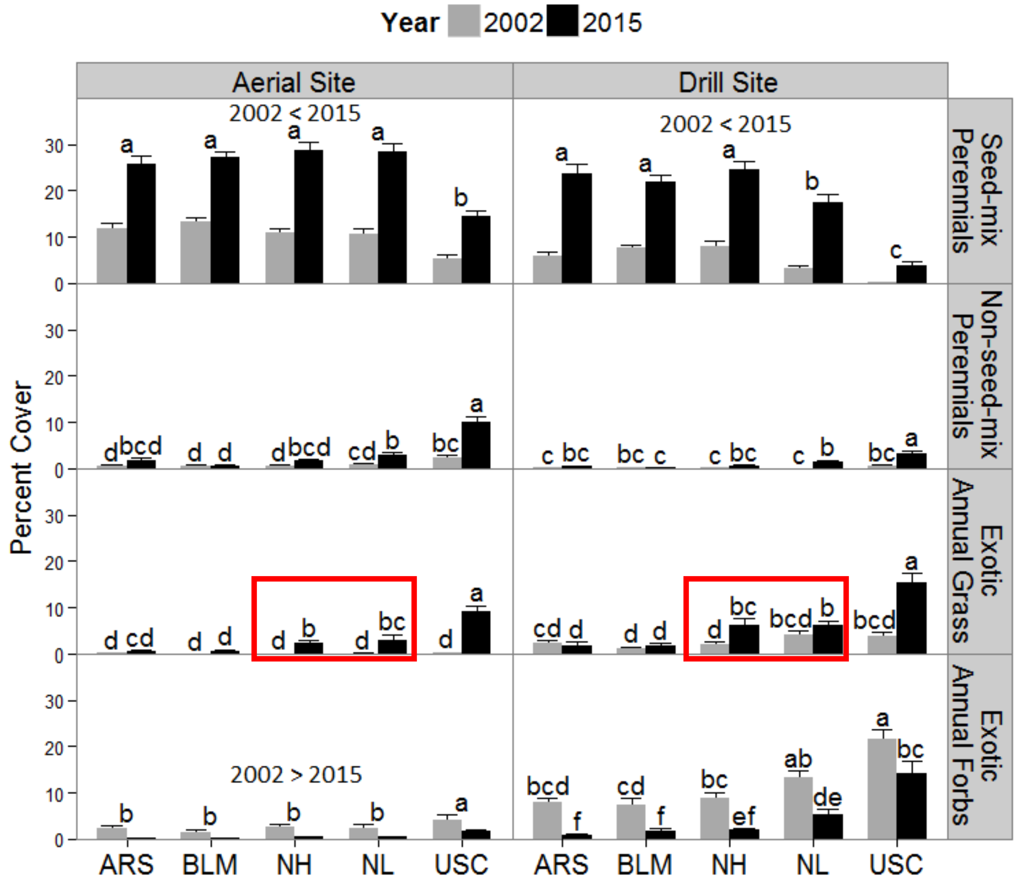


McAdoo et al. 2017. Restoration Ecology 25:53-62

Seed mixes matter!

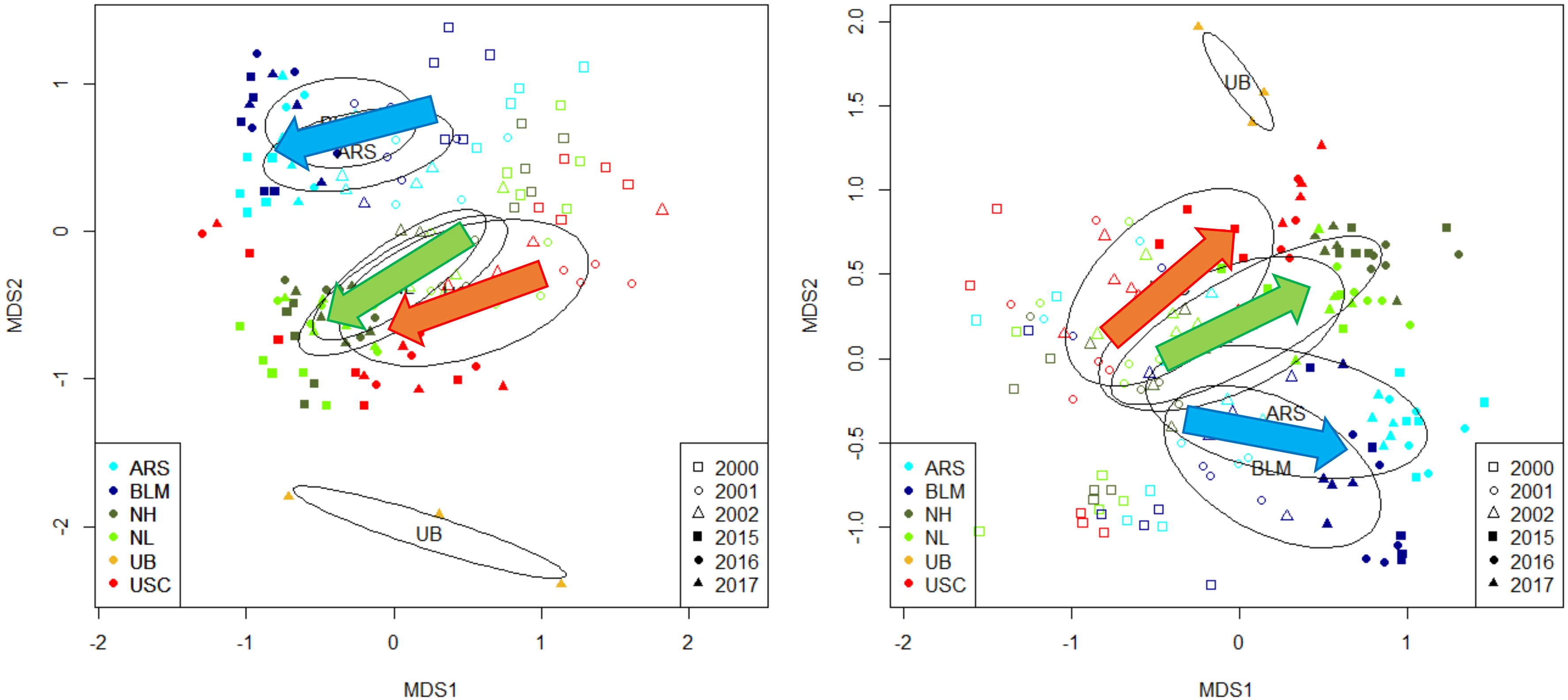
- Native-only seed mixes can suppress annual exotics nearly as effectively as conventional mixes

