Aquatic Animal Nutrition:

Understanding Feed Conversion Ratios

Grade Level:
9-12

Subject Area:
Aquaculture, Nutrition

Time:
30 minutes
+introduction/discussion time

Student Performance Standards (Sunshine State Standards):
15.05 Determine feeding methods and feed aquaculture species (LA.910.1.6.1, 2, 3, 4, 5; MA.912.A.1.4).
19.02 Demonstrate basic bookkeeping skills (MA.912.A.1.1, 2, 3, 4, 5, 6, 8; MA.912.A.2.1, 2, 3, 7; MA.912.A.5.1, 4, 7; MA.912.A.10.1, 2; MA.912.F.3.4,5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17; MA.912.F.4.4, 6, 7).
19.08 Complete supervised occupational (SAE) experienced records (LA.7.2.2.4, LA.8.2.2.4, LA.910.2.2.4, LA.1112.2.4).

Objectives: Students will be able to:

1. Calculate feed conversion ratios to two decimal places of accuracy.

Abstract:

Q: Why do we feed fish?

A: We feed fish to increase growth, promote health and facilitate reproduction. Natural pond productivity only provides a small amount of nutrition for fish in a culture setting. Therefore, supplemental or complete feeding is necessary to increase growth rates, stocking densities (carrying capacity), or both.

Q: How much food does it take to get a pound of fish?

A: We know we are what we eat. So are fish. But how much fish food is needed to grow a fish large enough for us to have a market sized animal (1.5-2.0 lbs., or 1 kg.)? By calculating **feed conversion ratios**, or the **mathematical relationship** between food fed and pounds of weight gain, students will understand a fundamental concept of production agriculture, see the differences between **growth**

efficiency of land animals vs. aquatic animals. Students will be able to determine how many pounds of fish can be grown from a fixed amount of feed and link it to the **economic importance** of correct feeding practices. The objectives presented here would be included on the unit exam. For this section there would be some short answer questions, and most likely some hands on activity like determining feed conversion ratios in aquatic animals vs. terrestrial animals. Specific topics to be covered on the unit exam will be pointed out and emphasized during instruction.

Interest Approach:

When students come into class have several samples of foods of different nutritional composition such as a piece of pizza, bowl of cereal, a salad, or hamburger (fish) sitting at your prep table or in front of the room. Ask the students a series of very easy questions. (Which has more calories? How is the food you eat used? Which one would cause you to gain weight faster, if eaten consistently? Which one is easily digested?) Students will likely point out the key differences in calories, as being a critical factor between food items and that several foods would be digested more easily than others. At this point explain that this concept of weight gain and eaten food is very important in the study of fish growth and feed conversion efficiency.

Student Materials:

1. Pencil
2. Paper
3. Calculator
4. PowerPoint handout

Teacher Materials:

Material	*Store*	*Estimated Cost*
Pencil/pen	NA	NA
Paper	Office Depot, WalMart	$1.99 and up
Calculator	Office Depot, WalMart	$5 and up
Blackboard/whiteboard	NA	NA
PowerPoint handout	NA	NA
PowerPoint ready pictures of cows, chickens, pigs, and fish	Any website www.aquanic.org	NA
Pictures/samples of feed for each animal	NA	NA
Examples of larval and adult fish foods (algae,	NA	NA

daphnia, feeds [flakes, pellets])		
Brine shrimp in canister or started brine shrimp culture	NA	NA
Scale		
Weighing boats	Carolina Biological	$16 and up
Fish meal (or can of sardines), Corn meal, Wheat flour, Soybean meal	NA	NA
IFAS publication VM 114 (Fish Nutrition)	http://edis.ifas.ufl.edu/FA096	NA

Student Instructions:

1. Go to the board (or use data sheet) and write one thing that you ate today.
2. Now write down what you fed your dog or cat.
3. How does what you wrote relate to your weight or that of your companion animal?
4. Using the data sheet and formula provided, calculate the feed conversion ratio in each situation.

Teacher Instructions:

Preparations:

For this section you may not have any preparation of material. This can be strictly a "pen and paper" exercise. Although you might wish to have several real examples of food for more visual appeal.

