5.03.P-Mo146. Realism, Conservatism, and Tiered Ecological Risk Assessment

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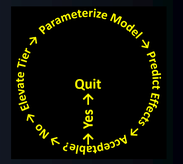
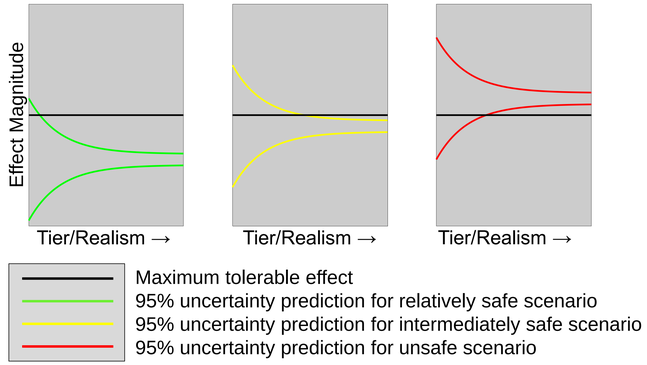


Motivating Observations

- Recent work has promoted the use of more complex realistic models in ecological risk assessment
- Deployment of ever more complex models at higher risk assessment tiers creates a model escalation sequence (Box 1)
- When to ***stop*** escalating is an important, unanswered question (Figure 1)
- Two competing stopping rules are explored:
  - Stop when a conservative model indicates a scenario is safe (***efficiency principle***)
  - Stop when we know "true" risk (***best practices***)

Figure 1. Conceptual model of the *efficiency principle* versus *best practices*



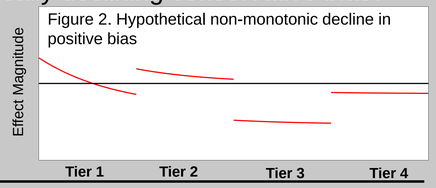
Conceptual Model Analysis

- A risk scenario is safe when the predicted effect is lower than the *a priori* maximum safe level (horizontal black line)
- "True" (unknown and therefore not shown) risk is assumed to lie at the asymptote of the hyperbolic cone (green, yellow or red lines) of increasingly realistic and precise model predictions at higher tiers
- Under the *efficiency principle*, a positively biased model prediction (e.g., the upper 95% confidence limit on model predictions) overestimates the true magnitude of effect
  - The green scenario (left panel) can be determined safe with lower tier model (e.g., risk quotient)
  - The yellow scenario (middle panel) can be determined safe with mid- or upper-tier model
  - The red scenario (right panel) should never be determined safe
- Under *best practices*, models give an unbiased estimate of effect magnitude (prediction lies somewhere within the hyperbolic cone, with higher uncertainty at lower tier)
- Following *best practices*, at lower tiers there is a region (between the black and red lines on the right panel) where we could conclude that an unsafe scenario is safe

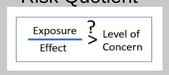
Box 1. Is it possible to create a model escalation sequence with monotonically declining conservative bias?

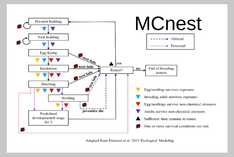
- The efficiency principle requires that positive bias decreases monotonically with increasing tier and increasing realism (e.g., upper hyperbolic cone in Figure 1)
- Figure 2 shows hypothetical examples in which tier-specific modeled biological and chemical complexity (TK/TD, exposure pathway, AOP) introduces discontinuities in the bias/complexity relationship

Figure 2. Hypothetical non-monotonic decline in positive bias

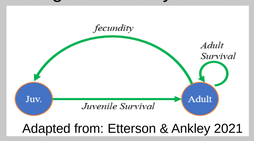


Risk Quotient

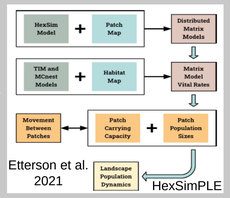




Endogenous Lifecycle Model



Adapted from: Etterson & Ankley 2021



Etterson et al. 2021

An empirical analysis: Evaluating an escalation sequence (above) from my own work I found:

1. Increasing realism necessarily introduces new modeled biological and chemical processes that may either increase or decrease positive bias
2. Pressing existing models into service along an escalation sequence will make the *efficiency principle* more difficult to achieve
3. Parameterization is a better strategy than model structure for satisfying the *efficiency principle*

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Conclusions

- In risk assessment, it can always be argued that more information & more realistic models are needed to identify true risk
- The *efficiency principle* provides a mechanism for stopping when a risk scenario is identified to be safe, but requires monotonically declining conservative bias with tier escalation
- However, the *efficiency principle* is in direct conflict with *best practices* for model development, which focus on unbiased prediction of outcomes
- The *efficiency principle* may be impossible to implement in an increasingly realistic model escalation sequence
- In contrast, *best practices* could lead to erroneous conclusions that risk is acceptable
- Resolution of the conflict between *best practices* and the *efficiency principle* will be a formidable challenge as we deploy ever more complex models
- Similar arguments, with similar challenges, could be made for quickly identifying risk scenarios that are *not* safe

Literature Cited

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