Kids on The Beach

(2019 – 2020)

Final Report Submitted By:

Padilla Bay National Estuarine Research Reserve
in collaboration with
Skagit County Marine Resources Committee

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Introduction

The Kids on the Beach (KOTB) program is a program designed to increase literacy in marine science in Skagit County middle-schools with real, relevant, local experience in marine science and restoration. The goal is to provide school kids with a variety of hands-on authentic marine conservation research in the classroom and on the beach, and build a program that is useful to teachers and patterned after and compatible with existing programs.

The Skagit Marine Resources Committee (MRC) first launched KOTB as a pilot program in 2018 in collaboration with marine science educator, Mira Lutz, with 50 eighth grade students from Conway Middle-School. The program was expanded to include both Conway and La Conner 8th grade students in the spring of 2019. In the fall of 2019, the Skagit MRC partnered with the Padilla Bay National Estuarine Research Reserve (Padilla Bay NERR) education team to administer the program.

Fall 2019 KOTB Program

The Padilla Bay NERR education team (with Annie England as lead educator and facilitator) implemented the 2019 - 2020 Kids on the Beach (KOTB) program in collaboration with Skagit MRC. Annie coordinated with Ron Haywood (Conway middle school science teacher), to have 53 of his 8th grade science students participate in the fall 2019 KOTB forage fish program. She also reached out to multiple LaConner teachers, but they were unable to participate. The KOTB forage fish curriculum was adapted and modified and was moved from a spring program to a fall program.

Event/Place:	Classroom Day 1:	Field Day: Padilla Bay	Classroom Day 2: Evergreen Elem.	Student-led Symposium: Padilla Bay
Day:	**Oct 7th and 8th**	**Oct 16th**	**Nov 13th and 14th**	**Nov 22nd**

Classroom visits by the PBNERR Education Team were conducted before and after each field study for content exploration, scaffolding for the broader learning objectives related to the field experience, and assist students with data analysis and report preparation**.** The first classroom day introduced the content, and prepared them for the field day. The second classroom day scaffolder broader learning objectives, put their field day data into graphs, and prepared them for the symposium.

The PBNERR education team coordinated and hosted field studies for the Conway Middle School 8th grade class to facilitate student engagement in authentic marine science inquiry to address a relevant question. Annie coordinated with various partnering organization including: Samish Indian Nation Department of Natural Resources, Skagit MRC forage fish volunteers, and Padilla Bay NERR staff for the forage fish field day. Ron Haywood's class of 53 8th graders went to Fidalgo Bay resort to work in the marine environment to collect data. One group focused on nearshore fish diversity and the other group focused on surf smelt egg survival.

Conway Middle School 8th Grade Class Field Day at the Fidalgo Bay Resort
Collecting Nearshore Fish Diversity Data

Conway Middle School 8th Grade Class Field Day at the Fidalgo Bay Resort
Collecting Forage Fish Data

PBNERR education team coordinated and hosted a research symposium for the Conway Middle School 8th grade students to give final presentations that summarize their findings and share results from their data analyses. The symposium for forage was held on Nov 22, 2019. It allowed students to share their learning experience and the data they collected from the field day. Pete Hasse (Skagit MRC Project Lead for the KOTB), Nicole Burnett, and Shauna Bjornson presented their scientific work— giving the symposium a more professional tone. Their topics were related back to forage fish—giving a broader context to the students investigation.

Conway Middle School 8th Grade Class Science Symposium at Padilla Bay NERR

Spring 2020 KOTB Program:

Prior to disruptions related to COVID-19, Annie created a new curriculum focused on the invasive mud snail *Batillaria* to be implemented as part of the Spring 2020 KOTB program. She worked closely with Padilla Bay Stewardship Coordinator Roger Fuller and Padilla Bay Washington Service Corps Member Madison McKay to design *Batillaria* field investigations. The curriculum was reviewed by Dr. Sylvia Yang (Padilla Bay Research Coordinator) and Susan Wood (Padilla Bay Education Coordinator), and field tested by Annie England and Madi McKay. In preparation for the spring 2020 field season, Annie met with each of the classroom teachers for planning and scheduling for involvement of their students.

The Padilla Bay Education Team initially recruited and scheduled three Skagit County teachers to participate in the spring 2020 *Batillaria*/Invasive Species education program at Padilla Bay. These teachers included Charlie Huddleston (5th grade teacher in Sedro Woolley), Sacha Buller (middle school science teacher in Concrete), and Shaunna Holcomb (middle school science teacher in Mount Vernon).

Spring 2020 schedule (prior to COVID-19):

Sedro-Woolley SD Charlie Huddleston has 87 5th graders that will participate. (28, 29, and 30)

Event/Place:	Classroom Day 1: Evergreen Elem.	Field Day: Padilla Bay	Classroom Day 2: Evergreen Elem.	Student-led Symposium: Padilla Bay
Day:	**April 27**	**May 5, 6, & 7**	**May 13**	**May 21**

Concrete SD Sacha Buller has 27 7th and 8th students participating. Class from 11:10-12pm

Event/Place:	Classroom Day 1: Concrete	Field Day: Padilla Bay	Classroom Day 2: Concrete	Student-led Symposium: Padilla Bay
Day:	**April 30**	**May 8**	**May 12**	**May 28**

Mount Vernon SD Shaunna Holcomb has around 34 highly capable 8th graders set to participate.

Event/Place:	Classroom Day 1: LaVenture Middle	Field Day: Padilla Bay	Classroom Day 2: LaVenture Middle	Student-led Symposium: Padilla Bay
Day:	**April 15**	**April 21**	**April 23**	**May 28**

PBNERR education team coordinated field studies for each participating school with Roger Fuller and Madison McKay to help assist with data collection, and quality assurance. They recruited volunteers and set up a volunteer training to help with Batillaria KOTB program. Arrangements were made for Kimberly Cauvel, Skagit Valley Herald, to come on May 6th to write an article on the Batillaria KOB program.

Changes Due to COVID-19

After restrictions on school and workplace attendance were imposed as a result of COVID, Annie England took on the monumental task of developing an entirely new web-based curriculum that was tailored to individual teacher and student needs. This was all completed on a very short timeline in response to an ever changing landscape of what teachers and students would be allowed to do, and what capacity they had for participation. This was no small feat and represents a commendable effort by Annie England and the other staff at Padilla Bay supporting her work. A marine investigation activity, based on real field data on Batillaria, was created for students to do at home. One version was created for elementary school students and middle school students that have access to online materials and another version for elementary school students and middle school students who do not have internet access.

- Elementary School Online: **Elementary Kids on the Beach**
- Elementary School Offline: **Elementary Kids on the Beach**

- Middle School Online: **Middle School Kids on the Beach**.
- Middle School Offline: **Middle School Kids on the Beach**

The video presentations on Batillaria were pre-recorded and sent to the teachers that were interested. Through these efforts, the 2020 KOTB program provided learning experiences for over 580 students and engaged with 11 teachers representing 8 different schools via Mailchimp and Facebook.

Below is a summary of the KOTB learning opportunities and schedule under COVID-19 restrictions:

Charlie Huddleston (5th graders, 87 total) and Kathryn Peck (6th graders, 82 total) from Sedro Woolley
Offline, four 30 min activities:
1. Estuary Food Web Game
2. High/Low tide coloring page and I spy game
3. Estuary Habitat coloring book
4. Batillaria Investigation for Elementary Students

Online, four 30 min activities:
1. 30 min presentation by Annie, with accompanying science journals to fill in while they watch.
2. 20 min interview with Roger, 10 min data collection practice
3. 30 min presentation by Madi, with worksheet to fill out while watching
4. Batillaria Investigation for Elementary Students

Ari Landworth (LaConner 7th grade, 30 total) and Sacha Buller (Concrete 7th & 8th grade, 27 total)
Offline, four 30 min activities:
1. The Great Plankton Race
2. How to Catch a Fish
3. Shell Shocked
4. Batillaria Investigation for Middle School students

Online, four 30 min activities:

1. 30 min presentation by Annie, with accompanying science journals to fill in while they watch.
2. 20 min interview with Roger, 10 min data collection practice
3. 30 min presentation by Madi, with worksheet to fill out while watching
4. Batillaria Investigation for Middle School Students

The Table Below Summarizes Schools, Teachers, and Students Participating in the 2020 KOTB Program

City	School	Teacher	Grade(s)	# of Students
Sedro Woolley	Evergreen Elementary School	Charlie Huddleston	5th	87
Sedro Woolley	Evergreen Elementary School	Kathryn Peck	6th	82
LaConner	La Conner Middle School	Ari Landworth	7th	30
Concrete	Concrete Middle School	Sacha Buller	7th & 8th	27
Everett	Forest Park Christian	Lucille Nelson	6th-8th	11
Poulsbo	West Sound Academy	Karen Mattick	6th 7th	19
Mukilteo	Endeavour Elementary	Al Harris	5th	24
Mukilteo	Endeavour Elementary	Roxanne Geving	5th	24
Mukilteo	Endeavour Elementary	Ken Napier	5th	24
Blaine	Blaine Elementary School	Amy Keiper	Elementary	175
Arlington	Presidents Elementary School	Karin Stringer	2nd	84

Feedback from Participating Teachers

Kathryn Peck- Evergreen Elementary, Sedro Woolley
First of all, thank you for all your hard work in getting a field experience turned into an online experience! Many of our kids are still working on it for next week too. I loved your videos! They were helpful for the kids… Our students are now doing a writing project about nonnative and invasive species. This was a perfect segway!

Sacha Buller- Concrete Middle School
I can't thank you enough for putting this together.

Lucille Nelson- Forest Park Christian, Everett
Thank you for this resource... This will replace the field trip we were supposed to take to Padilla Bay in April!

Karen Mattick- West Sound Academy, Poulsbo
I received your email last Thursday with online lessons about *Batellaria* snails. I used one of the lessons and thought I'd share.

I teach at a small, independent, IB school. We've been doing full-time online school since March 19. I teach many classes, but the relevant one here is 6th/7th grade Marine Biology.

The day I received your email was the last day of our Sandy Beaches unit. I closed the unit that day with a lesson about muddy beaches. The students' last assignments of the unit were to create a sandy beach food web, a muddy beach food web and then compare the two.

When I saw the Padilla Bay lessons I decided to delay the start of the next unit by one day. I made my own short slide show to introduce the snail, questions scientists want to investigate and shared a little vocabulary. If we had in-person school, the students would have just done transect studies at Indianola Beach. Since we weren't able to do that, I taught a little about transects and quadrats.

Then I played Madi's lecture in lesson 3 and stopped it right before she presented graphs. I had taken screen shots of the graphs and pasted them into a google doc. I had the students go to the doc and describe patterns in the data and brainstorm possible reasons for the patterns. A discussion would have been the next good step, but I ran out of time. Instead, I read their answers and shared them the next class and I played the rest of the talk so they could hear the explanations Madi presented.

What I especially appreciated was the real-world problem and authentic data students could analyze. Another approach would be to send raw data so students could do their own graphing and statistical analysis.

Many, many thanks. I was really happy to see a resource like this!

Roxanne Geving- Endeavour Elementary, Mukilteo
Thank you for creating and sharing this resource!

Karin Stringer- Presidents Elementary, Arlington
I appreciate all the materials you sent out during the distance learning spring trimester. It allowed our students to experience Padilla Bay until they are able to visit on site.

Have a great summer and we hope to actually visit next spring.

Fall 2020 KOTB Program Plans and Recommendations:

During the late summer and early fall of 2020, Annie and the Padilla Bay education team continued to adapt the program to meet the ever changing needs of the teachers and students in Skagit Co. as they navigate a mixture of virtual, blended, in person, and online learning environments. Most schools are in a complicated transition period from fully remote, to blended, to partially in class/remote experiences. As a result, the teachers are re-evaluating their needs and those of their students on a weekly basis, and the Padilla Bay education team has continued to make real-time adjustments as the needs of students and teachers change. One example is that we have moved from a very rigorous, science-heavy approach for lesson planning to a more interactive and "fun" approach to learning about fish ecology and habitats of Padilla Bay and adjacent waters. One Skagit County teacher (i.e. Charlie Huddleston, 6th grade teacher in Sedro Woolley) has been recruited and scheduled to participate in the fall 2020 Fish Seine education program. Annie England has also been working closely with coordinators of the Swinomish "Between Two Worlds" program (Jen Willup and Dean P. Dan) on a bridged learning opportunity where Tribal youth will serve as mentors for LaConner middle school students during the Fall 2020 Forage Fish KOTB investigations.

ATTACHMENTS

A. Fall 2019- Conway Middle School Student Field Journal for Fish Diversity
B. Fall 2019- Conway Middle School Student Field Journal for Forage Fish Investigation
C. Fall 2019- Conway Middle School Student Symposium Agenda
D. Spring 2020- Modified Batillaria Snail Investigation Program
E. Spring 2020- Padilla Bay Unit for Elementary Students – online
F. Spring 2020- Padilla Bay Unit for Elementary Students – offline
G. Spring 2020- Padilla Bay Unit for Middle School Students- online
H. Spring 2020- Padilla Bay Unit for Middle School Students- offline
I. Skagit Valley Herald Article

ATTACHMENT A

Fall 2019- Conway Middle School Student Field Journal for Fish Diversity

Kids on the Beach

Marine Scientist:

MARINE STEWARDSHIP PLEDGE

I, _____, do hereby solemnly pledge to be a good steward of the marine environment. This means that I will:

1. *Work to understand the ecological role of each organism in its habitat*
2. *Walk on the beach with care to avoid hurting myself, others, and the marine life*
3. *Treat all marine life with care and respect*
4. *Use only wet hands to gently touch organisms that I find*
5. *Leave creatures attached to rocks to avoid tearing tube feet, radula, mantles, and more*
6. *Not hold any marine life out of the water for more than one minute*
7. *Avoid walking on eelgrass and seaweed whenever possible*
8. *Leave no boulder overturned; I will carefully replace all rocks that I look under and I will only turn over rocks that are smaller than my head.*
9. *Return all organisms to where I found them*

Signed:_____

Dated: _____

The Scientific Process

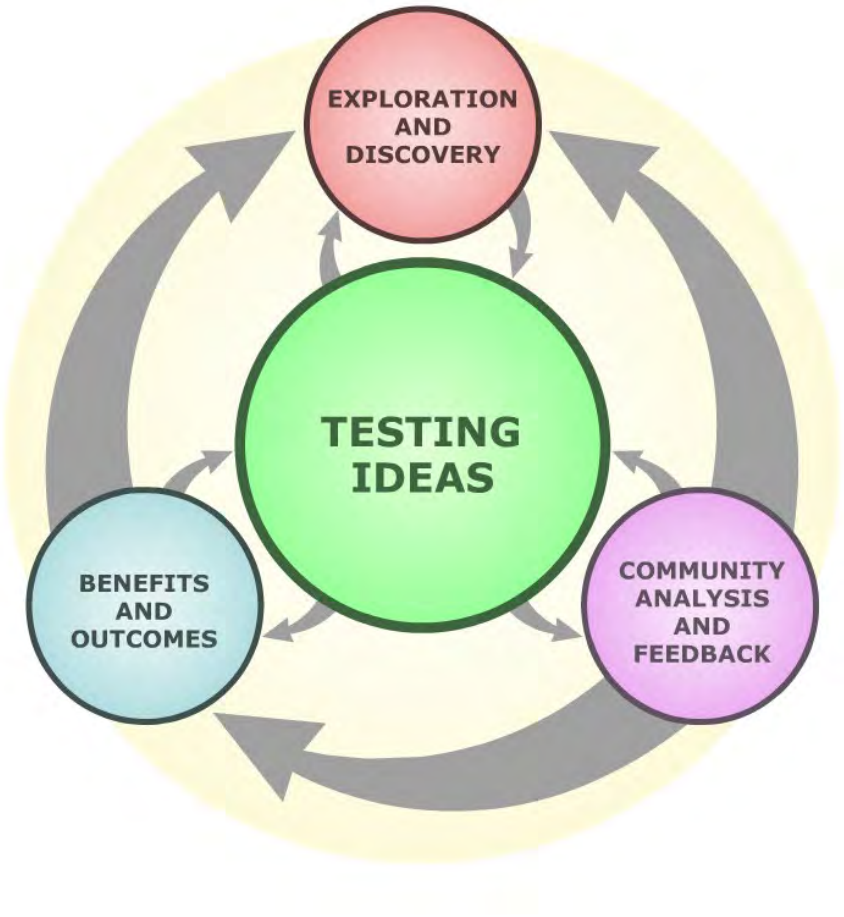


Figure 1: The wonderfully messy process of science diagram. Track your team's process at https://undsci.berkeley.edu/interactive/#/intro/1

Citizen Science

Citizen Science is the involvement of the public in scientific research. Citizens are trained by scientists, follow specific protocol in the fields, and report data to scientists for analysis.

Pros	Cons

Request for Proposals (RFP)

Skagit MRC seeks to fund research that informs recovery efforts of fish species in Fidalgo Bay, WA.

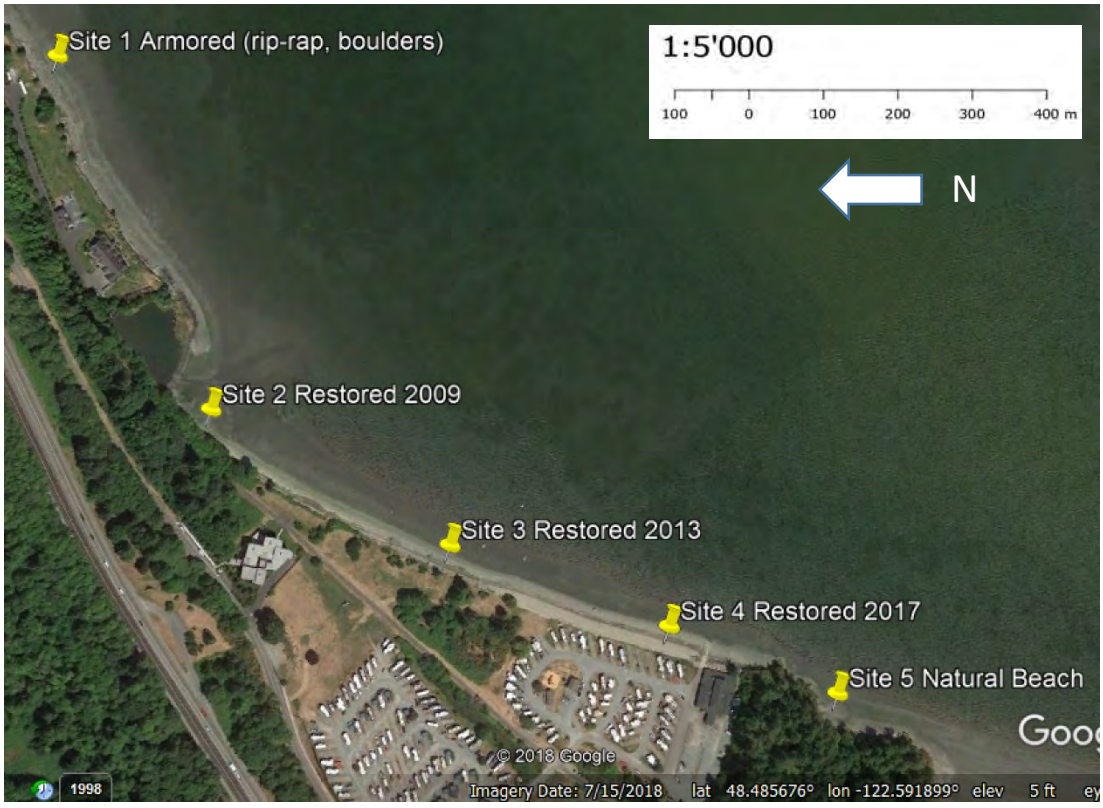
- We shall place a priority on cooperative research, designed to measure whether beach restoration is improving fish abundance and diversity.
- Approved research projects shall be funded through a competitive grant program, using funds from the Skagit Co. Marine Resources Committee, NW Straits Initiative, Puget Sound Partnership, and the US Environmental Protection Agency.

PROPOSALS DUE: FRIDAY, APRIL 19, 2019 at 3 pm. The anticipated allocation of funds is outlined in Table 1.

Table 1: Financial support for nearshore fish research in Fidalgo Bay, including public presentation of results.

Surf smelt spawning success	$2,000
Nearshore fish abundance and diversity	$2,000

Fidalgo Bay Site Map



Beach restoration

What are some ways in which Salish Sea beaches are restored?

