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Teach Aquaculture Curriculum: How big is that pond?[1]

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This is Activity 5 in a series of 24 in the Aquaculture Curriculum.

Abstract

This activity will provide examples of volume and area calculations of ponds of various types and shapes. The students will learn to calculate volumes and surface areas of ponds and use this information to calculate stocking densities and chemical application rates. Students will be able to make these calculations in both US and metric units. This activity has direct application to aquaculture, and these calculations are commonly used by federal and state agencies, private companies, engineers, toxicologists, and other people related to the aquatic sciences.

Objectives

Students will be able to:

1. Calculate the volume of ponds with various shapes.
2. Calculate surface area of ponds with various shapes.
3. Calculate stocking densities of fish for various ponds.
4. Calculate chemical application amounts to various ponds.

Grade Level

5–12

Subject Area

Mathematics, geometry, aquaculture

Time

Preparation: 60 minutes

Activity: Three 60 minute blocks (one to present the concepts, one for students to work the calculations, and one to explain/discuss the results)

Cleanup: 5 minutes

Student Performance Standards (Sunshine State Standards)

03.01 Employ scientific measurement skills (SC.912.E.7.8; SC.912.L.14.4; SC912.S.3.1, 9; MA. 912. A. 1.5; MA.912.S.4.2; MA.912.S.5.1, 3; MA.912.S.5.2, 3, 4, 5).

13.02 Explain how changes in water affect aquatic life (LA.910.1.6.1, 2, 3, 4, 5; SC.912.L.17.2, 3, 7, 10).

13.04 Calculate volume in circular, rectangular, and irregular-shaped water structure (LA.910.1.6.1, 2, 3, 4, 5; MA.8.G.5.1).

13.09 Observe different stages of construction of ponds and/or other aquaculture production facilities (LA.910.1.6.1, 2, 3, 4, 5; MA.912.G.2.7; MA.912.G.3.1; MA.912.G.1,3, 4; MA.912.G.6.2, 5, 7).

14.01 Identify factors to consider in determining whether to grow an aquaculture species (LA.910.1.6.1, 2, 3, 4, 5; MA.912.G.2.5; MA.912.G8.3, 6; SC.7.L.17.3).

Interest Approach

Government agencies or private companies manage almost all water bodies in Florida. Aquatic plants commonly accumulate in high-nutrient water bodies. Herbicides are used to eliminate unwanted plants. These chemicals are applied on a surface area or volume basis. In aquaculture, fish are stocked into ponds on a surface area basis. Use these as examples to introduce the importance of calculating the surface area and volume of ponds.

Ponds are typically constructed by scraping one or two feet of soil from the area where the pond will exist and pushing this soil to form the levee of the pond. Heavy equipment, including bulldozers, dirt pans, graders, rollers, and backhoes, is often used. Levees should have a slope between 3:1 and 4:1. A slope of 3:1 means that the rise of the pond levee is one foot for each three feet of horizontal distance. This creates a gradual slope to the pond levee and provides strength.

All aquaculture ponds need to have a drain to maintain the proper depth and prevent water from flooding over the levee and mixing with other ponds. The depth of the pond can be maintained with a standpipe or sluice gate. Standpipes release water and can be on the inside or outside of the pond. Typically there is a swivel joint at the base of the standpipe, and when the pipe is swiveled and pushed down, it allows the water to drain to the level of the standpipe. To completely drain a pond, the standpipe must be lowered to the bottom of the pond. A sluice gate is a water control device that maintains water level with sluices that are slats of wood within the structure. The depth of water in the pond is maintained at the top of the sluices. As sluices are removed or added, the depth of the water changes. Both standpipes and sluices are effective methods to maintain water depth by allowing excess water to drain out and not flood over the levee.

Student Materials

1. Pencil
2. Paper
3. Calculator (optional)
4. *Conversion Table and Calculating Pond Areas* handouts http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php
5. Publication: Masser, M. P. and J. W. Jensen. 1991. *Calculating Area and Volume of Ponds and Tanks.* Southern Regional Aquaculture Center. SRAC Publication 103. http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php

Teacher Materials

Table 1. Teacher Materials:

Material	Store	Estimated Cost
Calculator	Walmart, office supply store	NA
Conversion Table handouts	http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php	NA
Calculating Pond Areas handout copies	http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php	NA
Calculating Pond Areas answer sheet	http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php	NA
Publication: Masser, M. P. and J. W. Jensen. 1991. *Calculating Area and Volume of Ponds and Tanks.* Southern Regional Aquaculture Center. SRAC Publication 103.	A PDF version of this article can be found at: http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php	NA

Student Instructions

1. Knowing the area of the pond's surface is necessary to calculate the volume of the pond. Volume is a calculation of the number of gallons or liters that can be held in the three-dimensional space of a pond.
2. Teacher will provide this handout: Masser, M. P. and J. W. Jensen. 1991. *Calculating Area and Volume of Ponds and Tanks.* Southern Regional Aquaculture Center. SRAC Publication 103. This document contains the information necessary to complete this activity.
3. Teacher will provide handouts and work through example calculations. Using the surface area and volume calculations of the ponds, calculate stocking densities and application rates.

