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## Shellfish stalkers: Threats to an oyster - Activity booklet for educators

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## SHELLFISH STALKERS: THREATS TO AN OYSTER

### *Activity Booklet for Educators*

#### Introduction

This booklet is intended as a companion to the VORTEX Instructional Booklet **SHELLFISH STALKERS: THREATS TO AN OYSTER**. These activities have been designed to help science educators reinforce concepts presented in the **SHELLFISH STALKERS: THREATS TO AN OYSTER** Instructional Booklet. Relevant Virginia Math and Science SOL have been highlighted. Hands-on activities have been designed to 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: *Oyster Predators*, *Oyster Diseases*, and *Trapped in a Shell*.



Predation by Atlantic oyster drills *Urosalpinx cinera* (above) is only one of the threats faced by Chesapeake oysters.

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## OYSTER PREDATORS

**Objectives:** Apply information regarding oyster predators to:

1. Determine potential sources of oyster mortality from photographs of oyster shells.
2. Evaluate potential economic impacts of oyster predation on a hypothetical aquaculture project.

**Skills:** Observation, communication, hypothesis testing, and computation.

### Relevant SOL

- 6.9 Living systems
- BIO.5 Life functions
- LS.10 Organism adaptation to biotic and abiotic factors
- A.1-A.4 Solving equations relating to practical problems

### Materials

1. A copy of the **SHELLFISH STALKERS: THREATS TO AN OYSTER** instructional booklet.
2. A copy of the *Oyster Predators Worksheet* for each student.

### Procedure

1. Give students copies of the **SHELLFISH STALKERS: THREATS TO AN OYSTER** instructional booklet and have them read the *Oyster Predators* section (pp 3-8).
2. Have each student individually complete **PART I: OYSTER DETECTIVE WORK** of the *Oyster Predators Worksheet* (page 3).
3. Divide students into small groups or research teams.
4. Ask each group to discuss their individual answers to Part I and arrive at group answers including justifications.

5. Have each research team present to the class its consensus answers (including justification) to the questions in Part I. Discuss how oyster size might influence vulnerability to particular predators.
6. Have the students return to their research teams and work together on the mathematics problem presented in **PART II: THE ECONOMICS OF OYSTER MORTALITY - PREDATORS** of the *Oyster Predators Worksheet* (page 4).
7. Have each research team present its answers to Part II (including intermediate steps) to the class.
8. If appropriate, ask the students to apply the calculations describing mortality in 2000 and estimate the number of living oysters at the same site in Fall 2001.

### Related vocabulary

**chela:** a crab's claw

**habitat:** the place where an organism lives

**radula:** a snail's toothed tongue-like structure which may be used to bore or drill through an oyster's shell

### Suggested discussion questions

1. In terms of both ecology and fisheries management, why might it be important to be able to identify the specific predator that ate an individual oyster?
2. Discuss potential biological, economic, and social impacts of predator-induced oyster mortality on individual oyster growers and on the oyster fishery in general.

Answers to **PART II: THE ECONOMICS OF OYSTER MORTALITY - PREDATORS** are available from the VIMS VORTEX Internet web site at:

[www.vims.edu/mollusc/education/vortex.html](http://www.vims.edu/mollusc/education/vortex.html)

## OYSTER PREDATORS WORKSHEET

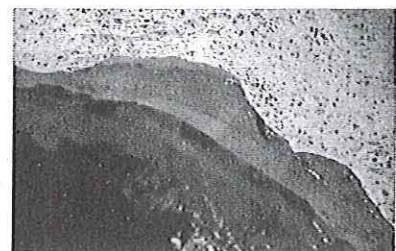
### Part I: Oyster Detective Work

You are a marine scientist working for a state agency. Your colleagues are conducting the annual survey of the oyster populations in Mobjack Bay. They have found two oyster “boxes” or empty pairs of oyster shell valves and have asked you to determine the possible cause of death for these oysters. All of the oyster predators discussed in this chapter are present in Mobjack Bay. Using the photographs and laboratory notes provided, “examine” the oyster boxes, determine which predator(s) may have had a role in the oysters’ demise, and justify your recommendations in the space provided.

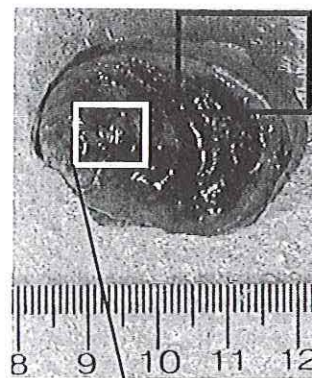
#### Oyster Box 1

Laboratory notes:

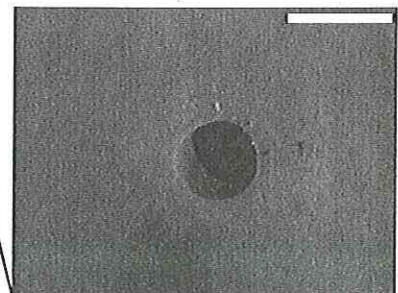
- Small, fresh oyster box received on 11/19/01.
- Collected during fall survey in Mobjack Bay.
- Specimen examined in laboratory on 11/20/01. Whole specimen photographed with macro lens (Photograph A to the right). Scale bar is metric (cm/mm). Gross examination revealed several chips on left valve growth margin and a hole in right valve near hinge.
- Chips in left valve margin examined under dissecting microscope at 10x magnification (Photograph B). Rasping marks and cracks visible on edges of chips.
- Single hole near hinge on right valve examined at 40x under dissecting microscope and photographed (Photograph C). Scale bar in upper right corner represents 1 mm. Hole penetrates shell valve.



B.



A.



C.

