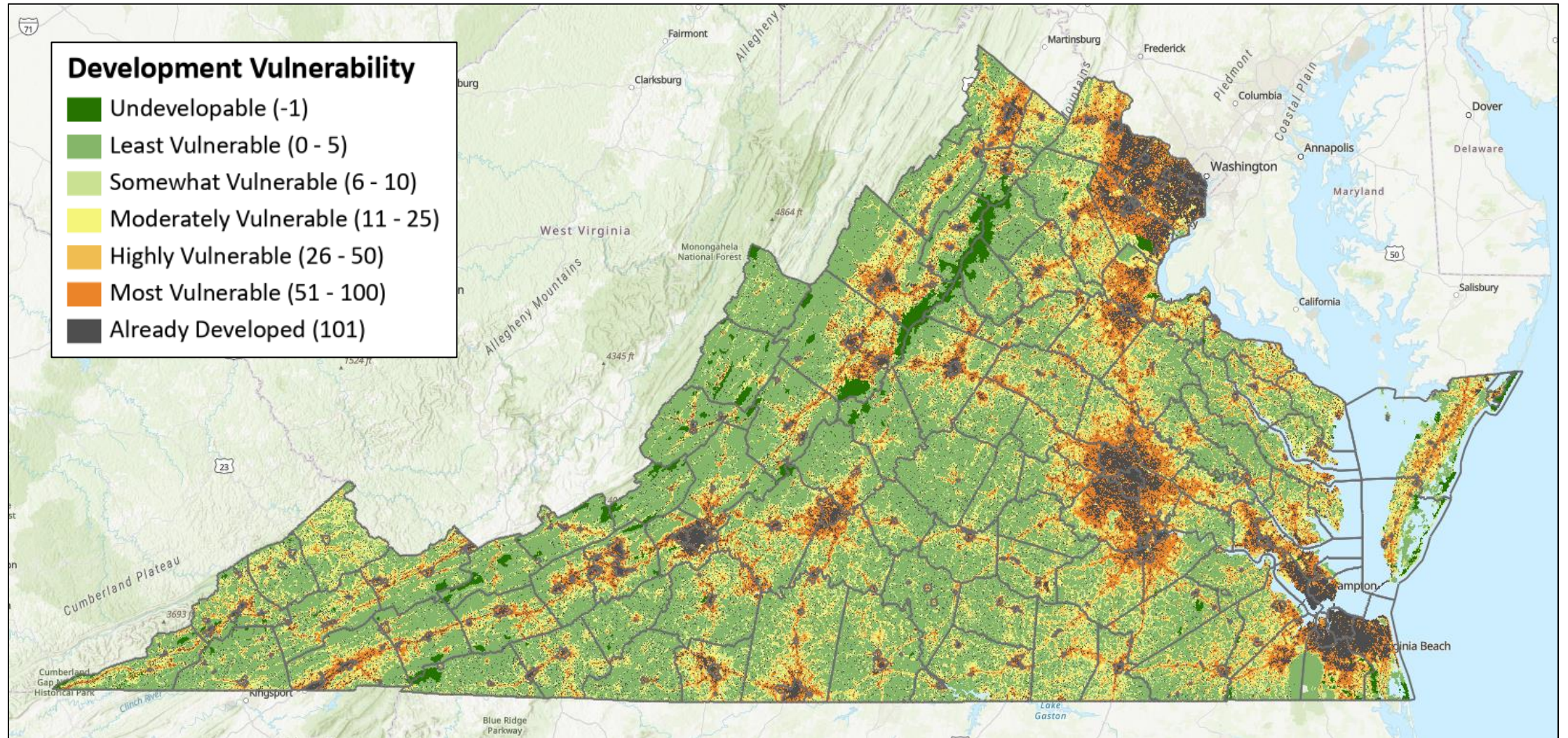


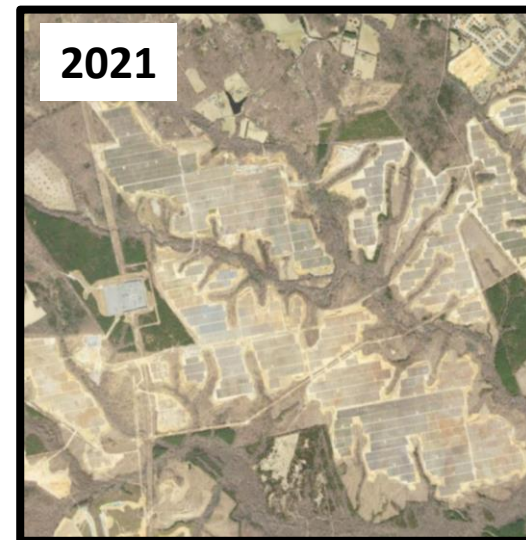
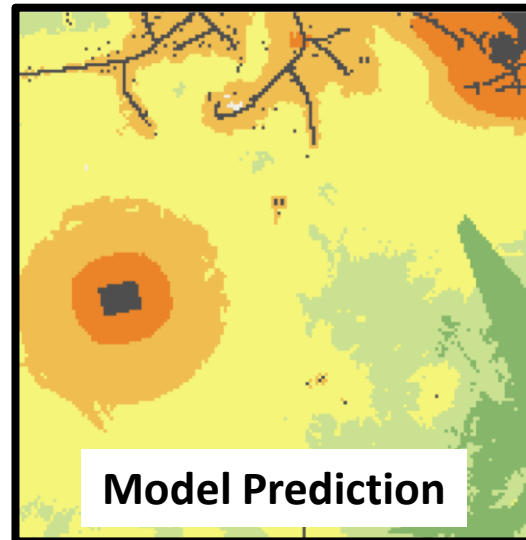
Virginia ConservationVision Development Vulnerability Model



Model Purpose

To quantify the **relative risk of conversion** from greenspace (natural, rural, or other open space lands) to urbanized or other built-up uses.

This model is intended for use in conjunction with other data to help target lands for protection. The model can also serve as an input for simulating future land cover change and its consequences under different planning scenarios.



Example Case

A mostly forested area in 2017 (left) was converted to a solar farm by 2021 (right). The model, based on conditions in 2019, predicted moderate or higher vulnerability in most of this area.

Methods

The basis of the Development Vulnerability Model is a Random Forest machine-learning model, used to relate a suite of predictor variables representing conditions at an initial time to outcomes (developed or not) a decade later.

