Software systems to help predict invasive plant establishment - A short overview

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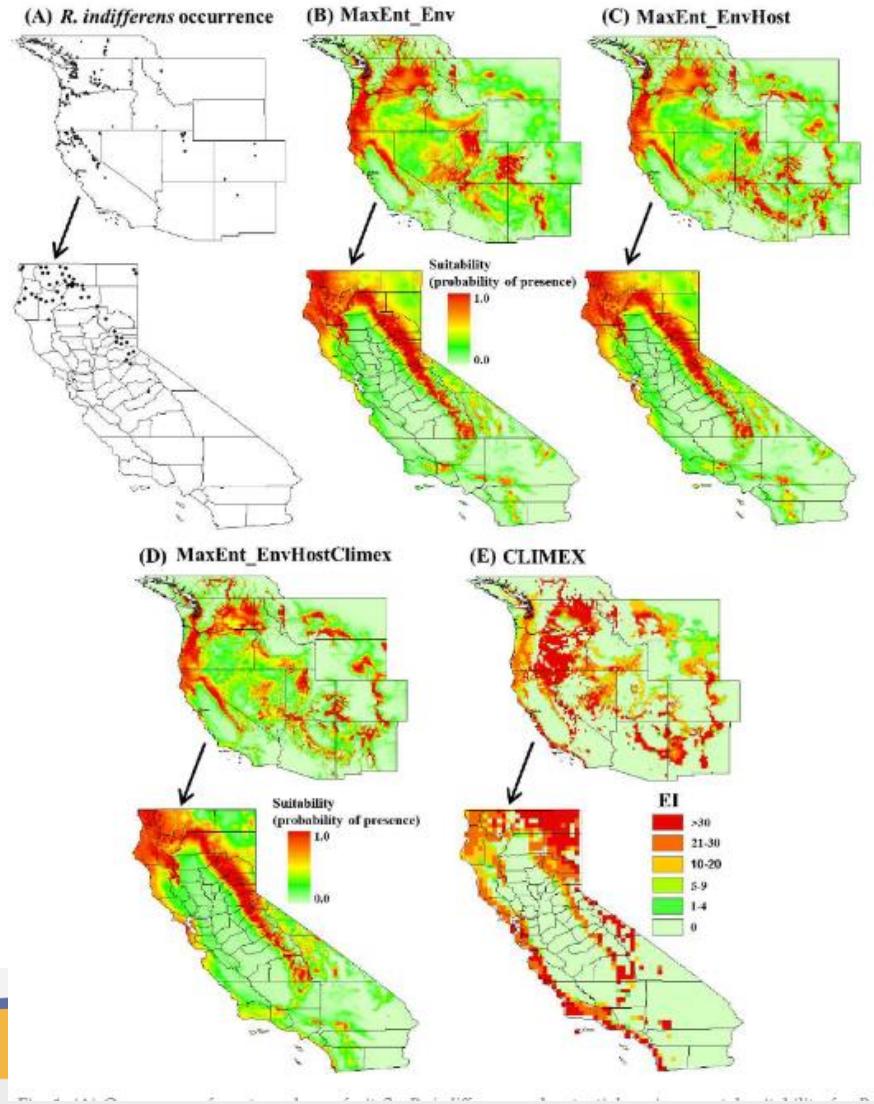


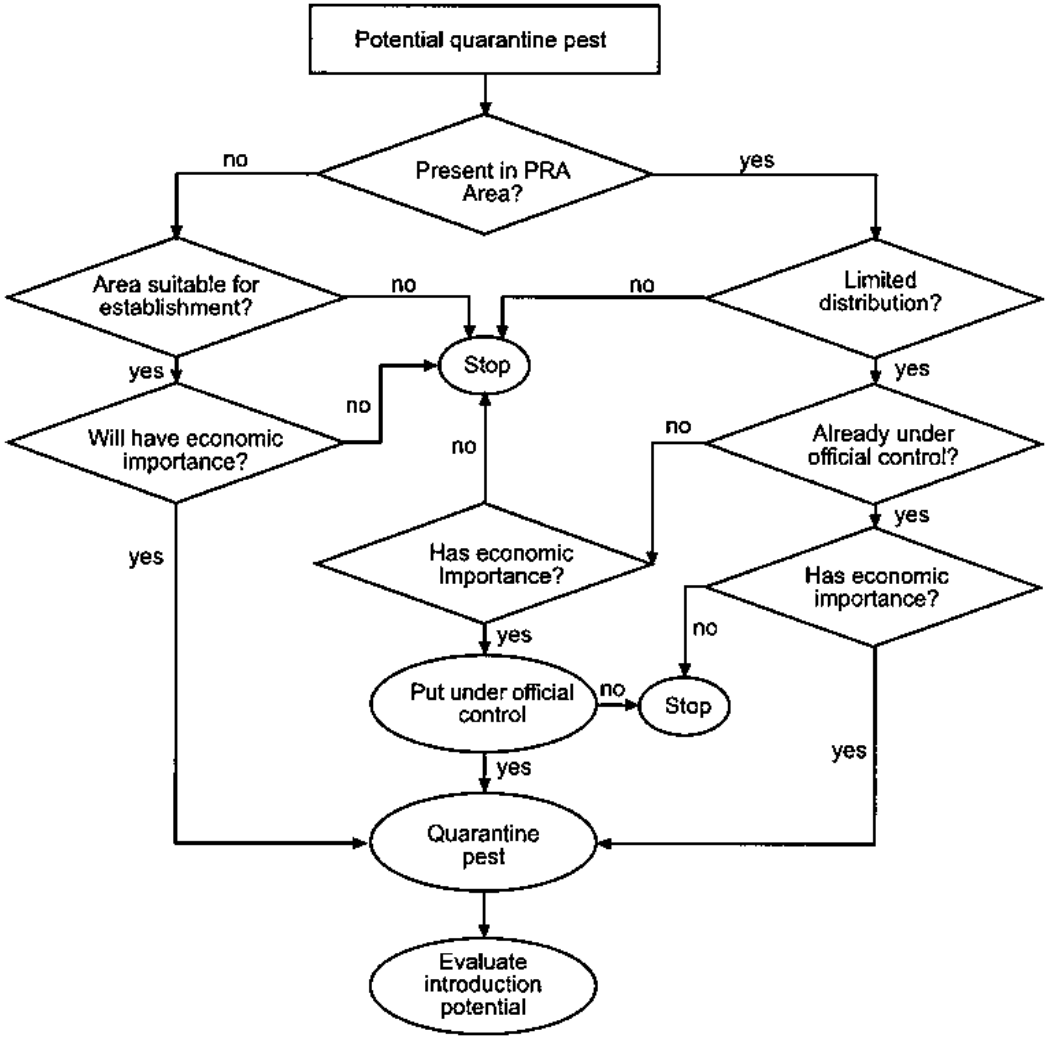
(A) Occurrence of western cherry fruit fly and potential environmental suitability predicted by (B) MaxEnt_Env, (C) MaxEnt_EnvHost, (D) MaxEnt_EnvHostClimex, and (E) CLIMEXmodels (Kumar et al. 2014)

