Lesson 4: Collaborative Research - Case Study on Kelp

Overview: Students will continue to learn about the concept of collaborative research and how this approach is being used to inform future planning for the Great Bear Sea region. This lesson will highlight the research on kelp forests that is taking place in the Great Bear Sea region.

Subjects: Science, Language Arts, Math

Suggested Time: 3 classes (45-60 minutes)

*** Teacher Note:** Throughout this resource, additional materials, several images and colour resources are noted with a ***** in the materials list. See **Teacher Note in Lesson 3** for other ideas. These resources are available on the Great Bear Sea USB, or at www.greatbearsea.net.

Materials and Resources:

- Computer, projector and screen
- Chart paper and markers
- Several hula-hoops, string and tape
- Lesson 4 Film Clip:
  - Otter Kelp Research (8 mins)
- Teacher Background – Lesson 4
- 4.1: Kelp Research Project
- 4.2: Kelp and Map of Sites
- 4.3: Kelp Data
- 4.4: Research Questions for Kelp Data
- Picture of hula-hoop plot*
- Kelp Research Images*

Learning Objectives:

Students will:

1. Understand the Great Bear Sea is an ecosystem that is important for its ecology, economy as well as culture and social elements of First Peoples.
2. Be introduced to collaborative science, which includes traditional knowledge, local knowledge, and science.
3. Understand the value of traditional knowledge and how it contributes to sustainability and planning for the future.
4. Explore the ideas of stewardship and leadership in planning for the future of marine resources and ecosystems in the Great Bear Sea.

Lesson Context

This lesson will introduce the students to some of the collaborative research that is taking place in the Great Bear Sea region on kelp. They will learn that the research that is taking place is partnering with various universities as well as First Nations to learn more about the kelp harvest and rates of re-growth of the kelp after harvest. By gathering data and learning more about the plants through these key partnerships planning can move forward with proper decisions to conserve and protect the Great Bear Sea region for the future. Students will learn more about the concept of collaboration, including what collaboration looks like from a science/research perspective. This example of collaborative research pairs traditional and local knowledge with academic research methods and is a key component to marine planning, helping communities make informed decisions while ensuring stewardship and conservation. There are various activities that students will engage in throughout this lesson including examining data from a kelp research project and doing some analysis with specific target questions.

Learning Activities

Activity 1: Plot Study (45-60 minutes)

1. Write the word **plot study** on the board. What do students think this means? Some discussion points may include:
   - What is a plot?
   - What is a study?
   - Show the students the picture of the **hula-hoop plot***. How might this connect to a plot study?
   - What organisms could be studied using this technique?

   Explain to the students what a plot study is and how plots are used to conduct research using a small sample size. See **Teacher Background – Lesson 4** for more information.

2. Divide the class into small groups and explain that the groups will create a plot study using a hula-hoop. Give each group a hula-hoop, string and tape. Have each group make a plot, by placing 3 pieces of string horizontally and 3 pieces of string vertically to divide the hula-hoop into quadrants. See example picture of **hula-hoop plot***.

3. Head outside to the field, playground, school garden or green space. Have each group place their plot study down on the ground. Observe and record what is in their plot by sketching the hula-hoop grid in their Science journal. Draw pictures or list what they see in each section of the plot.

4. Discuss what the students found in their plots. Some discussion points may include:
    - Were the plot study findings similar or different for the class?
    - Would the findings be the same in a different area? For a larger plot?
    - How does a small plot connect to the larger sample area?

Activity 2: Collaborative Research (45-60 minutes)

1. Review the meaning of **collaborative research** – collaborative research in this context is when the researchers and scientists are working with First Nations territories to learn more about something.
2. Let the students know that they will be learning more about a collaborative research study on kelp. Review the key information of the kelp research using **4.1: Kelp Research Project**.
3. Show the students the **Kelp Research Images*** where kelp is being harvested and measured by researchers. Let the students know that these researchers are using a plot that measures 30 x 30m. Measure out the size of this on the field so the students understand the size of this plot compared to their hula-hoop plot.
4. Write the word **kelp** on the board. Have the students work in small groups to brainstorm their current knowledge of kelp. Do the students know what kelp is? Can students classify it, list any species of kelp and discuss how it's important to the ecosystem?
5. Share the students' brainstorming on kelp and then share with the students some additional information on kelp and the purpose of this research project on giant kelp.

    Key points to cover:
    - Kelp is a producer which is an organism including green plants that can produce its own food through photosynthesis
    - Giant kelp is the fastest growing primary producer on the planet
    - Kelp is a plant and also contributes to releasing oxygen and taking in carbon dioxide in the ecosystem
    - Provides a habitat and source of food to many species
    - Giant kelp is harvested on the coast of British Columbia
    - Kelp is also used to collect herring eggs in the spring – the eggs get caught in the kelp and can be eaten with the kelp when it is harvested
    - Kelp has other commercial uses such as producing fertilizers, food additives and cosmetics

- Purpose of the research study was to investigate how quickly kelp recovers from harvest and the factors that influence how quickly it recovers and to determine whether commercial kelp harvesting is a sustainable activity

6. Ask the students what challenges the researchers might have by studying something that lives in the water? How would this be done in an extreme environment?