4. Calculate the stocking density of fish on a surface area (per acre) and per volume (per liter or gallon) basis.
5. For the ponds in the questions, calculate the application rate for an aquatic dye, Aquashade, which should be applied at 1 gallon/acre foot.

Teacher Instructions

Preparations

1. Obtain publication: Masser, M. P. and J. W. Jensen (1991). *Calculating Area and Volume of Ponds and Tanks.* Southern Regional Aquaculture Center. SRAC Publication 103. http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php
2. Obtain handouts *Conversion Table, Calculating Pond Areas,* and *Calculating Pond Areas* answer sheet. http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php
3. Understand area and volume calculations of rectangular-, almost square-, circular-, triangular with 90° angle-, triangular without 90° angle-, and irregular-shaped ponds with flat, sloped, and variable pond bottoms. These are discussed in Masser and Jensen (1991).
4. Knowing the surface area of a pond is necessary to calculate the volume of a pond. Volume is a calculation of the number of gallons or liters that can be held in the three-dimensional space of a pond.
5. Know how to calculate the volume of rectangular-, almost square-, circular-, triangular with 90° angle-, triangular without 90° angle-, and irregular-shaped ponds with various depths including flat, sloped, and variable. These are discussed in detail in Masser and Jensen (1991).
6. Copy worksheets for each student.
7. Provide a calculator to each student or group (optional).

Activity

1. Give students an oral quiz on some basic formulas for area, surface area, and volume.
2. Hand out the worksheets to each student.
3. Work example calculations for each section with the class.
4. Have the students calculate stocking densities and Aquashade application rate (see student instructions 3 and 4).

Postwork/Cleanup

1. Clean area, and put away calculators.

Anticipated Results

1. Students will be able to calculate surface areas and volumes of various pond types.
2. Students will be able to calculate stocking densities of fish and chemical application rates of various ponds.
3. Students will gain confidence in their understanding of geometry.

Support Materials

1. *Conversion Table* handout http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php
2. *Calculating Pond Areas* handout http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php
3. *Calculating Pond Areas* answer sheet http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php
4. Masser, M. P. and J. W. Jensen (1991). *Calculating Area and Volume of Ponds and Tanks.* Southern Regional Aquaculture Center. SRAC Publication 103. http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php
5. "Aquaculture Ponds" section (below)
6. *Pond Lecture* PowerPoint presentation http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php

Aquaculture Ponds

This written description of aquaculture ponds will accompany the *Pond Lecture* PowerPoint presentation, http://irrec.ifas.ufl.edu/teachaquaculture/curriculum/3growout.php. Levee ponds are the most common pond type used in aquaculture. They are constructed with sloping sides or levees and a slightly sloping bottom. Sloping levees provide strength to the pond, minimize erosion, and allow for easy harvest using a seine net. The levees are typically made of compacted soil or can be lined with a plastic or rubber material. The depth of an aquaculture pond is important. Aquaculture ponds should be three to six feet deep. If the water is less than three feet deep, it will be vulnerable to growth of unwanted algae including macrophytes and filamentous algae. If a pond is deeper than six feet, there can be stratification, or layering, of the water due to differences in temperature. This can cause additional water quality differences between layers including disparities in dissolved oxygen levels. Deep water can be anoxic, or lack oxygen, and will not support fish life.

Watershed ponds are filled with water that drained from the local watershed. A watershed is the area of land surrounding the pond where surface water from rain or other sources flows. Visualize a pond at the base of a hill, and the rain that hits the hill will drain down the hill into the pond. In this example, the hill is the watershed. However, depending on the contour of the land, watersheds can be much larger. Some are even thousands of square miles in size. Think about the watershed of a large river in your area. Watershed ponds are rarely used for aquaculture except in hilly areas. Watershed ponds only fill with water from the watershed; there are no wells or other sources of water. Therefore, they are vulnerable to seasonal changes in water availability, including drought and flooding. Watershed pond depth is determined by the topography of the land and should be built with an emergency drain or spillway. The water running to the pond from the watershed can carry substances such as silt, high concentrations of nutrients, and pesticides or other chemicals. Some watersheds contain water with high nutrients from agriculture or human activity. These unwanted chemicals can make watershed ponds difficult to use for aquaculture. Finally, watershed ponds can easily be stocked with unwanted fish or other aquatic organisms that enter the pond from the watershed. Fish eggs can flow for great distances in a small amount of water during a rain event and can end up stocking unwanted fish. As a general rule, a one-acre watershed pond needs about five to seven acres of watershed to stay filled, but this can vary with the amount of rain, land topography, and soil type.

A lined pond is used in areas where the soil does not hold water. For example, sandy soils will not hold water, so ponds in areas with sandy soil types are often lined. The lining material varies in purpose, price, and availability. Pond liner is typically made of a rubber or plastic material and is thick enough to prevent being easily punctured or torn. Plastic liners are made of high density polyethylene, or HDPE, and rubber liners are made of ethylene propylene diene M-class rubber, or EDPM. These liners allow aquaculture to occur in areas where the soil will not retain water, but adequate culture conditions are present. This includes sandy areas like Florida and many deserts throughout the world. Lined ponds are almost always a levee-style pond that has been shaped properly with plastic material covering the exposed soil. The liner must extend to the crest of the levee to prevent wave action from eroding the top, inside edge of the levee.

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