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Rundown on the Rapa : activity booklet for educators

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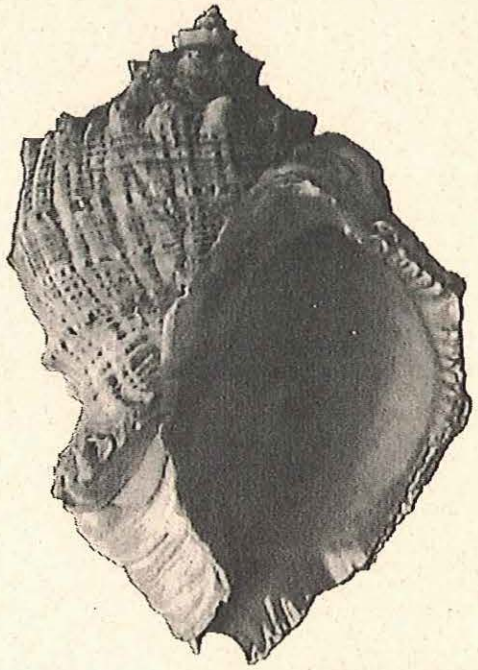
RUNDOWN ON THE RAPA

Activity Booklet for Educators

Introduction

This booklet is intended as a companion to the VORTEX Instructional Booklet **RUNDOWN ON THE RAPA**. These activities have been designed to help science educators reinforce concepts presented in the **RUNDOWN ON THE RAPA** Instructional Booklet. Relevant Virginia Math and Science SOL have been highlighted. Hands-on activities encourage problem solving and application of concepts. Student worksheets and relevant illustrations are included for each chapter.

The three chapters in this Activity Booklet parallel the three chapters in the companion Instructional Booklet: *Aliens Among Us*, *Recipes for Reproduction*, and *Locals by Land, Aliens by Sea*.



An adult rapa whelk shell from the Chesapeake Bay. This animal was approximately the size of a softball (165 mm long).

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ALIENS AMONG US

Objective: Examine Chesapeake Bay snail shells and identify the non-native veined rapa whelk from native channelled and knobbed whelks on the basis of shell morphology and color.

Skills: Observation, communication, hypothesis testing, and group collaboration.

Relevant Virginia SOL

LS.5 Classification of organisms
BIO.5 Life functions
BIO.7 Examination of local fauna

Materials

1. One copy of **RUNDOWN ON THE RAPA** Instructional Booklet per student.

2a. If the Individual student assignment format is chosen: one copy of the ***Aliens Among Us*** worksheet (page 4 of this booklet) per student.

2b. If the Small group activity format is chosen: one copy of the ***Aliens Among Us*** worksheet (page 4 of this booklet) per student group and, if possible, one channelled, knobbed, or rapa whelk shell per group.

Procedure

1. Ask students to read the ***Introduction*** and chapter entitled ***Aliens Among Us*** in the **RUNDOWN ON THE RAPA** Instructional Booklet.
2. There are three possible formats for this activity:

A. Game show format: Divide students into groups or research teams. Ask the groups questions from the ***Aliens Among Us*** worksheet (page 4 of this booklet). Within a group have the students come to a consensus on their team answer immediately after each question is asked. Award points for correct answers. The team with the most points at the end of the game wins.

B. Individual student assignment: Give each student a copy of the ***Aliens Among Us*** worksheet (page 4 of this booklet). Ask them to write the answers to the questions and turn them in to be evaluated.

C. Small group format: Divide the students into groups or research teams. Have the students select one student in each group to be the "Marine Scientist" first; each student should have a chance to be the Marine Scientist during the activity. Ask the Marine Scientists to turn around and pretend that they are on the phone with the rest of the group. Have the other students in the group pretend that they have just found the whelk shell given to their group and that they have called the Marine Scientist for help identifying the shell. The students must attempt to describe the whelk shell to the Marine Scientist without naming the animal and without allowing the Marine Scientist to see or touch the shell. Students may use the vocabulary and descriptions on page 3 of the ***Aliens Among Us*** worksheet as a reference when attempting to describe the whelk shells. Marine Scientists may ask questions to clarify the other students' descriptions as needed. After a designated time interval, ask each Marine Scientist to identify their group's shell sight unseen. Afterwards, appoint new Marine Scientists in each group and give each group a different whelk shell.

Related vocabulary

columella: the central pillar of a coiled gastropod shell

gastropod: a member of the Molluscan class Gastropoda characterized by a distinct head, antennae, large foot, and a hard shell. Snails and whelks are gastropods.

introduced: an organism that is not native to a habitat that has been brought to the habitat by another party.

native: an organism whose ancestors have lived in a habitat for decades or centuries.
non-native: an alien or introduced species.
operculum: the hard chitonous plate used by gastropods to protect their soft tissue from damage and dessication when the animal is retracted or pulled into its shell.
opercular opening: the opening in a gastropod shell through which the gastropod retracts into its shell and which is sealed by the operculum.
siphonal canal: the protective channel in a gastropod shell through which the animal extends its siphon out into the environment.
spire: the top or apex of a gastropod shell.
whelk: a predatory or carnivorous gastropod.

