Oregon Blackberry Invasion Analyzed by Spatial Stochastic Modeling

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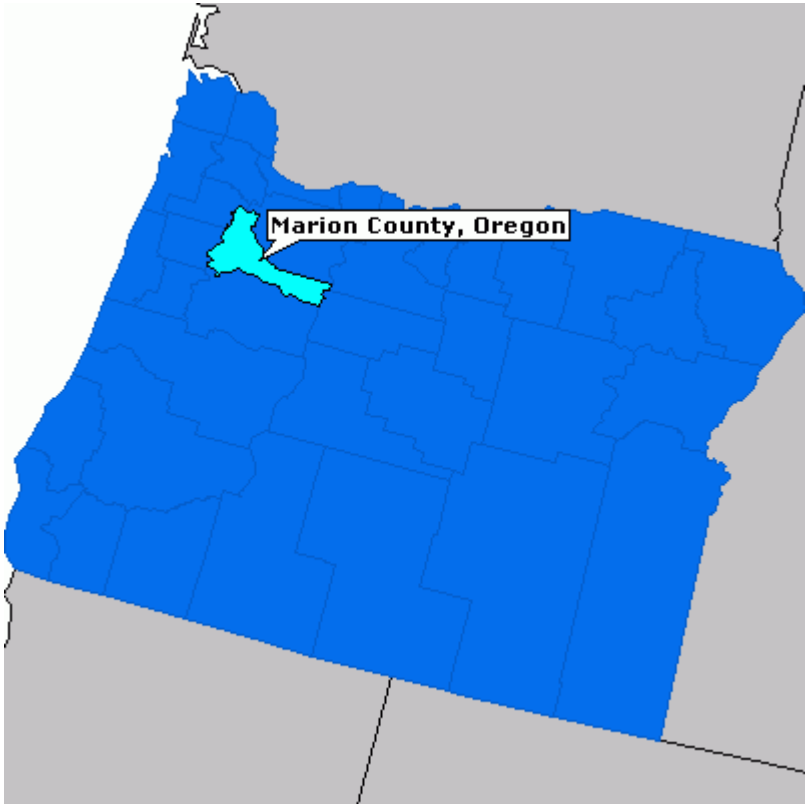
Background



- Invasive species introduced to Oregon in late 19th century for crops
- Discovered unleashed in Marion County in 1922
- Rank “B” by Oregon Dept. of Agriculture

Biology

- Blackberry prefers habitats that are disturbed (urban) or riparian (river beds)
- Grows in all soil types, alkaline and acidic
- Found in areas with as little as 50 cm annual precipitation
- Frost resistant

Reproduction and Spread

- Root-tipping and daughter plants
- Fruit floats downstream
- Spread by animals
  - Squirrels, birds
  - Black bears, deer

The Problem

- Blackberry has taken over the Western part of the state, creating huge barriers for crops and animals leading to massive economic damage
- Most effective removal strategies are
  - Cutting and spot treatment pesticide
  - Goats: for temporary residential removal
  - Newly discovered blackberry rust: also effects Evergreen blackberry

The Model

- Stochastic spatial modeling can evaluate effectiveness for eradication
- Predicting spread will give other counties better preparation
- Current invaded areas are kept track by Oregon Department of Agriculture

