A BAYESIAN BELIEF NETWORK TO PRIORITIZE CONSERVATION NEED AMONG DIVERSE AQUATIC TAXA

Given resources to conserve few species, which do you choose?

INVESTIGATORS

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How do you decide?

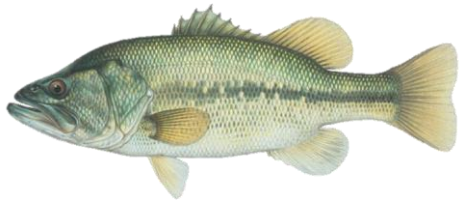
WHAT TO CONSERVE?

- Conservation – maintenance of "representative" biodiversity
- Financial resources are limited
  - Need to prioritize geographic areas, species, or populations
- Several conservation-prioritization frameworks exist:
  - Similar biological criteria & known threats
  - Identify most vulnerable and irreplaceable taxa (extinction risk)

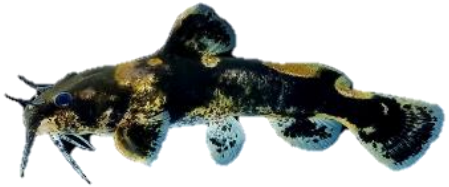
Sensitivity to:

Demographic stochasticity

Environmental stochasticity



Low risk



High risk

NEED FOR A NEW APPROACH

- No universally applicable conservation prioritization tool
  1. Unable to represent uncertainty
  2. Unknown sensitivity to biological criteria
  3. High resource & labor demands

- Aquatic taxa feature especially poorly in existing models
  - Relatively understudied worldwide
  - Often excluded despite potential conservation significance
  - IUCN issues

Data Deficiencies

46% of Chondrichthyes

44% of Upper Yangtze River species

~32,000 fish species are unassigned

BAYESIAN BELIEF NETWORK

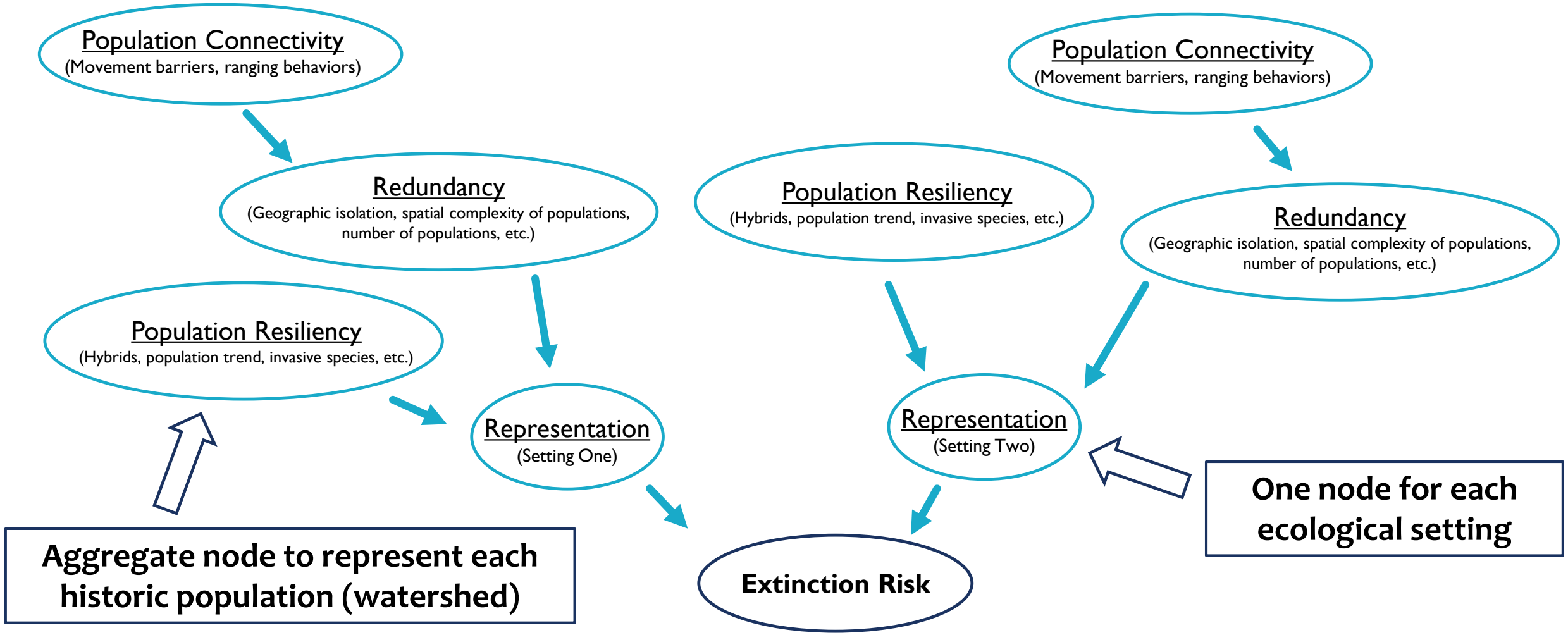
- Objective: Use a Bayesian network analysis to identify fishes in need of conservation attention
  - Consistent with the concepts of redundancy, resiliency & representation (US Fish and Wildlife Service)
  - Collectively predict species' extinction risk
- Improvements to future status assessments:
  1. **Uncertainty**
     - Method to assess potentially rare but poorly known taxa
  2. **Spatial scale**
     - Applicable at different administrative & geographic scales
  3. **Sensitivity to specific biological criteria**
     - Identify components driving status designation