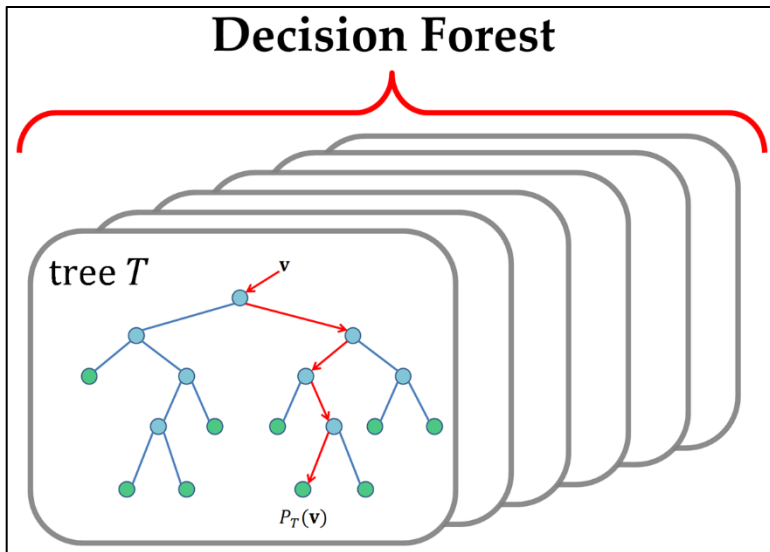
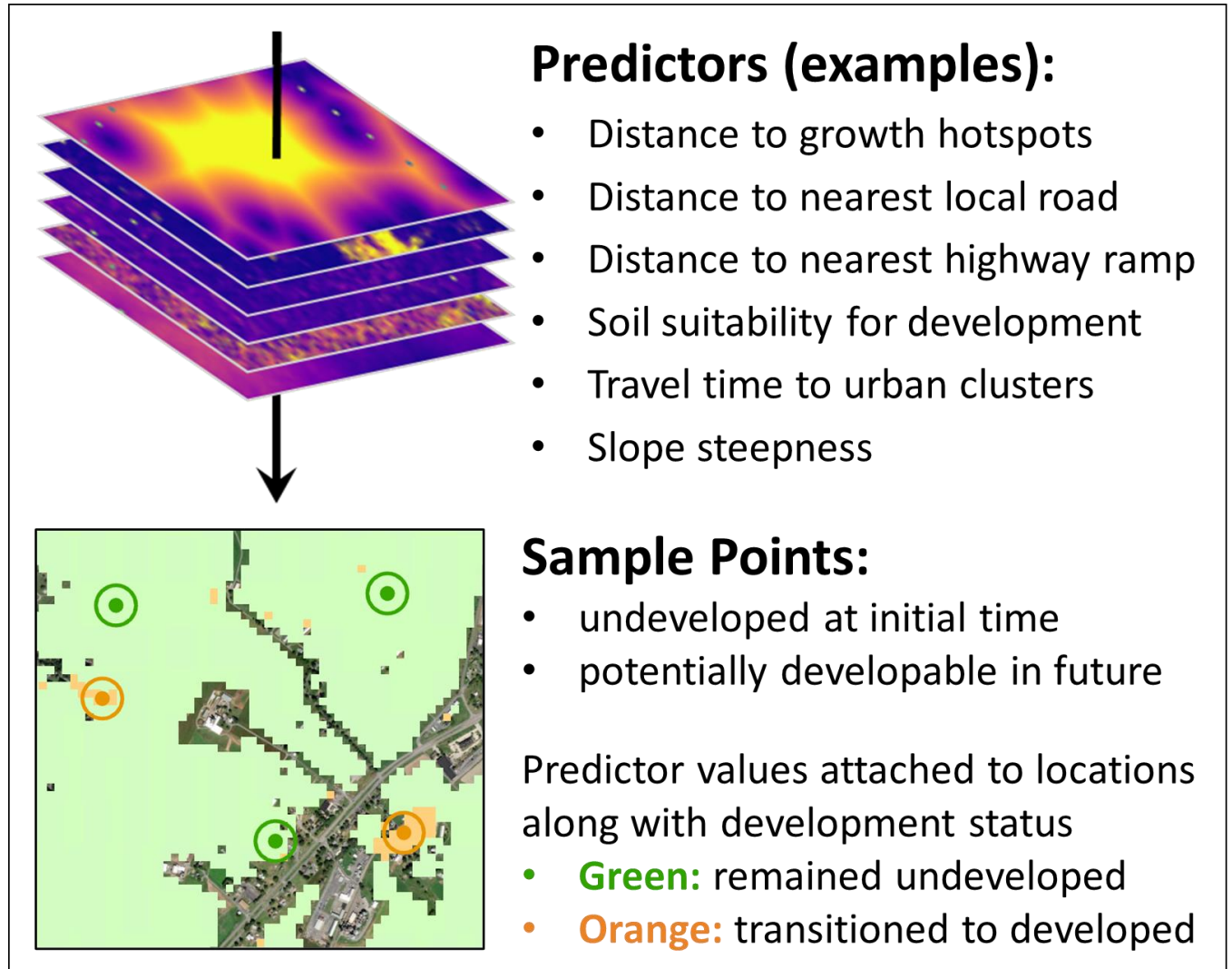