How would beach restoration support a variety of nearshore fish species?

Species Diversity: Richness and Evenness

Species diversity is a measure of the number of species and their relative abundance in an ecosystem.

Species richness is the number of different species that live in an ecosystem. More species often indicates a healthier habitat.

Species evenness is a measure of the relative abundance of each of the species in the community.

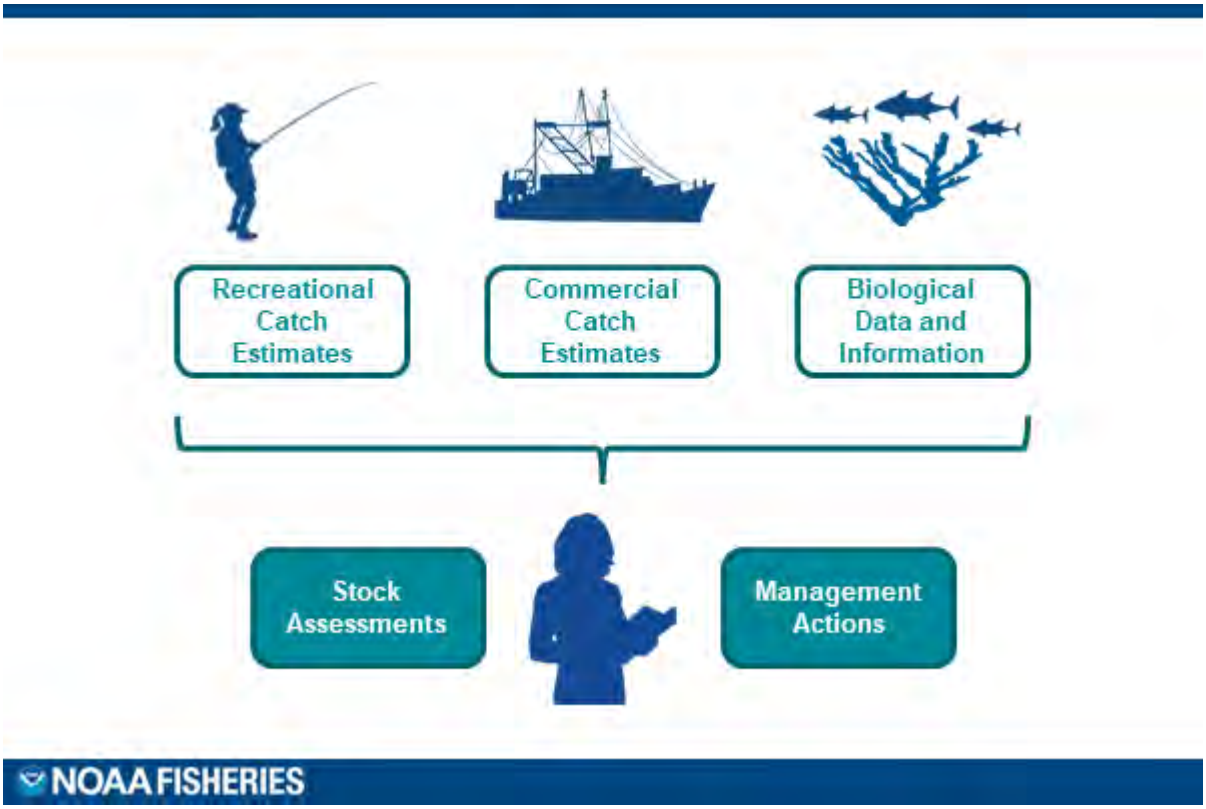
What are some benefits of having a variety of fish species in the Salish Sea? (high richness)

How could changes in habitat type decrease fish species richness?

What could happen to a community of living things in an ecosystem if there are very few of one species? (low evenness)

Protecting fish diversity

Good science and Native Ecology help manage healthy fish populations.



NOAA.gov

NWIFC

Fig. 2: a) Levels of fish management to return fish to stable populations for generations to come.
b) Native Ecology, such as honoring fish in the first salmon ceremony, ensured stable populations for 500 generations.

So, let's do some good science!

Design an experiment on nearshore fish diversity:

Title _____

Choosing Variables: I will change _____(one manipulated/independent variable)

I will measure (observe) _____ (one responding/dependent variable)

I will control (keep the same) _____and _____and _____

(several controlled variables)

Research Question: What is the effect of the MV on the RV?

_____

_____?

Hypothesis/Prediction: If MV… then RV… because (*of this scientific reason*).

_____

_____

_____

Diagram: Draw a labeled illustration of the field investigation set-up.

Procedure:

1. Step- by-step directions for how to do the experiment.
2. Tell how you will set up the experiment (CV's).
3. Tell how you will change the manipulated variable.
4. Tell how you will measure the responding variable.
5. Tell how often you will take and record measurements.
6. Tell how many times you will do each test/observation.

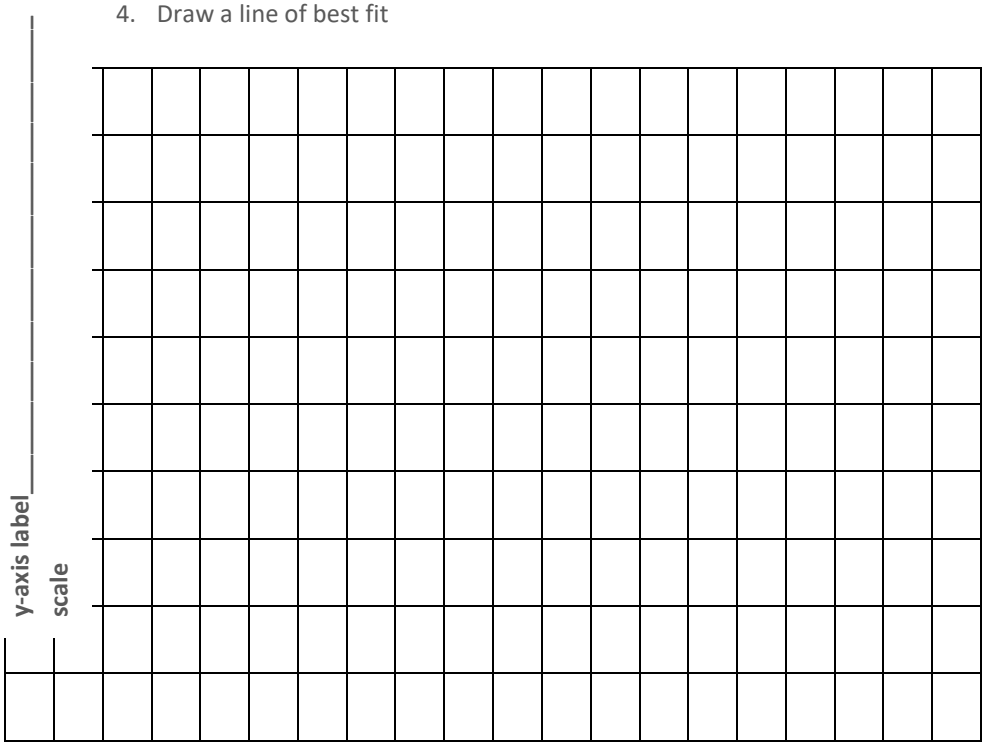
Results: Tables, graphs, and brief description of outcome

Table: set up the table

Site 1	Site 2	Site 3	Site 4	Site 5
Trial 1				
2				
3				

Graph:

1. Label Axis (x-axis = mv, y-axis = rv) and Title
2. Number Axis (use > half the graph, even intervals)
3. Plot data
4. Draw a line of best fit



Site #/Trial #

x-axis label _____

Discussion (Conclusions):

1. Answer the question with an inference
2. Support your answer with evidence from your data (average, minimum, and maximum will do)
3. Summarize the difference (subtract) with a "more than" or "less than" statement. If there is a difference in your data between sites, how big of a difference?

From the data, I can infer that _____

_____

_____

_____

_____

_____

_____My

hypothesis _____ (was/was not) supported because _____

_____

_____

_____

_____.

Surprising results included_____

_____

_____

_____.

Explanation: (Use your science vocabulary for this study to explain what you think your results mean)

Reflection:

1. Possible sources of error in your data
2. Implications (meanings) of this study in the world-why is this data important to know?
3. Potential applications of your findings-what can be done with this new information?
4. Opportunities to investigate this system or concept further

Field Study Presentation

The most important part of the scientific method is communication. When the public understands the issues, they can make informed voting choices and take action to get new bills passed. If our policy makers, land managers, and stakeholders understand ecosystems and their functions, they can make decisions that save money and vital habitats. Prepare a presentation that will communicate your scientific findings, but in a way that will educate, not intimidate, a less-informed audience.

Time frame: 15 min Audience: Skagit Marine Resource Committee members, 3 other 8th grade classes, and a few parental units.

Format: Slideshow OR webpage-get your tech-savvy on

Must include: Introduction, Methods, Results, Conclusion, References Cited, and Acknowledgments exercise

Group member Task/slide

Slideshow checklist:

- Words on slides should be a summary of ideas or talking points
  -Use words on each slide as a guide. Slides are not meant to be read from, use notecards for that.
- Only one graph per slide
- Font must be big enough for the audience to read (err on the side of bigger font)
- Graphs must be labeled and easy to understand
- Slides must use language that everyone understands
- Define scientific terms; assume your audience has a fourth grade understanding of science
- Pictures are important, but they need to be the right picture…

Background slide/photo

Introduce your audience to your topic, its importance, and the purpose of your study

Question/Hypothesis slide/photo/diagram

Our question was

We predicted that if

then

because

Methods slide

Keep this brief!

Summarize your procedure

Results slide/s and photos

No raw data. Tables, graphs, photos, brief description of results in bullet points.

Discussion slide/s and photos

QCEE Conclusion (Question, Claim, Evidence, Explanation):

Implications and applications slide and photos

What is the meaning of your results in the bigger picture of the ecosystem?

How could decision-makers apply this knowledge to important choices for this ecosystem?

References cited slide

List all sources of information that helped you understand and describe your topic and results. Use this website to find proper citation format: https://www.scientificstyleandformat.org/Tools/SSF-Citation-Quick-Guide.html

Example of a scientific article

Haywood, Ronald. 2019. Black brant and their impacts on eelgrass canopy height. *Estuaries and Coasts.* 23(2): 1226-128.

Acknowledgements slide w/photos

Thank all those who supported your work with money, blood, sweat, tears, food, interviews, etc.

ATTACHMENT B

Fall 2019- Conway Middle School Student Field Journal for Forage Fish Investigation

Kids on the Beach

Marine Research Scientist:

_____

MARINE STEWARDSHIP PLEDGE

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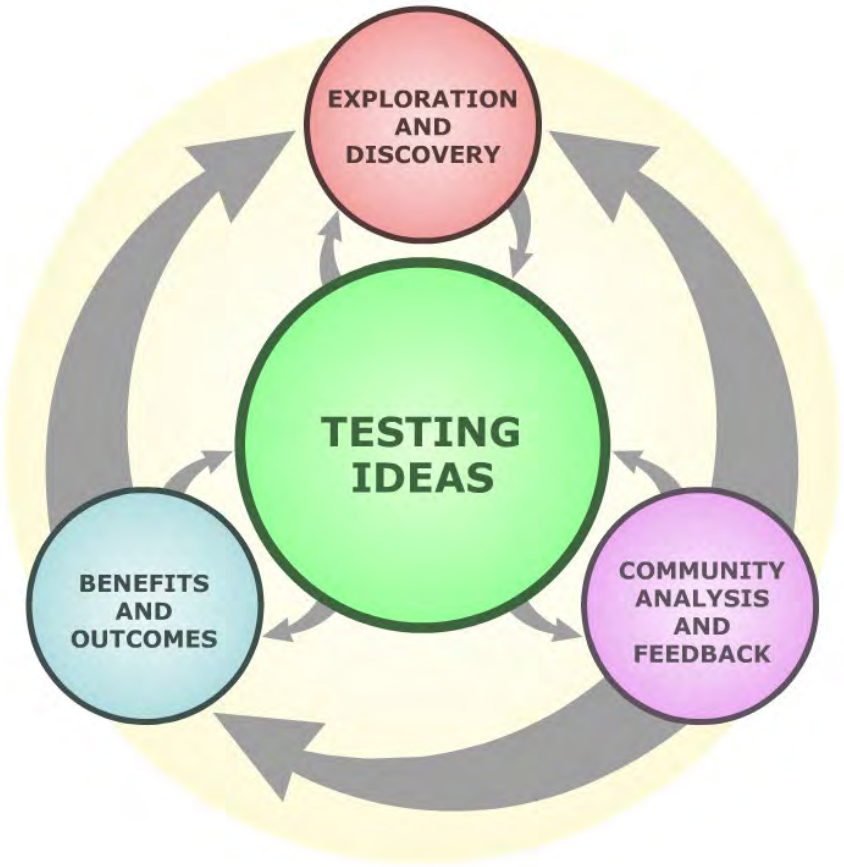

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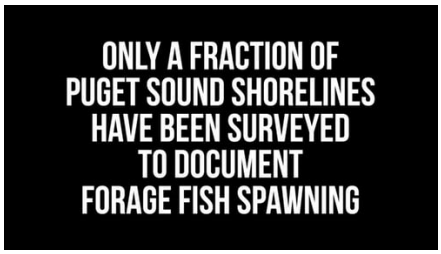


Skagit MRC seeks to support student research that informs recovery of nearshore fish species in Fidalgo Bay, WA. We shall place a priority on cooperative research efforts designed to address the effectiveness of beach restoration efforts in the bay. Approved research projects are funded through a competitive grant program, using funds from the Skagit MRC, NW Straits Initiative, Puget Sound Partnership, and Environmental Protection Agency. One Ocean Environmental prioritizes research that improves our understanding of the effects of beach restoration on surf smelt spawning success.

PROPOSALS DUE: October 11th 2019 at 3 pm. The anticipated allocation of funds is outlined in Table 1.

Table 1: Financial support for nearshore fish research in Fidalgo Bay, including public presentation of results.

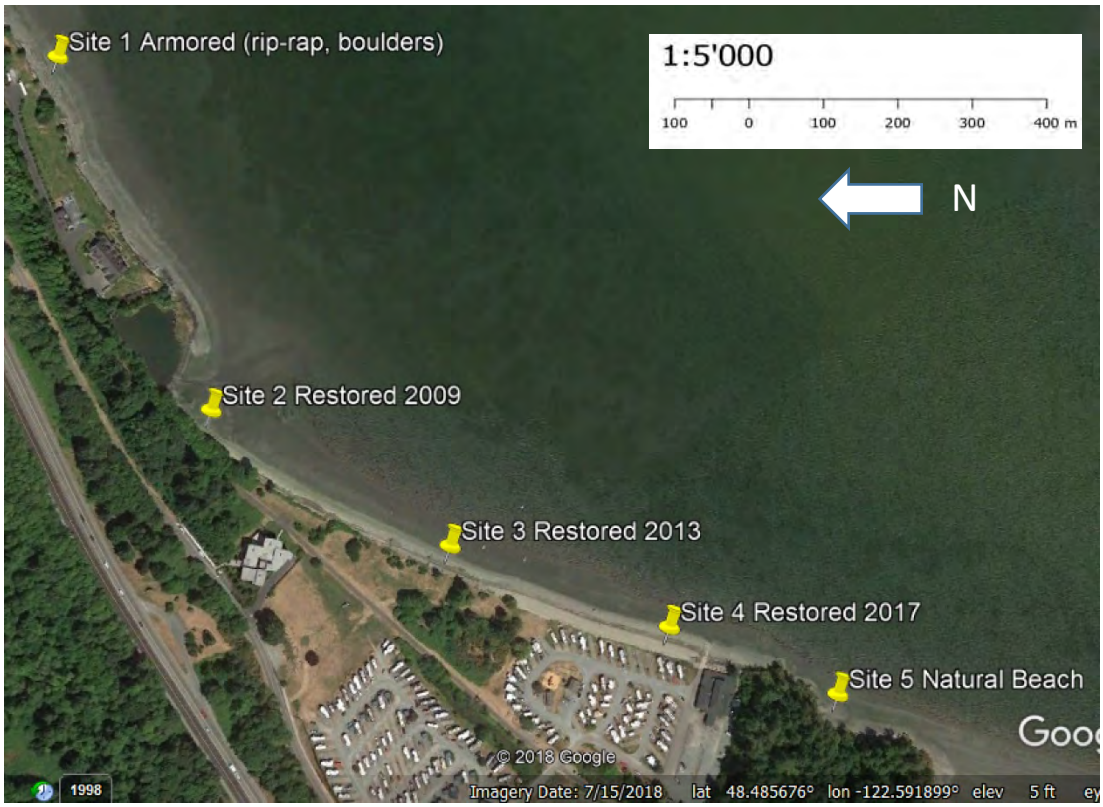
Surf smelt egg survival	$2000
Nearshore fish diversity	$2000

Kids on the Beach 2019 Research Proposal Scoring Rubric

0 = missing 1 = present, but poorly developed, lacking detail
2 = present and complete, but lacking clarity, thoroughness, or detail
3 = complete, articulate, thorough, and clear

Introduction-project background, including importance of forage fish or juvenile salmon in the ecosystem and a clear question to address	0	1	2	3
Research project rationale-why it is important to conduct this study	0	1	2	3
Procedure-Clear steps to completing the study with identified variables and replicate sampling	0	1	2	3
Budget-how the $2,000 will be spent in your proposed procedure	0	1	2	3
References cited	0	1	2	3
Total out of 15 possible points				

Fidalgo Bay Site Map



Forage Fish Background Information

Go fishin':

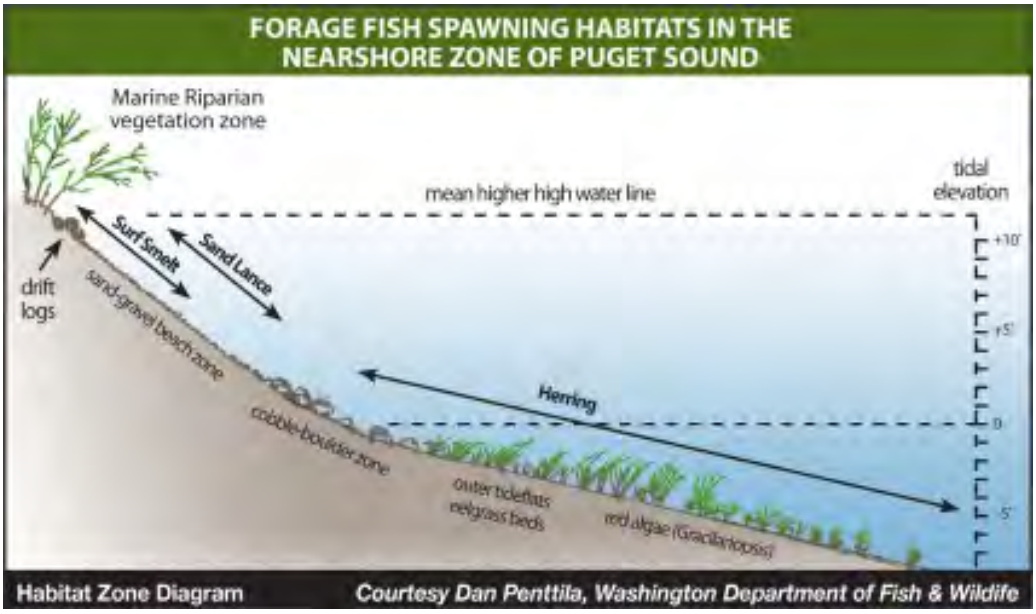
What is a forage fish?

Why are forage fish important?

List 3 found commonly in the Salish Sea

What is unique about their spawning habitat?

How have human activities changed this type of spawning habitat?



Beach restoration background information

What are some ways in which Salish Sea beaches are restored?

How would beach restoration support forage fish?

Surf smelt background information

What do surf smelt need specifically in their habitat for successful spawning?

Typical Surf Smelt Spawning Beach, Semiahmoo Bay, WA (Photo By: Dan Penttila - WDFW, 1992)

WASHINGTON STATE SURF SMELT FACT SHEET

NAME: Surf smelt, *Hypomesus pretiosus* (Girard 1855).

GEOGRAPHIC RANGE:

Long Beach, California to Chignik Lagoon, Alaska. The Asian subspecies, *Hypomesus pretiosus japonicas*, occurs in the northwest Pacific Ocean.