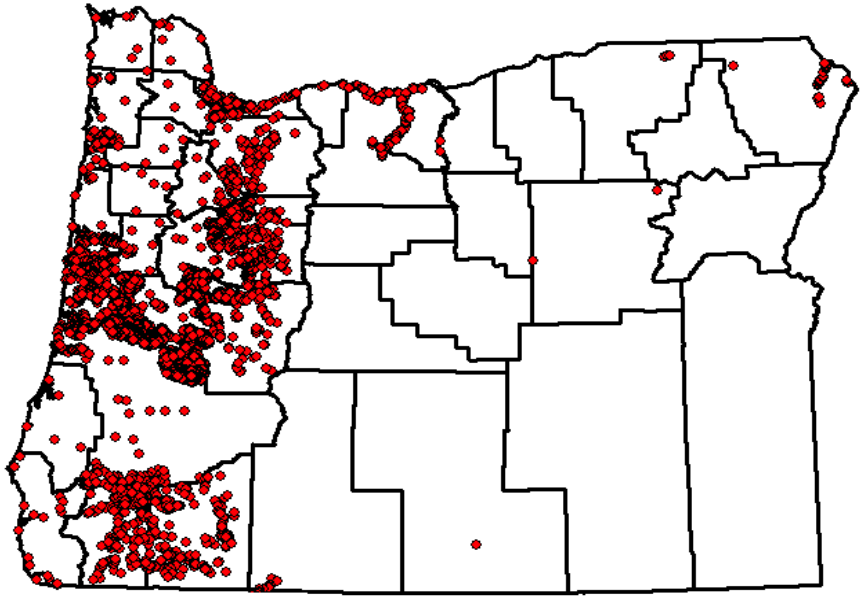
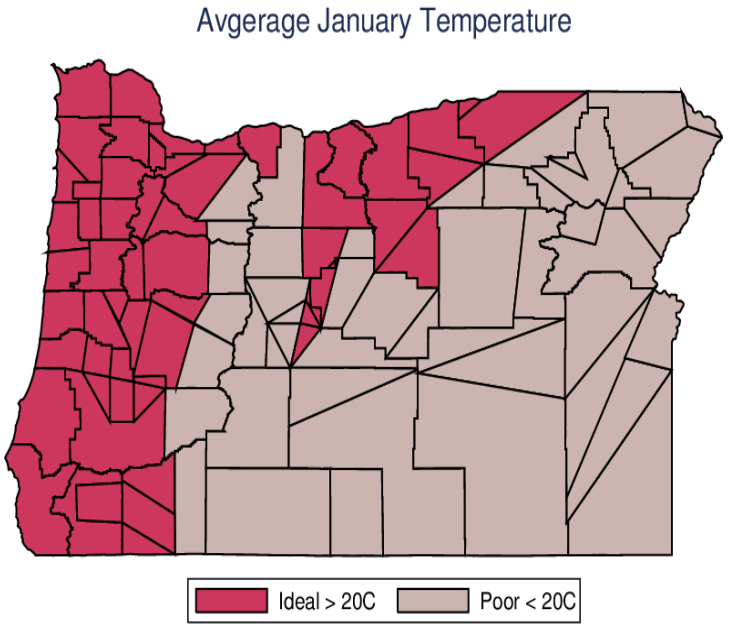


Fig. 1 Known Blackberry plots in 2010

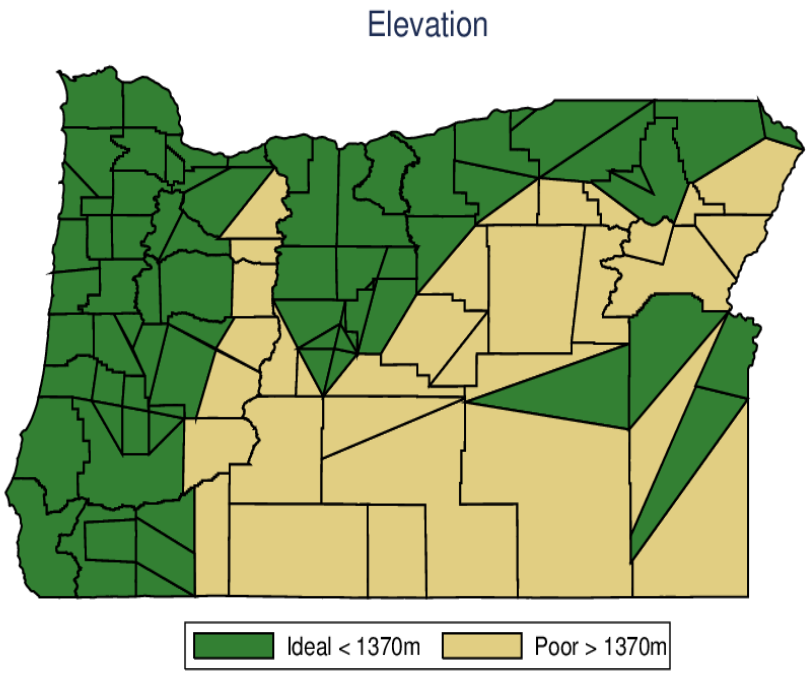
Data Collection: Factors Used

- Temperature
  - Blackberry likes temperate weather but has been found in Juno, Alaska