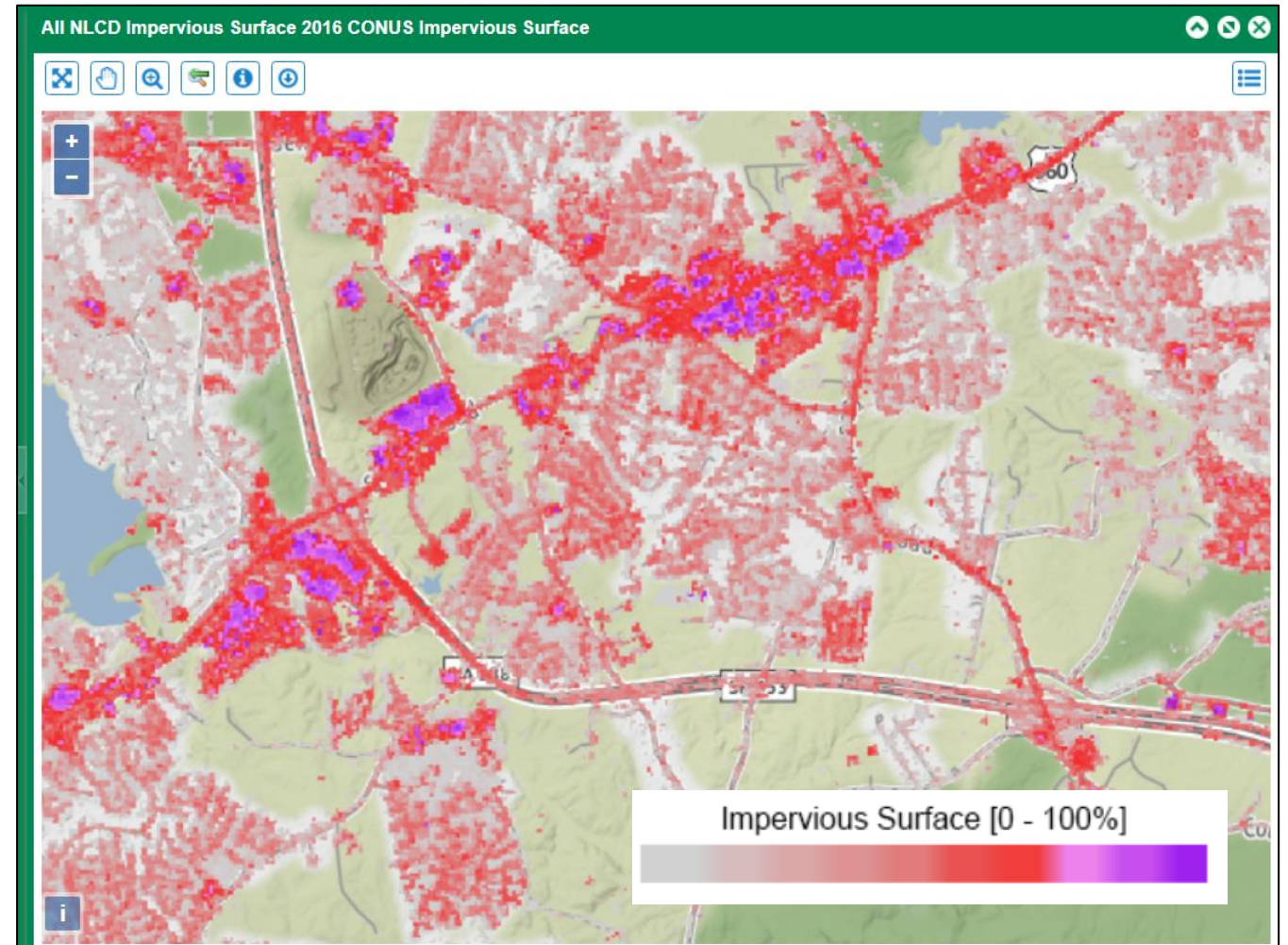


