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Abstract

A working group at the National Institute for Mathematical and Biological Synthesis (NIMBioS) explored the feasibility of integrating 2 complementary approaches relevant to ecological risk assessment. Adverse outcome pathway (AOP) models provide “bottom-up” mechanisms to predict specific toxicological effects that could affect an individual’s ability to grow, reproduce, and/or survive from a molecular initiating event. Dynamic energy budget (DEB) models offer a “top-down” approach that reverse engineers stressor effects on growth, reproduction, and/or survival into modular characterizations related to the acquisition and processing of energy resources. Thus, AOP models quantify linkages between measurable molecular, cellular, or organ-level events, but they do not offer an explicit route to integratively characterize stressor effects at higher levels of organization. While DEB models provide the inherent basis to link effects on individuals to those at the population and ecosystem levels, their use of abstract variables obscures mechanistic connections to suborganismal biology. To take advantage of both approaches, we developed a conceptual model to link DEB and AOP models by interpreting AOP key events as measures of damage-inducing processes affecting DEB variables and rates. We report on the type and structure of data that are generated for AOP models that may also be useful for DEB models. We also report on case studies under development that merge information collected for AOPs with DEB models and highlight some of the challenges. Finally, we discuss how the linkage of these 2 approaches can improve ecological risk assessment, with possibilities for progress in predicting population responses to toxicant exposures within realistic environments.