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Control of Bullfrogs and Their Tadpoles on Commercial Fish Farms

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The most common frog present on commercial fish farms in Arkansas is the American bullfrog (*Lithobates catesbeianus*, formerly *Rana catesbeiana*) (Figures 1 and 2). Native to the eastern half of the U.S., including Kansas and Oklahoma, the bullfrog was intentionally introduced to western states as early as a century ago (Storer, 1922; Boersma et al., 2006; Snow and Witmer, 2010). It is considered an invasive species in a number of western states and Hawaii. As such, bait and sportfish farmers work to separate any tadpoles from harvested fish (Figure 3). Additionally, bullfrogs cause fish farm losses by eating fish (adult frogs) and fish food (tadpoles). Hence, it is advantageous for fish farmers to control bullfrog populations in ponds. This fact sheet compiles measures, many developed by fish farmers, that can be taken to reduce fish losses in ponds and the chances of accidental inclusion of tadpoles in fish shipments.

Figure 1. *(Photo by Trevor Luna)*

Figure 2. Adult bullfrog captured at the University of Arkansas at Pine Bluff Aquaculture Research Station, Pine Bluff, Arkansas. *(Photo by Dr. Herbert Quintero)*

Figure 3. Adult bullfrogs are common inhabitants of commercial baitfish and sportfish ponds in Arkansas.

Commercial fish ponds provide suitable habitat, excellent breeding conditions and abundant food for bullfrogs. During bullfrog breeding season, females are capable of laying 1,000-40,000 eggs per clutch. Eggs hatch in 3-5 days, and in southern states, females are capable of having two clutches of eggs per year (Snow and Witmer, 2010). The life cycle of frogs includes a free-swimming larval stage, which is commonly known as a tadpole (Figure 4). Tadpoles differ from adult frogs in diet, mode of respiration and form of locomotion. These differences effectively reduce competition between adult frogs and tadpoles for resources and food. Tadpoles develop into frogs by growing limbs, lungs and their tail receding through metamorphosis (Figure 4). An average size commercial fish pond can effectively serve as a nursery for thousands of tadpoles. Not all tadpoles complete metamorphosis in the same year they were hatched. Tadpoles hatched late in the year must overwinter and complete their metamorphosis the following spring (Nie et al., 1999). The necessity for tadpoles to overwinter in permanent water bodies may explain why adult bullfrogs commonly choose habitat near ponds (Nie et al., 1999).

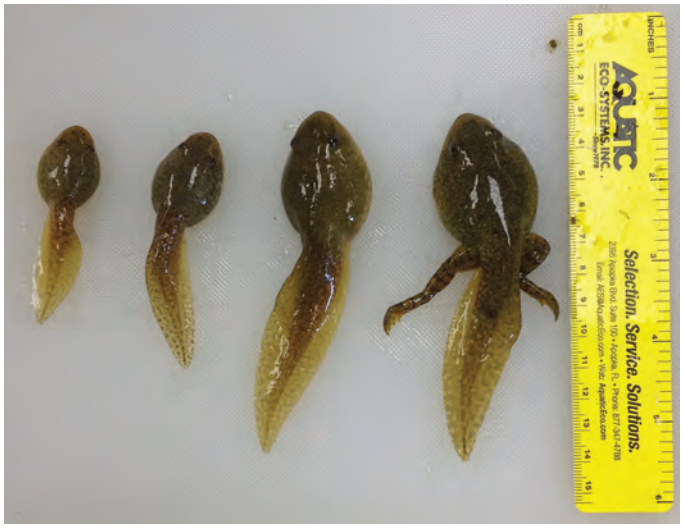

Figure 4. There can be several different sizes of tadpoles present in the same pond at the same time. These tadpoles were bycatch associated with the harvest of a fathead minnow pond in Lonoke, Arkansas.

Tadpoles on Commercial Fish Farms

A survey conducted in the early 1990s in Florida and Arkansas found that fish farmers considered tadpole infestations to be a serious problem. Competition between tadpoles and fish for resources and difficulties with harvest and post-harvest sorting and grading were specifically mentioned (Kane et al., 1992). Tadpoles are particularly problematic for producers of small fish, such as bait and ornamental species. Under optimal conditions, tadpoles can be present in high numbers in ponds (Figure 5). Prather et al. (1953) documented tadpole production as high as 2,000 pounds per acre. Farmers who raise predatory fish, such as largemouth bass and catfish, typically do not have as many problems with tadpoles and adult frogs.

Figure 5. A seine haul at Joe Hogan State Fish Hatchery (Lonoke, Arkansas) that yielded more tadpoles than fathead minnows. *(Photo by Jason Miller, Arkansas Game and Fish Commission)*

Dense populations of tadpoles in commercial ponds can be detrimental in several ways. Tadpoles consume feed intended for fish (Corse and Metter, 1980; Kane et al., 1992). Tadpoles can also interfere with post-harvest sorting and grading, resulting in additional labor costs to manually remove them. Extremely small tadpoles are difficult to detect. If care is not taken by farm personnel in grading and loading fish, tadpoles could inadvertently end up in a shipment. In Arkansas, tadpoles are most problematic during the spring months when the abundance of small tadpoles is highest.

Adult bullfrogs cause economic losses to farmers by consuming fish (Corse and Metter, 1980). A study on a Missouri fish farm found that the average fish-based meal for a bullfrog consisted of two goldfish or

three bait minnows, with each bullfrog consuming approximately 60 meals during its eight-month active season. At this rate of consumption, just a few frogs per pond can result in a substantial financial loss for a farm.

Current Practical Control Measures

Arkansas fish farmers typically employ a combination of techniques to control bullfrogs in ponds and to prevent tadpoles from entering live haul tanks or box shipments. These strategies are summarized below.

