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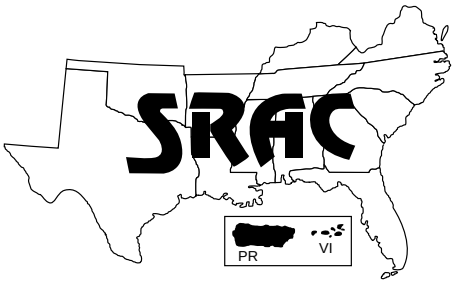

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Inventory Assessment Methods for Aquaculture Ponds

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The contents of aquaculture ponds are sometimes a mystery. After stocking, the inventory of fish is unknown until the pond is harvested and drained. At harvest time, producers often discover far fewer fish in the pond than they expected. This "disappearing fish" phenomenon has been called the "black hole syndrome." Probable reasons for fish loss include predation, cannibalism, and undetected disease. Without reliable estimates of the numbers and size distributions of fish in the ponds, producers cannot accurately project harvests. Lenders may be reluctant to extend credit unless they have confidence in a producer's inventory estimates and harvest projections.

Unfortunately, we do not have an accurate, cost-effective method for counting fish in ponds. Though sonar counting devices may someday provide a fast and accurate way to inventory fish ponds, for now, harvesting and completely draining a pond is the most reliable method for determining fish inventory. There are, however, ways to improve pond inventory estimates. This publication describes several methods for estimating pond inventories more reliably.

Estimating inventories based on historical records

Pond inventory records have two components: the total weight of fish, and the total number of fish. Producers can estimate pond inventories based on historical records of the weight of fish stocked and harvested, and their growth (the Estimated Weight Method). Or they can estimate inventories on the basis of numbers of fish stocked and harvested, and the estimated mortalities (the Estimated Numbers Method). (Van Wyk et al. 1997).

The Estimated Weight Method

The Estimated Weight Method can be used when producers have fairly good records. This method is based on the following formula for estimating ending inventory:

Lbs. beginning inventory
\+ *Lbs. stocked*
– *Lbs. harvested*
– *Lbs. mortality*
\+ *Lbs. gained*
= *Lbs. ending inventory*

Beginning inventory is the total weight of fish in the pond listed as the ending weight of the previous inventory.

Pounds of fish stocked since the pond was last inventoried will come from each pond's records. If the pond is being inventoried for the first time, this will be the total weight of fish stocked into the pond since the last time the pond was clean harvested.

Pounds of fish harvested is equal to the total weight of fish harvested since the pond was last inventoried. The weight of other fish species harvested (e.g., grass carp and gizzard shad) should be excluded from this total.

Pounds of mortalities is the estimated weight of fish lost to disease, predators and water quality problems.

Pounds gained by the fish is calculated by dividing the pounds of feed given the fish by the number of pounds of feed required to produce 1 pound of weight gain. The

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feed required to produce 1 pound of weight gain is called the Feed Conversion Ratio (FCR) and is a function of several factors, including fish size distribution, fish health, feeding rates, water quality, temperature, and feed quality. If we assume FCR values are consistent from pond to pond and from year to year, then fish weight gain can be estimated by dividing the total quantity of feed that has been fed by the historical or assumed FCR.

$$\textit{Lbs. gained} = \frac{\textit{Cumulative feed total (lbs.)}}{\textit{Assumed FCR}}$$

Example:

Calculated to Solve for Ending Inventory

20,000 lbs. beginning inventory
\+ *6,160 lbs. stocked*
\+ *44,591 lbs. weight gain*
– *43,900 lbs. harvested*
– *1,500 lbs. mortalities*

= *25,351 lbs. ending inventory*

The Estimated Weight Method for estimating pond inventories will become more accurate as producers gain experience in estimating FCR and mortalities.

The Estimated Numbers Method

The Estimated Numbers Method for determining pond inventories is based on the numbers of fish stocked and harvested, the number of fish mortalities, and the number of fish in the beginning inventory. The basic formula used for calculating the number of fish present in a pond at inventory time is as follows:

Number of fish in beginning inventory
\+ *Number of fish stocked*
– *Number of fish harvested*
– *Estimated number of fish mortalities*

= *Number of fish in ending inventory*

Beginning inventory is the number of fish in the pond when the last inventory was taken. If the pond has been inventoried before, the beginning inventory will be the ending figure on the date of the last inventory.

