



# AQUAPONICS: FISH SPECIES SELECTION

Joseph Masabni, Ph.D.<sup>1</sup>, Brittany Chesser, M.S.<sup>2</sup>, and Todd Sink, Ph.D.<sup>3</sup>

According to the Oxford Dictionary, “aquaponics is an aquaculture system in which the waste produced by farmed fish or other aquatic animals supplies nutrients for plants grown hydroponically, which in turn purifies the water.”

In other words, aquaponics is a two-crop agricultural system consisting of 1) vegetables or herbs; and 2) fish, with each “crop” playing a unique role. However, fish are often treated as “fuel” and not as a marketable crop, especially in small-sized commercial operations and with hobbyists. In most commercial aquaponic operations, farmed fish is not forgotten as a potential source of income, yet is often neglected. So how can an aquaponics operation achieve maximum economic viability?

To create maximum production, sustainability, and economic viability, the fish must be treated as a commercial crop and must be sold to generate income. In this model, fish are fed to achieve a marketable size. The waste produced by the fish feeds the plants, and fish are sold to offset feed and operation costs. Plants, in turn, filter water of excess nutrients and are also sold for profit. Plants that are sold are not meant to cover all costs and be the sole source of profits. It is the combined sales of fish and plants that allow a commercial operation to reach the goal of sustained profitability and economic viability.

If fish are not utilized as an income source in a business model, operating a hydroponic system is suggested instead. A common myth among hobbyists is that aquaponics is cheaper than hydroponics. Initial start-up costs for hydroponics can be much cheaper, as it requires fewer parts such as water or air pumps, filters, and fewer tanks. Hydroponics is also cheaper long-term since

additional costs for fish or fish feed are not needed, along with reduced electricity and labor. With hydroponics, it is much easier to maintain optimal culture conditions for plants. Many fertilizer formulations are calibrated to provide accurate nutrient concentrations of each element.

**QUICK FACT:** Nitrate production (via fish feed) is costly compared to fertilizers. A typical fish feed with 32 percent protein costs \$485 per ton in bulk—or \$15 to \$18 per 40 pound bag when purchased by the bag. When fed to hybrid striped bass, 1 ton of 32 percent fish feed will provide 305 pounds of waste nitrates based on protein digestion and turnover rates. To obtain a similar nitrate load from the common farm fertilizer urea (46-0-0), only 628 pounds of urea is required and costs only \$215 (50 pound bag of 46-0-0 at \$17 per bag).

This publication ranks common aquaculture fishes—labeled from “Poor” to “Excellent”—depending on their suitability for use in a commercial aquaponic system. Species are ranked based on commercial production and profit potential. Some of the “poor” fish species are acceptable for home-use and consumption in a home hobby system, but not for optimal system performance. In general, “ideal” fish species are those that can reach market size in less than 1 year and before they begin their reproductive development.

## POOR SPECIES FOR AQUAPONICS

### Comet Goldfish:

Comet goldfish can be—and have been—used by homeowners or hobbyists. On a commercial scale, it is not a preferable option, as it has no real market value. The sale

<sup>1</sup>Associate Professor and Extension Vegetable Specialist

<sup>2</sup>Aquatic Vegetation Management Specialist

<sup>3</sup>Associate Professor and Aquaculture Extension Specialist

price does not offset the cost of feeding. In other words, feed costs are more than the fish are worth. For example, the comet goldfish farm gate price is 1.5 to 3 cents each. As an ornamental species, retail price is 16 cents for small fish and 31 cents for large fish. When considering that feed costs for 6 months is 28 to 33 cents to reach market size, comet goldfish are not profitable and should not be used in a business model.

### Marine Fish Species:

**QUICK FACT:** Marine or brackish species, including red drum, cobia, flounder, Atlantic croaker, pompano, and marine baitfish (Figs. 1 and 2), are UNACCEPTABLE for aquaponics. Although they may have a high market value, production and survival of these species is not possible in the low salinity water required for aquaponics. Marine fish often requires culture salinities of 5 ppt, but most vegetables and herbs will die at salinity levels as low as 1 ppm.



