**State of BLM Rangelands: Data and Analysis Outline**

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**Rangeland Analysis Platform**

*Overarching Goal:*

To summarize the current vegetation state and temporal trends in production and cover of BLM grazing allotments across the West.

*Analysis objectives:*

1. Produce histograms of average cover of RAP vegetation classes across BLM Districts and EPA Ecoregions? How do average values from the 1980’s, 90’s, 00’s and 10’s compare? Do the same for rangeland production?
2. What are the temporal trends in RAP vegetation classes in allotments averaged at level of BLM districts and EPA Ecoregion?
   1. Where is cheatgrass increasing?
   2. Where is woody encroachment occurring?
   3. Where is bare ground increasing?
3. Compare annual variation in cover across BLM Districts and EPA ecoregions? Is annual variation in cover increasing overtime?
4. Summarize fire frequency and fire extent in BLM allotments at the BLM District and EPA Ecoregion level. Analyze trends in fire frequency across allotments? Are fires increasing or decreasing?
5. Which climatological factors are drivers of variation in forage production? Compare effects of drought, temperature and precipitation across BLM districts and Ecoregions. How has the frequency and severity of drought changed across BLM allotments?
6. Compare grazing utilization (AUM) per allotment across BLM districts and Ecoregions. Are there trends in AUM over time or differences between decades?
7. Can we detect a signal of grazing on BLM allotment vegetation? Analyze allotment cover and productivity in a model containing effects for climate, year and grazing. Do grazing AUMs have a significant effect on vegetation?
8. How has timing of peak biomass production changed for BLM allotments? Has the average date of peak biomass production become earlier over time?

*Data collection:*

1. Extract average values from each BLM/Forest Service Allotment in Earth Engine:
   1. Yearly cover
   2. Yearly annual aboveground production (lbs. per acre and kg per hectare)
   3. Mean elevation
   4. MAP and MAT
   5. Average quarterly precipitation and temperature per year from PRSIM
   6. Proportion burned per year (fires perimeters)
   7. Week of peak biomass production per year (Phenology)
2. Get BLM AUM per year per allotment or per district (Brady)
3. Miscellaneous: AUM fee rates per year, dates of changes in policy

*Data organization:*

1. Allotment INFO
   1. Allotment ID
   2. Allotment Name
   3. State
   4. Mgmt. District
   5. Ecoregion
   6. BLM/Forest Service/Tribal
   7. Mean Elevation (m)
   8. MAP (mm)
   9. MAT (d. C)
   10. Allotment Acreage (acres)
   11. Allotment Centroid (Lon/Lat)
   12. Allotment Shape (sf polygon)
2. Yearly Cover
   1. Allotment ID
   2. Year
   3. Average cover:
      1. AFGC, PFGC, LTTR, SHRB, BG, TREE, cheatgrass, red cedar
3. Yearly production
   1. Allotment ID
   2. Year
   3. Average Production (lbs./acre, kg/hectare):
      1. HERB (AFGC + PFGC), Woody (SHRB + TREE)
4. Yearly climate by quarter:
   1. Allotment ID
   2. Year
   3. Quarter (Winter, Spring Summer Fall)
   4. Total precipitation (mm)
   5. Avg. temp (deg. C)
   6. Avg. drought (SPEI?)
5. Annual Grazing:
   1. Allotment ID
   2. Year
   3. Animal unit months (AUM)
6. Yearly burns
   1. Allotment ID
   2. Year
   3. Amount burned (proportion)
7. Yearly phenology
   1. Allotment ID
   2. Year
   3. *DOYmax* = Date of peak herbaceous biomass production (DOY)

*Analyses:*

For each summarize at the level of Ecoregion, State or BLM District.

1. Preliminary Analysis, for each decade (80s, 90s, 00s, 10s) generate histograms of:
   * Cover
   * Production
   * DOYmax
   * Burned
   * AUM
2. Change over time using linear regression:

* Model:  *Y* ~ *T* + (1|*T*) + (*T*|allotment ID) + *T*:District (or Ecoregion)
* *T* = year
* *Y* = [Cover, Production, DOYmax]
* Model coefficients give average annual rates of change for each BLM District
* Allotment covariance matrix weighted by distance between allotments

1. Calculate annual variation in allotment conditions (following Matt Jones earlier analysis)

* Ten year rolling standard deviation of [Cover, Production] over time
* Plot rolling standard deviation to show trends in variation

1. Influences of climate:
   * Use R Cross Correlation Function (CCF) to find correlation between *Yt* and lagged values of climate
   * *Yt* = [Yearly Cover, Production, DOY*max* at time *t*],
   * *Xt* = [Yearly Temp, Precip, Drought]
   * Lag correlations show where X leads Y (possibly causal)
   * Identify lags that are strongest influences on production etc.
   * Also try using ClimWin?

1. Trends in wildfire frequencies
   * Model probability of fire in an allotment as a function of year.
   * Model: Logit(*Yt* ) ~ Bernouli( *T* + (1|*T*) + (1|allotment) + *T*:District (or Ecoregion) )
   * *T* = Year
   * *Yt* = Fire in Allotment in year *t* [0,1]
   * Allotment covariance matrix weighted by distance between allotments
2. Joint influence of grazing and climate
   * Model change in cover and production overtime as a function of AUM and Climate
   * Use climate lags identified previously (not sure this is the right way to go).
   * Use AUM from brady

* Model: *Yt*~*X* + *Ct* + *Gt* + (1|*T*) + (*T*|allotment ID) + *T*:District (or Ecoregion)
  + *Y* = [cover, production]
  + *T* = Year,
  + *Ct* = Climate @ lags (from #4)
  + *Gt* = AUM at year *t*
  + Allotment covariance matrix weighted by distance between allotments