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TESTING THE FISH INVASIVENESS SCORING KIT (FISK) AS A SCREENING TOOL FOR FLORIDA

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ABSTRACT

Interest in risk analysis for non-native freshwater fishes and other organisms is increasing. Unfortunately, complete risk analysis for a single species is data-intensive, time-consuming, and expensive. A relatively quick and simple screening process may be able to identify species as low or high risk and other species where the risk level is more moderate or uncertain. The Fish Invasiveness Scoring Kit (FISK) was developed in the United Kingdom (UK) as a screening tool to assess potential invasiveness of non-native freshwater fishes. The method is semi-quantitative and provides a scoring framework for biogeographical, historical, biological, and ecological information on a species. Higher scores indicate higher risk. We created a list of non-native freshwater fishes introduced into peninsular Florida, scored two sample species using the online FISK toolkit, and determined risk categories for each species based on original and UK-calibrated FISK. Over 120 fish species were introduced into peninsular Florida, with 33 currently reproducing. Barramundi *Lates calcarifer*, a species not introduced into open waters but used in Florida aquaculture, scored high risk in the FISK. This agreed with a recent risk assessment of the species in Florida. Nevertheless, the score was only a minimal value for high risk in the UK-calibrated FISK. Zebra danio *Danio rerio* scores were at the minimum value for "evaluate further." Previous risk assessment in Florida considered zebra danio to be very low risk. Lack of variation between two scorers for both species suggested that scorers with different levels of experience can come to a similar conclusion using FISK. Future work will evaluate the remaining species, calibrate the scoring thresholds for Florida, and develop a web-based tool of the modified Florida FISK.

INTRODUCTION

Invasive species threaten native species, natural ecosystems, agriculture and other industries, and human health (Lockwood et al. 2007). On the other hand, many non-native species provide important benefits to humans in agriculture and fisheries, and as pets. Management goals vary across different types of agencies, but a balanced management approach is to seek to reduce the negative impacts of invasives while simultaneously allowing for use of non-native species by agriculture, industries, and the public (e.g., Gozlan 2008). Distinguishing high risk from low risk species is an important management goal.

There is considerable interest in the United States and in Florida to evaluate methods and to conduct risk analysis for non-native freshwater fishes and other organisms. For example, one of the priority objectives in the *2008–2012 National Invasive Species Management Plan* (NISC 2008) was the development of screening processes to evaluate invasiveness in non-native aquatic species. Risk analysis has figured prominently in recent congressional initiatives (e.g., H.R. 669, *Non-Native Wildlife Invasion Prevention Act*, and the Senate Committee on Environment and

Public Works' July 7, 2009 hearing on "*Threats to Native Wildlife Species*"). State agencies in Florida reviewed methods through the Risk Assessment Sub-Working Group of the Florida Invasive Species Working Group, with the objective of choosing and adapting methods that work best for Florida. Subsequently, the Florida Fish and Wildlife Conservation Commission evaluated a series of non-native aquatic and terrestrial species, including full risk analyses of grass carp *Ctenopharyngodon idella* (Zajicek et al. 2009b), barramundi *Lates calcarifer* (Hill and Thompson 2008; Hardin 2009), and blue tilapia *Oreochromis aureus* (Hill 2011; Hardin et al. 2011), and of the marine ornamental trade pathway (Zajicek et al. 2009a).

The use of risk assessments and the implementation of risk management (i.e., full risk analysis) for species newly imported and those in trade are effective strategies to reduce the probability that non-native species will establish and have negative impacts (NISC 2008). Risk analysis identifies problematic species and risky activities and provides a framework for managing risks at acceptable levels (Hill 2009). Unfortunately, complete risk analysis for a single species is data-intensive, time-consuming, and expensive (Hill and Zajicek 2007). It can be beyond the resource capability of agencies or industries to evaluate a large number of species. A relatively quick and simple screening process may be able to categorize species at a coarse scale to identify those that have low or high risk and other species where the risk level is more moderate or uncertain. For species with medium or uncertain risk, a thorough evaluation of risk can be conducted as warranted by agency or industry interests. Screening tools also can be used in the initial stages of a full-risk assessment or as a component of a risk assessment scheme (e.g., RAM Committee 1996; Copp et al. 2008).

