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Predators in action : rapa whelks vs. hard clams

Juliana M. Harding

Virginia Institute of Marine Science

Vicki P. Clark

Virginia Institute of Marine Science

Roger Mann

Virginia Institute of Marine Science

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PREDATORS IN ACTION: RAPA WHELKS VS. HARD CLAMS

INTRODUCTION

Rapa whelks (*Rapana venosa*) are large predatory marine snails (Figure 1). These large snails were discovered in the Chesapeake Bay in 1998. Rapa whelks are native to the marine and estuarine habitats off the coast of Japan and Korea. They were introduced to the Black Sea in the mid 1940s and have since spread from there into the Mediterranean, Adriatic, and Aegean Seas. It is very likely that the Chesapeake Bay population began with the introduction of baby snails from the Black Sea into the waters of the lower Chesapeake Bay in ships' ballast water.

Rapa whelks eat bivalve molluscs. They are generalist predators; that is, they do not require a particular kind of bivalve. They will eat whatever bivalves are available to them. In the lower Chesapeake Bay the potential menu for rapa whelks includes hard clams (*Mercenaria mercenaria*, Figure 2), mussels (*Mytilus* and *Geukensia* sp.), and oysters (*Crassostrea virginica*), as well as others. Adult rapa whelks or animals with shells bigger than 75 mm (about the size of a tennis ball) seem to live in the same places that hard clams live and probably eat them as a main food item.

Hard clams are commercially fished in the lower Chesapeake Bay, so humans are interested in where the clams are too! The local hard clam fishery is worth more than \$3 million dollars each year. Hard clam fishermen



Figure 1: An adult rapa whelk from the lower Chesapeake Bay. This animal's shell is 165 mm long. ©2002. J. Harding.



Figure 2: Two adult hard clams. These animals are approximately 80 mm long. ©2003. J. Harding.

and fishery managers are concerned about the potential effects that rapa whelk predation might have on hard clam stocks. A large rapa whelk population living among the hard clams has the potential to eat many clams and potentially reduce the fishermen's catch. Thus the question "How many clams could a rapa whelk eat in a year?" has real scientific and economic implications.

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Visit the VORTEX web site for information on other rapa whelk educational materials:

www.vims.edu/mollusc/education/vortex.html

INFORMATION FOR INSTRUCTORS

Objectives

1. Estimate how many hard clams a population of rapa whelks could eat in one year using laboratory data.
 2. Combine fishery data for hard clams in the Hampton Roads region with estimates of rapa whelk abundance in the same area and compare the predation estimates for rapa whelk with removal of clams by the fishery.
2. Give each student a copy of the **PREDATORS IN ACTION: RAPA WHELKS VS. HARD CLAMS Data Protocol** (page W1-3).
 3. Divide the students into research teams.
 4. Have the students read the **Data Protocol** (page W1-3) and then ask the students to explain how the two types of data (rapa whelk and hard clam) were collected.
 5. Ask the students to work within their groups to complete the calculations and present their group's answer to the class (including intermediate mathematical steps).

Skills: Observation, communication, computation.

Relevant Virginia SOL

- | | |
|---------|---------------------------------------------------------------------|
| 6.9 | Living systems |
| LS.9 | Population interactions within a community |
| BIO.5 | Life functions |
| BIO.9 | Dynamic equilibria within communities, analysis of local ecosystems |
| A.1-A.4 | Solving equations relating to practical problems |

Materials

One copy of each of the following for each student:

1. The **PREDATORS IN ACTION: RAPA WHELKS VS. HARD CLAMS Introduction** (page W1-1).
2. The **PREDATORS IN ACTION: RAPA WHELKS VS. HARD CLAMS Data Protocol** (page W1-3).
3. The **PREDATORS IN ACTION: RAPA WHELKS VS. HARD CLAMS Student Worksheet** (page W1-5).

Procedure

1. Ask the students to read the **PREDATORS IN ACTION: RAPA WHELKS VS. HARD CLAMS Introduction** (page W1-1).

See the *VORTEX* instructional booklet **RUNDOWN ON THE RAPA** for additional information on the biology and ecology of rapa whelks in the Chesapeake Bay.

Suggested Discussion Questions

1. How does the percentage of clams eaten by rapa whelks in one year compare to the percentage of clams caught by the clam fishermen in one year?
2. On the basis of these calculations, characterize the probable impact of rapa whelk predation on the Hampton Roads hard clam predation in 2001 as LOW, MEDIUM, or HIGH. Justify this characterization.
3. Do you think that this characterization will change within one year? Five years? Ten years? Why or why not?

*Note: The information contained in the **RUNDOWN ON THE RAPA** chapter **Recipes for Reproduction** addresses rapa whelk potential for population growth and is directly relevant to this question.*

DATA PROTOCOL

Rapa whelk feeding

Rapa whelk activity levels are directly related to water temperature. Most rapa whelk feeding occurs at water temperatures above 18-20°C. In the Chesapeake Bay, this water temperature threshold usually coincides with a time window from early May through September.

