EVALUATING THE DECISION PROCESS TO RESTRICT BLACK CARP (*Mylopharyngodon piceus)* IN AQUACULTURE: USING A DECISION PROTOCOL WITH ASSURANCE BONDING FOR RELEASING POTENTIALLY INVASIVE EXOTICS: [1.]

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Abstract:

The use and/or release of potentially invasive species are a concern to the public and the aquaculture industry. Used to protect channel catfish from flesh eating trematodes, the nonindigenous black carp has been evaluated by the U.S. Fish and Wildlife Service (USFWS) and deemed potentially "injurious" under the terms of the Lacy Act and may be restricted from interstate commerce and eventually removed from U.S. waters. An alternative approach to evaluating these risks is considered and compared to that used by the USFWS. Reasonable options to outright restriction likely exist, including better use of environmental assurance bonds and return-deposit models.

Key words:

Invasive exotics, nonindigenous species, environmental assurance bonds, return-deposit, black carp, catfish, aquaculture, trematode

Introduction

Intentionally released, either directly or indirectly, to generate various benefits to private agents and/or the public at large, nonindigenous species may adversely affect the indigenous fauna and flora and cause harm to humans and their enterprises. Aquaculture is one potential source of invasive aquatic species. Annually, scores of nonindigenous aquatic species are reared in ponds, raceways, pens, tanks and cages for the human food and pet industries.

While the efforts of the aquaculture industry to confine and/or restrict nonindigenous species may greatly lower the probability of a successful release and eventual establishment, many believe there are no guarantees of avoidance and the probability of an invasion remains greater than zero. For this reason some believe that all species used in aquaculture should be viewed as intentional releases and as potentially invasive. However, others argue that under controlled conditions, careful actions and mitigation plans, it may be possible to essentially guarantee against accidental escapes and invasions.

Traditionally, resource agencies evaluating nonindigenous species have used decision protocols that rely heavily on gaining *ex ante* (before-the-fact) information to help predict the likelihood of harmful outcomes. Due to the complexity of ecosystems, this approach is commonly costly and highly uncertain; consequently their success rate has been mixed at best.

In response to these ambiguous outcomes, and in an attempt to better integrate economics into the present decision process, Thomas and Randall (2000) introduced an alternative approach to evaluate the use of potentially invasive exotics that combines *ex*

ante information with revocable actions and economic incentives. This paper will use their approach to evaluate the present decision by the United States Fish and Wildlife Service (USFWS) to restrict the use of the nonindigenous black carp (*Mylopharyngodon piceus*) in Mississippi aquaculture.

The black carp, native to eastern Asia, was originally brought to the United States in the 1980's to help control the snail-linked parasites yellow grub and trematode. It has been determined that controlling these parasites hinges on controlling the intermediate host; ram's horn snail. These parasitic infections often either damage or kill the host fish, resulting in significant financial losses to aquaculture producers. As an effective snail predator, the black carp can effectively remove the ram's horn snail from closed production ponds and eliminate the parasitic threat from yellow grub and trematodes. It is the black carp's effectiveness as a molluscivore that gives it value to commercial aquaculture.

Many aquaculture producers contend that there is a need for the black carp unless a cost effective replacement, whether chemical or otherwise, can be found to deal with these parasites. Alternative snail treatments include copper sulfate and lime/citric acid, but these will only work in certain environments, i.e., where water is very hard (Bennett, 2002). Comparatively, the black carp is reported to completely eradicate the offending snail population over time.

Even though black carp have been in U.S. aquaculture for approximately 30 years, they have not escaped and become established in the "wild" (USFWS, 2002). However, it is possible for black carp to escape the confinement of aquaculture by accident, including flood or some other unintended pathway. Once free, survival of black

carp in riverine systems is likely and, once established, the spread of black carp throughout the U.S. would probably be assured (Nico et al., 2001) as evidenced by the grass carp, another Asian carp with similar reproductive requirements. An invasive black carp would likely compete for food with native species and may have a considerable impact on native mussel and snail populations and thus affect the food chain of native fish, turtles, birds, and vertebrates (Nico et al., 2001). If established in North American ecosystems, the black carp's feeding habits could drastically modify the ecological balance and forever change native aquatic systems (Nico et al., 2001; USFWS, 2002). These ecological impacts would likely lead to large and possibly widespread economic losses to many throughout the region.