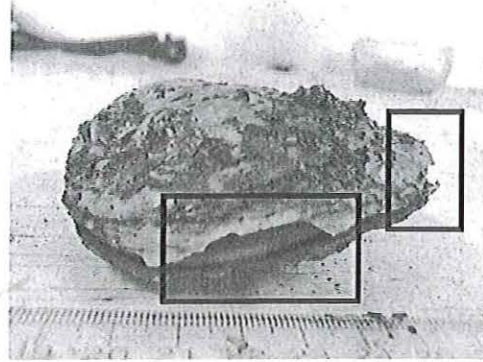
Possible oyster predators:

Justification:

## Oyster Box 2

### Laboratory notes:

- Large, fresh oyster box received on 11/20/01.
- Collected during fall survey in Mobjack Bay.
- Specimen examined in laboratory on 11/20/01. Whole specimen photographed in laboratory with growth edges closest to the camera (Photograph D to the right). Scale bar is metric (cm/mm).
- Numerous large chips visible on growth margins of both shell valves (indicated by squares in Photograph D)



D.

Possible oyster predators:

Justification:

## Part II: The Economics of Oyster Mortality - Predators

There are several private oyster leases that have been in your family for years. In Spring 1997, you decided to put or plant some small oysters or "seed" on a one acre lease so that the oysters could grow to harvestable size in the river.

- You purchased 500 bushels of seed oysters for a total of \$2,500. Assuming each bushel contained 1000 seed oysters, you bought 500,000 seed oysters and planted all of them on one acre. An acre is equal to 4047 m<sup>2</sup>.
- In November 1997, you visited the lease and used hand tongs to sample some of your crop. You sampled 10 different 1 m<sup>2</sup> sections and examined a total of 1,225 oysters. Only 980 of these oysters were alive but the live oysters seemed to be growing well. The other 245 oysters were fresh boxes or empty pairs of oyster shells. Half of the boxes or empty pairs of oyster shells had rasp marks or holes near the hinge and the other half had chips (large and small) in the growth margins. Predators seem to have eaten some of your crop.

Use your 10 representative 1 m<sup>2</sup> samples to estimate:

1. How many of your original 500,000 seed oysters were eaten by snails and crabs during 1997?
2. What percentage of your investment was lost to predators during 1997?
3. How many live oysters were left on your lease in November 1997?

## OYSTER DISEASES

**Objectives:** Apply information regarding oyster diseases to:

1. Data sets from a hypothetical oyster population to examine seasonal changes in the dynamics of Dermo disease.
2. Evaluate potential economic impacts of oyster disease on a hypothetical aquaculture project.

**Skills:** Observation, communication, hypothesis testing, and computation.

### Relevant SOL

- 6.9 Living systems
- BIO.5 Life functions
- LS.10 Organism adaptation to biotic and abiotic factors
- A.5 Create and use graphical representations of data

### Materials

1. A copy of the **SHELLFISH STALKERS: THREATS TO AN OYSTER** instructional booklet.
2. A copy of the *Oyster Disease Worksheet* for each student.

### Procedure

1. Give students copies of the **SHELLFISH STALKERS: THREATS TO AN OYSTER** instructional booklet and have them read the *Oyster Diseases* section (pp 9-11).
2. Divide students into small groups or research teams.

3. Give each student a copy of the Oyster Disease Data Protocol description and data found on page 6.
4. Have the students read the Oyster Disease Data Protocol and then ask them to explain how the data in Table 1 was collected.
5. Ask the students to make one graph with two lines: one line for each of the stations sampled during 1998 (A and B). Each line should be a plot of Dermo disease prevalence in relation to month. Month (x) is the independent variable and Dermo disease prevalence is the dependent (y) variable.

Graph paper is provided on page 13 of this booklet. The student graphs should look like the graph below.

### Related Vocabulary

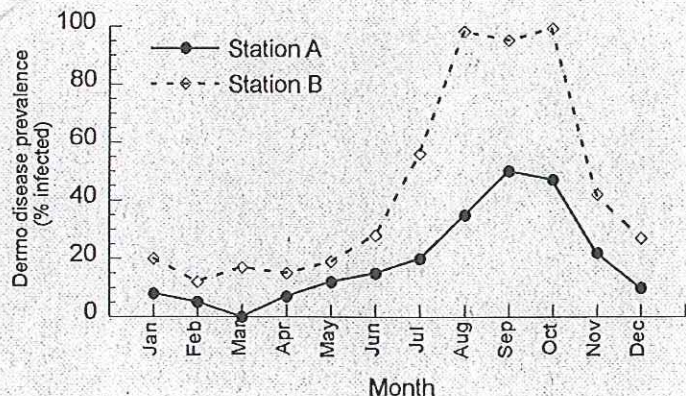
**prevalence:** The percentage of oysters in a population that are infected with a disease.

### Suggested Discussion Questions

1. Propose theories as to why the Dermo disease prevalence is higher for Station B than at Station A.
2. Discuss how changes in seasonal temperatures and rainfall might affect Dermo disease prevalence at Stations A and B.
3. On the basis of these Dermo disease prevalence data, what recommendations would the students make to oyster fisheries managers with regard to the harvesting of oyster seed from the oyster grounds in between Stations A and B?

Suggested graphing methods for Oyster Disease Data Activity on page 6.

Answers to **PART II: THE ECONOMICS OF OYSTER MORTALITY - DISEASE** are available from the VIMS VORTEX Internet web site at:  
[www.vims.edu/mollusc/education/vortex.html](http://www.vims.edu/mollusc/education/vortex.html)



## OYSTER DISEASES WORKSHEET

### Oyster Disease Data Protocol

#### Background

On the first Wednesday of each month, your agency sends a team of scientists into the James River to collect 25 adult oysters from two different sites. Oysters have been sampled at these two sites for over a decade. Station A is upriver from Station B. There are several commercially valuable oyster grounds in between Stations A and B.

