Development of MCnest v3.0 for Population Level Risk Assessment for Birds

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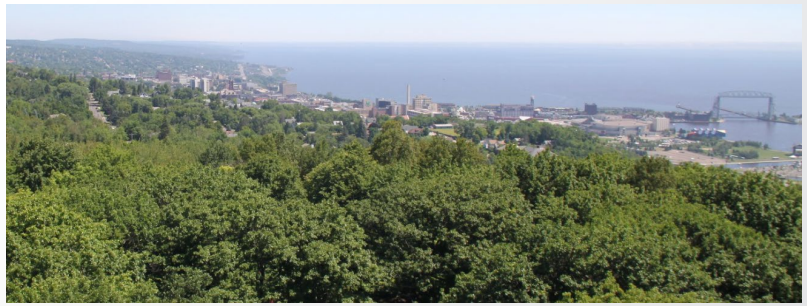


50 years of population level risk assessment?

- We're still talking about how to do population level risk assessment
- And talking
- And talking
- Maybe it's harder than we thought…?

REPORTS

A CONSIDERATION OF INSECTICIDE EFFECTS ON HYPOTHETICAL AVIAN POPULATIONS

HOWARD YOUNG

Wisconsin State University, La Crosse, Wisconsin

(Accepted for publication August 30, 1967)