Upon beginning the nutrition unit, explain every agriculture enterprise has limitations, which must be overcome, if it is to expand. Assuming that you have already taught water quality, you can explain that historically, provision of quality water has been a major limitation in the culture of aquatic animals, particularly fish. While water quality maintenance has been facilitated by technology and has increased fish production recently, nutrition of aquatic animals is also integral to production success of established aquaculture species. Also, limitations in nutritional knowledge can greatly limit production success when attempting to grow new species. Therefore, to understand production of aquatic animals better, a fundamental understanding of nutrition as it applies to these creatures is essential.

These differences that govern how terrestrial animals use food when compared to those of aquatic animals are biological in nature. You may wish to explain to students that some food terrestrials eat is used for maintenance, support and growth while some is used for heat production just to keep us warm. Also indicate

that aquatics do not share all of these factors since they live in water which supports their weight, yet draws heat from their bodies so fast that it would be too costly for fish to maintain a constant body temperature on their own. As a result, fish have adapted to live without generating internal body heat (poikilothermy) and can use more of the food they eat for growth. Conversely, it requires less food to gain a pound of fish than it does a pound of beef!

Activity:

1. Direct students to come to the board and write one thing that they ate that day.
2. Have students come to the board and write one thing that they feed their dog or cat.
3. Ask students how what they wrote related to the weight of themselves or their companion animal.
4. After a few have answered explain that everything animals eat is converted into some form of tissue, or contributes to body mass in some way.
5. Finally, explain that fish convert food to body mass better than terrestrial animals. (Why?)
6. To understand how fish convert food to body mass efficiently, we must know that when animals eat food, they grow (gain weight). For a given amount of food consumed we can expect a predictable amount of weight gain from the animal, in this case a fish or crustacean.
7. At this time show the list (Table or PowerPoint: Feed Conversion Ratio Calculations, slides) of typical daily feed rations for terrestrial and aquatic animals. Next show a table of feed costs/lbs. of feed for terrestrial vs. aquatic animals. Finally, show a table with daily growth of the same animals. Ask students to note any similarities or differences.

Calculation of Feed Conversion Ratio:

1. Explain that feeding and weight gain are interrelated in agriculture and that understanding this can help students determine the not only **efficiency** but **cost** of feeding terrestrial vs. aquatic animals.
2. Provide the students with the formula for feed conversion, or feed to gain, ratio:

$$\text{FCR} = \frac{\text{Total pounds of feed fed}}{\text{Total pounds of fish weight gain}}$$

3. Also, students will be able to determine how many pounds of fish can be grown from a fixed amount of feed and link it to the economic importance of correct feeding practices.
4. Emphasize to the students that weight gain is to be used and not just weight of the fish.

5. This is often a real world situation for farmers since they are interested in the efficiency of their feeding practices and the growth performance of the animals they raise.

Post work/Clean-up:

1. The good thing about this activity is that it requires no clean up!

Anticipated Results:

Review out loud with students. Ask the following questions and call on students for their answers. Students should understand the following after the lesson:

1. On average, how many pounds of feed are needed to produce a pound of land animal (cow, pig, etc.)? Of fish?
2. How can we measure the efficiency of weight gain in agricultural production?
3. What is the definition of feed conversion ratio (FCR)?
4. Which animals are more efficient at producing a pound of growth (weight gain), terrestrials or aquatics?

If questions are not answered correctly review the topic as needed.

Support Materials:

1. Sample exercises
2. *Aquatic Animal Nutrition Objective 1* handout
3. *Measure Feed Conversion Ratio of Your Own Fish* handout

Explanation of Concepts:

Unit conversion
Growth efficiency
Cost effectiveness

Support Materials

Sample Exercises

I. Calculate the feed conversion ratio of pigs and fish fed the same weight of feed and compare the two.

An in-class example might look like this.

Example 1

A farmer buys 1000 ornamental catfish, each weighing 0.10 lbs. She grew them until their average weight was 0.5 lbs. During that time she feeds them 70 lbs. of feed. What is the feed conversion ratio of the fish she grew?

Our formula is as follows:

$$\text{FCR} = \frac{\text{Total pound of feed fed}}{\text{Total pounds of fish weight gain}}$$

Since we know the amount of feed used already (70 lbs.), all we need to do is determine the weight gain of the fish during that time:

Step 1: Determine the total weight of fish in the beginning
1000 fish x 0.10 lbs. = 10.0 lbs. fish

Step 2: Determine the weight of fish at the end
1000 fish x 0.50 lbs. = 50.0 lbs.