#### Methods

The twenty-five oysters collected at each station are separated based on collection location and returned to the laboratory for Dermo disease analyses. In the laboratory, a small piece of each oyster's gill and rectum are incubated in an anaerobic medium in a test known as the Ray/Mackin tissue assay. During incubation, individual parasites will become larger and develop into cells with thick walls known as hyphospores. After incubation, the tissue samples are stained with Lugol's iodine. The iodine turns the parasites a dark blue or black color and makes them visible within the tissue. Stained tissue samples are then examined under the microscope and the number of parasites or hyphospores are counted.

Disease prevalence, the percentage of oysters within a population that are infected by Dermo, is reported for each site monthly.

Table 1: Dermo disease prevalence (% infected oysters) from two hypothetical stations (A and B) in the James River during 1997.

Month	Station A	Station B
Jan	8	20
Feb	5	12
Mar	0	17
Apr	7	15
May	12	19
Jun	15	28
Jul	20	56
Aug	35	98
Sep	50	95
Oct	47	99
Nov	22	42
Dec	10	27

## OYSTER DISEASES WORKSHEET

### Part II: The Economics of Oyster Mortality - Disease

In Spring 1997, you planted 10,000 seed oysters on the oyster grounds that your family leases from the Commonwealth.

In November 1997, you had \_\_\_\_\_ live oysters left on your lease after factoring in mortality due to oyster predators (See **Oyster Predators Activity**, Part II, Question 2, page 4).

Assume:

- that there was no mortality from the time that you sampled in November 1997 through April 1998;
- that by April 1998, all the oysters on your leases are too big to be vulnerable to predation by blue crabs and that there are no oyster drills or rapa whelks on your leases.

You know that some of the oysters that you planted on your oyster lease were infected by Dermo during 1997. You remove 25 oysters in April 1998 and take them to a local scientific agency for an evaluation of Dermo disease prevalence. The agency tells you that 5% of your oysters have Dermo in April 1998. In August 1998, you notice that many of the large oysters on your lease are gaping and have died. You take another 25 oysters in for analysis and discover that the Dermo disease prevalence on your lease is 50%.

In November of 1998 you use hand tongs to sample 10 1m<sup>2</sup> plots on your lease. You examine a total of 931 oysters. Only 838 of these oysters were alive but they seem to be growing well. The remaining oysters are all reasonably fresh boxes with no visible signs of predation. Assume that all mortality observed on your lease during 1998 is from Dermo.

1. In total, how many oysters died on your lease from disease between April and November 1998?
2. How many live oysters are left on your lease in November 1998 when you sample?



## TRAPPED IN A SHELL

### Objectives

Apply information regarding salinity and sediments to:

1. Data sets from a hypothetical river to examine seasonal changes in salinity and sediment levels with regard to oyster biology.
2. Evaluate the potential effects of salinity and sediment on a hypothetical oyster aquaculture project.

**Skills:** Observation, communication, math (averaging and graphing).

### Relevant SOL

- |        |   |
|--------|---|
| 6.9    | Living systems                                    |
| BIOS.5 | Life functions                                    |
| LS.10  | Organism adaptation to biotic and abiotic factors |
| A.5    | Create and use graphs                             |

### Part I: Salinity

#### Materials

1. One copy of the SHELLFISH STALKERS: THREATS TO AN OYSTER instructional booklet per student.
2. One copy of the *Trapped in a Shell: Student Worksheet* for each student.

### Procedure

1. Ask students to read the chapter entitled *Trapped in a Shell* in the SHELLFISH STALKERS: THREATS TO AN OYSTER Instructional Booklet.
2. Give each student a copy of the Flyer River map and accompanying legend found on page 10 of this booklet.
3. Divide the students into research teams.
4. Give each student a copy of the Salinity Data Protocol description and data found on pages 11-12 of this booklet.
5. Have the students read the Salinity Data Protocol and then ask the students to explain how the data in Table 1 was collected using the Salinity Data Protocol and Flyer River map.
6. Ask the students to make one graph with two lines:

**Line 1:** A plot of salinity values collected during 1999 in relation to day of the year. Day of the year is the independent (x) variable and salinity is the dependent (y) variable. Ask the students to include error bars showing the standard error of the mean.

**Line 2:** A plot of the average salinities observed from 1993-98 in relation to day of the year. Day of the year is the independent (x) variable and salinity is the dependent (y) variable. Ask the students to include error bars showing the standard error of the mean from 1993-98.

Graph paper is provided on page 13 of this booklet. The student graphs should look like the graph on page 14 of this booklet.

### Suggested Discussion Questions

Using the graphs as discussion tools, ask the students to:

1. Describe changes in salinity observed in 1999 in relation to the time of year. Remind them that there is usually more rain in the spring and early summer.
2. Propose theories as to why the salinity readings drop so suddenly in mid-September 1999. In reality, this decline in salinity is due to the 10+ inches of rain left by Hurricane Floyd in September 1999 and the rapid response of the Piankatank River to freshwater input. The Piankatank River (like the fictitious Flyer River) is a small watershed and is vulnerable to freshets.
3. Discuss how changes in salinity during 1999 might have affected oyster populations in the Flyer River.
4. Compare the 1999 salinity curve with the five year historic mean and propose theories as to why the 1999 values are higher. Remind them that during drought years salinities in the rivers will rise due to a lack of freshwater input caused by an absence of rain.
5. Apply the salinity data from stations B., C., and D. to predict whether Flyer River oysters grew better in 1999 than they did in previous years. Make sure students justify their answers in light of the oyster's preferred salinity tolerances as discussed in *Trapped in a Shell*.
6. Give the students salinity data from Station A. provided in Table 2 (page 12). Ask them to use this data to explain the historic upriver limit for oysters in the Flyer River as shown on Figure 1.

