A Method for Culturing Mussels Using In-River Cages

Tony R. Brady,* Doug Aloisi, Roger Gordon, Gary Wege

T.R. Brady
U.S. Fish and Wildlife Service, Natchitoches National Fish Hatchery, 615 S. Drive, Natchitoches, Louisiana 71457

D. Aloisi
U.S. Fish and Wildlife Service, Genoa National Fish Hatchery, S. 5631 State Highway 35, Genoa, Wisconsin 54632

R. Gordon
U.S. Fish and Wildlife Service, Jordan River National Fish Hatchery, 6623 Turner Road, Elmira, Michigan 49730

G. Wege
U.S. Fish and Wildlife Service, Twin Cities Field Office, 4101 E. 80th Street, Bloomington, Minnesota 55425

Abstract

A variety of techniques have been used since the early 1900s to produce mussels for augmenting depleted populations, including the use of wire-covered crates to house fish bearing mussel larvae. Here we describe a modification of earlier techniques, which provides a viable, low-cost method for producing large numbers of mussels. Aluminum-framed cages covered with commercially available hardware cloth are used to confine glochidia-bearing fish. Juvenile mussels then excyst off the host fish, and fall to the substrate-covered cage bottom, which protects the mussels from predation until they mature into subadult mussels. To date, seven species of mussels totaling over 57,100 2- and 3-y-old mussels have been reared in these culture cages.

Keywords: freshwater mussels; endangered mussels; Lambsilis higginsi; culture; cages

Received: October 26, 2009; Accepted: January 11, 2011; Published Online Early: January 2011; Published Online: June 2011


Copyright: All material appearing in the Journal of Fish and Wildlife Management is in the public domain and may be reproduced or copied without permission unless specifically noted with the copyright symbol ©. Citation of the source, as given above, is requested.

The findings and conclusions in this article are those of the author(s) and do not necessarily represent the views of the U.S. Fish and Wildlife Service.

* Corresponding author: tony_brady@fws.gov

Introduction

North America has the most diverse assemblage of freshwater mussel species in the world with over 300 species recorded (Williams et al. 1993). Today over one-half of these species are either extinct or imperiled due to habitat losses from flow alterations, or impacts related to human activities such as dredging and gravel mining (Neves et al. 1997). Huges and Parmalee (1999) suggest that this drastic decline in mussel populations began as early as the 1800s with vast deforestation and the resulting siltation devastating aquatic habitat. By the 1900s, mussels had gained commercial importance in the pearl button industry, causing further declines in populations due to overharvesting of mussel shells to be turned into buttons (Knott 1980). A new threat has emerged in the 1980s; colonization of the invasive zebra mussel Dreissena polymorpha has caused localized eradication of some mussel populations (Welke et al. 2000).

In the Upper Mississippi River, large increases in zebra mussel populations have become problematic. Barge and boat traffic aided in the spread of zebra mussels up the Mississippi River by transporting zebra mussels attached to their hulls, allowing them to reproduce in previously uninfested portions of the Mississippi River. Zebra mussels colonize on bottom substrates (including native mussels) in such large numbers that they inhibit the respiration, feeding, and successful reproduction of freshwater mussel populations. The federal 9-Foot Channel Project, a series of locks and dams operated and maintained by the U.S. Army Corp of Engineers that
Lampsilis higginsii