EXTINCTION RISK

- Modeling extinction risk:
  - Accessible biological data (i.e. life history, ecological traits, museum databases)
  - Well-known threats
  - Transparent and defensible species assessments

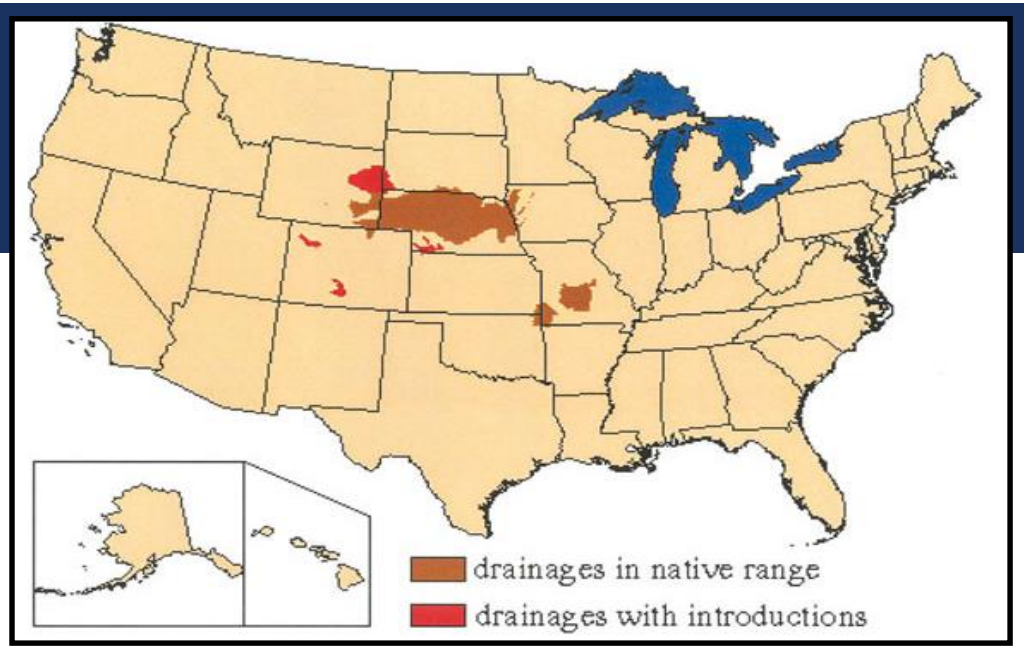
- Species with low risk (3Rs):
  - Redundancy - Replicate populations
  - Population resiliency - Genetically robust and demographically stable
  - Representation: Distributed throughout the full historic range of ecological settings in which the species evolved

