AFS Completes Assessment, Issues New Guidance Regarding Hatchery Operation and the Use of Hatchery-Origin Fish

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BACKGROUND

The American Fisheries Society (AFS) is the oldest, largest, and most influential professional organization devoted to fisheries conservation and, in this capacity, the AFS has routinely assessed the contributions of hatcheries to natural resource management and issued recommendations to guide natural resource managers in best uses of hatchery-origin fish. For the past several decades, the Society has explored these issues in a formalized process conducted at approximately 10-year intervals to assess contemporary issues related to hatcheries and management of aquatic resources. Representatives of the Fish Culture and Fisheries Management Sections came together in 1985 to answer the question "Fish culture—fish management's ally?" in a symposium entitled "The Role of Fish Culture in Fisheries Management." In 1994, AFS reexamined the issues of fisheries enhancement in the context of emerging ecosystem-based approaches to resource management in a symposium and workshop entitled "Uses and Effects of Cultured Fishes in Aquatic Ecosystems." A similar process was undertaken in 2003–2004 to once again review the uses of hatchery-origin fish and new scientific findings in the course of a symposium, web-based survey of fisheries professionals, and a facilitated workshop, collectively referred to as "Propagated Fishes in Resource Management (PFIRM)." Each of the previous cycles yielded a proceedings book (*Fish Culture in Fisheries Management* [Stroud 1986], *Uses and Effects of Cultured Fishes in Aquatic Ecosystems* [Schramm and Piper 1995], and *Propagated Fishes in Resource Management* [Nickum et al. 2004]), and most recently a guidance document, "Considerations for the Use of Propagated Fishes in Resource Management." The so-called "PFIRM Considerations" guide, published by AFS in 2005 (Mudrak and Carmichael 2005), provided resource managers with general recommendations for decision making and successful implementation of fisheries supplementation, rehabilitation, and restoration programs.

In response to fisheries management policy changes that have occurred, newly available information on supplementation and rehabilitation, and fisheries issues that have arisen since the previous cycle, AFS President William Fisher established a steering committee in 2012 to reengage the Society in the next cycle of this iterative process. Dubbed "Hatcheries and Management of Aquatic Resources (HaMAR)," the process brought together Doug Bradley, Tom Flagg, Kurt Gamperl, Jeff Hill, Christine Moffitt, Vince Mudrak, George Nardi, Kim Scribner, Scott Stuewe, John Sweka, Gary Whelan, and Connie Young-Dubovsky under the leadership of Jesse Trushenski and Don MacKinlay to represent interested AFS Sections and the perspectives of state and federal agencies. They were subse-

quently joined by Jay Hesse and Ken Leber, Kai Lorenzen, and Lee Blankenship to represent tribal/First Nation perspectives and the Science Consortium for Replenishment of the Oceans, respectively. Collectively, this committee worked to develop, organize, and implement the HaMAR process.

The HaMAR committee's work began with a scoping survey to give voice to a diverse cross section of fisheries professionals in identifying contemporary issues of concern. The respondents highlighted a number of critical issues related to hatcheries, hatchery-origin fish, and fisheries management.

Based on these priority topics, presentations were solicited for symposia held at the AQUACULTURE 2013 conference (Nashville, Tennessee, February 21–25) and the AFS 2013 Annual Meeting (Little Rock, Arkansas, September 8–12). With assistance from organizers of the HaMAR special publication module, Des Maynard (see below), and Past President of the Fish Culture Section, Jim Bowker, the HaMAR steering committee worked to distill the symposia into a new guidance document, "Hatcheries and Management of Aquatic Resources (HaMAR) Considerations for Use of Hatcheries and Hatchery-Origin Fish." This process included multiple rounds of drafting and revision, followed by consideration and approval by the AFS Governing Board on 16 August 2014. The full text of the "HaMAR Considerations" guide will appear in forthcoming special issue of the *North American Journal of Aquaculture*, along with a series of papers derived from HaMAR-related symposia presentations. The "HaMAR Considerations," summarized below, represents an update and expansion of the previous "PFIRM Considerations" and is intended to provide aquatic resource managers with timely and comprehensive guidance regarding hatcheries and their products.

