OCEAN NETWORKS CANADA

Ocean Sense
Program

Lesson

Module:
Loxiwey

Time:
45 minutes

Learning pillars:
- Indigenous knowledge
- Ocean science
- Data exploration

Grade & curriculum connection:
- **BC Science 5**
  "First Peoples concepts of interconnections in the environment."

Created in partnership with:

A-Tlegay Fisheries Society

Local knowledge holders of the Discovery Passage area.

A UNIVERSITY OF VICTORIA INITIATIVE

Model a Clam Garden

Using simple materials, students will model how clam gardens modify the slope of the beach, forming a deeper, sandy sediment that is ideal clam habitat.

Clam garden rock walls were and are constructed at particular heights in correlation with the local **tides**. Clam gardens expand the specific type of beach area where clams, or **gawiḵanam** in the Kwakwala language, are most productive. The rock wall helps to hold the smaller rocks and sediments that are the supporting habitat for clams. Each clam garden varies in size and structure, designed to suit its local ecosystem.

Learning objectives

Students have the opportunity to:

- Explore how clam gardens change the shape of the coast
- Demonstrate an understanding of ecosystems
- Explore the concept of tides using authentic data

Materials

- 1 small plastic container/group (~30 cm x 15 cm x 5 cm recommended)
- 1 heavy plastic or foam sheet/group, sized so it creates a slope inside the small containers with one end sticking out
- Stones, roughly ~2-3 cm diameter
- Sand, enough to fill up to ~2.5 cm depth inside each groups' container (pet or lizard gravel recommended)
- Plasticine, enough for ~3 cm diameter ball/group
- Slide deck: **Loxiwey (Clam Gardens)**
- Worksheet: *Exploring the Tides*

Teacher preparation

- Cut the plastic/foam to fit into the containers; the piece should be sized so it can touch one side and slope to the bottom of the container
- Distribute the building materials into small bundles to make it easier for students to access
- Preload the **Ocean Sense Dashboard: Loxiwey (Clam Gardens)**
- Preload slide deck, **Loxiwey (Clam Gardens)**

Classroom instructions

Hook

1. Explore tides and the tidal zones through discussion of students' personal experiences. Some example discussion starters may be as follows:
    a. Besides salty and fresh water, how are oceans and lakes different?
    b. Have you ever visited a beach at different times and noticed that sometimes there is a lot of beach and sometimes there is not?
    c. Have you ever looked up a tide chart online, perhaps at **Government of Canada: Tides, currents, and water levels**? Why was that important to do?
    d. Share a story of your connection with tides.

* For students who have not visited the ocean, explore the concept of tides using resources available online.

Step-by-step process

2. Explain that Indigenous communities have had in-depth knowledge about tides since time immemorial. Share slide 17 that highlights the connection between loxiwey and tides and slide 18 that highlights construction problem-solving.
3. Divide students into small groups of 3-4 students. Explain that their task is to use the materials to simulate a beach sloping down to the water's edge: the "beach" is created by the heavy plastic/foam sheet and the "ocean" is the area on the bottom of the container.
4. Share slide 19, Step 1. Explain that the plasticine will be used to hold the bottom of the "beach's" slope in place.
    a. Ask the students to roll a plasticine log and place it across in the middle of the container's bottom (figure 1).
5. Share slide 19, Step 2. Explain that the heavy plastic/foam sheet represents the "beach" and it slopes to the "ocean".
    a. Ask the students to place the heavy plastic/foam sheet so that one end sticks to the plasticine and the other end sticks outside the container (figure 2).
6. Ask the students to confirm the direction of the "ocean" and the "beach" in the container models.
    a. The beach is the sloped area and the ocean is the remainder of the container.
    b. Explain that this model does not use water because wet materials make it difficult to observe the difference between an unmodified natural beach and a modified loxiwey. A gentle back and forth motion is going to simulate the movement of ocean water on the beach.
7. Share slide 20, Step 3. Explain that they are going to first model an unmodified, or natural, beach.
    a. Ask the students to add the sand and stones to the "beach" and "ocean", placing the stones at random places on top of the sand (figure 3).
    b. Some sand may slip behind the heavy plastic/foam sheet, which is fine.
8. Share slide 20, Step 4. Ask the students to observe what happens when they gently shake the container in the direction that the ocean water would lap up on the shore.
    a. Confirm that they notice the sand and stones moving off the heavy plastic/foam sheet "beach". This models how sand and stones can be washed down the slope of the beach by ocean water (figure 4).
9. Share slide 21, Step 5. Explain that you are going to use the stones to modify the beach and model a loxiwey.
    a. Ask the students to make a wall with the stones at the bottom of the heavy plastic/foam sheet where the "ocean" meets the "beach" inside the container (figure 4).