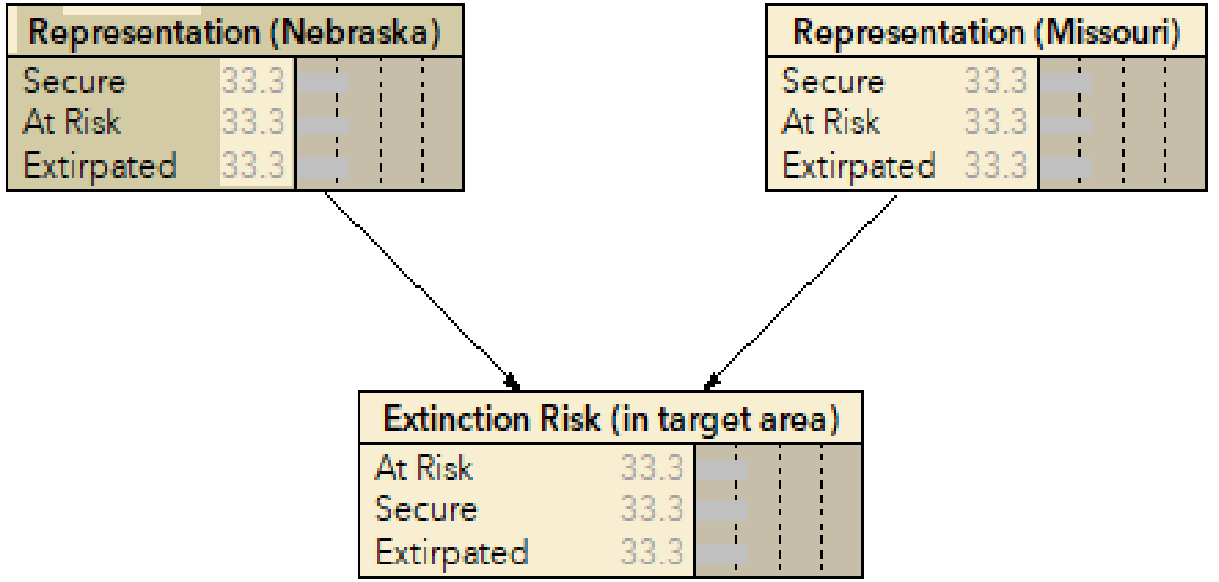
BASIC MODEL STRUCTURE



REPRESENTATION

- The ability to adapt to changing environmental conditions over time
  - Adequate: Extant populations are distributed across the full array of significant ecological settings
  - Protects local adaptations and genetic diversity
- Number of nodes = Number of unique ecological settings
  - Significant ecological, genetic, or life-history variation
  - Spatial population separation