Step 3: 50.0 lbs – 10.0 lbs. = 40.0 lbs.
Therefore the total weight gained in fish was 40.0 lbs.

Step 4: Now we can determine the FCR by using the formula above

$$\text{FCR} = \frac{\text{70 lbs. feed}}{\text{40 lbs. fish}} = 1.75{:}1$$

…a respectable FCR, indeed!

Using similar data and knowing that pigs exhibit an FCR of 3:1, ask student to determine how much additional feed would be needed to produce a similar weight of pork. As a general note, anything that approaches 3:1 for fish should be closely evaluated and reduced if possible. Several reasons for poor FCR are overfeeding the fish, improper diet, or poor environmental conditions, which don't support feed utilization, growth, or both.

II. Now how much would it cost to feed these fish?

By using the information above and adding price to the equation we could determine the cost of feeding fish in any operation.

Say that a farmer invests $10,000 in fish food which costs $250/ton. He therefore has 40 tons of fish feed to offer his fish. How many pounds of fish should he expect to grow, if the fish he raises have an FCR of those above (1.75:1)? Let's help the farmer out!

Solution:

$$\text{FCR} = \frac{\text{Total weight of feed}}{\text{Total weight gain of fish}}$$

Step 1: Since we are interested in pounds of fish, we must convert the 40 tons of feed to pounds of feed (1 ton weights 2000 lbs.).

40 tons x 2,000 lbs. = 80,000 lbs. feed

Step 2: Using our formula and the data provided we obtain:

$$1.75 = \frac{80{,}000 \text{ lbs.}}{X \text{ lbs. fish}} \quad \text{or} \quad 1.75X = 80{,}000 \text{ lbs.}$$

=45, 714 lbs. of fish

We would only be able to produce half that much pork or less!

As a final step, show **Handout 1 (or use slide)** to the students, which will illustrate different FCR's, and their associated effects on prices for producing a pound of catfish.

Note: To see how this can be applied to seasonal feeding of fish, reference Tables 7 and 8 in the ***Catfish Farmer's Handbook***

Name:_____
Date:_____

Aquatic Animal Nutrition
Objective 1: Understanding Feed Conversion Ratios

Student Worksheet:

Directions: Using the information given, calculate the feed conversion ratio of each animal. You must show your work to receive full credit for this assignment.

$$FCR = \frac{\text{Total pounds of feed fed}}{\text{Total pounds of weight gain}}$$

Problem 1: A farmer buys 1250 ornamental koi, each weighing 0.50 lbs. She grew them until their average weight was 1.5 lbs. During that time she feeds them 70 lbs. of feed. What is the expected feed conversion ratio of the fish she grew? Was this result typical of aquatic animals? Why, or why not?

Problem 2: Say that a farmer invests $25,000 in fish food, which costs $250/ton. She therefore has 100 tons of fish feed to offer his fish. How many pounds of fish should she expect to grow, if the fish she raises have an FCR of those above? Let's help the farmer out!

Measure Feed Conversion Ratio in Your Own Fish!

TIME: 10minutes a day for 6 weeks unless an aquarium is already established, then two months.

Materials:

1. Aquarium with several small fish (goldfish, cichlids).
2. Fish food from a local pet store.
3. Scale (kitchen food scale)
4. Paper towels.
5. Net for netting fish.
6. Calculator
7. Data sheet, or calendar.

Methods:

1. Start an aquarium with several gold fish.
2. It is important that they are juveniles as they will grow faster! If you know a hobbyist who has a regular supply of larval fish this becomes really cool as larval fish gain weight incredibly rapidly.
3. After they have been in the tank several weeks, remove the fish and weigh them altogether. It is a good idea here to blot the fish dry on a towel so you don't end up weighing water during your determination of feed conversion ratio.
4. Record the weight to the nearest gram and number of fish on your data sheet/calendar.
5. Place the fish back in the tank.
6. Obtain a feed container full of food and weigh it to the nearest gram.
7. Feed the fish as much food as they will eat in 5 minutes. You must feed slowly, or you will over-feed your fish and your results will not be very accurate.
8. Weigh the container of fish food again. Record the weight of the fish food remaining.
9. Continue to do this every time you feed the fish for the next two weeks to a month.
10. Following the feeding trial, weigh the fish again and calculate the feed conversion ratio! Was the number close to 1? If so, you're a great fish feeder and the fish grew well! Good job.