# Adapting LANDFIRE vegetation models for restoration planning

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## Introduction

- LANDFIRE (www.landfire.gov) vegetation dynamics (VDDT) models for reference conditions are being developed nationwide.
- These models are non-spatial and assume no temporal variation in transition probabilities.
- Models were developed in workshops with regional fire ecology and management experts.
- Reference conditions derived from the models are used as a benchmark against which to measure the ecological departure of current vegetation conditions across the country.

In this study we seek to answer the following key questions:

1. What are the implications of assuming non-spatially explicit dynamics to determine reference conditions?
2. How can we leverage the knowledge invested in the reference condition models and adapt them to asses the future range of variability in landscape conditions under alternative management scenarios?

We answer these questions by adapting LANDFIRE models for the Great Basin and applying them to a study area in NW Utah where managers are dealing with invasive species, improper grazing and altered fire regimes (Figure 1).

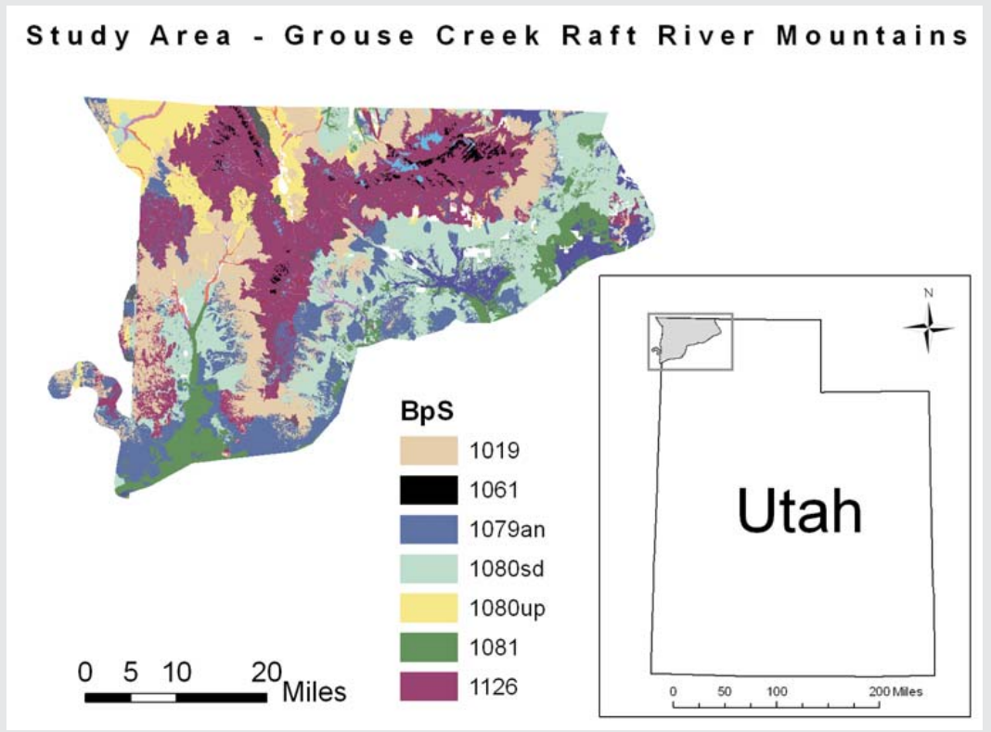

**Figure 1.** Study area

## Methods

1. Use expert knowledge to add uncharacteristic states and transitions to reference condition models. (Figure 2)
2. Determine temporal variability and fire size distributions from local fire history data. (Figure 3)
3. Obtain maps of current conditions from ground verified remote sensing data.
4. Develop alternative management scenarios in multi-stakeholder workshops. Scenarios address interagency cooperation, BpS priorities, fuel breaks, and spatial configuration of treatments.
5. Simulate the landscape using both non-spatial (VDDT) and spatially explicit algorithms (TELSA).