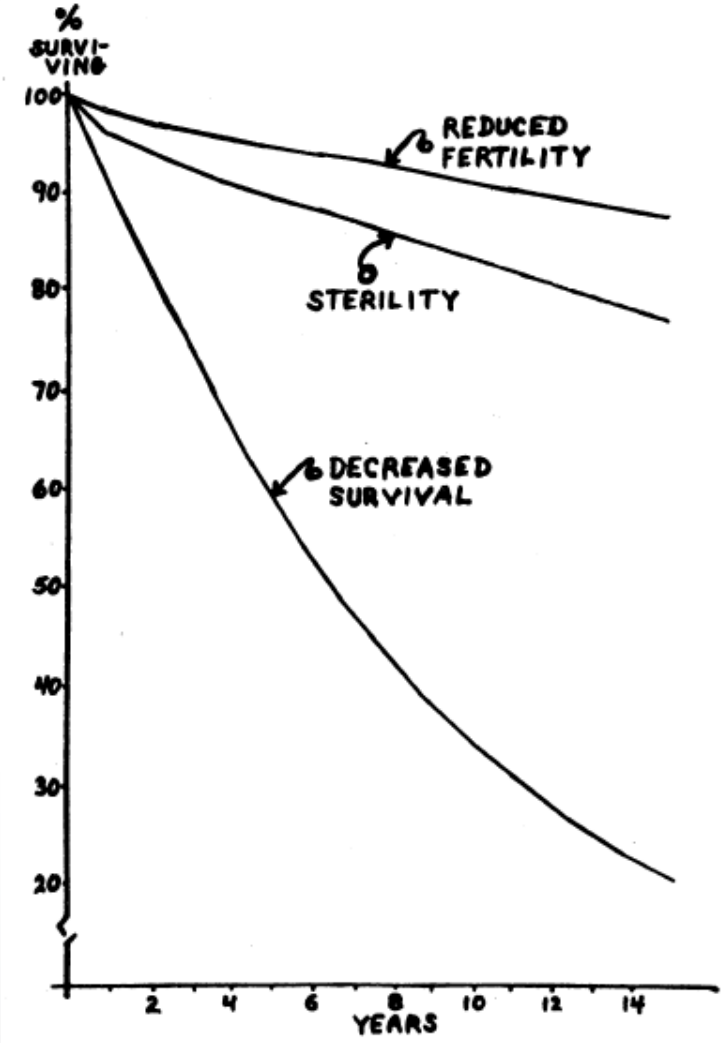


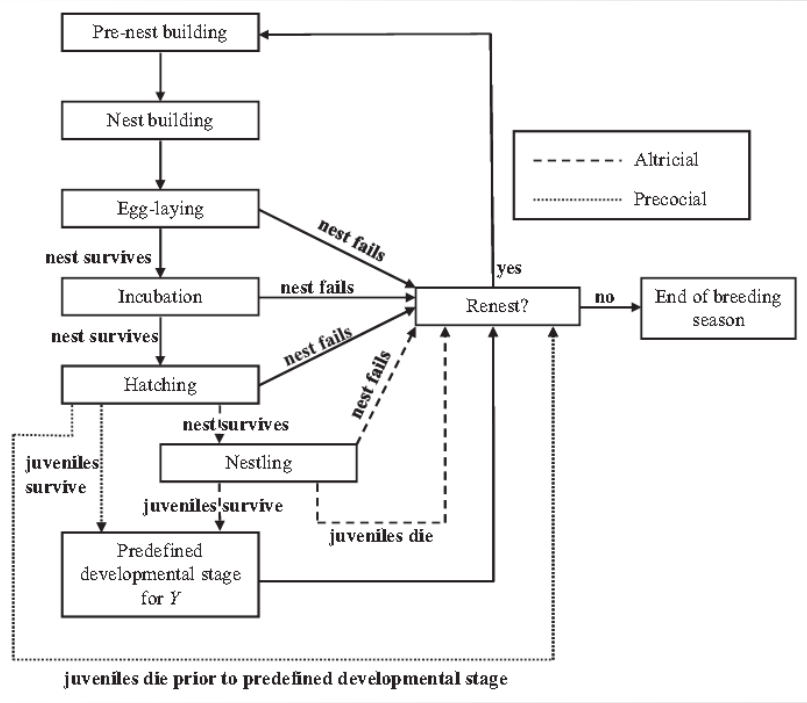
FIG. 1. Eagle population trends under 10% change in fertility, sterility and survival.

What is MCnest v2?