allows boats free access up and down the Upper Mississippi River, was constructed in the 1930s to allow for boat traffic to safely and effectively use the river for recreation and cargo transport. The U.S. Fish and Wildlife Service (USFWS; 2000) determined that the continuation of the 9-Foot Channel Project for an additional 50 y would jeopardize the continued existence of the Higgins eye pearl mussel Lampsis higginsii, a species listed as endangered under the Endangered Species Act (ESA 1973). To ensure the continued existence of Higgins eye, the U.S. Army Corp of Engineers was tasked to establish five new and viable populations of Higgins eye in areas of the Upper Mississippi River and tributaries where zebra mussels were absent or at low densities. In 2000, the U.S. Army Corp of Engineers established the interagency Mussel Coordination Team to assist in establishing these new populations. The Mussel Coordination Team approached Genoa National Fish Hatchery to assist in the recovery efforts for Higgins eye because of their ongoing culture programs for yearling largemouth bass Micropterus salmoides, smallmouth bass Micropterus dolomieu, and walleye Sander vitreus, all of which are known hosts (Watters 1994; USFWS 2004) for the successful transformation of Higgins eye larva, called glochidia. Almost all freshwater mussel species require a fish host to attach to as larva to complete their reproductive cycle. For most mussel species, their larvae attach to the gills or skin of fish, and live there until they are developed enough to feed on their own. The time spent on the fish host is water-temperature and species dependent.

The Mussel Coordination Team also asked Genoa National Fish Hatchery to develop culture techniques to produce large numbers of subadult mussels (age 1+) for their recovery efforts. Mussel cages were designed by modifying culture cages that were successful for culturing mussels in the early 1900s (Howard 1922). Mussels cultured in the cages are protected from large predators such as mollusk-eating fish, and are provided a natural food source from the river. Use of the culture cages requires less maintenance through the course of a growing season than lab-rearing mussels, which entails algae culture to provide a food source and weekly maintenance of culture systems (Barnhart 2006). Cage culture ensures not only that the nutritional requirements of the species are being met, but the effect of selection from intensive artificial culture is minimized by rearing the mussels in a more natural environment. Culture cages provide a means for harvesting subadult mussels, which can be marked and transported to relocation areas. The Genoa National Fish Hatchery and Mussel Coordination Team have successfully used these culture cages since 2002 to produce Higgins eye and six additional species of mussels for other restoration programs in the Upper Mississippi River Basin.

**Methods**

The mussel culture cage described here consists of two parts; the wire-covered top and a detachable base are combined for propagation and culture of mussels to subadults, age 1, or older (Figure 1). A rectangular top is used with a base fitted with an untreated plywood tray designed hold a thin layer of substrate and to collect the transformed mussels, allowing them to grow inside the protective cage. These culture cages are designed to be placed on the river bottom in waters deep enough not to impede recreational uses of the Mississippi River or to be suspended from a floating array.

The rectangular top has dimensions that are 24 in. × 36 in. × 18 in. high (Figure 1). Frames for the tops are constructed of 0.75-in. × 0.75-in. × 0.125-in. angled aluminum, and are enclosed with 0.5-in. mesh by riveting hardware cloth to the frame. A door is created in the tops by leaving one-half of the hardware cloth unattached. No hardware cloth is attached to the bottom of the rectangular top, to prevent mussels from being trapped between the wire and the plywood tray.

The base is constructed of 1.5-in. × 1.5-in. × 0.25-in. angled aluminum with inside dimensions slightly larger than the outside dimensions of the top frame, allowing the top to nest inside the base. The legs of the base are made from 1-in. × 1-in. × 0.25-in. angled aluminum. The leg ends are cut at a 45° angle, producing a sharp point that can be driven into the river bottom to prevent the cages from being overturned or washed away. Bases intended for use in a floating array do not need legs. The collection tray is made of 0.25-in. untreated plywood that is riveted to the base frame and sealed with silicone caulk. Tabs made from 3-in. × 1.5-in. × 0.25-in. angled aluminum are welded to each end of the base frame (Figure 1). Holes are drilled into the tabs to allow for bungee straps to be hooked to the base and secured to the top.

The tops and bases are assembled onsite by attaching the top to the base with 14-in. bungee straps. Bungee straps are hooked to the tabs and stretched to hook onto the top. River sand is placed on top of the plywood tray in the culture cage at a depth of ≤1 in. to provide substrate for the transformed juveniles. Inoculated fish are placed into the assembled cage and the door is closed.