7. Watch the film clip **Otter Kelp Research**.

Activity 3: The Kelp Research Project (45-60 minutes)

1. Use **4.2: Kelp and Map of Sites** to review the basic anatomy of kelp with the students and the sites of the kelp plots where the research is taking place. Discuss with the students why it would be important to examine different sites. For example are they finding the same trends in all sites or just one site? The researchers want to compare different site locations.

2. Divide the class into three groups. (Option: You could divide your class into six or nine groups and have multiple groups working on the same research question noted in step #3) Pass out the data **4.3: Kelp Data**. Allow the students time to examine the data. Use chart paper and have the students record any trends noticed, questions about the data, etc. Then in a large group share their observations and questions about the data.

3. Pass out **4.4: Research Questions for Kelp Data** and discuss each of the three research questions. Assign each group one of the research questions to investigate using data from the kelp research project. Each group will use the same data but will be researching different questions. The data is based on many factors: different site locations; water temperature; kelp density as well as kelp growth rates. Ensure the students understand what to do with the numbers in the data and how to calculate the answers. See **Teacher Background – Lesson 4** for information on the calculations.

4. Provide each group with time to create a poster that summarizes their findings to present to the class.

5. Share findings for each research question and discuss how Traditional Knowledge is connected in this research project and why this research project is important to the Great Bear Sea region.

Extension Ideas

- Using the data provided, brainstorm additional research questions to investigate.
- Explore some additional research provided from the project:

  Question: Did larger kelp individuals regrow more quickly than smaller kelps?

  Answer: There was only a weak relationship between the initial size of the kelp and how quickly it regrew. This means that other variables were likely more important in determining recovery rates.

  Question: Did the density of kelps at a site influence how quickly kelps recovered?

  Answer: There was a slight negative relationship between kelp density and re-growth rate, indicating that kelps regrew more slowly at sites with denser kelp. This may be because harvested kelps are competing with other kelps at the same site for light. With less light available at higher kelp densities, kelp regrowth rate declined.

  Question: Does the water temperature influence how quickly kelps regrow?

  Answer: Yes, kelp re-growth rate decreased at higher average water temperature.

  Question: Which factor out of those you considered do you think was most important in determining kelp recovery rates? What implications does this have for harvest?

  Answer: Temperature was the most important variable determining kelp re-growth rates. Climate change is expected to cause increases in water temperature, which may impact the ability of kelps to recover from harvest in the future. Harvest managers should consider monitoring water temperatures in association with harvest so that they can reduce or avoid harvesting during years with warm water.
- Have the students continue to do more research on kelp harvesting and whether or not it is sustainable. What further research would the students recommend? Discuss the students' ideas on kelp harvest being sustainable.
- If possible, explore and identify different species of kelp by heading to the beach at low tide to see if any species of kelp can be observed on the beach. Get the students to sketch the different species of kelp and then use ID books to identify the species.

Assessment Ideas

- Formatively assess students' engagement in individual and group work as well as large group discussion.
- Assess student work from the lesson.
- Have students check each others' data calculations.

Teacher Background – Lesson 4

Collaborative research is very important in the Great Bear Sea region, with several examples of academic institutions and First Nations working together to gather data and knowledge to inform decision making for marine planning. Students could consider all of the potential partners (such as the government and various other organizations) who could all work together to gather information to inform planning.

Collaborative Research

Contributed by Alejandro Frid - Science Coordinator/Ecologist Central Coast Indigenous Resource Alliance (27 April 2016). Do not duplicate without permission from the author.
www.alejandrofridecology.weebly.com/marine-resources-and-first-nations.html

Modern Indigenous people embrace new technologies and do not isolate themselves from contemporary culture and economy, yet maintain a tradition of deep interconnection with our non-human kin. Their gathering of edible and medicinal plants, their hunting and fishing, bring nourishment that not only is physical but also essential to sustaining worldviews that have been rooted in place for many generations. The implication is that habitat destruction and biodiversity loss are inseparable from the demise of cultural diversity, and therefore the rights of many human beings. Not surprisingly, Indigenous people have become conservation leaders in many parts of the world. Their efforts to conserve the ecosystems that sustain their traditional foods — mainly through protected areas that exclude large-scale exploitation — could make ecosystems more resilient to climate change and other stressors.

In the Central Coast of British Columbia, the Heiltsuk, Kitasoo/Xai'xais, Nuxalk, and Wuikinuxv First Nations have joined forces to proactively manage their resource, fostering collaborative research between scientists and holders of traditional knowledge. The elements of this collaboration are complementary.

On the one hand, science tests for explicit mechanisms that might affect ecological communities — such as fisheries and climate change — and uses empirical findings to predict future conditions. Yet science often occurs in short spurts and in few places, suffering from short-term, narrow perspectives that limit understanding.