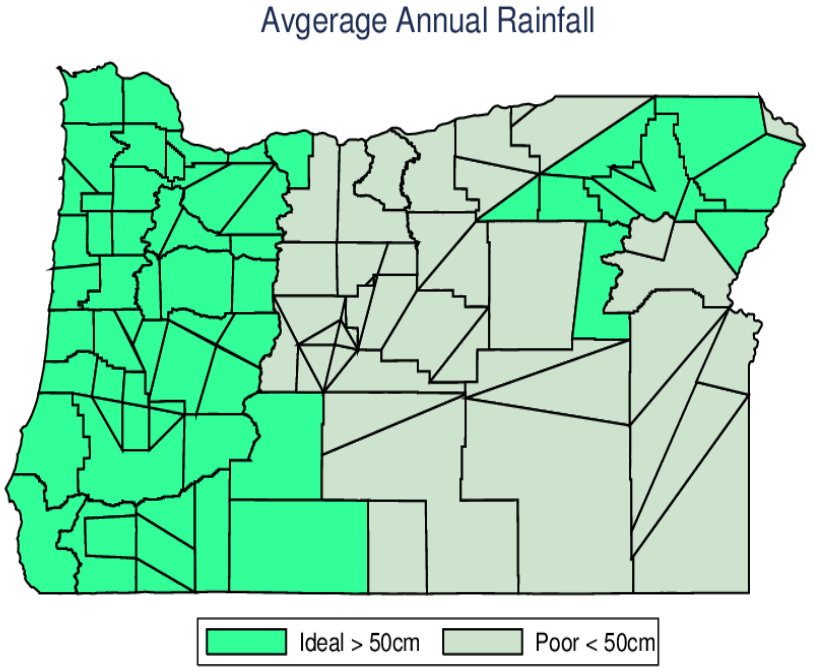
Data Collection: Factors Used

- Elevation
  - One of the most important variables when studying invasive species in Oregon is elevation