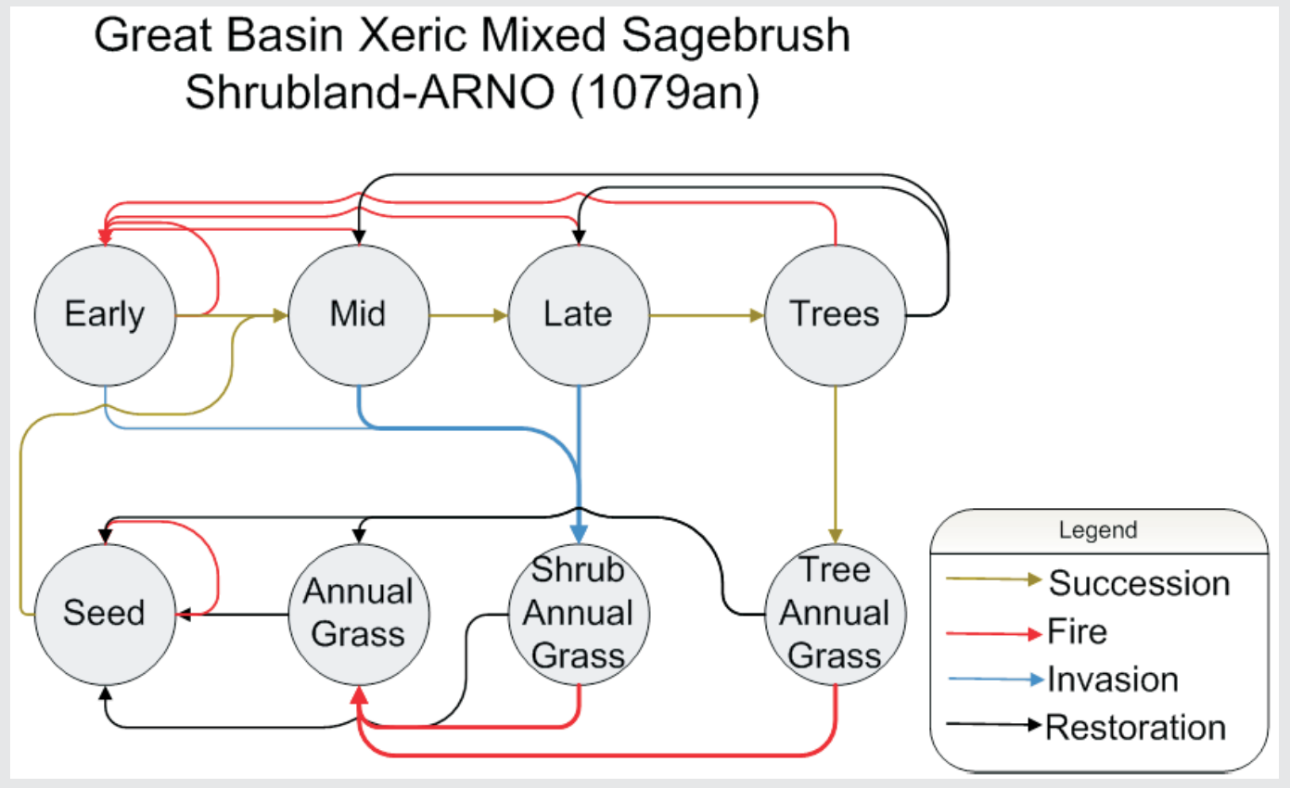

**Figure 2.** Sample state and translation model representing primary transition types.

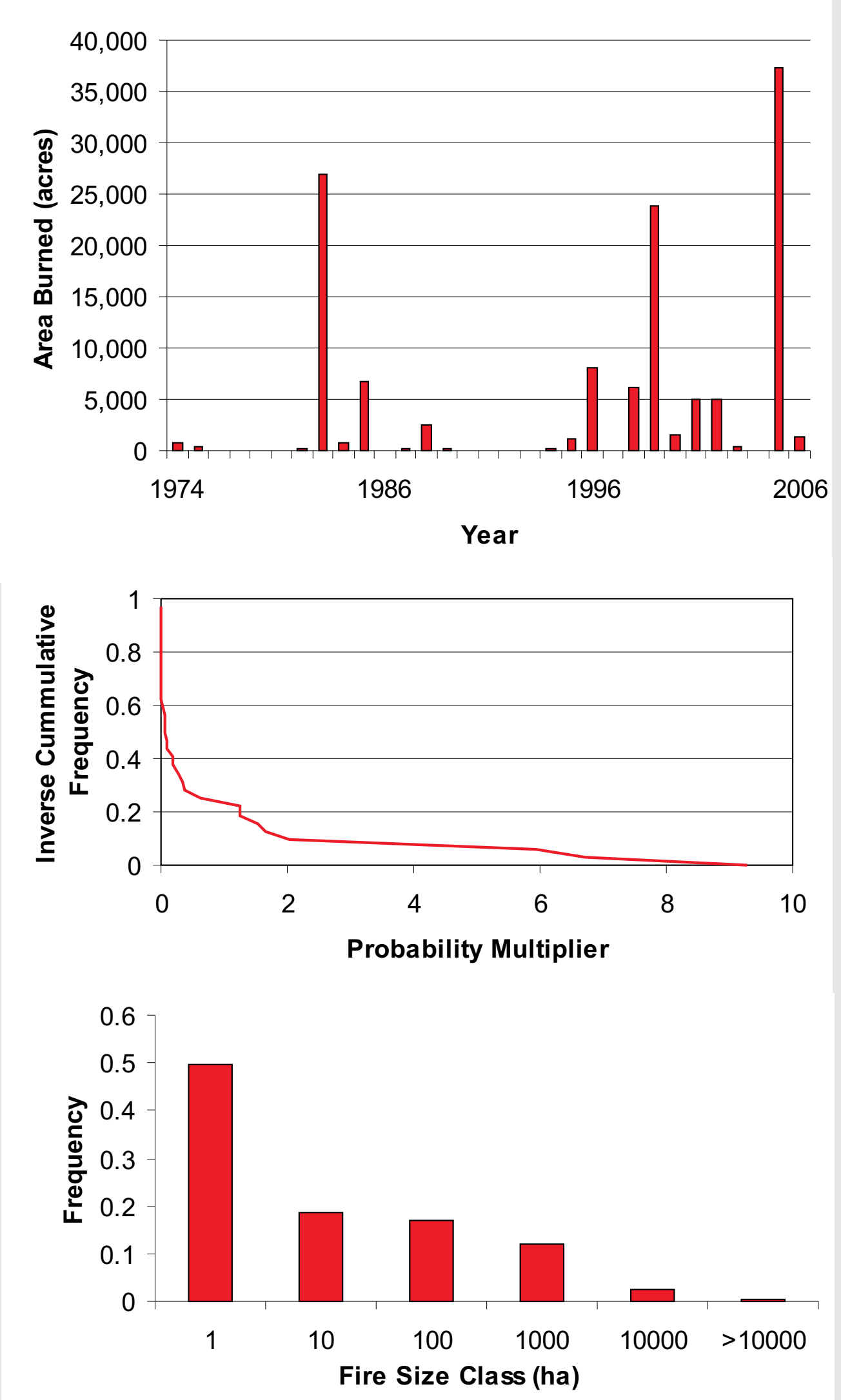

**Figure 3.** Fire history data used to derive temporal variability and fire size distributions.

## Results

**A) Ecological departure** with temporal variability in fire probabilities over the last 500 years of 1000 year reference simulations tends to be higher when spatially explicit algorithms are used. (Figure 4)