Weed risk assessment (WRA) examines situations in which an exotic plant species has already been, or may in future be, introduced to new region

- How much of the target region is the species likely to be able to persist?
- What economic or environmental threat does this weed pose?
- Modelling is done to *assist* in decision-making.

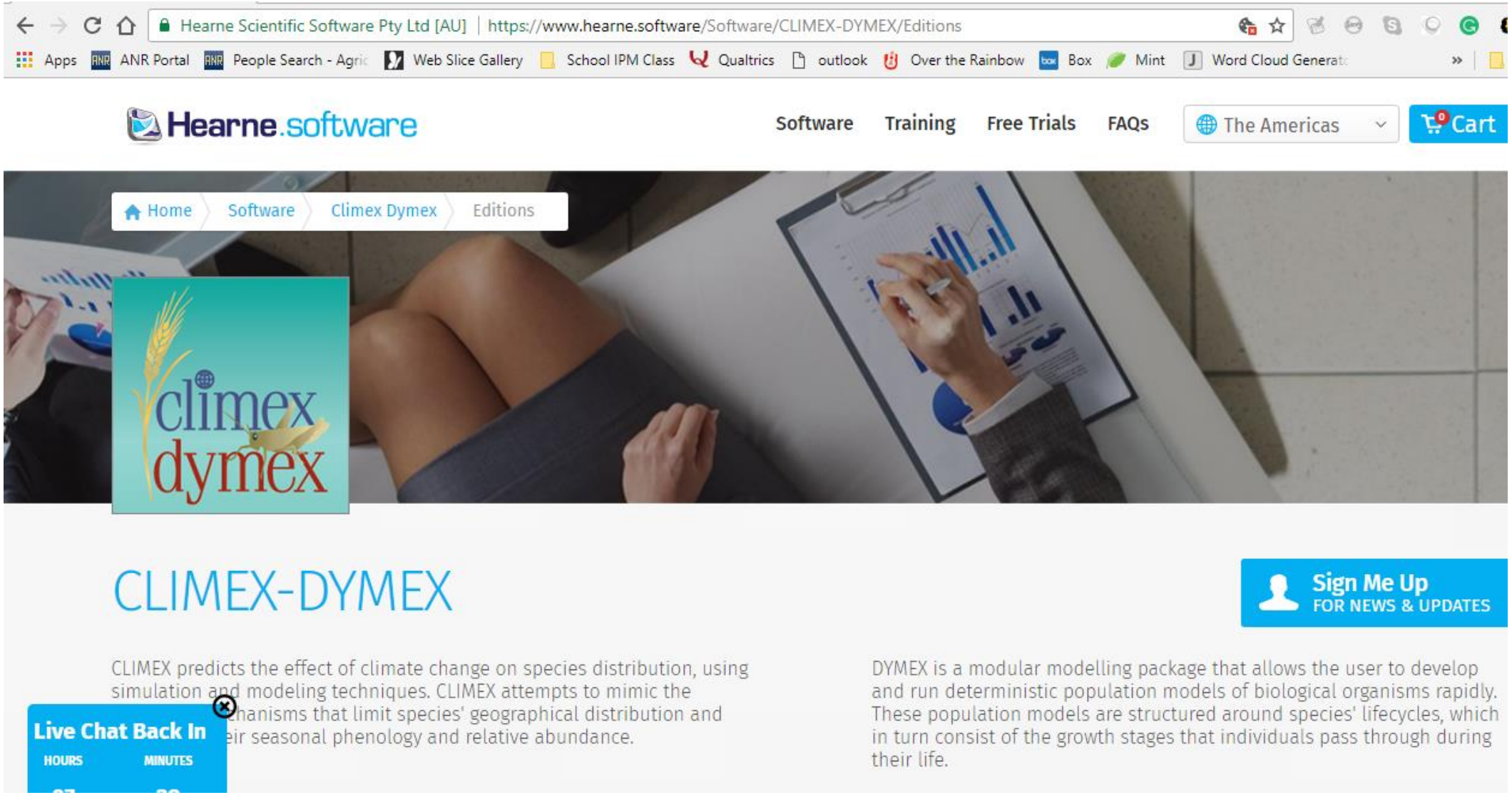
WRA Designations

Designation	Meaning
L	**Low Risk:** Not currently recognized as invasive in Hawaii, and not likely to have major ecological or economic impacts on other Pacific Islands based on the HPWRA screening process.
L (Hawai'i)	**Low Risk:** Not currently recognized as invasive in Hawaii based on a track record of not becoming naturalized despite being widely planted in Hawaii for at least 40 years.
H (HPWRA)	**High Risk:** Likely to be invasive in Hawaii and on other Pacific Islands as determined by the HPWRA screening process., which is based on published sources describing species biology and behavior in Hawaii and/or other parts of the world.
H (Hawai'i)	**High Risk:** Documented to cause significant ecological or economic harm in Hawaii, as determined from published information on the species' current impacts in Hawaii.
EVALUATE	The species has been assessed using the HPWRA system; however, no assessment of risk can be provided at this time because 1)important information is missing from the assessment or 2)the species possesses a combination of traits and characteristics that make its behavior difficult to assess using the WRA system.



Several computer-based systems that can assist in estimating the likely environmental suitability of a new environment

- Climate matching – CLIMEX, CLIMATE
- Observations/Georeferenced data - MAXENT
- Herbaria records - CLIMATE ENVELOPE, GARP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Apps
ANR Portal
People Search - Agric
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FOR NEWS & UPDATES
CLIMEX predicts the effect of climate change on species distribution, using simulation and modeling techniques. CLIMEX attempts to mimic the