Reduction of Habitat. Chemical and physical control of aquatic vegetation in and around ponds helps reduce the number of tadpoles and adult frogs by making them more visible and susceptible to natural predators such as snakes and birds. Mowing pond levees to reduce vegetation can be effective in reducing habitat for adult frogs. Aquatic herbicides can be effective at controlling vegetation in the pond. For further information on controlling aquatic vegetation, see the Arkansas Cooperative Extension publication, MP44, *Recommended Chemicals for Weed and Brush Contr*ol (www.uaex.edu).

Grading. Fish are typically graded in vats following harvest to separate different sizes of fish and, if needed, to remove tadpoles (Figures 6 and 7). This technique involves using an appropriately sized fish grader to separate fish from larger, plump tadpoles. Prather et al. (1953) recommended using a fish grader with a 1/2- or 5/8-inch bar opening (#32 or #40 grader) to grade golden shiners at harvest. If correctly implemented, this technique is very effective at separating tadpoles from fish and is the method most widely used by the commercial baitfish industry in Arkansas. Extremely small tadpoles, however, may still slip through the grader.

Visual Inspection. For small fish shipments of 1-3 pounds that are transported via ground or air freight, a visual inspection of each bag is a final necessary step to ensure the absence of tadpoles. Visual inspection is also important when loading fish haulers. A visual inspection is typically carried out by farm personnel after grading techniques have been employed. Farmers have indicated that tadpoles will often congregate at the bottom of vats in the corners. Since vats are typically operated as flow-through systems, the current will often push

Figure 6. Farmers often utilize graders to separate tadpoles from fish.

Figure 7. Tadpoles being separated from largemouth bass fingerlings in a vat using a grader. The white arrows indicate two largemouth bass in a handful of tadpoles.

tadpoles to one end of the vat, where they can either be siphoned out or removed with a net (Zajicek et al., 2009). Unlike fish, tadpoles do not have fins to aid in slowing down or stopping when subjected to a current (Hoff and Wassersug, 2000). In fact, tadpoles will actively swim away from a current source (Schmidt et al., 2011).

Other Control Measures

There have been several other techniques proposed to control tadpoles in ponds. However, these methods have been less effective when implemented at the commercial level on fish farms.

Lethal Control. In some fish hatcheries and farms, efforts are made to eliminate egg masses (Figure 8) or adult frogs to indirectly reduce the number of tadpoles. While this method can be somewhat effective, it can be extremely time consuming and involve large amounts of labor. Because of this, it is not practiced by most commercial fish producers. Some commercial fish farmers, during legal hunting seasons, will allow hunters to harvest adult bullfrogs from their ponds (frog gigging).

Figure 8. Bullfrog egg masses are often found along the banks of commercial fish farms, particularly in ponds with vegetative cover along the edges.

Salt. Salt (NaCl) is a low-cost alternative that has been suggested as a means to separate tadpoles from fish, particularly in vats designed to hold fish prior to being sold. A study examining three different salt levels (100 mg/L, 500 mg/L and 1,000 mg/L) found that American bullfrog tadpoles are not sensitive to high concentrations of salt (Matlaga et al., 2013). Unfortunately, most scientific studies that have examined salt tolerance in bullfrogs have used much lower concentrations of salt for their studies than typically used by commercial fish farmers. Commercial sportfish farmers, for example, will often add salt at levels exceeding 1 part per thousand (1,000 mg/L) as a prophylactic treatment for fish following harvest.

Chemical Treatment. Low concentrations of chemicals, such as formalin, have been tested to separate tadpoles from fish fingerlings after harvest. While this technique can be effective in some cases, formalin is not labeled for tadpole control. Formalin treatment of water containing largemouth bass and tadpoles at 76 mg/L [1 mg/L = 1 ppm] for 24 hours selectively killed tadpoles but not bass (Carmichael and Tomasso, 1983). In the same study, a one-hour treatment of formalin (250 mg/L) also killed all the tadpoles without harming largemouth bass fingerlings. However, Helms (1967) documented that the minimum lethal dose of formalin required to cause mortality in bullfrog tadpoles increased with increasing tadpole size.

Another chemical tested experimentally to selectively target frog larvae is 3-Trifluoromethyl-4-Nitrophenol (TFM). This chemical has been used as a lampricide in the Great Lakes (Kane and Johnson, 1989). Kane et al. (1985) reported that TFM was four times more toxic to larval bullfrogs than fathead minnows. This study also reported that TFM was effective at controlling infestations of frog larvae if applied to tadpoles when newly hatched but was not very effective at controlling older life stages. Currently, TFM is not registered as a selective amphibicide for static culture ponds, so it is not an option for fish farmers.

Electroshocking. A study in Vancouver Island, British Columbia, Canada, examined the effectiveness of an American bullfrog eradication program

that utilized modified fisheries electroshocking gear to capture juvenile (<3.2 inch body length) and adult (>3.2 inch body length) bullfrogs from a pond and a lake (Orchard, 2011). In one pond, 1,587 adult and juvenile bullfrogs were collected after 23 nights of effort. While this technique was reported to be quite effective, it is certainly not feasible for commercial farms with hundreds of acres of ponds.

Summary

The effective control of adult bullfrogs and tadpoles on commercial fish farms is challenging and costly for farmers. Tadpoles and adult frogs cause substantial economic losses to commercial fish farms every year, and thus farmers have developed measures to control bullfrog populations. Adoption of practical control measures outlined above can help control bullfrog populations on fish farms and reduce the chances of accidentally including a tadpole in a fish shipment. However, no method has been proven to be 100 percent effective, so a combination of control measures should be implemented.

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