Auburn University and USDA-Natural Resources Conservation Service

Alabama Aquaculture
Best Management Practice (BMP)

Managing Flow-Through Systems

BMP No. 20

Definition

Fish can be cultured in raceways, tanks, or small ponds through which water continuously flows. Raceways are used most commonly. Raceway dimensions typically are 50 to 100 ft long, 10 to 30 ft wide, and 3 to 6 ft deep. Water flow through raceways usually is adequate to provide three or more exchanges per hour with a minimum velocity of about 0.1 ft/sec.

Many species can be produced in flow-through systems, but the most common one is rainbow trout (Oncorhynchus mykiss). Rainbow trout live in coldwater, and they are stressed by water temperatures above 68 to 70^{o}F. There are some sites in northeastern Alabama where waters have sufficiently low temperatures for trout culture.

Source water for trout raceways usually is from springs or streams. Fingerlings are stocked at a high density and offered a high-protein, pelleted feed several times per day. Water from raceways usually flows directly into streams or other State waters.

Explanation

Inflowing water is the main source of dissolved oxygen in most flow-through systems. Thus, stock density, feed input, and flow rate should be balanced such that dissolved oxygen concentration does not fall below 5 ppm and stress fish. Water exchange in raceways also flushes away uneaten feed, feces, and metabolites to maintain good conditions for growth. However, a portion of the solid wastes settles and accumulates in the bottoms of raceways. Thus, raceways must be cleaned periodically. During cleaning, solids are suspended in the water and effluents discharged at this time have a higher concentration of suspended solids than does normal raceway effluent.

Trout feces are relatively heavy and can be removed from the water in raceways before being discharged into State waters. However, soluble nutrients and organic matter cannot be removed. Because fish are crowded in raceways, diseases are a major problem. A number of antibiotics, drugs, and other compounds are used in treating trout diseases. Many of these therapeutic agents are illegal for use in food fish in the United States, because they can have toxic effects in aquatic ecosystems.

Operating flow-through systems

Practices

Feed must be stored onsite, and guidelines for feed storage from Aquaculture Best Management Practice (BMP) No. 7 should be implemented. Therapeutic agents often are used in trout culture, and practices in BMP No. 11 should be implemented regarding storage, use, and disposal of these products. Moreover, BMP Nos. 14 and 15 should be followed regarding general operations, worker safety, and emergency response.

In addition to the practices mentioned above, certain practices specific to flow-through systems should be applied as follows:

- *Management plans should be prepared by and practices implemented with the assistance of a professional engineer (PE) licensed in the State of Alabama or other qualified credentialed professional (QCP). Periodic inspections of the operation also should be conducted by a PE or QCP.*

- *Feed should be offered several times per day in quantities that the fish will completely consume. The maximum daily feed input should be based on the relationship that 1 lb feed requires 0.2 lb oxygen.*

- *Fish should be excluded from the last 6 to 8 ft of each raceway unit by a screen. This will allow an area for sedimentation of uneaten feed and feces.*

- *Sediment should be removed from the ends of raceways at 1- or 2-day intervals by suction or via a center drain for treatment in a sedimentation basin. Any sediment that is removed should be disposed in a responsible manner according to NRCS technical standards and guidelines.*

- *Dead fish should be removed daily for disposal in a responsible manner according to NRCS technical standards and guidelines*

Flow-through aquaculture operations that qualify as concentrated aquatic animal production (CAAP) facilities must comply with EPA effluent limitation guidelines for flow-through systems, applicable NRCS technical standards and guidelines, and if required, ADEM NPDES permitting requirements.

Implementation notes

Experience with trout and other species in flow-through systems indicates that for each pound of feed applied, 0.2 lb of dissolved oxygen will be needed. Dissolved oxygen concentration should not decline below 5 ppm in trout raceways. Thus, if the incoming water contains 9 ppm dissolved oxygen, only 4 ppm dissolved oxygen (9 ppm in inflow – 5 ppm in outflow) is available. The weight of feed that may be applied daily can be calculated with the equations[1/]:

(1) Inflow (m^3/min) = Inflow (gpm) × 0.003785.