Presently, black carp production is limited to several hatcheries located in Alabama, Arkansas, Louisiana, and Mississippi, and because the black carp has the potential to become an invasive exotic, the USFWS is considering official actions to restrict their movement between states, and eventually remove them from United States waters (Federal Register, 2002). The protocol guiding the USFWS's decision is the "injurious wildlife" provision of the Lacey Act, historically their principal method to settle questions regarding the release and/or use of nonindigenous species. While this paper is not intended as a commentary on the final actions recommended by the USFWS, it will evaluate their decision making process (Lacy Act) in light of the decision protocol proposed by Thomas and Randall (2000).

Analysis

In their discussion of decision protocols historically governing the use and/or release of potentially invasive species, Thomas and Randall (2000) found that many standard approaches are heavily dependent on collecting costly and uncertain *ex ante* (before – the – fact) information. Yet, often these exhaustive and costly efforts provide little definitive insight on the uncertain outcomes from a pending release, and they almost always conclude by calling for additional research. Thomas and Randall (2000) propose a modified approach that depends on a balance between *ex ante* information and taking only revocable actions. Additionally, they present a principal-agent model to address the problem of information asymmetry and taking revocable actions.

In their five-step protocol, Thomas and Randall (2000) describe a detailed process for a benign oversight authority (OA) that has been granted permitting authority over private agents desiring to use and/or release potentially invasive nonindigenous species. The following is an evaluation of the USFWS process from the vantage of the Thomas and Randall protocol. For the purposes of this evaluation consider the USFWS as acting in the capacity of an OA assessing a request from an aquaculturist who wishes to use the potentially invasive black carp.

Step 1; is there a possibility of a large social loss?

Thomas and Randall (2000) describe how the OA should conduct an initial review of the possible outcomes of releasing the nonindigenous species. The study should be initial in scope and allow the public to review and comment on its findings. If there is no

potential loss to third parties, the release should be permitted, otherwise the process should move to step two.

In a process very close to this protocol, the USFWS uses the Lacy Act to complete a step-by-step analysis of the likely outcome resulting from an accidental release of the black carp. They include a review of the biology and how it would possibly impact the native species of mollusks and other ecosystem components.

While they didn't perform any formal simulation of black carp dispersion within the local environment, the USFWS does discuss the possible worst case outcome. They detail the likelihood and vectors of escape and how the black carp could become established and spread to compete with local species and cause damage to local ecological systems. They also detailed how difficult it will be to eradicate (non-revocable) or rehabilitate (mitigate). They conclude that the black carp posses a significant danger to local ecosystems and could cause considerable harm (economic and otherwise) to human interests. For these reasons they consider the black carp as potentially injurious and propose restricting its use and spread within the U.S.

Step 2: Identify the parties potentially affected by the release.

When third parties may be harmed by the proposed release, Thomas and Randall (2000) call for the identification of those potentially facing harm. If these parties are easily identifiable and relatively few in number the releasing party should be required to proceed with the release only with the consent of all affected parties. This would follow a Coasian approach and permit markets to determine the efficient level of caution by those desiring to introduce the exotic species. The level of caution and compensation for any harm would be negotiated by the affected parties.

However, if the number and/or identity of the potentially affected parties are unknown the potential for non-efficient levels of uncompensated harm exists and the evaluation should move to the second stage. In the case of the black carp, the USFWS does this rather broadly and indicates that it believes the harm could be widespread and the impact may be large. This is likely an adequate evaluation and is based upon well documented releases of similar species (Nico et al., 2001).

If the first two steps reveal the positive probability of a significant loss to third parties and that the number of affected parties are numerous and/or unknown, Thomas and Randall (2000) call for the agent desiring the release to assume *ex ante* liability in the form of an environmental assurance bond (EAB). Additionally, they state that the OA should assure that the key information necessary to estimate the impact of an escape is collected and used in determining the level of bonding.

Particularly well suited to manage situations where the environmental outcomes are uncertain due to unclear timing, incomplete information and/or difficult monitoring and enforcement, EABs have been considered as an approach to manage shrimp farming in Texas (Mathis and Baker, 2002). This type of bonding is promising to environmental managers because two key components contributing to environmental damage caused by third party actions can be addressed; internalization of the environmental damage by the offending party and the existence of incentives to avoid shirking by those introducing the potential harm.

Costanza and Perrings (1990) describe how EABs have their origin in the materials-use fee and can serve to force parties that introduce potential harm (through environmental damage) to indemnify society and in effect internalize these social costs.

Shorgren et al. (1993) have identified a set of conditions they feel are needed for EABs to perform well:

1. Costs of the environmental damage should be well understood to help establish the value of the bond.
2. Activities that may cause the environmental damage or the actual harm itself needs to be easily observable.
3. The number of parties contributing to the environmental damage should be few and easily identifiable.
4. The time period between the action of the party and observable outcome (damage) should be short.
5. Environmental outcomes should be well known with little if any uncertainty.
6. There should be no irreversible effects. Actions that are irreversible should not be allowed.