Answers to **PART III: THE ECONOMICS OF OYSTER MORTALITY - SALINITY AND SEDIMENT** are available from the VIMS VORTEX Internet web site at:

[www.vims.edu/mollusc/education/vortex.html](http://www.vims.edu/mollusc/education/vortex.html)

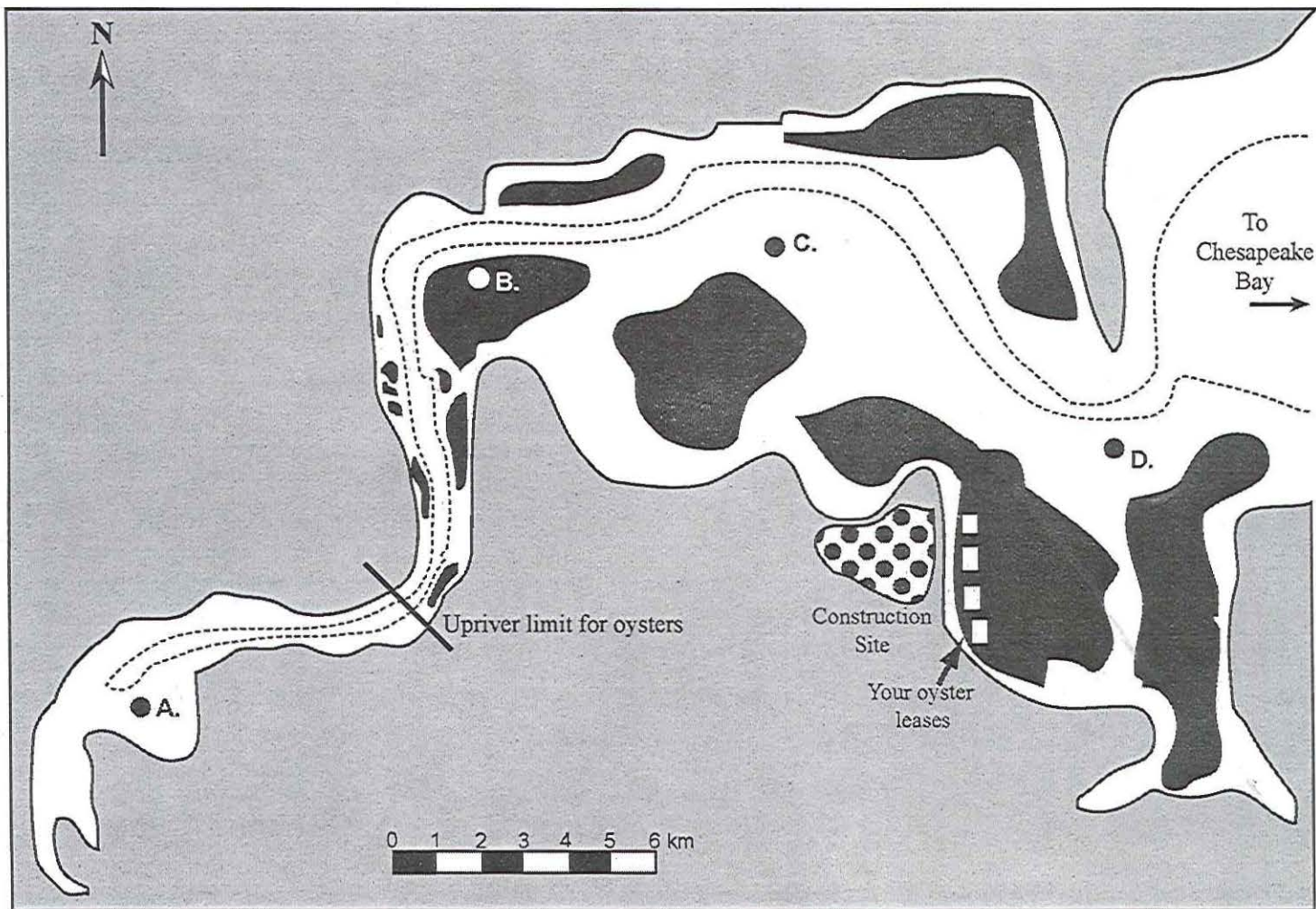


Figure 1: Map of a fictitious Chesapeake Bay tributary: Flyer River. The estuary's channel is indicated by the dashed outline. Four monitoring stations are indicated by circles (A.-D.). Black shapes represent good oyster habitats. Your oyster leases are shown by the four white squares. Development began at the construction site (area with polka dots) in 1999. The historic upriver geographic limit for oysters is shown by a solid black line. Downriver of this line, oysters survive and grow well. Upriver of this line, oyster populations do not survive.

## TRAPPED IN A SHELL

### Salinity Data Protocol

#### Background

The Flyer River has been the site of an environmental monitoring program conducted by your agency for many years. Data have been collected at 4 stations (A. - D.) weekly from the first week in June through the middle of October for over a decade.

#### Methods

At each station each week, a water sample is collected from approximately 0.5 m off the bottom. After the water sample is brought to the surface, a subsample of water is analyzed with a refractometer to determine the salinity at a particular site. Salinity values are recorded for each station in parts per thousand or ppt.

#### Data analyses - Modern

The Flyer River is a well mixed estuary and salinity values at stations B., C., and D. are similar. Thus, the data from these three stations are averaged to calculate average salinity on particular days during the sampling season ("Average salinity 1999" column in Table 1). Each sampling day the standard error of the mean (S.E.M.) is calculated to give an estimate of the variance in salinity levels between the three stations. Sampling days are identified in relation to the number of days that have passed since January 1 also known as "Day of the year" (Column 1 in Table 1).

*Activity:* Using data from Table 1, make a cartesian coordinate (X, Y) plot of average salinity in relation to Day of the Year (time) for the 1999 data from Stations B, C, and D. Include error bars showing the standard error of the mean.

#### Data analyses - Historic

Since the Flyer River is home to a long-term environmental monitoring program, it is possible for you to compare the salinity values that you obtained in 1999 with salinities recorded in previous years. The average salinities from similar dates for the years 1993-98 ("Average salinity 1993-98") have been computed along with the standard error of the mean for this 5 year average ("S.E.M. Salinity 1993-98").

