Managing Iowa Fisheries

Tilapia Culture in Iowa

Background

With the expansion of aquaculture (fish farming) in recent years, species other than trout, salmon, and catfish have been investigated for use in fish farming. In Iowa, tilapia culture is one such alternative. Several species of tilapia and tilapia hybrids are used in fish culture. But, because of Iowa's cold winter temperatures and because tilapia require warm water (85°F for optimum growth), tilapia should be reared in indoor recycle systems. (Most species of tilapia die when the temperature is below 50°F.) This fact sheet presents basic biological and marketing information for these fish.

Both domestic production and imports of tilapia are continuing to expand. According to the 1999 Aquaculture Outlook, published by the Economic Research Service, U.S. Department of Agriculture, estimates for the domestic industry show production was approximately 18 million pounds (liveweight) in 1998. These estimates are from a survey of growers by the American Tilapia Association. In contrast to other aquaculture species that are localized in specific regions of the U.S., domestic tilapia production is widely dispersed in the United States. The Midwest is now one of the largest producers of tilapia. Midwest production principally comes from indoor recirculating systems utilizing heated water.

The volume of imported tilapia is larger than domestic production. U.S. imports of tilapia, on a liveweight basis, reached 94 million pounds in 1998. This value represents a 15 percent increase from the previous year; imports have continued to rise in the first half of 1999.

Tilapia Species and Names

This fish is sometimes called "St. Peter's Fish" because it has been cultured since biblical times. In addition, trade names such as "Golden Tilapia" and "Cherry Snapper" are used, depending on the color phase of the fish. The U.S. Food and Drug Administration (USFDA) requires only the name "tilapia" or common names (blue tilapia) to be used to market these fish to the public.

Cultured Species of Tilapia

Tilapia originated in the tropical waters of Africa and the Middle East but have since been distributed to other warm regions including South America, the Near East, and southern regions of North America. Tilapia are members of the family Cichlidae. As a group, tilapia represent one of the most widely produced food fishes in the world.

The genus of *Tilapia* was divided into the genera *Sarotherodon* (mouth brooders) and *Tilapia* (nest brooders) about ten years ago. In countries outside the United States, most of the cultured food species are listed as *Oreochromis* spp. In contrast, the American Fisheries Society accepts only the genus *Tilapia*. Most fish farmers ignore the taxonomic semantics and refer to the fish as tilapia. For the purpose of this fact sheet, *Oreochromis* and tilapia will be used for scientific and common names, respectively.

Of the various species of tilapia, the principal species are *O. mossambicus, O. hornorus, O. niloticus*, and *O. aureus*. It is rare to find pure strains of any species being cultured in the

IOWA STATE UNIVERSITY
University Extension

PM 1352g Revised November 1999

U.S. because hybrids of various species have been cultured for both color and growth. One of the major limitations for future genetic work is the difficulty of obtaining non-hybrid species.

Legal Requirements

Because these fish are not native to the United States, the prospective fish farmer must prove to the Iowa Department of Natural Resources that these fish cannot escape into the environment. The fact that these fish will die at cool water temperatures is not adequate. These fish must be kept from escaping into public waters. For more information regarding the legal considerations of aquaculture in Iowa refer to Iowa State University Extension publication PM 1352h, *Managing Iowa Fisheries: Getting Started in Aquaculture Enterprises.*

Biological Requirements

The major restriction to growing these fish in temperate areas is that most species of tilapia will die at water temperatures less than 50°F and grow best at temperatures in the upper 80°F. *O. aureus* appears to be the most cold tolerant of the cultured species of tilapia (lower temperature limit = 46°F).

Fish exposed to low water temperatures may not die immediately but become so stressed that diseases affect their health. These diseases include the virus *Lymphocystis* spp., bacteria *Aeromonas* spp. and *Edwardsiella tarda,* and protozoans *Trichodina* spp. and *Ichthyophthirius* spp. Since there are a limited number of antibiotics approved for aquaculture by US-FDA, the best control of disease is prevention. This is accomplished through proper management, maintenance of good water quality, and insistence that all new fish introductions into a system be free of stress and disease.

Given these temperature restrictions, tilapia must be reared (in Iowa) in a facility with temperature control. Although culture of other warm-water species also requires temperature control, which costs money (i.e. expenses to heat water to an optimum level), the costs are higher for species such as tilapia that have higher temperature requirements.