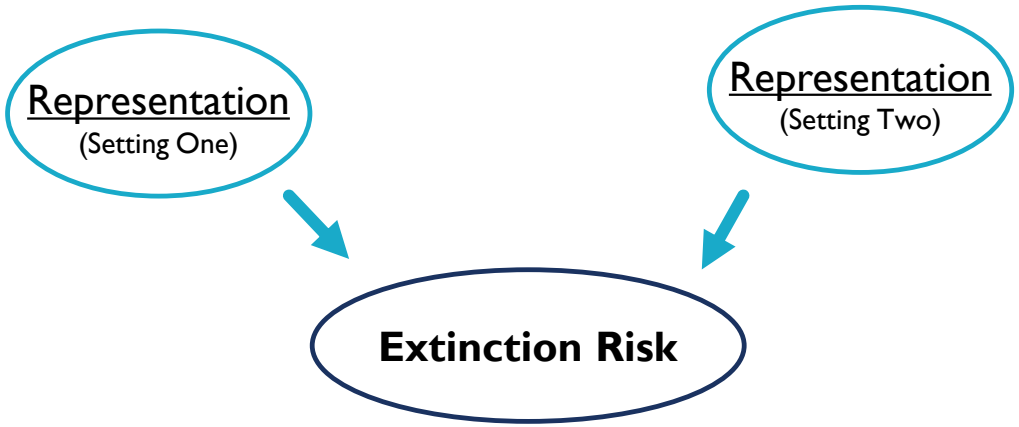


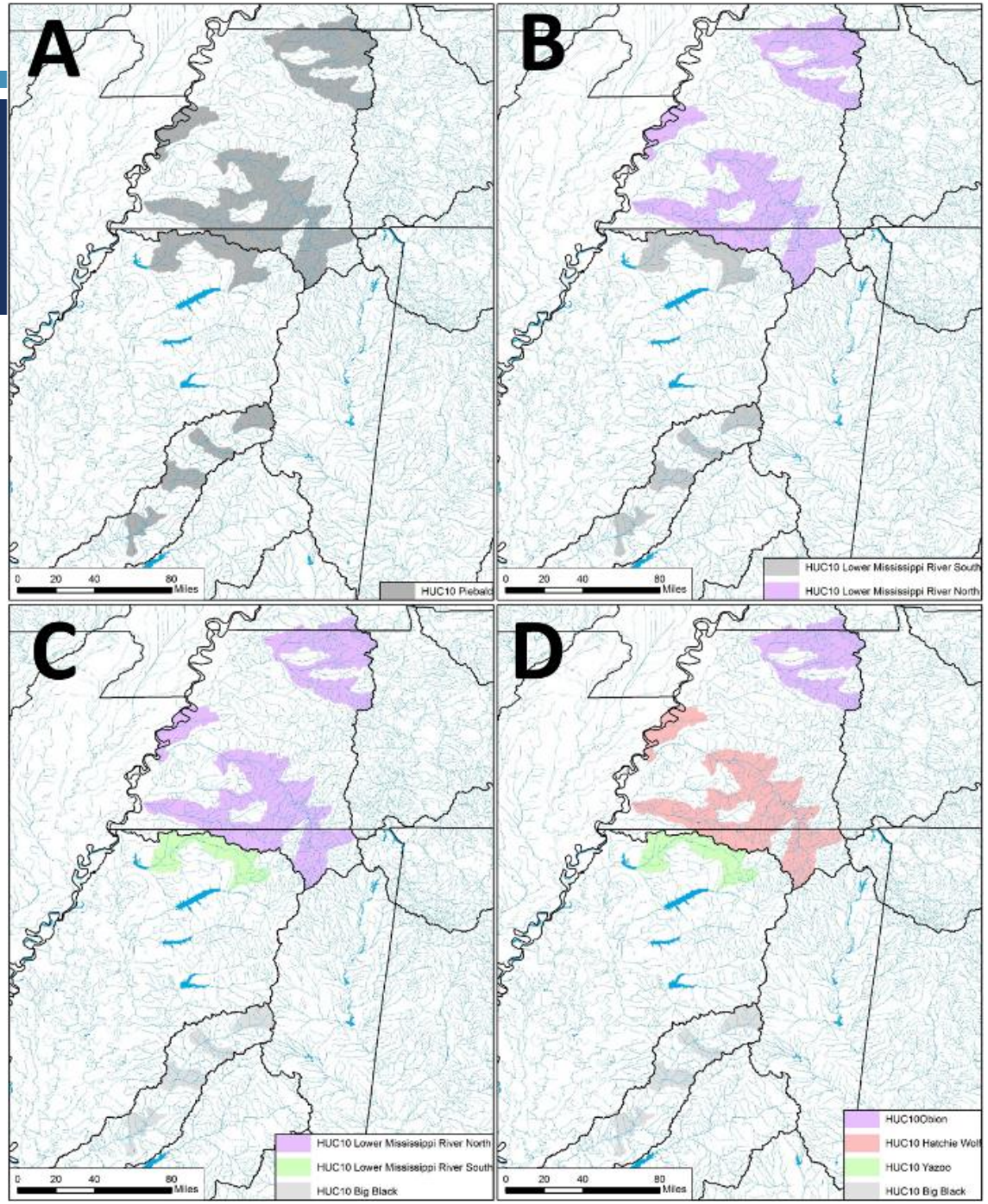


EX. EXPERT ELICITATION

- Piebald Madtom – federal candidate species
  - Identifying number & distribution of ecological settings
  - Soliciting input from species experts