hanisms that limit species' geographical distribution and
eir seasonal phenology and relative abundance.
DYMEX is a modular modelling package that allows the user to develop and run deterministic population models of biological organisms rapidly. These population models are structured around species' lifecycles, which in turn consist of the growth stages that individuals pass through during their life.
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HOURS
MINUTES

CLIMEX attempts to mimic the biological mechanisms that **limit** species' geographical distribution and determine their seasonal phenology and relative abundance.

- Matches climate suitability based on species' ecological parameters for growth and development.

Compare Locations

- Matches climate patterns when only a bare minimum (or nothing) is known about a species' distribution. The 'weakest' form of analysis.

Match Climates

- Uses inter-annual weather variability to examine the species' phenology for a single location.

Compare Years

CLIMEX

- **Compare Locations or Compare Years options**
  - "Growth Index" (GI) = potential for growth of a population during the favorable season
  - “Stress indices” (Cold, Hot, Wet and Dry) = the probability of the population surviving through the unfavorable season.
  - GI and Stress Indices combined into an "**Ecoclimatic Index**“ **(EI)** = overall measure of favorableness of the location or year for a species. The results can be presented as tables, graphs or maps.

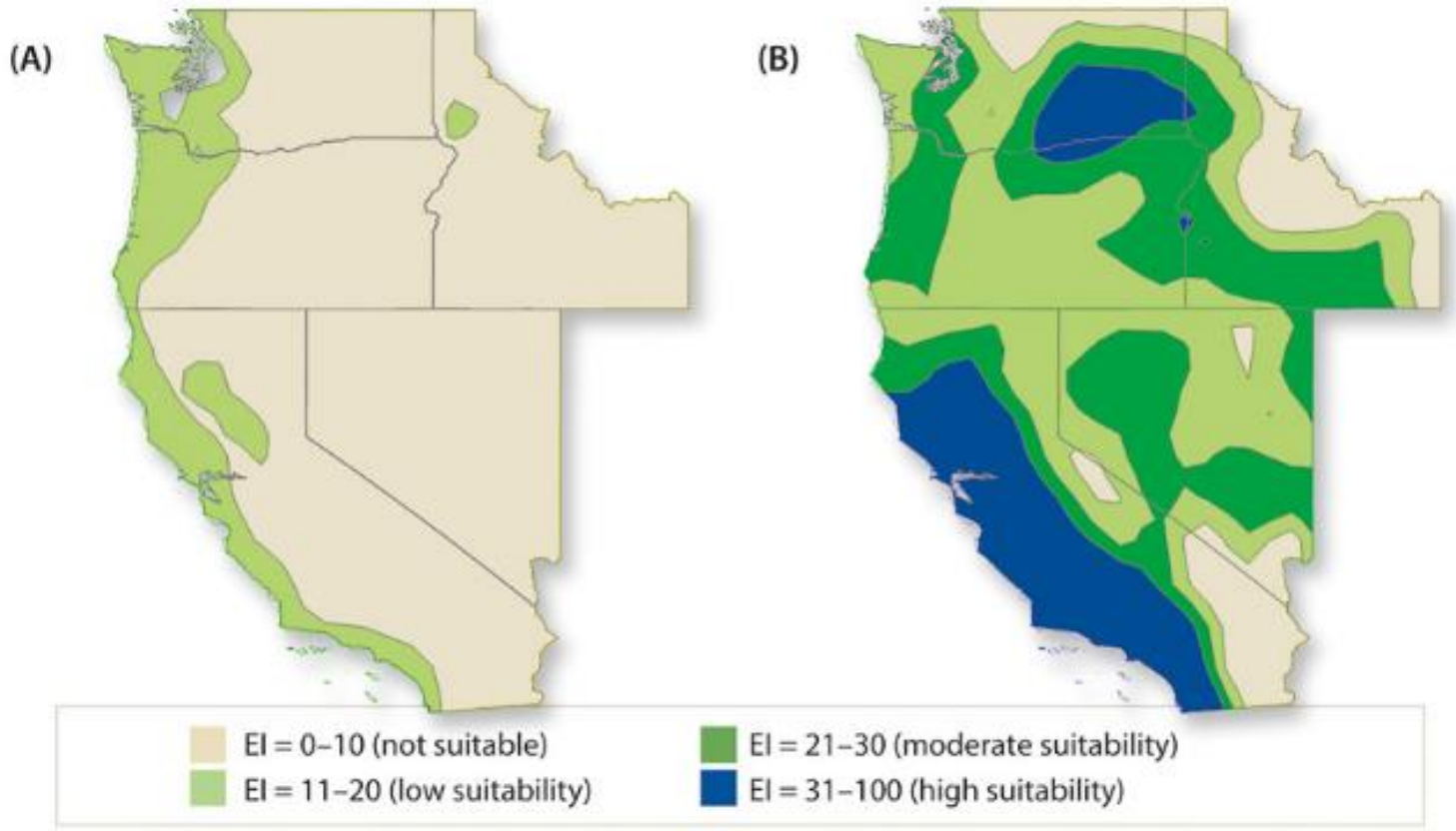
- **Climate-matching function that *can be used in the absence of any knowledge of the distribution of a species*.**
  - Identifies sites with similar climates for targeting collection and release sites, or for assessing risks from exotic species.
  - Can select variables for modeling (e.g., temperature) or to choose particular months that need to be used in a comparison (e.g., summer months in temperate zones).