Number of fish stocked must be accurately recorded when stocking a pond. The number of fingerlings in a shipment is calculated by dividing the total weight of the fingerlings by an average weight per fingerling. The average weight for the fingerlings should be determined on at least two tanks per truck (usually the first and last tank if only two tanks are sampled). A good way to do this is to empty two dipnets (~1/2 full) out of each tank sampled into a tared container and count the number of fish present. The average weight is then calculated by dividing the weight of the fingerlings by the number of fingerlings:

Example:

$$\textit{Average weight} = \frac{\textit{Pounds of fingerlings in sample}}{\textit{Number of fingerlings in sample}}$$

$$= \frac{\textit{30 lbs. fingerlings}}{\textit{500 head of fingerlings}}$$

$$= \textit{0.06 lbs./fingerling}$$

The total number of fingerlings in the shipment is then calculated by dividing the total weight of the fingerlings by their average weight. If the total weight of the fingerlings in this shipment was 6,520 pounds, then the total number of fingerlings would be:

$$\textit{Total number fingerlings} = \frac{\textit{Total fingerling weight}}{\textit{Average weight/ fingerling}}$$

$$= \frac{\textit{6,520 lbs.}}{\textit{0.06 lbs./fingerling}}$$

$$= \textit{108,667 fingerlings}$$

Number of fish harvested should be accurately recorded when fish are harvested. Fish numbers must be estimated based on the total weight of fish harvested, and the average weight of fish in randomly drawn samples.

Guidelines for obtaining average harvest weight estimates:

1. Use multiple samples to estimate average weight. This decreases the chance that some size groups of fish will be over or under represented. A good practice to follow when harvesting is to count two 100- to 200-pound baskets of fish per truckload.
2. Average weight estimates should be based on head counts of a minimum of 200 pounds of fish per truck.
3. Allow each basket to drain before recording the weight.

Example:

Two basket loads of fish are weighed and counted before they are loaded onto a truck at harvest.

Basket one held 81 fish weighing 122 pounds and basket two held 104 fish weighing 148 pounds

Total harvest weight loaded on the truck was 12,348 pounds.

Step 1. Total weight of fish sampled = 122 + 148 = 270 lbs.

Step 2. Total number of fish sampled = 81 + 104 = 185 fish

Step 3. Average weight of fish sampled = 270 / 185 = 1.46 lbs.

Step 4. Total number of fish harvested = 12,348 / 1.46 = 8,458 fish

In this example we have estimated that a total of 8,458 fish were harvested from this pond.

Number of fish mortalities can be estimated by studying fish loss in the historical records of each pond. (The Arkansas Catfish Yield Verification Trial calculated percent mortalities to be 35 percent over a 3-year period on commercial farms (Heikes 1997)). The amount of adjustments to account for mortalities depends on the species of fish cultured and the culture system. The ending inventory estimate is calculated by

adding the number of fish stocked to the beginning inventory number, and subtracting both the number of fish harvested and estimated mortality.

Example:

At the end of last year the number of catfish in the ending inventory for all ponds was estimated at 300,000. During the year 250,000 fingerlings were stocked and an estimated 190,000 were harvested. An estimated 30 percent fish mortality occurred during the year based on historical records.

300,000 head Beginning inventory
+ 250,000 head Fingerlings stocked
– 190,000 head Catfish harvested
– 75,000 head Estimated mortality
= 285,000 head Ending inventory number

Estimated inventories based on historical farm records using the Weight and Numbers Methods are essentially the same, though ending inventory estimates are only as good as the input data.

Estimating farm inventories using Fishy 98

Fishy 98, a computer program developed at Mississippi State University, can be an excellent tool for keeping track of fish farm inventories (Killcreas 1995). Since producers need accurate beginning inventories to get reliable information from the Fishy 98 program, it is best to start with a new or recently renovated pond. Fishy 98 also requires accurate estimates of fish populations (size and number) stocked and harvested and feed input per pond.

Fishy 98 can be more predictive if you divide large batches into a number of smaller batches at a stocking event. For example, a total of 90,000 pond run fingerlings with an average size of 50 pounds per 1,000 were stocked into a production pond. This single large batch should be divided into two or three smaller groups based on the population's size distribution (determined through sampling) before inputting the data into Fishy 98. The data could be handled as follows:

90,000 fingerlings stocked @ 50 lbs./1,000

Batch A - 20,000 head @ 80 lbs./ 1,000

Batch B - 50,000 head @ 50 lbs./ 1,000

Batch C - 20,000 head @ 20 lbs./ 1,000

By doing this, Fishy 98 will grow three batches independently and, therefore, be more predictive.