Virginia Institute of Marine Science (VIMS) researchers have a group of rapa whelks living in aquaria at their laboratory. These rapa whelks are fed hard clams and always have more hard clams available than they can eat. During 2001, there were 110 snails living at VIMS. Between May 1 and September 30, 2001, these 110 whelks ate a total of 1,202 clams (J. Harding and R. Mann, VIMS, unpublished data). Use the Student Worksheet (page W1-5) to estimate:

1. How many clams were eaten by each whelk during the course of the summer?
2. How many clams were eaten by one whelk in a one week interval?

Hard clam stock assessment

During 2001, VIMS scientists conducted a survey of the hard clam stocks in the Hampton Roads region of the Chesapeake Bay. Hard clams were collected from 1 m² bottom areas using patent tongs at over 2000 places. Scientists used the number of clams caught in this survey to estimate that in 2001 there were 107,725,604 live hard clams in Hampton Roads (R. Mann, J. Harding, M. Southworth, VIMS, unpublished data).

Hard clam fishery yield

During 2001, hard clam fishermen caught clams in the Hampton Roads area from May through August. The Virginia Marine Resources Commission reports that these fishermen caught a total of 4,984,397 clams during this time window in Hampton Roads (Virginia Marine Resources Commission, Newport News, VA).

3. Use the Student Worksheet (page W1-5) to calculate the percentage of the total number of Hampton Roads clams that were caught by fishermen in 2001.

Rapa whelk collections

Adult rapa whelks are often caught as bycatch by commercial fishermen; that is, the fishermen are fishing for another animal and they catch rapa whelks, too. The VIMS Molluscan Ecology program will pay a bounty on each rapa whelk from the Chesapeake Bay that fishermen give them provided the fishermen can tell the scientists where, when, and how they caught the whelk. From May through September 2001, fishermen donated 630 rapa whelks that were caught in the Hampton Roads region to the VIMS Rapa Whelk bounty program (J. Harding and R. Mann, VIMS, unpublished data). Use the Student Worksheet (page W1-5) to estimate:

4(a-c). The number of rapa whelks in the Hampton Roads region if the 630 whelks that were caught represent A) 10%, B) 20%, and C) 50% of the total rapa whelk population.

5(a-c). Using the feeding rate calculated above (number of clams/whelk/summer), estimate how many clams were eaten by each of the three size estimates for the Hampton Roads rapa whelk population in 2001. What percentage of the total number of clams in Hampton Roads would each of the three sizes of rapa whelk population have eaten in 2001?

ANSWERS TO STUDENT WORKSHEET

Rapa whelk feeding

Time window: May 1-Sep 30, 2001. How many weeks is this? **20 weeks**

Total number of rapa whelks = 110

Total number of hard clams consumed by 110 rapa whelks in **20 weeks** = 1,202

1. How many clams were eaten by each whelk during the course of the summer?

$$1,202 \text{ total clams eaten} / 110 \text{ total whelks} = 10.92 \text{ clams/whelk/summer}$$

2. How many clams were eaten by one whelk in a one week interval?

$$10.92 \text{ clams per whelk} / 20 \text{ weeks} = 0.54 \text{ clams/whelk/week}$$

Hard clam stock assessment

Total number of hard clams in Hampton Roads in 2001 = 107,725,604

Hard clam fishery yield

Total number of clams caught in Hampton Roads by fishermen from May 1-Aug 31, 2001 = 4,984,397

3. What percentage of the total number of hard clams from Hampton Roads is 4,984,397?

$$(4,984,397 / 107,725,604) * 100 = 4.6 \% \text{ of total clam population caught by fishermen in 2001}$$

Rapa whelk collections

Total number of rapa whelks donated to VIMS May-September 2001: 630

4A. If these 630 whelks represent 50% of the total number of whelks in Hampton Roads, how many whelks are there?

$$1A: 1,260 \text{ whelks}$$

4B. If these 630 whelks represent 20% of the total number of whelks in Hampton Roads, how many whelks are there?

$$1B: 3,150 \text{ whelks}$$

4C. If these 630 whelks represent 10% of the total number of whelks in Hampton Roads, how many whelks are there?

$$1C: 6,300 \text{ whelks}$$

5A: How many clams do the whelks in rapa whelk population 4A eat in summer 2001? What percentage of the total number of clams is this?

$$1260 \text{ whelks} \times 10.92 \text{ clams/whelk/summer} = 13,759 \text{ clams};$$

$$(13,759 \text{ clams eaten} / 107,725,604 \text{ clams total}) * 100 = 0.01\% \text{ of total clam population}$$

5B: How many clams do the whelks in rapa whelk population 4B eat in summer 2001? What percentage of the total number of clams is this?

$$3,150 \text{ whelks} \times 10.92 \text{ clams/whelk/summer} = 34,398 \text{ clams}$$

$$(34,398 \text{ clams eaten} / 107,725,604 \text{ clams total}) * 100 = 0.03\% \text{ of total clam population}$$

5C: How many clams do the whelks in rapa whelk population 4C eat in summer 2001? What percentage of the total number of clams is this?

$$6300 \text{ whelks} \times 10.92 \text{ clams/whelk/summer} = 68,796 \text{ clams}$$

$$(68,796 \text{ clams eaten} / 107,725,604 \text{ clams total}) * 100 = 0.06\% \text{ of total clam population}$$

