

Invasive Species: An Important Stressor in the Mid-Atlantic Area



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Mid-Atlantic Invasive Species

- Ecosystem structure and function
- Broad array of taxa
 - Plants, insects, pathogens
- Regional habitat diversity
 - Forest
 - *Alliaria petiolata*
 - *Discula destructiva*
 - *Adelges tsugae*
 - *Lymantria dispar*



Mid-Atlantic Invasive Species

- Regional habitat diversity
 - Streams, rivers
 - *Dreissena polymorpha*
 - *Hydrilla verticillata*
 - Wetlands
 - *Lythrum salicaria*
 - *Microstegium vimineum*
 - Chesapeake Bay
 - *Cygnus olor*
 - *Myocastor coypus*



Mid-Atlantic Invasive Species

- Ecosystem goods and services, socioeconomic costs

- *Dreissena polymorpha*
- *Hydrilla verticillata*

- Public health

- *Aedes albopictus*
- *Heracleum mantegazzianum*

Chestnut blight

Cryphonectria parasitica



Mid-Atlantic Invasive Species

- Significant, but often overlooked problem
- Existing strategies are reactive
- Action taken only after detection of invasion/collateral damage
- Due to time-lag, species may already be established
- Such an approach is environmental catch-up

What is a better way ? Predictive Modeling

- Accumulate occurrence data on native range
- Build ecological niche model
- Project niche model to areas of actual or potential invasion

Predictive Modeling: Genetic Algorithm for Rule-set Prediction (GARP)

- Uses a genetic algorithm, an artificial intelligence application, for choosing rules
- Uses multiple rule types (BIOCLIM, logistic regression, etc.)
- Different decision rules may apply to different sectors of species' distributions
- Extensive testing indicates excellent predictive ability

Tests of GARP Model Predictivity

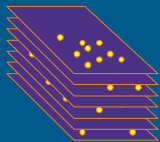
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Hydrilla verticillata