Step-by-step process cont'd

b. Ask the students to move some sand behind the stone wall so there is sand on the "beach".

10. Share slide 21, Step 6. Ask the students to observe what happens when they gently shake the container in the direction that the ocean water would lap up on the shore.
    a. Confirm that they notice the stones holding some of the sand on the heavy plastic/foam sheet "beach". This models how the stone wall collects and holds sandy **sediment**, creating an ideal habitat for clams.
11. Discuss the beach modification infographic on slide 22 (figure 5), asking students to explain why they think clam gardens are constructed along the low tide water line. Some points may be:
    a. When the tide goes from low to high, the action of the water lapping on the beach moves sand that gets trapped by the rock wall.
    b. The wall changes the slope of the beach and increases the sandy sediment that is ideal clam habitat.
12. Share slide 23 that shows underwater video from Ocean Networks Canada's observatory in Campbell River. In a manner that works best for the students, define an **ebb** (outgoing) and **flood** (incoming) tide.
13. Share slide 24 that highlights the **CTD** instrument on the Campbell River **Community observatory**. A CTD measures Conductivity (salinity), Temperature, and Depth (pressure). Explain that the observatory sits on the ocean floor and collects continuous data about the ocean.
14. Share slide 25 that shows the location of the Campbell River observatory off the Discovery Pier, a screenshot of the data captured, and a video (1:07 min) of lingcod captured by the underwater camera.
15. Share slide 26 that highlights how depth is actually calculated by a measurement of pressure. Connect pressure measurements to tides as follows:
    a. In an **ebb tide**, the tide is going out, water levels decrease above the observatory, and therefore the pressure drops.
    b. In a **flood tide**, the tide is coming in, water levels increase above the observatory, and therefore the pressure increases.
16. Share slide 27 that connects how the CTD data relates to the video data showing ebb and flood tides.
17. Complete the worksheet, *Exploring the tides*.
    a. Consider pre-teaching the worksheet section *Reading a tide table* as a whole class.
18. Use the *Ocean Sense Dashboard: Loxiwey (Clam Gardens)*, found at **Ocean Sense Dashboard: Loxiwey (Clam Gardens)** to consult if the tide around the Campbell River observatory is currently in ebb or flood.
19. Encourage discussion with the questions listed on slide 28.

figure 1

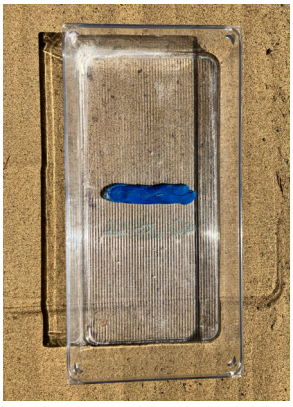


figure 2

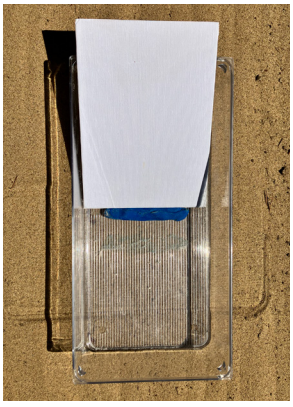
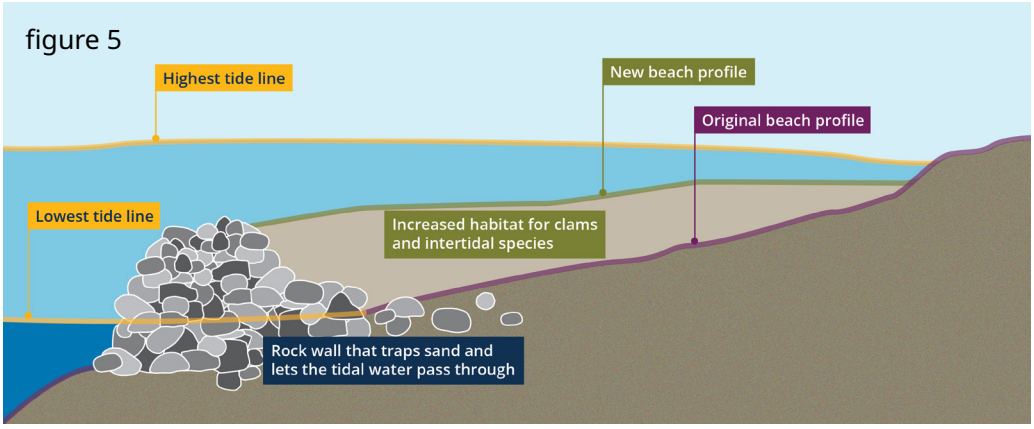


