Development of specific protection goals for FIFRA and ESA: A Scientific Perspective

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What we measure

- Genome
- Transcriptome
- Proteome
- Metabolome

What we care about

- DNA
- RNA
- Proteins
- Metabolites

How can we make these links?

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Driven to Discover
If it ain’t broke, don’t fix it…
Is it broke?

- Disconnect between ERA endpoints and protection goals adds uncertainty to risk assessments
- “New methods are more work and could land you in court” – works against the goal of using the best available science. Does this mean we never change methods?
- It is reasonable to conclude that the three-step consultation process for the first group of OPs, as implemented in practice, was not a resounding success.
- Higher-tier approaches are typically introduced to address specific ERA cases by one stakeholder group, which often leads to perception and process challenges.
Individual-level responses to chemicals are not simple proxies for effects on populations

Population-level effects of a 25% impact on reproduction in simulated fathead minnows in different systems.

Vaugeois, Venturelli, Hummel, Forbes (in prep)
Similar responses at the individual level do not guarantee similar responses at the population level

Impacts on population size of a stressor that decreases feeding rate by the same percentages (10% - 70%) in three species of trout. The stressor was applied in year 40.
We need to move beyond proxies because biological responses are highly nonlinear and context dependent.

And population properties are often not simple proxies for ecosystem processes or services.

But mortality (or survival or growth) are not linearly related to population dynamics.

What we measure: Individual toxicity
Moving beyond proxies requires models

SETAC Oct 2018: Special Symposium, Extrapolating Effects Across Biological Levels

Predictive Models for Ecological Risk Assessment A NIMBioS Investigative Workshop
April 28-30, 2014
NIMBioS at the Univ. of Tennessee, Knoxville

EFSA Sept 2018: Science, Food, Society

Forbes et al. 2019 STOTEN 649: 949-959
Galic et al. In preparation
Data gaps are a challenge, especially for T&E species

Of 773 plant species in the COMPADRE demographic database, < 4% are listed under ESA and 9% under IUCN.

Rueda-Cediel et al. (submitted) compared demographic data for a comparable subset of COMPADRE species.
Filling data gaps for listed plant species

- Life-history analyses of non-listed plant species may be useful for assessing the risks of pesticides to listed species
- A next step is to identify data-rich species that can represent clusters of similar, data-poor species

Rueda-Cediel, Brain, Galic & Forbes (submitted)
Filling data gaps for listed freshwater mussel species
Of 296 US Species, 74 are federally endangered and 16 are federally threatened.

Life History Traits
- **Periodic**
  - Life span: moderate (8-30 years)
  - Age at maturity: moderate (1-3 years)
  - Fecundity: low to moderate
  - Growth rate (k): moderate to high
- **Opportunistic**
  - Life span: low (<10 years)
  - Age at maturity: low (<1 year)
  - Fecundity: low to moderate
  - Growth rate (k): moderate to high
- **Juvenile**
  - Life span: high (>25 years)
  - Age at maturity: high (>3 years)
  - Fecundity: low
  - Growth rate (k): low

Based on Winemiller, 2005; Randklev, 2015; Haag 2012
We also need more consistency and transparency in model development and implementation.

Schmolke et al 2017, STOTEN

Raimondo et al 2018, IEAM
Next Steps

- Need a standard protocol for model design that links test endpoints to protection goals
- Develop as a multi-stakeholder collaboration
- End result: Improved efficiency, consistency and transparency in model design, development and implementation