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Modeling, Estimation, and Control Related Issues in Physical and Biological Applications

Population Models for the Protection of Ecosystem Services

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Abstract:
Using surrogate species to predict the effects of toxicants on endangered/threatened or economically important species is a common approach in applied ecology. While this approach has been criticized as being overly simplistic, a quantitative analysis linking life history traits and population predictions has been sorely missing. We describe here the derivation of a mathematical approach aimed at determining conditions under which the effects of toxicants on surrogate species population outcomes will reliably predict responses of species of concern. Using a simple Leslie matrix model parameterized with life history data, we compare critical thresholds in fecundity and survivorship reduction across species using life history data from parasitoid wasps important for biological control. Our results demonstrate that surrogate species approaches to assessing toxic insults may result in misleading information regarding protection of economically important species. In the suite of parasitoid wasps that we explored, some (e.g, Diaeretiella rapae) were much more robust than others, suggesting that sweeping generalizations about species (even those within the same family) may be misleading. A sensitivity analysis of the parasitoid wasp data further revealed that widely divergent population outcomes among similar species may correspond to divergent values for specific life history parameters. Our results highlight potential pitfalls associated with the use of a "one-size-fits-all" approach to the protection of species, and we discuss the implications of these findings for risk assessment and resource management.