The Fish Invasiveness Scoring Kit (FISK) was developed in the United Kingdom as a screening tool to access potential invasiveness of non-native freshwater fishes (Copp et al. 2005a,b). The method was adapted from the Australian Weed Risk Assessment (WRA) model (Pheloung et al. 1999). The method is semi-quantitative and provides a scoring framework for biogeographical, historical, biological, and ecological information on a species. Higher scores indicate higher risk, and threshold values are established to categorize species as low, medium, or high risk. FISK was explicitly designed to meet international standards, such as the World Trade Organization Sanitary and Phytosanitary Agreement and the Convention on Biological Diversity, and has been incorporated as a screening mechanism under the framework of the European Non-Native Species in Aquaculture Risk Assessment Scheme (ENSARS) (Copp et al. 2008).

We are in the process of evaluating FISK for use in Florida, including its application to over 120 species of non-native freshwater fishes introduced into peninsular Florida, the calibration and adjustment of scoring thresholds as needed to accurately categorize risk of individual species, and the development of a web-based tool kit to facilitate use and further adaptation of the Florida-specific FISK. In this document, we describe preliminary stages of the overall project.

OBJECTIVES

1) Create a list of non-native freshwater fishes introduced into peninsular Florida
2) Score two sample species using the online FISK toolkit and estimate between-scorer variability
3) Determine risk categories for each species based on original and UK-calibrated FISK

MATERIALS AND METHODS

Development of List of Non-Native Fishes Introduced into Peninsular Florida

We compiled a list of all non-native freshwater fish species introduced into open waters of peninsular Florida, the portion of the state south of the Suwannee River, using the U.S. Geological Survey Nonindigenous Aquatic Species database (http://www.nas.er.usgs.gov/). This region of Florida has differences in climate, habitat, and history of non-native fish introductions from that of northern Florida and the Florida Panhandle region (Fuller et al. 1999; Hill 2002). We used Shafland et al. (2008) and expert opinion to develop a list of species reproducing in peninsular Florida.

Fish Invasiveness Scoring Kit (FISK)

The FISK is an additive spreadsheet type model available on the Internet/World Wide Web at http://www.cefas.defra.gov.uk/our-science/ecosystems-and-biodiversity/non-native-species/decision-support-tools.aspx and is described in Copp et al. (2005a,b). Answers to 49 questions are assigned a value (generally, –1 to 2) or add weighting factors for other questions. The summation of these response values produces an overall score that is correlated to the invasive risk of the assessed fish species. Each question relates to the biology, ecology, history, biogeography, or presence/absence of "undesirable" traits. Responses that are offered for each question are either categorical (yes, no, or don't know) or numerical (1 to 3) and are selected on the basis of expert opinion and scientific literature specific to the species being evaluated. Categories (aquaculture, environmental, nuisance, or combined) are assigned to each question so that the final score identifies the sector most likely to be affected. The total score for a species can range from –11 to 54. The score thresholds for the original FISK pre-screening tool are "low risk" (score < 1), "medium risk" ($1 \leq$ score ≤ 6), and "high risk" (score > 6).

The original FISK model described by Copp et al. (2005a) used the same scoring thresholds as the WRA. Copp et al. (2009) later adjusted the scoring thresholds to calibrate FISK for the United Kingdom. They also incorporated a measure of assessor uncertainty. The UK-calibrated scoring thresholds categorized non-native fish species as "low risk" (score < 1), "medium risk" ($1 \leq$ score ≤ 19), or "high risk" (score > 19). Increasing the score thresholds for high risk proved a better reflection of independent assessments of risk for the species in the United Kingdom.

Scoring Sample Species

Two sample species were chosen to begin scoring using the FISK. We chose two species that (1) we anticipated would score at the relative extremes of the scoring scale, (2) have undergone some level of risk assessment previously in Florida, and (3) have considerable literature or other available data. The first species, the barramundi, a large (up to 200 centimeters in total length), euryhaline fish from Australia, New Guinea, and Southeast Asia, is an important aquaculture and fisheries species. It has not been introduced into open waters in Florida, but was the subject of a full risk analysis conducted by the Florida Fish and Wildlife Conservation Commission due to its use in aquaculture and at a fee-fishing operation in the state (Hill and Thompson 2008; Hardin 2009). The result of the risk assessment was high risk, and additional restrictions were placed on