RELATED SPECIES:

Several members of the smelt family, Osmeridae, occur in Washington waters, including eulachon (Columbia River smelt, hooligan) *Thaleichthys pacificus*, longfin smelt *Spirinchus thaleichthys*, whitebait smelt *Allosmerus elongatus*, and night smelt *Spirinchus starksi*. Unlike the other species, both eulachon and longfin smelt are anadromous, migrating into streams in the winter to spawn. **Note:** Columbia River smelt (eulachon) are listed as Threatened under the Endangered Species Act (ESA) and recreational fishing for this species in Washington waters is limited to years in which the run size is exceptionally large. Be sure to check the recreational fishing regulations (http://wdfw.wa.gov/fishing/regulations/) before attempting to fish for any smelt species.

RECOGNITION:

Characteristic dark stripe down the middle of the side of the body. Also notable for small mouth with maxillary (upper jaw bone) that does not extend past the midpoint of the pupil of the eye; dorsal fin begins in front of the pelvic fin; pelvic fins short; and small, curved adipose fin. Length up to eight inches.

LOCAL DISTRIBUTION:

Surf smelt occur abundantly throughout the nearshore marine waters of Washington, from the Columbia River to the Canadian border and into southernmost Puget Sound and Hood Canal. Genetic research suggests that, despite this broad distribution, surf smelt throughout Puget Sound represent a single stock.

SPAWN TIMING:

Surf smelt populations can generally be divided into summer spawners and fall/winter spawners, though year-round spawning has been documented in the Whidbey Basin, Port Susan, portions of the San Juan Islands, and central Puget Sound (Eagle Harbor and Sinclair Inlet). Spawning occurs along the central outer coast of Washington (i.e., from the Quillayute River to just south of the Quinault River) from January through October. Spawning generally occurs in the Strait of Juan de Fuca, northern Saratoga Pass, Birch Point, and Cherry Point from May to October. Spawning occurs from at least July to April in the Bremerton-Poulsbo area, southernmost Puget Sound, and southern Hood Canal. Currently, about 259 lineal statute miles of Washington State shoreline are documented surf smelt spawning beach.

LIFE HISTORY:

Surf smelt are generally an abundant, schooling forage fish living to a maximum age of about five years. Many spawn at one year of age; the majority by two years of age. Adults do not apparently die after spawning. Ecologically, surf smelt fill much the same role as herring and other local forage fishes in marine food webs. They are schooling plankton feeders that are, in turn, preyed upon by a host of other species. Spawning habitat is a mixture of coarse sand and fine gravel in the upper intertidal zone. Spawn is adhesive to particles of beach material and incubates from two to five weeks depending upon seasonal temperature. Juvenile smelt rear in nearshore areas. Surf smelt do not appear to form large schools in open water in Puget Sound. This, combined with their extended spawning season and the small-scale patchiness of their spawn deposition, makes it difficult to assess abundance using acoustic/trawl and spawn deposition survey techniques used for assessment of Puget Sound herring.

FISHERIES:

Unlike other local forage fish species, the surf smelt also supports significant human-consumption fisheries in many areas of Washington State. Surf smelt are fished commercially with beach seines with average annual landings of 95,000 pounds since 2000 in Puget Sound, most of which are harvested in central Puget Sound. A similar annual poundage is currently assumed to be taken by sportsmen with various designs of long-handled dip nets and hook and line jig gear, though this fishery is not actively monitored. Beginning in 2014, the commercial fishery was limited to an annual harvest quota of 60,000 lbs. A recreational fishing license is not required to harvest any species of smelt in Washington. Recreational fishing is **allowed** from 6:00 a.m. to 10:00 p.m. Friday to Tuesday with dip net gear; open 7 days per week (all hours) for jig gear.

HABITAT ISSUES:

The intertidal nature of surf smelt spawning habitat in Puget Sound has made the species quite vulnerable to shoreline development activities. Some spawning grounds are currently mere remnants of their original extent. The WAC Hydraulic Codes Rules (WAC 220-110) currently regulate the extent to which bulkhead-fill structure

can intrude seaward of the high tide line on known smelt spawning beaches and specific seasons during which admissible work can be undertaken.

Design an Experiment on Forage Fish Habitat:

Title _____

Choosing Variables: I will manipulate (change) _____(one manipulated/independent variable)

I will measure (observe) _____ (one responding/dependent variable)

I will control (keep the same) _____and _____and _____

Research Question: What is the effect of the MV on the RV? How does the MV affect the RV?

_____

_____?

Hypothesis/Prediction: If MV… then RV… because (*of this scientific reason*).

_____

_____

_____

_____

_____

Diagram: Draw a labeled illustration of the field investigation set-up.

Procedure:

1. Step- by-step directions for how to do the experiment.
2. Tell how you will set up the experiment (CV's).
3. Tell how you will change the manipulated variable.
4. Tell how you will measure the responding variable.
5. Tell how often you will take and record measurements.
6. Tell how many times you will do each test/observation.

Results: Tables, graphs, and brief description of outcome

1. Label Axis (columns = mv include UNITS!, rows = rv)
2. At least 3 trials
3. Average, min, max values

Average				

Graph:

1. Label Axis (x-axis = mv, y-axis = rv) and Title
2. Number Axis (use > half the graph, even intervals)
3. Plot data
4. Draw a line of best fit

Discussion (Conclusions):

1. Answer the question with an inference
2. Support your answer with evidence from your data (average, minimum, and maximum will do)
3. Summarize the difference (subtract) with a "more than" or "less than" statement

From the data, I can infer that _____

_____

_____

_____

_____

_____

_____

_____ My hypothesis _____ (was/was not) supported because _____

_____

_____

_____

_____Surprising results included____

_____

_____

_____

Explanation: (Use your science vocabulary for this unit to explain your results)

Reflection:

1. Possible sources of error in your data
2. Implications (meanings) of this study in the world
3. Potential applications of your findings
4. Opportunities to investigate this system or concept further

Field Study Presentation

The most important part of the scientific method is communication. When the public understands the issues, they can make informed voting choices and take action to get new bills passed. If our policy makers, land managers, and stakeholders understand ecosystems and their functions, they can make decisions that save money and vital habitats. Prepare a presentation that will communicate your scientific findings, but in a way that will educate, not intimidate, a less-informed audience.

Time frame: 15 min Audience: Skagit Marine Resource Committee members, scientists and a few parental units.

Format: Slideshow OR webpage-get your tech-savvy on

Must include: Introduction, Methods, Results, Conclusion, References Cited, and Acknowledgments

Group member Task/slide

Slideshow checklist:

- Words on slides should be a summary of ideas or talking points
  -Use words on each slide as a guide. Slides are not meant to be read from, use notecards for that.
- Only one graph per slide
- Font must be big enough for the audience to read (err on the side of bigger font)
- Graphs must be labeled and easy to understand
- Slides must use language that everyone understands
- Define scientific terms; assume your audience has a fourth grade understanding of science
- Pictures are important, but they need to be the right picture…

Background slide/photo

Introduce your audience to your topic, its importance, and the purpose of your study

Question/Hypothesis slide/photo/diagram

Our question was

We predicted that if

then

because

Methods slide

Keep this brief!

Summarize your procedure

Results slide/s and photos

No raw data-just tables, graphs, photos

Discussion slide/s and photos

CEE Conclusion (Claim, Evidence, Explanation):

Implications and applications slide and photos

What is the meaning of your results in the bigger picture of the ecosystem?

How could decision-makers apply this knowledge to important choices for this ecosystem?

References cited slide

List all sources of information that helped you understand and describe your topic and results.

Example of a scientific article

Haywood, Ronald. 2018. Black brant and their impacts on eelgrass canopy height. *Estuaries and Coasts.* 23(2): 1226-128.

Example of a reputable web page

Acknowledgements slide w/photos

Thank all those who supported your work with money, blood, sweat, and tears, food, interviews, etc.

This project was made possible by generous and enthusiastic support from:

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ATTACHMENT C

Fall 2019- Conway Middle School Student Symposium Agenda

Kids on the Beach Science Symposium

Friday, Nov 22 2019 9-11:30am

Padilla Bay National Estuarine Research Reserve
Stevens Meeting Room
10441 Bay View-Edison Road
Mount Vernon, WA 98271-9668

Padilla Bay
National Estuarine Research Reserve

TIME	EVENT
9:00-9:10	Symposium welcome and introduction
9:15-9:30	Conway students on beach enhancement and surf smelt spawning
9:35-9:50	Conway students on beach enhancement and fish species richness
9:50-10:10	Break- aquarium tour and fish feeding
10:15-10:30	Skagit Marine Resources Committee (MRC) on forage fish
10:35-10:50	Scientist Nicole Burnett on why zooplankton is important
10:55-11:10	Scientist Shauna Bjornson on eelgrass morphology and growth rates

The SeaDoc Society

SAMISH INDIAN NATION

Northwest Straits INITIATIVE
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ATTACHMENT D

Spring 2020- Modified Batillaria Snail Investigation Program

Kids on the Beach

Overview

Kids on the Beach is a hands-on program that has students doing real science and investigating the nearshore marine environment! Over the course of four days you will explore Padilla Bay and the non-native *Batillaria* snail. This program is designed for you to do one 30 min unit a day.

Day 1/Unit 1: Introduction to Padilla Bay's Food Web

Instructions: Watch the video and follow along in your student notebook.

Video: Day 1 Annie.mp4

Student Notebooks (Scientific Journal): Day 1 Student Notebook

Day 2/Unit 2: Introduction to the *Batillaria* snail

Instructions: Watch the video and try your hand at collecting data!

Video: Day 2 Interview with scientist Roger Fuller.mp4

Worksheet: Day 2 Practice Collecting Data Worksheet

Day 3/Unit 3: Introduction to the *Batillaria* snail Investigation with Madi McKay

Instructions: Watch the video and fill in the worksheet while you watch!

Video: Day 3 Madi.mp4

Worksheet: Day 3 Worksheet

Day 4/Unit 4: Investigation Activity

Instructions: Follow Madi and Roger along to investigate the *Batillaria* snail!

Investigation: Day 4 Scientific Investigation

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Skagit County Marine Resources Committee

Padilla Bay
National Estuarine Research Reserve

PUGETSOUND PARTNERSHIP

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ATTACHMENT E

Spring 2020- Padilla Bay Unit for Elementary Students – online

Please make a google copy of all the materials you choose to edit/use: Go to File->make a copy. This includes the links to the Notebook, worksheet, collecting data, and scientific investigation.

Also if you choose to use any of these materials please email: aengland@padillabay.gov and let Annie know what you are using and how many students you're sending the materials to.Thanks!

Kids on the Beach

Overview

Kids on the Beach is a hands-on program that has students doing real science and investigating the nearshore marine environment! Over the course of four days you will explore Padilla Bay and the non-native *Batillaria* snail. This program is designed for you to do one 30 min unit a day.

Day 1/Unit 1: Introduction to Padilla Bay's Food Web

Instructions: Watch the video and follow along in your student notebook.

Video: Day 1 Annie.mp4

Student Notebooks (Scientific Journal): Elementary Day 1 Student Notebook

Day 2/Unit 2: Introduction to the *Batillaria* snail

Instructions: Watch the video and try your hand at collecting data!

Video: Day 2 Interview with scientist Roger Fuller.mp4

Worksheet: Elementary Day 2 Practice Collecting Data Worksheet

Day 3/Unit 3: Introduction to the *Batillaria* snail Investigation with Madi McKay

Instructions: Watch the video and fill in the worksheet while you watch!

Video: Day 3 Madi.mp4

Worksheet: Elementary Day 3 Worksheet

Day 4/Unit 4: Investigation Activity

Instructions: Follow Madi and Roger along to investigate the *Batillaria* snail!

Investigation: [Elementary Day 4 Scientific Investigation]

This project was made possible by generous and enthusiastic support from:

Northwest Straits INITIATIVE
partners in marine conservation

Skagit County Marine Resources Committee

Padilla Bay National Estuarine Research Reserve

PUGETSOUND PARTNERSHIP

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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ATTACHMENT F

Spring 2020- Padilla Bay Unit for Elementary Students – offline

Padilla Bay Unit

Apart of the Kids on the Beach Program

Overview

This unit will explore life in the Padilla Bay estuary, in four 30 minute activities. Complete an activity a day and by the end you'll be a Padilla Bay expert!

Contents

Background

What is an Estuary?

An Estuary is a semi-enclosed body of water where salt water from the ocean is diluted by freshwater from the land.

What is a Habitat?

A habitat is the home of an animal or a plant.

What is the Padilla Bay Reserve?

The Padilla Bay Reserve is one of 29 sites in the National Estuarine Research Reserve system established to protect coastal areas for long-term research, monitoring, education, and stewardship. Padilla Bay Reserve is the only Research Reserve in Washington State.

Why is Padilla Bay important?

Padilla Bay is in the heart of the Salish Sea. It has more than 8,000 acres of eelgrass; it's the second largest eelgrass meadow on North America's Pacific Coast.

What is the Salish Sea?

The Salish Sea is an inland sea that encompasses Puget Sound, the San Juan Islands and the waters inside of Vancouver Island, BC. The area spans from Olympia, Washington in the south to the Campbell River, British Columbia in the north.

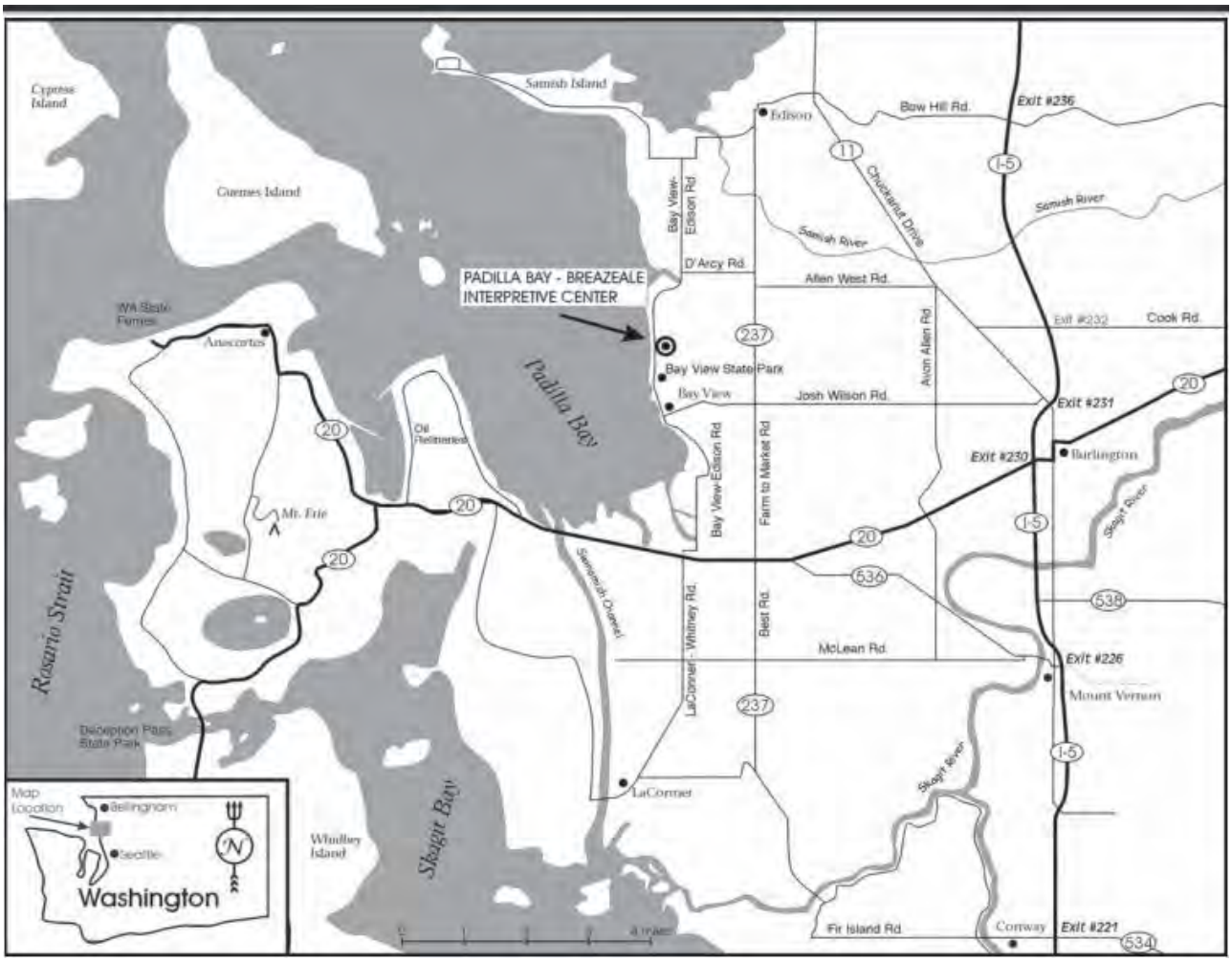
Why is eelgrass important?

Eelgrass is used as a nursery habitat for juvenile salmon, crab, and herring. It also provides critical habitat for waterfowl and marine birds.

Vocab

Estuary: a place where freshwater mixes with salty sea water. All of the Salish Sea is an estuary.
Salish Sea-The Salish Sea is an inland sea that encompasses Puget Sound, the San Juan Islands and the waters off of Vancouver, BC.
Plankton- plants or animals floating in the water, usually microscopic.
Phytoplankton- free-floating plants in water; often microscopic.
Zooplankton- free-floating animals in water; often microscopic.
Microscopic- too small to see without a microscope.
Detritus- dead rotting stuff. The compost of the estuary!
Filter feeder- an animal, such as a clam or oyster that strains food from the water.
Photosynthesis- the process in which plants and some other organisms use sunlight to create food from carbon dioxide and water.
Algae- a type of plant without a true stem, roots or leaves; mostly lives in water.
Food Chain- the transfer of energy (food) from plants to animals, and maybe then to other animals.
Food Web- overlapping and connecting food chains.
Eelgrass- a type of grass that grows in the water.
Copepods- type of zooplankton (microscopic animal), the animal plankton from sponge bob is modeled after.
Watershed- the area of land that drains into a body of water like a river or bay.

Location



Padilla Bay Food Web Game

Adapted from Hanging onto Wetlands

Overview

This game shows how energy flows. Play the game to build your own food web!

Background

An estuary food web begins with the producers. Plants use sunlight energy for photosynthesis, combining carbon dioxide (CO_2) and water (H_2O) to make sugar and oxygen. The sunlight energy is stored in the plants which can be eaten and used by animals. Without photosynthesis, animals (including people) would have nothing to eat and nothing to breathe!

When energy is done cycling through all the plants and animals it ends up in the form of detritus. Detritus is dead and rotting estuarine materials—it's the compost of the estuary. Just like compost people put on their gardens, detritus is rich in nutrients that help plants grow. Padilla Bay has 8,000 acres of eelgrass because it has such nutritious detritus.

Instructions

1. Cut along black lines on pages 4-10.
2. Gently shuffle cards.
3. Stack cards face up.
4. Take the top card and place it face up in the middle of the table.
5. Next place a card that gets energy from or gives energy to the first card by laying it side to side with the first card (each card tells which other cards it can be attached to).
6. If you have a card that can attach to two cards at the same time (it fits between two cards) you've made a food web!
7. Try to use all the cards to create one large food web.