figure 3

figure 4

figure 5



Final remarks to the educator

The rock wall of a clam garden transforms naturally sloping beaches or rocky shorelines into productive, level terrace-like beaches. If a beach hasn't been actively harvested and maintained, clams are found two or three inches below a hard layer of sediment, instead of near the surface when a beach is actively maintained. Homalco First Nation Knowledge Holder Chief Darren Blaney stated, "the regular harvesting of clams in a particular area encouraged greater productivity by reducing overcrowding and maintaining the amount of suitable habitat." Among the Kwakwaka'wakw, the ownership and maintenance of clam gardens was the express responsibility of high-ranking trained individuals (Deur et al., 2015). Throughout coastal communities, knowledge about clam harvesting, clam gardens, and the proper way to interact with clams was codified in songs, dances, and oral traditions (Lepofsky et al., 2015).

Assessment

- How do clam gardens change the beach? What impact on clam productivity does this have?

Extensions

- Consider how sea level change due to climate change affects established clam gardens.
- Consider threats to clam gardens, both physical and societal.
- Discuss the concept of managing natural resources and find other examples of this.

Glossary

Community observatory: A suite of oceanographic instruments custom-designed with community partners for year-round continuous monitoring of local ocean environments. ONC works with community partners to custom-design each observatory to meet local needs.

CTD instrument: A scientific instrument that measures conductivity (salinity), temperature, and depth (pressure) in water.

Ebb tide: An outgoing tide, when ocean water levels drop on the beach, which results in a low tide.

Flood tide: An incoming tide, when ocean water levels rise on the beach, which results in a high tide.

Gawiḵanaḿ: Clams in the Kwak̓wala language.

Habitat: The place where a living organism has everything it needs to survive, including food, shelter, water, and space.

High tide: When the ocean water levels are high up the beach.

Intertidal zone: The area of the marine beach between high and low tides.

Low tide: When the ocean water levels are low down the beach.

Sediment: Matter composed of many small particles that covers the seafloor; particles can include sand, stones, shell fragments, and bits of decomposing plants and animals.

Tides: The rise and fall of the ocean, usually twice a day at a particular location, resulting from the gravitational pull of the moon.

References

Blaney, D. Homalco Nation. Homalco Treaty. Oral teaching. personal communication. 2018.

Deur, D., Dick, A., Recalma-Clutesi, K., & Turner, N. (2015). Kwakwaka'wakw "clam gardens": Motive and agency in traditional Northwest coast mariculture. *Human Ecology*, 43(2), 201–212. doi:10.1007/s10745-015-9743-3

Groesbeck, A. S., Rowell, K., Lepofsky, D., & Salomon, A. K. (2014). Ancient clam gardens increased shellfish production: Adaptive strategies from the past can inform food security today. *PLoS ONE*, 9(3). doi:10.1371/journal.pone.0091235

Hunt, L. (2000-2024). gawi̱ka̱na̱m.MP3 [clam] [Audio recording]. In *Kwak̓wala*. FirstVoices. https://www.firstvoices.com/kwakwala/words/87cdc78f-adb7-47aa-8fe7-ca128cdaa519

Lepofsky, D., Smith, N., Cardinal, N., & Harper, J. (2015). Ancient shellfish mariculture on the Northwest Coast of North America. *American Antiquity*, 80(2), 237-259. doi:10.7183/0002-7316.80.2.236

