Drone-based predictions of big sagebrush demographics across an elevation gradient

Ryan Wickersham, Trevor Caughlin, Megan Cattau, Jennifer Forbey, Donna Delparte

Climate change and the sagebrush steppe

- Recognize sagebrush as a foundational species providing structure and functionality to plants and animals

- Increasing fire, unpredictable weather, and drought urge us to discover patterns of resilience of native plants across the sagebrush steppe

Focusing on demographics

- Flowering as an indication for overall sagebrush health in terms of timing and response (Richardson et al. 2017)

- Understanding flower response all us to focus on collecting locally adapted seed for better chance of recovery (Simler-Williamson and Germino 2022)

- Early practices of knowledge and reasoning to estimate cover and sagebrush health, field-based methods

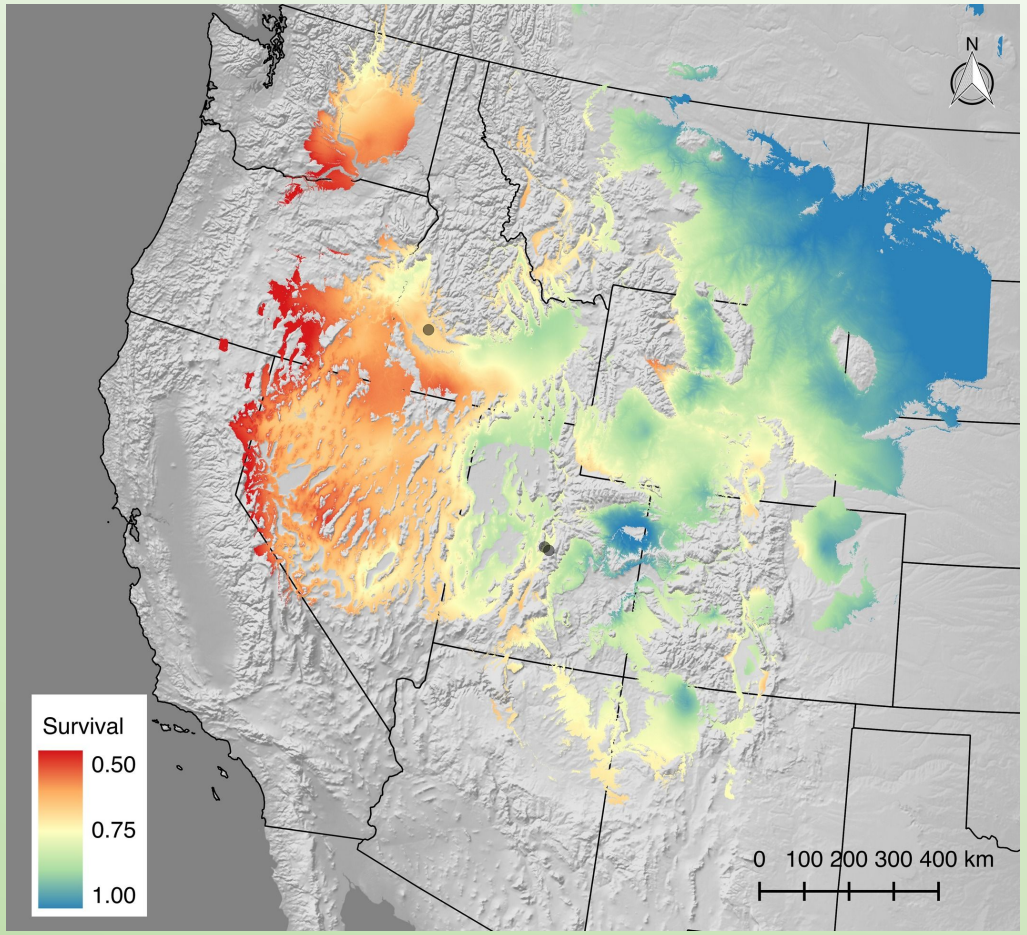


Fig.1 Sagebrush survival map based on temperature difference across the west (Chaney et al. 2016).

Can we predict flower production of sagebrush at large scales?

Can Land managers apply this research to practice?

How well can we predict flowers from sites with ranging elevations and densities of shrubs?