Suggested discussion questions

1. What is an alien or non-native or invading species?
2. Why is it important to investigate the location and abundance of an invading species within a particular habitat?
3. Describe some of the ecological impacts an invading species might have on a habitat's food web.
4. Why is it significant that adult veined rapa whelks are not at risk from any predators in the Chesapeake Bay once they reach a certain size?
5. Suggest some ways to reduce the spread of an alien species in a new habitat.
6. List several ways alien species invade new habitats.
7. Are all biological invasions facilitated by humans?

Answers to questions on the ***Aliens Among Us*** worksheet (page 4):

1. A predatory or carnivorous marine snail.
2. Channelled whelk (*Busycotypus canaliculatum*) and knobbed whelk (*Busycon carica*). Also: Atlantic oyster drill (*Urosalpinx cinera*), thick-lipped oyster drill (*Eupleura caudata*) or mottled dog whelk (*Nassarius viber*).
3. Veined rapa whelk (*Rapana venosa*).
4. Channelled, knobbed, and veined rapa whelks.
5. Bivalves including oysters and hard clams.
6. The operculum is a hard structure that the whelk uses to 1) block the opening of its shell to protect its soft tissue and 2) seal the animal in its shell when it is out of the water in an attempt to prevent dehydration and death from exposure to the air.

A. Channelled whelk
B. Channelled or knobbed whelk
C. Knobbed or veined rapa whelk
D. Veined rapa whelk
E. Knobbed or veined rapa whelk
F. Channelled or knobbed whelk
G. Veined rapa whelk
H. Veined rapa whelk
I. Channelled or knobbed whelk
J. Channelled, knobbed, and veined rapa whelks
K. Veined rapa whelk
L. Channelled, knobbed, and veined rapa whelks
M. Veined rapa whelk

ALIENS AMONG US WORKSHEET

1. The term "whelk" is used to describe what kind of marine animal?

2. Name two of the marine snails that are native to the Chesapeake Bay.

3. Which whelk was discovered in the Chesapeake Bay in 1998?

4. Which whelks burrow in sandy or muddy bottoms as adults?

5, What do whelks eat?

6. What is the function of an operculum?

Identify the type of whelk to which each of the following statements refers. Each statement will refer to at least one of the following whelks: Channelled, Knobbed, or Veined rapa. Some statements may refer to more than one whelk type.

A. My shell is smooth and sometimes covered by a green or brown velvety coating when I am alive.

B. I am native to the Chesapeake Bay.

C. My shell has knobs on its shoulders.

D. My shell has black or dark brown horizontal stripes in it.

E. The opercular opening of my shell may be very bright orange or red in color.

F. My shell is wide at the top and tapers like an hourglass in the middle.

G. My columella is broad and smooth and large enough to place your finger completely in it.

H. My shell is thick and almost square because it is almost as wide as it is tall.

I. My operculum is elliptical or tear-dropped shaped.

J. I eat hard clams and oysters.

K. Sometimes I live in sandy or muddy areas and sometimes I am found on rocks.

L. I use my large muscular foot to walk around and burrow in the sand.

M. I am native to Japanese and Korean waters.

Recipes for Reproduction

Objectives

1. Distinguish veined rapa whelk egg masses from egg strings laid by native channelled and knobbed whelks.
2. Estimate and compare the reproductive potential of veined rapa whelks and knobbed whelks over time and relate reproductive potential to biological invasion success and competition among species.

Part I: Whose eggs are they?

Skills: Observation, communication

Relevant Virginia SOL

BIO.5 Life functions
BIO.7 Examination of local fauna
BIO.8 Reproductive strategies
LS.4 Life processes
LS.5 Classification of organisms

Materials

1. One copy of Rundown on the Rapa Instructional Booklet per student.
2. One copy of the "Whose eggs are they?" worksheet (page 6) per student.

Procedure

1. Ask students to read the chapter entitled ***Recipes for Reproduction*** in the Rundown on the Rapa Instructional Booklet.
2. Divide students into small groups or research teams.
3. Using the " Whose eggs are they?" worksheet (page 6), have the students complete the matching activity describing the egg capsules laid by channelled,knobbed and veined rapa whelks.
4. Review the answers (given on the bottom of this page) with the students and compile them to form class descriptions of the type of egg capsule and group of capsules produced by each whelk.
5. Discuss the differences in egg capsule shape and mass or string attachment between native and non-native whelks. Ask the student groups to list advantages and disadvanges of morphological differences in egg capsule shape and methods of attachment. Have the students make predictions as to which egg capsule or mass morphology will be most successful in 1) shallow intertidal habitats with sand bottom, 2) deep areas with rocky substrate, and 3) estuarine areas with no natural hard substrate but increasing amounts of man-made hard structures.

Related vocabulary

egg capsule: a single packaging unit produced by a female whelk containing fertilized eggs and nutrients to sustain the eggs through development.
egg mass: a group of rapa whelk egg capsules.
egg string: a group of channelled or knobbed whelk egg capsules.

Suggested discussion questions

1. Why would it be important for whelks to congregate during the mating season from both a logistical and genetic standpoint?
2. List some advantages and disadvantages to producing egg capsules (as demonstrated by these whelks) versus simply releasing eggs and sperm in the water (broadcast spawning) as done by oysters and other marine invertebrates.

Answers to ***Recipes for Reproduction*** Part I Whose eggs are they? worksheet (page 6): 1. A&B, 2. A&B, 3. C, 4. A, B&C, 5. A, 6. C, 7. A&B, 8. A&B, 9. B, 10. C, 11. C, 12. A, 13. A, 14. B, 15. C.