*Activity:* Using data from Table 1, add a second line for the 1993-1998 average salinities (with error bars) to the 1999 plot of salinity data from Stations B, C, and D in the Flyer River over time.

## TRAPPED IN A SHELL Salinity Data Protocol

Table 1: Salinity data collected from the Piankatank River during 1999 (used with permission from Southworth et al. 2000). Assume that Flyer River stations B., C., and D. had an identical salinity profile during the same time window. "ND" indicates a day on which no data were available. "S.E.M." is the abbreviation for standard error of the mean.

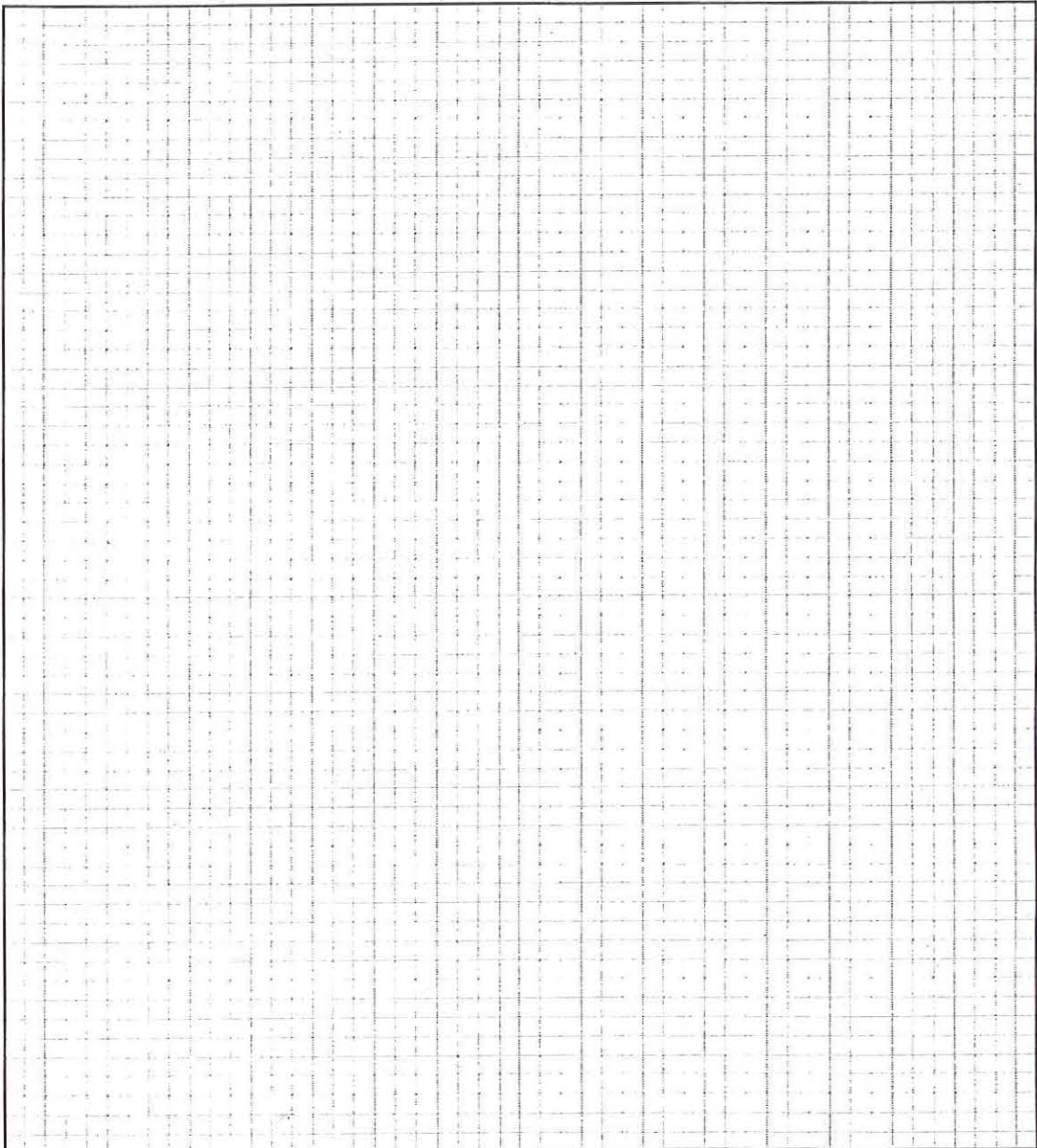
Day of the year	Average salinity 1993-98	S.E.M. Salinity 1993-98	Average salinity 1999	S.E.M. Salinity 1999
147	11	0	16.1	0.1
154	13.4	0.75	18.6	0.3
161	12.8	0.67	17.6	0.2
168	13.1	0.62	16	0.3
175	13.8	0.69	17.3	0.6
182	13.2	0.69	17.1	0.2
189	14.1	0.71	19.1	0.4
196	15.1	0.54	19.4	0.2
203	14.3	0.46	20	0
210	14.3	0.43	17.9	0.2
217	14.2	0.41	19.5	0.2
224	14.7	0.46	18.8	0.2
231	15.7	0.52	20	0
238	16.4	0.58	ND	ND
245	16.5	0.52	19.6	0.3
252	17.1	0.52	22	0.4
259	17.4	0.58	15.4	1.2
266	16.8	0.47	ND	ND
273	17.5	0.54	19.6	0.4
280	17.6	0.27	19.6	0.3

Table 2: Salinity data from the hypothetical Flyer River Station A. Note the absence of a standard error of the mean for the 1999 data. Since data from only one station (Station A) is available for this part of the river it is impossible to calculate either an average or a standard error of the mean. "ND" indicates a day on which no data were available.