For switchgrass cultivated as biofuel in California, invasiveness limited by several steps

Joseph DiTomaso, Jacob Barney, J. Jeremiah Mann, Guy B. Kyser

CalAg

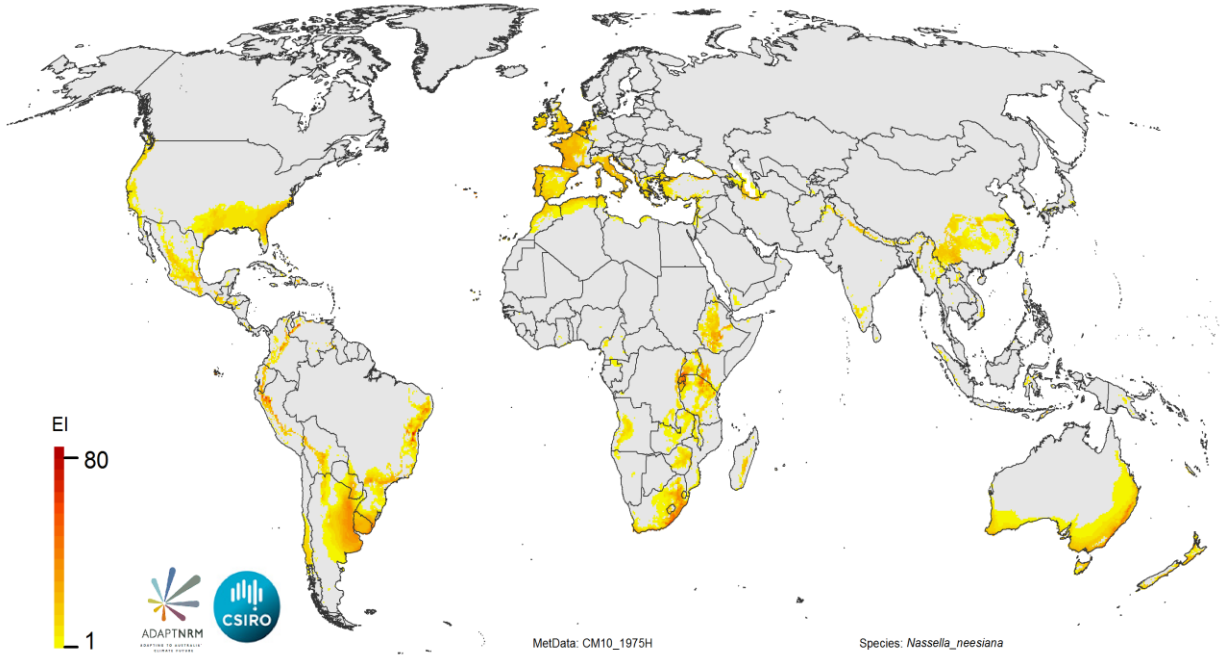
Can adjust parameters such as soil moisture, temperature for simulation. Can make “movies” showing seasonal or yearly variability.