Ecological Niche Modeling

Native range locality data



Specimen records

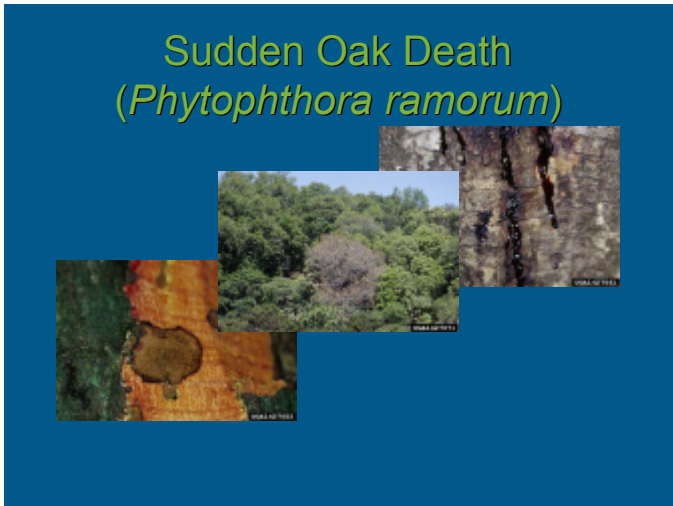
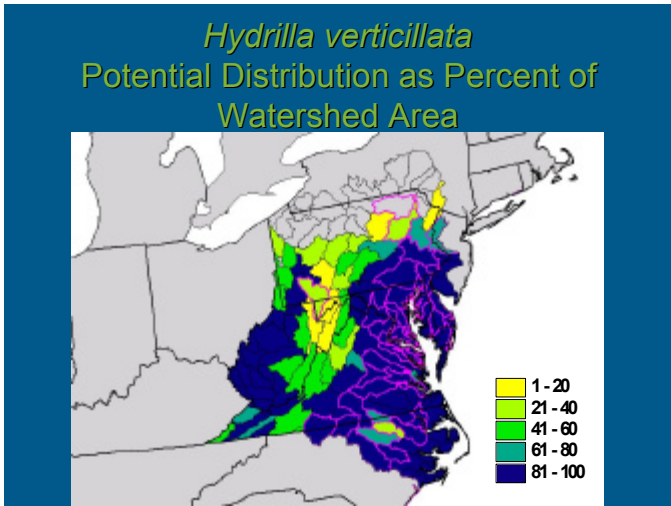
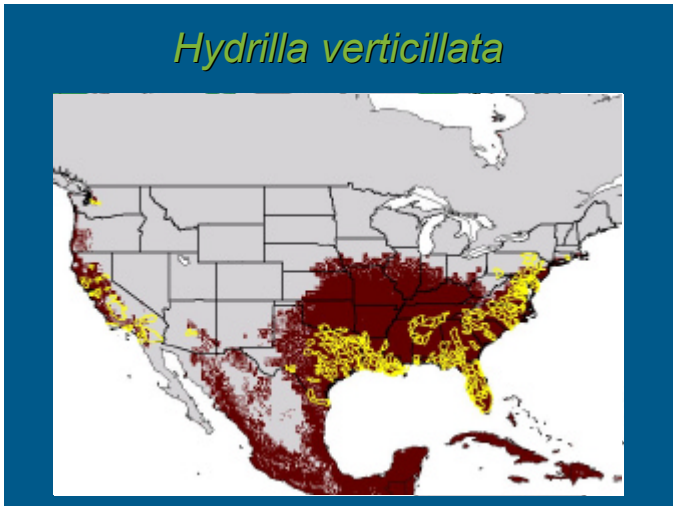
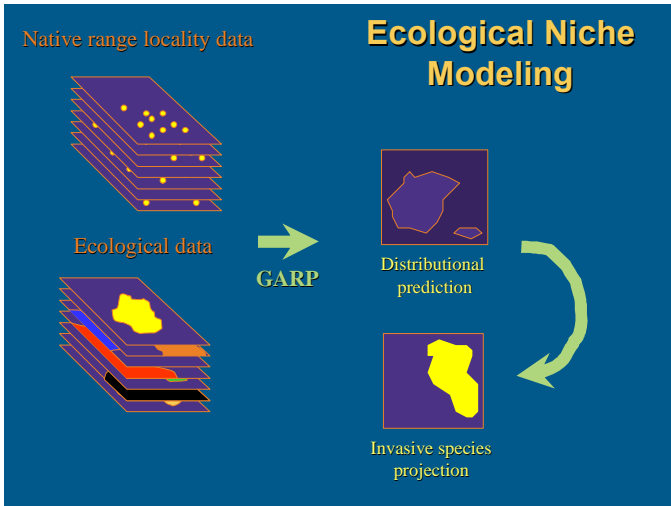


Temperature
Precipitation
Solar radiation
Snow cover
Frost-free days

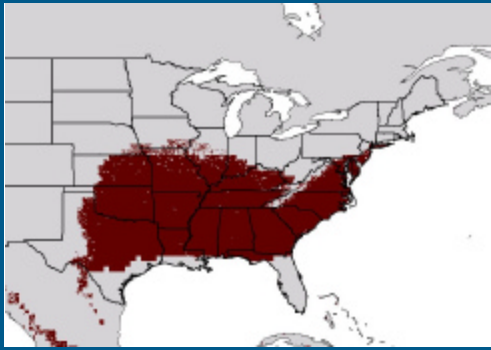
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4 r 0.53 0.86 23.58 0.51 0.314
  IF + Elev*0.32 r - Precip*0.19 r - Temp*0.10 r
  THEN Taxon=PRESENT
1 r 0.49 0.91 26.32 0.39 0.122
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  THEN Taxon=BACKGROUND
3 m 0.49 0.85 23.73 0.44 0.028
  IF Elev=[1482,3360]r AND Precip=[ 1, 4]r AND Temp=[ 2, 4]r
  THEN Taxon=PRESENT
6 d 0.49 0.86 20.90 0.33 0.019
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  THEN Taxon=PRESENT
2 d 0.49 0.85 23.78 0.44 0.013
  IF Elev=[ 0,2727]r AND Precip=[ 4, 9]r
  THEN Taxon=BACKGROUND
5 d 0.48 0.83 22.11 0.41 0.000
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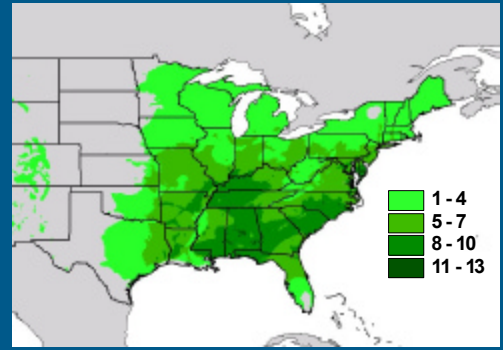
Rule set for prediction



