Developing population models for use in environmental risk assessment

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BACKGROUND
Population models have been increasingly recognized as useful and necessary tools in the context of environmental risk assessment (ERA). Their limited application in the ERA context so far can be mainly attributed to the lack of guidance and consensus about the specifications of models that are applicable for this purpose. A methodology for the systematic development of conceptual models for population modeling was proposed by Schmolke et al. (2017), using an example for herbaceous plants.

The outcome of these previous efforts have recently been merged and expanded upon as a collaborative multi-stakeholder initiative, “GuideME”.

GUIDE ME

Guideme overview. The individual phases are described in further detail at right.

SUMMARY AND OUTLOOK

GuideME is an on-going (in-development) effort, with the goal to provide a comprehensive and practical resource for the development of population models with the involvement of stakeholders, modelers and non-modelers alike. Developing population models in a systematic, transparent way as through the GuideME process, will increase their applicability and credibility, reduce development efforts, and result in models that are readily available for use in risk assessments. The linkage of the population model development process to an existing U.S. EPA ERA framework provides a critical functionality to place models in an appropriate context for use in regulatory assessments. GuideME addresses a number of historical limitations with the application and acceptance of population modeling as a risk assessment tool.

GUIDE ME COLLABORATIVE

The development of GuideME is a collaboration of academia (UMN), industry (Syngenta), consultancy (Waterborne) and government (EPA). The following people are part of the group: Chiara Accolla (UMN), Jill Awkerman (EPA), Matt Etterson (EPA), Valery Forbes (UMN), Niko Galic (Syngenta), Kris Garber (EPA), Andrew Kanarek (EPA), Katherine Kapo (Waterborne), Nathan Pollesch (EPA), Sandy Raimondo (EPA), Pamela Rueda-Cediel (UMN), Amelie Schmolke (Waterborne), Maxime Vagueois (UMN)

PHASE I: MODEL OBJECTIVES

Initial evaluation of the model objectives in the context of the specific ERA
- How will the model be used in the ERA, e.g., as a direct species assessment tool, location-specific ERA or as weight of evidence with additional data for broader ecological protections?
- Which ERA complexity category (General, Realistic, Precise, etc.) is most relevant to the ERA/modeling objective? Evaluate this further by: Taxonomic specificity, life-history information, spatial and temporal considerations, and any other model attributes that may be important to the assessment
- From the ERA category and intended use, what uncertainties are acceptable or should be explored?
- What assessment endpoint(s) are most relevant to the ERA objective and the intended model use?
- What are the project resources (time line, budget, etc.)?

PHASE II: DATA COMPILATION

Data available for the species and the chemical(s) of interest are compiled systematically. Taxa-specific template tables define the data to be collected for a general, realistic or precise representation of the characteristic, based on GuideME Phase I.

Example of data collection by complexity level for life history considerations for herbaceous plants:

PHASE III: DECISION STEPS

Model objectives and data compiled in Phases I and II inform the building of a conceptual model in GuideME Phase III. Decision tree templates provide taxon-specific guidance for incorporating 7 key model components: 1. the life-history graph, 2. organism-level processes, 3. temporal representation, 4. spatial representation, 5. density dependence, 6. population status/environmental conditions, and 7. indirect effects.

The process provides systematic questions to guide model development as appropriate for its objectives and data availability

Decision tree template, Example 1: Life-history graph, fish

PHASE IV: CONCEPTUAL MODEL SUMMARY

The templates from GuideME Phases I-III provide an organized set of model documentation: 1. Model objectives summary: Purpose statement and summary of model objectives within the ERA context 2. Data compilation: Species and chemical tables 3. Decision tree summary: final outcome of decision trees for each model component (decision step) This information provides a summary of the conceptual model which serves as the blueprint from which a formal model can be developed and applied.

PHASE V: UNCERTAINTY AND MODEL EVALUATION

Each development phase and associated template(s) include opportunities to document uncertainties in data and model assumptions that may exist and how the model addresses (or does not address them). This information can be compiled into a model uncertainty summary to provide a comprehensive view of potential model limitations. This information can be useful to guide subsequent evaluation of model implementation, for example in conducting sensitivity analysis of the model.