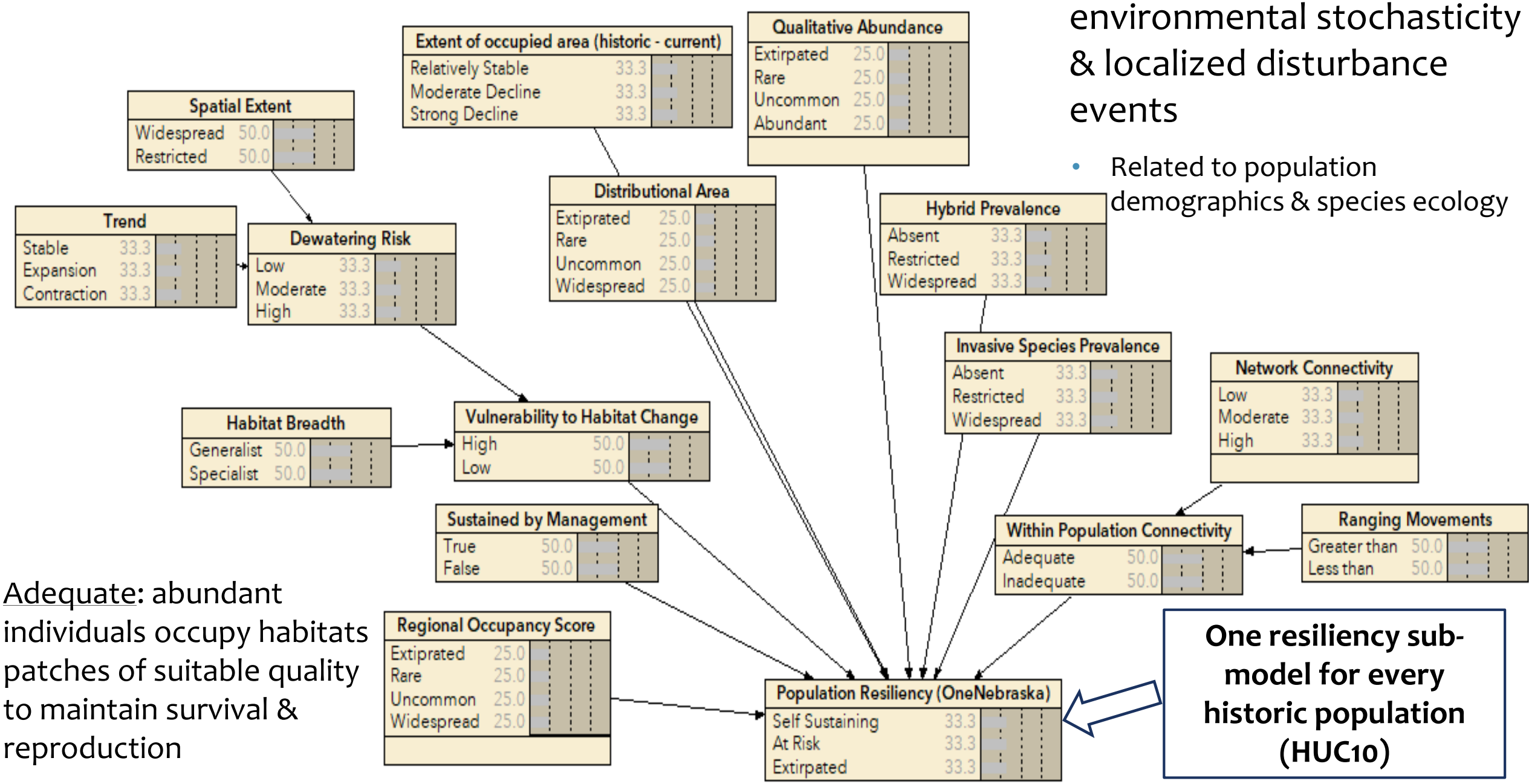
How many nodes?





POPULATION RESILIENCY

- The ability to withstand environmental stochasticity & localized disturbance events
  - Related to population demographics & species ecology