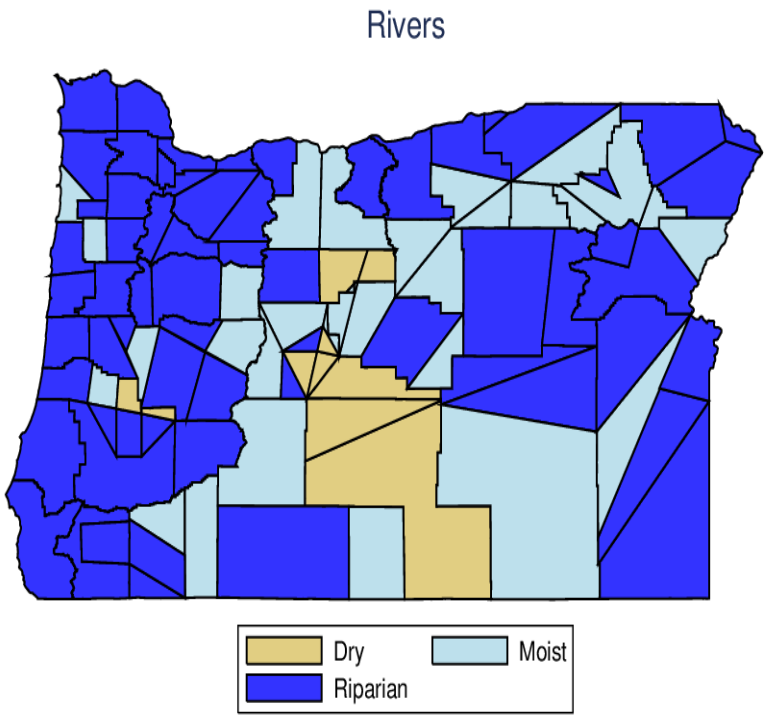
Data Collection: Factors Used

- Rainfall
  - Blackberry likes average precipitation of 110cm annually



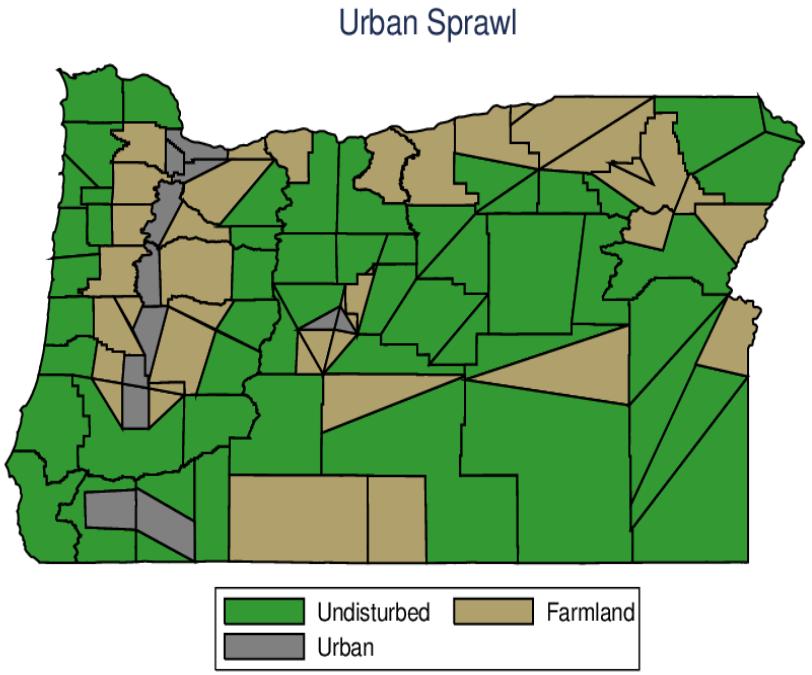
Data Collection: Factors Used

- Rivers
  - Map of Oregon was broken up into regions of varying levels of riparian habitats



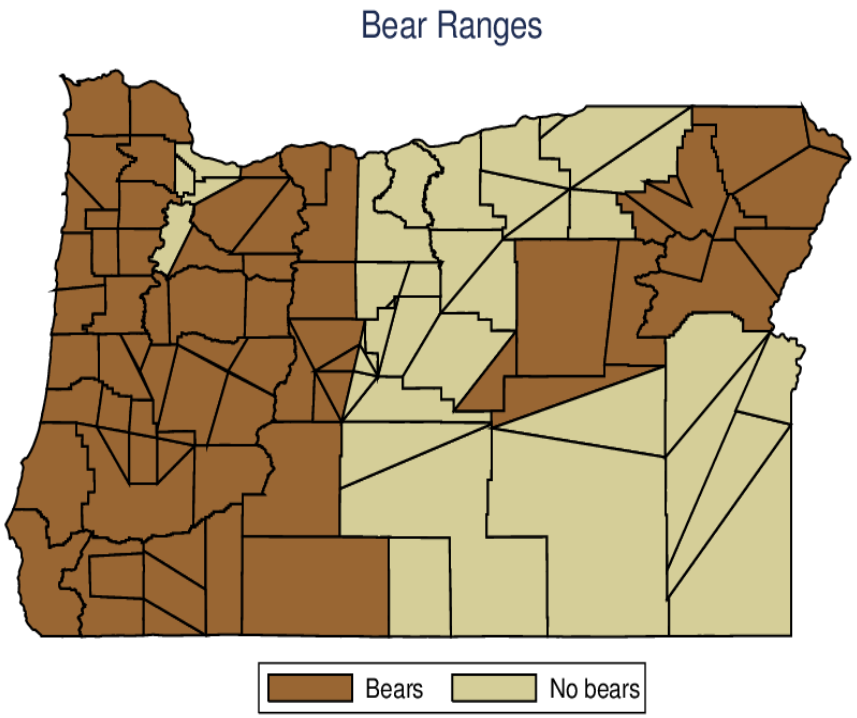
Data Collection: Factors Used

- Urban areas
  - Cities and farmlands are considered disturbed habitats, all other lands are old growth for our purposes