- Native-only and conventional mixes have different successional trajectories…



Ott et al. 2018. Rangeland Ecology and Management *in review*

Seed mixes matter! - Effects on succession



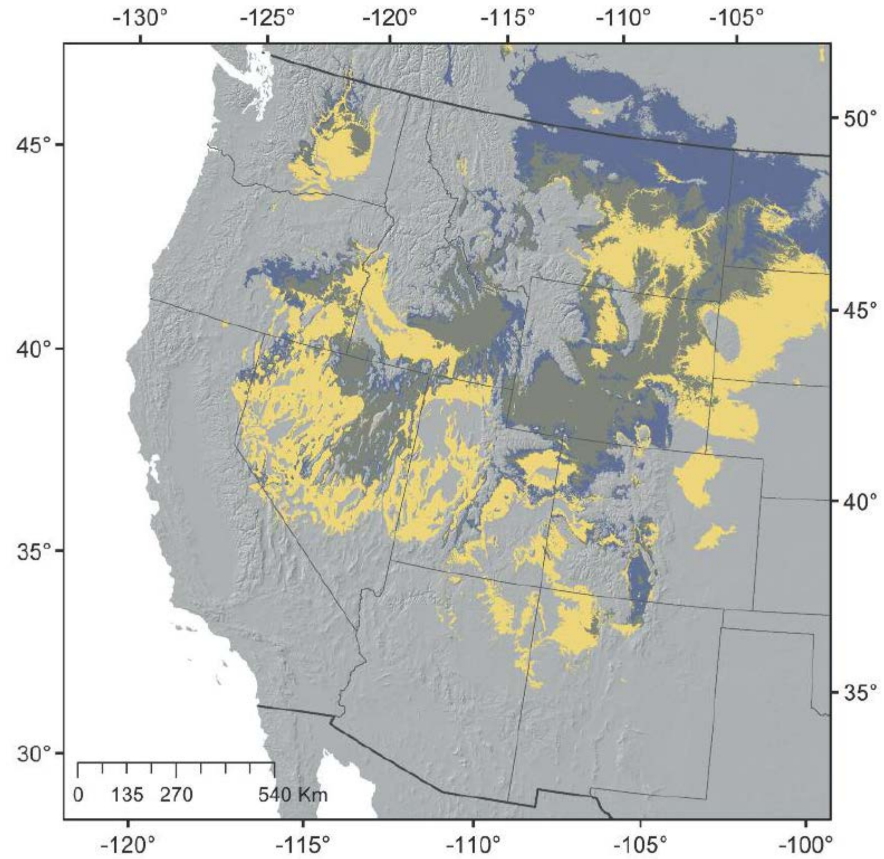
Ott and Kilkenny. Applied Vegetation Science *in prep*

Effect of climate change on sagebrush - 2050

- Yellow = contracting range
- Gray = stable range
- Blue = expanding range

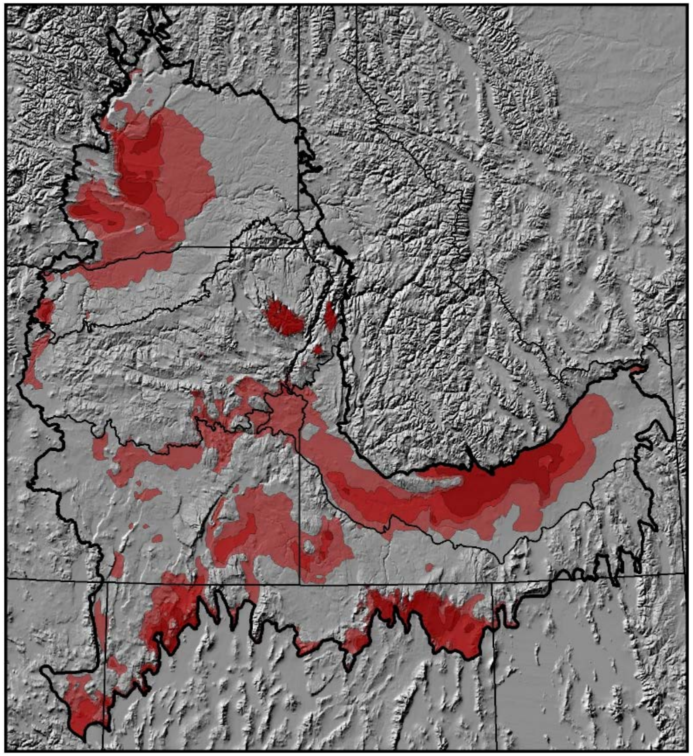
- Sagebrush range will likely contract faster than it naturally expand