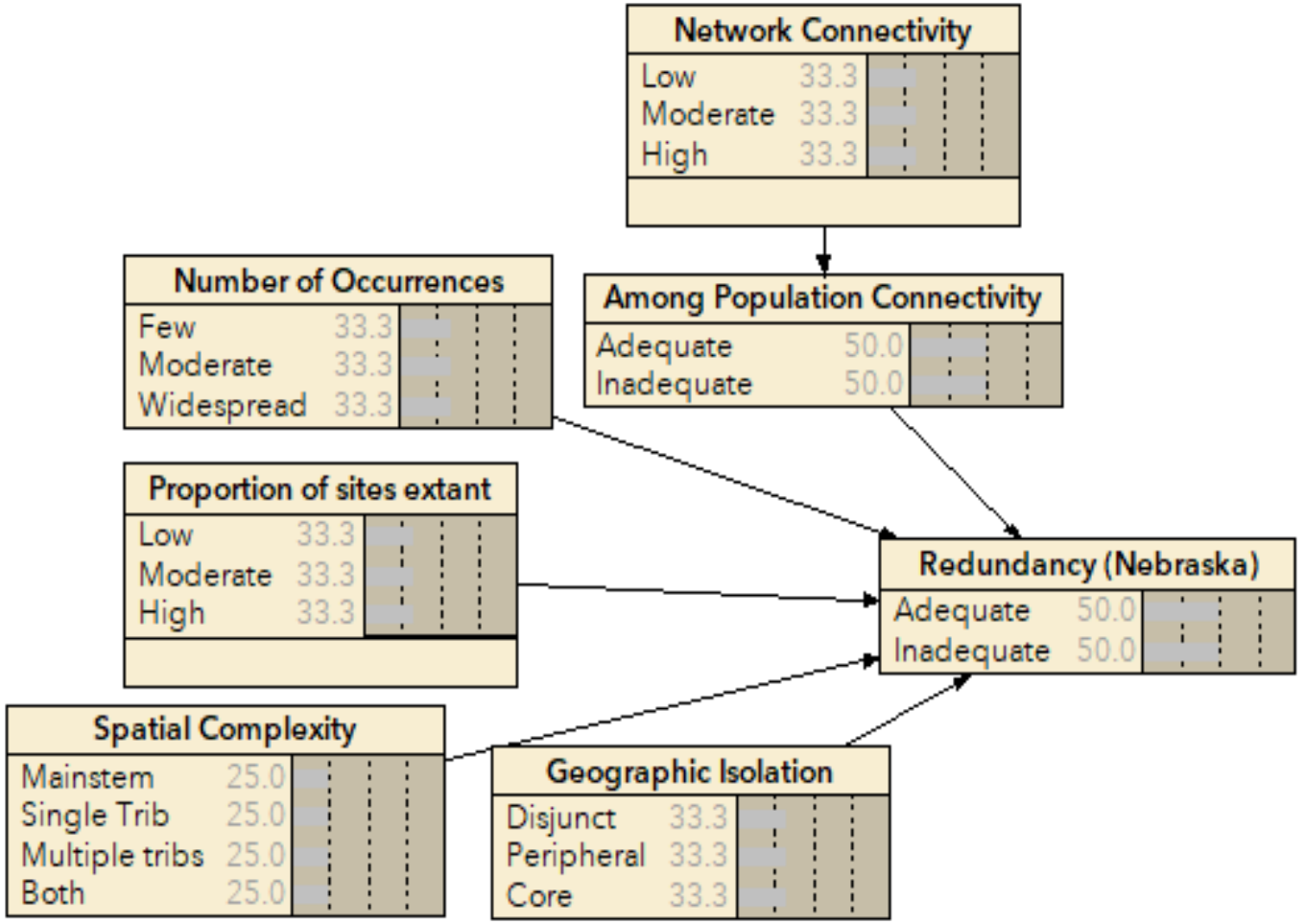


Adequate: abundant individuals occupy habitats patches of suitable quality to maintain survival & reproduction

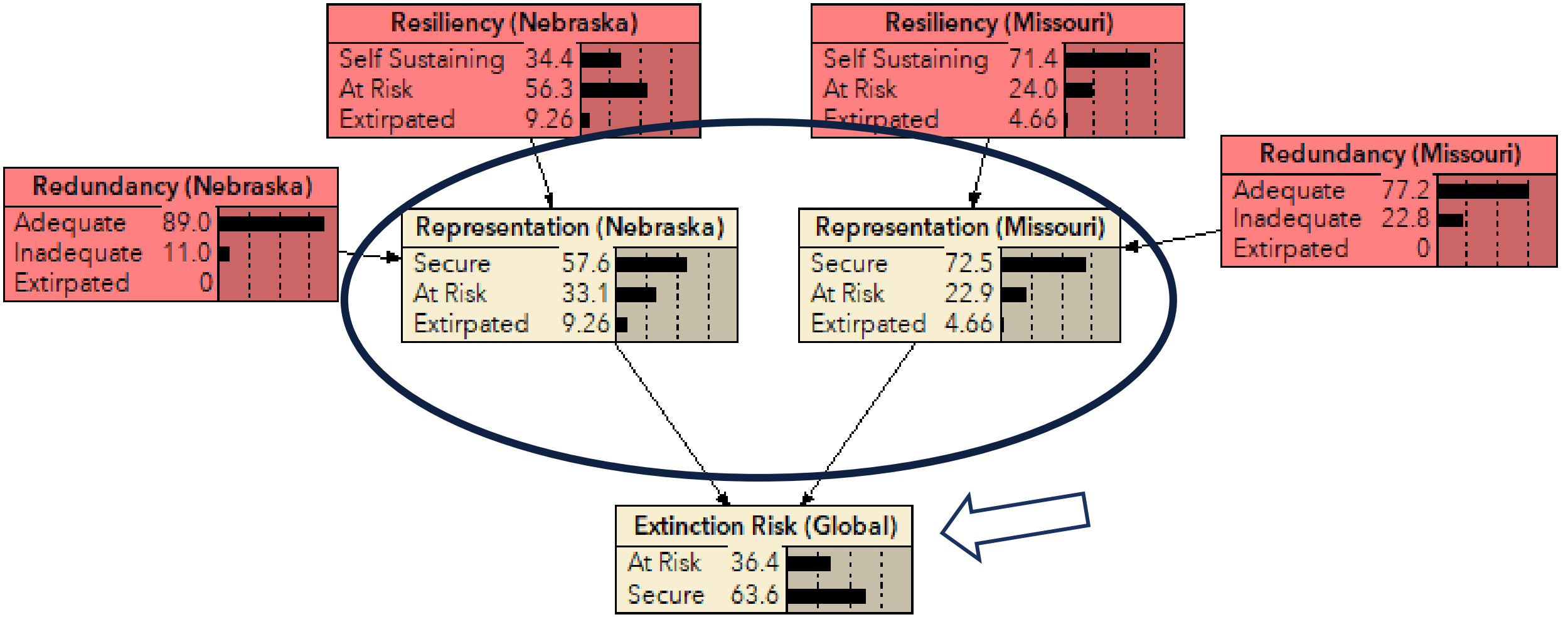
One resiliency sub-model for every historic population (HUC10)