M.A. Etterson et al. / Ecological Modelling 222 (2011) 2178–2190

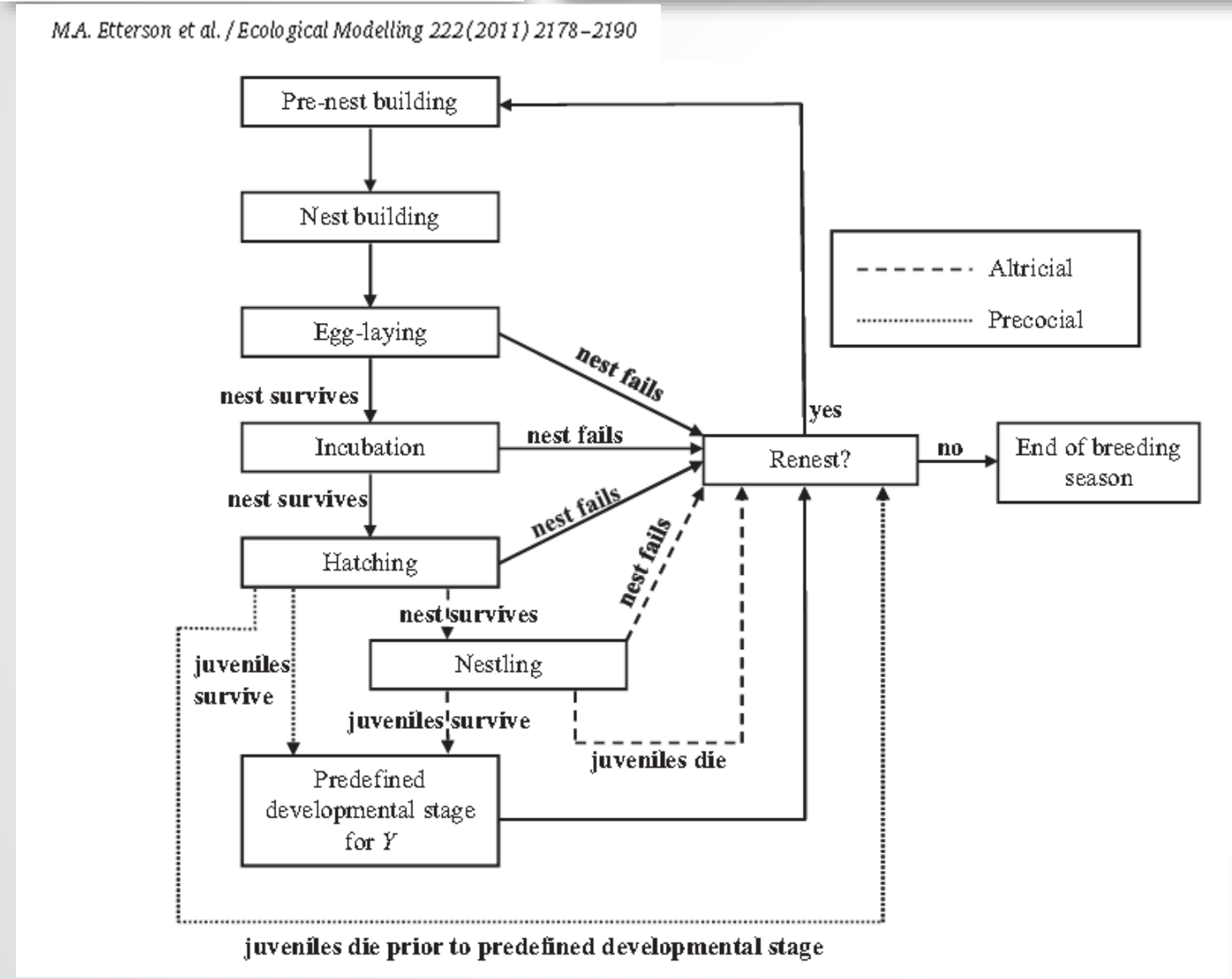
Markov Chain Nest Productivity Model

What is MCnest?



- Simulation model of avian reproductive success
- Predicts avian seasonal fecundity
- Incorporates results of 3 standard toxicity tests received during pesticide registration process

MCnest v2 requires 10 parameters



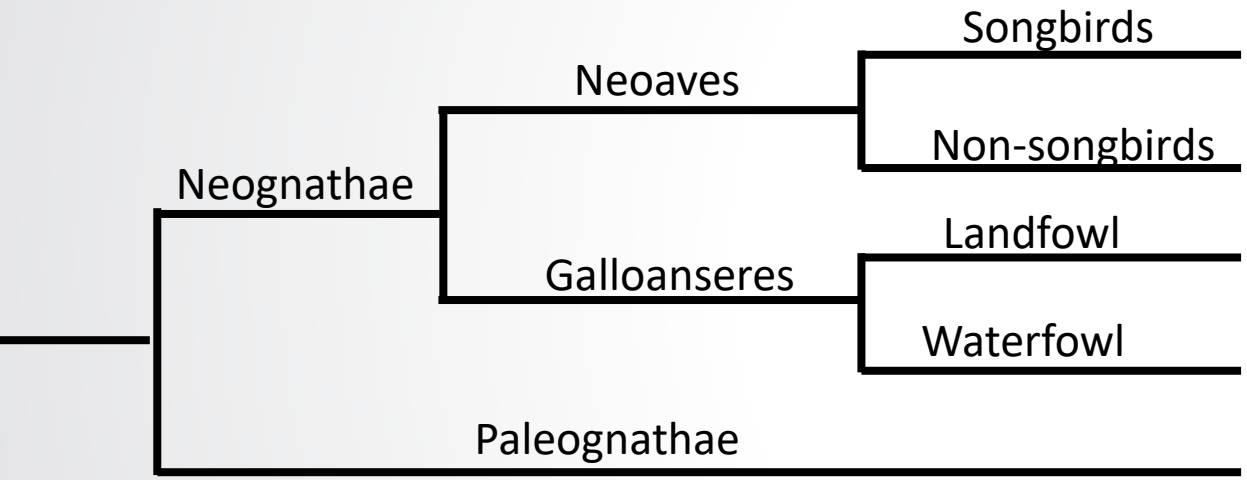
Parameter	*Type*
Adult mortality	probability
Nest failure	probability
Brood failure	probability
Egg development	duration
Clutch size	egg count
Egg laying interval	duration
Incubation duration	duration
Nestling duration	duration
Renest int (fail)	duration
Renest int (fledge)	duration