- Planting more aridity-adapted sagebrush will slow range contraction

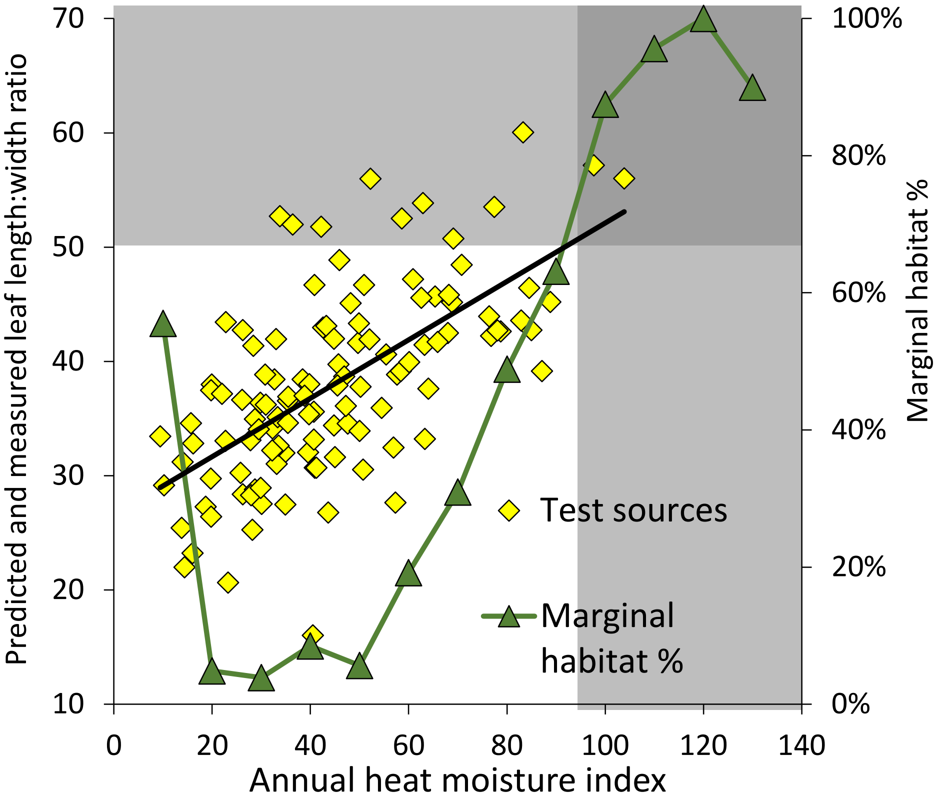


Dumroese et al. 2015. Native Plants Journal 16:276-299

Climate adapted traits can be found in many areas – seed transfer in bluebunch wheatgrass



Marginal habitat by 2050



Kilkenny 2015. Natural Areas Journal 35:152-164

Showy goldeneye
(*Heliomeris multiflora*)

Thickleaf penstemon
(*Penstemon pachyphyllus*)

Douglas' dustymaiden
(*Chaenactis douglasii*)

Hoary tansyaster
(*M. canescens*)

Nettleleaf horsemint
(*A. urticifolia*)

Yellow beeplant
(*Cleome lutea*)

Globemallow
(*S. grossulariifolia*)

Summary & Major Results

- Biodiversity is the basis for ecosystem functions and services
- Sagebrush steppe habitat restoration is dependent on re-establishing diverse plant communities
- Seed mixes matter! – long-term effects on succession
- Climate change is a challenge, but seed transfer guidelines and plant material development can help!
- USFS/BLM/FWS are building a diverse stable of forbs

Weblinks & Additional Resources

- **Great Basin Native Plant Project:** http://www.greatbasinnpp.org/
- **Western Center for Native Plant Conservation and Restoration Science:** https://www.fs.fed.us/rmrs/groups/western-center-native-plant-conservation-and-restoration-science
- **WWETAC Seed Zone Mapper:** https://www.fs.fed.us/wwetac/threat-map/web_maps/Seed_Zones.html
- **Seedlot Selection Tool:** https://seedlotselectiontool.org/sst/

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Strategies & Tactics to Conserve Fen & Pollination

Intermountain Region – Climate Assessment Workshop
May 22, 2018

Fen (water, carbon, biodiversity)

Pollination (essential supporting service)

Johnny Proctor

Regional Botanist, Invasive Species, Native Plant Materials
Intermountain Region – USDA Forest Service

Given the Range of Projections (RPC 4.5-8.5)

All Non-Forest Ecosystems would be at Risk (IAP 2018)

- As would Essential Services Provided to Humans;

- **Pollination Services Contribute to**
  - Carbon Sequestration, Water Filtration, Erosion Control (NRC 2007)
  - Pollinators are Declining at Alarming Rates
  - An All Hands/All Lands Response is Urgently Needed
    - To Sustain Environmental Health, Food Security & Economy

- **GDEs Including Fen Provide**
  - Cold, Clean Late Season Water Flows
    - To Surface & Subsurface Aquatic Ecosystems
    - And Municipalities & Agricultural Lands Downstream
    - Support Unique Flora & Fauna – Relic from Glacial Past

Ecosystems at Greatest Risk (IAP 2018)

- Have High Sensitivity & Low Adaptive Capacity including;

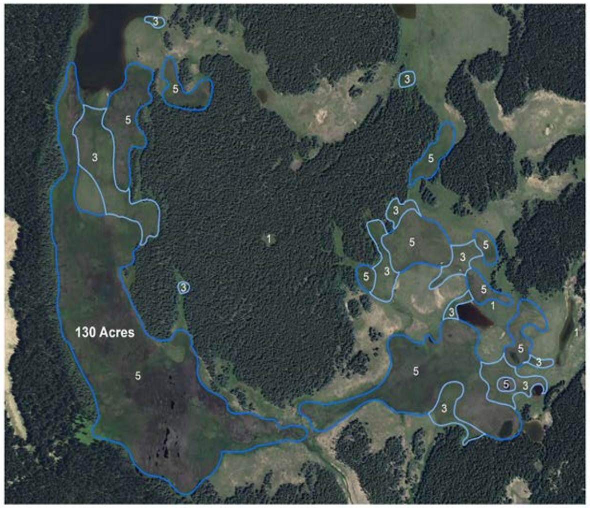
Providing Focus to our Priority Restoration & NPM Development

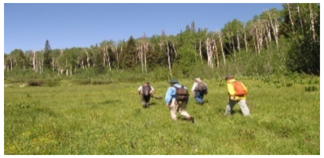
- Reverse Pollinator Loss & Restore Populations to Healthy Levels
- Resistance, Resilience, Response, Realignment

Adaptation Strategies & Tactics

- Resistance, Resilience, Response, Realignment

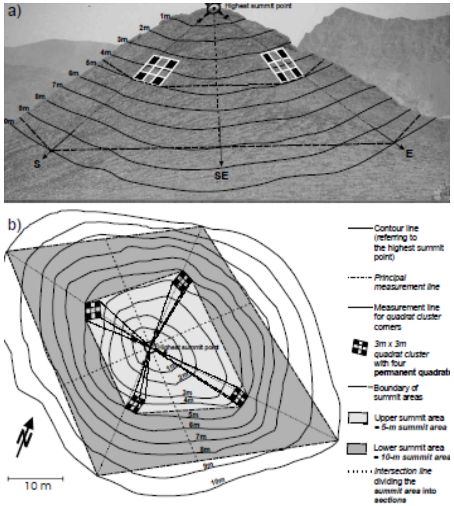
1) Fen Mapping, I&M, Restoration





R4 Wide 16-CS-1104-6000-07
FEN/GDE MAPPING Agreement CSU
WY Pilot 17-CS-11041563-03
FEN/GDE Inventory & Monitoring WYNDD