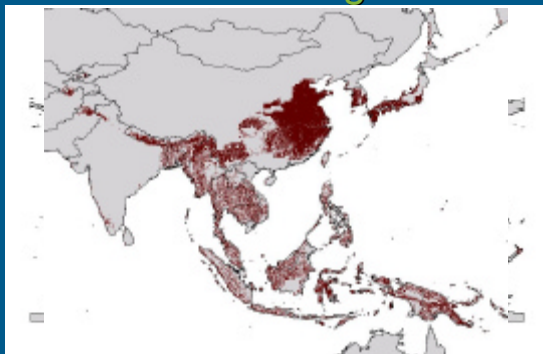
Sudden Oak Death (*Phytophthora ramorum*)



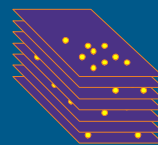
Section Lobatae Species Richness



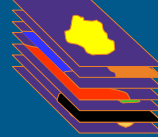
Sudden Oak Death Native Range?



Native range locality data

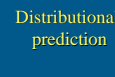


Ecological data

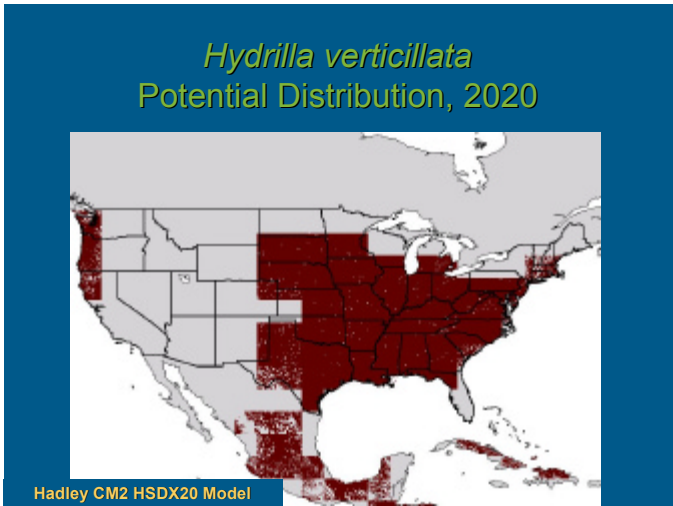
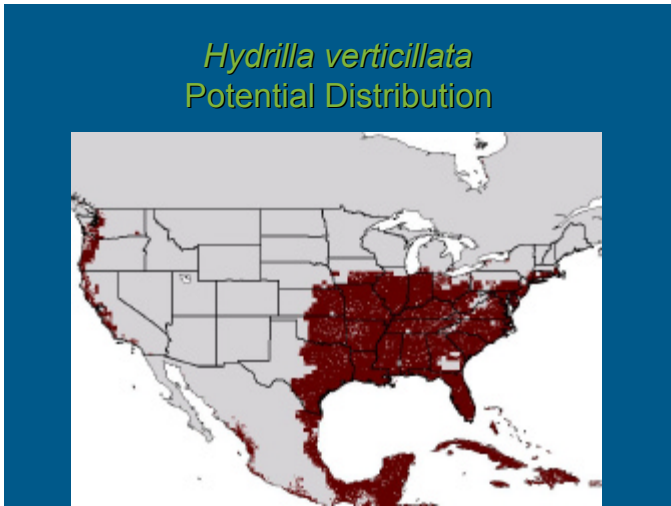
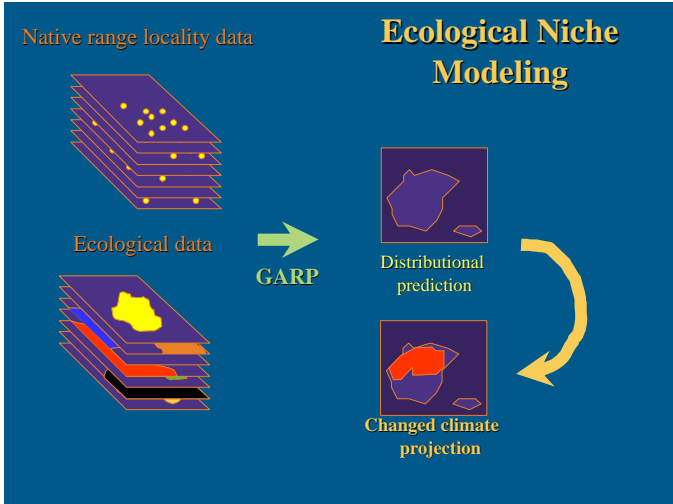
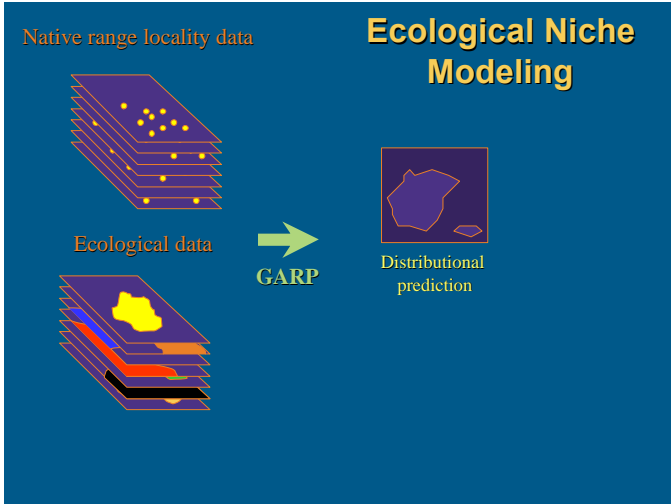


