Utilizing Harvest Incentives to Control Aquatic Invasive Species

Issue

Invasive species are estimated to cause the United States tens of billions of dollars in environmental and economic damage each year (Pimentel et. al. 2005). Prevention, containment, and control of invasive species are necessary to protect native species and ecosystems, economic development, and human health; however, such activities require financial resources and time. Recently, there has been significant interest in managing invasive species populations by encouraging the harvest and/or consumption of these species for various purposes. Examples of programs that encourage harvest and use of invasive species with an associated incentive include:

- *Bounty Program* – A financial incentive program in which a predetermined amount of money is paid to an individual upon satisfactory evidence of collection of a specified organism.
- *Contractor Payments– A* program that provides direct payment to a service provider to remove or harvest a species.
- *Commercial Market* – An effort that is undertaken, usually privately, when a perceived market exists for a species and it can be harvested for sale in the free market.
- *Recreational Harvest* – Recreational fishing, hunting and trapping of invasive species may be enhanced by modifying seasons, license requirements, bag limits and other regulations.

Many harvest incentive programs have demonstrated success in reducing numbers of non-native species (e.g. Bomford and O'Brien 1995, Choquenot et al. 1998, Riley et al. 2004), opening up the possibility that financial incentives may have potential to reduce, or even eradicate, invasive species populations. However, some reviews (e.g. Hassall and Associates 1998, Bartel and Brunson 2003, Barbour et al. 2011) have portrayed bounty incentives as a problematic tool for invasive species management. These reviews have reported such programs as ineffective, damaging, costly, and producing a poor return on investment compared to other available control measures. Until a thorough analysis is conducted, incentive programs that aim to manage invasive species should only be undertaken following careful consideration of the biological, ecological, and socioeconomic specifics of the targeted species. Furthermore, these programs should only be implemented if there are effective methods to ensure removal of the species and a strong commitment to accomplish program goals and objectives.

In general, incentive programs are one control strategy that can be used to compliment a species management plan. To incorporate incentive programs into a species management plan, there must be a clear vision of the desired goal or outcome, a robust strategy to achieve the goal, and thoughtful outreach that addresses a variety of stakeholders. It is critical to recognize that program goals will vary based on biological, ecological and socioeconomic considerations. The goals or outcomes of incentive programs will vary and may include a) species eradication, b) maintaining a specific population size, c) reduction or control of the number of a species, and d) engagement of the public in invasive species issues. Typically an incentive program will help achieve the overall goal of the species management plan. Multiple strategies that employ adaptive management may be the most effective in achieving the identified goal. Incentivizing or encouraging harvest may not be the most effective method of control or may need to be employed in tandem of other efforts. Careful analysis should be conducted to select the method(s) that will produce the best result for the least cost and that is both socially and legally acceptable. Harvest is just one of several tools that need to be evaluated.

This white paper, adopted by the Invasive Species Advisory Committee (ISAC), a Federal Advisory Committee to the National Invasive Species Council (NISC), will:

- Discuss the biological, ecological, and socioeconomic considerations involved in programs that utilize harvest incentives.
- Discuss options to develop cost-effective control of invasive species through the use of incentives that encourage harvest or removal.
- Provide recommendations to consider when developing, implementing, or encouraging incentive programs or harvesting efforts that target invasive species.

Biological Considerations

Knowledge of Population Dynamics

As with other control methods, harvest incentives are generally not an option for species eradication. Invasive species exhibit distinct life history traits that enable them to thrive in new habitats. Consequently, the traditional management principles applied to managing game or endangered species may not be directly applicable to invasive species management. Understanding the population dynamics and life cycle of the target species is the foundation for the successful management of invasive species (Barbour et al. 2011). Therefore, prior to applying an incentive program to an invasive species management plan the population dynamics of the targeted species (e.g. density dependent processes, demographic structure) should be examined.

Calculation of Removal Rates

Knowledge of the factors that influence population dynamics, including structure and recruitment, must be examined to meet the objectives of the harvest program. Specific types of removal methods and removal rates may change during the course of the program and may need to be reexamined.

Overcompensation

The removal of targeted invasive species may lead to undesirable consequences if demographic structure and density-dependent processes are not considered. For example, removal of surplus individuals may improve survival for those that remain (Zipkin et al. 2009). In these circumstances, increased mortality may increase population abundance as a reduction in numbers is offset with higher reproductive and survival rates due to an increase in available resources (Caughley 1977).

Population Monitoring

Monitoring the population of the target organism is essential to determine the effectiveness of the program; ideally the target organism must be detected at low densities and found relatively easily. If it's cryptic or located in an isolated area, an inhospitable environment, or an area that cannot be easily accessed, the effort required to remove individuals will be high. Incentive programs often lose their effectiveness once the target species becomes rare and the effort needed to capture the remaining individuals is high (Bomford and O'Brien 1995, Dedah et al. 2010).