- Utilizing low-cost, high-resolution drone data to supplement current field techniques with application to several sites

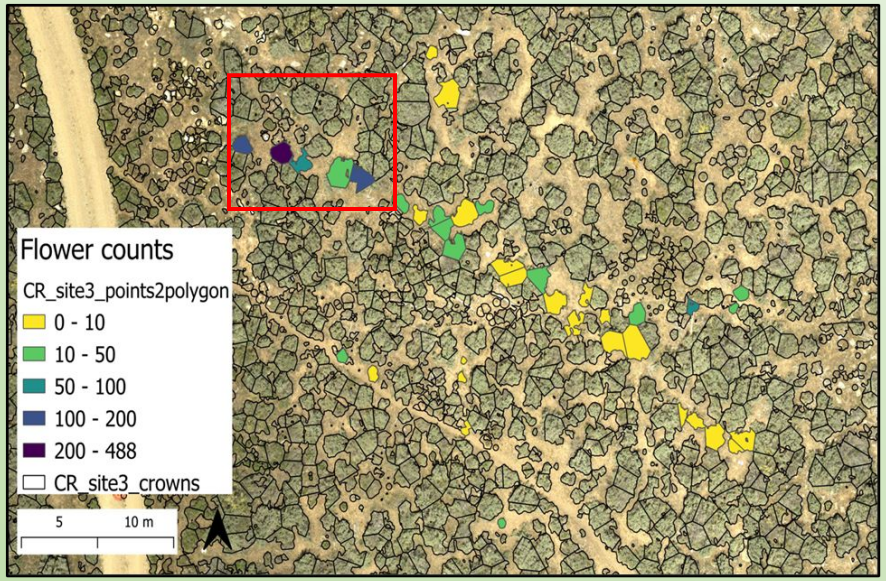
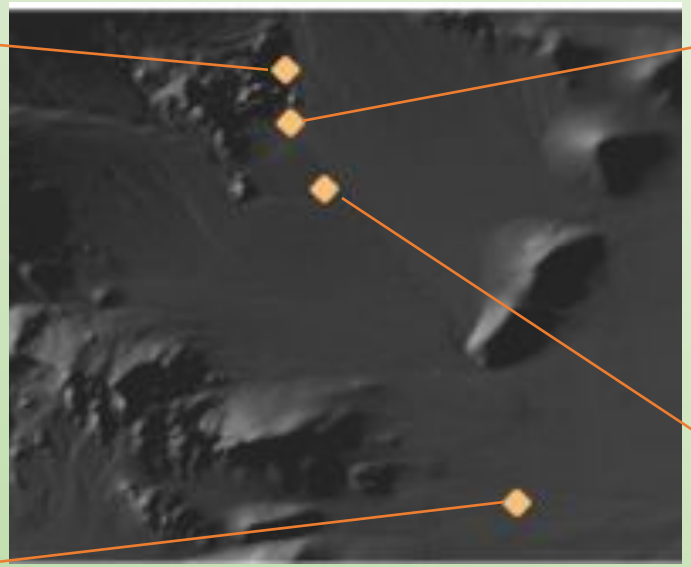
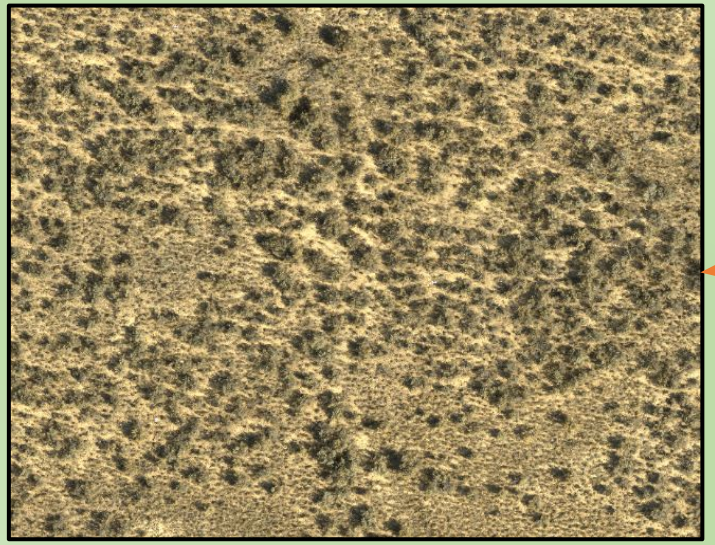
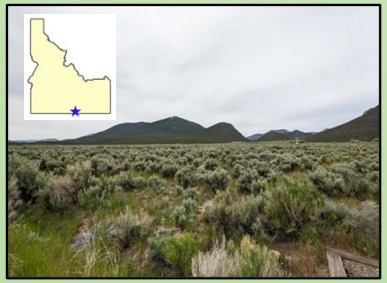