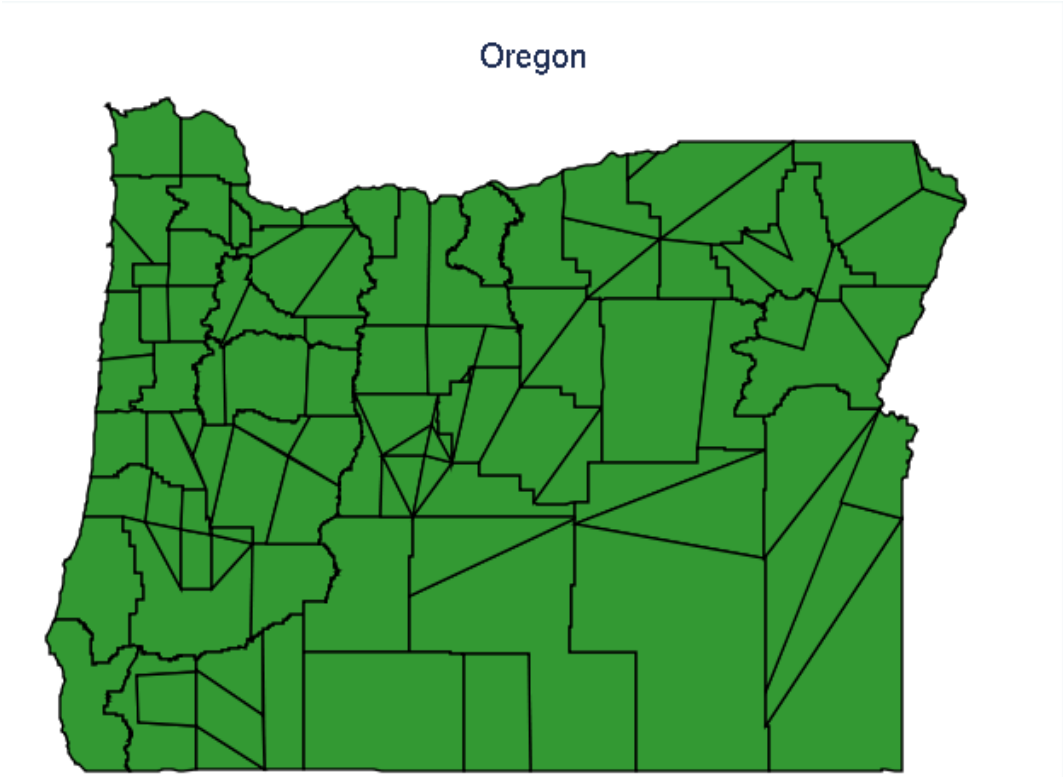
Data Collection: Factors Used

- Black bears
  - Bears help spread seeds within regions and to contiguous regions



Methods: Spread

- Make a gridded map of regions homogeneous with respect to influential factors of blackberry spread
- The probability of moving from region to region depends on the size of the borders and if black bears exist in the regions
    - The longer the border is between two regions, the higher probability the blackberry has to spread



Methods: Survival

- Seed survival depends on suitability of the habitat
- Once the seed lands in a region, all the factors mentioned can increase or decrease the probability of germination

Methods

- Data for blackberry spread in 1922 was used for initial conditions
- Implemented the Gillespie algorithm and increased time steps (or years)
- Regions that were more suitable for blackberry were given a higher probability of invasion per time step
- Parameters were adjusted so that after 98 years the spread matched current records in 2010