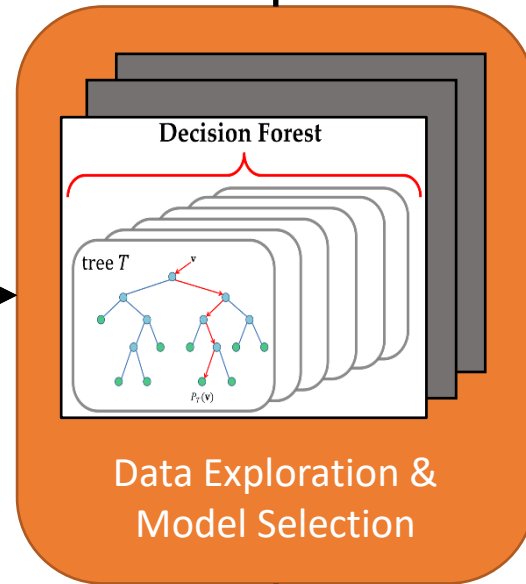
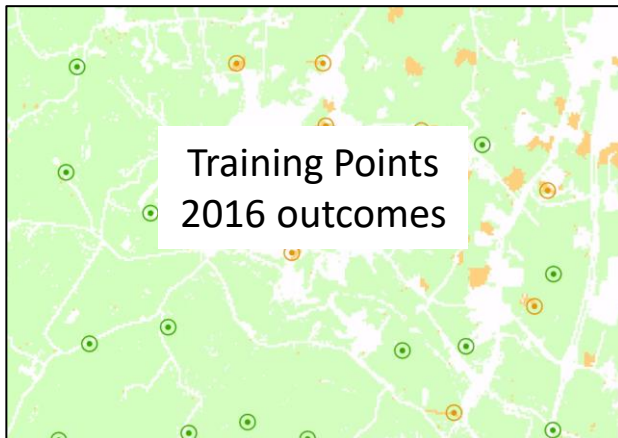
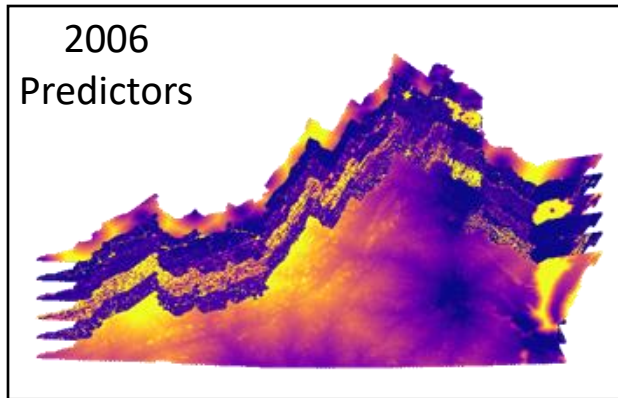
Image source: tinyurl.com/RFDecisionForest