Executive Summary of "HaMAR Considerations"

Summary of Findings from PFIRM

The PFIRM process identified seven primary concepts that remain informative and should be considered when stocking fish:

1. Comprehensive fishery management plans. Comprehensive fishery management plans should guide resource managers through the choice to stock fish, evaluate stocking programs, and manage fisheries in an adaptive, responsive fashion. The comprehensive management planning process should recognize and consider alternatives to stocking and include inputs from various resource partners. When stocking is delineated, specific goals and objectives should be considered. Objectives should be specific, measurable, accountable, realistic, and time-fixed.

2. Biological and environmental feasibility. Decisions to stock propagated fishes should be predicated on science-based evaluations that indicate that the environment can support the stocked fish and stocking will achieve the identified management objective(s).

3. Risk and benefit analysis. Scientific evaluations should be conducted to determine what effects stocked fishes may have on the environment and native and naturalized biota (including humans) and what benefits and risks various approaches may yield.

4. Evaluate potential beneficial or harmful effects of increased and directed public use of aquatic environments on biotic (including human) communities. Particular caution should be exercised if introducing fish to an area where they did not occur previously.

5. Economic evaluation. Benefits and costs should be comprehensively evaluated and quantitatively described as accurately as possible.

6. Public involvement. Keep the public informed about pending changes in fisheries management, encourage dialogue on potential changes, and provide a forum for public input. Moreover, when appropriate, educate the public on legal and interjurisdictional issues, including tribal/First Nation treaty rights and responsibilities.

7. Interagency cooperation. Share technical science-based fisheries information to strengthen interagency coordination and interjurisdictional fisheries monitoring programs. Recognize regulatory and legal differences for the United States, Canada, Mexico, tribes, provinces, states, territories, and federal lands such as national parks and military reservations.

The "PFIRM Considerations" provided a good summary of issues considered important at the time for fisheries managers to use in their comprehensive planning process and subsequent decisions involving the potential use of stocked fishes. We consider these key issues to still be a primary need for resource managers in developing fisheries management plans that include stocking propagated fish.

Priority Shifts Identified during HaMAR

The HaMAR scoping survey respondents were asked to assess the current relevance of the major elements identified in the "PFIRM Considerations." More specifically, they were asked to identify which three of the seven elements they considered to be the most important in terms of contemporary stocking programs. The responses received made it clear that the "PFIRM Considerations" remain relevant, but there is now even more emphasis on integrated management and a need for greater specificity in considering the use of hatcheries and hatchery-origin fish. In particular, the following priority topics were identified during the HaMAR process as being particularly relevant.

Habitat Restoration and Management Efforts as Companions to Stocking

Whereas the focus of the "HaMAR Considerations" guide is the use of hatcheries and hatchery-origin fish, it is imperative to note that stocking is just one leg of the "three-legged stool" of fisheries management: stocking for supplementation is unlikely to be successful in the absence of complementary habitat rehabilitation and harvest management strategies.

Establishing Appropriate Uses for Hatchery-Origin Fish and Defining Expectations for Stocking Programs

Hatchery-origin fish are used to achieve a number of management objectives, and appropriate propagation and stocking methods vary based on the intended use of the fish. It is impossible to apply the principles of adaptive management if goals and objectives are not clearly articulated and agreed to by decision makers and stakeholders. Stocking may or may not be an effective management action, depending on the targets identified for the fishery and the current status of the receiving system. If quantitative assessments indicate stocking are advisable, species selection processes should take a broad range of biological, economic, and risk management criteria into consideration.

Understanding the Limitations of Hatchery-Origin Fish and Stocking Programs

Hatcheries and hatchery-origin fish are an essential component of many fishery management plans. However, there are limitations to stocking, and failure to recognize and address these limitations is likely to yield less than desired results and unintended consequences. Successful enhancement programs are closely connected to the fishery management process and are integrated with ongoing fishery monitoring programs. Flexible/adaptive management of hatcheries, conducted in concert with that of fisheries management plans, enables refinement, progress, and success in stocking programs.

