Quantifying Post-wildfire Revegetation Using Satellite Data and Statistical Models: Challenges and Opportunities

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INTRODUCTION

- This project aims to evaluate ecological processes that drive population recovery after wildfires. We focus on quantifying the revegetation rate within a 1988 wildfire in Utah using Landsat data.
- Forecasting the recovery of plant populations is essential to land management and strategic planning of restoration efforts.
- Biologically meaningful models, such as the BH growth model, may be more robust to small sample sizes than phenomenological models, such as the ARIMA model?

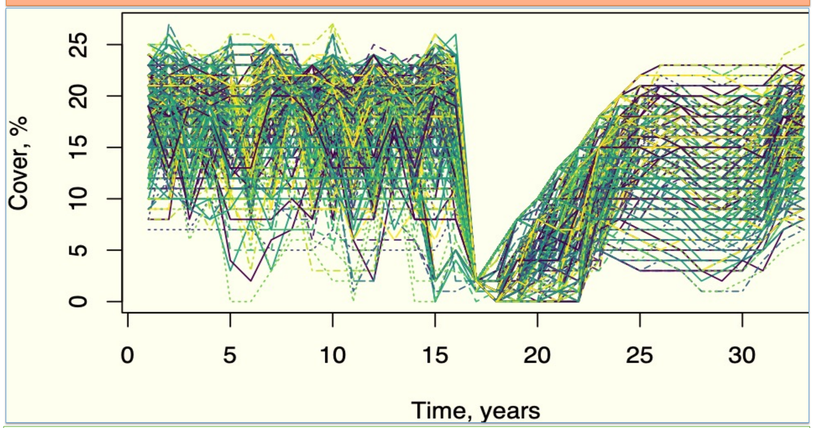

Figure 1 : A post-disturbance time-series of big sagebrush cover based on National Land Cover Database.

OBJECTIVE

- Forecast and analyze the difference between how the time series ARIMA model and Beverton-Holt ecological growth model behave for single-species population dynamics in the same dataset to estimate ecologically relevant parameter.

METHODS

- Fitting an ARIMA(2,2,0) model to the data. We found relatively high predictive accuracy. We then fit an ecological process model, the Beverton-Holt model, to the data for comparison.
- Compare the sensitivity of the ARIMA, and the BH growth models toward data test-train split experiment.
- Estimating parameter and sampling diagnostics of the Beverton-Holt model using HMC algorithm implemented in Turing.jl package.

RESULTS

Beverton-Holt growth model : $H_{(t+1)} = H_t \frac{r}{1+(H_t/k)}$

r-growth rate
k-is the strength of density dependence.
The carrying capacity, K = (r-1)*k

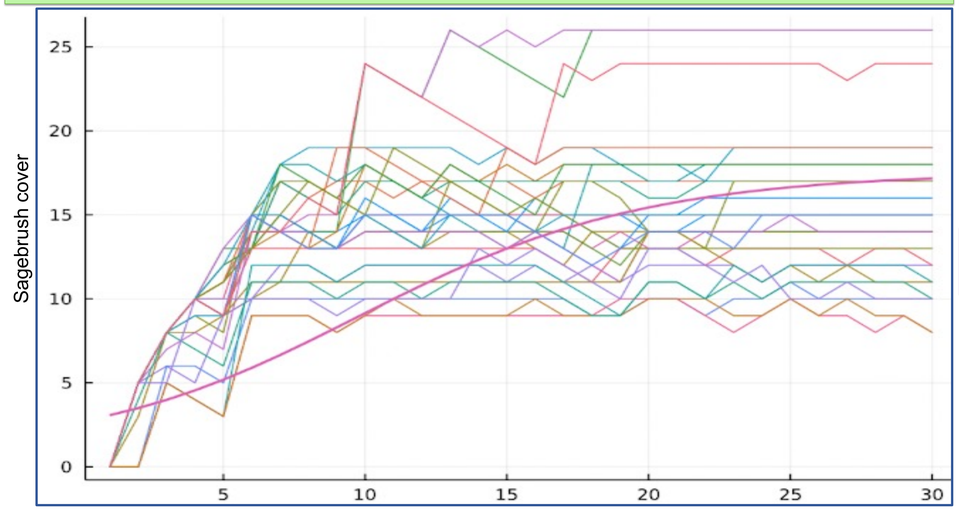

Figure 2: Thinner (jaggedy) lines represent a subset of the pixel-level trajectories of sagebrush covered. The purple smooth line indicates the Beverton-holt fit to the data given in the equation above.