Day of the year	Average salinity 1993-98	S.E.M. Salinity 1993-98	Salinity 1999
147	1	0.01	1.2
154	0.75	0.1	2
161	1.1	0.1	1.75
168	1.0	0.02	1.8
175	1.2	0.2	1.78
182	1.1	0.45	1.81
189	1.5	0.31	2
196	2	0.2	2.2
203	1.75	0.23	2.5
210	1.5	0.37	1.9
217	1.6	0.34	2.1
224	1.5	0.46	2
231	1.8	0.3	2.3
238	1.9	0.58	ND
245	1.85	0.46	2
252	1.9	0.38	2.5
259	1.87	0.47	0.5
266	1.9	0.47	ND
273	1.8	0.65	2
280	1.6	0.54	2.1

# TRAPPED IN A SHELL

## Student Worksheet

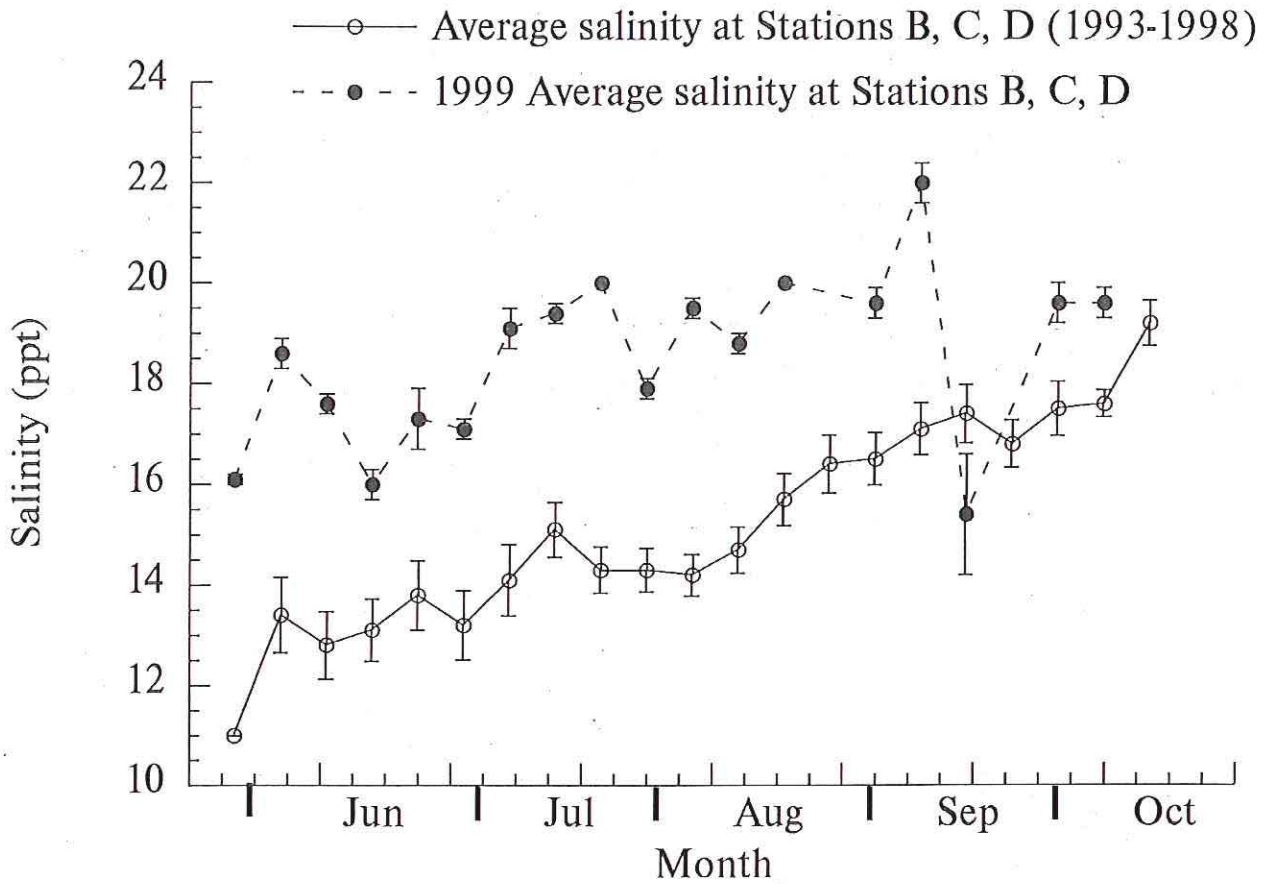


## TRAPPED IN A SHELL

### Part I: Salinity

#### Suggested Graphing Methods

Plot of Flyer River salinity data including historic average (1993-98) and data from 1999. The decrease in 1999 salinity in early September coincides with heavy rains brought by Hurricane Floyd. Student graphs should look like this one.



## TRAPPED IN A SHELL

### Part II: Sediment

#### Materials

1. One copy of the **SHELLFISH STALKERS: THREATS TO AN OYSTER** instructional booklet per student.
2. One copy of the *Trapped in a Shell: Student Worksheet* for each student.

#### Procedure

1. Ask students to read the chapter entitled *Trapped in a Shell* in the **SHELLFISH STALKERS: THREATS TO AN OYSTER** Instructional Booklet.
2. Give each student a copy of the Flyer River map and accompanying legend found on page 10 of this booklet.
3. Divide the students into research teams.
4. Give each student a copy of the Sediment Data Protocol Description and data found on pages 16-17 of this booklet.
5. Have all students read the Sediment Data Protocol. Ask the students how the data in Table 3 were collected using the Sediment Data Protocol and Flyer River map.
6. Ask the students to make one graph with four lines: one line for each of the Stations sampled during 1999 (A -D). Each line should be a plot of total suspended solid values (TSS) collected during 1999 in relation to day of the year. Day of the year is the independent (x) variable and TSS concentration is the dependent (y) variable.

