Feature

Effect of Tadpoles on Warmwater Fish Pond Production

Andrew S. Kane, Renate Reimschuessel, and Michael M. Lipsky

ABSTRACT

A survey was conducted to evaluate the effect of tadpole infestations on warmwater fish pond culture. The survey was sent to 174 pond culturists in Florida and 30 in Arkansas with a 21% overall response rate. Most respondents believed: (1) tadpole infestation was a serious problem, primarily due to competition between tadpoles and fish for food; (2) tadpoles caused harvest problems and impaired post-harvest sorting and grading; and (3) their tadpole control efforts were ≤30% effective. It was estimated that an average of 117 worker-hours of labor per surveyed facility were expended annually to contend with tadpole-related problems. Financial losses due to tadpoles were $1,000–8,000 per year for most farmers surveyed (54%) and $10,000–30,000 per year for others (36%). Annual losses of revenue from ornamental fish production in Florida (based on survey) and baitfish production in Arkansas (U.S. Fish and Wildlife Service) due to tadpole infestations were estimated at $1.78 million and $6.2 million, respectively.

Introduction

Tadpole infestations in warmwater fish culture ponds have been reported (personal communications) from Alabama, Arkansas, California, Florida, Hawaii, Indiana, Maryland, Michigan, Missouri, Ohio, South Carolina, West Virginia, and Wisconsin. At many facilities affected by tadpoles, it is not uncommon for 50% or more of the netted harvest to be tadpoles. Tadpole production in some fish-rearing ponds has been documented as high as 2,000 pounds per acre (Prather et al. 1953). Figure 1 shows a typical mixed harvest from a tadpole-infested baitfish culture pond. Sorting and removing tadpoles from harvest nets affects production quantification, is time consuming, and most important, subjects fish to severe mechanical injury and stress. Tadpoles may also substantially reduce primary production (Dickman 1968; Seale 1980), effectively compete for space and artificial feeds (Arroyo 1980; Dupree and Huner 1984), and serve as vectors for fish disease (Alderman 1982) and parasites (Stunkard and Cable 1931; Stunkard and Dunihue 1933; Lewis and Lewis 1963).

Current methods used to control tadpoles include removing by hand or poisoning egg masses, mowing pond banks to reduce frog habitat, and killing the adult frogs. These methods are costly, often haphazard, and not highly effective. Helms (1967) reported limited success with formalin to control tadpoles in fish production ponds. Formalin treatments, however, caused reduction of dissolved oxygen and did not completely eliminate the tadpoles. Formalin has also been used as a selective toxicant to separate tadpoles from fingerling largemouth bass, *Micropterus salmoides*, in raceways after pond harvest (Carmichael and Tomasso 1983). This technique was relatively effective and coincidental to ectoparasite treatment but did not alleviate the time and labor associated with pond harvest and post-harvest sorting and grading. Recent research using the lampricide 3-trifluoromethyl-4-nitrophenol (TFM) has demonstrated promising in-pond results in selectively controlling ranid tadpoles (Kane et al. 1985; Kane and Johnson 1989).

Although frogs and tadpoles have been cited as injurious to warmwater fish culture for over 100 years (e.g., Smiley 1883), the effect of tadpole infestations on pond production has yet to be quantified. A questionnaire regarding tadpole infestations was sent to fish farmers in Florida and Arkansas. This paper presents a summary of survey results and information obtained from personal communications with fish farmers, fishery biologists, and cooperative extension agents.

***Andrew S. Kane** is a research associate at the Aquatic Toxicology and Pathology Facility, University of Maryland School of Medicine, 10 South Pine Street, Baltimore, MD 21201. **Renate Reimschuessel** is an assistant professor and **Michael M. Lipsky** is an associate professor at the University of Maryland at Baltimore.*

The Survey

A self-administered, multiple-choice questionnaire was mailed to 204 fish farmers—174 in Florida and 30 in Arkansas. Florida fish culturists were identified from the *1989 Florida Fish Culture Directory*. Arkansas culturists were randomly chosen from the *1988 Arkansas Fish Farming Directory*.