Ecological Considerations

Management of invasive species through harvest may have unintended consequences on native species and cause potential damage to non-target species. Native species populations may be impacted directly though

by-catch or increased human activity; however, ecological complexities may also result in unexpected consequences for these species. Given the complex interactions among species and their environment, it is difficult to predict the outcome of the removal of invasive species. Therefore, careful evaluation of the functional roles of invasive species within the ecosystem and trophic interactions with native species prior to initiating any harvest program is encouraged.

Human Health Impacts

Incentive programs can involve members of the public who may be untrained in the proper methods of capturing and handling the target species. This lack of information can have serious consequences. For example, lionfish (*Pterois* spp.) tournaments and derbies have risen in popularity and serve as a means to raise awareness and manage growing populations of this invasive species regionally. However, improper handling of the fish can lead to envenomation from the spines (Morris 2012). Even when harvested by professionals, there are concerns for encouraging the harvest of invasive species which may pose public health risks.

Socioeconomic Considerations

Managers must consider various socioeconomic factors in choosing and designing an effective harvest strategy. Often harvest incentives are implemented in response to public demands for such programs. Managers must weigh the social and political consequences of implementing, or not supporting, harvesting incentives against the potential benefits and risks to the resource. Resources managers must consider both monetary and environmental costs of such programs, while advocates for harvesting incentives may be more focused on perceived benefits. Conflicts may arise from differing perceptions between risk-adverse managers and risk-taking entrepreneurs.

Nutria Harvest Has Variable Utility

Nutria have significantly invaded both Chesapeake Bay and Louisiana marshes. Chesapeake Bay officials decided to pursue eradication because the population size (±100,000) is small enough to allow for eradication given available resources. Rather than encourage public harvest, the program began with a "knock-down" phase where high density populations could be found and traps, firearms, and dogs could be easily employed. As the population density decreased, the program switched to other methods. Because bounties are illegal in Maryland, the program relies on wildlife specialists from the U.S. Department of Agriculture (USDA) for complete eradication. In contrast, hundreds of thousands of nutria exist in Louisiana (Jordan and Mouton 2011). As the Louisiana Department of Wildlife and Fisheries (LADWF) noted, "Currently in Louisiana, there is no known method that will completely eradicate nutria, nor is it a viable option." Instead of pursuing eradication, Louisiana's Coastwide Nutria Control Program "consists of an economic incentive payment of $5 per nutria tail delivered by registered participants to collection centers established in coastal Louisiana. The goal of the Program is to encourage the harvest of up to 400,000 nutria annually from coastal Louisiana." (LADWF Web site, accessed April 19, 2012).

Market Economics and Perverse Incentives

Using harvest incentives successfully will depend in part on the value of the harvested commodity, the cost associated with the harvest, and the minimum profit acceptable to the harvester. As noted earlier, the marginal cost and effort needed to capture the species is expected to increase as the population decreases. Thus, managers need to plan accordingly by either raising bounties (if used) or employing other control mechanisms should demand lessen. In some cases the use of supplementary control methods may enhance the effectiveness of the program; in others the concurrent use of control methods may reduce the economic viability of harvest programs. Careful planning can help anticipate and mitigate these issues.

Perhaps the biggest challenge to using incentivized harvest is its potential to generate perverse incentives that could unintentionally cause the further spread of the target species. For example, people may come to rely on the income that harvest incentives generate or may develop a "taste" for the species and value its long-term presence. These perverse incentives may encourage the intentional release of species back into the control area or into previously non-invaded areas. Such activities have been observed as part of traditional restoration activities, where people have "seeded" favorite nonnative gamefish into areas that had been restored for native fishes. Furthermore, individuals that perceive incentivized harvest as a benefit in one region may intentionally introduce the species into new regions.

A Multifaceted Approach to Species Management

Adoption of a harvest program is under review for the Asian carp of the Great Lakes. A recent study explored factors involved in driving down carp populations in the Mississippi River. Garvey et al. (2012) identified a number of key issues if market approaches are to be utilized effectively including re-colonization potential during harvest, nutritional composition of fish, and how an incentives program might function.

The study noted developing a diverse market could be effective as a control activity. For example, rather than focusing solely on large fish, all sizes of carp must be harvested to create effective population control; thus different size fish would require different markets.

The study highlights the need to invest in baseline research to develop an effective strategy, as simply encouraging the public to "go forth and use" will almost certainly not achieve desired goals of eradication. However, combined with an understanding of the target species biology, harvest incentives may play an important role alongside other control measures.