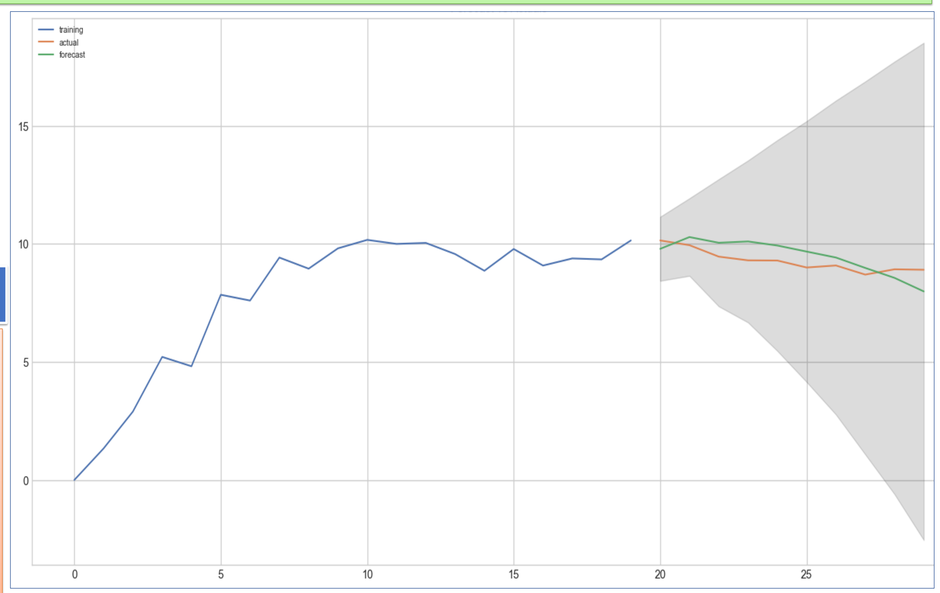

Figure 3: Forecast Vs Actual using ARIMA(2,2,0)

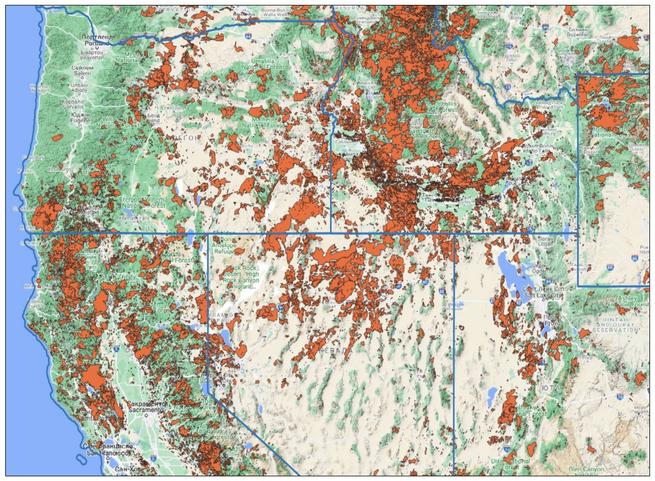

Figure 4:Wildfire polygons in the Western United States burnt between 1950 and 2016 (Welty et al. 2020)

Data		RMSE	
Train	Test	ARIMA	B-H growth model
83.32%	16.68%	1.86	1.84
73%	27%	1.24	1.83
67%	33%	0.57	1.83

CONCLUSIONS

In conclusion, ARIMA model shows a significant dependence over the data test-train proportion. On the other hand, the Beverton-Holt growth model doesn't substantially change performance with the data test-train proportion.

Figure 4: Before and after restoration at Great Basin