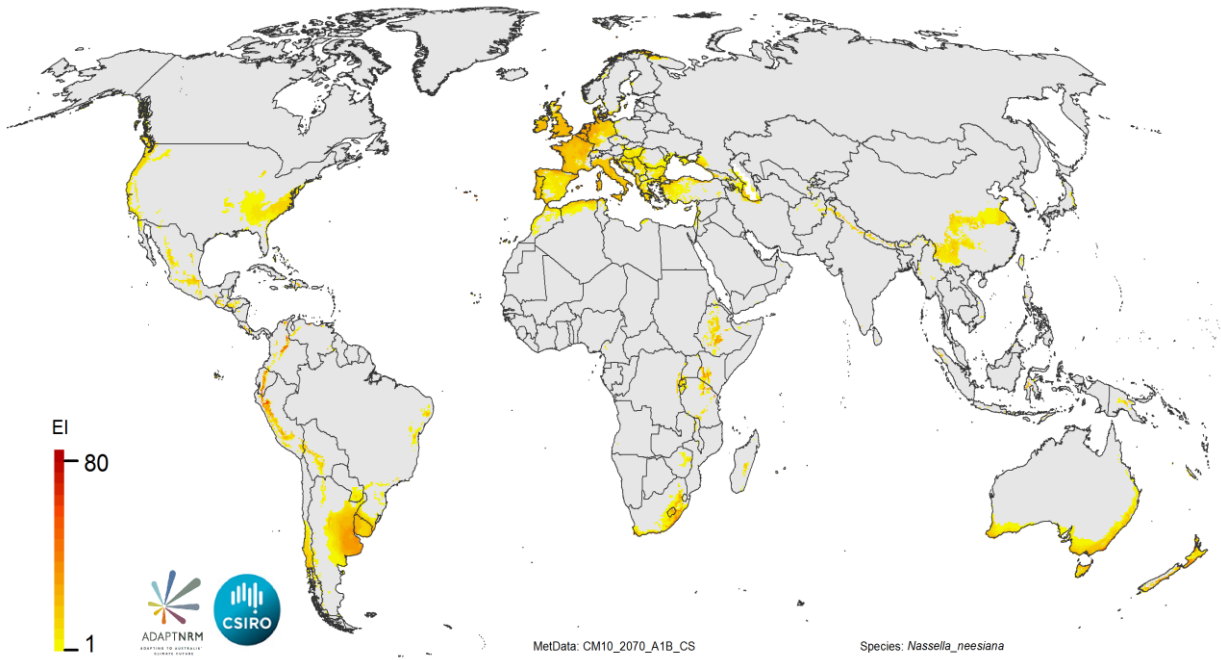


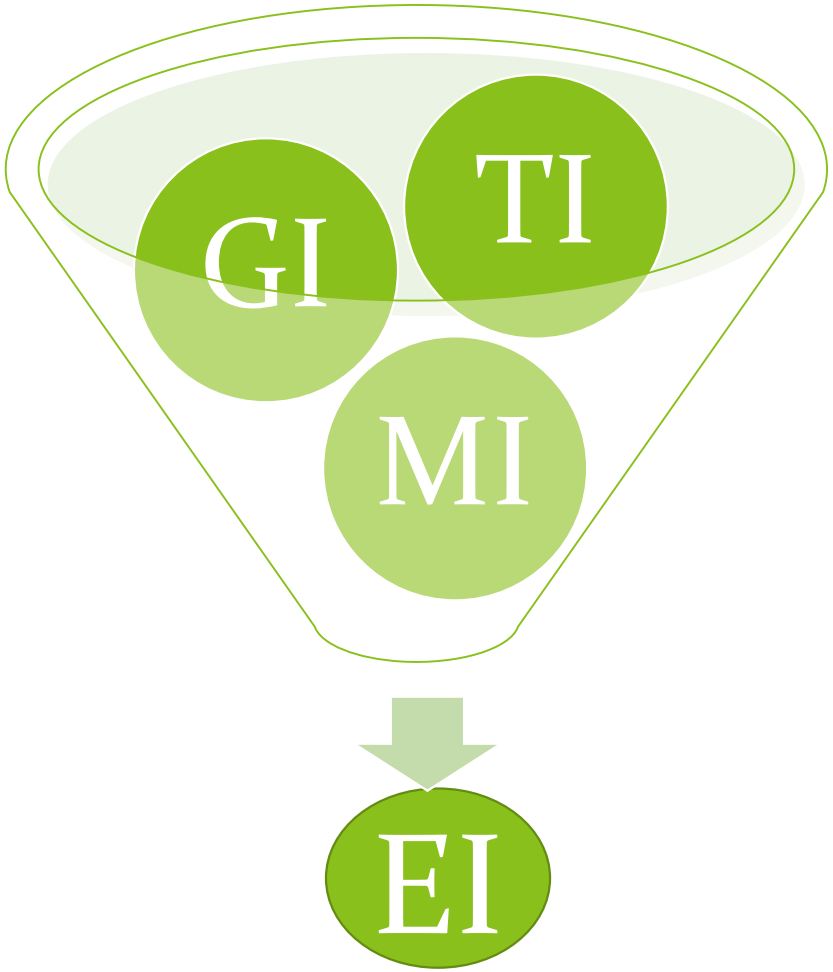
[View Enlargement]

Fig. 2. CLIMEX climate-matching results for switchgrass based on climate preferences estimated for (A) the nonnative range of the western United States and for (B) the nonnative range of the western United States assuming yearlong access to water (e.g., land along a stream or land that is irrigated). The colors represent CLIMEX ecoclimatic index values (EI; 0–100), where higher numbers represent a more suitable environment (see figure legend) (Barney and DiTomaso 2011).