The questionnaire addressed physical characteristics of the fish farms (pond size, water quality, and bottom type), and the degree to which infestations of frog larvae affected fish production. Fish farmers were asked to respond to questions defining the type of frog larvae (if any) present at their facility, tadpole control measures used, degree of success in tadpole control efforts, and amount of tadpoles produced. Other questions addressed loss of fish, increased harvest time, and additional post-harvest sorting labor.

Figure 1. Net haul from a tadpole-infested baitfish production pond. Dark-colored organisms are tadpoles.

The Survey Response

There was an overall 21% response rate from the survey mailing; 36 of 174 responded from Florida and 6 of 30 responded from Arkansas. Most respondents in Florida were culturists of tropical or ornamental fish while respondents from Arkansas were predominantly culturists of baitfish and catfish. Fifty percent of the respondents farmed between 0.1 and 10 pond acres; 36% farmed between 11 and 50 acres, and 14% of respondents farmed greater than 51 acres.

According to respondents, tadpole infestation was one of the most serious fish production problems, second only to predation by birds (Figure 2). Aquatic vegetation (too much or too little), disease, predation by snakes, otters, turtles, alligators, and adult frogs, as well as water quality management and poaching, were also cited as problems.

Ninety-eight percent of the respondents had tadpoles in their ponds; of these, 88% considered tadpoles to be a problem. Most respondents believed that tadpoles competed for food in the ponds (93%), impeded harvest (67%), and caused post-harvest problems during sorting and grading (57%). Several other respondents believed that frog larvae "fouled the water," contributed to oxygen depletion, and inhibited fish growth. The most common species of frog larva (83%) encountered at the facilities surveyed was the bullfrog, *Rana catesbeiana*, which is considered the largest and hardiest North American ranid (Bury and Whelan 1984). Table 1 lists the species of frog larvae reported in the survey.

The most frequently cited methods for tadpole control included removing frog eggs by hand or net (80%), shooting adult frogs (48%), and keeping pond banks well mowed to reduce frog habitat (33%). However, the most frequent response (45%) indicated that tadpole-control efforts were negligible or only "a little effective" (≤30% effective). An additional 29% of the respondents cited intermediate success (31–70% effectiveness) controlling tadpoles and 17% claimed their control efforts to be "very effective" (71–99% effective). Some pond owners have gone to the expense of installing plastic pond covers, primarily to extend the growing season and defend against bird predation; these culturists have also benefited by excluding breeding frogs (they responded