2) Monitoring Alpine Vege



Est. Sub Regional GLORIA Sites
Document Vege & Climate Factor Change Over/Time w multi-summit plots - Broad-scale Monitoring

3) Forb Diversity Plantings

Establish Priority Forbs Species w/ Site Specific Genetics-High Value
SG Brooding, Pollinator Conserve Areas, Pollinator Limited SCC Plant Sp. Pops

FEN

Ancient - Organic Soil Wetlands - Ground Water Driven – Irreplaceable

- **Low elevation Fen are at Greatest Risk** (Millar, Dwire & Hubbard 2017)
  - Warming & Evapotranspiration = Drying & Decomposition Peat Substrate
- **Mid - High Elevation Fen are Likely to Persist if;**
  - Have Undisturbed Hydrologic & Mineral Sediment Influx Regimes
    - Studies found these are Peat Accumulating Today (Pers com Cooper 2018)

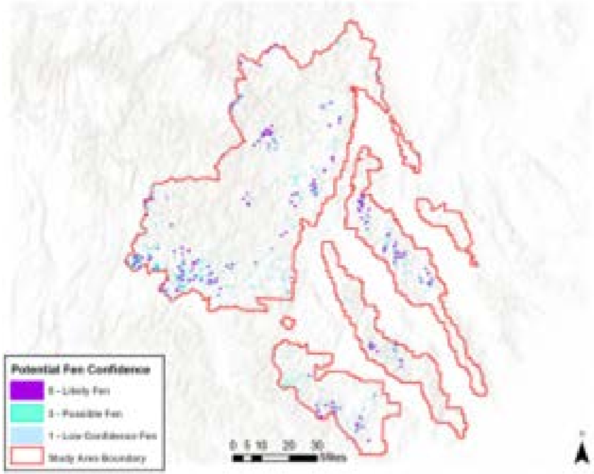
- **Water** - Slowly release cold, clean water to ecosystems & working lands downstream
- **Biodiversity** - Unique flora & fauna – Relic from glacial past
- **Carbon** - Peat Soils - 40% carbon - often meters deep ~10,000 yrs./old
- **Paleo-Eco Fossil Record** – Clues to Vegetation response from past C-change
  - Transecting Peat Core. Radio Carbon Date. Analyze Fossil Leaves & Pollen + Testate Amoebae Concentrations

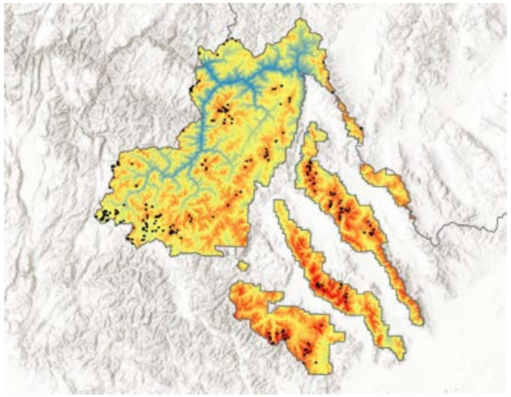




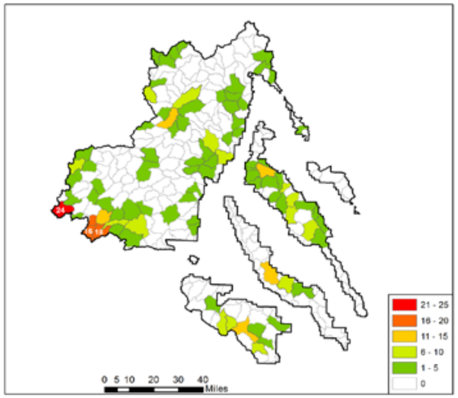
Fen Mapping on Salmon Challis NF (3,401 p.Fen-5,749 acres, <1%)

Distribution Analyzed by Elevation, Watershed, LTA, Geology, Water Ways

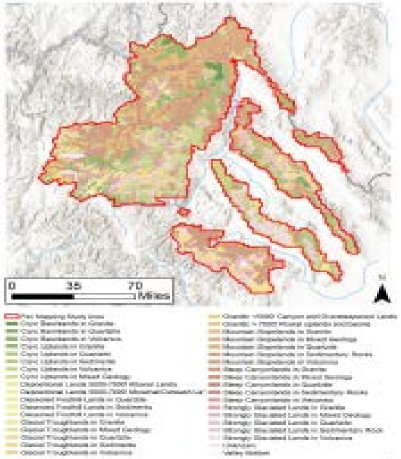




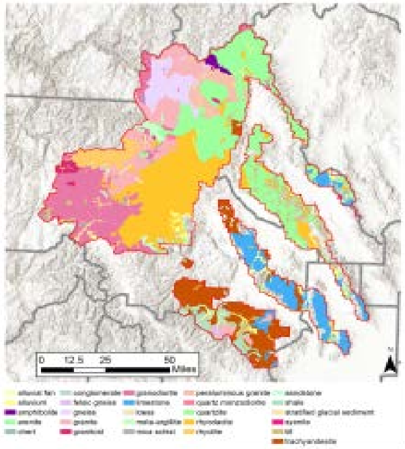
Avg. Elevation 6-9K ft.