Fig. 2 Field flower counts at site 3 of Castle Rocks in September of 2022.

Castle Rocks State Park







Field data collection

Allometric measurements

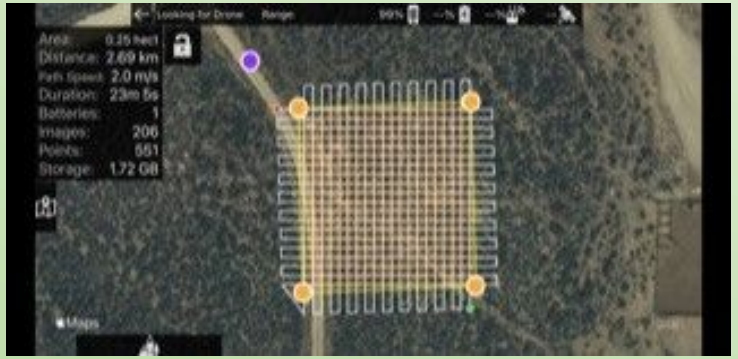
Flower counts separated by node (shown above)

Heights (ground to leaf), width 1, width 2 (perpendicular)

Drone data

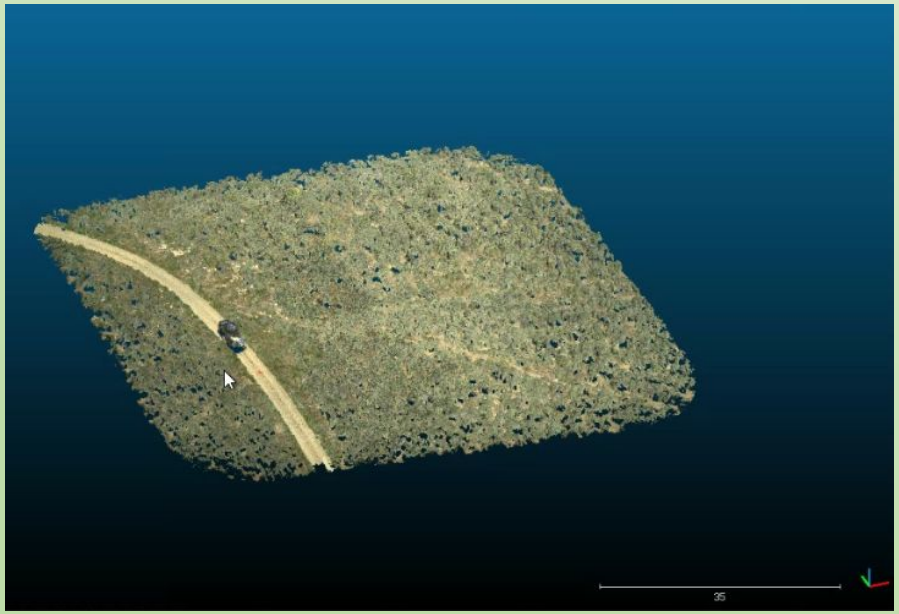
June-Sept 2021/2022 Mission planning, Topcon GCPs, Flights

Sensor	AGL	GSD	Camera angle	Cross grid	Flight speed	Overlap
20MP Hasselblad	~41m	1.0cm	90 (+5 degrees)	Yes	2m/s	~70/85