(2) Inflow (m^3/min) = Inflow (ft^3/sec) × 1.7.

(3) Weight feed (lb/day) = Inflow (m^3/min) × (g/m^3 DO in inflow – 5 g/m^3) × 1,440 min/day × 0.001 g/kg × 5 kg feed/kg oxygen × 2.205 lb/kg.

For example, suppose a flow-through system has an inflow of 2,000 gpm containing 9 ppm dissolved oxygen. The maximum daily feed input is calculated as follows:

Inflow = 2,000 gpm × 0.003785 m^3/min = 7.57 m^3/min.

[1/] Weight feed = 7.57 m^3/min × (9 g/m^3 – 5 g/m^3) × 1,440 min/day × 0.001 g/kg × 5 kg feed/kg oxygen × 2.205 lb/kg = 481 lb/day.

[1/] The calculations are much easier with metric units than with English units. Please note that 1ppm=1mg/L=1g/m^3.

The available dissolved oxygen can be increased by providing gravity aeration that allows water to fall between raceway units or by applying mechanical aeration or oxygenation. For warmwater fish culture in flow-through systems, the dissolved oxygen concentration can be allowed to decline to 4 ppm without stressing fish.

A method for removing solids from the ends of raceway units is illustrated in Figure 1. One way of removing the solids is by suction and collecting them in a portable tank which can be emptied into the settling basin. A center drain can be installed in a circular tank to allow solids removal as illustrated in BMP No. 17. The water and solids removed during sediment removal should be transferred to a sedimentation basin. This basin should be operated according to BMP No. 6. Dead fish should be disposed of according to BMP No. 13. Chlorides concentrations and saline water management is considered in BMP No. 16.

References

ADEM Administrative Code Chapter 335-6-6. (NPDES Rules)

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Soderberg, R. W. 1995. Flowing Water Fish Culture. CRC Press, Boca Raton, Florida.

Westers, H. and K. M. Pratt. 1977. Rational design of hatcheries for intensive salmonid culture based on metabolic characteristics. Progressive Fish-Culturist 39:157-165.

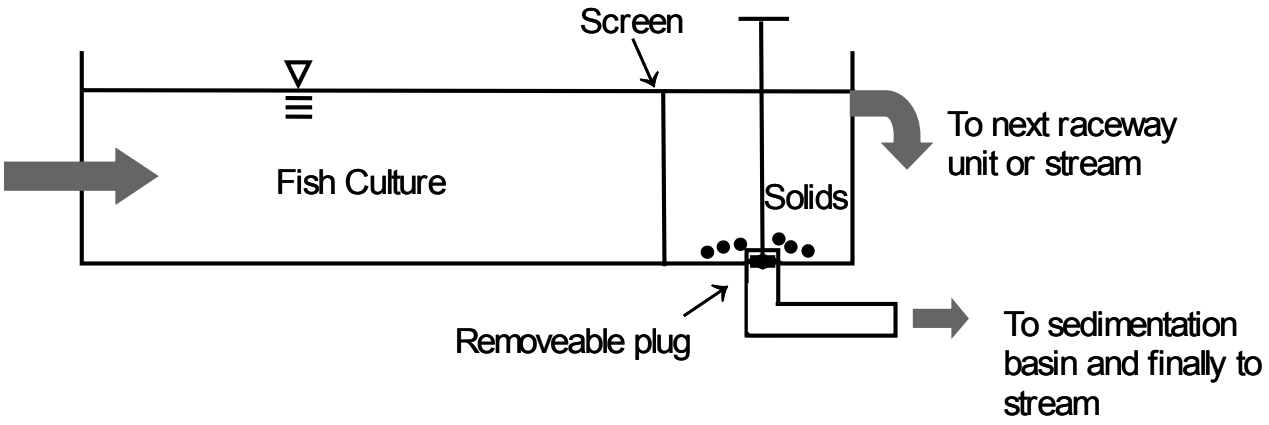

Figure 1. Illustration of the use of the end of a raceway for solids removal. Drawing is not to scale.

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