Gets energy from:
nobody

Gives energy to:
phytoplankton
eelgrass

SUN

Gets energy from:
copepod
phytoplankton
detritus

Gives energy to:
duck seal gull octopus
otter human detritus

CLAM

MUD SNAIL

Gets energy from:
phytoplankton
detritus

Gives energy to:
crab detritus

Gets energy from:
sun

Gives energy to:
detritus

EELGRASS

CLAM

GULL

Gets energy from:
copepod
phytoplankton
detritus

Gives energy to:
duck seal gull octopus
otter human detritus

Gets energy from:
clam detritus
crab

Gives energy to:
detritus

Gets energy from:
sun

Gives energy to:
clam oyster copepod
snail detritus

PHYTOPLANKTON

Gets energy from:
sun

Gives energy to:
clam oyster copepod
snail detritus

PHYTOPLANKTON

MUD SNAIL

Gets energy from:
phytoplankton
detritus

Gives energy to:
crab
detritus

Gets energy from:
detritus
phytoplankton

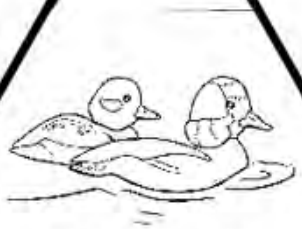
Gives energy to:
duck jellyfish crab
clam detritus

COPEPOD

Gets energy from:
detritus
phytoplankton

Gives energy to:
duck jellyfish crab
clam detritus

COPEPOD



BUFFLEHEAD DUCK

Gets energy from:
crab copepod
clam

Gives energy to:
eagle otter
detritus

Gets energy from:
sun

Gives energy to:
detritus

EELGRASS

DUNGENESS CRAB

SHORE CRAB

Gets energy from:
oyster clam snail fish
worm shrimp copepod
shore crab

Gives energy to:
duck eagle heron
humans gull detritus
otter seal octopus

Gets energy from:
phytoplankton
clam worm

Gives energy to:
duck gull fish octopus
Dungeness crab detritus
sunflower star

Gets energy from:
everyone except
human and sun

Gives energy to:
clam oyster
copepod eelgrass

DETRITUS

Gets energy from:
everyone except
human and sun

Gives energy to:
clam oyster
copepod eelgrass

DETRITUS

HERMIT CRAB

Gets energy from:
phytoplankton worm
copepod detritus

Gives energy to:
fish detritus
octopus sunflower star
Dungeness crab

Gets energy from:
detritus
phytoplankton

Gives energy to:
duck jellyfish crab
clam detritus

COPEPOD

Gets energy from:
detritus
phytoplankton

Gives energy to:
duck jellyfish crab
clam detritus

COPEPOD

LUGWORM

Gets energy from:
detritus

Gives energy to:
crab fish duck
octopus detritus

Gets energy from:
sun

Gives energy to:
detritus

EELGRASS

OCTOPUS

Gets energy from:
crab clam fish
worm shrimp snail

Gives energy to:
duck eagle heron
humans gull detritus
seal otter fish

OCHRE STAR

Gets energy from:
clams oyster

Gives energy to:
eagle detritus
gull otter seal
sunflower star

Gets energy from:
everyone except
human and sun

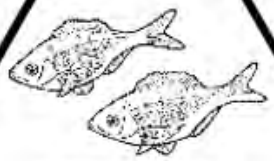
Gives energy to:
clam oyster
copepod eelgrass

DETRITUS

Gets energy from:
everyone except
human and sun

Gives energy to:
clam oyster
copepod eelgrass

DETRITUS



SHINNER PERCH

Gets energy from:
phytoplankton fish
copepod crab worm

Gives energy to:
eagle heron duck
gull otter seal
anemone octopus

Gets energy from:
fish crab octopus

Gives energy to:
detritus

GREAT BLUE HERON

Gets energy from:
detritus
phytoplankton

Gives energy to:
duck jellyfish crab
clam detritus

COPEPOD

BAY PIPEFISH

Gets energy from:
copepod
phytoplankton

Gives energy to:
detritus heron
duck fish

Gets energy from:
sun

Gives energy to:
detritus

EELGRASS

CLAM

Gets energy from:
copepod
phytoplankton
detritus

Gives energy to:
duck seal gull octopus
otter human detritus

EAGLE

Gets energy from:
fish duck
crab

Gives energy to:
detritus

Gets energy from:
sun

Gives energy to:
clam oyster
copepod snail
detritus

PHYTOPLANKTON

Gets energy from:
sun

Gives energy to:
clam oyster
copepod snail
detritus

PHYTOPLANKTON

MUD SNAIL

Gets energy from:
phytoplankton
detritus

Gives energy to:
crab
detritus

Gets energy from:
detritus
phytoplankton

Gives energy to:
duck jellyfish crab
clam detritus
barnacle

COPEPOD

Gets energy from:
detritus
phytoplankton

Gives energy to:
duck jellyfish crab
clam detritus
barnacle

COPEPOD

BARNACLE

Gets energy from:
phytoplankton
copepod

Gives energy to:
fish sea star
detritus gull human

Gets energy from:
sun

Gives energy to:
detritus

EELGRASS

SEA CUCUMBER

Gets energy from:
detritus

Gives energy to:
eagle gull detritus
heron human
seal sea star otter

RIVER OTTER

Gets energy from:
fish sea cucumber
crab duck octopus
sea star clam oyster

Gives energy to:
detritus

Gets energy from:
everyone except
human and sun

Gives energy to:
clam oyster
copepod eelgrass

DETRITUS

Gets energy from:
clam octopus
fish barnacle jellyfish
cucumber flounder shrimp
oyster

Gives energy to:
nobody

HUMAN

JELLY FISH

Gets energy from:
copepod
phytoplankton

Gives energy to:
human fish
detritus

Gets energy from:
detritus
phytoplankton

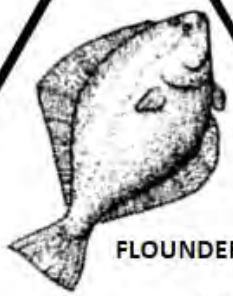
Gives energy to:
fish jellyfish crab
clam detritus

COPEPOD

Gets energy from:
detritus
phytoplankton

Gives energy to:
anemone jellyfish crab
clam detritus

COPEPOD



FLOUNDER

Gets energy from:
crab clam fish octopus
worm shrimp copepod

Gives energy to:
eagle gull duck
heron octopus seal
otter human detritus

Gets energy from:
sun

Gives energy to:
detritus

EELGRASS

HELMET CRAB

Gets energy from:
oyster clam snail fish
worm shrimp copepod

Gives energy to:
duck eagle heron
humans gull detritus
otter seal octopus

MUD SHRIMP

Gets energy from:
detritus copepod
phytoplankton

Gives energy to:
octopus anemone
fish detritus crab

Gets energy from:
everyone except
human and sun

Gives energy to:
clam oyster
copepod eelgrass

DETRITUS

Gets energy from:
everyone except
human and sun

Gives energy to:
clam oyster
copepod eelgrass

DETRITUS

SUNFLOWER STAR

Gets energy from:
ochre star clam crab
oyster sea cucumber

Gives energy to:
otter seal
detritus

Gets energy from:
detritus
phytoplankton

Gives energy to:
fish anemone crab
clam detritus

COPEPOD

Gets energy from:
detritus
phytoplankton

Gives energy to:
fish anemone crab
clam detritus

COPEPOD

ANEMONE

Gets energy from:
fish copepod crab
phytoplankton

Gives energy to:
detritus

Gets energy from:
sun

Gives energy to:
detritus

EELGRASS

OYSTER

Gets energy from:
phytoplankton
copepod

Gives energy to:
human sea star
crab fish otter
detritus

HOODED NUDIBRANCH

Gets energy from:
copepod

Gives energy to:
detritus

Gets energy from:
everyone except
human and sun

Gives energy to:
clam oyster
copepod eelgrass

DETRITUS

HARBOR SEAL

Gets energy from:
everyone except
human and sun

Gives energy to:
clam oyster
copepod eelgrass

DETRITUS

Gets energy from:
crab fish octopus
sea stars clam shrimp

Gives energy to:
human detritus

High Tide/Low Tide Coloring Pages and Organism Identification Game

Instructions

Try and see if you can find the estuary plants and animals on page 12 and 13. Color in the two pages, then answer the questions below.

Background

An estuary is the place where fresh water from the land meets the salt water of the sea. Estuaries are amazing places. They are home to all sorts of plants and animals that are specially adapted to live in a changing environment. During the course of any given day an estuary plant or animal may have to face hot, dry sun and cold salty ocean water. This is because of the tides. It's not easy to live in a place that changes so much, but for those that do survive, the estuary offers something— a place to live.

Padilla Bay is a special estuary near you! It's within a larger estuary known as the Puget Sound or The Salish Sea. Since the bay is filled with sediment from the Skagit River, the bottom is very shallow, flat, and muddy. It is so shallow that almost the whole bay is intertidal. This means it is flooded at high tide but when the tide goes out, the whole bay empties, exposing miles of mud flats. This condition allows unusually large eelgrass meadows to grow. Padilla Bay's nearly 8,000 acres of eelgrass is a key reason it is protected.

Questions (after you're done with the activities on page 13 & 14)

1. What are the differences between high tide and low tide?

2. In Padilla Bay the tide goes out every six hours, and comes in every six hours. How do you think this affects the animals that live in the bay?

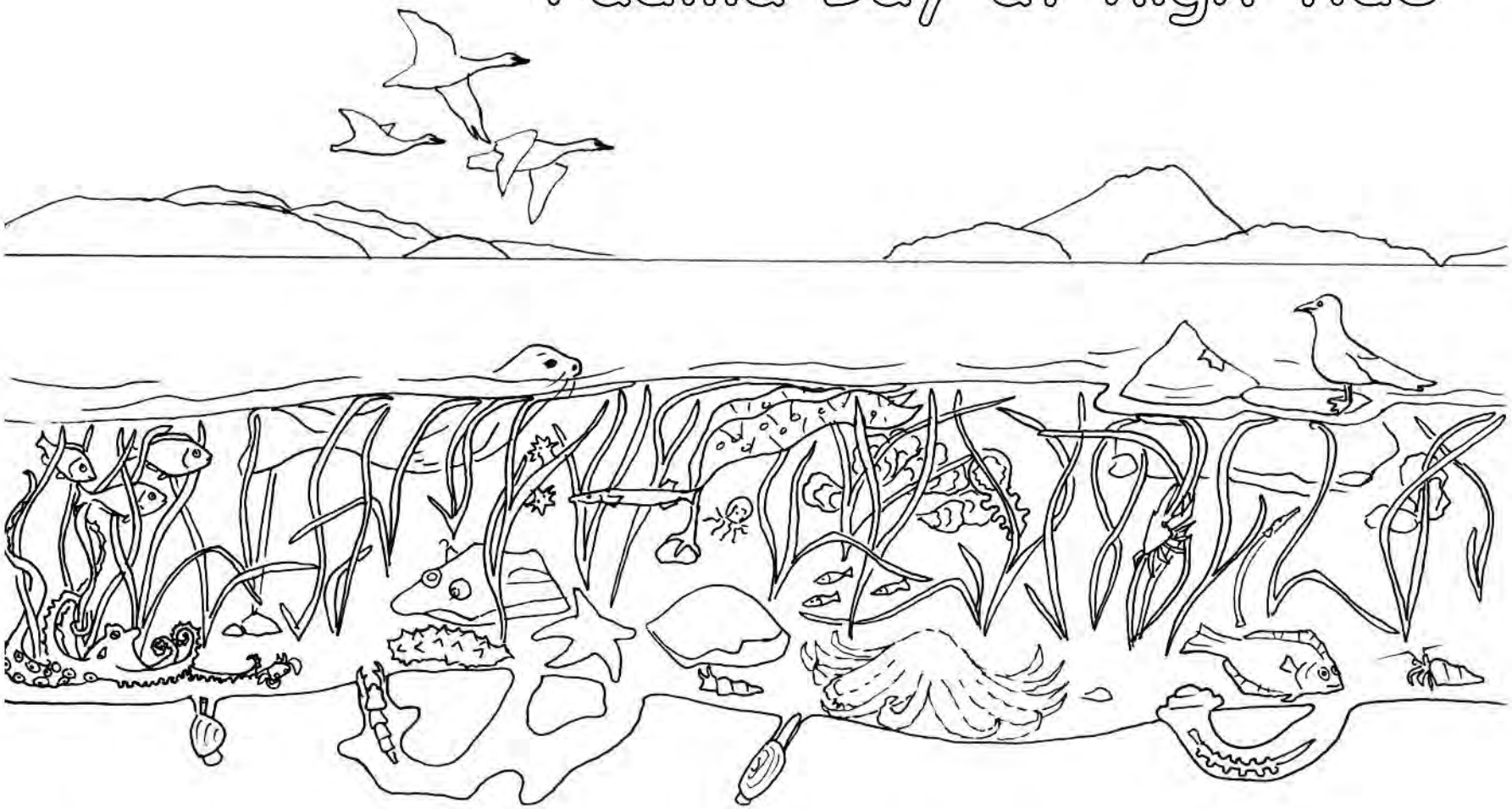
3. What plants or animals in the estuary coloring pages seem to be thriving (to do well; to prosper)? Why?

4. If you could be any plant or animal in the picture which one would you be? Why?

Padilla Bay at low tide

Can you find: a river otter, a sea star, a bald eagle, oysters, eelgrass, barnacles, a hermit crab, five snails, a bufflehead duck, two clams, a mud shrimp, a worm, a Dungeness crab, a shore crab, and a great blue heron?

Padilla Bay at high tide



Can you find: three shiner perch, a sea star, a sea cucumber, oysters, eelgrass, barnacles, a hermit crab, a snail, a gull, two clams, a mud shrimp, a worm, a flounder, a shore crab, an octopus, a hooded nudibranch, a jellyfish, a harbor seal, a hairy helmet crab, a pipe fish, three trumpeter swans, two anemones, and a sunflower star?

Estuary Habitat Coloring Book

Instructions

All of the estuarine animals in this coloring book need a habitat to live and thrive. Read the coloring book and then choose at least three animals to help by drawing them habitats!

Questions (after you read the coloring book)

1. Can any of the animals camouflage into their habitats? Which ones?

2. Have you seen any of these animals in real life? Where did you see them?

3. What are three things estuary animals need to thrive? Why do they need these things to thrive?

Great Blue Heron

I'm the largest of the North American herons with long legs, a sinuous neck, and a thick, dagger like bill. I appear blue-gray from a distance with a wide stripe over the eye. Right now I'm flying over the Estuary to head back to my heronry (nesting site in a tree).

Bay Pipefish

I'm a Bay Pipefish and I spend most of my time blending into the tall, green eelgrass that grows in Padilla Bay. Can you draw me hiding in eelgrass?

Painted Anemone

I am olive-green with red blotches that look like paint strokes (That's how I got my name!). I like living on big rocks or on the side of docks; they're great places to attach so I can sting prey as it passes by.

Green Shore Crab

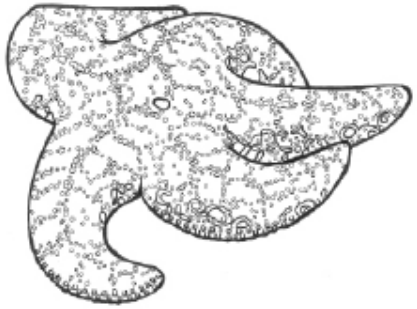
I'm the one of the smaller crabs in the estuary, never getting more than 2 inches long. I might be olive green, reddish-brown, or even purple. I like to munch on green algae, so if you draw me a chunk I'll take a bite!

Moon Jelly

You might have trouble coloring me, I'm white and translucent! I am plankton and I eat plankton. I can pulsate my bell to propel myself forward, but this force is not strong enough to propel me against the current. Draw a blue Salish Sea full of plankton for me to feed!

Taylor Sea Hare

I'm bright green with black and white stripes, allowing me to blend with the eelgrass. I like to crawl up and down a blade of eelgrass to feed on diatoms and other small organisms. Draw the eelgrass blade I'm crawling up.



Purple Sea Star

Did you know I don't have a brain? I use chemical sensors to detect pray. I like to eat mussels, barnacles, snails, limpets, clams, and chitons. Although most Purple Sea Stars are purple, we can also be dark brown and yellow-orange.

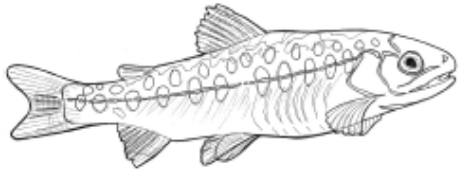
East Pacific Red Octopus

I am the most intelligent mollusk, I'm way smarter than my bivalve kin! I prefer the shallow bays of the Salish Sea. I'm not a picky eater and will hunt for many different types of seafood. One of my hunting tricks is to change my appearance to blend in with my environment; although normally I'm a reddish brown.

Bufflehead

We are buffleheads on the hunt for small invertabrates. We can dive and stay underwater for up to 13 seconds.

One of us is male and one of us is female; bufflehead males are mostly white with a purple-green iridescence on the head and the females are smaller brownish ducks with a single white patch on the check. Can you tell which one of us is female and which one of us is male?

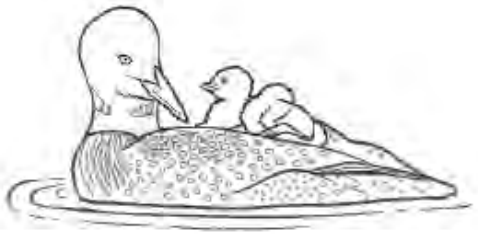


Juvenile Chinook Salmon

I'm a silvery fish with darker grayish brown patterns. I need the estuary to grow bigger. I like to hide in eelgrass until I'm big enough to hunt out in the Pacific Ocean.

Helmet Crab

I really like Padilla Bay's muddy bottom; I like to burrow into its sediment. I can be red, orange, or brown if very young.



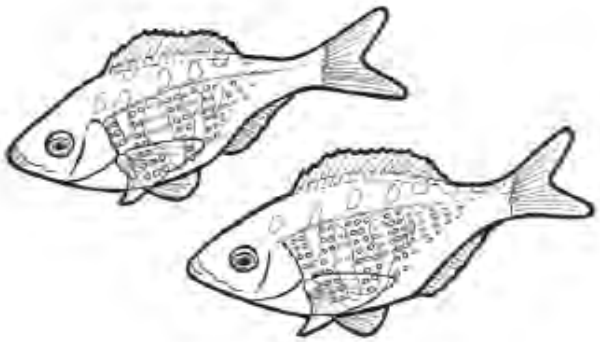
Common Loon

I sit low in the water, scanning below the surface to catch a treat. I have a rich black head and back with white spots. You can sometimes see different colors shinning in my black feathers. I'd love it if you drew me some fish to dive after.

Sunflower Star

I'm the star of the underwater world, for I'm the largest sea star in the Pacific Northwest! I can have up to 24 arms, and will eat almost anything in my path! Draw me urchins, bivalves, and other stars for me to eat.

I'm also very beautiful. I can be bright orange or purplish



Shiner Perch

We're one of the most common fish in estuaries. Our favorite habitat is eelgrass beds. We're shinny silver with yellow stripes.

Blue mud shrimp

I'm a gray, brown, white, or bluish shrimp. I like to burrow down in U shaped holes, often making little mounds on the mud surface.

California Sea Cucumber

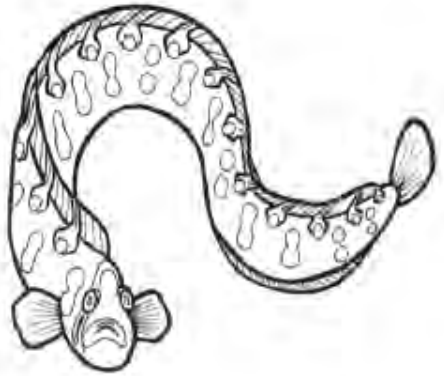
Don't be fooled, I'm no garden variety cucumber...I'm an animal! I may look scary with my dark red body and orange spikes, but I'm really a squishy softy. I look scary to ward off sea otters and other fish that like to eat me. Please draw me in a safe place!

Lined Chiton

I come in a variety of dazzling colors; I can be pink, red, white, black, purple, gold or brown. I spend most of my time clinging to rocks. I like to hang out around red encrusting coralline algae.

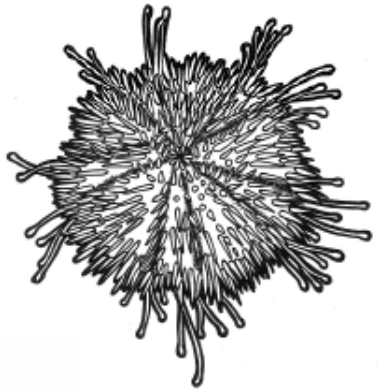
Keyhole limpet

I'm a keyhole limpet; but despite my name I'm more closely related to abalones than limpets. I'm brownish white, and enjoyeating encrusting sponges and diatoms.



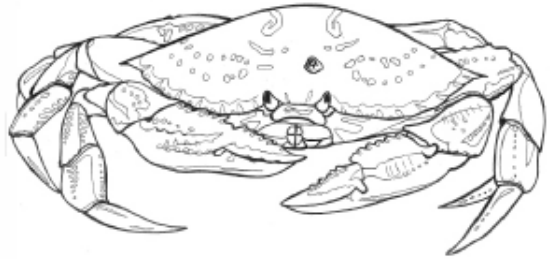
Saddleback Gunnel

I'm not an eel, I'm a fish! I'm nocturnal, which means I like to hide during the day. I like to hang out on muddy bottoms among the eelgrass and seaweed.