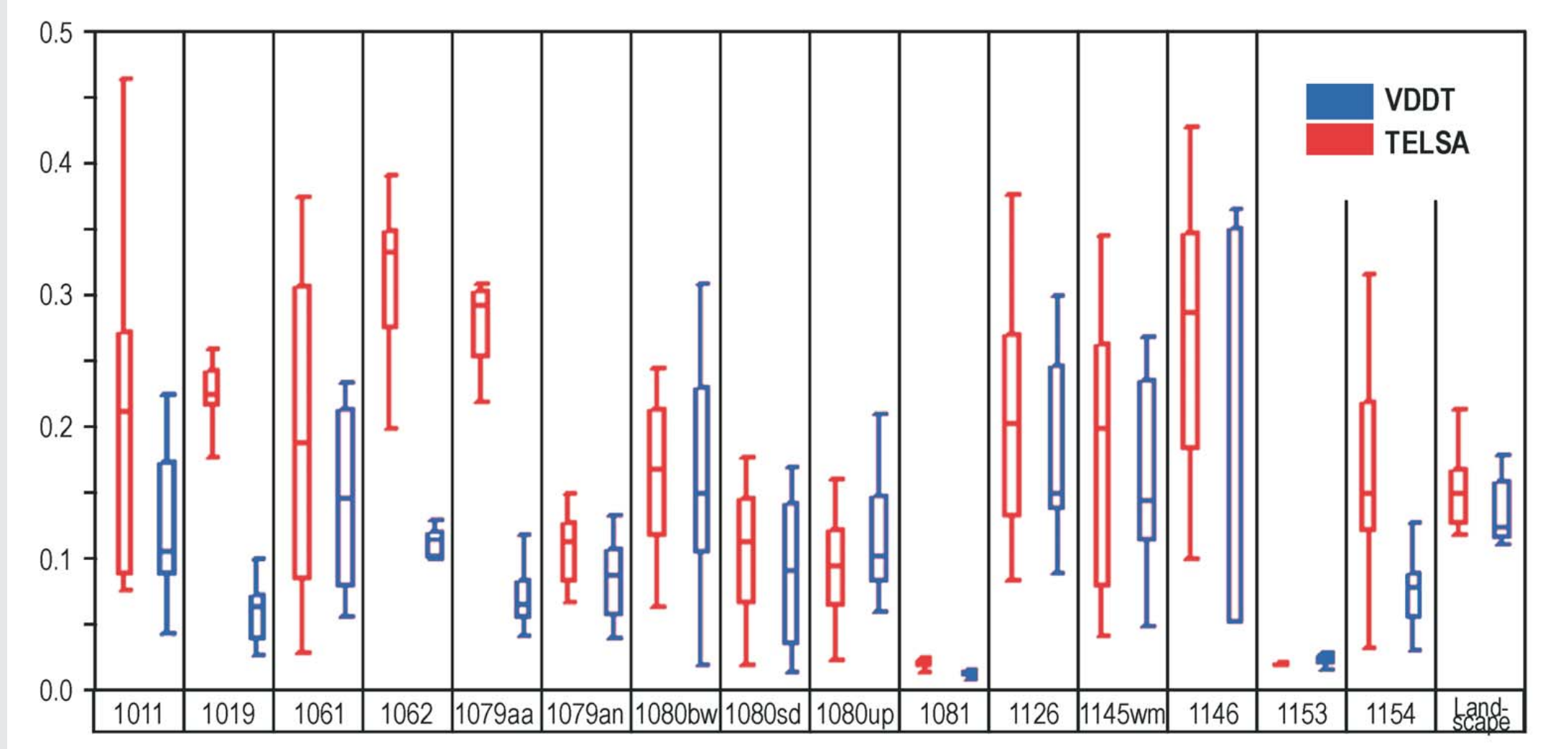

**Figure 4.** Ecological Departure by BpS measured every 50 years for the last 500 years of spatially explicit (TELSA) and non-spatial (VDDT) simulations with temporal variability in fire probabilities using reference condition models.

**B) Fire regime:** Excluding biophysical settings where fire is extremely rare, the difference in ecological departure is expected to be greater for BpS that have high fire return intervals and a large perimeter to area ratio. The fire regime for these BpS is most likely to be influenced by fire spreading into them from neighbors. (Table 1)

**Table 1:** Summary of regression results for the difference between ecological departure for LANDFIRE models using spatial and non-spatial simulations ($r^2 = 0.57$).

| Effect | Coefficient | Std Error | Std Coef | Tolerance | t | P(2 Tail) |
|---|---|---|---|---|---|---|
| Constant | -0.031 | 0.034 | 0 | . | -0.935 | 0.372 |
| Perimeter/Area | 1.452 | 0.651 | 0.47 | 0.979 | 2.229 | **0.05** |
| FRI | 0.001 | 0 | 0.658 | 0.979 | 3.121 | **0.011** |

**ANOVA**

| Source | Sum of Squares | DF | Mean Square | F-ratio | P |
|---|---|---|---|---|---|
| Regression | 0.036 | 2 | 0.018 | 6.483 | **0.016** |
| Residual | 0.028 | 10 | 0.003 | | |

**C) Management simulations** tested the effects of constraining restoration funds by ownership (Yes/No), constraining restoration funds to BpS where success rates are highest (Yes/No), using fuel breaks to reduce the size of uncharacteristic fires (Yes/No) and prioritizing restoration to areas adjacent to desirable habitat (Yes/No).

We ran 16 simulations for 50 years to represent the full factorial combination of these 4 management decisions.

Figure 5 shows sample maps of S-Classes at year fifty for (a) the worst and (b) the best simulations in terms of ecological departure.