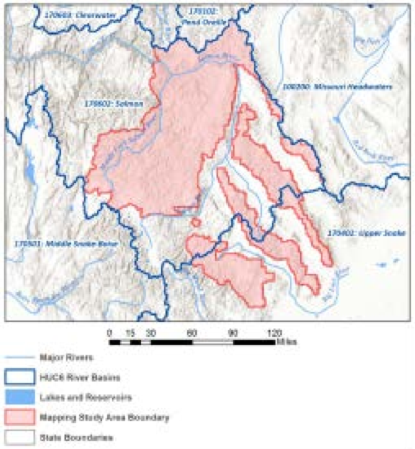
FEN by Watershed



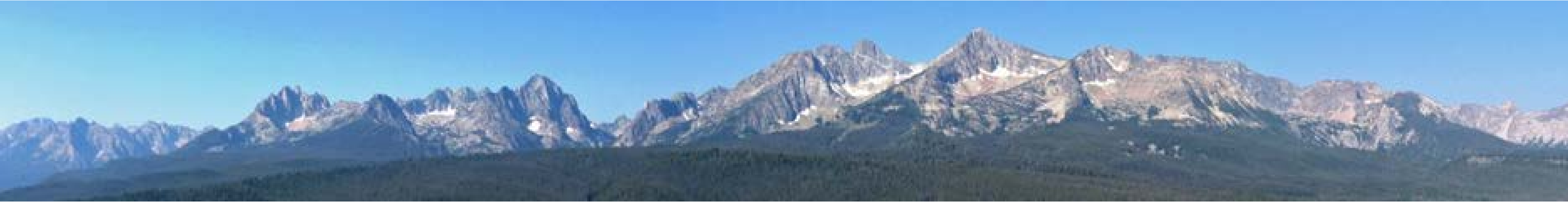
Land Type Association



Geology

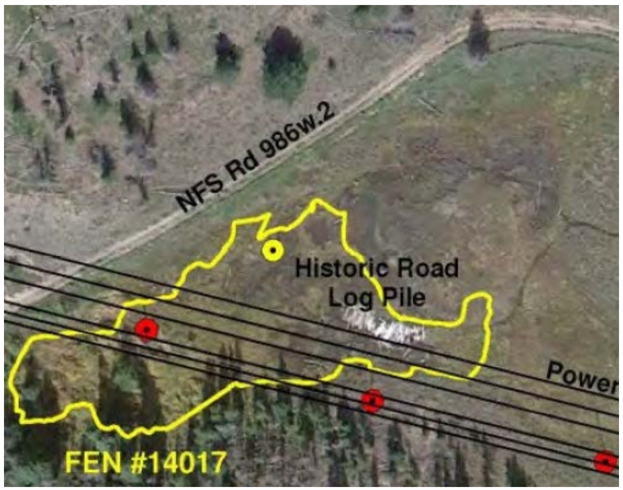


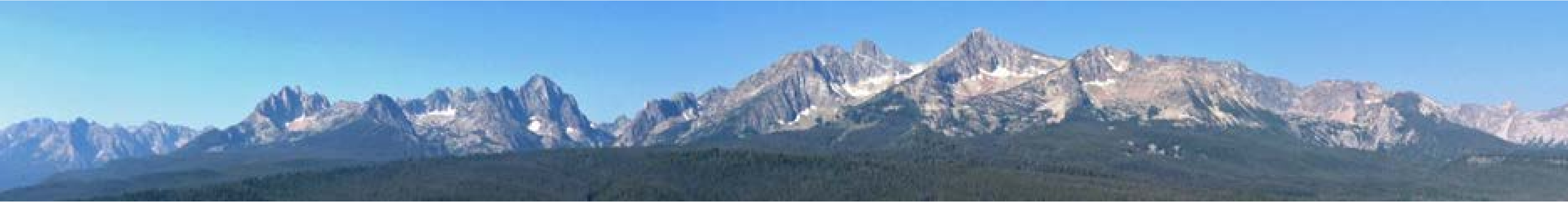
Major Water Ways



With Fen Mapping (Spatial Data) in Hand

Est. Ref Fen Monitoring Sites, Design to Protect & Improve, Seek & Restore Degraded

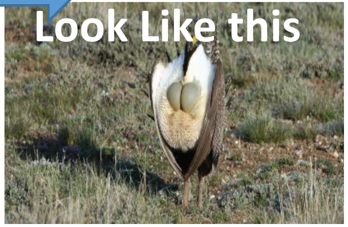




Difficult Sites? Need Forbs at High Value Areas?

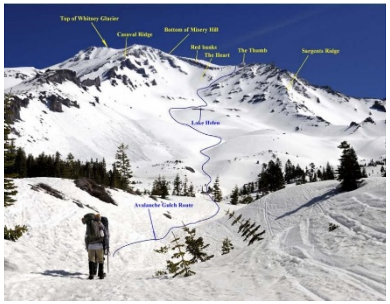
Augmented "Soils" w/ Compost & Bio Char. Installed Site Specific Genetics

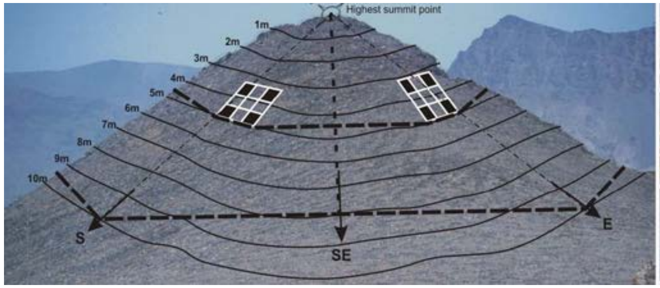
Riparian Restoration



Broad-scale Monitoring Approach

- **Establish Sub-Regional GLORIA Monitoring Sites (Global Network)**
  - **Document vegetation changes/time using multi-summit plots**
    Placed across Low to High elevation gradients
  - **Obtain Hard Climate Data / Monitoring**. Re-measure every 5 years





GLORIA (Global Observation Research Initiative in Alpine Environments)

Concurrent Studies

The National Pollinator Strategy has Three Overarching goals:

- Reduce honey bee colony losses to economically sustainable levels
- Increase monarch butterfly numbers to protect the annual migration;
- Restore or enhance 7 million acres of land for pollinators over the next 5 years through Federal actions and public/private partnerships

- Read the ***National Strategy to Promote Pollinator Health*** HERE
  https://www.whitehouse.gov/sites/default/files/microsites/ostp/Pollinator%20Health%20Strategy%202015.pdf