Recipes for Reproduction

Part I: Whose eggs are they?

Match the type of whelk with the descriptions of egg capsule or egg mass features given below. Write the letter for the correct whelk species in front of the appropriate description. Some descriptions may apply to more than one whelk species.

A. Channelled whelk
B. Knobbed whelk
C. Veined rapa whelk

_____ 1. Produces disk shaped egg capsules that form strings which look like rotini (spiral pasta)

_____ 2. Lays eggs from September through November

_____ 3. Lays tall thin egg capsules in masses that look like yellow shag carpet

_____ 4. Lays more than one group of egg capsules per season

_____ 5. Makes disk shaped egg capsules that have smooth, tapered edges

_____ 6. Cements its egg capsules to each other and to hard substrate

_____ 7. Buries the first part of its egg string in the sand

_____ 8. Produces egg capsules that take 7 to 8 months to hatch

_____ 9. Makes disk shaped egg capsules that have squared edges

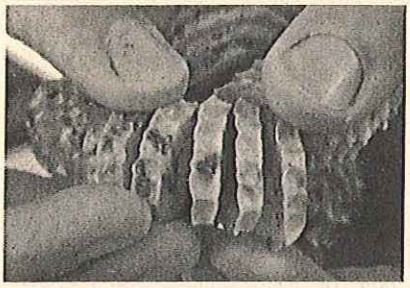
_____ 10. Lays eggs from May through September

_____ 11. Produces egg capsules that hatch in less than 6 weeks

_____ 12 Attaches the first egg capsule in its string to a piece of hard substrate

_____ 13.

_____ 14.



_____ 15.

Part II: How does your family grow?

Skills: Observation, communication, group collaboration, math (graphing), computation

Relevant Virginia SOL

BIO.5 Life functions
BIO.7 Examination of local fauna
BIO.8 Reproductive strategies
BIO.9 Dynamic equilibria
LS.4 Life processes
LS.12 Population dynamics

Materials

1. One copy of **Rundown on the Rapa** Instructional Booklet per student.
2. One copy of the ***Recipes for Reproduction*** Part II: How does your family grow? worksheet (pages 8 and 9) per student.

Procedure

1. Ask students to read the chapter entitled ***Recipes for Reproduction*** in the **Rundown on the Rapa** Instructional Booklet.
2. Divide students into small groups or research teams.
3. Ask half of the research teams in the class to complete Section A: Kate Knob of the *Recipes for Reproduction* Part II: How does your family grow? worksheet (page 8). Ask the remaining teams to complete Section B: Rhonda Rapa of the *Recipes for Reproduction* Part II: How does your family grow? worksheet (page 8).
4. Have each research team present their calculations and answers to the class. Check their math with the answers given below. Ask the students to complete the tables on page 8 using the class data.
5. Using the data in Table 1, ask the students to make an X,Y plot or graph comparing Kate Knob's reproductive output (number of eggs) over time with Rhonda Rapa's.
6. Use the resulting graphs to discuss some of the differences in reproductive strategies displayed by these species and how these differences might relate to the abilities of rapa whelks to successfully invade other habitats.

Related vocabulary

***r*- selected species:** a species characterized by small size, early sexual maturity, and smaller offspring. These species are generally suited to ephemeral or seasonally unpredictable habitats.

***K*- selected species:** a species characterized by large size, later sexual maturity, and larger offspring. These species are generally suited to habitats that are constant or predictably seasonal in time.

Suggested discussion questions

1. List some of the advantages and disadvantages of the different reproductive strategies demonstrated by Rhonda Rapa and Kate Knob. (Use the graph as a discussion tool).
2. Identify Rhonda Rapa and Kate Knob as examples of either *r*- or *K*- selection. How does rapa whelk life history differ from the stereotypical example of *r*- selection? How does this enhance the rapa whelk's ability to successfully invade a new habitat?

Recipes for Reproduction

Part II: How does your family grow?

Section A: Kate Knob

Kat e Knob is a female knobbed whelk. She started laying egg strings during the fall of her ninth year. She has laid egg strings every fall since then. Kate lays egg strings composed of disk shaped egg capsules. Each capsule contains many eggs. Kate is now 12. Use the table below to figure out:

1. How many total eggs did she lay in each year that she laid eggs?
2. What is the cumulative number of eggs that Kate has laid in her lifetime?

Year or Age	Number of egg strings	Number of egg disks per string	Number of eggs per disk	Total number of eggs	Cumulative number of eggs
1	0	0	0		
2	0	0	0		
3	0	0	0		
4	0	0	0		
5	0	0	0		
6	0	0	0		
7	0	0	0		
8	0	0	0		
9	3	100	50		
10	5	90	56		
11	4	75	48		
12	3	105	45		