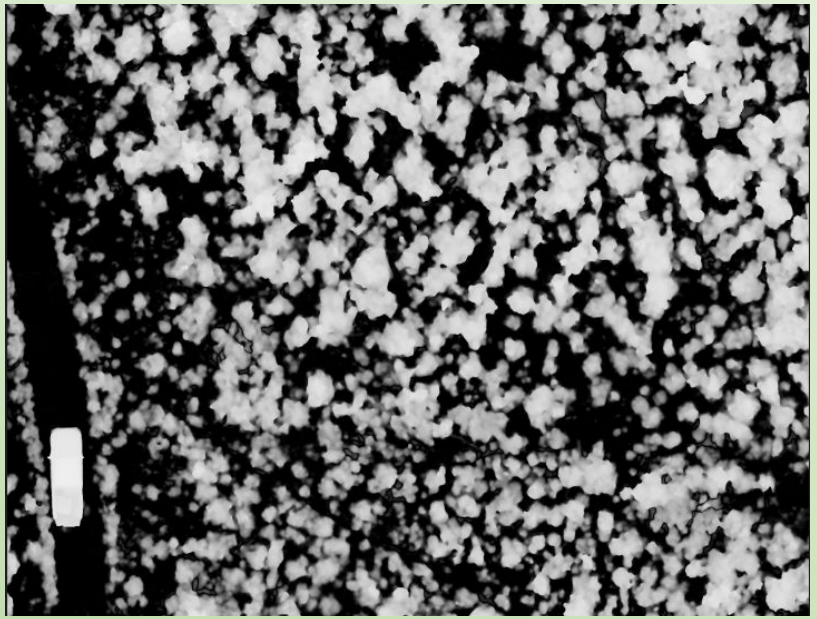


Processing drone data

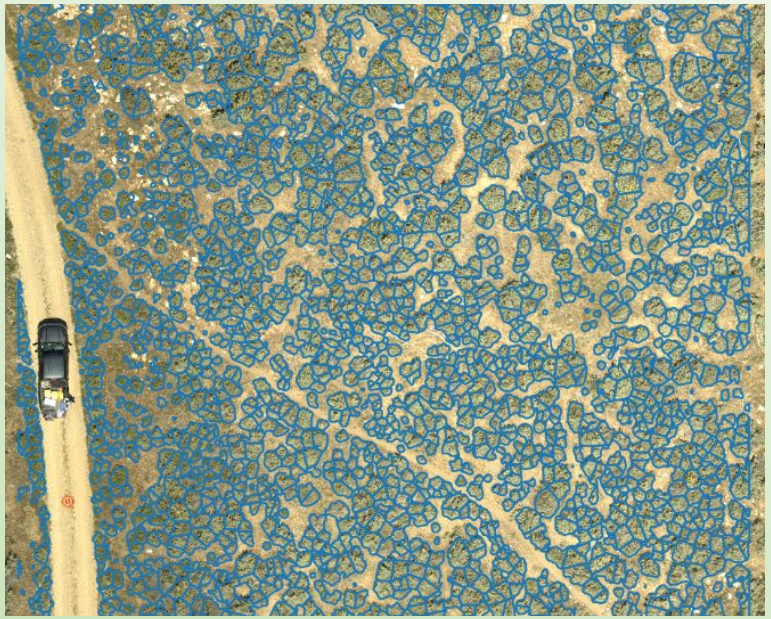
1. Point cloud- SfM imagery



2. CHM- shrub canopies



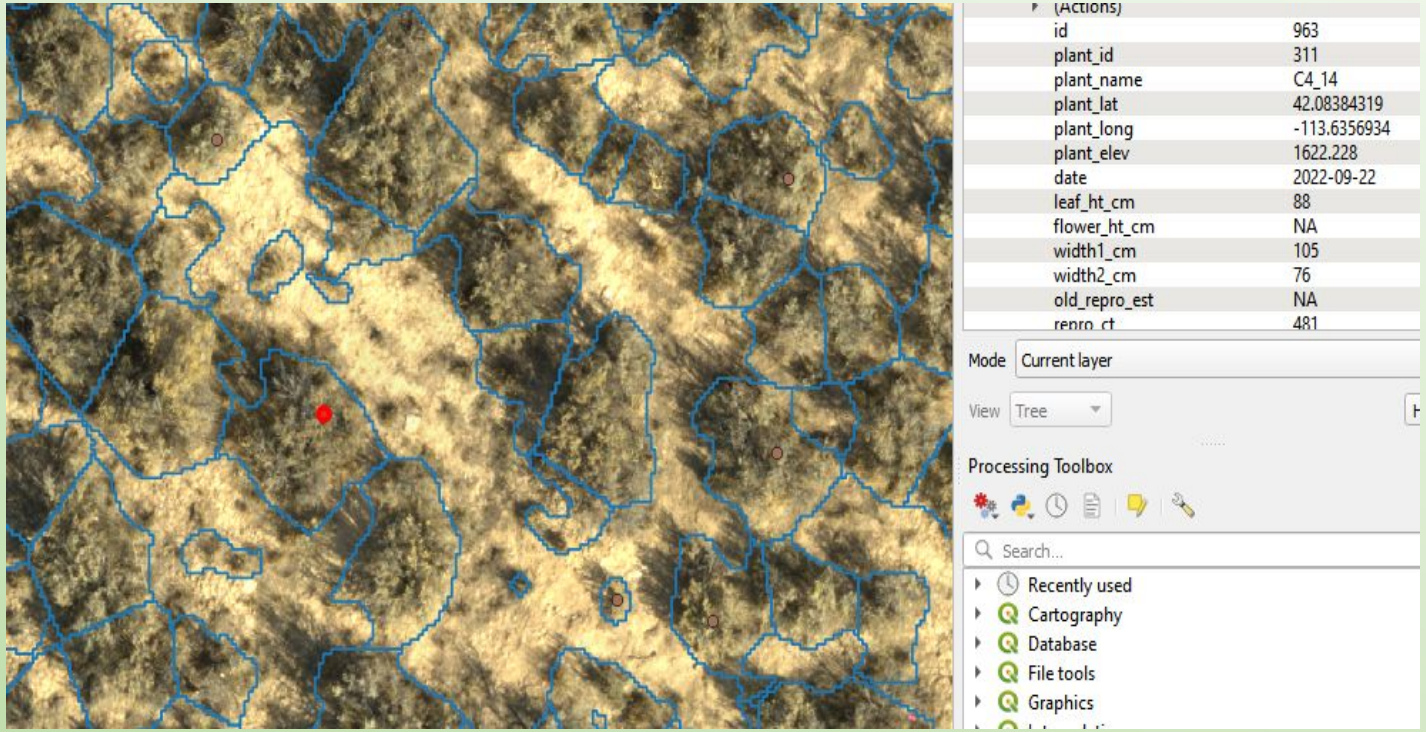