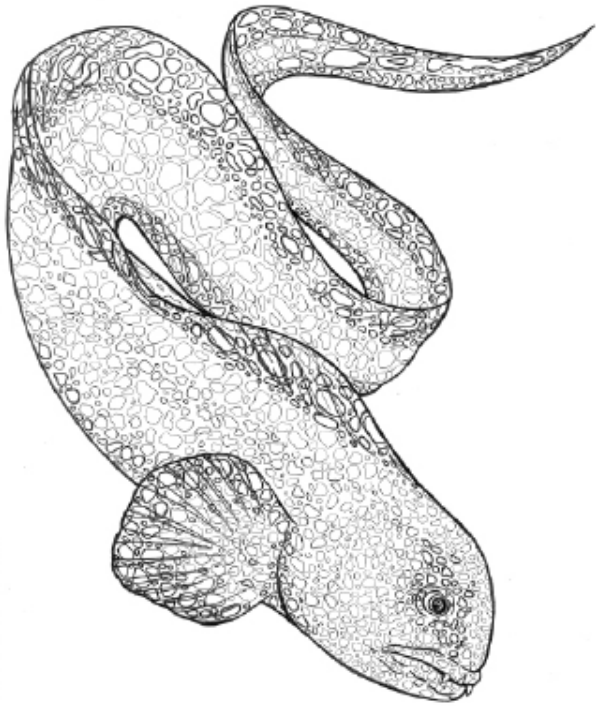
Green Sea Urchin

Just like my name implies I'm nice and green; I also often have a little pink. I like to hang out in rocky areas, sandy areas on floats, and especially in kelp beds. Draw me some tasty brown kelp to munch on if you want to be my friend.



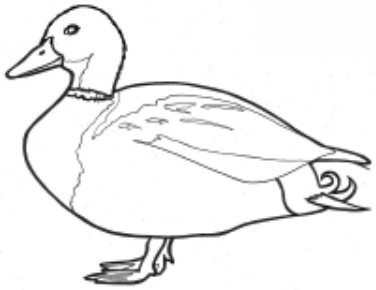
Dungeness Crab

I really like to hang out on muddy bottoms of bays with eelgrass. My color ranges from brown to purplish and may have a gray tint. I will keep growing my entire life.



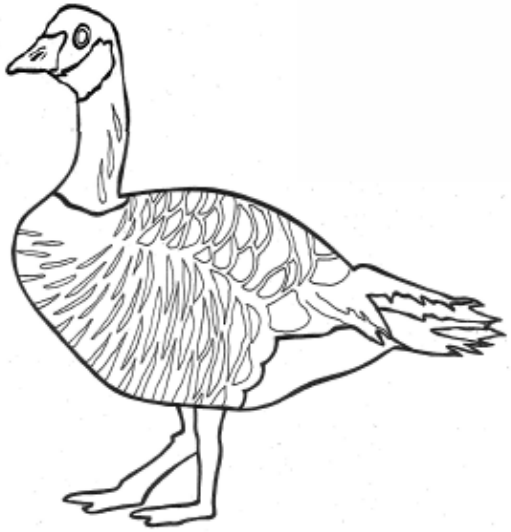
Wolf Eel

Right now I'm just a 4 foot long juvenile; I'll eventually grow to be 8 feet long! Though I may look scary, I'm actually pretty shy and like to hide. I mate for life and would love it if you would draw me a mate!



Mallard Duck

I'm a dabbling duck, which means I don't dive. Instead I tip forward to graze on underwater plants. I'm a male duck and have a green head and a gray-brown body.



Canada Goose

I like to live near the water, I especially like parks or fields near water. I'm large with a black head and neck, white cheeks and chin, and I have a brown body.

Monterey Sea Lemon

Just like my name implies I look like a lemon peel, ranging from pale yellow to bright orange. I'm a very picky eater, I love to eat bread crumb sponge especially if it's the same color as me.

Hot on the trail of the *Batillaria* mud snail!

Featured scientists: Madi McKay and Roger Fuller

Padilla Bay National Estuarine Research Reserve

Research Background:

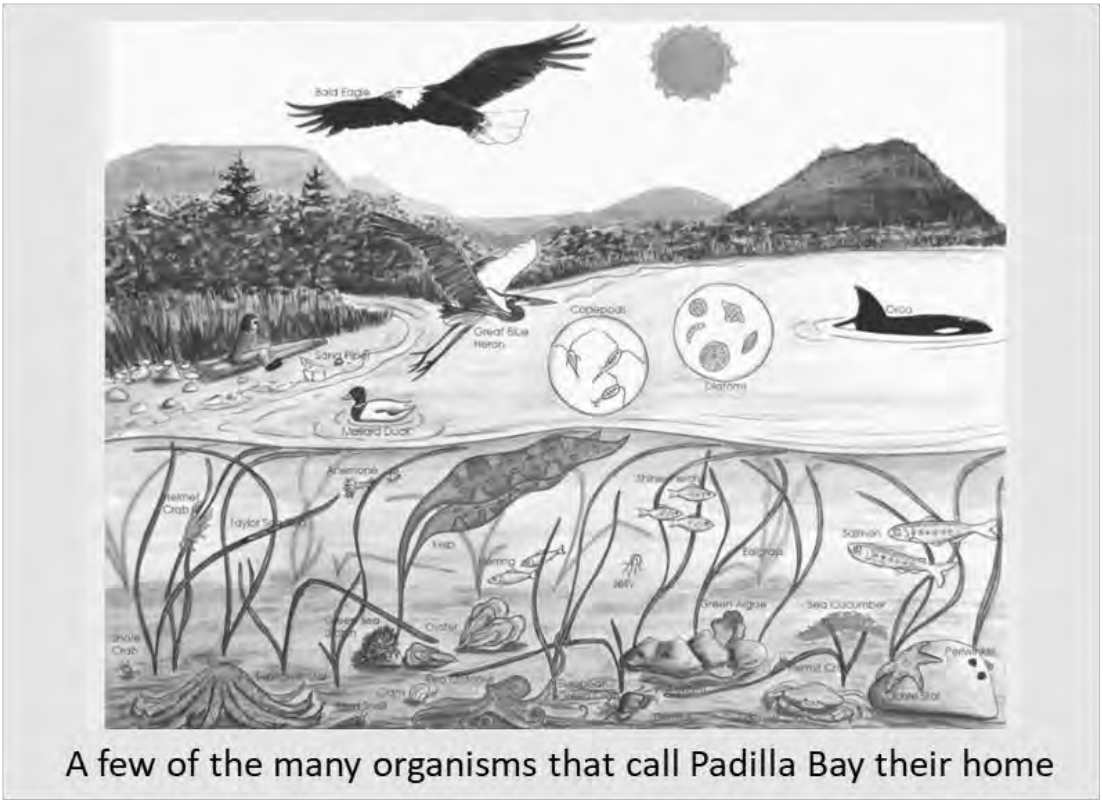
Padilla Bay is located in the heart of the Salish Sea!

It holds more than 8,000 acres of eelgrass - the second largest on North America's Pacific Coast.

Aerial photo of Padilla Bay

A look just below the surface of Padilla Bay

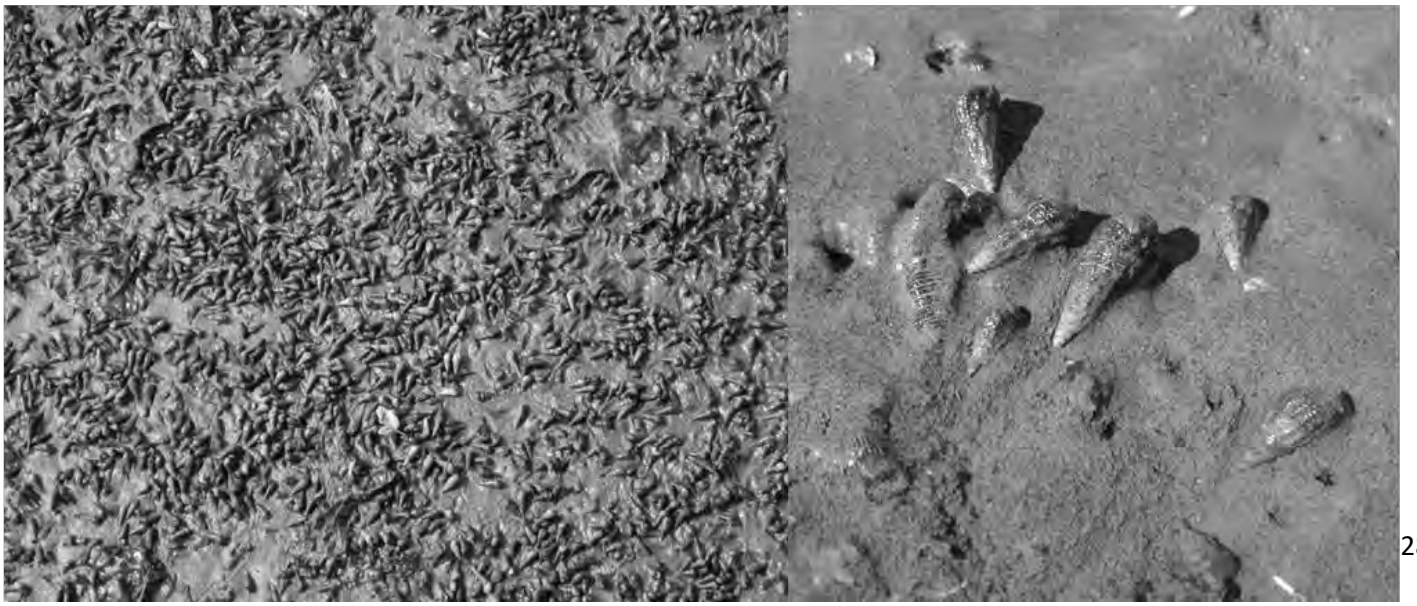
Eelgrass is used as a nursery by juvenile salmon, crab, and herring. It also provides critical habitat for waterfowl and marine birds.



A few of the many organisms that call Padilla Bay their home

When you visit Padilla Bay the mud snails may not be the first thing you notice, but once you've noticed them—you won't stop. Currently there are up to 5 billion snails thriving in Padilla Bay! That's enough to fill 340 school buses!

They range from brown to gray in color, have a spiral-conical shell shape, and are about the size of a pen cap. Their coloring blends in perfectly with the mudflats that cover the entire bay in stinky, sticky mud!

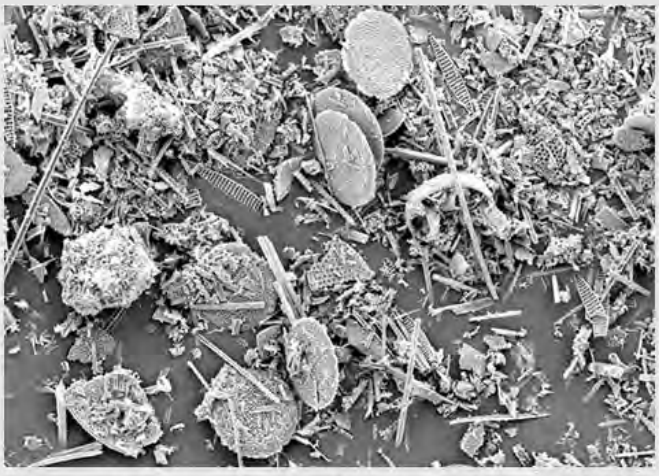


The mud snails are a non-native species brought here in the 1920s from Japan, most likely having hitched a ride with Pacific oysters that were shipped here for farming.

Shellfish harvesters, harvesting Pacific oysters

Although they have been here for almost 100 years, little is known about their impact on Padilla Bay's ecosystem. In order to get a better sense of *Batillaria*'s role in the food web, scientists Roger Fuller and Madi McKay set out to investigate.

An important piece of information we know is that the snails graze on a microscopic algae meadow that grows on the surface of the mud.



Microscopic algae meadow

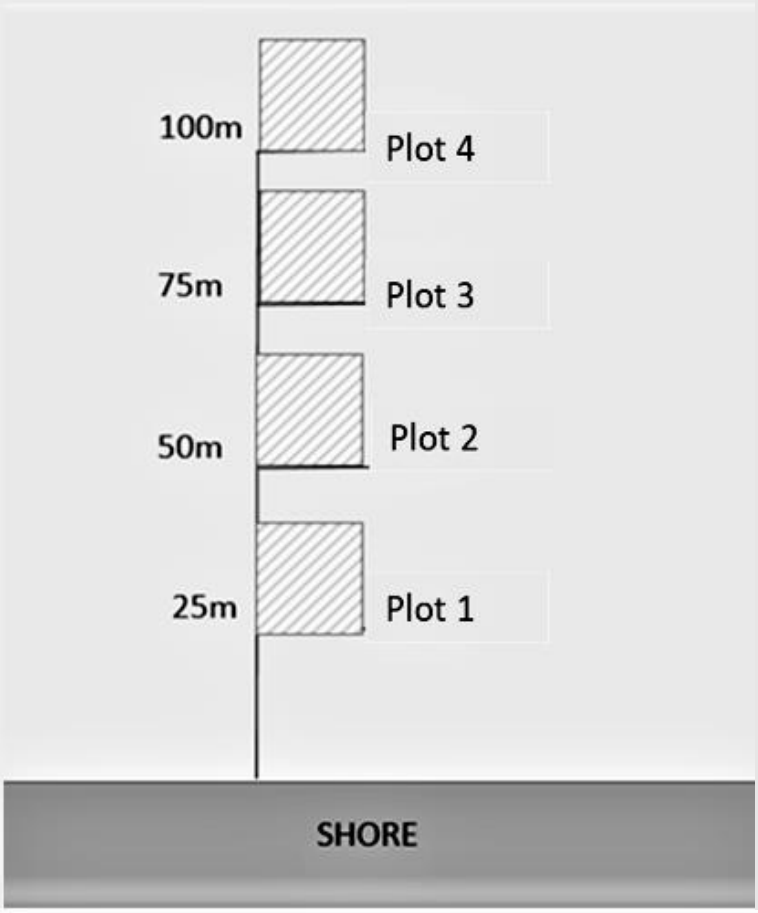
Recently, it was discovered that shore birds, particularly sandpipers, also eat this algae. In fact, up to 50% of their diet consists of these microscopic organisms! The local hairy shore crab also feeds on the algae. This suggest that the snails, sandpipers, and crabs are competing for the same food.

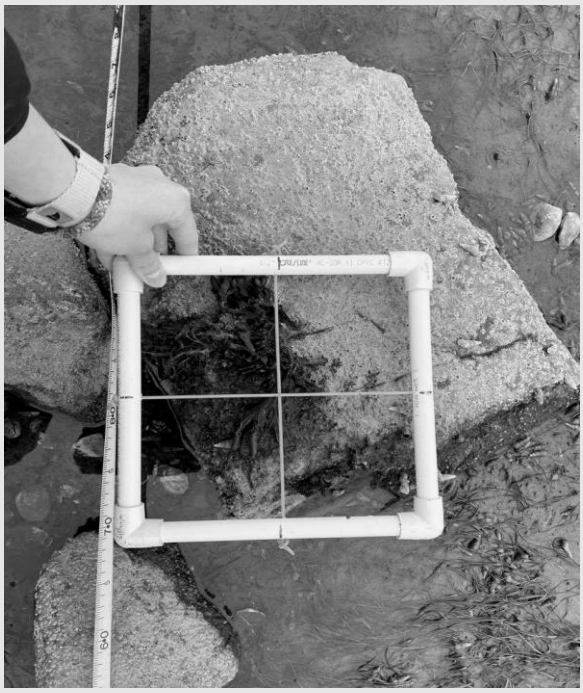
Western sandpiper eating algae with its hairy tongue

Hairy shore crab

This insight led Madi McKay, who has a particular fondness for sandpipers and crabs, to take a closer look at *Batillaria attramentaria* to better understand this food web. Based on her observation she believes the snails found closer to the shore will be larger in size and more abundant than the ones found further from shore.

Hypothesis: Based on her observation she believes there will be more snails closer to shore and those snails will be larger in size than the ones found further from shore.





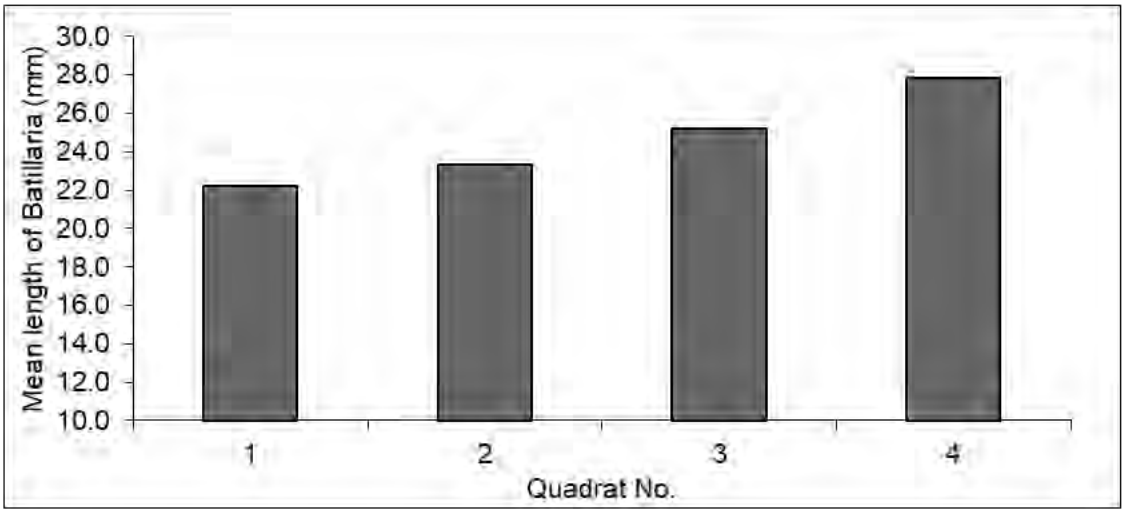
Quadrat used at sampling plots. A quadrat is a portable frame, often with an internal grid. This one is gridded off into four sections.

Experiment: Madi and Roger set up an experiment to measure the population and distribution of *Batillaria* on the mud flats. They start by looking at 4 different plots (sites) at increasing distance from the shore. At each plot they record the number of *Batillaria* found and the length of the snails in each section of a quadrat. Then they calculate the mean number and the mean length of the total quadrat. This is done by adding up the four sections and dividing it by four. Below are the results:

What they found (Scientific Data):

Plot	Mean length of Batillaria (mm)	Number of Batillaria	Distance from shore (meters)
1	22.2	126	25
2	23.2	111	50
3	25.2	120	75
4	27.9	110	100

Below is a graph of the mean length of Batillaria per quadrat (remember 1 is closest to the shore, and 4 is farthest from the shore):



Are there any changes or trends differences you see in this graph? Draw arrows pointing out what you see, and write one sentence describing what you:

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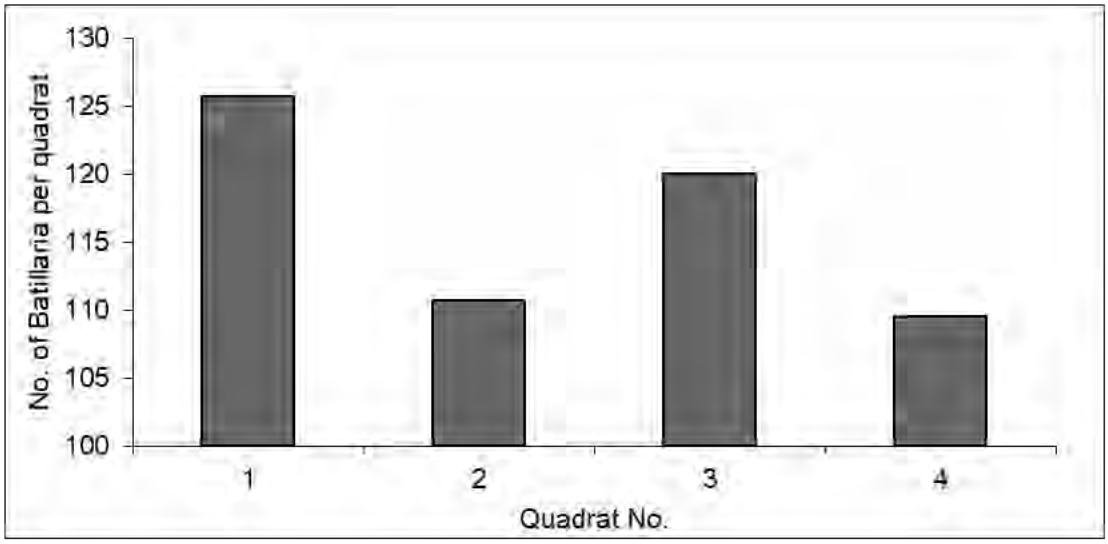
Below is a graph of the number of Batillaria per quadrat (remember 1 is closest to the shore, and 4 is farthest from the shore):



Are there any changes or trends differences you see in this graph? Draw arrows pointing out what you see, and write one sentence describing what you:

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Scientific Questions:

Where along the shore are Batillaria the longest?