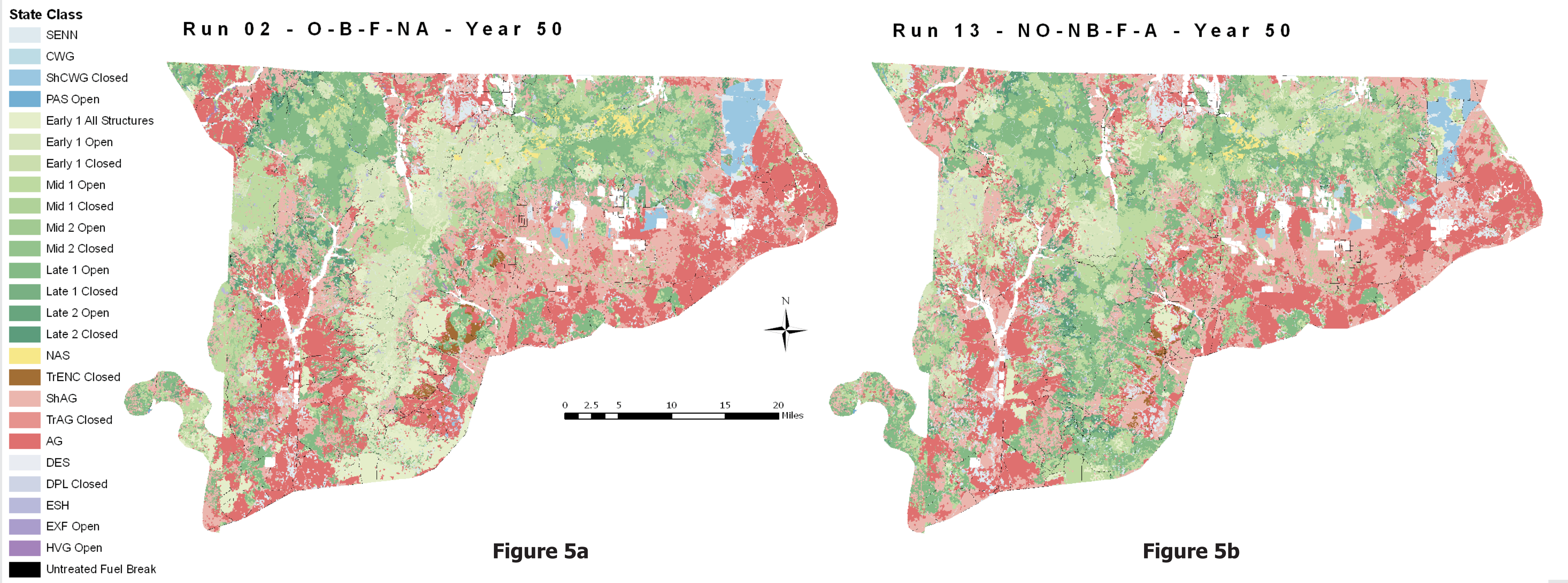

**Figure 5a**

**Figure 5b**

**D) Shannon diversity:** Figure 6 shows a map of shannon diversity index in habitat types using a 60 ha moving window for the simulation that ranked highest in mean habitat diversity.