Monitoring and Flexible/Adaptive Management of Stocking Programs

It is absolutely essential that fishery management plans include preestablished timelines and criteria for evaluating enhancement and deciding whether to continue, modify, or terminate the stocking program. The specific objectives and benchmarks of effectiveness will vary from one situation to another depending on the stakeholders involved and their values. The decision to continue or discontinue a long-standing stocking program can be fraught with political discord without agreed-upon criteria and quantitative measures to reference. Monitoring provides decision makers with the evidence needed to objectively evaluate enhancement effectiveness.

Hatchery Operation and Propagation Techniques

- Types of enhancements and complementary modes of hatchery operation. Not all fish tolerate the same environmental conditions, and husbandry methods vary substantially among the hundreds of finfish species that are reared throughout the world. Just as propagation techniques vary from fish to fish, what constitutes "best management practices" for a hatchery depends on the operation's requirements. Much progress has been made toward defining common stocking strategies; however, standardized terminology and definitions remain elusive. We encourage adoption of standardized terms to broadly characterize managers' expectations of the hatchery origin fish and help to frame the principles of hatchery operation and propagation methods. With this in mind, it is important to recognize that many hatcheries are functional hybrids, operating as harvest augmentation, supplementation, or conservation hatcheries by turns or simultaneously to produce various fishes in a manner consistent with their intended uses. Clear and well-documented objectives are essential for all hatchery programs, especially facilities rearing fish for different uses.

- Conflicting mandates. During development and operation of hatchery programs, managers are often faced with having to address competing and often conflicting objectives or mandates. Achieving a scientifically defensible but socially acceptable balance between harvest and conservation has proved to be challenging in many situations, both politically and biologically. To be considered successful, hatcheries should be used as part of a comprehensive strategy where habitat, hatchery management, and harvest are coordinated to best meet resource management goals that are defined for each population.

- Controlling the costs of hatchery operation. Feed cost and effluent management are increasingly critical constraints for hatcheries: flat or declining budgets and stricter oversight of water usage make the prospect of producing the same or greater numbers of fish a difficult, if not impossible, proposition. The costs of hatchery operation will continue to increase as a result of increasing feed prices and/or the need to implement more robust water treatment methods or transition to more intensive, water reuse–based rearing systems. Though reductions in effort or hatchery closures may offer short-term savings, it is important to recognize that curtailing hatchery programs will undoubtedly have broader economic consequences. In assessing their costs, the value of hatchery programs and their products must also be considered.

Culture of Imperiled Species and Conservation Hatcheries

The operational approaches and measures of success for a conservation hatchery may differ considerably from those of harvest augmentation/production or supplementation hatcheries. The mission of a modern conservation hatchery is twofold: gene pool preservation and recovery. Each conservation program will be site specific and depend on the physical and management limitations of each individual hatchery. The exact application of conservation hatchery strategies will depend on the particular stock of fish, its level of depletion, and the biodiversity of the ecosystem but will generally involve rearing protocols to maximize genetic diversity and the inherent fitness of the fish to survive and breed in its natural environment. In the future, creation of gene banks using cryopreservation and other biotechnological tools for reproduction may be increasingly important in the preservation or production of rare aquatic organisms.

Fish Health and Access to Disease Management Tools

Successful hatchery programs take a comprehensive approach to aquatic animal health, including use of biologics (i.e., vaccines and bacterins), biosecurity measures, and other preventative strategies; use of therapeutants and other disease management techniques; broodstock conditioning and spawning; marking progeny; and reducing handling stress. Many of these activities require administration of fish drugs, including antimicrobials, spawning aids, marking agents, and sedatives. To maximize the effectiveness of drug treatments and remain compliant with relevant regulations and aquatic animal health plans, hatcheries have a responsibility to ensure that staff know what drugs are legal and how to apply them correctly.

Biosecurity

"Biosecurity" refers to practices used to prevent the introduction and spread of disease-causing organisms and nuisance/invasive species. Biosecurity is commonly associated with disinfection, but comprehensive biosecurity plans can go well beyond simple disinfection procedures to include everything from facility layout and design, to livestock sourcing and quarantine, to record-keeping. Although many common fish pathogens and parasites are present in virtually all environments and are difficult or impossible to eradicate, others have a regional distribution or are easier to avoid or contain. In any event, biosecurity is an essential first line of defense against introduction or transmission of undesirable organisms.

