COMMENTARY

Making Wise Decisions about Transferring Fish among Lakes within the Great Lakes Basin

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The management of Great Lakes fisheries is guided by Fish Community Objectives defined for each lake by the lake committees under A Joint Strategic Plan for Management of Great Lakes Fisheries. The lake committees meet twice per year in a Council of Lake Committees (council) to discuss issues of basin-wide concern to the Great Lakes. To achieve these objectives and satisfy stakeholder expectations for healthy fish communities and fisheries, fishery managers use a variety of tools. These include direct measures such as harvest restrictions, sea lamprey control, stocking, and habitat protection and improvement, as well as indirect measures such as advocacy for better ballast water exchange programs and for effective policies to govern water withdrawals. Among the direct measures are tactics, such as stocking, that can involve the transfer of fish from one part of the Great Lakes basin to another. The purpose of this essay is to examine issues surrounding the transfer of fish among lakes within the Great Lakes basin and to suggest a general process for decision-making to manage this practice wisely.

The decision to transfer fish is associated with uncertain benefits and risks. Fish transfers are considered or implemented for at least three different reasons: (1) to support restoration of depleted or extirpated native species, such as lake trout (Salvelinus namaycush); (2) to support economic opportunities for use of Great Lakes fisheries, through stocking of non-native salmonines; and (3) to increase effectiveness of sea lamprey (Petromyzon marinus) control efforts, through a sterile-male-release program. In all three cases, recommendations or decisions to transfer fish have been defended through a subjective assessment of the contribution the action is expected to make to the achievement of agreed-upon Fish Community Objectives. To date, there is little evidence that a defensible, uncertainty-sensitive approach has been employed to guide these fish transfer decisions. In the absence of such an approach, there is considerable risk that inappropriate decisions will be made.

Fish transfer decisions are no different from other fishery management decisions—they entail costs, usually borne by the public, and are expected to provide benefits that accrue to the Great Lakes ecosystem and to the public. Two current examples of fish transfer decision-making in the Great Lakes are the ongoing transfers of adult sea lampreys from Lake Ontario for release as sterilized males into the St. Marys River and the proposed re-introduction of bloaters (Coregonus hoyi) into Lake Ontario from the upper Great Lakes. For decisions like these, neither the costs—defined broadly, as discussed below—nor the benefits are fully known in advance; that is, they are uncertain. An objective decision process needs to carefully consider costs and benefits, as well as the uncertainty associated with both. Good decisions clearly balance benefits and costs while simultaneously accounting for uncertainty.

The costs of fish transfers such as stocking and species re-introductions are often subjectively viewed as small relative to the benefits. This happens because
the costs are viewed narrowly (i.e., only the labor and capital costs of the transfer action are considered) and because the benefits are assumed to be realized with a high degree of certainty (e.g., the re-introduction will be successful). The reality is that there are (or should be) other costs to consider, including the costs of assessing the risks of the fish transfer before taking the proposed action, and of assessing the consequences of the action (monitoring success or failure). Additionally costs (or risks that can lead to costs) can arise from unplanned and undesirable consequences of the action. The reality is also that fish transfer actions are not always successful.

Several undesirable consequences can arise from the transfer of fish including: (1) accidental introductions of pathogens or parasites that accompany the introduced species into the new lake; (2) introduction of exotic genotypes into a remnant native genotype; (3) unanticipated effects of the introduced species on other taxa in the extant food web; and (4) deterioration of the credibility of a management agency due to a failed introduction (“another waste of taxpayer’s money”).

The unintended transfer of pathogens can be especially problematic, because so few measures effectively prevent the spread of introduced pathogens. Because the Great Lakes are artificially connected to other drainages through canals and diversion structures, the effects of spreading a pathogen could extend well beyond the Great Lakes basin. As an example, viral hemorrhagic septicemia (VHS), a virus that can cause large-scale fish mortality, was recently discovered in parts of the Great Lakes (Elsayed et al. 2006). Clearly, fish managers should weigh the risks of moving fish very differently now, knowing that VHS is sporadically present in parts, but not all, of the system as opposed to the virus being absent from or ubiquitous throughout the Great Lakes.