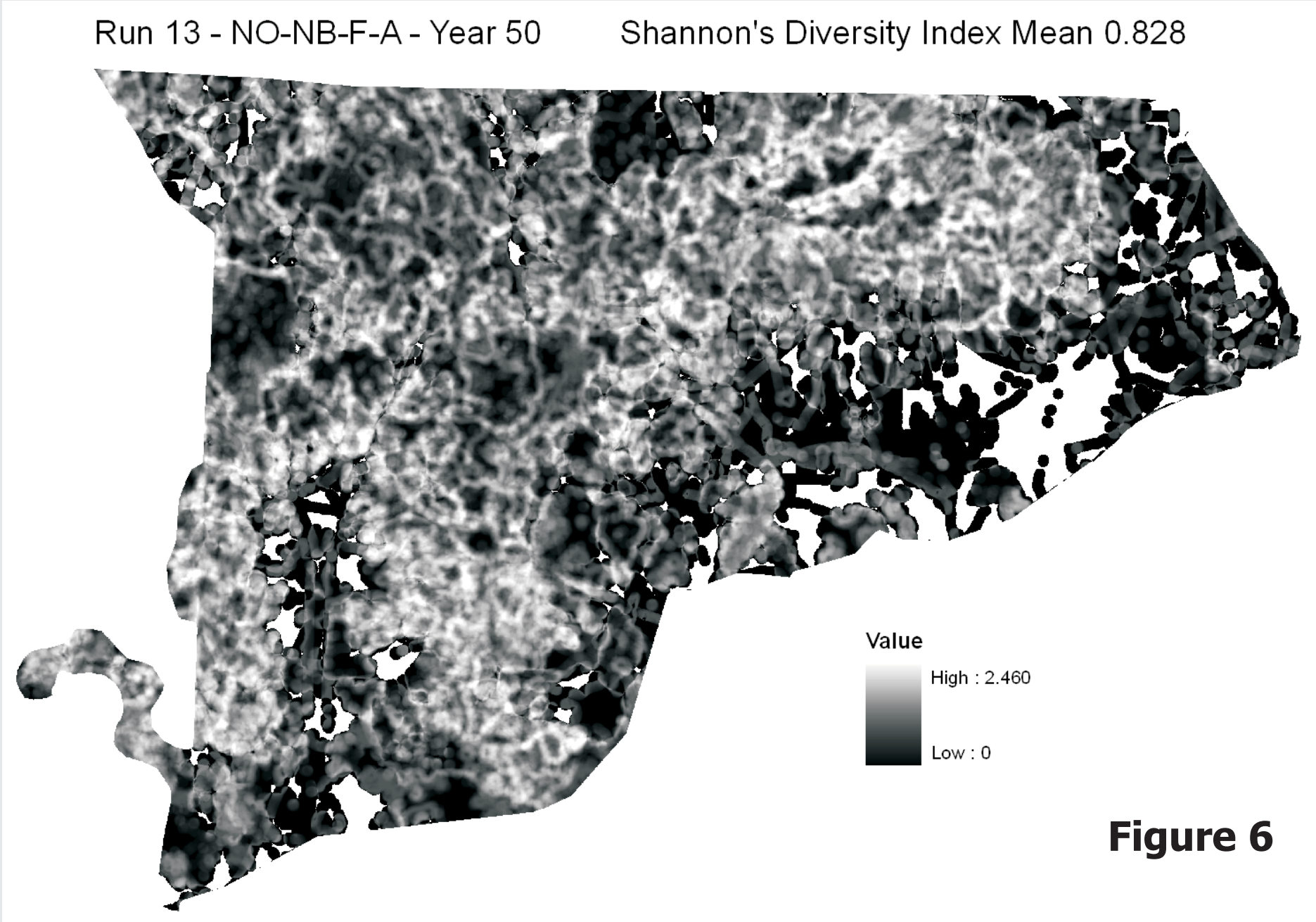

**Figure 6**

**E) Strategies:** Ownership (P= 0.026) and the interaction between ownership and fuel breaks (P = 0.057) had a significant effect on the ecological departure of the landscape after fifty years. Constraining restoration efforts by ownership results in less effective results across the landscape and when restoration treatments are not constrained by ownership, fuel breaks are effective at reducing ecological departure. (Figure 7)

Not constraining funds by Ownership (P = 0.042) and utilizing fuel breaks (P = 0.004) both help increase the mean diversity of habitat types at a 60ha scale on the landscape.