_____

_____

Where along the shore are the Batillaria in the greatest concentrations?

_____

_____

Interpret the data:

Did the data support Madi's hypothesis? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why:

_____

_____

_____

Your next steps as a scientist: Science is an ongoing process. What new question do you think should be investigated? What future data should be collected to answer your question?

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This project was made possible by generous and enthusiastic support from:

"This project has been funded wholly or in part by the United States Environmental Protection Agency under Assistance Agreement [CE-01J02301-0]. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use."

ATTACHMENT G

Spring 2020- Padilla Bay Unit for Middle School Students- online

Please make a google copy of all the materials you choose to edit/use: Go to File->make a copy. This includes all of the links, please make a copy of everything.

Also if you choose to use any of these materials please email: aengland@padillabay.gov and let Annie know what you are using and how many students you're sending the materials to. Thanks!

Kids on the Beach

Overview

Kids on the Beach is a hands-on program that has students doing real science and investigating the nearshore marine environment! Over the course of four days you will explore Padilla Bay and the non-native *Batillaria* snail. This program is designed for you to do one 30 min unit a day.

Day 1/Unit 1: Introduction to Padilla Bay's Food Web

Instructions: Watch the video and follow along in your student notebook.

Video: Day 1 Annie.mp4

Student Notebooks (Scientific Journal): Middle School Day 1 Student Notebook

Day 2/Unit 2: Introduction to the *Batillaria* snail

Instructions: Watch the video and try your hand at collecting data!

Video: Day 2 Interview with scientist Roger Fuller.mp4

Worksheet: Middle School Day 2 Practice Collecting Data Worksheet

Day 3/Unit 3: Introduction to the *Batillaria* snail Investigation with Madi McKay

Instructions: Watch the video and fill in the worksheet while you watch!

Video: Day 3 Madi.mp4

Worksheet: Middle School Day 3 Worksheet

Day 4/Unit 4: Investigation Activity

Instructions: Follow Madi and Roger along to investigate the *Batillaria* snail!

Investigation: [Middle School Day 4 Scientific Investigation]

This project was made possible by generous and enthusiastic support from:

Northwest Straits INITIATIVE
partners in marine conservation

Skagit County Marine Resources Committee

Padilla Bay National Estuarine Research Reserve

PUGETSOUND PARTNERSHIP

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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ATTACHMENT H

Spring 2020- Padilla Bay Unit for Middle School Students- offline

Kids on the Beach

Overview

Kids on the Beach is a hands-on program that has students doing real science and investigating the nearshore marine environment! Over the course of four days you will explore the Salish Sea and issues affecting it. This program is designed for you to do one 30 min activity a day.

Contents

Background

What is an Estuary?

An Estuary is a semi-enclosed body of water where salt water from the ocean is diluted by freshwater from the land.

What is a Habitat?

A habitat is the home of an animal or a plant.

What is the Padilla Bay Reserve?

The Padilla Bay Reserve is one of 29 sites in the National Estuarine Research Reserve system established to protect coastal areas for long-term research, monitoring, education, and stewardship. Padilla Bay Reserve is the only Research Reserve in Washington State.

Why is Padilla Bay important?

Padilla Bay is in the heart of the Salish Sea. It has more than 8,000 acres of eelgrass; it's the second largest eelgrass meadow on North America's Pacific Coast.

What is the Salish Sea?

The Salish Sea is an inland sea that encompasses Puget Sound, the San Juan Islands and the waters inside of Vancouver Island, BC. The area spans from Olympia, Washington in the south to the Campbell River, British Columbia in the north.

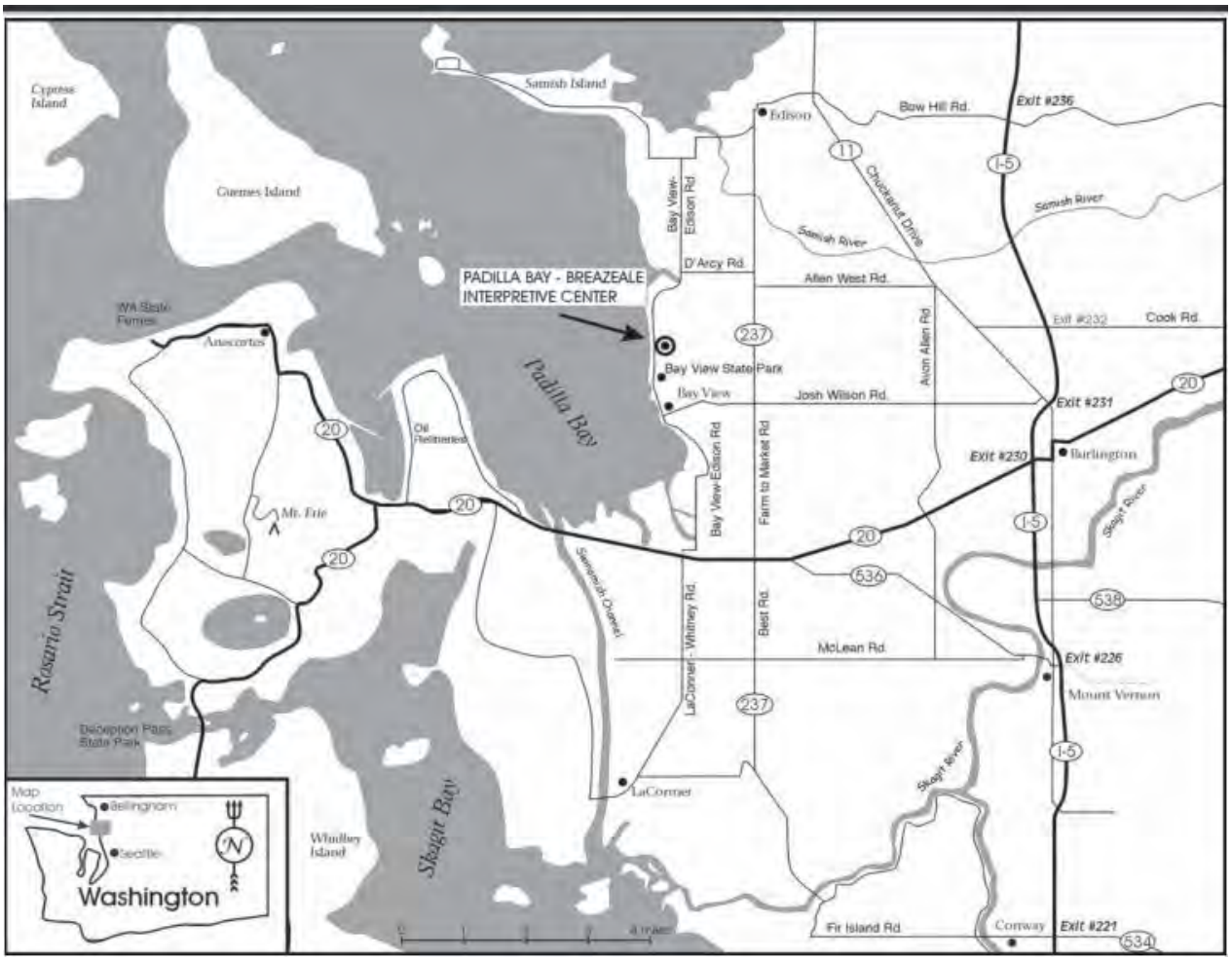
Why is eelgrass important?

Eelgrass is used as a nursery habitat for juvenile salmon, crab, and herring. It also provides critical habitat for waterfowl and marine birds.

Vocab

Estuary: a place where freshwater mixes with salty sea water. All of the Salish Sea is an estuary.
Salish Sea-The Salish Sea is an inland sea that encompasses Puget Sound, the San Juan Islands and the waters off of Vancouver, BC.
Plankton- plants or animals floating in the water, usually microscopic.
Phytoplankton- free-floating plants in water; often microscopic.
Zooplankton- free-floating animals in water; often microscopic.
Diatoms-Diatoms are a single-celled algae which has a cell wall of silica (glass-like structure). Like other algae they photosynthesize.
Microscopic- too small to see without a microscope.
Detritus- dead rotting stuff. The compost of the estuary!
Filter feeder- an animal, such as a clam or oyster that strains food from the water.
Photosynthesis- the process in which plants and some other organisms use sunlight to create food from carbon dioxide and water.
Algae- a type of plant without a true stem, roots or leaves; mostly lives in water.
Food Chain- the transfer of energy (food) from plants to animals, and maybe then to other animals.
Food Web- overlapping and connecting food chains.
Eelgrass- a type of grass that grows in the water.
Copepods- type of zooplankton (microscopic animal), the animal plankton from sponge bob is modeled after.
Watershed- the area of land that drains into a body of water like a river or bay.

Location



The Great Plankton Race

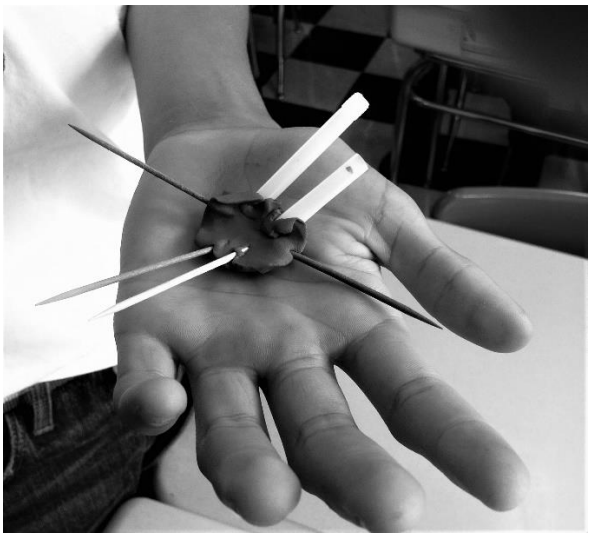
Adapted from the COSEE's "The Great Plankton Race" lesson plan

Background

The word **plankton** is from the Greek word for "wandering". They are organisms that drift or wander the oceans at the mercy of the currents. Plankton can't move against currents. Some planktonic organisms can be large (like jellyfish), but most are small enough that they must be viewed under a microscope. The plankton that photosynthesize are called **phytoplankton**. Plankton that eat other plankton are called **zooplankton**. All Plankton must avoid sinking. Phytoplankton need sunlight for photosynthesis, so they must stay within the **photic zone** (the top 200m of water column). Zooplankton depend on phytoplankton and other zooplankton for food, so they must avoid sinking as well. Plankton avoid sinking by increasing their surface area and/or decreasing their **density**. Flattened bodies, spines, and other body projections slow sinking by adding surface area without increasing density. Some plankton resist sinking by forming chains. The use of low-density substances like oil or fat helps increase **buoyancy** and can serve as food reserves. While plankton are too weak to swim against a current, many do swim vertically each day. Great numbers of zooplankton commute up to the surface at night and back down each day. Migrating plankton can take advantage of more food near the surface at night when predators can't see as well.

Activity

Construct a model plankton using your choice of materials. Using things like corks, tooth picks, paper clips, coins, string, and rubber bands work well. It is a good idea to try lots of different types of materials. Your goal is to produce a creature as close to neutrally buoyant (doesn't sink or float) as possible. Construct your plankton to be roughly the size of a golf ball. Use a bucket, dishpan, soda bottle, or your kitchen sink to test your model. Your plankton should float just below the water's surface but not sink to the bottom.



Check your understanding

1. Why would plankton want to go up in the water column?

_____

_____

2. Why would plankton want to go down in the water column?

_____

_____

3. If plankton cannot swim against the current, how do they move within the water column?

_____

_____

4. Draw a picture of your plankton model.

5. Describe its features. What materials did you use to build your model?

_____

_____

6. Test your plankton in water three times. Record your observations below. If your model sinks, record the time it takes to reach the bottom.

Trial 1: (sec)	**Trial 2: (sec)**	**Trial 3: (sec)**

7. What is the average time to reach the bottom? **((Trail 1)+(Trial 2)+(Trial 3)) / 3 =**

_____

8. Describe how well your plankton performed the test.

_____

_____

_____

9. This race was performed in freshwater. How would the performance of your plankton be different in saltwater? Why?

_____

_____

10. This race was performed in room temperature water. How would the performance of your plankton be different in very cold water?

_____

_____

In very hot water?

_____

_____

Why?

_____

_____

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11. What factors, other than buoyancy, influence the evolution of plankton's external features?

_____

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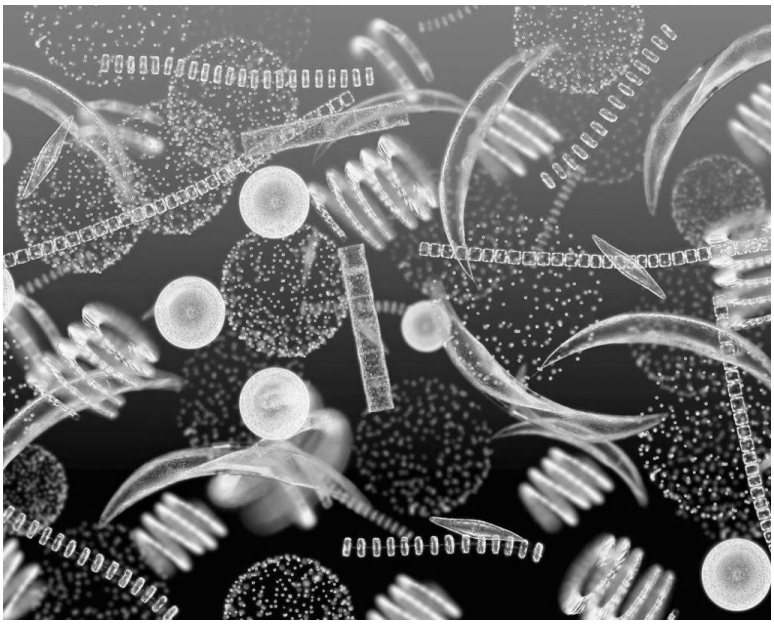
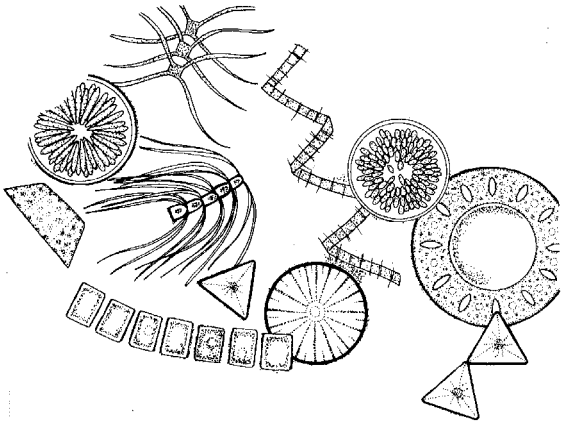
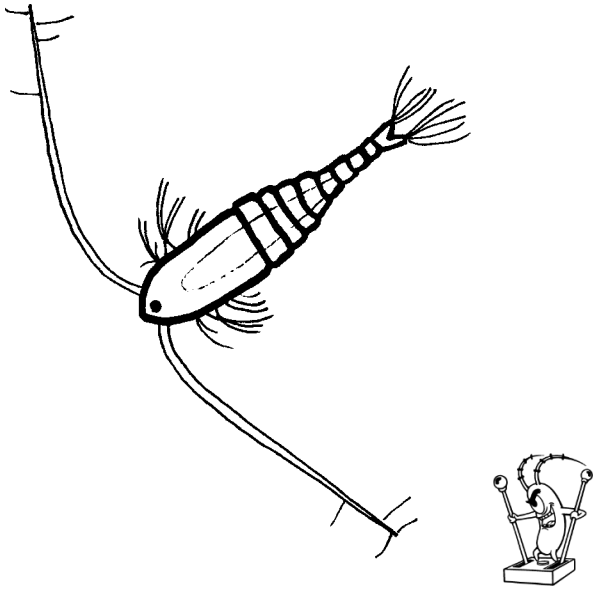
Plankton images

Phytoplankton image and drawing of diatoms (a type of phytoplankton that produces up to 50% of the oxygen on Earth!)





Zooplankton image and a drawing of a copepod (a type of zooplankton fish really like to eat—Plankton from SpongeBob is based off of a copepod)



How to Catch a Fish

Adapted from the Smithsonian's "How to Catch a Fish" lesson plan

Background

Adding or removing any animal from an ecosystem can cause big changes to the entire food web and change how healthy an ecosystem is. When animals are removed more quickly than they can reproduce, the animal can go extinct. Sometimes an animal won't go completely extinct, but will become what scientists call "functionally extinct." This means that there are still some of the animals in the ecosystem, but that there are so few of them that they cannot do their job. If the animal is a predator that eats other animals, when it is functionally extinct, it won't be able to eat enough of the other animals to keep the prey population low. If the animal that goes functionally extinct is a prey species, there won't be enough of them for the predators to eat.

As humans have gotten better at designing fishing equipment, humans have been able to catch more fish in a shorter amount of time. Scientists are worried that this fishing equipment is allowing us to take too many fish out of estuaries and the oceans. One of the big problems with commercial fishing is something called bycatch. Bycatch is anything that you did not mean to catch. In this activity we will look at how bycatch might affect an estuary's food web.

Materials

- Attached readings and chart
- Plankton - Sprinkles or rice
- Baby target fish - Small pasta
- Target fish - Large pasta
- Sharks - Goldfish crackers, small pretzels, or a similar food
- A cup or small bowl and a plate
- A net - strainer, colander, or basket with holes

Instructions

1. What do you know about different types of fishing methods? Write down the methods you can think of. Can you think of benefits of each method? What about drawbacks?

   _____

   _____

   _____

   _____

2. Look at the "Fishing Gear and Technology - Advantages and Disadvantages" page. Are there types of fishing you hadn't heard of before? Choose three fishing methods and fill out the advantages and disadvantages from the perspective of the fisher and from the perspective of the fish. (Look at the chart for an example of how to set yours up.)
3. Read the handout "A Net Loss: The Effects of Bycatch."

4. Fill your cup with a mixture of the different foods.
   a) Sprinkles or rice = Plankton
   b) Small pasta (like macaroni) = juvenile (young) target fish
   c) Larger pasta = adult target fish (these are the ones we want to catch)
   d) Goldfish/Pretzels/etc. = sharks
5. Using a colander, strainer, or something else with holes. as your 'net', dump the contents of your cup into the net. (Do this over the plate or bowl so you don't make a mess!) Shake the net a bit then count and record the number of each species that remain in your net after sifting under Trial 1.
6. Put all your species back in the cup and repeat step 5 for Trial 2 and Trial 3. Did you get the same results?

	Trial 1	Trial 2	Trial 3
Plankton			
Juvenile Fish			
*Target Fish			
Sharks			

*Target Fish are what you want to get!

7. Think about or talk about the following questions:

   a) Did you catch species other than the target fish? If so what?

   _____

   _____

   b) If you had bycatch, how do you think it will affect the ecosystem in the future? Will those species be able to reproduce?

   _____

   _____

   c) If you had sharks as bycatch, how will removing the predator effect the rest of the ecosystem?

   _____

   _____

   d) If you had juvenile (young) fish as bycatch, how will removing these fish before they can reproduce affect the ecosystem?

   _____

   _____

Fill in this chart for three fishing methods:

	FROM THE PERSPECTIVE OF THE FISH		FROM THE PERSPECTIVE OF THE FISHER	
FISHING METHOD	**Advantages**	**Disadvantages**	**Advantages**	**Disadvantages**
Gillnets				
Longlines				
Bottom Trawls				
Midwater Trawls				
Traps (Pots)				
Purse Seines				
Hookas				
Spearguns				
Hook and Line				

Fishing Gear and Technology - Advantages and Disadvantages

Gillnets
Kept at the desired depth by floats or weights, these long nets trap and entangle fish, turtles and marine mammals as the lines move with the current or the boat to which they are attached.

Longlines
These lines with baited hooks are kept at the desired depth by spaced floats (for drift longlines) or held to the bottom with weights (bottom longlines).

Bottom Trawls
Bag-shaped nets are held open at one end by long horizontal beams, or planers, and dragged along the ocean bottom to catch fish and shrimp.