MCnest v2 limitations

- Not a full annual cycle model
- Not chemically agnostic (specific to pesticides)
- Limited species coverage, strongly weighted towards altricial birds
- Large simulations run slowly
- Limited ability to explore model sensitivity

Why we need a (more) mechanistic MCnest

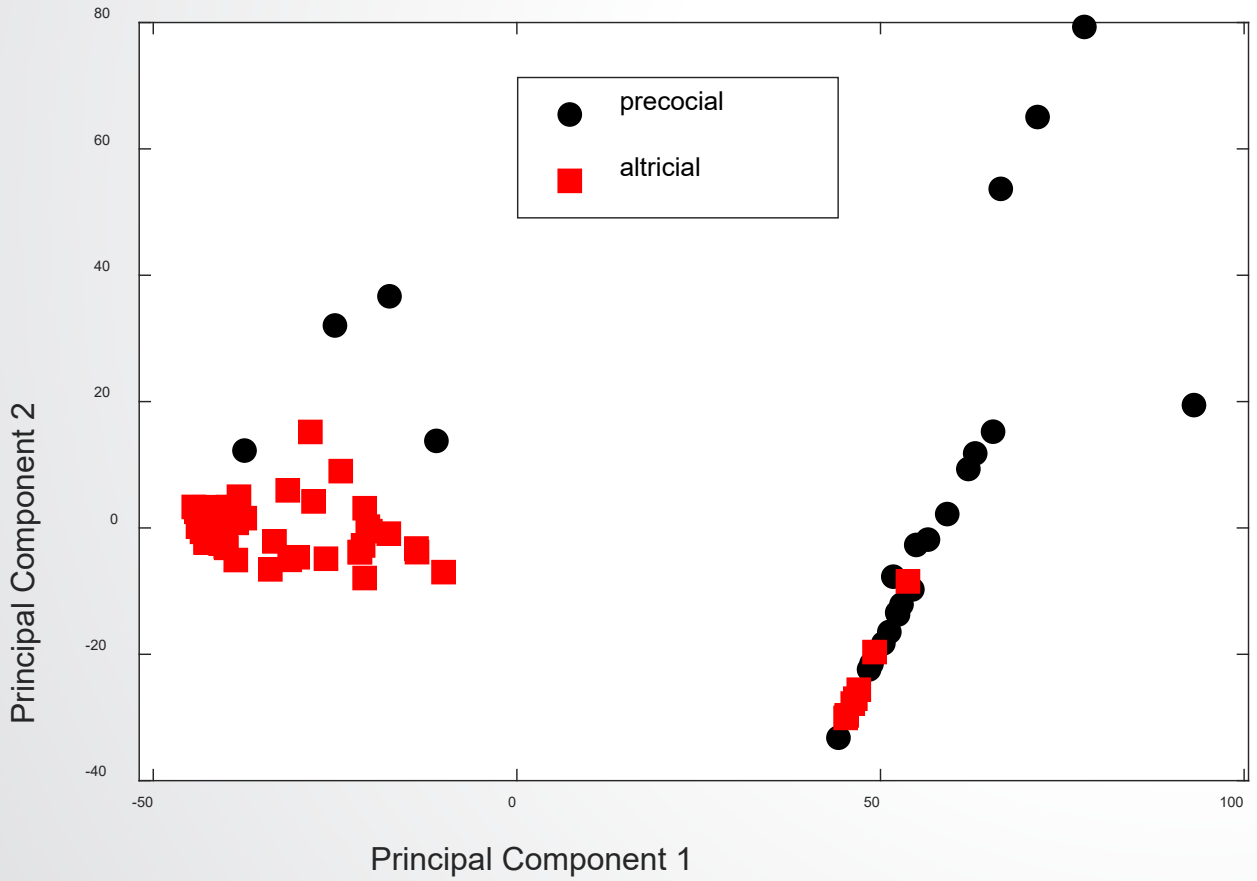
Avian phylogeny and species names from:
https://www.worldbirdnames.org/
Toxicity test results from: https://cfpub.epa.gov/ecotox/



Avian Orders	Species	Ecotox Results
2% (1)	**59%** (6,456)	**4%** (1,695)
78% (32)	**36%** (3,952)	**2%** (627)
2% (1)	**3%** (300)	**74%** (26,980)
2% (1)	**2%** (177)	**20%** (7,222)
12% (5)	**<1%** (60)	**0%** (0)

Principal Components Analysis

- 90% of variance explained by PC1 & PC2
- First principal component splits altricial v precocial birds



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Local Sensitivity Analysis (10% perturb.)