- Read the ***Pollinator Research Action Plan*** HERE
  https://www.whitehouse.gov/sites/default/files/microsites/ostp/Pollinator%20Research%20Action%20Plan%202015.pdf

- Read ***Pollinator-Friendly Best Management Practices for Federal Lands*** HERE
  http://www.fs.fed.us/wildflowers/pollinators/BMPs/documents/PollinatorFriendlyBMPsFederalLands05152015.pdf

- Access ***Appendices to the National Strategy*** HERE
  https://www.whitehouse.gov/sites/default/files/microsites/ostp/Pollinator-Strategy%20Appendices%202015.pdf

Johnny Proctor

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- Invasive Species
- Native Plant Materials
- Pollinators

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Ecosystem Services and Impacts to Human Communities

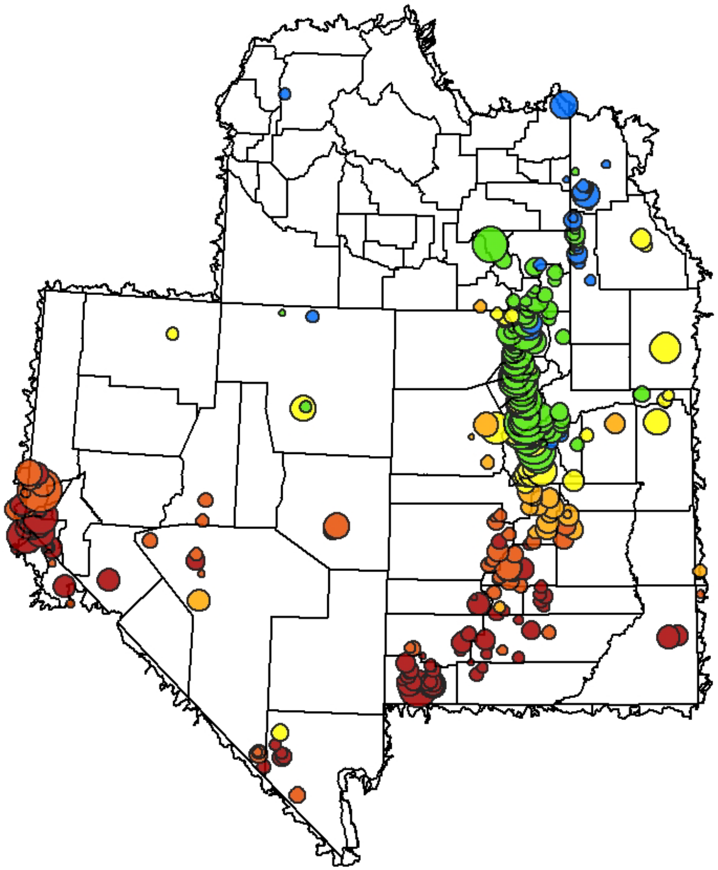
Intermountain Region – Climate Assessment Workshop
May 22, 2018

Travis Warziniack, PhD

Regional Botanist, Invasive Species, Native Plant Materials
Intermountain Region – USDA Forest Service

Figure 13.3, 13.4

Mean Annual Flow (2080)

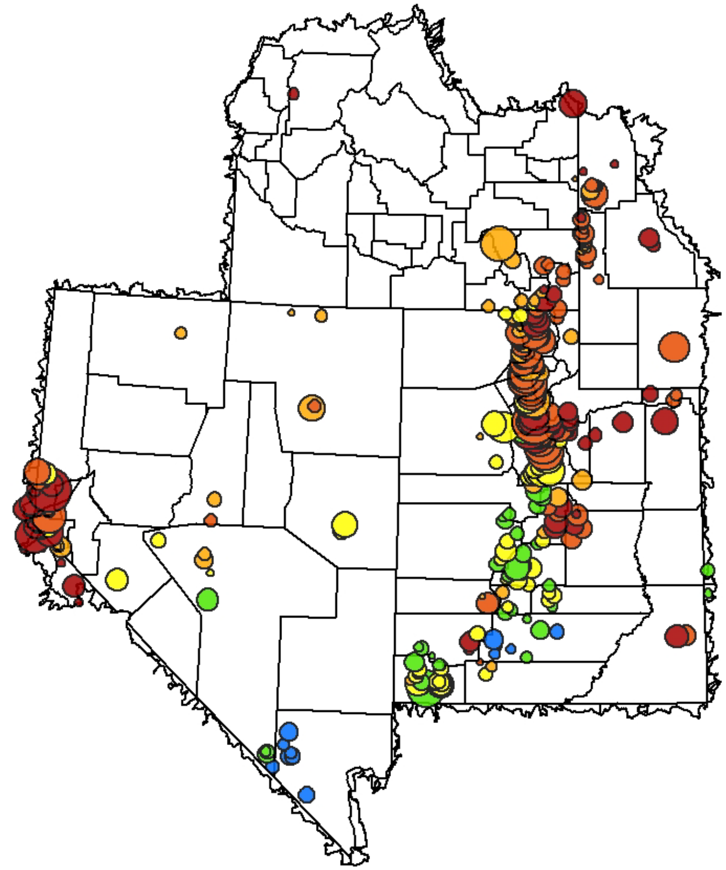


Key

Change in flow
- *decrease over 10%*
- *decrease 5-10%*
- *decrease 0-5%*
- *increase 0-5%*
- *increase 5-10%*
- *increase over 10%*

Population Served
- *less than 100*
- *between 100-500*
- *between 500-10,000*
- *more than 10,000*

Summer Flow (2080)