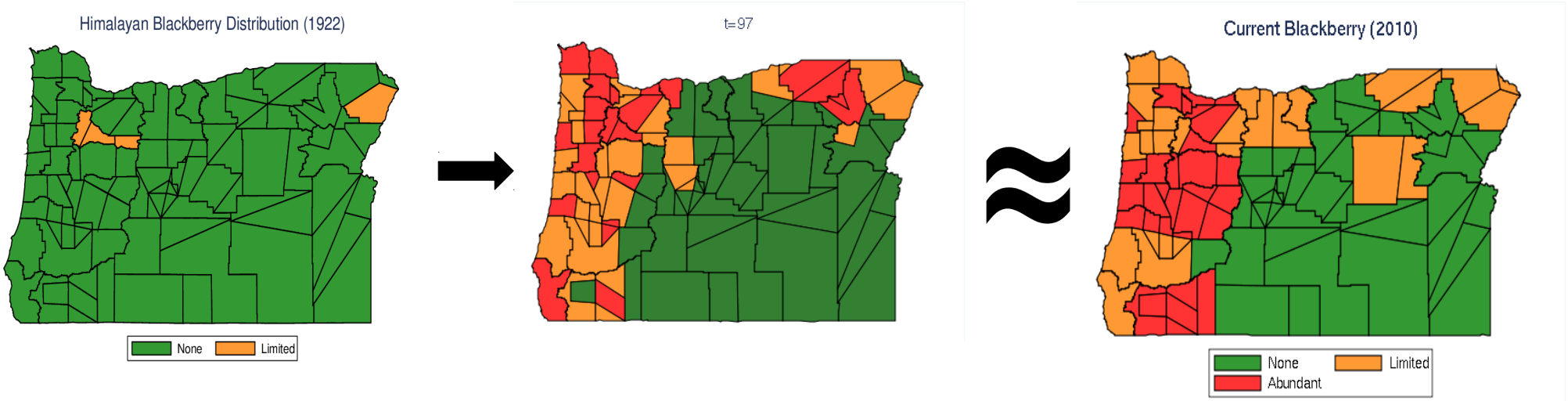
Stochastic Model

$$\frac{dH_i}{dt} = Bs_i + \sum_{j\text{neighbor}} Db_{ij}(H_i - H_j)s_i,$$

where H_i is the level of infestion in region i and $s_i = a_i t_i r_i e_i u_i v_i$

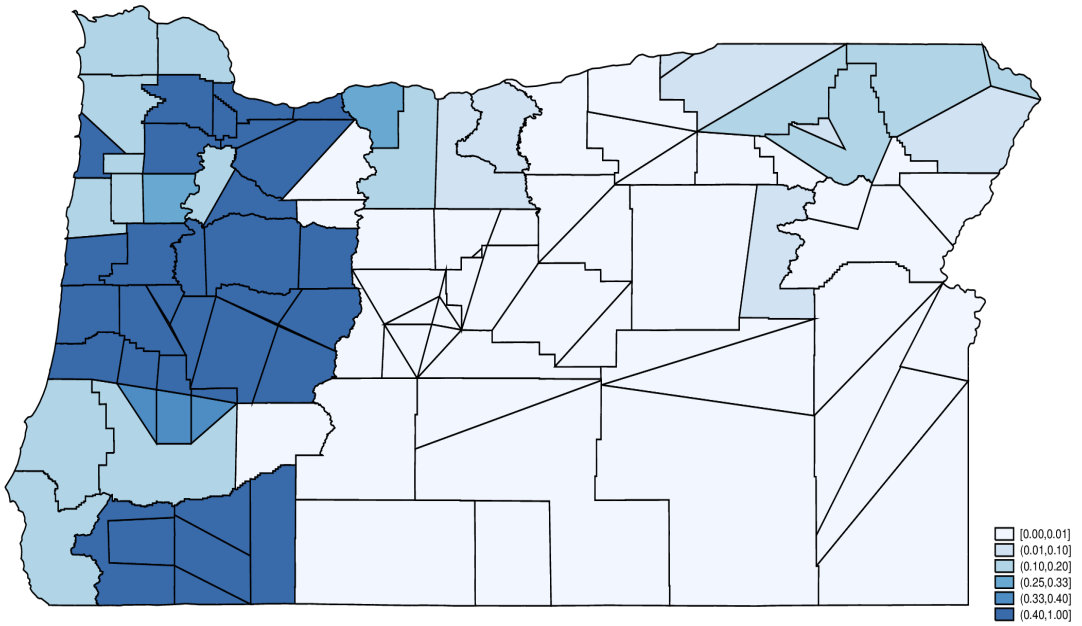
- ODE models are too precise for the data
- Stochastic models allow us to see where blackberry is likely to go
- Interpret rates as probabilities of events: growth and spread in a small time period in the ith region
- Implemented in C