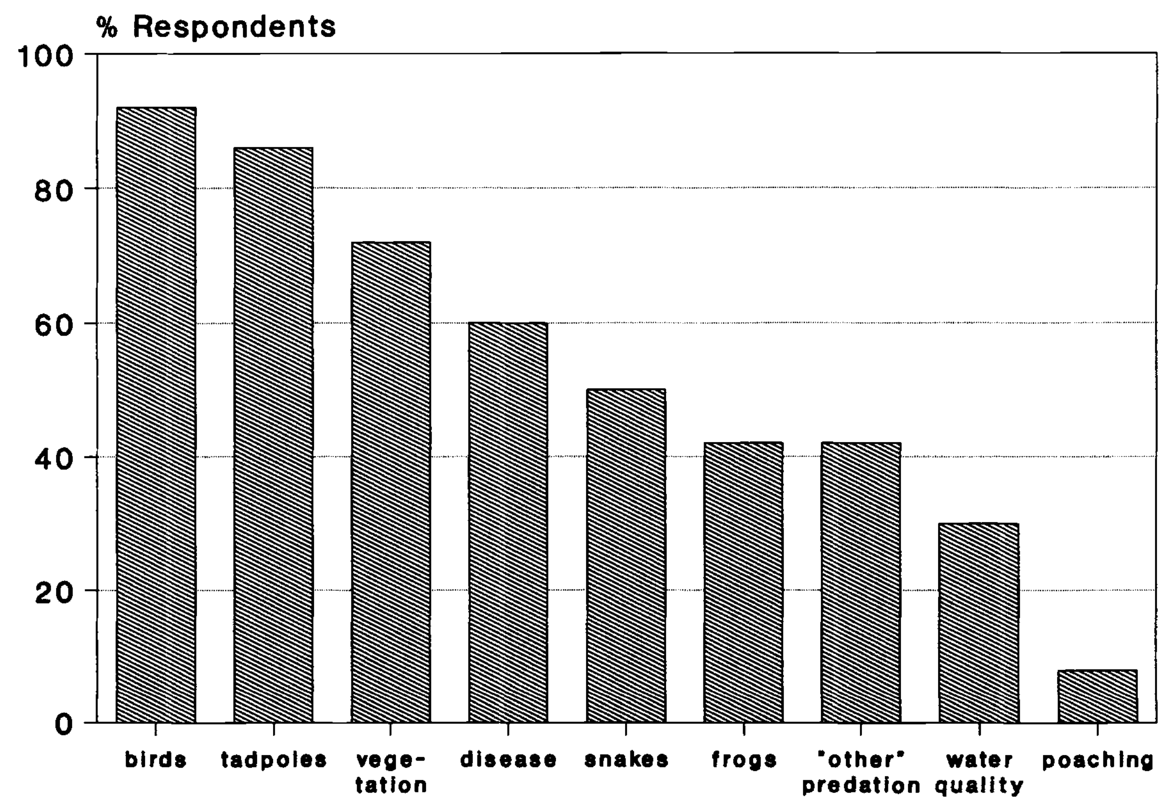

Figure 2. Incidence of pond production problems (predation by birds, tadpole infestations, aquatic vegetation, disease, predation by snakes, predation by frogs, "other" predation, water quality, and poaching) cited by survey respondents.

Table 1. Proportional response (%) data on tadpole species at surveyed pond culture facilities.

Larval species	% Response
Bullfrog	83
Leopard frog	60
Green frog	32
Tree frog	32
Pickerel frog	2
Wood frog	2
Toad	47

in the "very effective" tadpole control category). Degree of tadpole control effectiveness reported was completely subjective.

Tadpole harvests reported from smaller culture facilities (0.1–10 water acres) ranged from 1–1,300 pounds per acre (mean = 194 pounds per acre) while tadpole harvests from larger facilities (11–700 acres) ranged from 11–240 pounds per acre (mean = 39 pounds per acre). The most frequent response concerning production losses due to tadpoles indicated an average of 250 pounds of fish lost per facility per year. The corresponding financial loss represented $1,000–8,000 per year for most farmers surveyed (54%) and $10,000 per year or greater for others (36%). In addition, an average of 117 worker-hours of labor per facility was annually expended to contend with tadpole-related problems.

Water quality data collected from this survey suggest that the degree of tadpole infestation is not related to pond pH, temperature, water hardness, or bottom type.

Discussion

The average dollar value of annual fish loss due to tadpole infestation for both states surveyed was estimated to be $9,220 per facility. In Florida, 36 survey respondents representing 615 pond acres reported a total revenue loss of $200,150 due to tadpoles. There are presently 193 producers of tropical fish in Florida using 1,139 acres of water (FASS 1990). Based on the average loss per facility, tropical fish loss in Florida due to tadpoles would be approximately $1.78 million in net fish production per year. However, an extrapolation based on fish loss per acre (rather than per facility) would indicate a loss of revenue from the Florida tropical fish industry of $0.37 million. This suggests that 1.1–5.3% of Florida's net revenue from tropical fish production is lost due to tadpole infestation. Although this estimate appears low, it is probably quite conservative and actually represents a substantial portion of the fish farmers' profit margin (C. Watson, Institute of Food and Agriculture Science, personal communication). The above figures do not take into account tadpole-related feed and labor expenses (additional net or trap hauls, post-harvest sorting, and physical pond management).