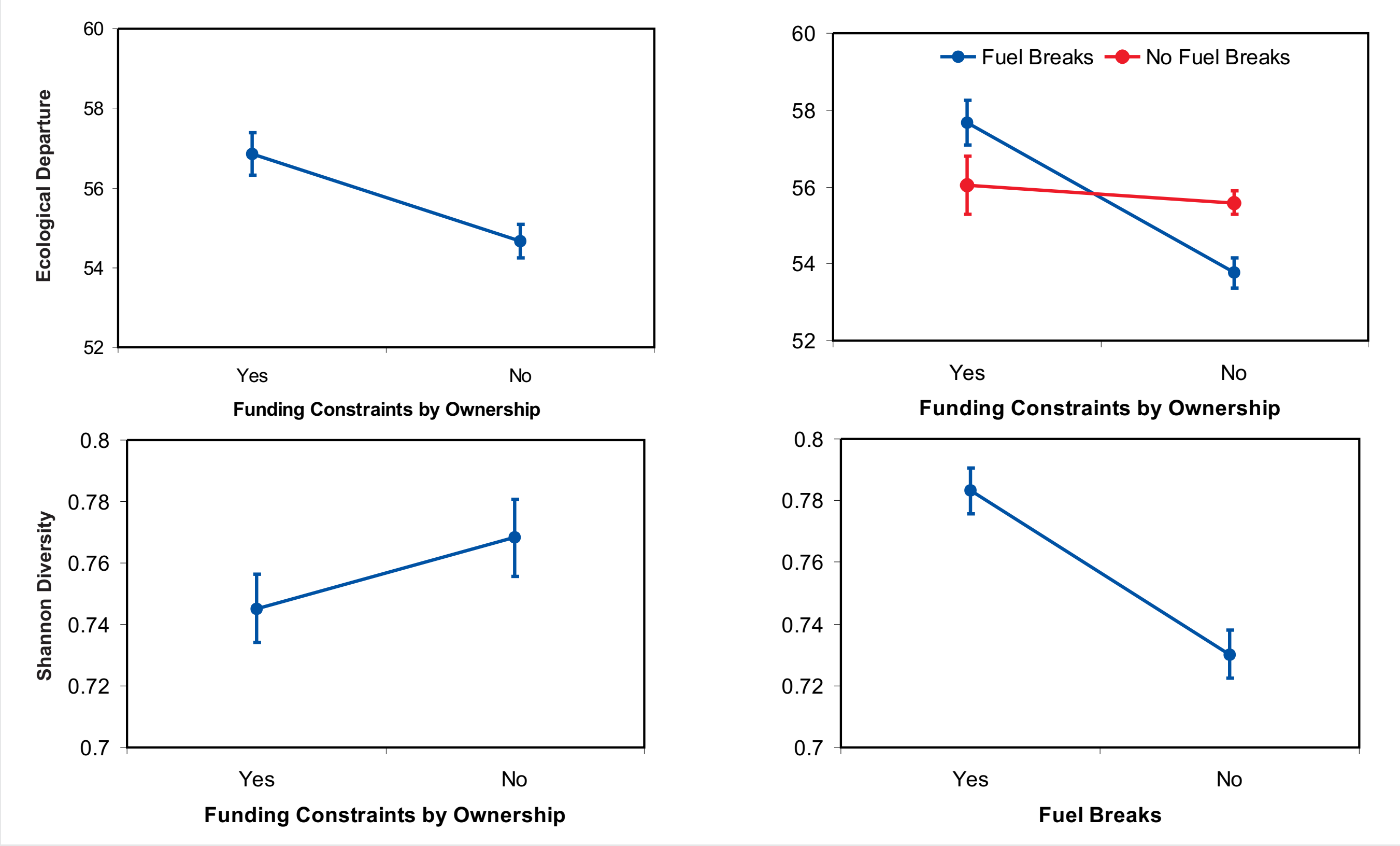

**Figure 7.** Plots demonstrating the effects of ownership and fuel breaks on ecological departure and habitat diversity. Values are means (±SE).

## Conclusions

1. For the landscape as a whole ecological departure measurements for reference simulations using spatially explicit and non-spatial algorithms were similar. This suggests that using non-spatial models to determine reference conditions at large scales is adequate and less expensive than with spatially explicit models.
2. The spatial configuration of BpS in any one particular landscape is important in defining reference conditions. This was demonstrated by differences in outcomes of reference simulations using non-spatial (VDDT) and spatial (TELSA) modeling algorithms.
3. Results of non-spatial reference condition models should be interpreted cautiously at smaller scales, particularly for BpS that have a high perimeter to area ratio and a long fire return interval.
4. LANDFIRE reference condition models can be adapted to ask important spatially explicit questions about management implications for the future range of variability in a landscape.
5. Our models for the Grouse Creek Mountains and Raft River Mountains of NW Utah suggest that the constraints placed on restoration by the configuration of ownership boundaries on the landscape is an important barrier to improving the ecological condition of the landscape over the next 50 years.
6. Our models also show that investing in the creation of fuel breaks to reduce the size of uncharacteristic fires may be effective at improving the ecological condition of the landscape.

## Acknowledgements

This research was funded by the Utah Partners for Conservation and Development, LANDFIRE, The Nature Conservancy of Utah and ESSA Technologies Ltd. We thank the numerous agencies and individuals that participated in two model development workshops. We thank Kelly Robson for preparing the figures and the graphical layout of the poster.

## For further information

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More information on this and related projects can be obtained at www.essa.com/services/forestry/LM_restoration.htm

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