Nassella neesiana 1975 vs 2070

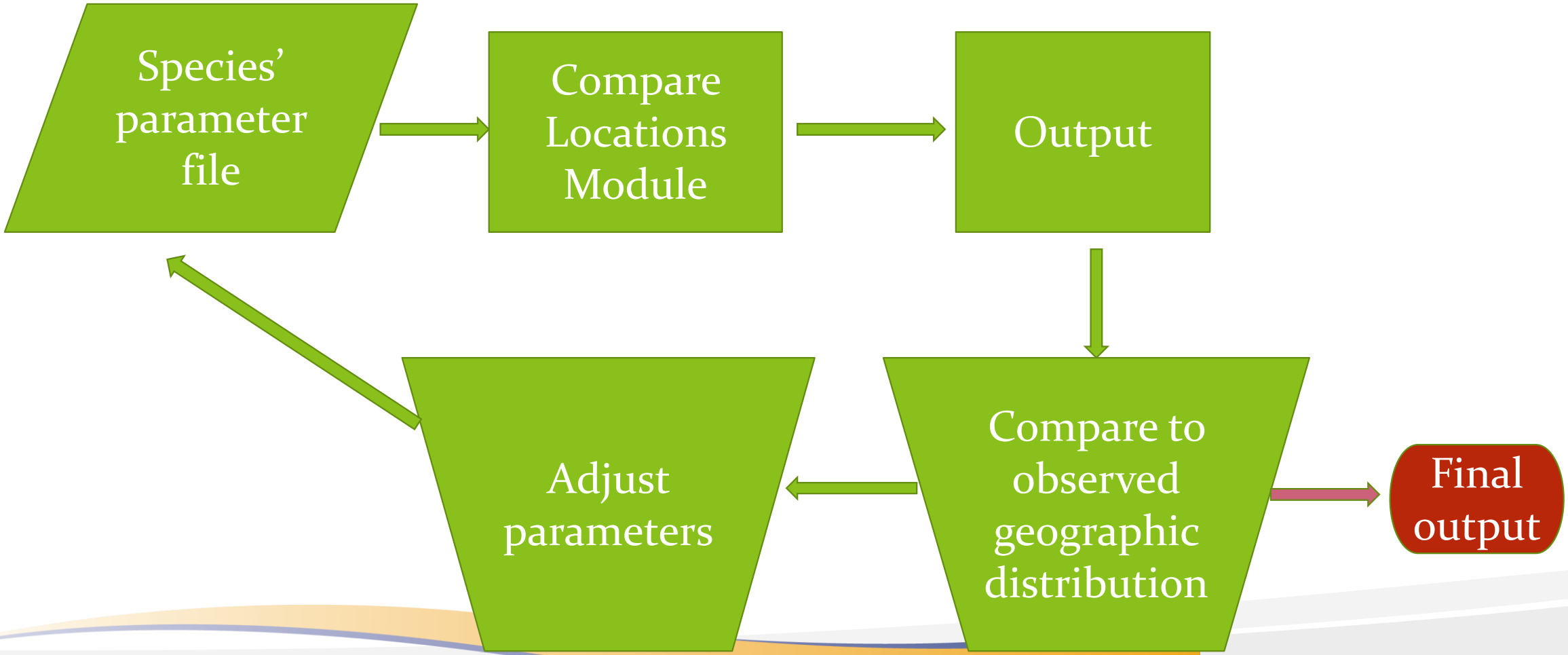






- Seasonal population growth (GI)
- Stresses (cold, hot, wet and dry) that limit the species' geographical distribution (TI, MI)
- Overall annual index of climatic suitability, the ecoclimatic index (EI)
  - 0=no match, 100=perfect match
  - 20-50 is usually enough to support

GIGO: A species' behavior in a CLIMEX simulation depends on the parameter values.