Section B: Rhonda Rapa

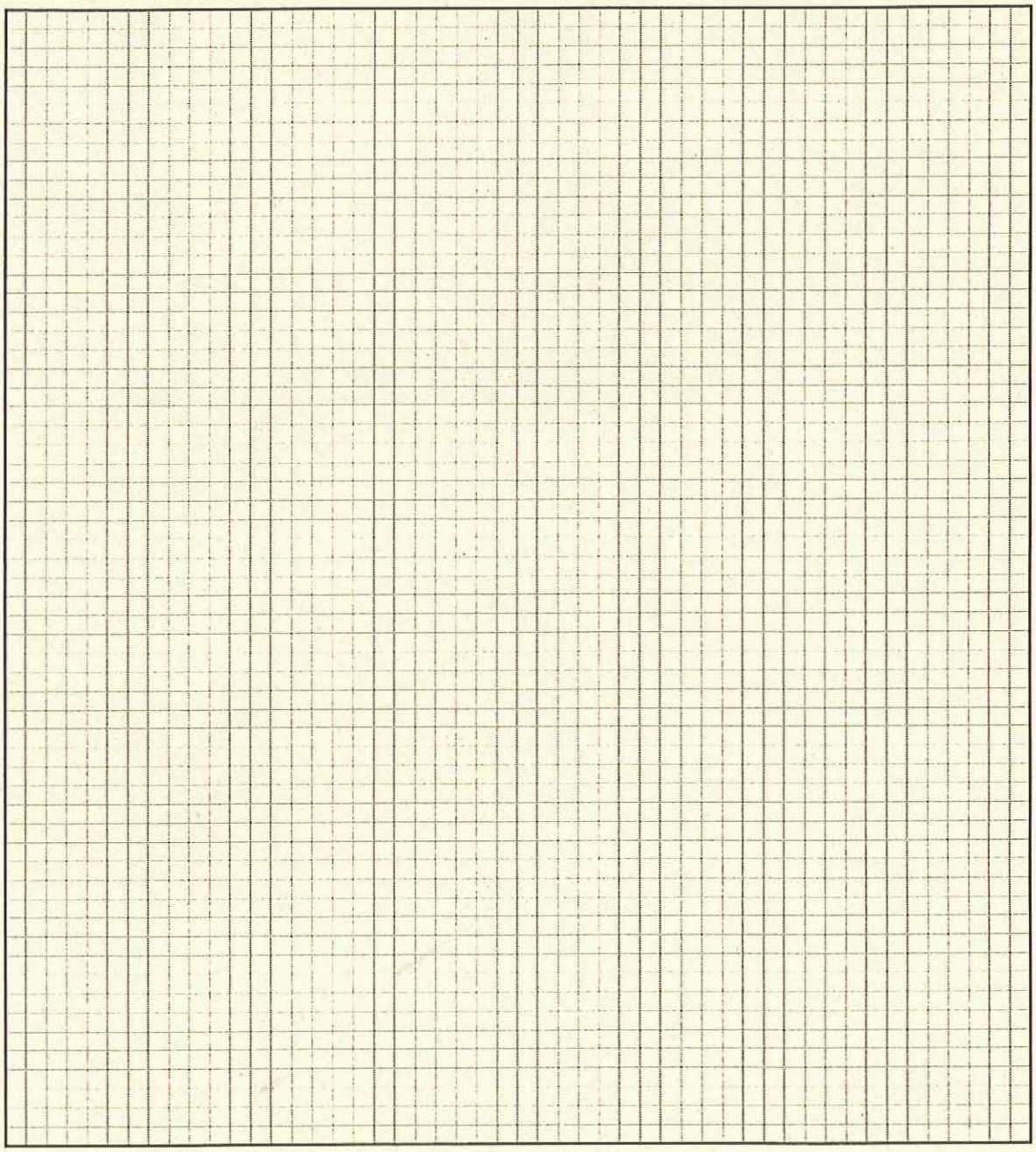
Rhonda Rapa is a female veined rapa whelk. She began laying egg masses during her first year. She has laid eggs every summer since then. Rhonda lays egg masses composed of cylindrical egg capsules. Each capsule contains many eggs. Rhonda is now 12. Use the table below to figure out:

1. How many total eggs did she lay in each year that she laid eggs?
2. What is the cumulative number of eggs that Rhonda has laid in her lifetime?

Year or Age	Number of egg masses	Number of egg capsules per mass	Number of eggs per capsule	Total number of eggs	Cumulative number of eggs
1	5	35	250		
2	7	54	300		
3	9	78	150		
4	11	82	200		
5	10	100	175		
6	7	250	400		
7	8	200	350		
8	10	205	200		
9	11	85	400		
10	9	124	256		
11	12	96	400		
12	10	330	275		

Recipes for Reproduction

Part II: How does your family grow?



Recipes for Reproduction

Part II: How does your family grow?
Teacher's key

Calculations for Kate Knob:

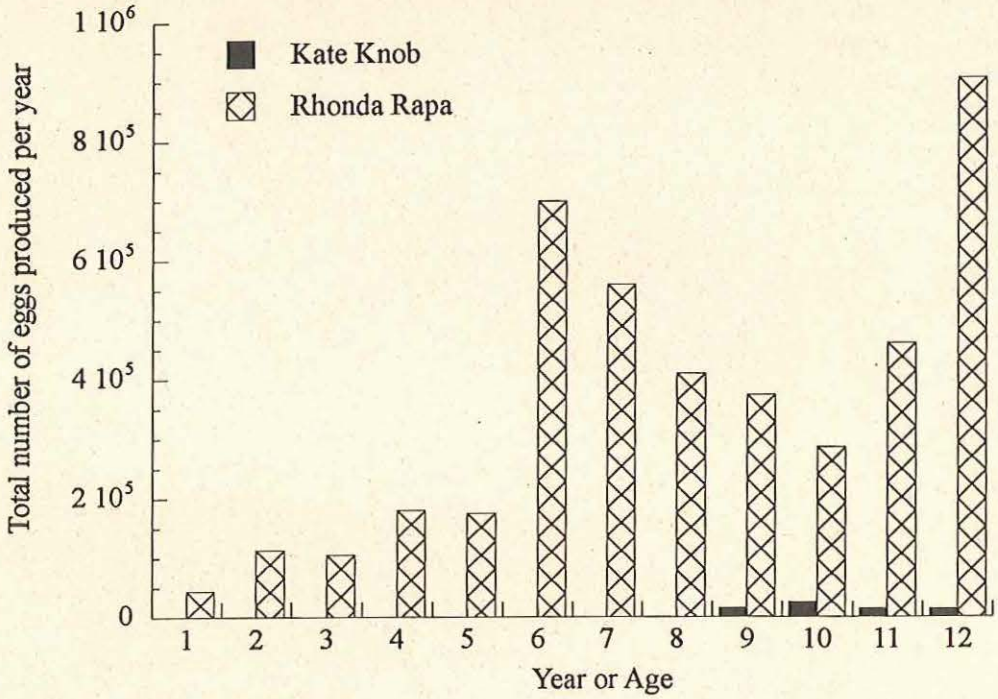
Year or Age	Number of egg strings	Number of egg disks per string	Number of eggs per disk	Total number of eggs	Cumulative number of eggs
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	3	100	50	15000	15000
10	5	90	56	25200	40200
11	4	75	48	14400	54600
12	3	105	45	14175	68775

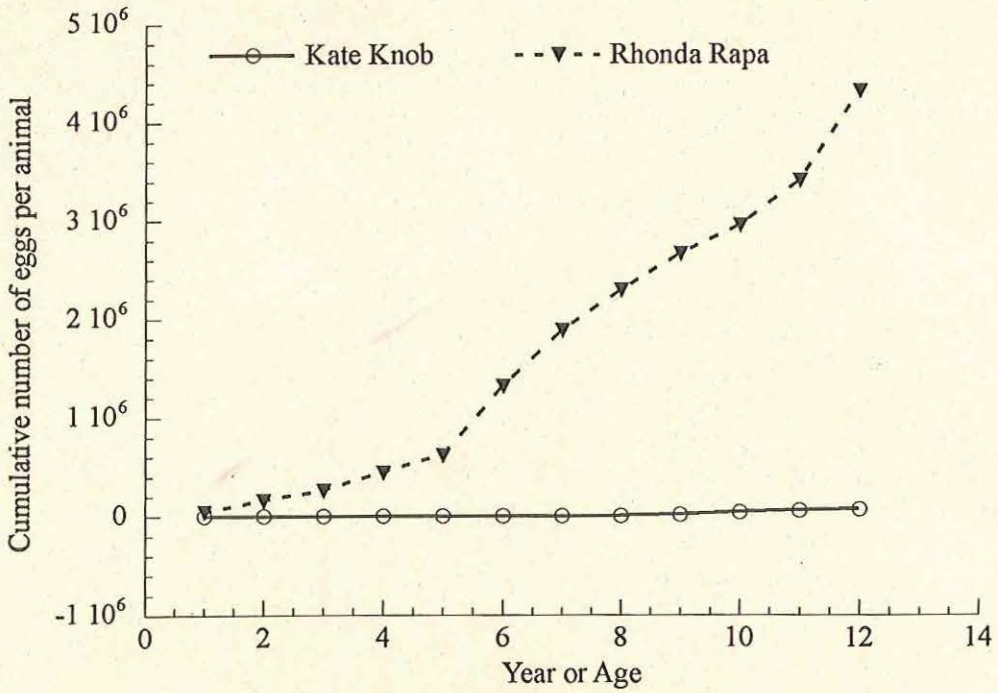
Calculations for Rhonda Rapa:

Year or Age	Number of egg masses	Number of egg capsules per mass	Number of eggs per capsule	Total number of eggs	Cumulative number of eggs
1	5	35	250	43750	43750
2	7	54	300	113400	157150
3	9	78	150	105300	262450
4	11	82	200	180400	442850
5	10	100	175	175000	617850
6	7	250	400	700000	1317850
7	8	200	350	560000	1877850
8	10	205	200	410000	2287850
9	11	85	400	374000	2661850
10	9	124	256	285696	2947546
11	12	96	400	460800	3408346
12	10	330	275	907500	4315846

Recipes for Reproduction

Part II: How does your family grow?
Suggested graphing methods





Locals by Land, Aliens by Sea

Objectives

1. Quantitatively compare the dispersal mechanisms used by local whelks in relation to non-native rapa whelks.
2. Evaluate the relative success or failure of each with regard to potential for biological invasions.

Skills: Observation, communication, hypothesizing, mapping (latitude, longitude).

Relevant Virginia SOL

BIO.7 Examination of local fauna
BIO.8 Reproductive strategies
BIO.9 Dynamic equilibria
LS.7 Ecosystem relationships
LS.10 Adaptations for survival
LS.12 Population dynamics

Materials

1. One copy of **Rundown on the Rapa** Instructional Booklet per student.
2. Two copies of the ***Locals by Land, Aliens by Sea*** worksheet (page 14) per student.