Figure 1. Flounder

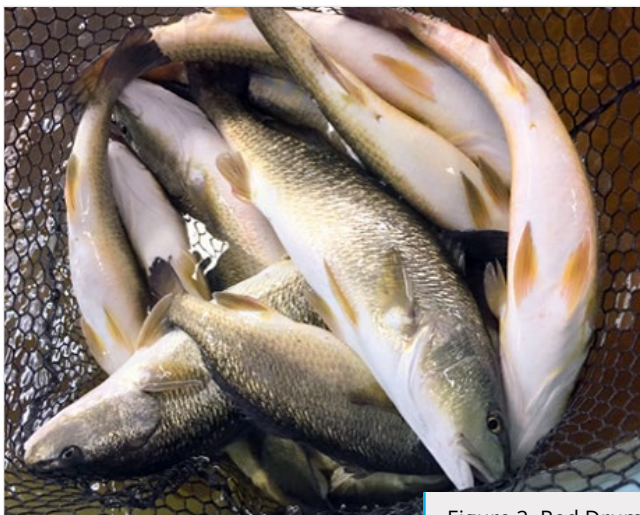


Figure 2. Red Drum

## FAIR SPECIES FOR AQUAPONICS

### Bluegill, Redear, or Hybrid Sunfish

Sunfish (Fig. 3) are a popular “sportfish” and an excellent table fare, with low initial cost at about 25 to 35 cents per 1 to 3 inch fingerling fish. Sunfish are easy to grow and can be spawned outdoors or in greenhouses by providing nest boxes and pea gravel. Sunfish readily accepts commercial diets but are still considered a poor choice in aquaponics.



Figure 3. Sunfish

The biggest hindrance to using sunfish in aquaponics is that they are illegal to be sold as a food fish in some states, including Texas. As a reminder: Ideal fish species reach market size in less than a year and before they begin their reproductive development. Bluegill is a somewhat slow-growing fish and can take 2 to 2.5 years or more to reach a market size of 1 pound. With the slow, maturing bluegill, one crop every 2 or 3 years can be expected. Additionally, bluegill have a poor feed conversion ratio (FCR). On average, it takes 3.5 to 4.4 pounds of feed for every pound of weight gain. At a feed cost of \$1.06 to \$1.83 per pound, the cost of feed for every pound of fish weight is \$3.71 to \$8.05. With a dress out percentage at 27 percent for bluegill, the break-even price for bluegill fish for 1 pound of fillet is \$13.74 to \$29.81. These prices are too high and are not achievable with the current market.

### Channel Catfish, Blue Catfish, or Hybrids

Catfish (Fig. 4) are widely known and have demonstrated market acceptability. They are the largest produced food fish in the U.S. fish industry. Catfish also have an excellent fillet yield and dress out percentage as a whole fish (e.g., gutted). Additionally, their FCR in tanks is good at 1.5 to 1.8 when carefully fed. However, the issue with catfish is a stagnant selling price of 85 to 95 cents per pound and a high-level of competition within an already well-









Few disease issues are observed in HSB when water quality is maintained correctly. Known bacterial diseases are columnaris, motile aeromonas septicemia (MAS), and *Streptococcus iniae* (Fig. 8).



Figure 8. Lesions forming on side of hybrid striped bass caused by the bacterium *Streptococcus iniae*.

**QUICK FACT:** Poor water quality can increase susceptibility to diseases, such as those caused by aeromonas. Such diseases should be avoided, even if some species have a high tolerance.

Table 1. Acceptable and desirable ranges of various water quality parameters for productive fish growth.

	Acceptable	Desirable
pH	5.5 to 10	6.5 to 9.0
Alkalinity	20 to 400 ppm	50 to 150 ppm
Calcium	>10 ppm	>20 ppm
Hardness	>20 ppm	50 to 150 ppm
Iron	Any ppm ferric	<1 ppm ferric
Chloride	10X nitrate level	10X nitrate level
Nitrate	<90 ppm	<50 ppm
Nitrite	1:10 chloride	<0.1 ppm

Table 2. Fish production time, costs, and associated market value for aquaponics production.

Species <sup>1</sup>	Time to Market (Months)	Feed Cost (\$)	Market Size (lbs.)	Market Price (\$)
Comet Goldfish	6	\$0.30-\$0.34/fish	N/A <sup>2</sup>	\$0.16-\$0.31/fish
Sunfish	24 to 30	\$1.06-\$1.83/lb.	>1	\$13.95/lb. fillet <sup>3</sup>
Catfish	18	\$0.80-\$0.82/lb.	>1.5	\$0.85-\$1.25/lb. whole
Largemouth Bass	18	\$4.17/lb.	>1.25	\$10-\$25/lb. live <sup>4</sup> \$4-\$6/lb. whole <sup>5</sup>
Koi	Variable	\$0.53-\$0.70/lb. <sup>6</sup>	1 to 3	\$20-\$65/fish
Tilapia	6 to 8	\$1.51-\$1.79/lb.	1 to 1.25	?
Hybrid Striped Bass	12 to 14	\$0.97-\$1.19/lb.	1.5 to 2.5	\$3.30-\$3.60/lb. whole \$8.99-\$9.99/lb. fillet

<sup>1</sup>Color code description: Red = Poor; Orange = Fair; Yellow = Good; Green = Excellent

<sup>2</sup>Sizes ranges from small to large.

<sup>3</sup>Sunfish are illegal to sell as a food fish in some states.

<sup>4</sup>Live weight sportfish.

<sup>5</sup>Live weight food fish. Largemouth bass are illegal to sell as food fish in some states.

<sup>6</sup>Additional \$1.60 finishing feed cost per fish.