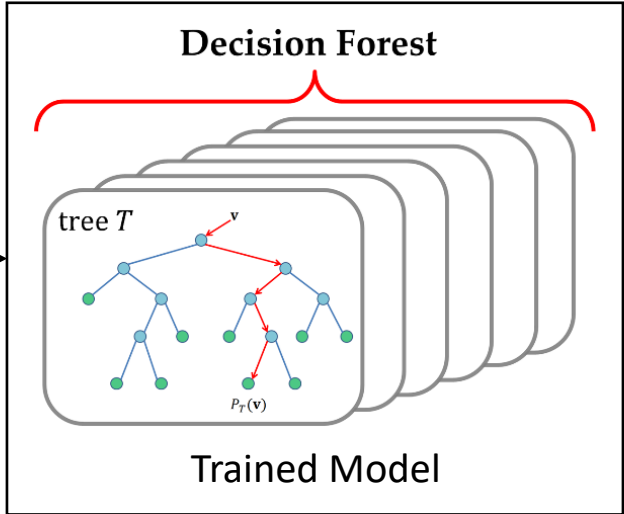
Training and validation samples

- **Development status (2006-2016)** assigned based on National Land Cover Database (NLCD) data
 - 0% impervious → undeveloped
 - $\geq 1\%$ impervious → developed
- **Areas excluded from sampling**
 - Already developed in 2006
 - Fully protected in 2006
 - Open water
 - Very steep slopes ($>70\%$)
 - Greater than 2-km from nearest road



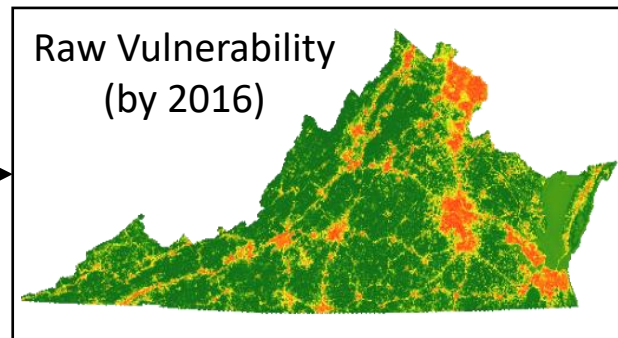
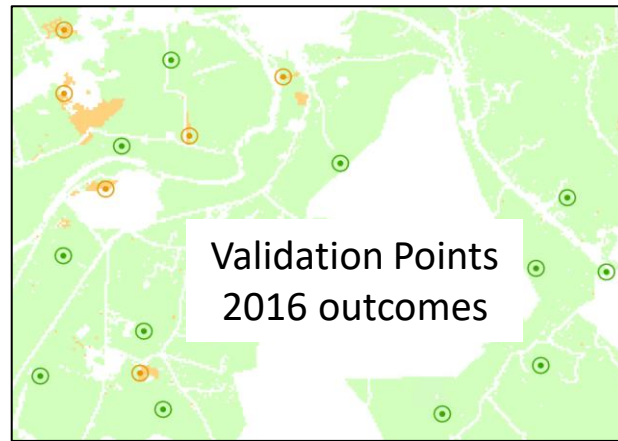
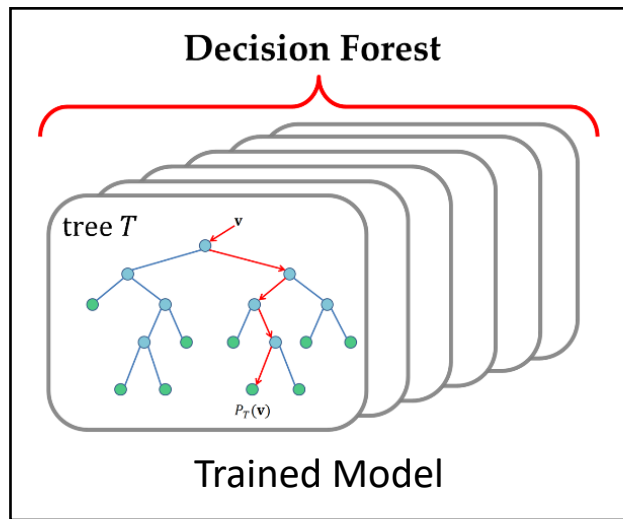