Procedures

1. Ask students to read the chapter entitled ***Locals by Land, Aliens by Sea*** in the **Rundown on the Rapa** Instructional Booklet.
2. Divide students into small groups or research teams.
3. Ask half of the research teams in the class to work with data for Kate Knob and the other half to work with data for Rhonda Rapa.
4. Using the data given in Table 3.1 and 3.2 (page 13), ask the students in each group to plot on the map (page 14) the trajectory given by the latitudes and longitudes for each of Kate Knob's larvae and each of Rhonda Rapa's larvae at hatching and, 5, 10, and 20 days after hatching.
5. After each group has plotted a trajectory for each larval snail, have the students use the scale on the map (page 16) to calculate the distance that each larvae actually travelled.
6. Have each research team present their maps and calculations to the class. Check their math with the answers given on page 15. Ask the students to complete Tables 3.1 and 3.2 (page 13) using the class data. Make copies of the completed maps so that every group has one map for Kate Knob's offspring and one map for Rhonda Rapa's veligers.
7. Use the resulting maps to discuss some of the differences in reproductive strategies displayed by these species and how these differences might relate to the abilities of rapa whelks to successfully invade other habitats.

Related vocabulary

larvae: a baby snail or whelk.
semi-diurnal tidal cycle: a set of two tidal cycles (one high and one low tide) occuring in a habitat within a single lunar day (24 hours and 50 minutes).
tidal cycle: a sequence of high and low tides.
veliger: a swimming Molluscan larvae.

Suggested discussion questions

1. List some advantages and disadvantages of each reproductive strategy (crawling vs. swimming larvae).
2. Compare the cumulative and net distances travelled by the knobbed whelk larvae with the cumulative and net distances travelled by the rapa whelk veligers. Which reproductive strategy seems best suited to invading a new habitat?

Answers to calculations for cumulative and net distances travelled by larval whelks based on the maps (p. 14 and 15).

Time	Tom Knob	Beth Knob	John Knob	Teresa Rapa	Larry Rapa	Bob Rapa	Jim Rapa
Day 0 to 5	1.26 km	1.26 km	0.95 km	6.95 km	4.42 km	6.21 km	5.05 km
Day 5 to 10	2.21 km	2.11 km	2.21 km	12.31 km	8.0 km	11.89 km	9.26 km
Day 10 to 15	3.05 km	3.37 km		17.79 km		18.21 km	17.16 km
Day 15 to 20	3.89 km	4.21 km		26.84 km			25.37 km
Net distance	0.84 km	1.89 km	0.84 km	2.42 km	6.63 km	6.21 km	11.58 km

Kate Knob

An egg string laid by Kate Knob came to rest on the bottom in Hampton Roads near Craney Island, Virginia (36°56'30", 76°21'30"). On April 10, the egg string hatched and the larval whelks crawled out of their egg disks. Using the tables below, track the progress that three of Kate's offspring (Tom, Beth, John) make after hatching on the map (page 14). John is eaten by a blue crab on Day 11 post-hatch.

Time	Whelk	Latitude	Longitude	Cumulative distance travelled (km)
Hatch	Tom	36°56'30"	76°21'30"	0
	Beth	36°56'30"	76°21'30"	0
	John	36°56'30"	76°21'30"	0
Day 5	Tom	36°56'00"	76°21'00"	
	Beth	36°57'00"	76°21'00"	
	John	36°56'30"	76°22'00"	
Day 10	Tom	36°56'00"	76°21'30"	
	Beth	36°56'30"	76°21'00"	
	John	36°57'00"	76°21'30"	
Day 15	Tom	36°56'30"	76°21'30"	
	Beth	36°57'00"	76°20'30"	
	John			
Day 20	Tom	36°57'00"	76°21'30"	
	Beth	36°56'30"	76°20'30	
	John			