Precocial

Altricial

Sensitivity

Elasticity

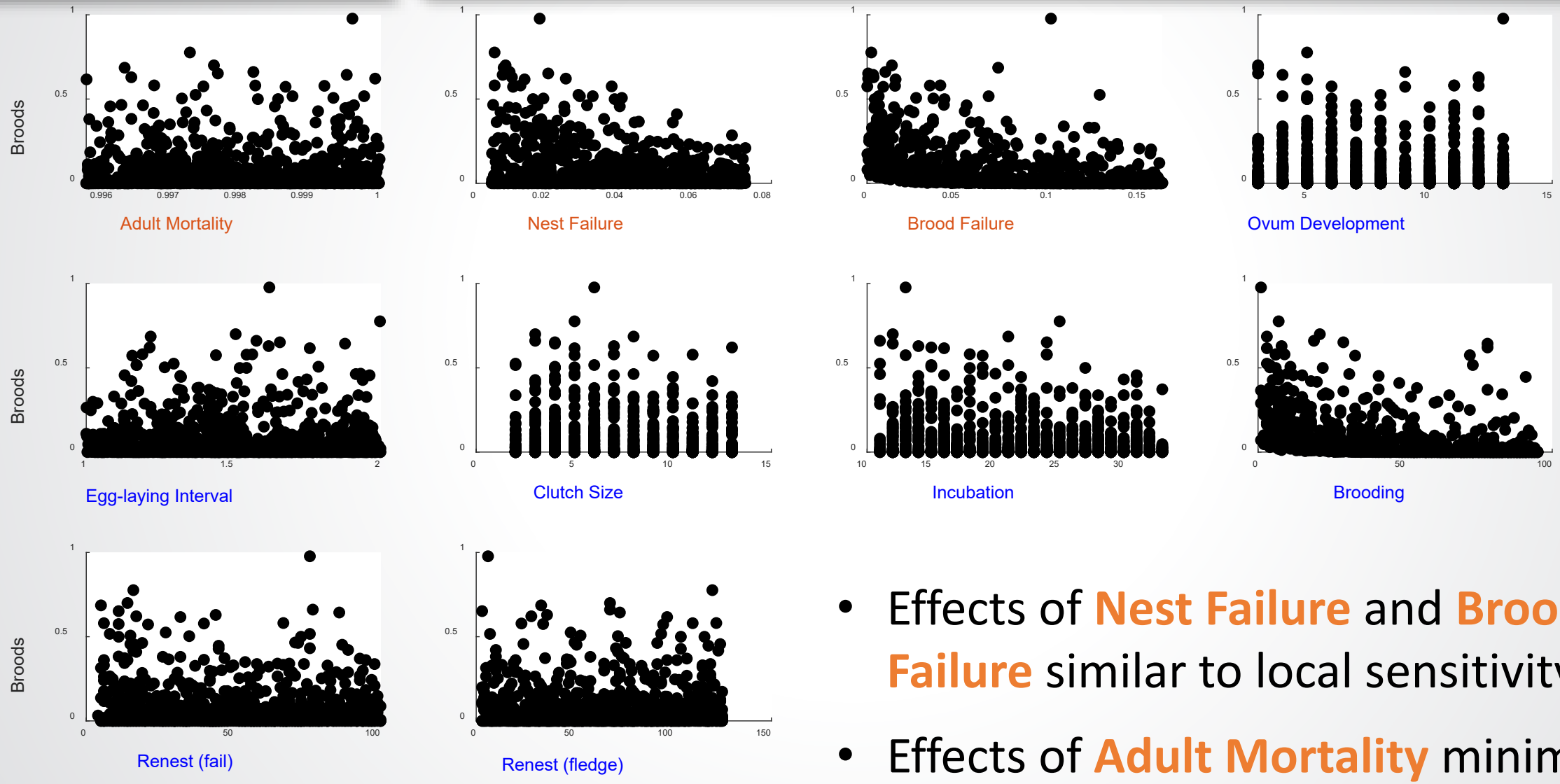
0
-10
-20
-30
-40
-50

0.0
-0.5
-1.0
-1.5
-2.0

Adult Mortality
Nest failure
Brood fail
Ovum development
Egg-laying interval
Clutch size
Incubation
Brooding
Renest (fail)
Renest (fledge)

Photo: E. Pavlovic

Global Sensitivity Analysis



- Effects of **Nest Failure** and **Brood Failure** similar to local sensitivity
- Effects of **Adult Mortality** minimal

MCnest v3 generalizations

- Full annual cycle model
  - Retain ability to run MCnest v2.0 as a sub-model
- Chemically agnostic
  - Retain pesticide functionality