Multiple Predictor Sets/
Models Considered

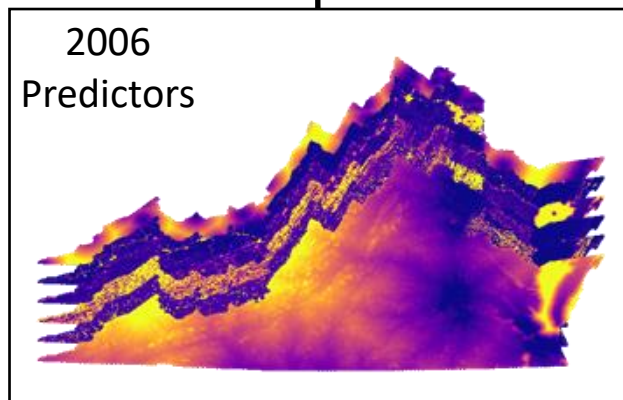


Model Training

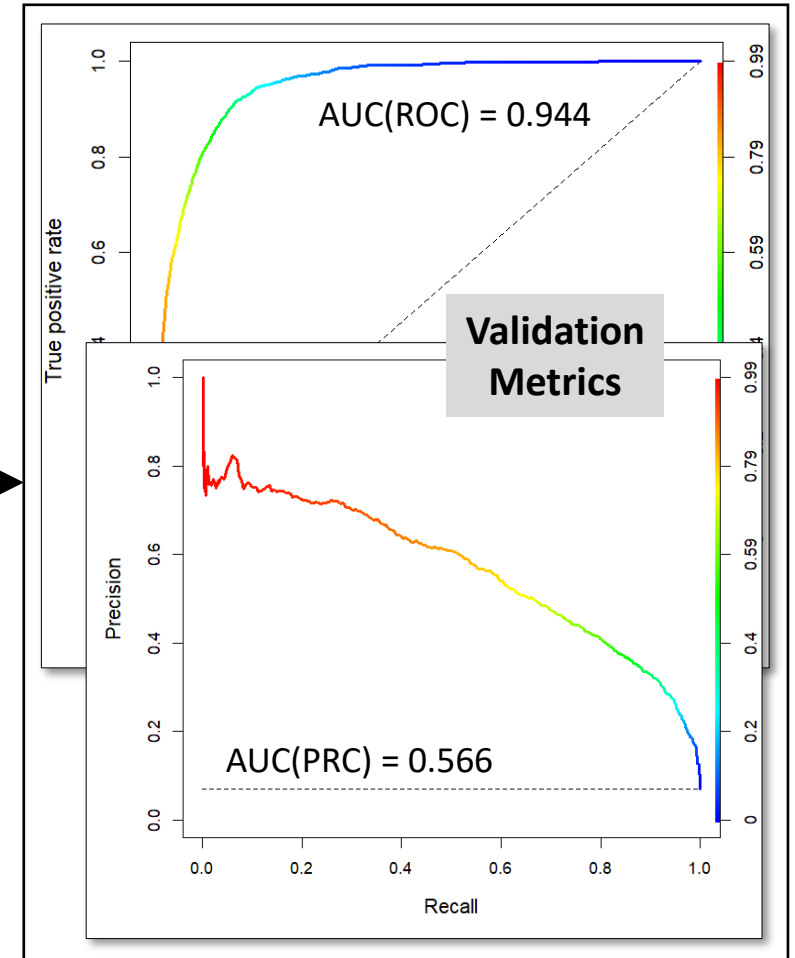
- **2006 conditions** associated with **2016 outcomes** using a Random Forests machine-learning algorithm
- Output is a trained model that can be used for prediction