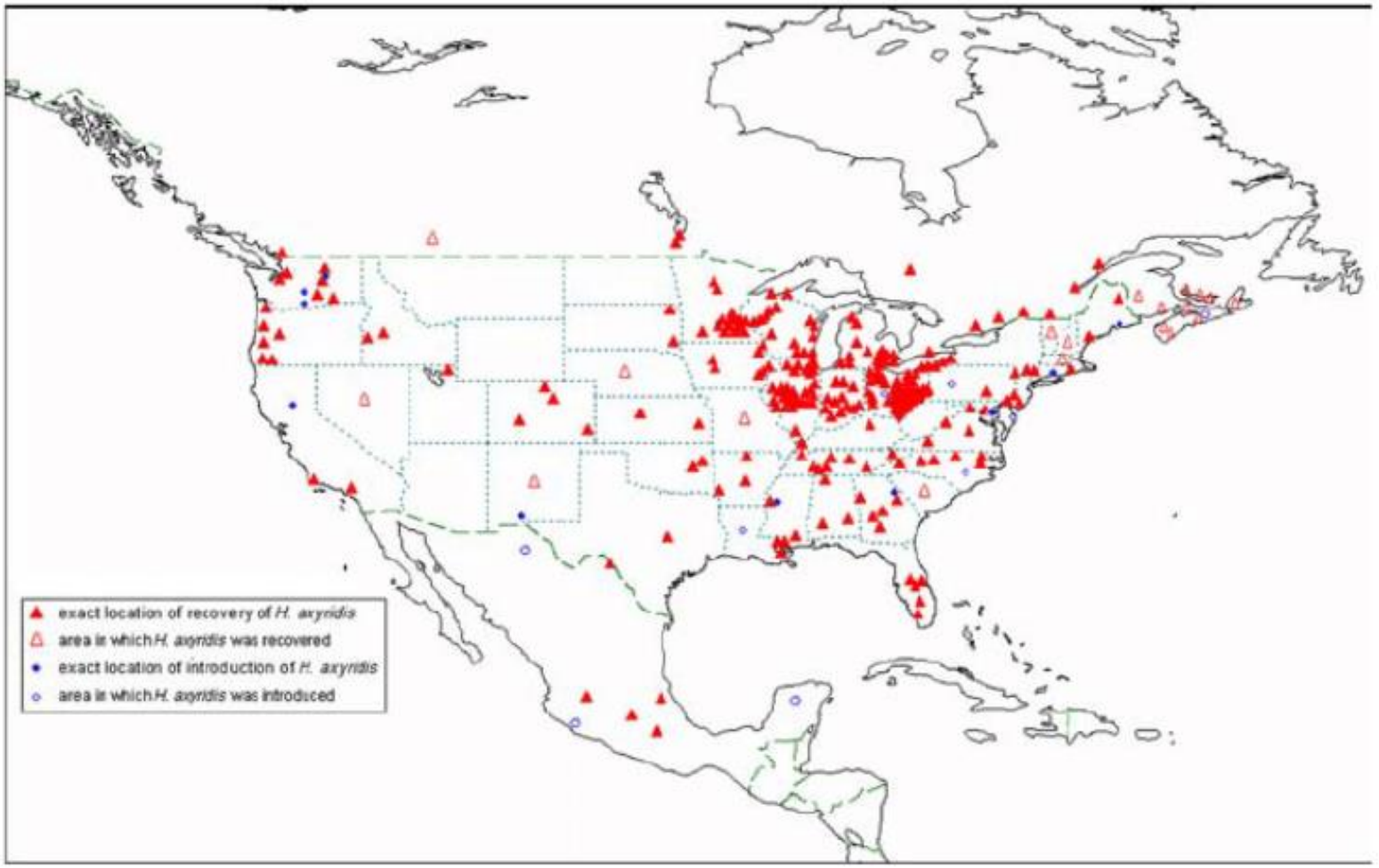
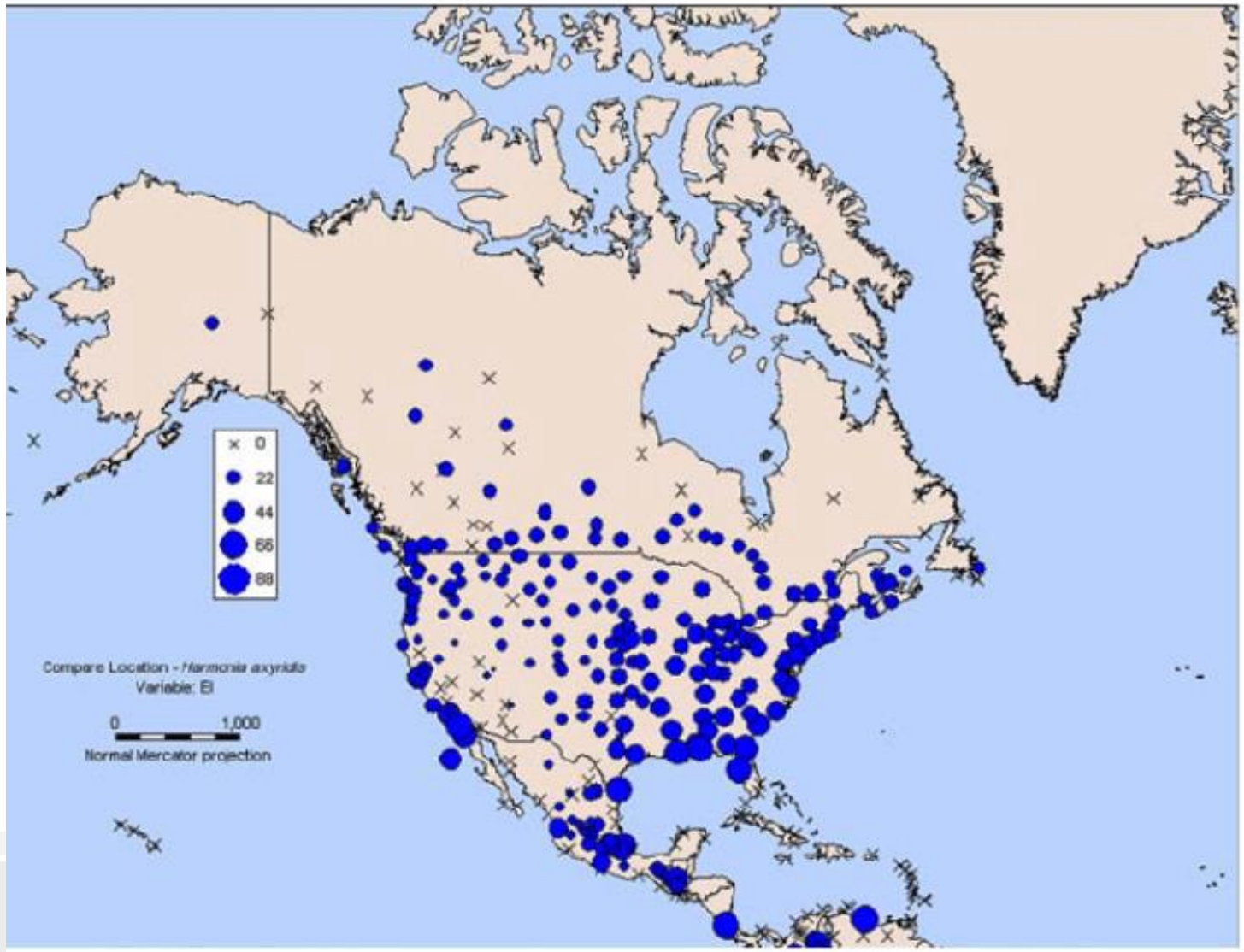


Fig. 5 Distribution of *Harmonia axyridis* in North America (based on CABI/EPPO 2007, and Koch et al. 2006)



Maximum Entropy MaxEnt

- Useful when complete information is not available
  - Model all that is known: satisfy a set of constraints that must hold
  - Assume nothing about what is unknown
- Bias
  - assumption that species occurrence data are unbiased

MaxEnt is statistical - provides probability distributions.