Graph paper is provided on page 9 of this booklet. The student graphs should look like the graph on page 18 of this booklet.

#### Suggested Discussion Questions

Using the graphs as a discussion tool, ask the students to:

1. Describe changes in TSS concentrations observed in 1999 in relation to the time of year. Remind them that there is usually more rain in the spring and early summer.
2. Propose theories as to why the TSS values are higher for Station D (the downriver station) than at any other station.
3. Using the Flyer River map, relate the location of the construction project to Station D. What, if any, relationship might there be between the relatively higher sediment concentrations at Station D and the presence of the construction project?
4. Discuss how changes in sediment load or concentrations of TSS during 1999 might have affected oyster populations in the Flyer River.
5. Decide if monitoring of sediment concentrations in the Flyer River should continue. Why or why not? On the basis of the TSS data collected in 1999, what should be reported to the residents of the watershed who are concerned about the development project?



## TRAPPED IN A SHELL

### Sediment Data Protocol

#### Background

The Flyer River has been the site of an environmental monitoring program conducted by your agency for many years. Salinity data have been collected at four stations (A. - D.) weekly from the first week in June through the middle of October for over a decade. However, during 1999 your agency decided to begin measuring the concentration of the total suspended solids found in the river as an indicator of the sediment concentrations in the river. This addition to the historic monitoring protocol is partially driven by a request from residents in the watershed who are concerned about possible environmental impacts of a large building project that has been started on a site in the Flyer River watershed.

#### Methods

At each station each week, a water sample is collected in the middle of the water column. Each water sample is returned to the laboratory. In the laboratory, the water sample is forced through a very fine mesh filter that has been weighed before any water is added. Any sediment particles that were suspended in the water are trapped on the filter. These filters are carefully dried and then weighed. The change in filter weight from before any water was added to after all the water has been filtered is due particles in the water and provides an estimate of the total suspended solids (TSS) in the water on a per volume basis. Quantities of TSS are usually described in terms of milligrams of TSS per liter of river water filtered ( $\text{mg L}^{-1}$ ).

#### Data analyses

Total suspended solid (TSS) concentrations collected from each of four stations (A.-D.) during 1999 are presented in Table 3. Sampling days are identified in relation to the number of days that have passed since January 1 also known as "Day of the year" (Column 1 in Table 3).

*Activity:* Using data from Table 3, make a cartesian coordinate (X, Y) plot of total suspended solid concentrations (TSS) in relation to Day of the Year (time) for the 1999 data from Stations A, B, C, and D.

## TRAPPED IN A SHELL

### Sediment Data Protocol

Table 3: Total suspended solid (TSS) data from the hypothetical Flyer River Stations A.-D. collected during 1999. All TSS data are in units of  $\text{mg L}^{-1}$ .

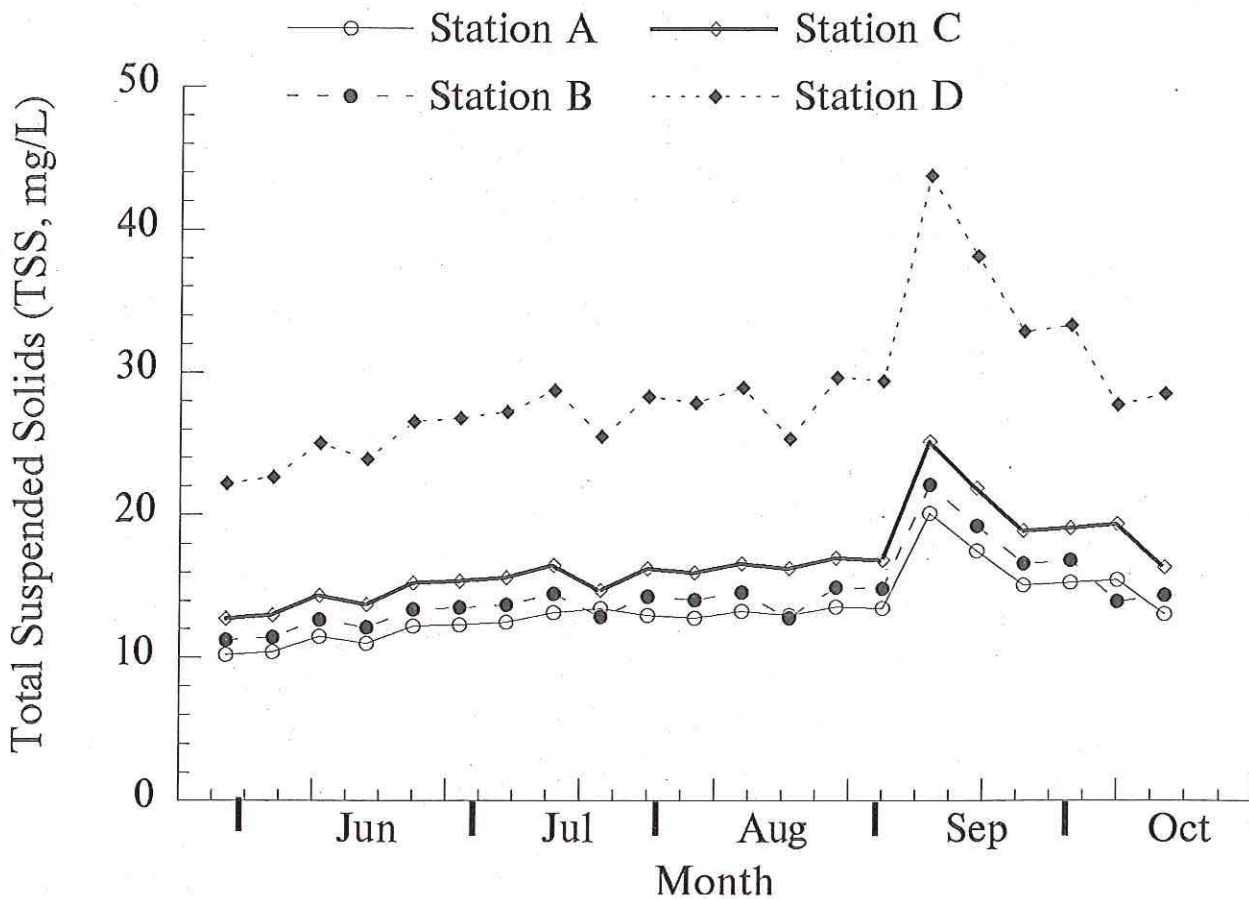
Day of the year	Station A	Station B	Station C	Station D
147	10.2	11.22	12.75	22.22
154	10.4	11.44	13.00	22.65
161	11.5	12.65	14.38	25.05
168	11	12.10	13.75	23.96
175	12.2	13.42	15.25	26.57
182	12.3	13.53	15.38	26.79
189	12.5	13.75	15.63	27.23
196	13.2	14.52	16.50	28.75
203	13.5	12.90	14.75	25.54
210	13	14.30	16.25	28.31
217	12.8	14.08	16.00	27.88
224	13.3	14.63	16.63	28.97
231	13	12.80	16.25	25.34
238	13.6	14.96	17.00	29.62
245	13.5	14.85	16.88	29.40
252	20.1	22.11	25.13	43.78
259	17.5	19.25	21.88	38.12
266	15.1	16.61	18.88	32.89
273	15.3	16.83	19.13	33.32
280	15.5	14.00	19.38	27.72
287	13.1	14.41	16.38	28.53