3. Segmentation- shrub metrics w ortho



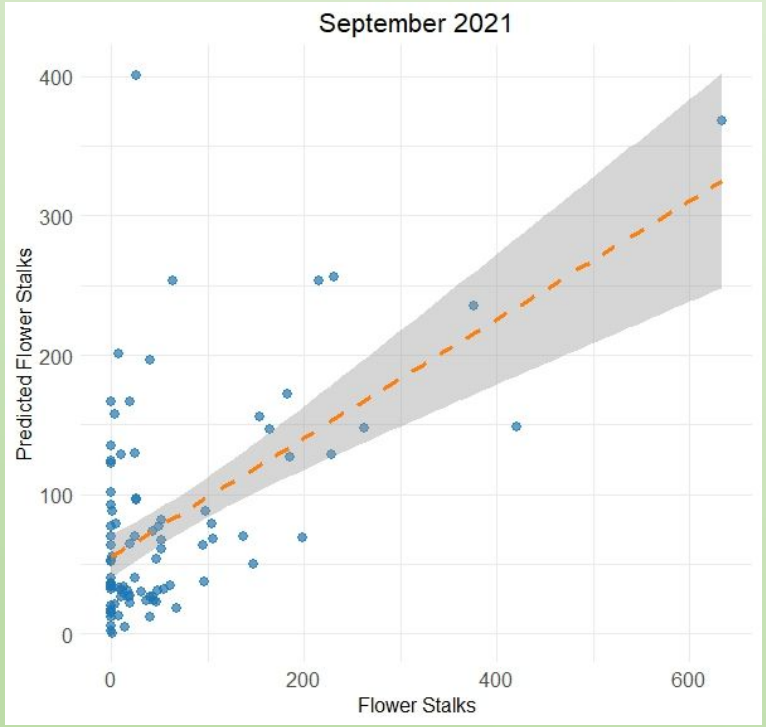
Webodm worklow: https://data.nkn.uidaho.edu/sites/default/files/WebODM_Workflow_v1.0.pdf
Andrii Zaiats- uas_data_preprocess: https://github.com/andriizayac