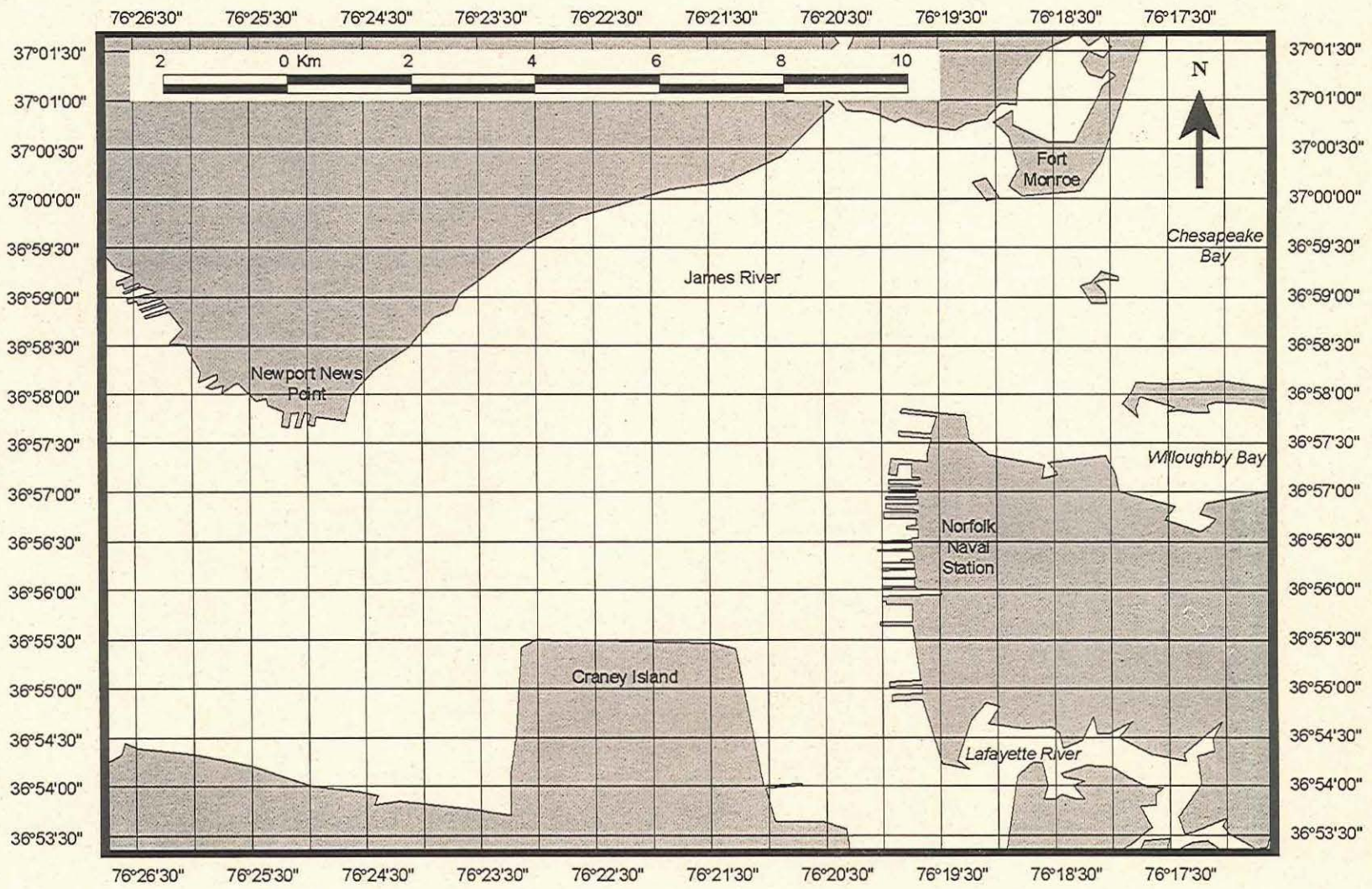
Table 3.1: Data for knobbed whelks.

Rhonda Rapa

An egg mass laid by Rhonda Rapa was laid on a rock off Craney Island, in Hampton Roads, Virginia (36°56'00", 76°23'30"). On July 10, the egg mass hatched and the veligers swam out into the water. Using the tables below, track the progress that four of Rhonda's veligers (Teresa, Larry, Jim and Bob) make after hatching on the map (page 14). Larry is eaten by a blue crab on Day 11 post-hatch and Bob is carried into low salinity water on Day 16 post hatch and dies on Day 17.

Time	Whelk	Latitude	Longitude	Cumulative distance travelled (km)
Hatch	Teresa	36°56'00"	76°23'30"	0
	Larry	36°56'00"	76°23'30"	0
	Bob	36°56'00"	76°23'30"	0
	Jim	36°56'00"	76°23'30"	0
Day 5	Teresa	36°58'00"	76°19'00"	
	Larry	36°56'30"	76°20'00"	
	Bob	36°58'00"	76°20'30"	
	Jim	36°57'30"	76°25'00"	
Day 10	Teresa	36°58'30"	76°16'00"	
	Larry	36°54'30"	76°20'00"	
	Bob	36°58'30"	76°23'30"	
	Jim	36°55'00"	76°24'00"	
Day 15	Teresa	37°00'00"	76°19'30"	
	Larry			
	Bob	36°58'00"	76°26'30"	
	Jim	36°57'00"	76°21'00"	
Day 20	Teresa	36°57'30"	76°23'30"	
	Larry			
	Bob			
	Jim	36°57'30"	76°16'00"	