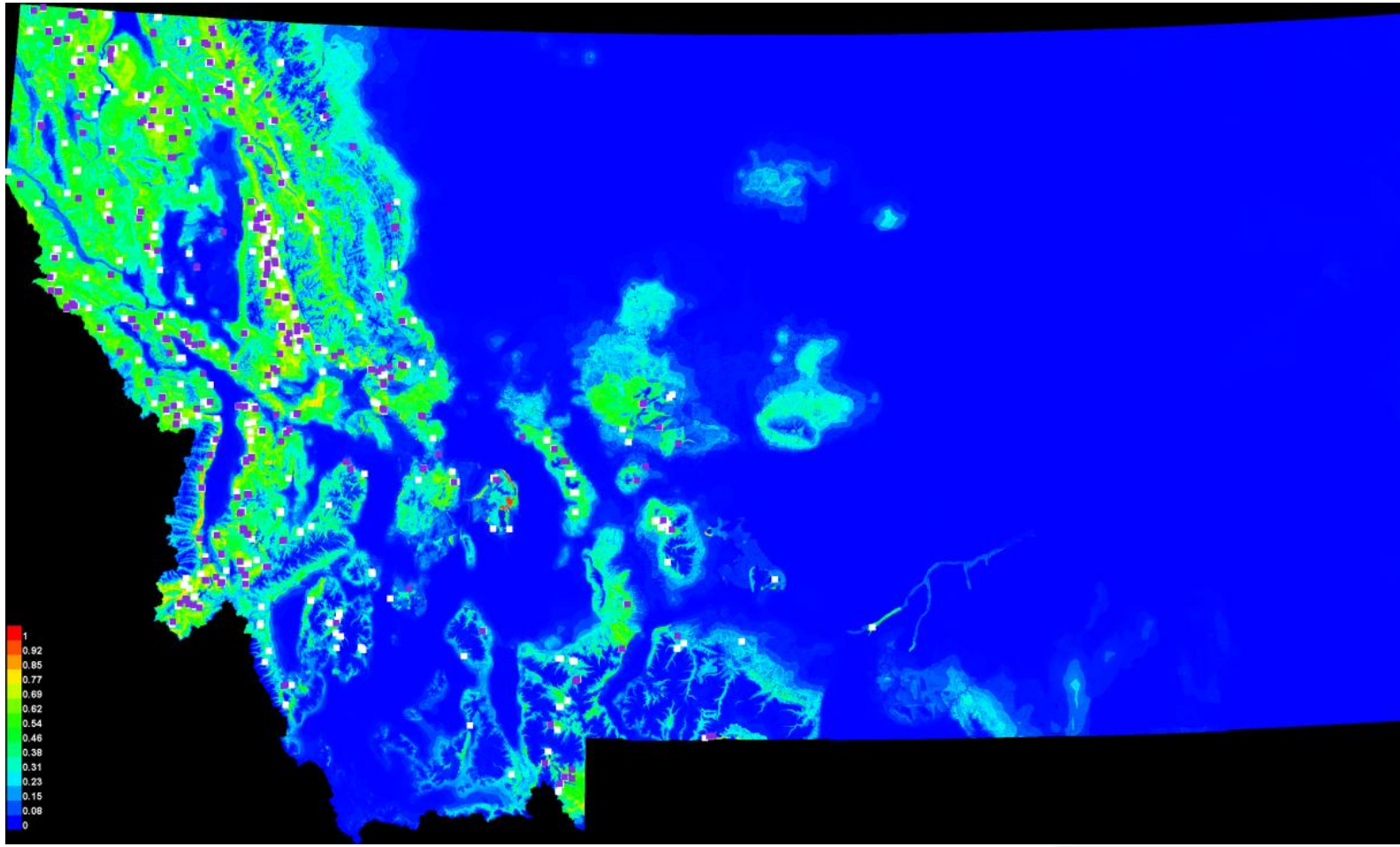
Download & Install MaxEnt

- http://biodiversityinformatics.amnh.org/open_source/maxent/
- FREE
- Tutorials and help like
  - Modeling Species Distribution with MaxEnt
  - ftp://gisportal.mt.gov/Maxell/Models/Predictive...for.../scottsPresentation.ppt

Logistic Ouput

High probability of suitable conditions

Low predicted probability of suitable conditions



MaxEnt

Advantages:

- uses presence occurrence data only
- can consider interactions between environmental variables
- potential to investigate the influence each environmental predictor has on the elements distribution
- relatively easy to run, stand alone software
- seems to perform relatively well with small sample sizes of occurrence data

Disadvantages:

- no procedure for variable selection
- need fast processor/more ram
- limited experiments investigating potential weaknesses when dealing with biased sampling