the possession and culture of barramundi in Florida. The second species, zebra danio *Danio rerio*, is a small-bodied (~50 millimeters in total length) fish from southern Asia that is a well-known aquarium and research fish cultured in Florida. It has been recorded in Florida waters but there is no evidence of reproduction. It was assessed by the Transgenic Aquatic Species Task Force, a scientific advisory committee for the Florida Department of Agriculture and Consumer Services, relative to the potential approval of the culture of transgenic fluorescent zebra danios. The conclusion of the qualitative risk assessment was that zebra danio was of extremely low risk for Florida. Both species were scored by two scorers (JEH and LLL). Both species were placed into risk categories described in the original and UK-calibrated FISK.

RESULTS

At least 122 species of non-native freshwater fishes from 29 families have been introduced into peninsular Florida. The three families with the most introductions are Cichlidae (cichlids | 30 species), Cyprinidae (carps and minnows | 16 species), and Poeciliidae (livebearers | 16 species). A total of 33 non-native species of 10 families have reproducing populations in peninsular Florida. The family Cichlidae (19 species) dominates in numbers of reproducing species, followed by the family Loricariidae (armored suckermouth catfishes | 4 species).

A score of 20 led to an outcome of "reject" for barramundi using both the original and the current (UK-calibrated) scoring thresholds of FISK (Table 1). A strong climate and habitat match between its native range and Florida contributed nearly 50% of the score. Undesirable attributes included large size, predatory diet, and high fecundity. A score of 1 led to an outcome of "evaluate" for zebra danio for both versions of FISK (Table 2). Small size, non-predatory diet, and aspects of the biology resulted in a low score. There was no variability in scores between the two scorers for either species.

Table 1. FISK output for barramundi *Lates calcarifer* for Florida

	Outcome:	Reject
	Score:	20
	Biogeography	9
Score partition:	**Undesirable attributes**	6
	Biology/ecology	5

Table 2. FISK output for zebra danio *Danio rerio* for Florida

	Outcome:	Evaluate
	Score:	1
	Biogeography	1
Score partition:	**Undesirable attributes**	2
	Biology/ecology	-2

CONCLUSIONS

A list of freshwater fishes introduced into peninsular Florida was developed, with literature reviews underway to provide information necessary for scoring each species. While scoring sample species so far suggests that FISK will place species in appropriate positions along the risk scale relative to one another, it also suggests that scoring thresholds may require calibration.

The score for barramundi was well within the category of high risk for the original FISK but had only a minimal score for high risk in the UK-calibrated FISK. We anticipated a higher score based on a previous risk analysis for Florida. During Florida's risk analysis, most assessors considered the risk of escape from the small aquaculture industry and establishment of barramundi to be low, but rated environmental risks high if the species were established (Hardin 2009). In particular, the strong climate and habitat match, large body size, and predatory diet, coupled with high ecological similarity to an important native fisheries species, the common snook *Centropomus undecimalis*, drove the risk estimates. The first three factors contributed considerably to the FISK score. Nevertheless, FISK also strongly weights previous history of invasiveness. Based on barramundi risk, there are no data suggesting negative impacts.

The FISK returned a score that indicated either medium risk or evaluate further for zebra danio, although the score was minimal for the category for both versions of FISK. Members of the Transgenic Aquatic Species Task Force in Florida considered the zebra danio to be very low risk. Indeed, the committee acknowledged the potential for establishment due to a match between the native climate and Florida, yet still estimated the risk of establishment to be very low, and described the species as one of the ecologically least risky species if establishment occurred. Characteristics of the zebra danio that contributed to the FISK score included use in aquaculture and aquarium industries, short generation time, and environmental tolerance.

The lack of variation between the two scorers suggests that scorers of differing experience with risk assessment, non-native fishes, and Florida's environment can arrive at a similar conclusion of risk using the FISK method. One scorer has over 15 years of experience with non-native fishes in Florida and has been involved in several risk assessments of fish or aquatic introduction pathways. The other scorer has about 1 year of experience. The ability of assessors with differing experience to arrive at the same answer is an important attribute of successful risk assessment.