In light of these potential undesirable consequences, one might wonder why fish transfers are contemplated at all. What are the benefits of fish transfers? In no particular order of importance, the potential benefits include: (1) re-establishment of extirpated native species; (2) suppression of undesirable species, either directly (e.g., sea lamprey control) or indirectly (e.g., salmon predation on alewife); (3) a more balanced and efficient food web (e.g., greater utilization of offshore benthic production by economically valuable fish species); (4) additional opportunities for resource use (e.g., valuable recreational salmon fisheries); and (5) reduced management costs in healthy, sustainable ecosystems.

Ideally, an objective, defensible process for deciding whether to transfer fish among the Great Lakes should properly account for all of these costs and benefits. In our experience, past decisions have not been based on such an accounting. Why not? Simply put, the costs and benefits are highly uncertain. This leads many decision makers and the staff that advise them to conclude that there is no way to meaningfully quantify costs and benefits; thus the arithmetic is not worth doing. Alternatively, decision-makers acknowledge that quantification may be possible, but consider the technical challenge beyond their capability. Sometimes, the disinclination to do the accounting may be motivated by a concern that the conclusion will be at odds with the desired outcome. Generally speaking, these are not good excuses.

What should decision makers do, then? How can they ensure that decisions to transfer fish will be based on a conscientious review of the action? We propose that the following steps be included in all analyses of fish transfer decisions:

1. Decide on and clearly define the objectives of management. No decision can be judged wisely except in terms of its expected performance at reaching management objectives.

2. Describe the expected benefits of the fish transfer decision (the action). To the greatest extent possible, these benefits should be described in quantitative terms. For example a transfer of sea lampreys from Lake Ontario to Lake Huron for the sterile male program should be enumerated in terms of the expected suppression of sea lamprey populations in Lake Huron that will result.

3. Describe the expected costs of the action. All possible costs should be documented, including both certain costs (labor, capital), and costs that arise from the risks of unexpected but plausible, undesirable consequences. Again quantification is critically important, but at a minimum a complete set of risks should be documented.

4. Determine how uncertainty about the benefits and costs affects the expected performance of the action. This step calls for some sort of decision analysis, wherein the expected outcomes of alternative choices (i.e., to transfer fish or not transfer fish) are compared after explicitly accounting for the uncertainty associated with each choice. See Figures 1 and 2 for examples.
5. Consider whether there is greater value in delaying the decision to learn more (reduce uncertainty) than in acting now. Sometimes the benefits of delaying a decision and subsequent action and actively seeking more knowledge about the problem can outweigh the expected loss of benefits that results from the delay. This determination can be aided by decision analytic approaches.

Completion of these steps will likely require the development of a model to represent the state of understanding of the system being managed and to simulate the possible consequences of alternative decisions. Models can be immensely valuable for this sort of analysis, if only because they provide a means to systematically organize what is known and unknown about a decision problem. Moreover, stochastic models can be used to examine the influence of uncertainty on the expected (average) performance of a decision, as well as quantify the likelihood of undesirable outcomes.

The process described above, and particularly step 4, is essentially a form of decision analysis (Peterman and Anderson 1999, Clemen and Reilly 2001). Decision analysis comprises a formal, systematic process for comparing choices in the face or risk or uncertainty. The process has become increasingly a part of fisheries management, particularly in the area of marine capture fisheries (e.g., Butterworth et al. 1997, Sainsbury et al. 1997, Punt et al. 2002) where it has been mainly used to examine alternative harvest policies in the face of uncertainty about exploited fish population dynamics. We have more recently applied decision analysis to Great Lakes fishery management issues, including sea lamprey control (Haeseker et al. 2007), Chinook salmon stocking, and percid harvest strategies, so Great Lakes fishery managers are gaining experience with these methods.

A challenging step of most decision analysis procedures is to accurately represent critical uncertainties. Clearly this will be the case for the fish transfer issue, where the ecological effects of an inadvertent pathogen introduction, for example, will be highly uncertain. Whenever possible, it is desirable to use formal statistical methods to quantify uncertainty based on available data. Bayesian statistical methods are especially valuable for this, not least because they allow analysts to combine prior knowledge about a quantity with new data. Often it is the case, however, that there are not sufficient data to allow a statistical assessment of an uncertain quantity. This should never be used as grounds to exclude a key uncertainty from an analysis; instead decision analysts should rely on expert judgment about the probable values for the quantity of interest, and subsequently assess the sensitivity of the conclusions to such assumptions about uncertain quantities.