  - Allow user-defined exposure & toxicokinetics
- Expanded species coverage
  - Near term emphasis on waterbirds & raptors
  - Include more precocial birds
- Exploit MC theory to estimate expectations (must faster than simulation)
- Innate sensitivity routines

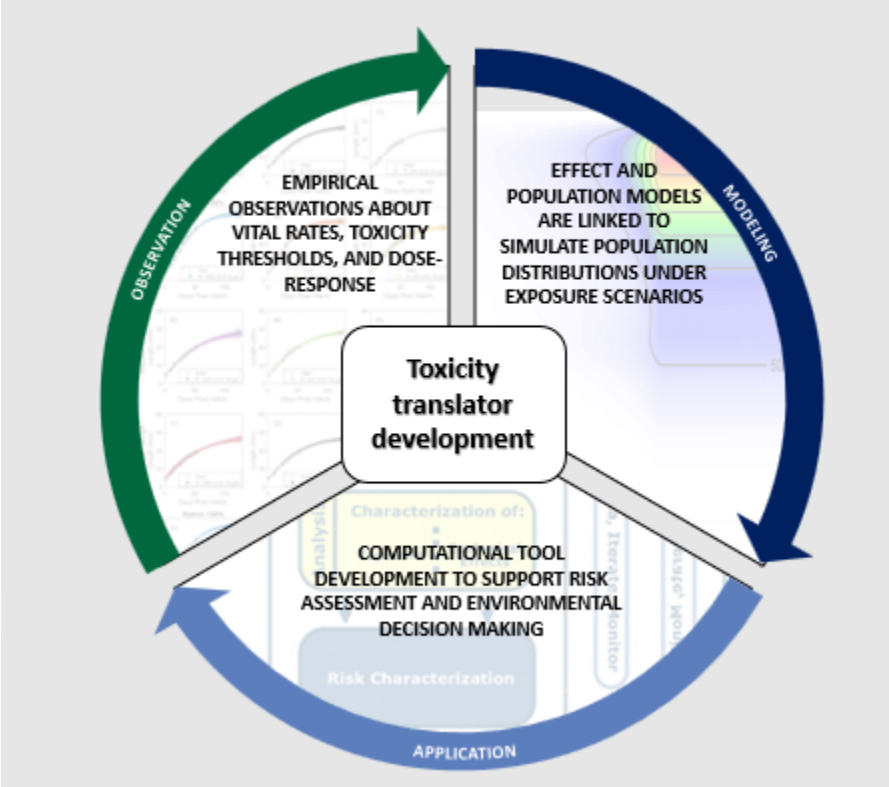
Timeline

• Pseudocode/coding	Winter 2020/2021
• Testing/verification	Spring 2021
• Beta Testing	Spring/Summer 2021
• Peer Review	Summer/Fall 2021
• Release	Winter 2021/2022

EPA Toxicity Translators

Toxicity Translators

- MCnest
- Fish Translator
- Mysid Model
- Amphibian Translator



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