Training brms model

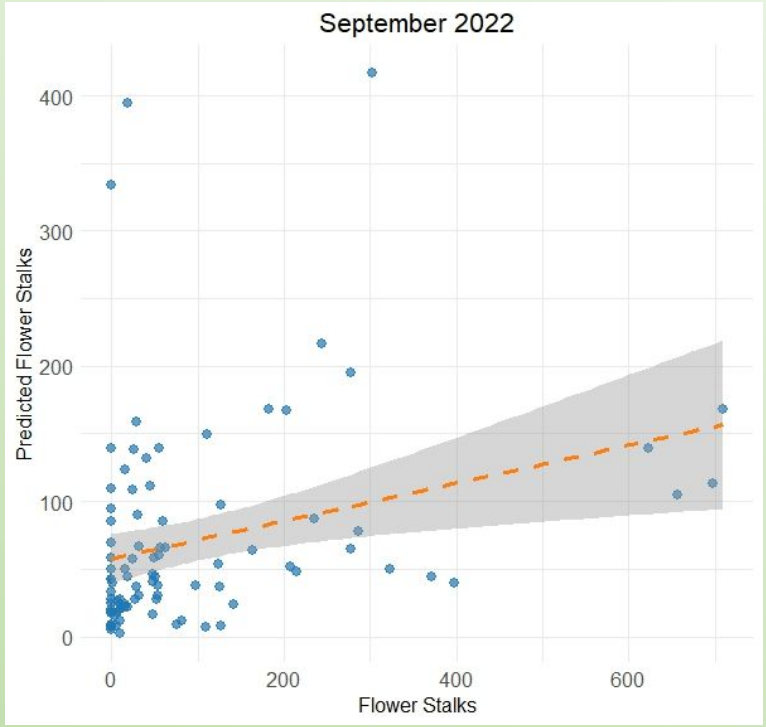
- Compiled data frame with gps data of field-observed shrubs (approximately 999 sagebrush)
- Combine field observed gps points with field data and remote sensing covariates, using segmented shrubs that overlap gps points
- Test (prediction) and training (field) data split using Rstudio
- Graphing posterior distribution from testing prediction or priors set by training data of flower production at castle rocks