REDUNDANCY

- The ability to withstand catastrophic events
  - Related to the number, distribution & connectivity of populations
  - Adequate: risk is spread among multiple, connected populations

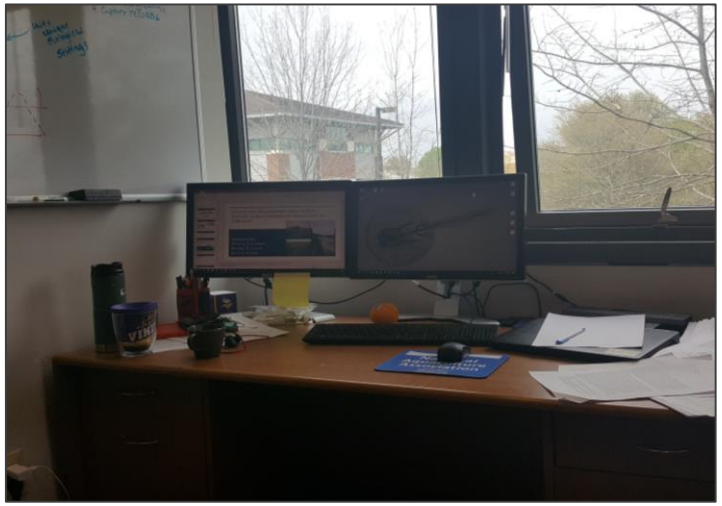


JUST FOR FUN…


Resiliency (Nebraska)
Self Sustaining 34.4
At Risk 56.3
Extirpated 9.26
Resiliency (Missouri)
Self Sustaining 71.4
At Risk 24.0
Extirpated 4.66
Redundancy (Nebraska)
Adequate 89.0
Inadequate 11.0
Extirpated 0
Representation (Nebraska)
Secure 57.6
At Risk 33.1
Extirpated 9.26
Representation (Missouri)
Secure 72.5
At Risk 22.9
Extirpated 4.66
Redundancy (Missouri)
Adequate 77.2
Inadequate 22.8
Extirpated 0
Extinction Risk (Global)
At Risk 36.4
Secure 63.6

PRIORITIZING CONSERVATION EFFORTS

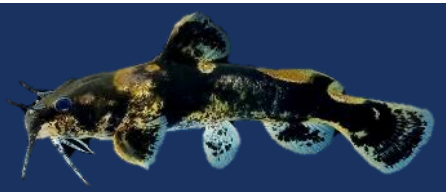
- A new tool to identify species needing conservation attention
  - Addresses concerns about risk assessments when applied to aquatic species
    1. Uncertainty – poorly known species & data limitations
    2. Spatial scale – any spatial or administrative scale
    3. Straightforward parameterization & prompt decision
  - Broad applicability to diverse aquatic taxa



No more "echo chamber"

Moving forward:

- Further validation of the model structure
  - Federal partners assessing assigned & petitioned aquatic taxa
  - Training the model using species designated by USFWS



Piebald Madtom