## TRAPPED IN A SHELL

### Part II: Sediment

#### Suggested Graphing Methods

Plot of Flyer River total suspended solid (TSS) data from four stations collected during 1999. The increase in TSS values in early September coincides with heavy rains brought by Hurricane Floyd. Student graphs should look like this one.



## TRAPPED IN A SHELL

### Part III: Economics of Oyster Mortality - Salinity and Sediment

#### Materials

1. One copy of the **SHELLFISH STALKERS: THREATS TO AN OYSTER** instructional booklet per student.
2. One copy of the *Trapped in a Shell: Economics of Oyster Mortality - Salinity and Sediment description* for each student.

#### Procedure

1. Ask students to read the chapter entitled *Trapped in a Shell* in the **SHELLFISH STALKERS: THREATS TO AN OYSTER** Instructional Booklet.
2. Make sure that the students have correctly completed both of the previous sections of Economics of Oyster Mortality (**Oyster Predators Part II** and **Oyster Diseases Part II**).
3. Divide the students into small groups or research teams.
4. Ask them to complete the third and final section of Economics of Oyster Mortality within their groups and present their group's answer to the class (including intermediate mathematical steps).

#### Suggested Discussion Questions

Using the calculations for the Economics of Oyster Mortality exercises as a discussion tool, ask the students to:

1. Discuss the economic feasibility of oyster aquaculture under similar conditions on a larger scale.
2. Even if the economic basis for oyster aquaculture might not be cost effective for some years, ask the students to justify oyster restoration and replenishment (planting of seed oysters on leases) in ecological terms. Remind students that living oysters are active filter feeders and provide habitat for a variety of other animals (a detailed discussion of the value of oyster reefs as habitat is provided in two other VORTEX instructional booklets **OYSTER REEF COMMUNITIES IN THE CHESAPEAKE BAY: A BRIEF PRIMER** and **SHELL GAMES**).

#### Economics of Oyster Mortality - Salinity and Sediment

The private oyster leases that you have been working for the last several years are in the Flyer River and are shown on the Flyer River Map as areas filled with diagonal lines. In Spring 1997, you spent \$2,500 to purchase 500,000 seed oysters.

In November 1997, you had \_\_\_\_\_ live oysters left on your lease after factoring in mortality due to oyster predators (See **Oyster Predators Activity**, Part II, Question 2).

In November 1998, you had \_\_\_\_\_ live oysters left on your lease after factoring in mortality due to oyster diseases (See **Oyster Diseases Activity**, Part II, Question 3).

Assume there was no mortality from November 1998 to Spring 1999.

In November 1999, you return to your leases and collect 10 individual 1 m<sup>2</sup> samples. In 50% of the samples that you collect, the oysters are heavily covered by sediment and none of the oysters are alive. In the other half of the samples, the oysters seem to be growing really well and all of them are alive. You collect a total of 390 live oysters in your 10 samples. Use these 10 representative samples to estimate:

1. How many of the original 500,000 seed oysters are still alive?
2. These survivors are now big enough to sell. You can sell them for \$20 per bushel. It takes approximately 300 of them to make a bushel. How much of your original investment (\$2,500) do you get back?
3. Do you break even financially?

## 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:

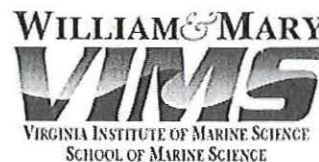
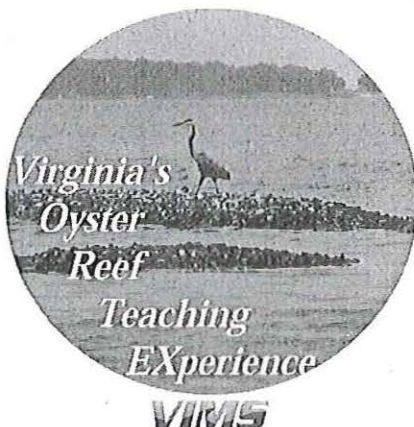
Virginia Institute of Marine Science Department of Fisheries Science

Virginia Sea Grant Marine Advisory Program

Virginia Environmental Endowment

Chesapeake Bay Restoration Fund Advisory Committee

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



## VORTEX