The ability of tilapia to withstand low levels of dissolved oxygen (DO) (less than 1 ppm.) is well known. Tilapia can obtain oxygen at the air-water interface, but, again, stress associated with low dissolved oxygen may lead to reduced growth and susceptibility to diseases.

Tilapia can withstand high levels of un-ionized ammonia better than most fish (LC_{50} of 2 to 3 ppm. un-ionized ammonia). LC_{50} is the lethal concentration of a chemical that will kill half of the fish within a given time. In contrast, other fish, such as bluegills, have LC_{50} values for un-ionized ammonia ranging from 0.5 to 4.6 ppm. For more information regarding the toxicity of un-ionized ammonia refer to ISU Extension publication PM 1352a, *Managing Iowa Fisheries: Water Quality.*

Tilapia Spawning Requirements

Most commercially cultured tilapia are mouthbrooders. The males build a nest and attract the female. Eggs are laid in the nest, fertilized, and picked up for incubation (mouth brooding) in the mouth of one of the adults. In some species, only the females practice mouth brooding while in other species, either sex may do so. Once the fry hatch, they remain in the mouth of the parent until the yolk sac is absorbed. During the first few days after fry are actively swimming, they remain close to the parent. Fry seek refuge in the parent's mouth when faced with danger.

Sexual maturity may occur at 3 months in *O. mossambicus* and 6 months in *O. aureus* and *O. niloticus*. Sexually mature fish may be 4 to 6 inches long. Fecundity (number of eggs) varies with the species. Generally, these fish will produce from 70 to 300 offspring at one time.

Temperature plays a more critical role than the photoperiod in the reproductive cycle of these fish. The average daily temperature during the spawning season needs to be 68°F to 70°F. When water temperature is relatively constant, tilapia will spawn throughout the year at 5- to 7-week intervals. Otherwise, the spawning season is determined by the incidence of suitable water temperatures.

Tilapia are well known for their high reproductive rates. Reproduction control is needed if large fish are desired rather than a large number of stunted ones. Reproduction can be partially controlled by removing spawning substrate, hybridization, manual sexing to maintain unisex population, and use of chemicals (androgens).

Removal of spawning substrate appears to work fairly well in intensive systems. Hybridization is not always 100 percent effective; manual sexing is laborious and time consuming. The androgen testosterone is a hormone that is fed to fish for a 30-day period during their initial life stages to convert them all to males. The US-FDA, through the Investigational New Animal Drugs/New Animal Drug Application (INAD/NADA) program, has investigated the use of this hormone in fish culture. To date, this agency has not authorized the general use of this chemical in aquaculture or the marketing of a hormone-injected fish.

Nutrition

Tilapia species consume a wide variety of foods. Some tilapia are plankton feeders, while others will feed on insect larvae, crustaceans, and plants. These fish can not absorb organic matter across their gill filaments. (There are no such animals as “gill feeding” tilapia.) Instead, tilapia filter out the food particles and swallow them in the same manner as shad and bluegill.

Commercially produced fish need to be fed a nutritionally complete diet that promotes fast growth and good health. As with other fish species, tilapia are efficient converters of food consisting of fish meal and plant proteins. Current literature indicates a variable range of conversion of fish food to fish flesh ratios: 1.5 - 3.0 lb. of food to 1 lb. of flesh. Under ideal culture conditions, fry are fed a diet of 40 percent protein up to 20 percent of body weight per day. As the fish weight approaches 1 lb., the feeding rate can be reduced to 1 percent per day (for maintenance), and feeds with lower protein levels can be used.

Growth Rates

Tilapia are noted for their rapid growth rates. Tilapia may grow (under ideal conditions) to 1 lb. in 150 to 180 days, depending on water quality conditions, temperature, and initial weight of fingerlings. Stocked fingerlings are at least 45 days old and no more than 3 in. long. Often, it takes more than 200 days to grow the fish to the same weight under variable water quality conditions. Growth varies with species, the individual fish, available feed, and gender (males tend to grow faster than females).

Production Costs

Current literature indicates that the production cost per pound live weight is from $1.20 to $1.80 in intensive recirculating systems. Given that these fish will dress out at 32-35 percent, production costs for fillets would be $3.75 to $5.63/lb. Retail fillets average about 4 to 6 oz. In calculation of production costs, the aquaculturist should realize that under ideal culture conditions, maximum density of fish in intensive systems is about 0.7 lb./gal. or 5.2 lb./cu. ft. with an adequate water exchange rate. With higher stocking densities of fish, increased production costs and management skills are required, and decreased individual growth rates may result.