Midwater Trawls
Large bag-shaped nets, open at one end, are towed by a boat to catch fish between the surface and the bottom.

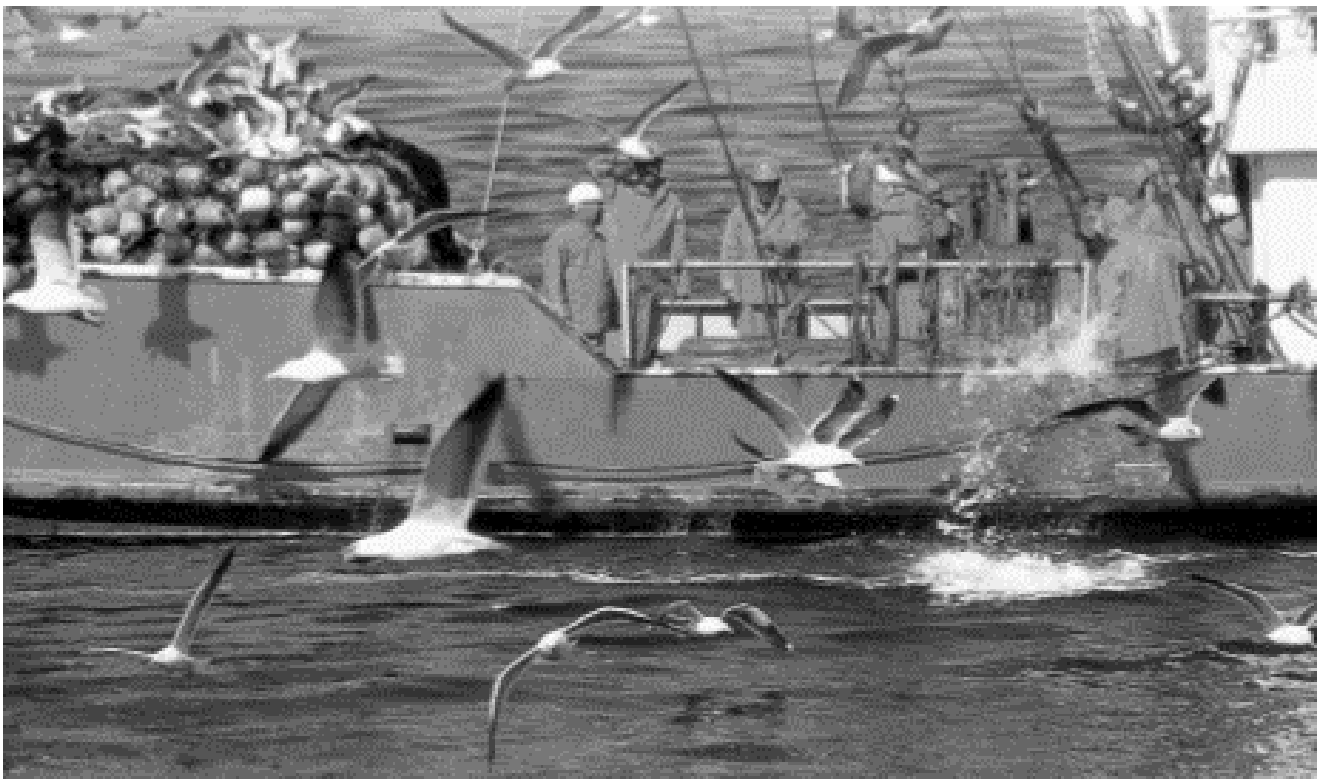
Traps (Pots)
These are cages and baskets made of wood, wicker, metal rods, wire netting or other materials for catching fish and crustaceans that enter through one or more openings. The traps are set at the bottom and connected to ropes attached to buoys on the surface.

Purse Seines
Large nets surround fish and are drawn closed at the bottom, like a purse, preventing fish from diving to escape.

Hookas
Using hoses and compressors, divers use this method to collect such species as lobster and sea cucumbers from the ocean floor.

Spearguns
These are guns whose ammunition is spears rather than bullets. They are used to shoot fish one at a time. Generally, they are used only by recreational fishers and by small-scale artisanal fishers. Spearguns can be used in conjunction with the hooka method.

Hook and Line
This is a fishing rod with one line and one hook.



What is bycatch?
Commercial fishing boats generally intend to target only a few commercially valuable species, but the gear and fishing technologies they use often catch much more than just these specific marine animals. More than 25 percent of all species caught are not used. These unwanted animals are dumped back into the ocean, dead or dying.

What species are affected and how?
As bycatch, marine animals become waste. Marine mammals, including dolphins, whales, seals and sea lions, as well as sharks and sea turtles fall victim when entangled in nets intended for tuna, pollock, cod and other fish. Baited hooks from longlines, splayed out for miles behind boats, attract seabirds, such as albatrosses and petrels, which often get hooked and dragged underwater, where they drown. Shrimp trawling is especially devastating when it comes to bycatch. For every pound of wild shrimp caught, an average of eight pounds of bycatch is discarded. Juveniles of many commercially fished species are routinely caught and discarded as bycatch, destroying their future reproduction potential. Some bycatch species are valuable food sources; nevertheless, if they are not the target species, they become waste. Boats seeking halibut discard cod as bycatch, and boats seeking cod discard halibut.

Shell Shocked

Adapted from the Shape of Life's "Shell Shocked" lesson

Background

Few things in nature are as beautiful and fascinating as seashells, with their graceful spirals, marvelous shapes, and dazzling colors. However, the handsome homes of snails (gastropods) are built at a great cost. Creating a shell requires a huge investment of energy and building materials, so there must be a big payoff for the snail. That payoff, of course, is protection. Snails build their expensive shells not for beauty, but to defend their soft bodies against the sharp claws of hungry crabs and lobsters, and the strong jaws of predatory fish.

Here are some good shell designs and traits for thwarting predators:

- **Thick walls** – stout, heavy armor is the most basic defense, but costly to build
- **Protrusions** – spikes and spines, flanges and fronds: these extensions are an economical way to distance claws and jaws from the central cockpit where the soft animal resides; they also make for an uncomfortable mouthful
- **High Spires** – the shells of most snails are twisted, but some are "flat" coils whereas others spiral out to a tall point like soft-serve ice cream; the latter are harder to swallow and also put some distance between the attacker and the wider part of the shell that houses the snail
- **Narrow Aperture** – the shell's opening is the place most vulnerable to attacks; a slit-like opening is tougher for predators to infiltrate
- **Long Siphonal Canal** – Many snails' possess a siphon, a snorkel that sticks out into the water through a siphonal canal in the shell. They use the siphon to bring water in over their gills and also to taste the water. A long, slender siphonal canal is less vulnerable to entry by predators, and also permits the snail to burrow without suffocating
- **Thickened aperture margins** – the outer rim or "lip" of the aperture is especially vulnerable to the shell breaking grip of attackers; the thicker the better

Study the armor from different species of gastropods in the images. Photos are actual size. Grade each one A, B, C, D, or F (A is good, F is bad) on each of the six defensive traits on the report card:

Species	Shell Size	Shell Thickness	Protrusions	High Spire	Long Canal	Thickened Margins	Narrow Aperture
Japanese Oyster Drill Whelk	Up to 5 cm						
Black Turban	Up to 2.5 cm						
Queen Conch	Up to 30 cm						
Tiger Cowrie	Up to 15 cm						
Lattered Olive	Up to 9 cm						
Common Auger	Up to 4 cm						
Venus Comb Murex	Up to 15 cm						
Oregon Triton	Up to 15 cm						
Silvery Top Shell	Up to 3 cm						
Mud Snail (*Batillaria*)	Up to 5 cm						
Lewis's Moon Snail	Up to 14 cm						
Pinto Abalone	Up to 18 cm						

Shell Thickness:

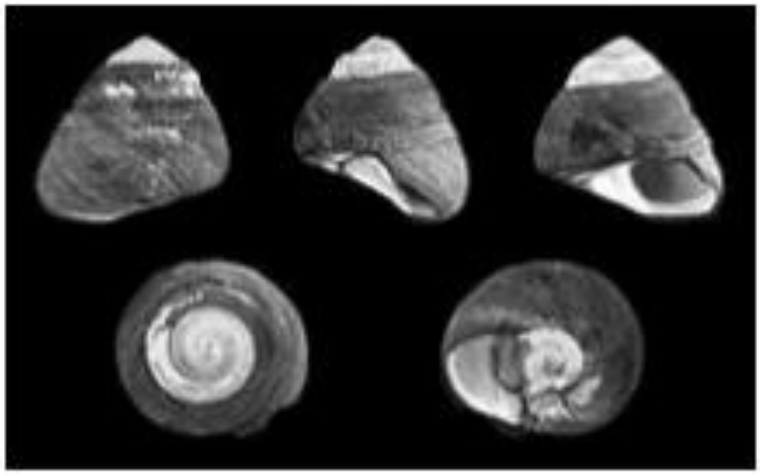
Thin: ———

Medium: ▬▬▬

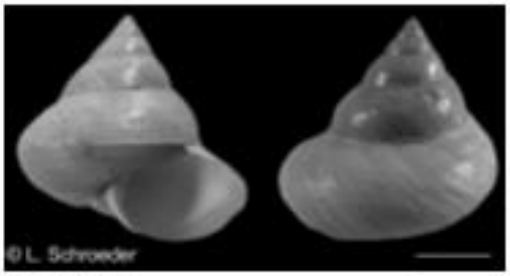
Thick: ▬▬▬▬

Japanese Oyster Drill Whelk –

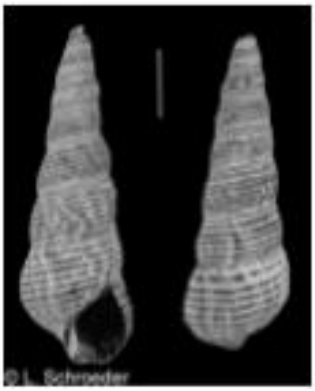
Black Turban -



Silvery Top Shell -

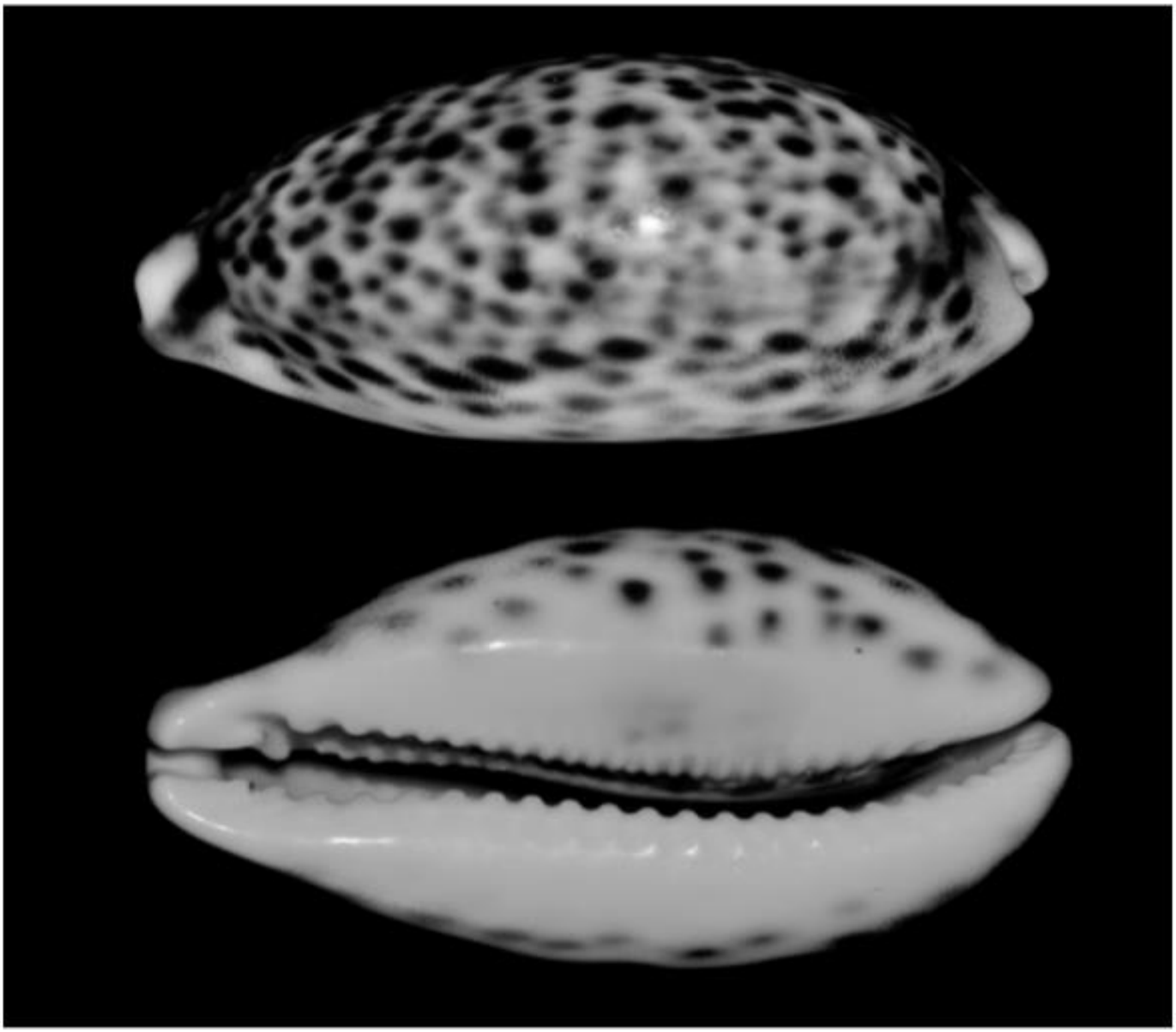


Mud Snail -

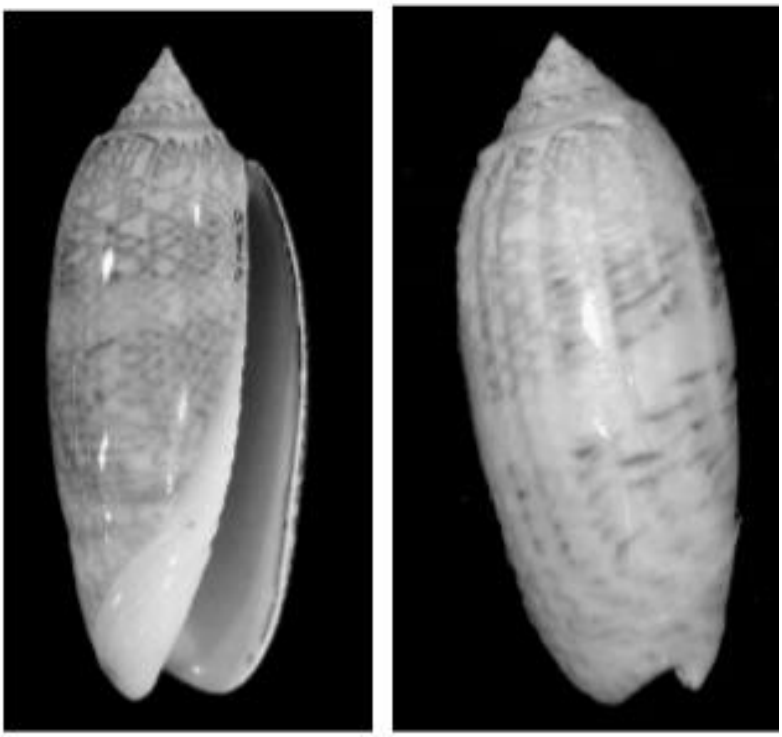


Queen Conch-

Tiger Cowrie-



Lattered Olive -



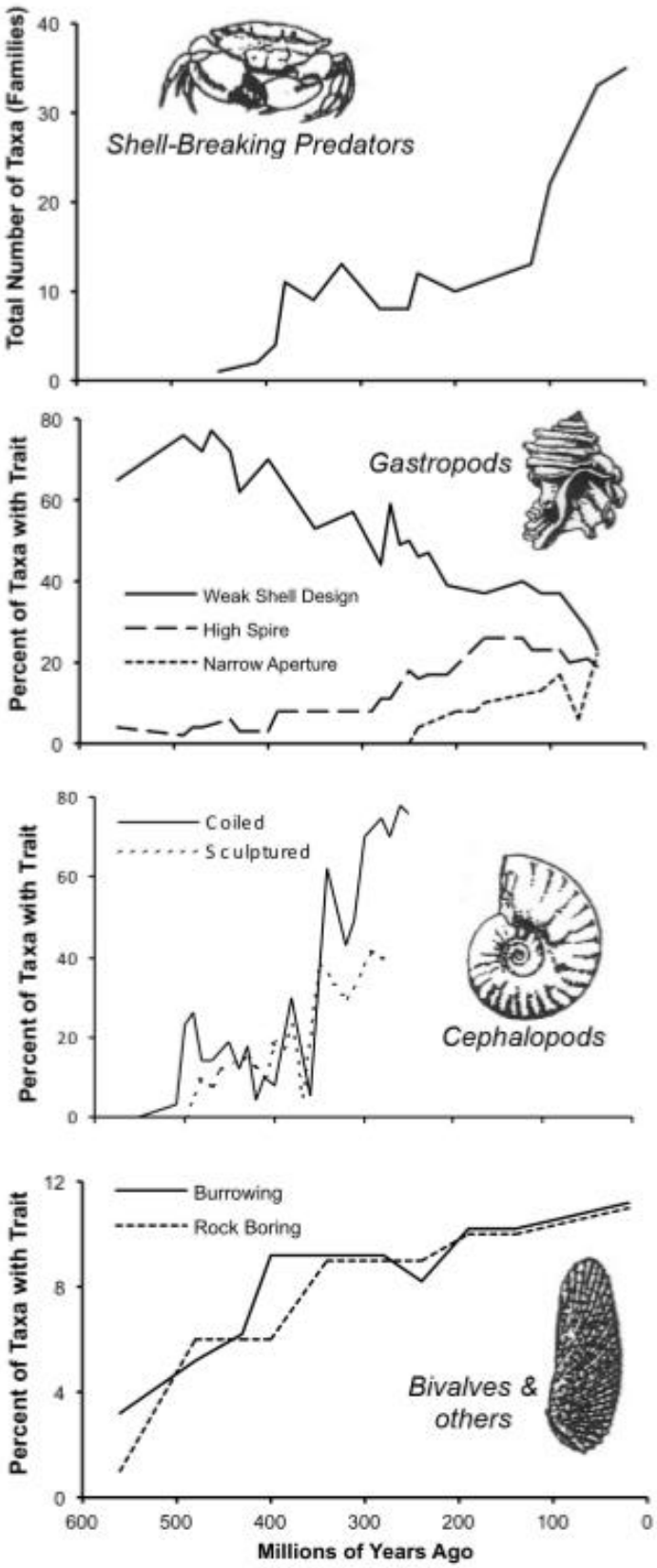
Common Auger -

Venus Comb Murex-

Oregon Triton-

Lewis’s Moon Snail-

Pinto Abalone-


Total Number of Taxa (Families)
40
30
20
10
0
Shell-Breaking Predators
Percent of Taxa with Trait
80
60
40
20
0
Gastropods
Weak Shell Design
High Spire
Narrow Aperture
Percent of Taxa with Trait
80
60
40
20
0
Coiled
Sculptured
Cephalopods
Percent of Taxa with Trait
12
8
4
0
Burrowing
Rock Boring
Bivalves & others
600
500
400
300
200
100
0
Millions of Years Ago

One nice thing about seashells is that they preserve well as fossils. So do the hard claws, jaws, and teeth of shell-breaking predators. Geerat Vermeij (say "ver-MAY") is probably the paleontologist who has done the most careful surveys of fossilized seashells. His renowned studies are especially remarkable because he's been blind since birth. He collected all his data (tons of it) by studying the fossils with his hands! The graphs on page 3 show data from Vermeij's research. All four graphs share the same x-axis at the very bottom: Vermeij studied fossils spanning over 500 million years! Analyze the graphs carefully and answer the following questions. The first graph (Shell-breaking Predators) shows the number of fossilized predators that had claws or jaws powerful enough to break seashells.

How long ago did predators first develop shell-breaking traits? Since then, what has happened to the frequency of these traits in the fossil record?

_____

_____

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The next three graphs (Gastropods, Cephalopods, and Bivalves) show three different groups of soft-bodied, shell-making animals. Gastropods were snails that crept on the seafloor. Cephalopods were swimmers: By collecting gas inside their shells, they could float above the seafloor and swim! Bivalves have two hinged shells that open and close like a jewelry box. Modern bivalves include clams and oysters.