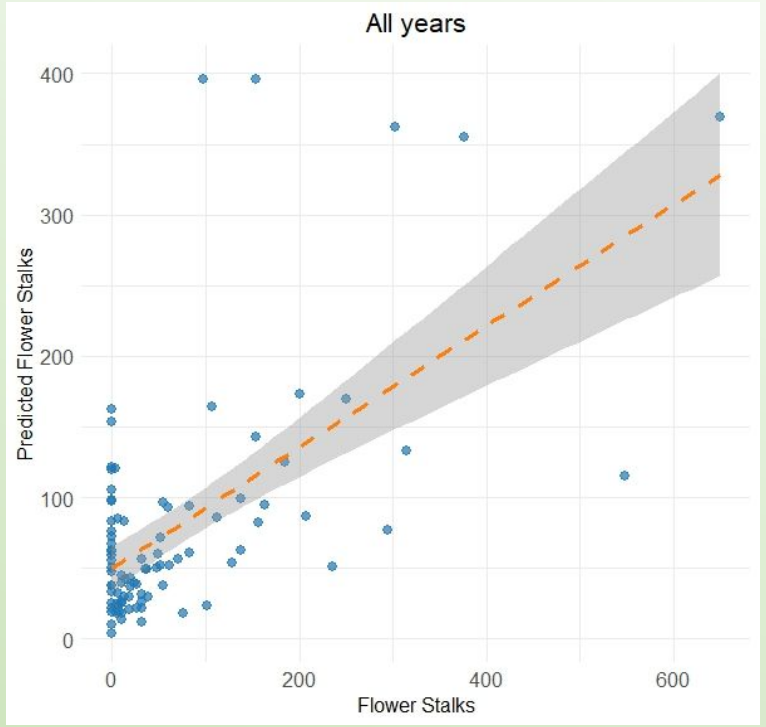
Flower model



MAE: 59 flower stalks
R2: 0.34

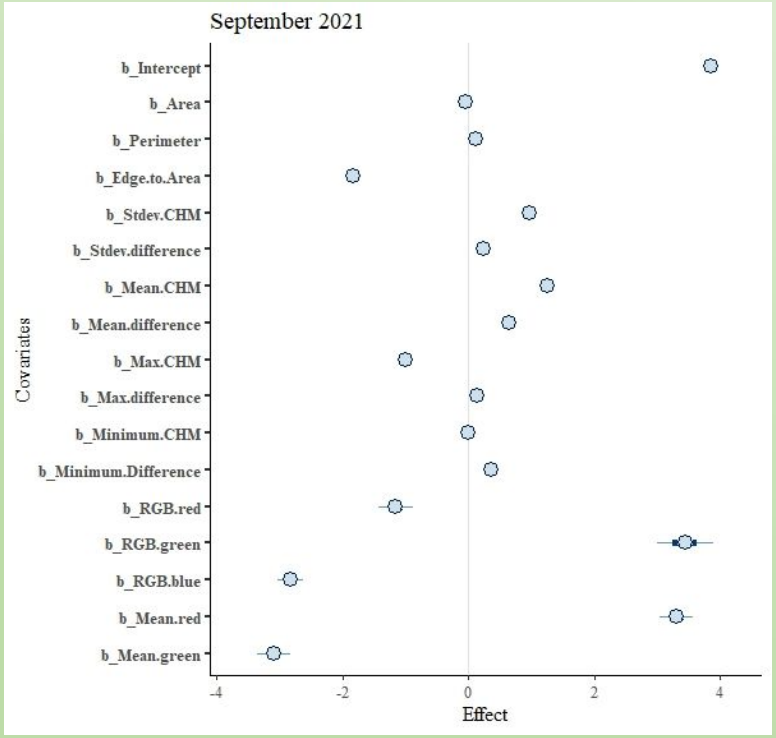


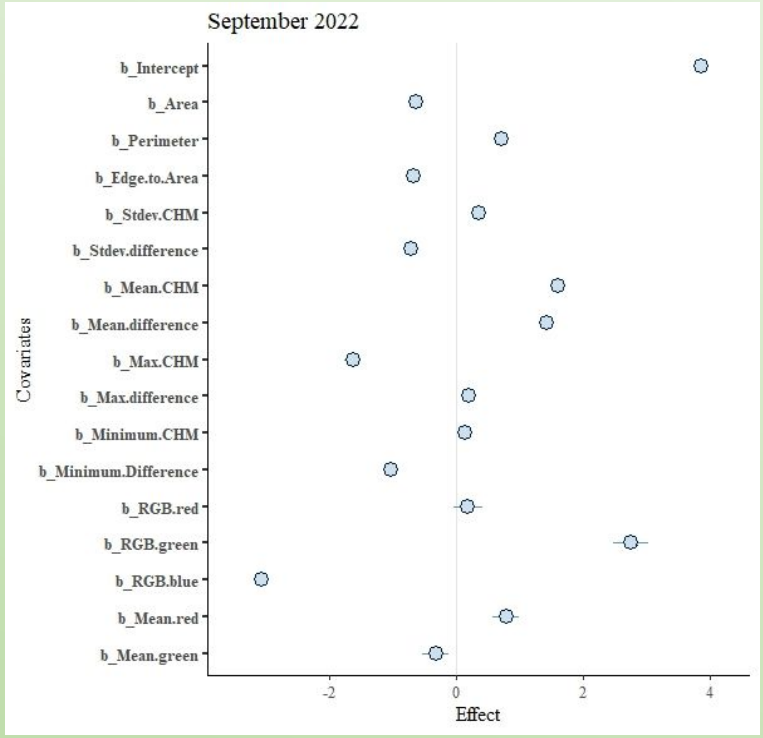
MAE: 72 flower stalks
R2: 0.28

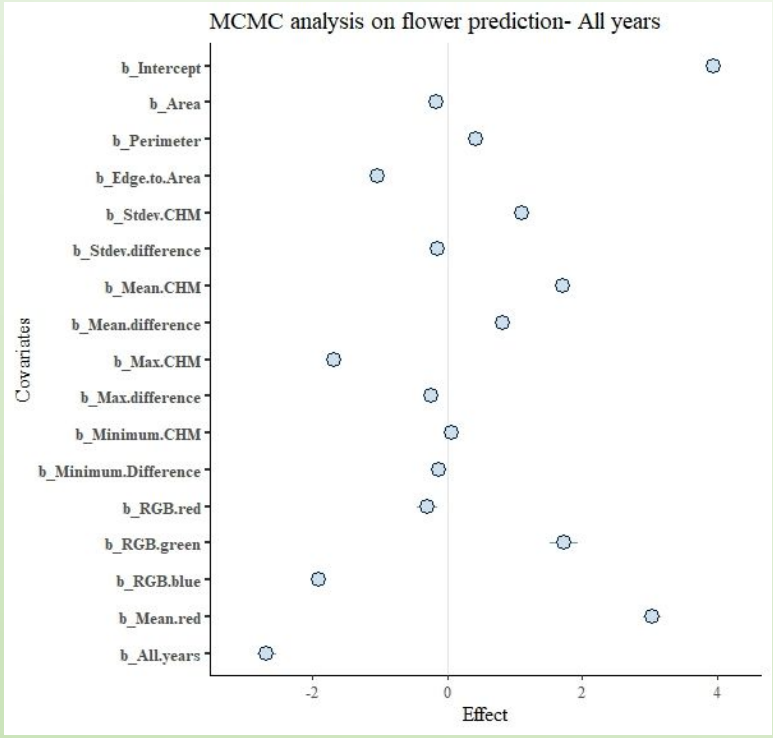


MAE: 68 flower stalks
R2: 0.24

MCMC of covariates







Positive: RGB green, mean red, CHM mean heights
Negative: RGB blue, edge-to-area

Value of prediction

Remote sensing

- Opportunity for repeat analysis over several years to detect variations in terms of stressors to climate
- Singling out a specific season for prediction of flowers (September instead of June)
- Pairing high resolution imagery with developing field tactics, like sagebrush woody ring growth over time (Apodaca et al. 2017)

Management

- Flower prediction can work, will only get better with time- keep up with tech
- Ability to observe large scales of habitat with maps

Acknowledgements

GEM3- Boise State University- Great opportunity to connect with experienced professors and students.

- STEM outreach
- VIP students

Special thanks…