In some cases where the species has reached low population levels but cannot be eradicated, the continued harvest of the species may not benefit the program. In these instances managers may choose to reclassify the species as a nonnative and may need to shift to management that allows the presence of the species at low population levels. Such an approach should be considered a means of last resort, as it means accepting irreversible changes in the local ecosystem and adopting the invasive as a permanent presence, an approach that is generally not preferred (Lambertucci and Speziale 2011).

Legal Issues

In choosing an effective management strategy, managers also need to consider existing laws. Invasive species management with the use of harvest incentives is complex when multiple jurisdictions are involved. Federal and state agencies often have differing policies or restrict certain harvest activities. For example, during the "2013 Python Challenge", sponsored by the Florida Fish and Wildlife Conservation Commission, Everglades National Park, was not open to public hunting whereas the adjacent Big Cypress National Preserve and state lands were opened to python hunters. Legislation may help encourage or allow access to all lands to ensure all individuals in a population have been removed.

Further, the market may demand species to be supplied in a variety of ways, but bringing those species to market does not comply with federal restrictions. For example, certain markets may prefer live Asian carp, but their listing as injurious wildlife under Title 18 of the Lacey Act prohibits live interstate and cross-border movement. Specific legal constructs may not be able to accommodate market demands particularly when measures have been taken to minimize further introduction.

Outreach

Regardless of which mechanism is selected for control, strong public outreach is essential. When the public understands and accepts the need for control then a successful incentivized harvest program can be realized. In order to build support for the program and encourage active participation, outreach should communicate the impacts of the target species on the environment, economy, and public health. It can also generate financial support for the effort from decision-makers and ethical support from a community that may not favor the killing of large numbers of animals for moral, emotional, or cultural reasons.

Stakeholder engagement can also help resolve possible differences prior to program implementation. For example, what is considered a pest by one person is an essential income source to another and a source of recreational pleasure to a third. Outreach, and facilitated discussions with the public as needed, can help resolve disputes before program implementation begins.

There may be situations in which the incentivized harvest is promoted to provide an outreach benefit; not for any level of species control. In these cases, the harvest activity becomes the vehicle through which a message is communicated. An example of this type of program is the "2013 Python Challenge" which provided significant incentives for the harvest of constrictor snakes in southern Florida. While this effort resulted in few individuals removed from the population, the attendant media coverage provided very significant outreach benefits.

Conclusion

As with other control and management options for addressing invasive species, success will depend upon numerous biological, socioeconomic, and legal considerations. Programs that encourage harvest may be a successful management tool in targeting small, distinct populations, in high priority areas within a larger invasion or they may play a supplementary role within larger control programs. Their use, however, will require careful review, planning, and monitoring to ensure success and that they do not unintentionally lead to further spread of invasive species.

Recommendations

Incentivized harvest is just one type of strategy used to manage and control invasive species. As dedicated funding for invasive species management is limited, resource managers should conduct a basic analysis of various options based on the species life history and socioeconomics to identify the most effective solution. The anticipated costs and risks of eradication should be weighed against long-term control and management that mitigates damage to an acceptable level. ISAC recommends the following be considered before implementing any harvest incentive program:

1. Prior to undertaking a harvest incentive program a management plan and objectives should be developed that incorporates each of the following
    a. Assess the risk of creating perverse incentives –Before initiating a program, identify what risk exists and include a plan to address/reduce perverse incentives.
    b. Understand the costs - Once the decision has been made to reduce numbers of a specific invasive species, then costs of various potential control methods should be compared to identify the most cost-effective method.
    c. Research the target species' population dynamics - Managers should determine the program's impact on the target population. This requires an understanding of the relationship life history characteristics of the target species.

d. Identify human health risks - Before managers encourage consumption, they should ensure that the target species does not pose a significant risk to human health through handling or use for its intended purpose.
e. Understand potential ecological outcomes - Invasive species alter biodiversity and ecosystem processes, thereby their removal may result in unexpected consequences. Species interactions and effect of removing a dominant invasive species from the system should be evaluated prior to program start.

2. In addition to the considerations given to any control effort, the following actions should be incorporated into the implementation of any harvest incentive program
    a. Monitor for unintended consequences - Incentive programs and commercialized harvest of invasive species may create perverse incentives that do little to encourage long-term control or eradication.
    b. Incorporate adaptive management. - Harvest may work early on when there are large, easily accessible populations, but other control measures may be needed as species density declines.
    c. Address humane treatment - Processes for humane treatment of target species, including euthanasia, should be established.

3. Incorporate Outreach
    a. All outreach should be clear about the goals of the program to ensure public support.
    b. Unless a sustainable market is the goal, outreach should help ensure that public does not grow to "want" the targeted species. Success is more likely if the public understands the long-term harm the species can cause.
    c. Active enforcement can also help avoid mitigate perverse incentives by offering a counterincentive to release.
    d. When outreach is the primary objective of the harvest program be sure to carefully plan for maximum media exposure.

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