Results: Parameter Selection



Results: Predicting the Future

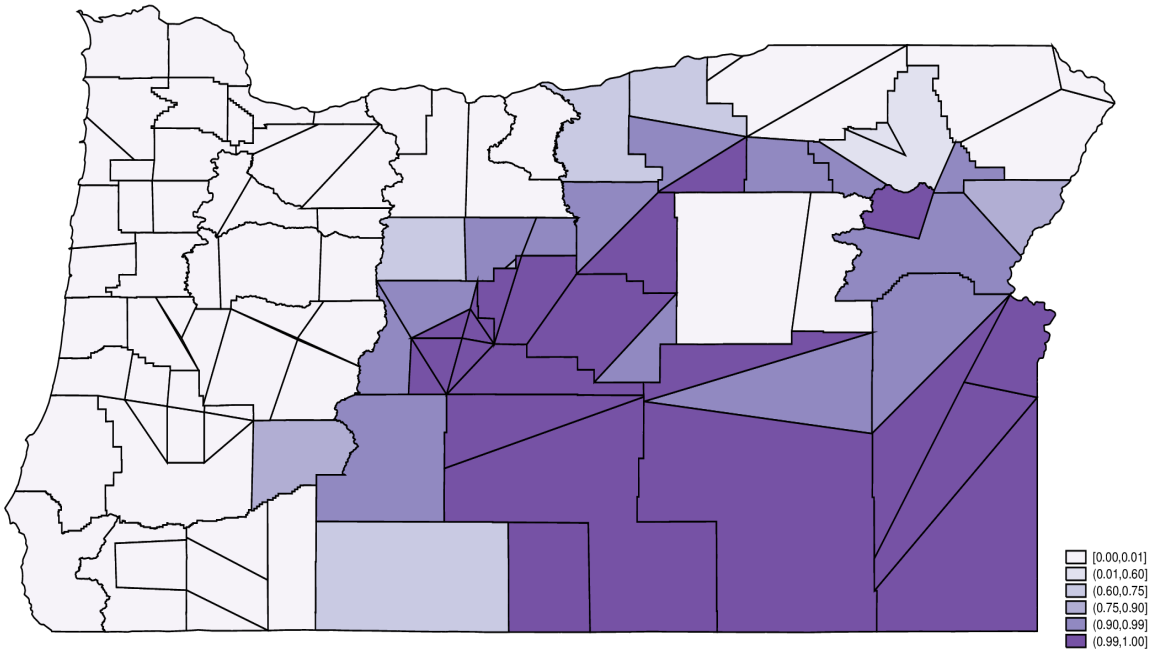
- Using the adjusted parameters and data from current blackberry spread, the model was projected 20 years into the future after 1000 trials



We can see that in 2030, the regions that are more probable to become highly infested are colored in darker hues

Results: Predicting the Future

- Similarly, in 2030, the regions more likely to remain un-infested are shaded in darker purple



Conclusion

- Model was successful in giving reasonable predictions of spread from 1922 to 2010
- Highlights which regions of Oregon are more likely to be infested in the future
- Future work: model could be used to compare different eradication procedures

Thank you!

- Dr. May Boggess of Texas A&M University
- Dr. Jay Walton of Texas A&M University

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