Explaining Inter-annual Variability of Invasive Annual Grasses in the Sagebrush Ecosystem

Stephen P. Boyte\textsuperscript{1}, Bruce K. Wylie\textsuperscript{2}, and Donald J. Major\textsuperscript{3}

\textsuperscript{1}SGT, Inc. Contractor to the U.S. Geological Survey Earth Resources Observation and Science Center (EROS), Sioux Falls, SD, work performed under contract G15PC00012;
\textsuperscript{2}U.S. Geological Survey, EROS, Sioux Falls, SD;
\textsuperscript{3}BLM Idaho, Boise, ID
Why

- Annual grasses are highly flammable and experience high interannual variability
- Precipitation is the main driver of annual grass percent cover interannual variability
- Understanding precipitation timing’s effect on annual grass percent cover can help predict near real-time annual grass percent cover
- Near real-time annual grass percent cover spatial data can help land managers strategize and fire modelers predict for upcoming fire season
Sagebrush in the arid and semiarid West

- ~27 varieties of sagebrush grow in the West, from sea level to ~12,000 feet.
- Several wildlife species require sagebrush to survive including the greater sage grouse and pronghorn.

Map developed by Laura Quattrini

www.pronghornpride.com/
Background synopsis

- Annual grasses have invaded sagebrush ecosystems for ~100 years.
- Positive feedback exists between fire/annual grass that increases fire frequency and size (Balch et al 2013).
- Fires destroy wildlife habitat, recreational lands, and human-built structures.
- Climate change, development, and grazing also modify ecosystems.
- ≥15% cheatgrass cover exists in 31% of Intermountain West and doubles fire risk of areas with lower abundances (Bradley et al 2018).
Use remotely sensed data integrated into regression-tree models

- Empirical models using regression-tree software integrated with:
  - 250-meter eMODIS NDVI data
    - 7-day best pixel composites
    - Growing season averages
  - Biogeophysical data
    - Climate, topographic, soils
  - Ground truth data
    - Driven by field collected data
Annual grass percent cover time series (2000 – 2016) mean values

- Areas classified by NLCD as shrubland or grass/herbaceous.
- Elevation ≤ 2250 meters.
- Limited to where training data existed.
- Overall Mean cover = 7.3%
- Snake River Plain mean cover = 20%.
The annual grass percent cover mapping model

- 250-meter remotely sensed (eMODIS NDVI) data integrated with ground-truth training data, 30-yr precipitation data, and biogeophysical data in a rule-based regression-tree model.

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<td>North facing steep slope</td>
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Train MAE = 5.79%; \( r = 0.87 \)
*Test MAE = 5.84%; \( r = 0.86 \)
St Dev = +/-0.11 (*over 9 randomizations)

May 2018 near real-time annual grass percent cover map

- Areas classified by NLCD as shrubland or grass/herbaceous.
- Elevation ≤ 2250 meters.
- Limited to where training data existed.
- Overall mean cover = 8.3%
- Snake River Plain = 24.8%.
Purpose

▪ Use the time series to inform the near real-time mapping model
  ▪ Possible fine tuning of the NRT mapping model with precipitation data
    ▪ Important to understand how precipitation affects annual grass ecologically, especially timing of precipitation on interannual variability of annual grass percent cover

Method

▪ Straightforward comparison of the time series of yearly annual grass percent cover with an associated time series of precipitation data in monthly and annual time steps.
“Parsimonious models achieve a balance between bias and variance” (Burnham and Anderson 2002).

“Data-driven models need to make sense biologically or they run the risk of being overfit” (Wylie et al 2007).

“Increasing model parameters can increase model uncertainty” (Burnham and Anderson 2002).

So, we are investigating the addition and subtraction of variables in our mapping model to develop the most parsimonious model that produces results that make sense biologically and can be produced in near real-time.
Tracking percent cover and precipitation
Snake River Plain

Annual Grass Percent Cover
Estimated Mean (2000 – 2016)
Precipitation timing can be critical.
Monthly precipitation and annual grass percent cover – most explanatory months
Monthly precipitation and annual grass percent cover– least explanatory months
Next steps

- Conduct preliminary test to determine the relationship between temperature and annual grass percent cover.
- Test model accuracy improvement by adding precipitation data and temperature data from the most relevant months.
- Developing process that uses harmonized Landsat and Sentinel 2 data to produce 30-meter annual grass mapping model and maps.

Access to data, metadata, and papers

- Annual grass percent cover
  - Near real-time (2017)
    - May - Doi: 10.5066/F7445JZ9
    - July - Doi: 10.5066/F7M32TNF
  - Near real-time (2018)
    - May - Doi: 10.5066/P9KSR9Z4
    - July - Doi: 10.5066/P9RIV03D
- Cheatgrass dieoff - Doi: 10.1016/j.rama.2014.12.005
- Cheatgrass and climate change - Doi:10.1016/j.rama.2016.03.002
- Validating annual grass percent cover