While the second and third conditions are likely met with the captive-reared black carp restricted to closed aquaculture systems, many of the remaining conditions may be difficult to meet. Because of the extent and severity of local environmental harm that may result from an invasive black carp is so poorly understood, an *ex ante* estimate of this damage would be guess work at best. Additionally, it is uncertain how much time would expire between an escape and any noticeable environmental harm, or even how that harm would be manifested.

While many of Shorgren's conditions may be difficult to apply, EABs may still have applicability. It is relevant that the aquaculture industry has managed to avoid the successful escape of breeding black carp into the wild during their 30 plus years of

management (USFWS, 2002). While there remains a large degree of uncertainty in the environmental outcome of a successively invasive black carp, there seems to be very little uncertainty in their propagation and distribution within the aquaculture industry. Several states have already adopted restrictive aquaculture management policies which may have effectively reduced the chance of accidental escapes to near zero (Nico et al., 2001). In these cases, EABs could prove a useful tool in further encouraging black carp managers to continue their responsible behavior.

The Thomas and Randall protocol continues with the following five steps:

Step 3: *Ex ante* refinement of the worst-case social loss and revocability

This is a continuation of the first step. Information will continue to be collected to better define the estimate of the worst-case loss to third parties (society). This refinement of information will be conducted by the releasing agent and overviewed by the OA, but to speed up the decision process and avoid a drawn out and expensive research agenda, initial efforts should rely primarily on existing research and secondary data. The USFWS, or its representative, could review the results and judge the level and quality of this initial review.

Step 4: Financial coverage of the worst-case social loss

Based upon the results of Step 3, the USFWS would determine the worst case social loss and the potentially effected parties. Before the aquaculture firm could proceed with introducing the nonindigenous species, they would be required to provide an assurance bond to protect the public from any potential losses resulting from a successful invasion by the released species. If the firm is not able to provide this financial bond, the introduction is prohibited.

In their review of the black carp, the USFWS does not attempt to measure the potential worst case social loss nor suggest that aquaculture firms be financially liable for their actions. Instead, they estimate the potential economic harm to the aquaculture industry if the black carp is not used as a trematode control agent and conclude that it is relatively small compared to the potential damage of an accidental escape and conclude the black carp's use should be restricted.

Even though the USFWS ends their analysis here, the remaining step suggested by the Thomas and Randall protocol is informative and presented here as potential improvement to the decision making process.

Step 5: Conditions for release without private insurance

If the conditions are not suitable for a privately provided assurance bond, the OA may still desire to permit the release if it believes the potential social benefits from a release are significantly larger than the potential social losses. Under these circumstances, the OA becomes the insurer of last resort and in this role it should become more actively involved in the exotic species' management (Thomas and Randall, 2000).

In the case of the black carp, if one (either the USFWS or the aquaculture firms) can demonstrate that the potential benefit to society of using black carp (e.g., saving fish for human food) is clearly larger than the potential loss (e.g., possible extinction of several native molluscan species) then the USFWS, as an agent of the federal government, could de facto self-insure and permit the continued use of black carp.

Extreme care is the watchword for releases at this point. Because society (i.e., government) is self-insuring for a potentially large loss, all actions must be taken with due deliberation and supervision, and should work toward improving the accountability

of behavior by considering incentive compatible. This process can serve as a learning experience and, given enough time and care, reduce uncertainty about the means and methods of accidental escape, spread and damage.

EABs may again prove useful for the OA to help insure that the aquaculturist and other related agents take careful actions. For example, one could turn to the well known model of deposit – return bottles. Based on the materials – use fee, a bottle user is required to pay a deposit, refundable when the bottle is properly returned, or forfeited if the bottle is disposed of inappropriately (litter). Forfeited deposits are retained by society to cover the environmental loss of litter. Bottle users are less likely to shirk and litter if there is an economic deposit they can collect by disposing of the bottle in the environmentally correct manner for a refunded deposit, or if there is another purposefully collecting litter to obtain the refundable deposits.

An example EAB: Deposit – Return System

Most catfish producers hire private contractors to harvest and to transport their catfish to the processor. During a typical harvest, many undesirable species (by-catch), including black carp intentionally stocked into ponds to reduce fish deaths from trematodes, are removed and either returned to the pond, or tossed along the shoreline to die. Some of the by-catch avoids initial removal and is transported to the processor where it is extracted and safely discarded as waste. However, fish tossed along the shoreline are not always accounted for, and with nearby ditches and other waterways, this process becomes a potential vector for black carp escape. With a relatively simple two step deposit-return procedure, the handling of black carp during catfish harvests could be

made more accountable. In the first step (initial deposit), the black carp breeders could be required to register and certify each triploid sold; uniquely identified with a pit or coded wire tag inserted in a common location (e.g., the head). When a black carp is purchased, the catfish aquaculturist would be required to pay a refundable deposit of $X. The black carp breeder could be required to keep records of fish sold by identification number, and hold the deposit funds in escrow.