Validation

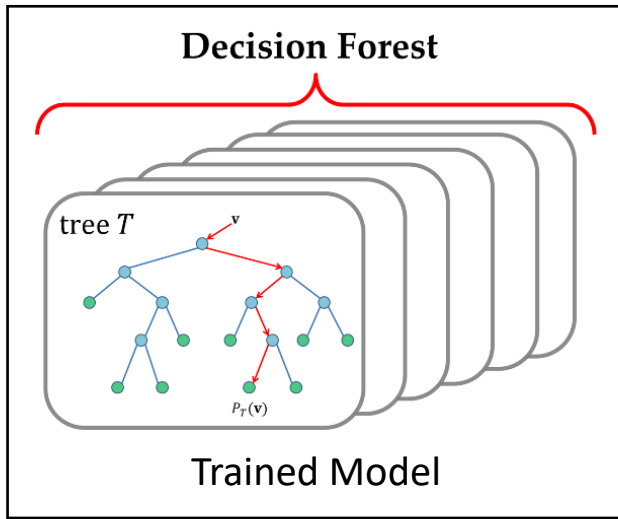


Prediction

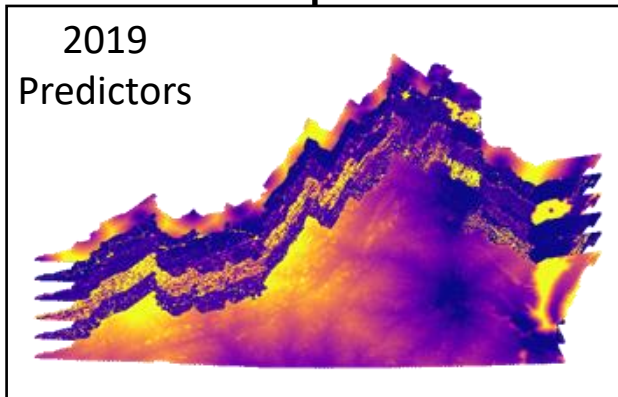


Model Validation

- Trained model used to predict 2016 outcomes from 2006 predictor variables
- Validation procedures compare predicted vulnerability to development status of validation points (independent samples NOT used to train model)
- Validation metrics confirm that trained model is useful for prediction