Table 3.2: Data for rapa whelks.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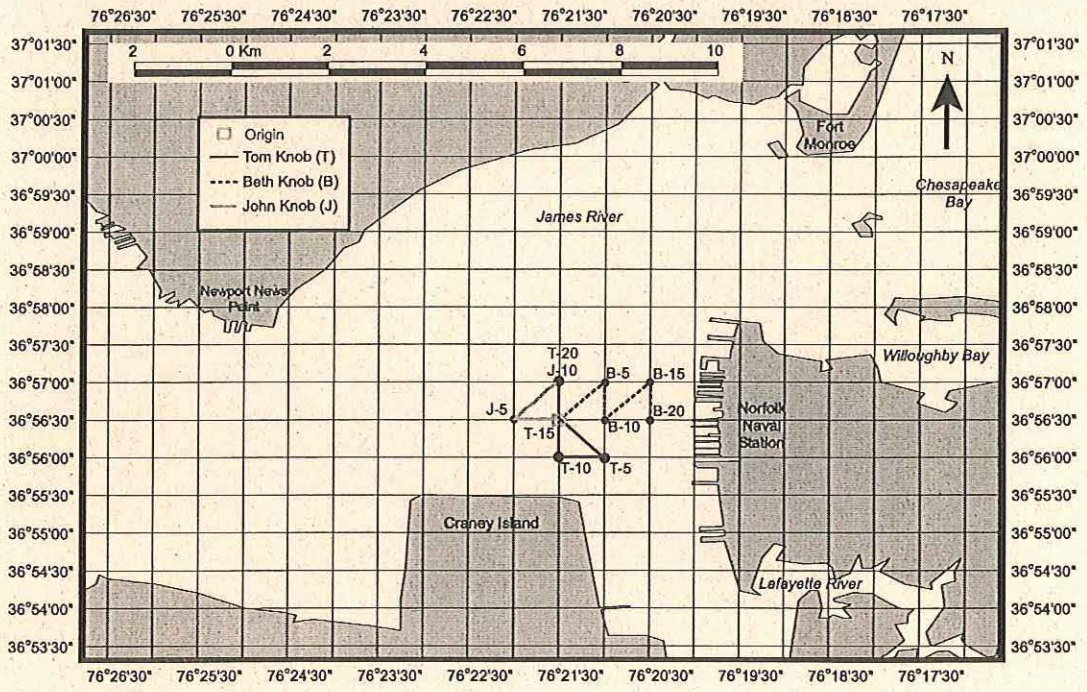
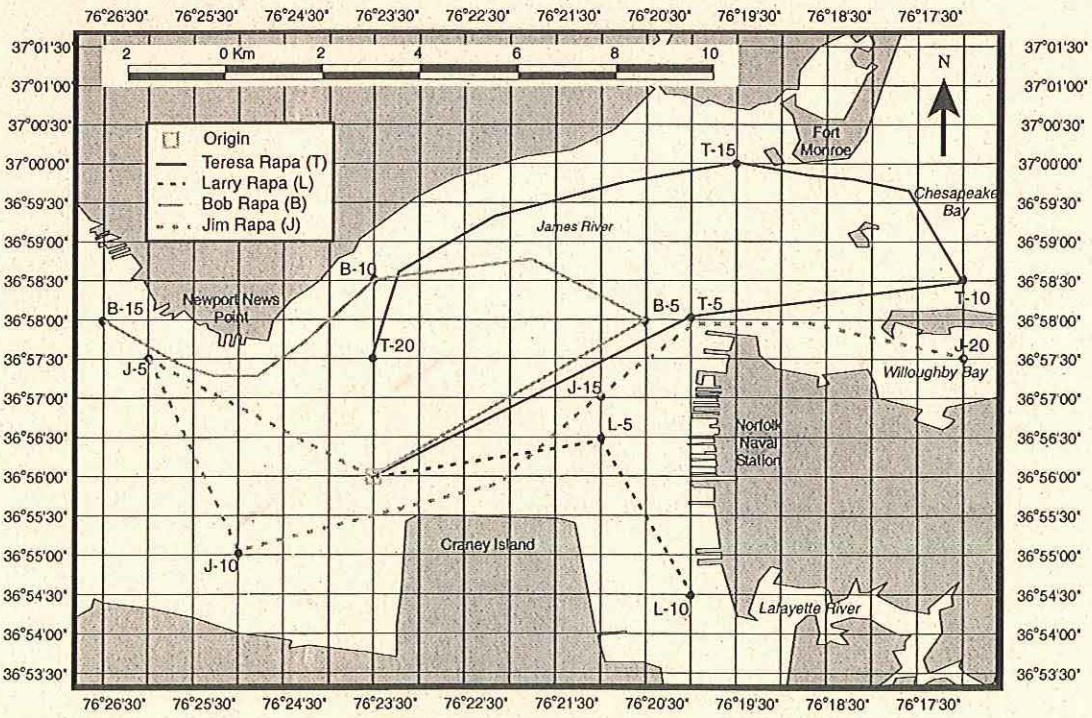
8
10
N
Fort Monroe
Chesapeake Bay
James River
Newport News Point
Willoughby Bay
Norfolk Naval Station
Craney Island
Lafayette River

Locals by Land, Aliens by Sea

A. Map of larval knobbed whelk dispersal post-hatching.



B. Map of rapa whelk veliger dispersal post-hatching.



VORTEX

Virginia's Oyster Reef Teaching EXperience

An Educational Program for Virginia Science Educators

What is VORTEX?

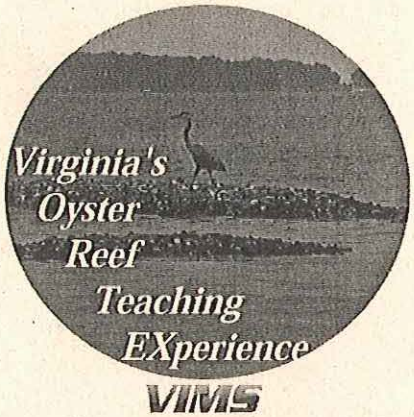
Virginia's Oyster Reef Teaching EXperience (VORTEX) is a multi-component program focusing on the importance of oyster reef communities in the Chesapeake Bay ecosystem. VORTEX is designed specifically for science educators by the Virginia Insitute of Marine Science. The program includes a series of workshops 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.

Current program partners and co-sponsors include:

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

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

Sea Grant Virginia



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