In the second step (deposit refund), the deposit of $X would be paid to any person returning a pit or coded wire tag uniquely identifiable as belonging to a black carp in the deposit-return system. This could be either the tag itself, or still embedded in the fish's body, so long as the tag's removable assures the fish's death. The redemption locations would need to be readily accessible, perhaps county, state or federal offices of (e.g., the Mississippi Department of Fish and Wildlife, or some other similar organization). Unredeemed deposits (fish that die in the aquaculture ponds or escape) would be considered a cost of using black carp and their unclaimed proceeds would help fund the system's operation. This system could also provide bounties to anglers who catch black carp in the wild by fining specific owners of the escaped fish and using this money to supplement the original deposit of $X. Over time with unredeemed black carp tags accumulating a pool of money would be available to address environmental damage if black carp do escape and cause damage to indigenous species.

By permitting anyone to collect the black carp deposit, there will be more accountability of individual fish. Catfish aquaculturists and workers seining the pond will have incentives to account for these fish and claim the monetary deposit. The bounty

on wild-caught black carp provides economic incentives to sport and commercial anglers to catch and remove these fish.

There could be several benefits to catfish producers resulting from a deposit – return system; improved accuracy in the deductions made against the pond-side harvest weights for trash fish and knowledge of average black carp length of service. Likewise, the USFWS could enjoy benefits from a deposit-return system, including; improve accountability for individual black carp, a better understanding of the life history of black carp and a better internalization of the external costs associated with using black carp.

Conclusion

Overall the USFWS approach closely mirrors the Thomas and Randall (2000) protocol during the first two steps, however in the next two steps there are several principal points of departure that emerge. After recognizing that the potentially affected parties are numerous and difficult to identify, the USFWS makes no attempt to require financial assurance to protect these unwitting third parties. Instead, they do a brief review of federal laws that define how their ruling will impact the private parties who desire to introduce the potentially invasive exotic. Then they estimate that the impact of not permitting aquaculture to use the black carp is less than $100 million, but they provide little supportive evidence for this conclusion, or even why they would be in a position to know this figure.

From an incentive compatibility perspective, there is a fundamental flaw with requiring the USFWS (as the OA) to estimate the scope and type of harm the releasing agent might experience if not permitted to use the exotic species. Without the first-hand

experience of being in the aquaculture business, the USFWS would be required to rely on production and cost information provided them by the industry. The industry has incentive to present information favorable to their case, casting doubt on any conclusions based on these estimates. On the other hand, if the OA has a vested interest in not permitting the release (e.g., management goals to protect indigenous species); it has the incentive to underestimate the hardship to the industry. There is an inherent problem with the command-and-control approach to management; the incentives are backwards. Here we see the USFWS trying to justify its decision based on the "small" economic impact to aquaculture by restricting the use of black carp and ignoring the potential damage to third parties (public at large). The industry is in the best position to estimate these costs and the OA should focus on estimating the potential costs to society.

By moving the process beyond the first two steps and requiring the aquaculture firm to post a financial assurance against mistakes, Thomas and Randall (2000) suggest the incentives are there for agents to act in responsible ways. The use of EABs has had measured success in some historic environmental settings, perhaps most notably in strip mine restoration. Assurance bonds are financial obligations to insure the proactive agent can indemnify other agents for financial losses resulting from a release that has gone badly. If the action is deemed safe then the bond is refunded, providing an incentive for the releasing agent to exercise due caution in their actions and take all measures to avoid an accidental establishment by the exotic species. The releasing agent is required to post a financial bond equal to the amount of the worst-case loss assuming the introduced species escapes and becomes established and invasive.

The use of assurance bonds helps any regulatory agency avoid the problem of information asymmetry by removing the problems of hidden actions and/or hidden information. The bonding approach puts the emphasis on the party that desires use of the exotic species, knowing an accidental release could occur, but is willing to accept that risk. The USFWS should establish that those who desire to use exotic species become fully liable for damage and that they post a bond equal to the potential loss, placing the onus on the aquaculture firm to determine an initial estimate of loss that can be independently verified. When traditional EABs are not practical, variations, such as the deposit-return model, might add needed accountability and improve the likelihood of careful actions by agents handling the potentially invasive species.

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