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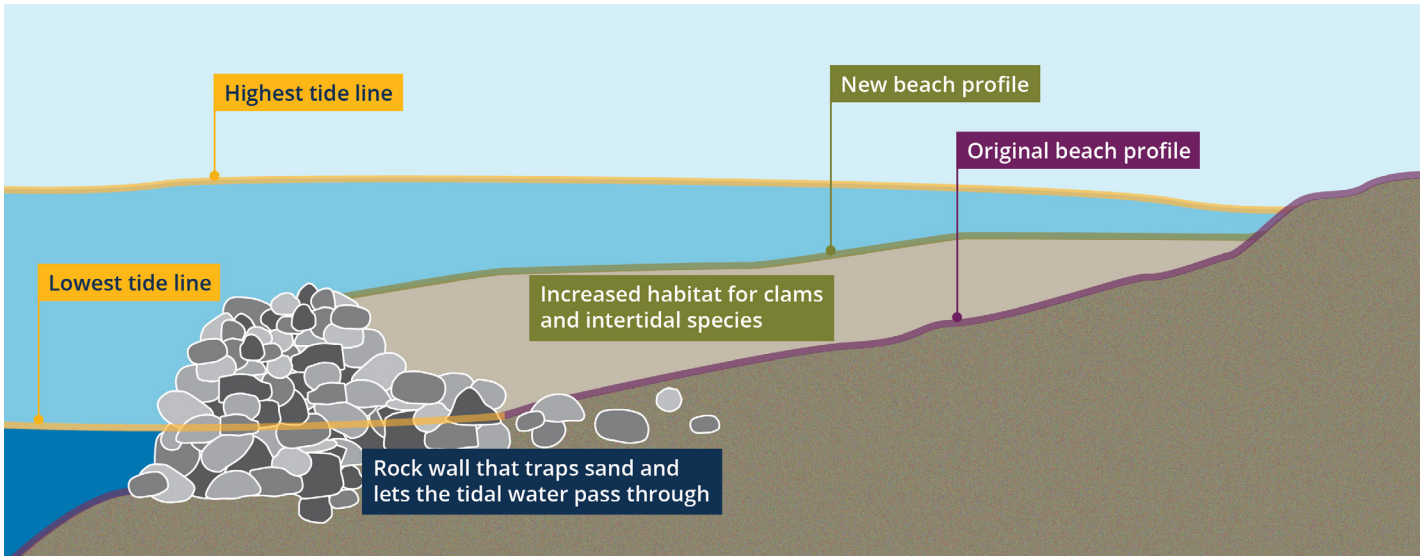
Exploring the Tides

Fill-in-the-blanks



Use the words below to fill in the blanks. **All** words will be used, and words are only used **once.**

intertidal lowest out in ebb flood rocks sand

1. At loxiwey, tides and the tidal cycle play an important role in helping people decide where to place _____ on the beach.

2. The rocks need to be placed at the _____ tide line so that the _____ can gather behind the rocks as the tide goes _____.

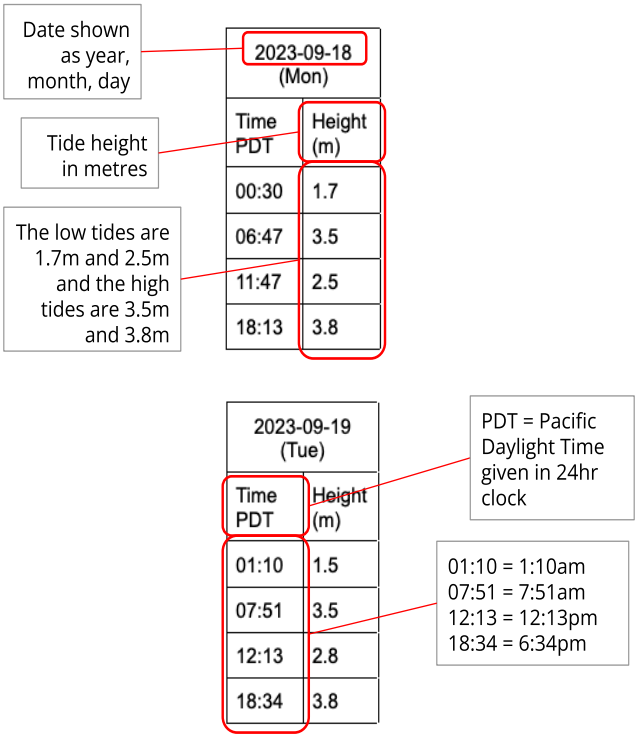
3. The area of the beach between the high tide and low tide is called the _____ zone.

4. An incoming tide, resulting in rising water levels on the beach, is called the _____ tide, whereas an outgoing tide, when water levels drop on the beach, is called an _____ tide.

5. You can see less of the intertidal zone, and therefore less of the beach, when the tide is _____.

Reading a tide table

The tide table forecasts the height of the water at specific shore locations during the tidal cycle. Typically, there are two high tides and two low tides each day on Vancouver Island. Tide table charts are available online, in printed books, or through many different apps. The Government of Canada website **tides.gc.ca** is a reliable source for Canadian tide information.



The tidal values above are actual data from the Government of Canada for Campbell River (station 08074). The date, tide height, and times are key pieces of information in tidal data. If you are using an app, tidal information may be displayed in different formats. Be sure to note what order dates are listed (e.g., year-month-day or year-day-month), if the times are listed as 12hr or 24hr, and if heights are in metres or feet.

Check your understanding

Answer the following questions according to the Campbell River (station 08074) tide table to the right. Always remember to include symbols for units of measurement (e.g., 3**m** for height, 6:00 **am** or **pm** for 12hr clock).

