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The Fish Invasiveness Screening Kit (FISK) for Non-Native Freshwater Fishes—A Summary of Current Applications

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A major step forward in the screening of non-native species came with the development of the *weed risk assessment* (WRA) of Pheloung *et al.*[1] for terrestrial plants of Australia and New Zealand. Based on the generally accepted premise that weeds in one part of the world will have an increased chance of being weedy (i.e., invasive) in other areas with similar environmental conditions, the WRA's question and answer scoring system provided a conceptual, semi-quantitative basis from which to develop similar screening tools for a range of aquatic species.[2] Funded by the U.K. Department of Environment, Food and Rural Affairs (Defra), five screening tools were developed from the WRA template, with permission from the original authors of the WRA: the freshwater Fish Invasiveness Screening Kit (FISK), a variation of FISK for non-native marine fishes (MFISK), the Freshwater Invertebrate Invasiveness Screening Kit (FI-ISK), a variation of FI-ISK for marine invertebrates (MI-ISK), and the Amphibian Invasiveness Screening Kit. Of these, the FISK for freshwater fishes was the first to be calibrated,[3] with subsequent applications of FISK in Belgium,[4] Belarus,[5] Japan,[6] Brazil,[7] and Mexico.[8] All but one of these subsequent applications involved a single assessor for each species, and the threshold value (i.e., 19.0) from the initial U.K. calibration[3] was used to distinguish between species classed as medium or as high risk of being invasive. The initial FISK calibration involved two assessors and focused specifically on England and Wales as the "risk assessment area." The application of FISK to northern Kyushu Island (Japan) followed and extended this approach by carrying out a region-specific calibration that was based on assessments from five researchers.[6] Remarkably, the calibrated threshold between medium and high risk for northern Kyushu Island was very similar (i.e., 19.8) to the U.K. value.[3]

The development of FISK took another step forward at the American Fisheries Society meeting in Ottawa, Canada, in August 2008, where Dr. Jeff Hill (University of Florida) and I began discussing risk assessment approaches. This led to a collaboration supported by a USDA grant (awarded to Jeff) to examine the potential application of FISK to the multitude of non-native freshwater fishes in peninsular Florida. The first step in this process was to revisit each question and associated guidance in FISK, and where necessary modifications were made to improve clarity and to expand the relevance of the questions to encompass warm temperate and tropical regions as well as the original temperate zone. To complement this comprehensive revision of FISK questions and guidance, the user interface and functionality of the FISK software package were also dramatically improved, yielding FISK v2,[9] which was then applied in Australia,[10] Iberia,[11] Finland,[12] the Balkans,[13] and Turkey (A.S. Tarkan, G. Ekmekçi, L. Vilizzi, and G.H. Copp [private communication]).

The application of FISK v2 to non-native freshwater fishes in the Murray-Darling Basin of Australia[10] provides an alternative, though of Australian origin, to other risk screening tools that have been applied to freshwater fishes in Australia.[14,15] There were some discordances between FISK v2 and two of the other Australian-based assessment protocols, one of which is qualitative and the other being a

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simplified version of FISK. Similarly, the application of FISK v2 to Iberia provides a direct contrast to that proposed by Clavero,[16] which focuses mainly on early invasion stages (i.e., arrival and establishment) and requires a profound understanding of invasion pathways as well as a detailed knowledge of the key biological features that determine invasion success in the Iberian region (see Almeida *et al.*[11] for details). The calibration of FISK v2 in these various countries/regions highlighted the importance of assessing species within the context of a defined risk assessment area. The calibrated threshold values (for distinguishing the medium- and high-risk categories) generally fell within a range of 18 to 23 (Iberia[11] = 20.25; Southern Finland[12] = 22.5; Turkey (Tarkan *et al.* [private communication] = 23), with the exception of the Balkans,[13] where a much lower threshold (9.5) was attributed to the high number of fish species (19 of 43, i.e., 44%) translocated within the Balkan countries.

FISK has been the subject of various reviews of screening tools[17,18] and is generally viewed favorably. Of the other screening tools adapted from WRA to address aquatic species,[2] the FI-ISK is the only other one to have been calibrated[19] and that application was restricted to the assessment of non-native crayfishes in Italy. Nonetheless, a Canadian government study[19] has recommended the use of both MFISK and MI-ISK as potential screening tools for marine species, and recent interest has been expressed in a possible adaptation of FISK for screening animal diseases (J. Kyyrö, Finnish Food Safety Authority, [private communication]). Overall, the Pheloung *et al.*[1] model has provided a very useful template for identifying potentially invasive organisms, having spurred not only the above-mentioned adaptations of the WRA but also acting as the inspiration for a generic screening module in the European Non-Native Species in Aquaculture Risk Assessment Scheme,[20] which was developed specifically for implementation of the European Regulation on the use of non-native species in aquaculture.[21]

The four articles appearing in this issue of *Risk Analysis* comprise the USDA- and Defra-funded revision of FISK[9] and three applications of the resulting FISK v2—the Murray-Darling Basin in Australia[10] and two regions at the extreme ends of Continental Europe, Iberia in the south[11] and southern Finland in the north.[12] Given the Australian origin of the WRA, the application of FISK v2 to non-native freshwater fishes of the Murray-Darling Basin in Australia[10] represents a "home coming" for this screening tool. Having revised and/or written much of the VisualBasic® code for FISK v1 and v2, Dr. Vilizzi was keen to trial FISK v2 in the country where he undertakes the bulk of his research activity, and this application to the Murray-Darling Basin highlights some discrepancies between FISK v2 and two other screening tools currently being applied to non-native freshwater fishes in Australia.

The Iberian application[11] of FISK v2 resulted from discussions between myself and my postdoc at the time, Dr. D. Almeida, which extended to include two postdoctoral fellows working in Iberia. It is probably the most biogeographical application in that it addresses the geographically distinct Iberian Peninsula using assessors from the two constituent countries (Spain and Portugal). The application of FISK v2 in southern Finland[12] came about through casual discussions over lunch at an ICES working group meeting in Lisbon (ITMO—Introductions and Transfers of Marine Organisms). My Finnish colleagues mentioned that they were carrying out a few trials with FISK v1 on non-native fishes already in southern Finland, and I suggested they consider using the latest version of FISK in a series of assessments that encompassed both existing and potential future non-native fishes. The Finnish paper[12] represents the first application of FISK in a north temperate country, with all previous northern hemisphere applications being within the temperate zone, except perhaps for Belarus,[5] which is classed as temperate-continental but falls within the "cold" climate zone according to the updated Köppen-Geiger climate map.[22] Regardless, as a screening tool for freshwater fishes, FISK has proved relatively popular, mainly because it is self-explanatory and easy to use, and FISK v2[9] is now applicable to virtually all climatic zones.

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