It is also important to recognize that there is a broader context for this issue. Great Lakes fishery managers should examine the experience of other jurisdictions with similar issues. Concern for the risks of introductions and transfers of organisms is global in scope. For example the ICES Code of Practice on the Introduction and Transfer of Marine Organisms 2004 describes a detailed process for evaluating the risks of a planned introduction that at the very least provides a very useful checklist of risk factors to consider. A similar risk assessment procedure has been approved by the Canadian Council of Fisheries and Aquaculture Ministers in their “National Code on Introductions and Transfers of Aquatic Organisms.” The approach outlined in
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this commentary is compatible and complementary to these codes, but differs by seeking to explicitly place the risk assessment in a decision-making context rather than only documenting the risks as input to a subsequent decision-making process.

The Council of Lake Committees recently recognized the importance of fully documenting both the benefits and risks of fish transfer decisions. The council is currently developing a task group to evaluate and provide insight into potential intra-basin fish transfers. Based on discussions prompted by the framework we outline herein, the council supported establishing a Risk of Fish Transfers Task Group, composed of an epidemiologist, a fish pathologist, a population dynamics expert, a decision analysis expert, a population geneticist, a lake manager, and a technical fisheries biologist. This group should have the appropriate expertise to develop a generalized framework for evaluation of potential fish transfers. When specific cases arise, additional expertise about the particular lakes and fish involved could be added to provide the needed information and to assess uncertainty.

The task group could work in the following way. For the sea lamprey example mentioned earlier, the objective might be to maximize the suppression of sea lamprey reproduction in the St. Marys River, while minimizing the risk of an accidental introduction of a new pathogen into Lake Huron. The benefits to be quantified would include (1) increases in the ratio of sterile to fertile male sea lamprey in the river; (2) reduced recruitment of sea lamprey larvae; and (3) reduced abundance of parasitic sea lampreys in Lake Huron. The costs to be quantified would be (1) collection and sterilization; (2) screening animals for pathogens; (3) the risk and consequences of an accidental pathogen introduction; and (4) the costs of assessing the effects of the action. An ongoing debate among managers over bloater reintroduction in the Great Lakes basin would profit from similar objective setting. A need for specific evaluation of benefits and costs highlights the need for such a group in the region. Figures 1 and 2 depict simple decision trees for each of these examples. The decision trees illustrate the key elements of the decision problem: the choice (to transfer or not to transfer fish) is on the left; the outcomes, defined in terms of the management objectives, are on the right; the lines connecting choices to outcomes represent alternative choices and uncertainties about the possible outcomes. Models are commonly used to forecast the possible outcomes of each choice. Note that in these examples we only illustrate uncertainties associated with the “do transfer fish” option. This was done for simplicity only; we do not mean to imply that there is no uncertainty associated with the “do not transfer fish” option. A comprehensive assessment for either of these examples would entail many more uncertainties, but the basic concept remains the same.

In conclusion, decisions to transfer fish among lakes in the Great Lakes basin, however pure the motives, involve significant risks. Wise decisions will not be made if too much emphasis is placed on benefits, thereby biasing the outcome toward action, or on risks, thereby biasing the outcome toward inaction. A fair and balanced consideration of all plausible benefits and risks of a fish transfer decision is essential to defensible decision-making. The council is proceeding in this direction. We believe that no matter how large the uncertainty, a formal process for weighing benefits, costs, and uncertainties can and should be carried out. In fact, to execute a fish transfer decision in the absence of a formal, documented assessment is, in our view, irresponsible. We urge all management agencies contemplating the transfer of fish to develop an objective process to evaluate both benefits and risks of their actions.

ACKNOWLEDGMENTS

This commentary was developed from a presentation given by the primary author to the common session at the 2006 Lake Committee meetings held in Windsor, Ontario. We thank Chris Goddard, Kurt Newman, and three anonymous referees for many helpful comments on earlier drafts. This is contribution number 2007-06 of the Quantitative Fisheries Center, Michigan State University.

REFERENCES


Submitted: 9 April 2007
Accepted: 15 July 2007