GARP

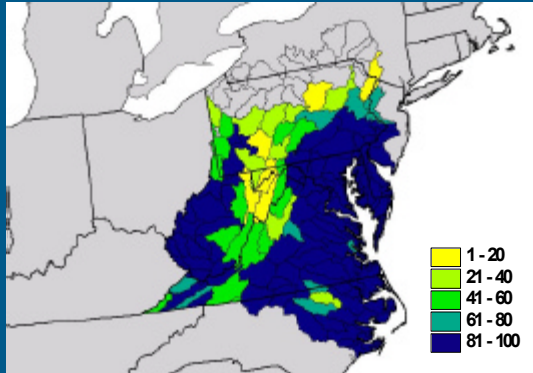
Ecological Niche Modeling



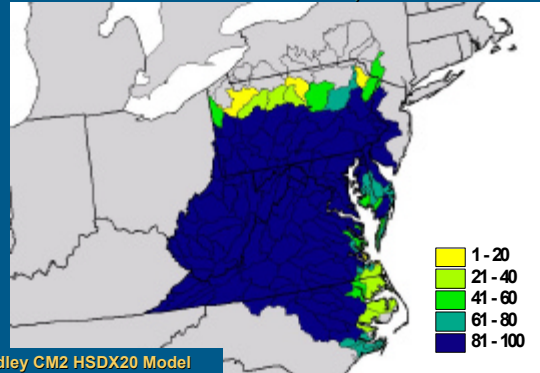
Invasive species
projection



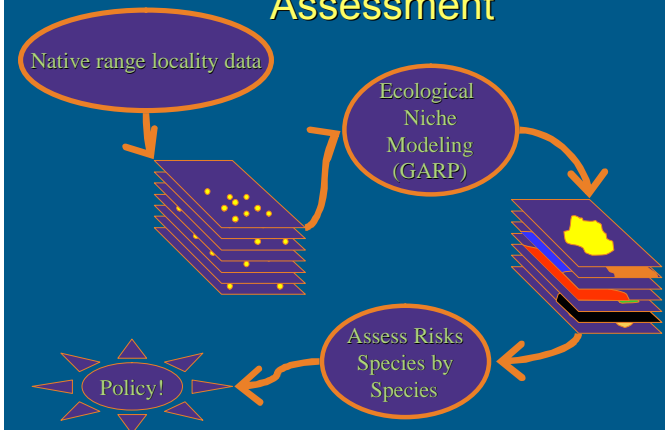
Hydrilla verticillata
Potential Distribution as Percent of
Watershed Area



Hydrilla verticillata
Potential Distribution as Percent of
Watershed Area, 2020



Invasive Species Risk
Assessment



Other Applications

- Model/predict spread of emerging diseases
- Predict and avoid environmental impacts
- Design agricultural systems to avoid pests
- Develop optimal conservation strategies
- Design species reintroduction programs

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