Markets

Some individuals consider tilapia to be an ideal aquaculture species, based on its light flaky flesh and mild taste. To obtain this mild taste in fish raised in intensive systems, the fish farmer must purge the fish in clean water for 2 to 3 weeks before processing.

According to the USDA 1999 Aquaculture Outlook report, frozen whole tilapia are imported at an increasing rate into the United States at the wholesale price of approximately $0.55/lb. According to the American Tilapia Association, farm gate values of live tilapia were $0.80 - $2.00/lb. in 1998. Retail values of live tilapia in ethnic markets in 1998 were $2.49 - $4.59/lb. Such markets are restricted in scope and number in the Midwest and are typically located in large metropolitan areas. Although some Midwestern grocery store chains retail tilapia fillets for $5.00 to 7.00/lb., the individual aquaculturist has difficulty selling fillets in any appreciable quantity at this price. To date, the sales of tilapia have been disappointing with the principal reason being lack of consumer recognition. The commercial producer not only has to convince the public that this is an acceptable fish to consume, but producers also have to compete with "wild" harvests and cultured tilapia imported into the United States.

For this fish to become established as an aquaculture species the following is required:

- expanded markets,
- decreased production costs,
- genetic work to increase yields, and
- development of cost-efficient water recir culating systems.

Conclusions

With the use of intensive systems and abandoned farm buildings, tilapia culture is a recent addition to aquaculture in Iowa. The main limitations to Iowa tilapia culture are:

- the lack of research on designs of cost-effective indoor recycle systems,
- relatively low market value of the product,
- competition from imports,
- consumer acceptance of the product, and
- high production costs.

However, tilapia are good candidates for intensive aquaculture systems because of:

- their ability to withstand low water quality and crowded conditions associated with intensive systems,
- their ease of breeding,
- good growth rates under suitable water temperatures, and
- the large number of suppliers of brood stock throughout the United States.

If tilapia are to be raised in Iowa, it is best to devise a marketing plan to differentiate this Iowa product from fish cultured elsewhere or those commercially caught, while maintaining high quality. The original high prices obtained by tilapia producers are no longer possible due to the increase in the number of producers as well as imports. The price of tilapia began to drop in 1997 and has continued to drop until the present time. Whether or not future prices will remain low is difficult to forecast.

. . . and justice for all
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Many materials can be made available in alternative formats for ADA clients. To file a complaint of discrimination, write USDA, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence Avenue, SW, Washington, DC 20250-9410 or call 202-720-5964.
Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Stanley R. Johnson, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.

Printed on Recycled Paper

File: Wildlife 1

Other Sources of Information

Garling D. L. 1992. Making plans for commercial aquaculture in the North Central Region, North Central Regional Aquaculture Center Fact Sheet #101, Ames, IA.

Popma, T. and M. Masser. 1999. Tilapia: life history and biology. Southern Regional Aquaculture Center Publication #283, Stoneville, MS.

Pullin, R. S. V. and R. H. Lowe-McConnell. 1982. The Biology and Culture of Tilapias. International Center for Living Aquatic Resources Management, Manila, Philippines.

Rokocy, J. E. and A. S. McGinty. 1989. Pond culture of tilapia. Southern Regional Aquaculture Center Publication #280, Stoneville, MS.

Rokocy, J. E. and A. S. McGinty. 1989. Cage culture of tilapia. Southern Regional Aquaculture Center Publication #281, Stoneville, MS.

Rokocy, J. E. 1989. Tank culture of tilapia. Southern Regional Aquaculture Center Publication #282, Stoneville, MS.

Swann, L. and J. R. Riepe. 1997. Niche marketing your aquaculture products. North Central Regional Aquaculture Center Fact Sheet #107, Ames, IA.

Internet Sites

North Central Regional Aquaculture Center "White Papers"
http://ag.ansc.purdue.edu/aquanic/ncrac/wpapers/wpapers.htm

Aquanic
http://aquanic.org

Written by Joseph E. Morris, ISU Extension fisheries/aquaculture specialist and Charles C. Mische, Department of Animal Ecology. Text reviewed by Bruce Menzel, Jim Pease, and Bob Summerfelt, ISU Department of Animal Ecology; and Pete Kies and Curt Stutzman, Kirkwood Community College.