Fishy 98 also requires accurate estimates of both pounds and numbers of fish harvested. When implementing a Fishy 98 program, producers should sample fish at a harvest event using methods discussed previously in this publication. Using these samples of average weights and distributions over time, Fishy 98 users can more accurately calculate the pounds of fish to remove from each batch at a harvest event.

Detailed feeding records for each pond are needed to track the population weight and Fishy 98 is more predictive when feed data are entered weekly. The program uses different FCRs based on the average size of each batch. The producer can use the FCR that is built into the program or can modify them based on historical records for a given farm.

The producer can input fish mortalities into Fishy 98 at the time of stocking, monthly or quarterly, which will help to account for "black-hole" losses. One method that has been successful in channel catfish production is to remove 25 percent of the population from the records at the time of stocking and then continue to remove 1 percent of the fish population per quarter. Using this method, the head count will be reduced by about 30 to 35 percent over the lifetime of a population of fish in a pond. This reduction is close to what is seen in commercial catfish production. Methods must be developed for each species to estimate population mortalities, or in the case of tilapia in ponds, population expansion.

Fishy 98 is not the answer to all our inventory questions. Feed conversion ratios and unaccounted for fish losses vary among ponds and farms and, as a result, predicted inventories may be more or less than expected. However, Fishy 98 is an excellent tool for record keeping; it can help producers refine FCR and mortality rates, and then make more accurate inventory estimates.

Determining fish inventory from the feeding response

Theoretically, it should be possible to calculate the total number and total weight of fish in a pond if one knows the maximum quantity of feed that the fish of different sizes will consume under a given set of conditions. The accuracy of this method depends on detailed knowledge of how feeding response varies according to: fish species, fish size, fish health, temperature, and oxygen concentrations. Researchers at Auburn University are currently evaluating the precision and accuracy of inventory estimates based on feeding response. Initial studies indicate that the feeding response method yields extremely variable results. Inventory estimates based on feeding response predicted by models of catfish feeding behavior have varied from actual inventories by 50 percent or more.

Using the depletion method to estimate inventories

The depletion method allows fish producers to estimate the weight and number of fish in ponds without completely draining and scraping the population. This method involves seining a pond three times with a small mesh seine. The fish caught on each seine pull must be weighed, the average weight determined, and the fish removed from the pond. Each seine pull must be performed in the same direction and

manner to take out seining as a variable. The remaining inventory in the pond is calculated through a linear regression program. This method has been tested on research ponds at the University of Arkansas at Pine Bluff with inventory estimates varying from the actual inventory by -0.1 to -7.7 percent. In 17 commercial ponds, 82 percent of the depletion estimates were ± 15 percent of the actual fish biomass inventories (Engle et al. 1997). The depletion method is one tool that could be used on selected ponds every 4 or 5 years to adjust Fishy 98 inventories and calculate improved feed conversion and mortality values without draining and scraping production ponds. (The depletion estimating program is available through the Arkansas Cooperative Extension Program at Pine Bluff.)

Summary

Producers have been waiting a long time for some technological innovation that would allow them to quickly and accurately measure pond inventories without having to drain the ponds and harvest all the fish. Hydro-acoustic monitoring devices have been cited as the technological solution most likely to succeed. Unfortunately, that technology still seems far from being a viable inventory tool. Meanwhile, the industry continues to operate "in the dark," managing fish ponds with rough estimates of their inventories.

Producers do have options available to them for improving the reliability of their inventory estimates. Historical records of the number and weight of fish stocked and harvested, when diligently maintained, can provide the basis for calculating fish inventories with the Estimated Weight method, the Estimated Numbers method, and the Fishy 98 computer program. Each of these approaches works best when samples are taken at each stocking and harvesting event to determine the average weight of the fish stocked and harvested. Average weight estimates are then used to estimate the numbers of fish in the transactions. A producer can generally also make a reasonable estimate of mortality if he/she takes into account a variety of information about a pond's history over the past year. Finally, feed consumption records provide the producer with alternative methods for estimating pond inventories.

The methods outlined here do have costs associated with them. Additional labor may be required to sample fish during stocking and harvest events and it takes time to develop and maintain a record-keeping system. However, there are also costs associated with not maintaining good inventory records. Until the long awaited "In-pond Fish Inventory Machine" is invented, these methods are the best available, and they are far better than no method at all.

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