STUDENT WORKSHEET

Rapa whelk feeding

Time window: May 1-Sep 30, 2001. How many weeks is this? _____

Total number of rapa whelks = 110

Total number of hard clams consumed by 110 rapa whelks in _____ weeks = 1, 202

1. How many clams were eaten by each whelk during the course of the summer?

_____ clams/whelk/summer

2. How many clams were eaten by one whelk in a one week interval?

_____ clams/whelk/week

Hard clam stock assessment

Total number of hard clams in Hampton Roads in 2001 = 107,725,604

Hard clam fishery yield

Total number of clams caught in Hampton Roads by commercial fishermen from May 1-Aug 31, 2001 = 4,984,397

3. What percentage of the total number of hard clams from Hampton Roads is 4,984,397?

_____ % of total clam population

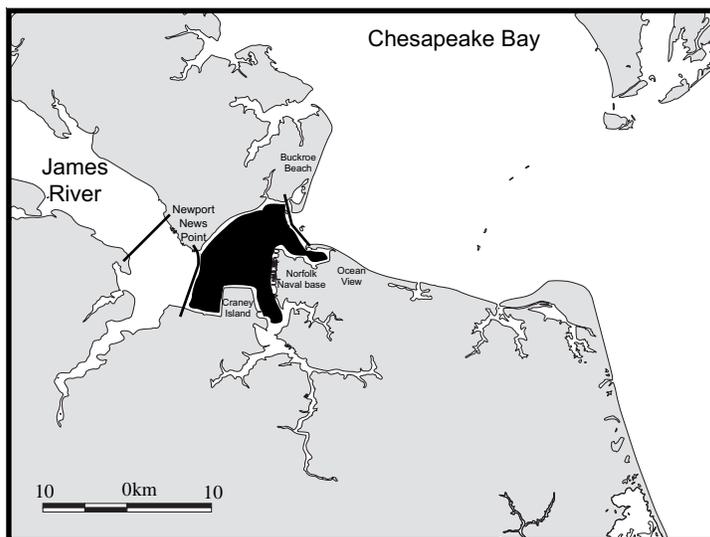


Figure 3: Map of the lower Chesapeake Bay, USA. The Hampton Roads region is shown in black.

STUDENT WORKSHEET

Rapa whelk collections

Total number of rapa whelks donated to VIMS May-September 2001: 630

4A. If these 630 whelks represent 50% of the total number of whelks in Hampton Roads, how many whelks are there?

1A: _____ whelks

4B. If these 630 whelks represent 20% of the total number of whelks in Hampton Roads, how many whelks are there?

1B: _____ whelks

4C. If these 630 whelks represent 10% of the total number of whelks in Hampton Roads, how many whelks are there?

1C: _____ whelks

What is the estimated feeding rate of rapa whelks on hard clams in one summer (from Rapa whelk feeding #1) :

_____ clams/whelk/summer

5A: How many clams do the whelks in rapa whelk population 4A eat in summer 2001? What percentage of the total number of clams is this?

_____ clams; _____% of total clam population

5B: How many clams do the whelks in rapa whelk population 4B eat in summer 2001? What percentage of the total number of clams is this?

_____ clams; _____% of total clam population

5C: How many clams do the whelks in rapa whelk population 4C eat in summer 2001? What percentage of the total number of clams is this?

_____ clams; _____% of total clam population

VORTEX

Virginia's Oyster Reef Teaching EXperience

An Educational Program for Virginia Science Educators

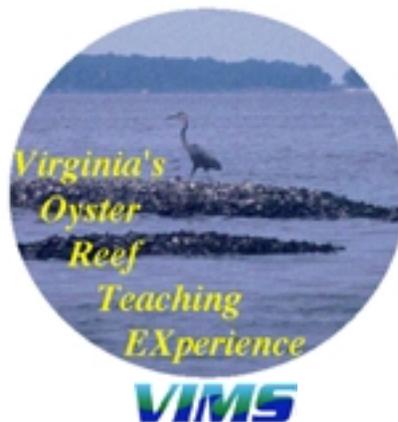
What is VORTEX?

Virginia's Oyster Reef Teaching EXperience (VORTEX) is a multi-component program focusing on the importance of oyster reef communities in the Chesapeake Bay ecosystem. VORTEX is designed specifically for science educators by the Virginia Institute of Marine Science. The program includes a series of workshops and multimedia materials (i.e., a CD ROM and Internet web sites). All program components are designed to provide a basic biological and ecological background to enable participants to integrate program materials into hands-on science lessons that support selected Virginia Standards of Learning in Science.

Program partners and co-sponsors to date include:

Virginia Institute of Marine Science Department of Fisheries Science
Virginia Sea Grant Marine Advisory Program
Chesapeake Bay Restoration Fund Advisory Committee
Virginia Environmental Endowment

For more information, visit the VORTEX web site at: www.vims.edu/mollusc/education/vortex.html or contact Juliana Harding (jharding@vims.edu), Vicki Clark (vclark@vims.edu), or Roger Mann (rmann@vims.edu).



VORTEX