

# Biosecurity under uncertainty: the influence of information availability and quality on expert decision-making for risk outcomes

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## ABSTRACT

Alongside climate change and habitat loss, aquatic nonindigenous species (ANS) introductions comprise a large and increasing contribution of the anthropogenic threat to environmental, economic, sociocultural and human health values worldwide. Biosecurity agencies aim to prevent and manage introductions using various tools, including risk assessment. Risk assessment can prioritize threats, but is frequently compromised by uncertainty, often due to information availability, quality and interpretation. **Many risk assessment processes lack consistent and transparent treatment of uncertainty, particularly when biosecurity objectives warrant a precautionary approach.**

This thesis aims to identify methods for managing uncertainty via an initial review of 14 existing national, regional and international biosecurity instruments. Results from this review found over half of the instruments explicitly included or mentioned precaution, and many instruments acknowledged the potential influence of subjective risk perceptions. Based on these outcomes, **this thesis aims to: determine sources of uncertainty; understand the cognitive process of estimating consequence, and therefore risk under uncertainty; and provide transparent methods to reduce uncertainty that allow for precaution,** using input from ANS experts in scientific and management fields. Finally, this thesis aims to examine how the frequentist statistical focus on low acceptable rates of Type I errors, most frequently applied in ANS impact research, influences findings of significant impact and the implications for management decisions.

Results of this thesis indicate that the scarcity of ANS impact information constitutes a primary source of uncertainty. When faced with knowledge gaps and other forms of uncertainty, experts tended to assume and assign lower consequence via a 'hindsight approach' (assume no impact without sufficient information), which stands opposite to precaution. **To mitigate the effects of uncertainty, experts supported the use of alternative information sources, including non-empirical evidence. In practice, the provision of information and group discussion generally increased the consequence estimate,** thus suggesting methods that allow functional and, if desired, precautionary consequence assessments despite high uncertainty. **In situations of expected 'low' certainty, when information is available, my research indicated that an extremely high proportion of statistical analyses of impact had insufficient power to detect an impact, leading to 'false certainty' of no impact. This bias toward 'missing' impacts, again opposite to precaution, may further prevent appropriate management action.**

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(p. 179)