Future research includes completion of the species literature reviews and scoring of species (4 scorers), calibration of scoring thresholds, and modifications to questions or scoring. Upon completion, the web-based Florida FISK will provide a tool for natural resource managers and regulators to screen species newly proposed for culture or importation but not yet introduced into Florida's environment and to integrate into existing risk analysis protocols.

REFERENCES

Copp, G.H., R.Garthwaite, and R.E. Gozlan. 2005a. *Risk Identification and Assessment of Non-Native Freshwater Fishes: Concepts and Perspectives on Protocols for the UK*. Science Series Technical Report 129. Centre for Environment, Fisheries, and Aquaculture Sciences (CEFAS), Lowestroft, Suffolk, UK. http://www.cefas.co.uk/publications/techrep/tech129.pdf.

Copp, G.H., R. Garthwaite, and R.E. Gozlan. 2005b. A risk assessment protocol for non-native freshwater fishes. *Applied Ichthyology* 21:371-373.

Copp, G.H, J.R. Britton, G. Jeney, J-P Joly, F. Gherardi, S. Gollasch, R.E. Gozlan, G. Jones, A. MacLeod, P.J. Midtlyng, L. Miossec, A.D. Nunn, A. Occhipinti-Ambrogi, B. Oidtmann, S. Olenin, E. Peeler, I.C. Russell, D. Savini, E. Tricarico, and M. Thrush. 2008. *Report D3.2 to the European Commission Coordination Priority Action FP6 2005-SSP-5A Project IMPASSE Environmental Impacts of Alien Species in Aquaculture*. Centre for Environment, Fisheries, and Aquaculture Sciences (CEFAS) Lowestroft, Suffolk, UK.

Copp, G.H., L. Vilizzi, J. Mumford, G.V. Fenwick, M.J. Godard, and R.E. Gozlan. 2009. Calibration of FISK, an invasiveness screening tool for non-native freshwater fishes. *Risk Analysis* 29:457-467.

Fuller, P.L., L.G. Nico and J.D. Williams. 1999. *Nonindigenous Fishes Introduced into Inland Waters of the United States*. Special Publication 27, American Fisheries Society, Bethesda, MD.

Gozlan, R.E. 2008. Introduction of non-native freshwater fish: Is it all bad? *Fish and Fisheries* 9:106-115.

Hardin, S. 2009. *Risk Analysis of Barramundi Culture at BRA-ROD, LLC, Final Report*. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Hardin, S., P. Zajicek, J. Hill, and K. Gestring. 2011. *Tilapia Risk Analysis Report*. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Hill, J.E. 2002. Exotic fishes in Florida. *LakeLines* 22 (1): 39-43.

Hill, J.E. 2009. *Risk Analysis for Non-Native Species in Aquaculture*. USDA/Southern Regional Aquaculture Center Publication No. 4304, Stoneville, Mississippi.

Hill, J.E. and K.A. Thompson. 2008. *Bioprofile of barramundi Lates calcarifer (Latidae), Final Report*. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL.

Hill, J.E., and P. Zajicek. 2007. National aquatic species risk analysis: a call for improved implementation. *Fisheries* 32:530-538.

Lockwood, J.L., M.F. Hoopes, and M.P. Marchetti. 2007. *Invasion Ecology*. Oxford, UK: Blackwell Publishing.

NISC (National Invasive Species Council). 2008. *2008–2012 National Invasive Species Management Plan*. National Invasive Species Council, Washington, DC.

Pheloung, P.C., P.A. Williams, and S.R. Halloy. 1999. A weed risk assessment model for use as a biosecurity tool evaluating plant introductions. *Journal of Environmental Management* 57:239-251.

RAM Committee (Risk Assessment and Management Committee). 1996. *Generic Analysis*. Aquatic Nuisance Species Task Force, Risk Assessment and Management Committee, Washington, D.C.

Shafland, P.L., K.B. Gestring, and M.S. Stanford. 2008. Florida's exotic freshwater fishes. *Florida Scientist* 71:220-245.

Zajicek, P.W., S. Hardin, and C. Watson. 2009a. A Florida marine ornamental pathway risk analysis. Reviews, *Fisheries Science* 17(2):156-169.

Zajicek, P.W., T. Weier, S. Hardin, J.R. Cassani, V. Mudrak. 2009b. A triploid grass carp risk analysis specific to Florida. *Journal of Aquatic Plant Management* 47:15-20.