Over the past 500 million years, what gradually happened to the design of gastropod shells?

_____

_____

_____

_____

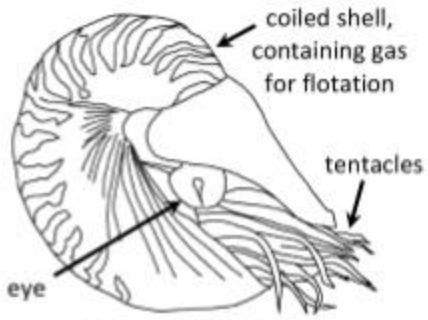
A coiled shell gives a soft animal a bigger space to retreat into. "Sculptured" shells have ribs and ridges that reinforce the shell, or bumps and spines that make it hard to swallow. For cephalopods, what pattern do we see in the fossil record?

_____

_____

_____

_____



Chambered Nautilus, a modern cephalopod

(NOTE: On the graph it looks like cephalopods suddenly went extinct 250 million years ago. This graph represents a group that went extinct 250 million years. Other groups continued. The ancestors of the squid and octopi won the day by evolving into the modern day animals. An exception is the living chambered nautilus, which has a squid-like body with eyes and arms, yet has kept its coiled shell and sluggish lifestyle.) Some modern bivalves – like clams – burrow into the seafloor. Others – like oysters – do not. Over the past 500 million years, what trend do we see in such behaviors?

_____

_____

What do you think prompted all these changes in the bodies and behaviors of gastropods, cephalopods, and bivalves over the past 500 million years? Back up your hypothesis with evidence from the four graphs.

_____

_____

_____

_____

_____

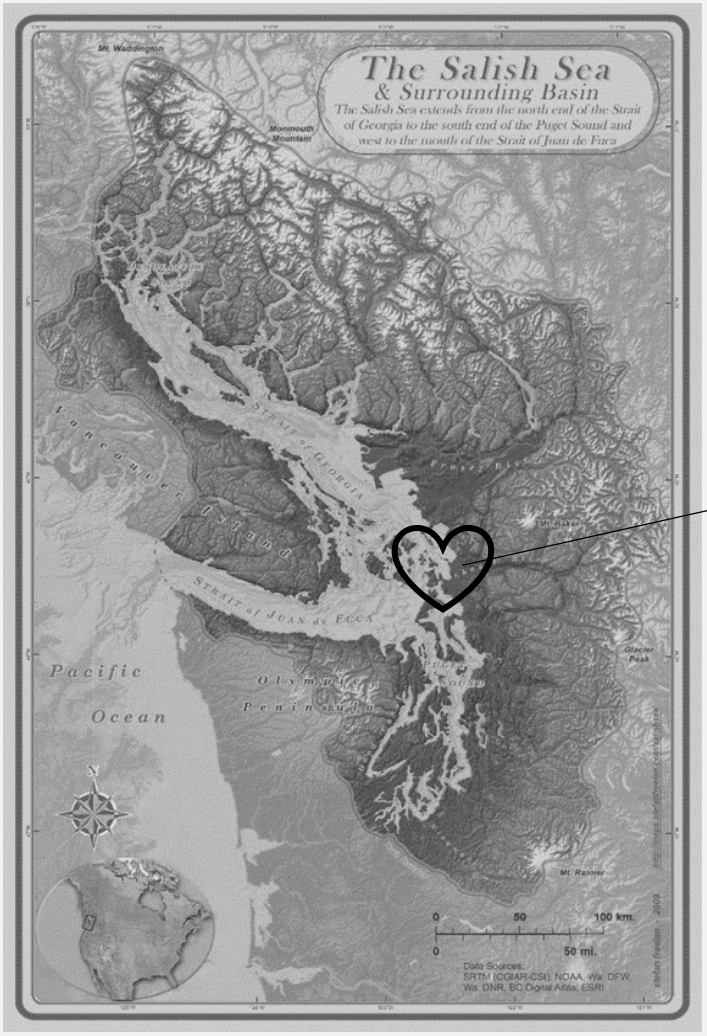
Hot on the trail of the *Batillaria* mud snail!

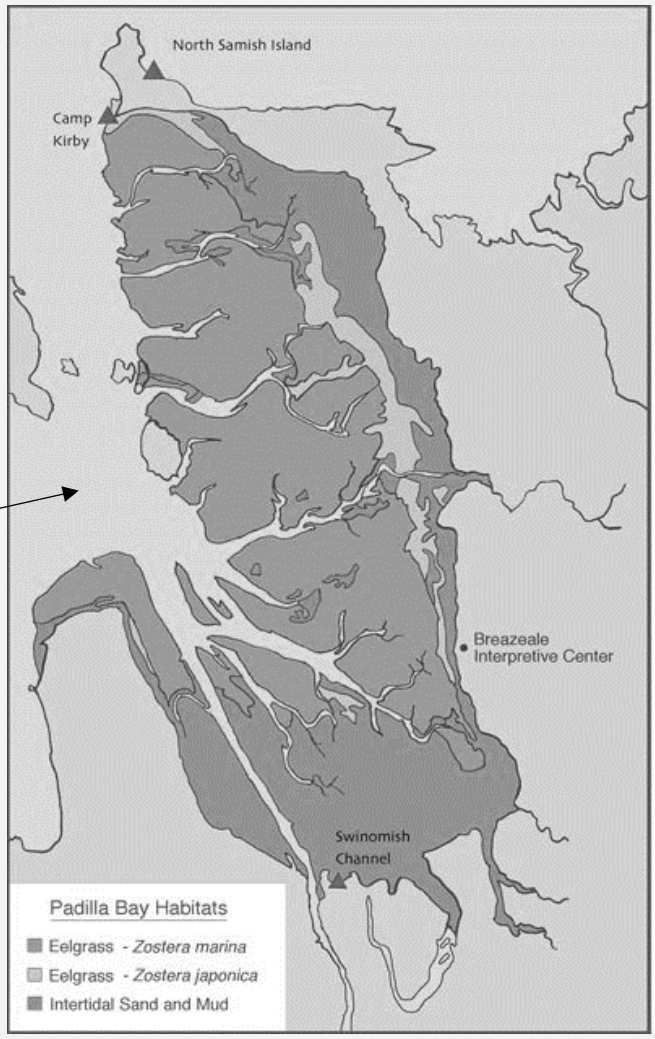
Featured scientists: Madison McKay and Roger Fuller *Padilla Bay National Estuarine Research Reserve*

Where can we find *Batillaria* mud snails?

Padilla Bay is located in the heart of the Salish Sea, and it holds more than 8,000 acres of eelgrass—the second largest on North America's Pacific Coast. Eelgrass is used as a nursery by juvenile salmon, crab, and herring. It also provides critical habitat for waterfowl and marine birds.

When traveling to Padilla Bay the mud snails may not be the first thing you notice, but once you've noticed them—you won't stop. Currently there up to 5 billion snails in Padilla Bay!





Scientific name: *Batillaria attramentaria*

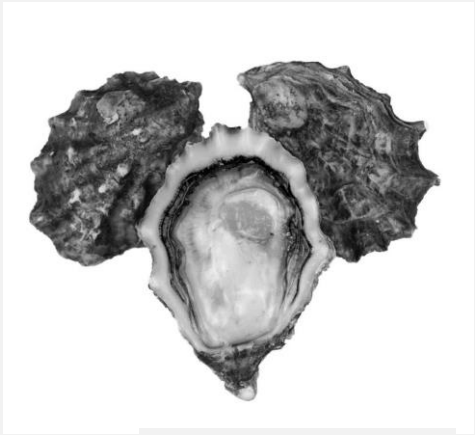
What do they look like?

They range from brown to gray in color, have a spiral-conical shell shape, and are about the size of a pen cap. Their coloring blends in perfectly with the mudflats that cover the entire bay in stinky, sticky mud!

Where did they come from?

The mud snails are an invasive species brought here in the 1920s from Japan, most likely having hitched a ride with Pacific oysters that were shipped here for farming.

Although they have been here for almost 100 years, little is known about their impact on Padilla Bay's ecosystem. In order to get a better sense of *Batillaria*'s ecological role, scientists Madi McKay and Roger Fuller set out to investigate.



Pacific oyster

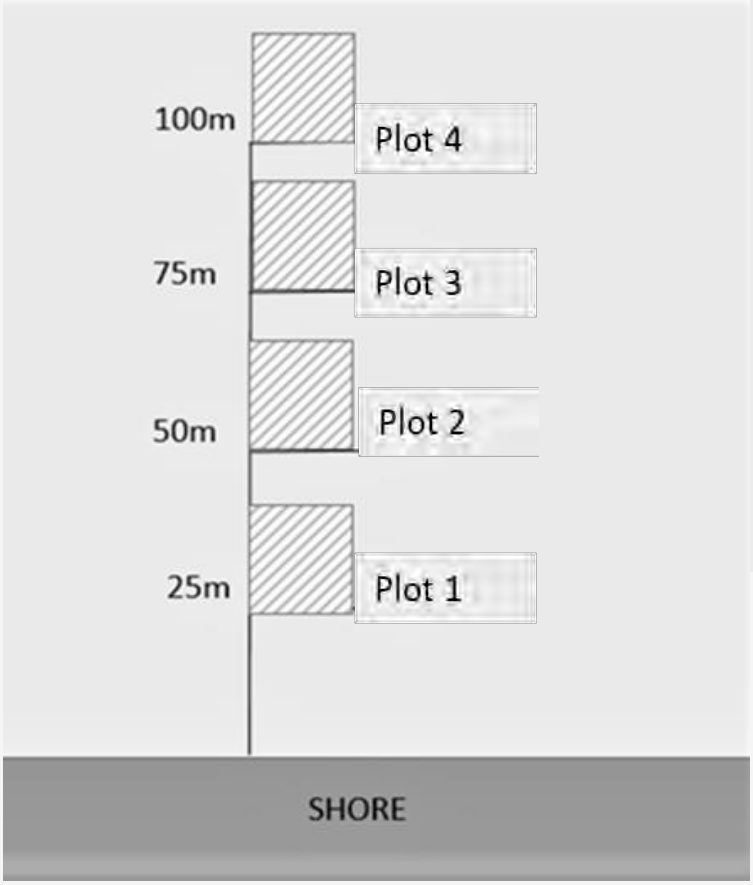
Top: Western sandpiper eating algae

Bottom: Hairy shore crab

What do we know?

An important piece of information we know is that the snails graze on diatom (a microscopic algae) meadows that grow on the surface of the mud. Recently, it was discovered that shore birds, particularly sandpipers, also eat diatoms. In fact, up to 50% of their diet consists of these microscopic organisms! The local hairy shore crab also feeds on the algae. This suggest that the snails, sandpipers, and crabs are competing for the same food.

This insight led Madi McKay, who has a particular fondness for sandpipers and crabs, to take a closer look at *Batillaria attramentaria* to better understand this food web. Based on her observation she believes the snails found closer to the shore will be larger in size and more abundant than the ones found further from shore.



Left: Model of sampling plots.

Right, Above: Quadrat used at sampling plots. A quadrat is a portable frame, often with an internal grid. This one is gridded off into four sections.

Experimental design:

Madi and Roger set up an experiment to measure the population and distribution of *Batillaria* on the mud flats. They start by looking at 4 different plots (sites) at increasing distance from the shore. At each plot they record the number of *Batillaria* found and the length of the snails in each section of a quadrat. Then they calculate the mean number and the mean length of the total quadrat. This is done by adding up the four sections and dividing it by four. Below are the results:

Plot	Mean length of Batillaria (mm)	Number of Batillaria	Distance from shore (meters)
1	22.2	126	25
2	23.2	111	50
3	25.2	120	75
4	27.9	110	100

Scientific Question: Where along the shore are Batillaria the longest, where is it in the greatest concentrations?

What is the hypothesis: Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can be tested with experimentation or other types of studies.

Hypothesis:

_____

_____

_____

_____


What data will you graph to answer the question?
Independent variable:

_____

_____

_____

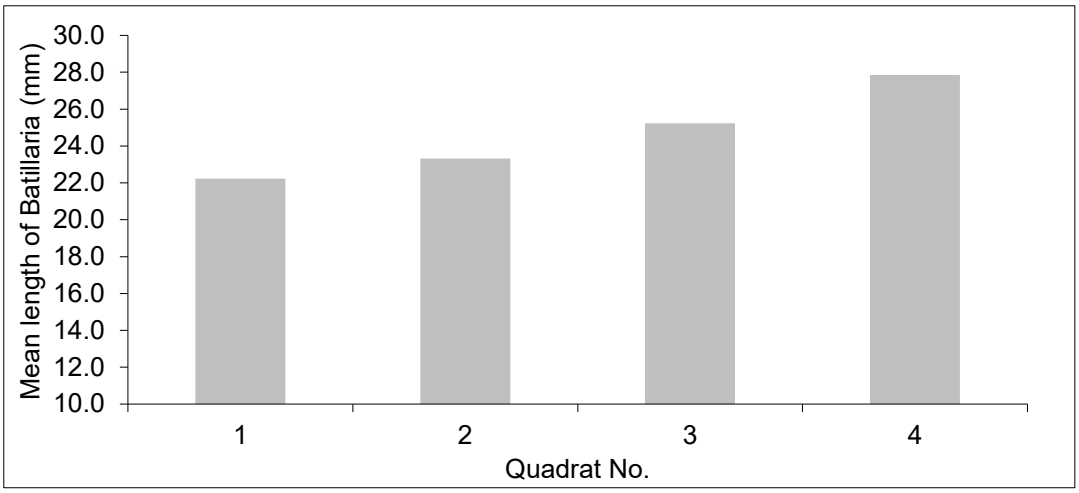
Dependent variable:

_____

_____

_____

Below is a graph of the mean length of Batillaria per quadrat (remember 1 is closest to the shore, and 4 is farthest from the shore):



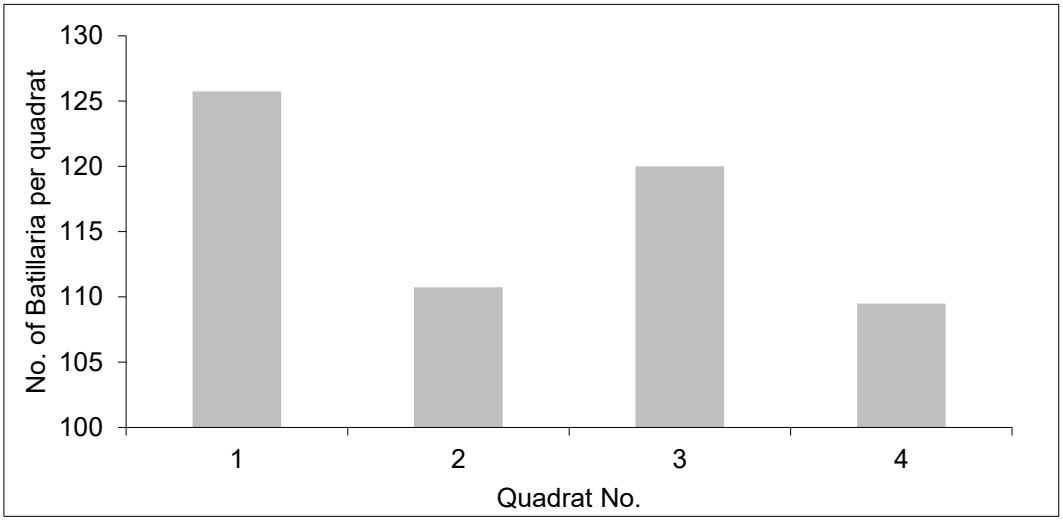
Are there any changes or trends differences you see in this graph? Draw arrows pointing out what you see, and write one sentence describing what you:

_____

_____

_____

Below is a graph of the number of Batillaria per quadrat (remember 1 is closest to the shore, and 4 is farthest from the shore):



Are there any changes or trends differences you see in this graph? Draw arrows pointing out what you see, and write one sentence describing what you:

_____

_____

Interpret the data:

Make a conclusion that answers the scientific question.

_____

_____

_____

_____

What evidence was used to write your claim? Reference specific parts of the table or graph.

_____

_____

_____

_____

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how the distance from the shore may affect the number and size of the snails.

_____

_____

_____

_____

Did the data support Madi's hypothesis? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why.

_____

_____

_____

_____

Your next steps as a scientist: Science is an ongoing process. What new question do you think should be investigated? What future data should be collected to answer your question?

This project was made possible by generous and enthusiastic support from:

"This project has been funded wholly or in part by the United States Environmental Protection Agency under Assistance Agreement [CE-01J02301-0]. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use."

ATTACHMENT I

Skagit Valley Herald Article

https://www.goskagit.com/news/education-focus-marine-science-education-program-undergoes-changes/article_f2231b70-3a99-59d3-b542-32a885af5576.html

Education Focus: Marine science education program undergoes changes

By KIMBERLY CAUVEL @Kimberly_SVH
Jun 1, 2020

Nonnative mudsnails are seen last September during a survey at Padilla Bay near Bay View.

Charles Biles / Skagit Valley Herald

This spring, about 150 Skagit County students were expected to descend onto the mudflats of Padilla Bay to help document the presence of the spiral-shelled snail that dots the beach at low tide through the Kids on the Beach Program.

With students sent home in March for their safety amid the COVID-19 pandemic, that didn't happen.

"I was really looking forward to having my students have the experience of collecting field data, learning and working with scientists ... on the beach," said Concrete science teacher Sacha Buller, whose class planned to participate for the first time. "I have students who are fascinated with marine biology from watching nature documentaries on Netflix, but have only been to the beach a few times in their lives."

While the pandemic took beach trips off the table, about 300 students from the region are studying the nonnative snail using new remote-friendly curriculum developed by the Padilla Bay National Estuarine Research Reserve's education specialist Annie England.

Students from Everett, Friday Harbor and Mukilteo are now participating, though England said the majority — about 230 — are fifth through eighth graders from Concrete, La Conner and Sedro-Woolley.

Buller said she was excited to offer a science-focused field trip this spring to help keep students in her seventh and eighth grade class focused on their studies. Using Google Classroom to connect her students with the Kids on the Beach program content has been a welcome backup plan.

"It is very hard to get our students engaged, especially as we near the end of the school year," Buller said. "I've been lucky in having fantastic environmental educators supporting my distance learning in my environmental science class."

England, with the help of lead batillaria researcher Roger Fuller and others at the reserve, developed digital and print versions of the Kids on the Beach curriculum for at-home study, to ensure students without internet capability could still participate.

That curriculum had to come together fast after schools — and Padilla Bay National Estuarine Research Reserve facilities — closed in mid-March, not long before field trips were set to begin in April.

“There’s no way we’re going to be able to bring kids onto the beach in person. We’re going to adjust and adapt,” reserve Research Coordinator Jude Apple said during an April 9 Skagit Marine Resources Committee meeting, when the team was grappling with how to keep the program alive.

A month later, the program was nearly ready for student use.

“That’s really great to see how you have pivoted … well done,” Northwest Straits Commission Marine Program Manager Dana Oster said after a presentation by England during a May 7 Skagit Marine Resources Committee meeting.

The curriculum explains the Padilla Bay food web and how the nonnative mudsnails fit into it.

It also relates the science to the students’ lives. Fun fact: The millions of mudsnails living in the bay could fill 340 school buses, according to the curriculum.

The Kids on the Beach program is sponsored by the Skagit Marine Resources Committee, Northwest Straits Commission and Shell Puget Sound Refinery. The program has been growing and transforming since its start, as a study of forage fish on a Fidalgo Bay beach, during the 2017-2018 school year.

This is the first year the program was hosted by the Padilla Bay reserve with a focus on the nonnative snail species.

Students and volunteers look forward to the field excursions, usually the focus of the program.

“It has been a challenge due to COVID-19. A lot of the intentions, a lot of time planning for volunteers of course has had to shift,” said Pete Haase, Skagit Marine Resources Committee volunteer and founder of the Kids on the Beach Program. “We have a lot of disappointed volunteers, but schools are thankful for the opportunity.”

— Reporter Kimberly Cauvel: 360-416-2199, kcauvel@skagitpublishing.com, Twitter: @Kimberly_SVH, Facebook.com/bykimberlycauvel

Kids on the Beach program expands

By KIMBERLY CAUVEL @Kimberly_SVH May 27, 2020

Researchers take new look at longtime non-native snails in Padilla Bay
By KIMBERLY CAUVEL @Kimberly_SVH May 27, 2020

KIMBERLY CAUVEL