Andrii Zaiats, Valorie Marie, Anna Roser, Andrew Child, Josh Enterkine, Kyle Paulekas, Cayden Whipkey, Lena Griffith, Peter Olsoy, Richard Rachman, Meg Dolman

BOISE STATE UNIVERSITY

Caughlin Lab

IDAHO EPSCoR

GEM3
Genes by Environment
Modeling · Mechanisms · Mapping

Sources

- Chaney, L., Richardson, B. A., & Germino, M. J. (2017). Climate drives adaptive genetic responses associated with survival in big sagebrush (Artemisia tridentata). Evolutionary Applications, 10(4), 313-322.
- Richardson, B. A., Chaney, L., Shaw, N. L., & Still, S. M. (2017). Will phenotypic plasticity affecting flowering phenology keep pace with climate change?. Global change biology, 23(6), 2499-2508.
- Apodaca, L. F., Devitt, D. A., & Fenstermaker, L. F. (2017). Assessing growth response to climate in a Great Basin big sagebrush (Artemisia tridentata) plant community. Dendrochronologia, 45, 52-61.
- Simler-Williamson, A. B., & Germino, M. J. (2022). Statistical considerations of nonrandom treatment applications reveal region-wide benefits of widespread post-fire restoration action. Nature Communications, 13(1), 3472.