The number of survey responses from Arkansas (6) was obviously not sufficient to extrapolate statewide tadpole-related fish loss. However, Arkansas baitfish production reports indicate that for every 600–1,000 pounds of minnows harvested, it would not be uncommon to harvest 1,000 pounds of tadpoles (H. K. Dupree, U.S. Fish and Wildlife Service, personal communication). Dupree estimated that tadpoles cause 100–200 pounds of fish loss per acre per year, and that Arkansas maintains 24,680 acres of baitfish production ponds. Therefore, with 100 pounds of fish loss per acre at $2.50 per pound of fish, annual Arkansas wholesale production loss is estimated at $6.2 million dollars (baitfish only—this figure does not include losses from other cultured species).

Some culturists cited heavy tadpole infestation as the cause for stunted fish growth. Decreased fish growth is most likely due to: (1) competition by tadpoles for food resources (Seale 1980; Kane and Johnson 1989); (2) suboptimal water quality due to crowding, particularly reduced dissolved oxygen in ponds with high tadpole biomass (Wedemeyer et al. 1976; Alabaster and Lloyd 1980; Smart 1981); and (3) interspecific social stressors (i.e., aggressive behavior, visual interactions, pheromones) (Billard et al. 1981). In addition, ranid tadpoles contain and exude intra- and interspecific growth inhibiting substances (Licht 1967) that are believed to be parasitic yeasts, primarily *Candida humicola* (Petranka 1989). Earlier, Steinwascher (1978) had interpreted intraspecific effects of such water conditioning substances as chemical interference competition. The role of these substances on fish growth remains to be discerned.

With regard to disease, several culturists claimed that during bacterial outbreaks, ponds with large amounts of tadpoles tend to be more affected than ponds without heavy tadpole infestations. This suggests that tadpoles as well as frogs may act as vectors of fish pathogens (Reichenbach-Klinke 1973; Alderman 1982; Newman 1982). However, these increased losses may have been induced by crowding or other nonspecific stressors.

Interviews with fish producers and aquaculture extension agents throughout the United States indicated that tadpole infestation problems vary geographically, and are based, in part, on the fish species produced. Catfish and bass production, for example, appear relatively unaffected by tadpole-related problems. When full grown, these fish harrass and eat adult frogs (if they can catch them); when starving they may eat tadpoles. Tadpoles do not appear to be a preferred food item. However, smaller nonpredatory species (i.e., baitfish or ornamental fish) or fry and fingerlings are more susceptible to tadpole infestation and associated problems.

Other communications associated with the survey suggest that ponds situated near streams, drainage ditches, or vegetative cover may be a more likely frog breeding habitat. In dryer years, frogs tend to aggregate at culture ponds since other natural breeding habitats may be less predominant. Also, geographic regions with large snake populations appear to have reduced tadpole infestations and fewer predatory frogs.

The impact of predatory adult frogs in fish pond production should not be overlooked. Bullfrogs were responsible for an estimated loss of $43,800 of goldfish and minnows at a fish hatchery in Missouri in one year (Corse and Metter 1980).

Data from this survey and other reports indicate that tadpole infestations cause economic damage and production hindrance in warmwater fish pond culture. It should be understood that information presented in this paper is based on estimates or "guesses" from a relatively small sample size. Further, the data were primarily collected from a specific (and important) subset of warmwater pond aquaculturists: those culturing species that are small at time of harvest and that command a relatively high price per pound (or even price per individual fish). In fact, culturists who may have been most affected by tadpole infestation were those who farmed a smaller number of water acres to produce a higher priced product (i.e., ornamentals).

Although pond culturists with more severe tadpole infestation problems may have been more likely to respond to the questionnaire, the authors believe that the information presented is reflective of "real world" warmwater pond culture scenarios. This information will be useful in supporting further research directed toward tadpole control and improved pond culture technology.

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