Prediction

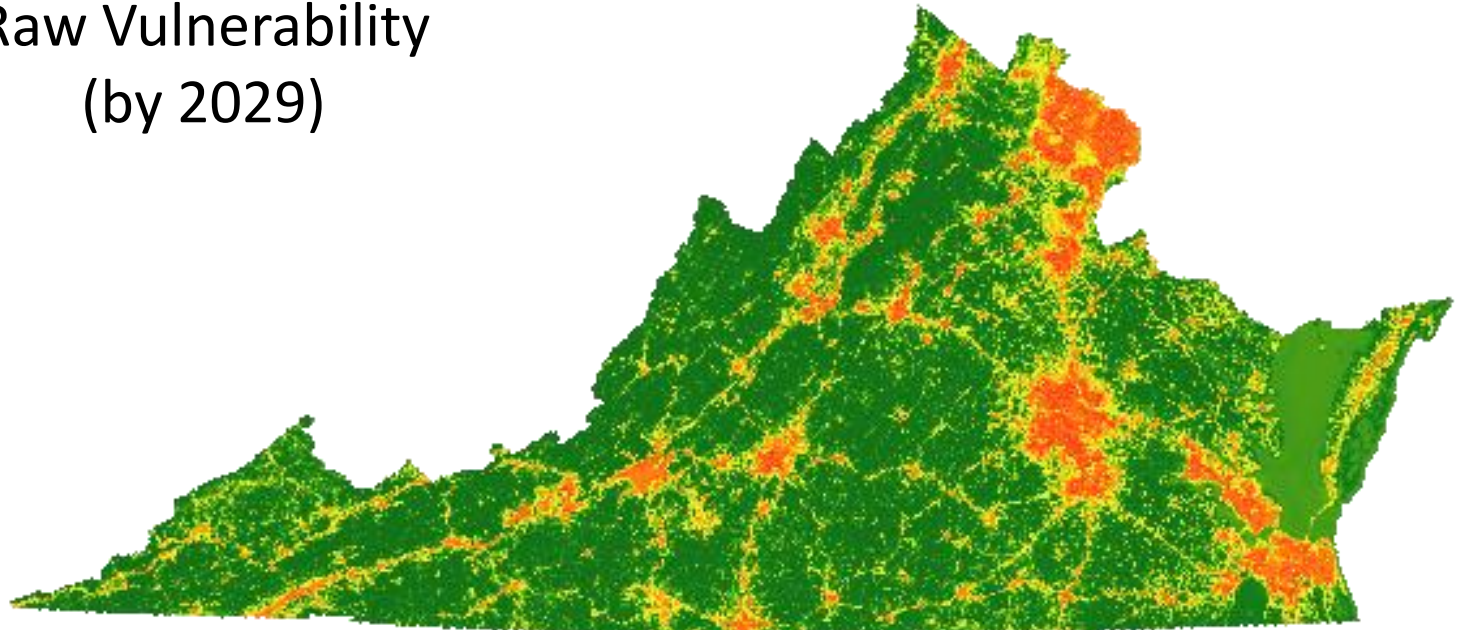


Model Forecast

Relative potential for development by 2029 based on:

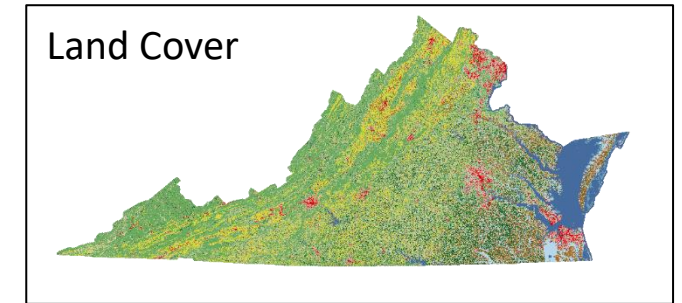
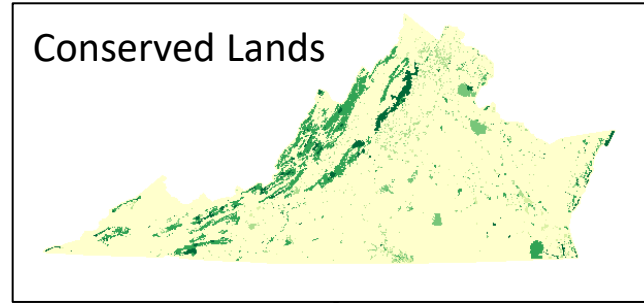
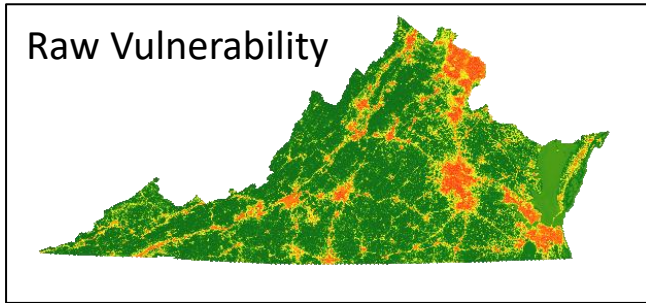
- Model trained and validated with 2006-2016 data
- 2019 predictor variables

**Raw Vulnerability
(by 2029)**



Note that vulnerability is NOT the same as the probability of development, which depends on numerous additional factors such as zoning and population pressure. **Vulnerability values should be interpreted as a relative measure of development potential.**

Creating the Final Vulnerability Map



The output is a raster dataset (30-m pixels) in which:

- Vulnerability of undeveloped lands ranges from **0 (least vulnerable)** to **100 (most vulnerable)**
- On protected lands, raw vulnerability values are adjusted based on level of biodiversity protection
- Protected lands with biodiversity protection as the primary goal are coded **-1 (undevelopable)**
- Areas where development has already occurred are coded **101 (already developed)**