Strategies to Maintain Genetic Integrity and Diversity in Hatchery-Origin Fish

Proper genetic management of and spawning strategies for hatchery-origin fish are critical to maintaining genetic diversity, minimizing inbreeding, maximizing effective population size, and reducing artificial selection. The degree to which these elements are intensively managed depends, in part, on the type of hatchery and intended use of the hatchery-origin fish. Various spawning strategies can be employed in hatcheries that can maintain genetic diversity, minimize inbreeding, maximize effective population size, and reduce adaptation in captivity and upon supplementation of these fish into wild populations.

Biological and Other Interactions between Wild and Hatchery Fish

Much of the concern over interactions between hatchery and wild fish has centered on genetic effects of hatchery fish on wild populations, and hatchery management strategies are often in place to minimize genetic risks. However, ecological effects may be just as important as genetic effects and should be considered when releasing hatchery origin fish into the wild.

Responsible use of hatchery fish in sympatry with wild fish should strive to minimize risk of negative interactions with wild populations, and a number of strategies may be applied to mitigate ecological risks from hatchery programs.

Risk Assessment and Decision Making

Risk assessment is the process by which the likelihood of an event occurring and the severity of its consequences are described. Risk itself is defined as the product of these two factors—likelihood of occurrence and negativity of consequences. Risks associated with hatchery operation and use of hatchery-origin fish should be delineated and integrated into the decision-making process in as quantitative a manner as possible, including the consequence of taking no action. Potential benefits should also be considered as a part of such an assessment. Benefits often relate to society, such as angling days, fish yield, and public access, but may also include ecosystem function, stability, cultural value, productivity, and others.

Depending on the elements of the scenario and the availability of quantitative information, risk assessment can be a straightforward assembling of facts and figures or it can be a challenging process involving considerable uncertainty. These challenges should not dissuade resource managers from attempting to assess the relative risk of proposed actions, including stock enhancement, with the caveat that decisions will still need to be made even when risks are not completely understood.

FINAL THOUGHTS

- Effective communication. Though the need for cooperative management, inclusive planning, and interdisciplinary approaches to fisheries management may seem self-evident today, this was not always the case. Those participating in HaMAR exemplified a willingness to engage those with differing views and focus on science-based decision making, both of which are essential to the creation of effective fisheries management plans, including the use of hatcheries and hatchery-origin fish.

- Issues yet to be resolved. Like any scientific endeavor, HaMAR effectively addressed many questions but raised others. What progress has there been in quantifying the socioeconomic impact of fisheries enhancement? Why are state fisheries managers reluctant to resist stakeholder demands to judge stocking programs simply by the numbers of organisms stocked? Is there an urgent need to increase seafood production? Whereas some of these questions may find quantitative responses or solutions in the future, it may not be possible to address all of them in the context of traditional fisheries science.

To be fully successful, every hatchery program must be scientifically defensible, have well-defined and documented goals, and be flexible and respond adaptively to new information. Proper forethought and documentation will go a long way to strengthening the scientific foundation of hatchery operation and the use of hatchery-origin fish.

For more information about the HaMAR process or its deliverables, please contact the authors.

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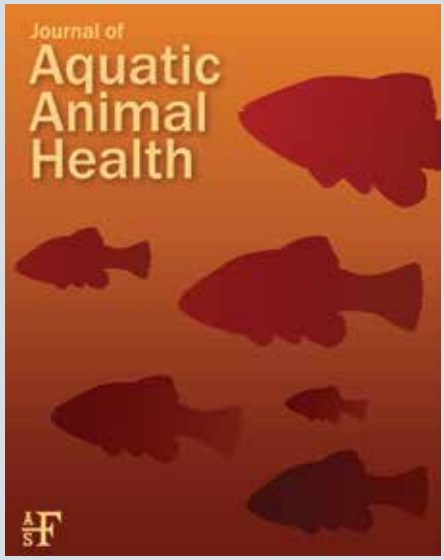

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