![Figure 1](image-url) This photo shows the top and base of a mussel culture cage. Note that the top is secured to the base using bungee straps.
secured shut with plastic cable ties. Fish are released from the cages by cutting the cable ties, folding back the hardware cloth doors, and allowing the fish to swim out of the cages. The cage door is again secured with cable ties to prevent any potential disturbance inside the cage.

Culture cages are monitored for mussel production either at the end of the first growing season or midway through the second, by removing the cages from the river, separating the top from the base, then sieving the contents of the base to harvest any mussels that were produced. A three-tier sieve is used to sort the mussels from the sediment in the cages (Figure 2). The top tier has a mesh size of 0.5 in., the middle-tier mesh size is 0.25 in. and the bottom-tier mesh is 0.125 in. The bottom tier has legs welded to it that extend up to receive and hold the other two tiers.

Cages were modified to meet challenges encountered in the production of other mussel species. The need for one cage modification was evident for the production of endangered winged mapleleaf Quadrula fragosa. The winged mapleleaf uses channel catfish Ictalurus punctatus as their fish host. Confined channel catfish cluster together and their combined swimming actions can remove large amounts of the sand and mussels from the plywood tray. A dual-top system was developed, which uses a smaller, 4-in.-high, rectangular top that sits on the base. A full sized top, fully enclosed in hardware cloth, sits above the smaller top and is bunged to the base. The dual-top design can also be used in situations when resource managers prefer that host fish not be released into the water body. Once the fully enclosed top is removed, the smaller top is secured to the base with the bungee straps. Other modifications, such as using a smaller mesh hardware cloth (0.25 in.), have been used to house smaller host-fish species such as minnows and darters.

A floating array can be used to suspend culture cages when the river bottom is subject to high bed-load movement or anoxic conditions during the growing season (Figure 3). The floating array is constructed of 1.5-in. x 1.5-in. x 0.25-in. angled aluminum, and is 12 ft long and is 6 ft high. Fifty-five-gallon plastic barrels are used as floats and are housed at the top of each end of the array. Outside railings, 3.3 ft high, are placed 1.5 ft up from the bottom to keep the cages inside the array. Bottom railings, 1.9 ft apart, support the weight of the cages. These floating arrays are designed to hold four rectangular cages.

Results

The use of the culture cages has proven a viable tool for large-scale production of freshwater mussels. Culture cages both placed on the bottom and in floating arrays have been successfully producing mussels in the Upper Mississippi River for 8 y. Mussels cultured in cages have been tagged and used in recovery and restoration efforts in four states. These
subadult mussels have also been used by universities and research organizations to advance mussel conservation. To date, these cages have cultured seven mussel species, totaling over 57,100 individuals, to the subadult life stage, (Higgins eye pearlymussel \( n = 48,270 \); winged mapleleaf \( n = 31 \); sniffbox Epioblasma triquetra \( n = 1,001 \); fat mucket Lampsilis siliquoidea \( n = 3,900 \); plain pocketbook L. cardium \( n = 480 \); black sandshell Ligumia recta \( n = 3,200 \); mucket Actinonaias ligamentina \( n = 220 \)).

Acknowledgments

We would like to thank the U.S. Army Corp of Engineers St. Paul and Rock Island Districts and the U.S. Fish and Wildlife Service’s Twin Cities Ecological Services Office for funding for this project. This project also would not have been successful if it were not for the vision of the following people and agencies: Todd Turner, Kurt Welke, Pam Thiel, Dave Heath, Mike Davis, and the Minnesota and Wisconsin Departments of Natural Resources. We would like to give special thanks to Jeff Lockington and Dan Kumlin for their countless hours of metal fabrication, and to all the volunteers that have helped in cage assembly. Finally we would like to thank the editors and anonymous reviewers for their comments of previous versions of this paper.

Any use of trade, product, website, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government.

References