Campbell River tide tables

2023-09-18 (Mon)	
Time PDT	Height (m)
00:30	1.7
06:47	3.5
11:47	2.5
18:13	3.8

2023-09-19 (Tue)	
Time PDT	Height (m)
01:10	1.5
07:51	3.5
12:13	2.8
18:34	3.8

2023-09-20 (Wed)	
Time PDT	Height (m)
01:52	1.3
09:08	3.5
12:45	3.1
19:00	3.8

2023-09-21 (Thu)	
Time PDT	Height (m)
02:38	1.2
10:32	3.5
13:31	3.3
19:32	3.7

2023-09-22 (Fri)	
Time PDT	Height (m)
00:32	1.1
11:54	3.6
16:34	3.5
20:09	3.6

2023-09-23 (Sat)	
Time PDT	Height (m)
04:40	1.1
13:02	3.8
18:40	3.5
21:02	3.5

2023-09-24 (Sun)	
Time PDT	Height (m)
06:00	1
13:53	3.9
20:07	3.4
22:48	3.4

Name: _____

Check your understanding

1. On Tuesday, September 19 (2023-09-19), what times were the low tides?
    a. Answer using the 24hr clock: _____ and _____
    b. Answer using the 12hr clock: _____ and _____
2. On Wednesday, September 20 (2023-09-20), what were the heights of the high tides?
    a. Answer in metres: _____ and _____
3. On Thursday, September 21 (2023-09-21), what was the height of the lowest tide and the highest tide?
    a. Answer lowest: _____
    b. Answer highest: _____
4. On Friday, September 22 (2023-09-22), what time was the lowest tide and highest tide?
    a. Answer lowest tide using the 24hr clock: _____
    b. Answer lowest tide using the 12hr clock: _____
    c. Answer highest tide using the 24hr clock: _____ and _____
    d. Answer highest tide using the 12hr clock: _____ and _____

Questions to extend your thinking

5. With two high and two low tides most days, sometimes we get a low high and a high high. For example, on Monday, September 18 (2023-09-18), the two high tides are 3.5m and 3.8m; the low high is 3.5m and the high high is 3.8m. On Sunday, September 24 (2023-09-24), what is the height of the low high and the high high?
    a. Answer low high: _____
    b. Answer high high: _____
6. What day and time is the best opportunity to explore marine organisms that live in the lower intertidal zones? Explain your answer.

Answer Key

Fill-in-the-blanks

1. At loxiwey, tides and the tidal cycle play an important role in helping people decide where to place **rocks** on the beach.
2. The rocks need to be placed at the **lowest** tide line so that the **sand** can gather behind the rocks as the tide goes **out**.
3. The area of the beach between the high tide and low tide is called the **intertidal** zone.
4. An incoming tide, resulting in rising water levels on the beach, is called the **flood** tide, whereas an outgoing tide, when water levels drop on the beach, is called an **ebb** tide.
5. You can see more of the intertidal zone, and therefore more of the beach, when the tide is **out**.

Check your understanding

1. On Tuesday, September 19 (2023-09-19), what times were the low tides?
    a. **24hr clock: 01:10 and 12:13**
    b. **12hr clock: 1:00am and 12:13pm**
2. On Wednesday, September 20 (2023-09-20), what were the heights of the high tides?
    a. **3.5m and 3.8m**
3. On Thursday, September 21 (2023-09-21), what was the height of the lowest tide and the highest tide?
    a. **lowest: 1.2m**
    b. **highest: 3.7m**
4. On Friday, September 22 (2023-09-22), what time was the lowest tide and highest tide?
    a. **lowest tide using the 24hr clock: 03:32**
    b. **lowest tide using the 12hr clock: 3:32am**
    c. **highest tide using the 24hr clock: 11:54 and 20:09**
    d. **highest tide using the 12hr clock: 11:54am and 8:09pm**

Questions to extend your thinking

5. With two high and two low tides most days, sometimes we get a low high and a high high. For example, on Monday, September 18 (2023-09-18), the two high tides are 3.5m and 3.8m; the low high is 3.5m and the high high is 3.8m. On Sunday, September 24 (2023-09-24), what is the low high and the high high?
    a. **low high: 3.4m**
    b. **high high: 3.9m**
6. What day and time is the best opportunity to explore marine organisms that live in the lower intertidal zones? Explain your answer.

    Sunday, September 24 around 06:00 or 6:00 am has the lowest low tide this week. Explanations will vary but should indicate that 1m is the lowest tide height and therefore the water level will be the lowest it has been all week. The lowest tide occurs when the tide has fully ebbed.