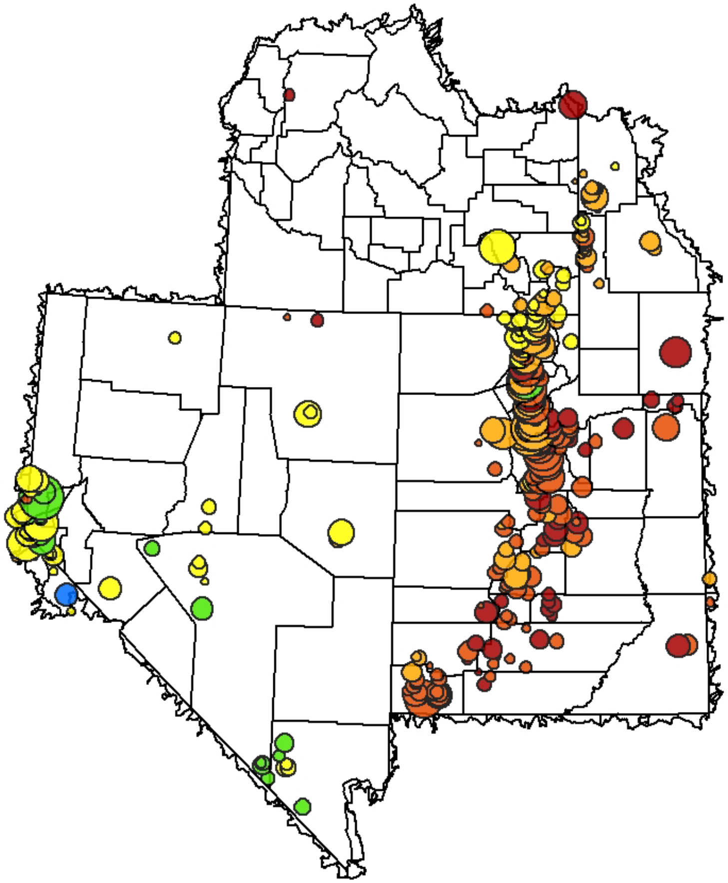
Key

Change in flow
- *decrease over 50%*
- *decrease 25-50%*
- *decrease 10-25%*
- *decrease 0-10%*
- *increase 0-10%*
- *increase over 10%*

Population Served
- *less than 100*
- *between 100-500*
- *between 500-10,000*
- *more than 10,000*

Figure 13.5, 13.6

Temperature (2080)



Key

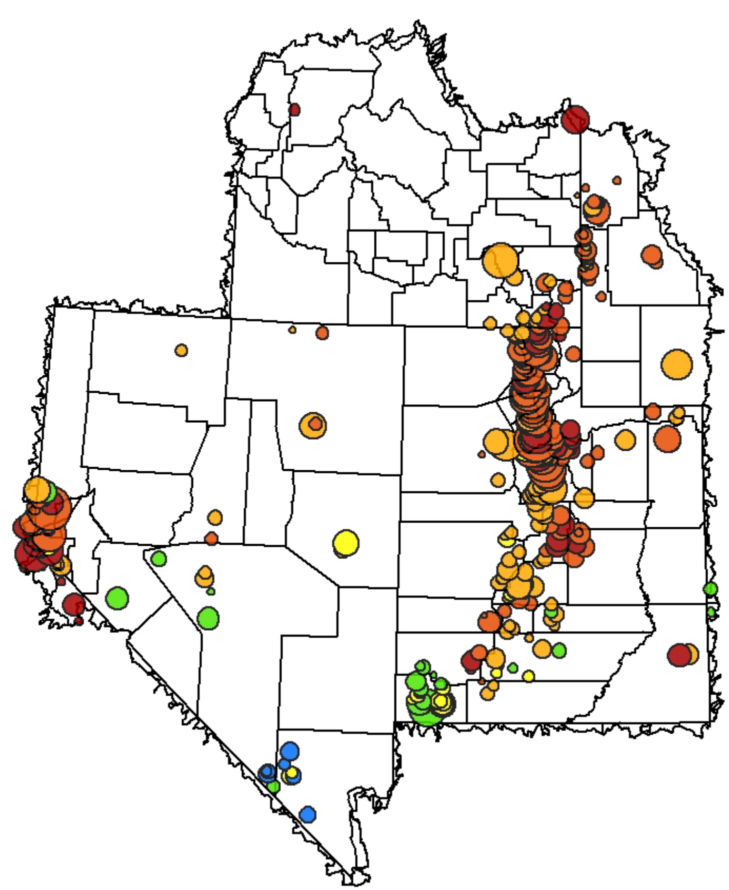
Change in Temperature

- *increase over 15%*
- *increase 12.5-15%*
- *increase 10-12.5%*
- *increase 7.5-10%*
- *increase 5-7.5%*
- *increase 0-5%*

Population Served

- *less than 100*
- *between 100-500*
- *between 500-10,000*
- *more than 10,000*

Timing of flow (2080)



Key

Change in Timing (CFM)

- *over 30 days earlier*
- *20-30 days earlier*
- *10-20 days earlier*
- *5-10 days earlier*
- *0-5 days earlier*
- *0-5 days later*

Population Served

- *less than 100*
- *between 100-500*
- *between 500-10,000*
- *more than 10,000*

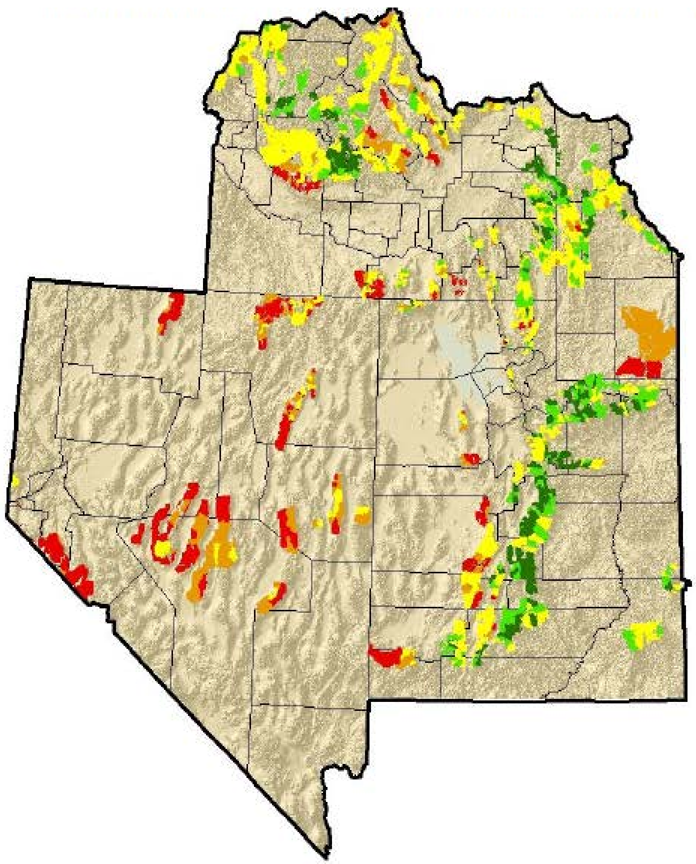
Grazing

Threats:

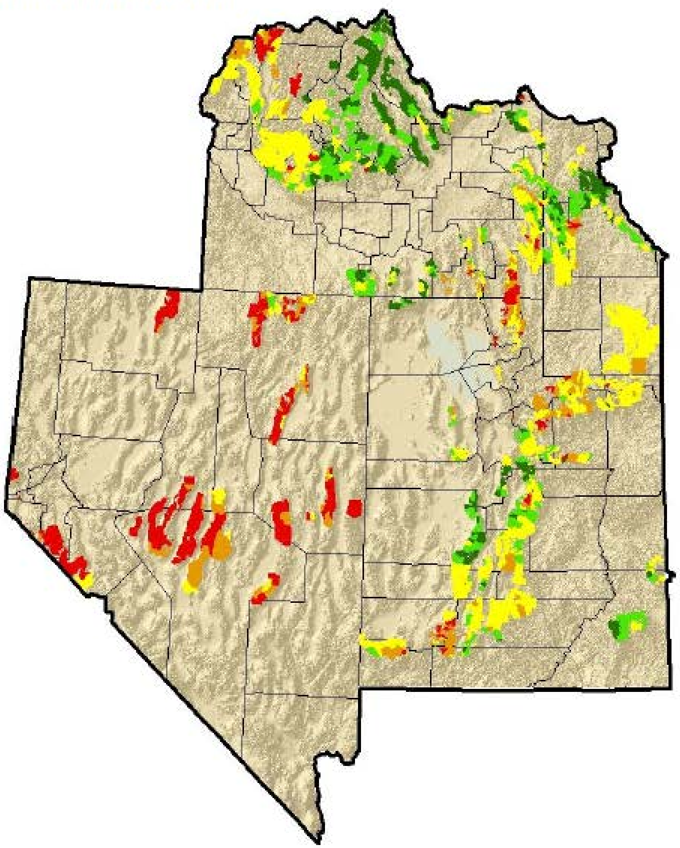
- Declining profitability
- Urbanization
- Invasive species
- Co-managed with other ungulates

Rangeland Vulnerability Analysis

Forage Vulnerability



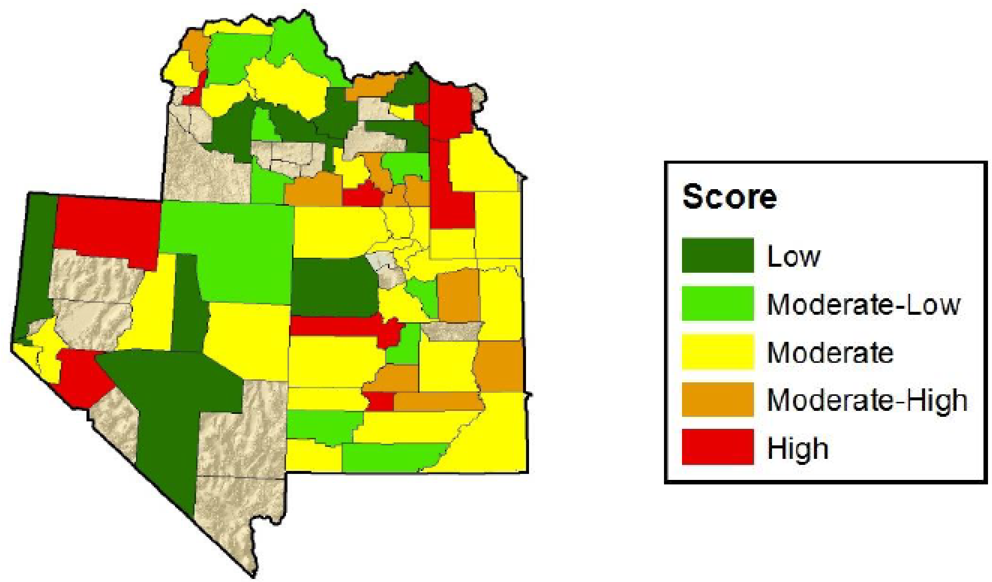
Water Vulnerability



Rangeland Vulnerability Analysis

Figure 46: Principle component and factor analysis for livestock vulnerability

Original Livestock Vulnerability Score

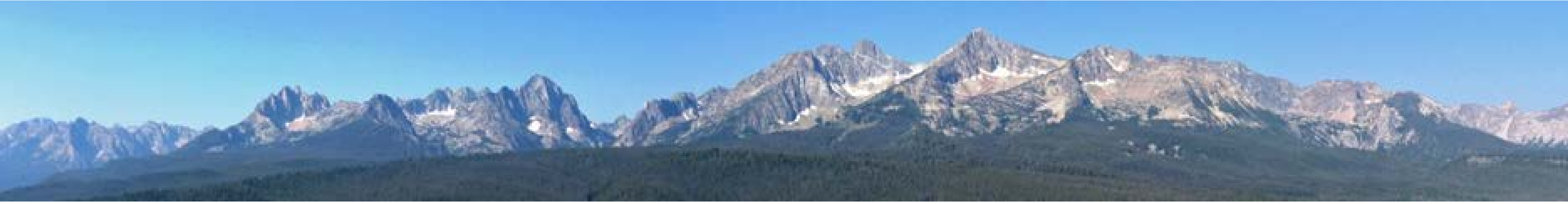


Adaptation Strategies & Tactics

- Resistance, Resilience, Response, Realignment

Weblinks & Additional Resources

- Technical advice bulletins on vulnerability analysis (Chris Miller, USFS-WO)
- More detailed look at rangeland vulnerability for the Ashley National Forest
- Benefits to People at a Glance https://www.fs.fed.us/emc/economics/contributions/at-a-glance.shtml
- Resource Planning Act (RPA) Assessment https://www.fs.fed.us/research/rpa/



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DIALOGUE AND Q&A

GROUP EXERCISE

LUNCH TIME