In contrast, Indigenous Knowledge derives from cumulative and collective observations made by many generations of people who are connected to the resources of vast ecosystems. Oral traditions preserve this knowledge as Indigenous laws and stories that transcend many limitations of science.

In concert, science and traditional knowledge can merge the holistic and long-term perspectives of Indigenous people and the predictive abilities of science. The potential result is a stronger foundation for conservation and resource management policies.

Vocabulary

Plot Study: a small-scale study that uses a plot to observe and record information in an area.

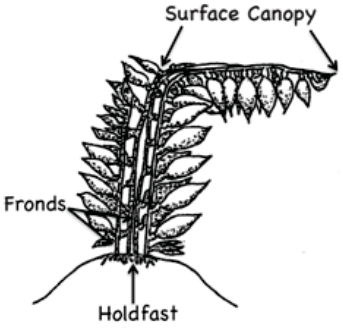
Collaboration: the action of working with someone to produce or create something.

Background on Kelp:

This information and data was submitted by Kira Krumhansl, Postdoctoral Researcher at Simon Fraser University and Hakai Institute.

Giant kelp (Macrocystis pyrifera) is the fastest growing primary producer on the planet. This species has been harvested by First Nations on the coast of British Columbia for millennia, and is still being used to collect herring eggs in the spring for subsistence and commercial fisheries (i.e. spawn on kelp fishery). Giant kelp is also being considered for other commercial uses, such as the production of fertilizers, food additives, and cosmetics. Before commercial harvests begin for these purposes, the Heiltsuk First Nation worked in collaboration with researchers at the Hakai Institute and Simon Fraser University to investigate how quickly the kelp recovers from harvest, and what factors influence how quickly kelp recovers. This information helps Heiltsuk Research Managers to determine whether commercial kelp harvesting is a sustainable activity, and if so, how best to manage it.

The basic anatomy of giant kelp is shown in the diagram below. Giant kelps are anchored to the substrate via a root-like structure known as a holdfast. Each **holdfast** has multiple stems or **frond** that grow up through the water column towards the surface of the water. Once the frond reaches the surface, it grows along the surface to form a **surface canopy**. This surface canopy is where most of the kelp's photosynthesis occurs, and is visible from a boat (maybe you've seen one!). Harvesting involves cutting the surface canopy portion of the kelp.



We harvested kelps at 5 sites on the Central Coast of BC near Bella Bella in 2014, and measured how quickly the kelps regrew (meters of canopy growth per day). We were interested in understanding what factors influence how quickly the kelp regrows following harvest. Some of the questions we were interested in were:

Would larger kelp individuals regrow more quickly?

Would kelps grow back more quickly when they are in sparse kelp beds or dense kelp beds?

Does the water temperature influence how quickly kelps regrow?

To answer these questions, we measured the water temperature at each site (°C), the initial size of each harvested kelp before harvest (surface canopy length in meters), and the density of kelps at each site (kelps m^{-2}, i.e. how many kelps there are per meter of ocean bottom). We did an analysis of the data to investigate which factor was most important.

Answer Key to Research Questions

Below you will find specific research questions and answers. You will find tips to help the students solve the calculations below using the data. If students have not done these kinds of calculations some pre-teaching will be required on how to calculate averages.

Question One: Did kelps grow back at the same rate at each site? Find the average growth rate at each site. What is the range of the average kelp growth rate for each site?

Answer: No, kelps grew back at different rates across sites. The average growth rates are: Golden 0.053; Meay 0.53; Simonds 0.62; Strykeer 0.045; Triquet 0.009 m per day (i.e. surface canopy growth per day). The range of growth rates was 0.009 (Triquet)-0.062 (Simonds) m per day.

Calculations Required: The students need to find the average kelp growth rate for each site. In order to calculate the average students will need to add up each kelp growth rate for each site and divide by the number of samples in that site. Note: The sample number varies between sites.

Question Two: Is the water temperature the same at each site? What is the range of average water temperatures? What is the average water temperature?

Answer: No, the average water temperature varied among the fives sites. The average temperatures ranged from 11.96 (Simonds)-12.70 (Triquet)°C. The average temperature among the five sites was 12.32°C.

Calculations Required: The students need to find the site with the coolest temperature and the warmest temperature. In order to calculate the average students will need to add the average water temperate for each site and divide by the number of sites in the data set.

Question Three: Is the kelp density the same at each site? What is the average kelp density?

Answer: No, the average kelp density ranged from 0.15 (Meay)-0.49 (Triquet) kelps m^{-2} (i.e. how many kelps there are per meter of ocean bottom). The average kelp density (rounding to the nearest ten thousandths) among the five sites was 0.4005 m^{-2} (per meter of ocean bottom).

Calculations Required: The students need to find the site with the smallest and largest density. In order to calculate the average students will need to add up each average density and divide by the number of sites in the data set.

Name:_____

4.1: Kelp Research Project

Purpose:

To see if kelp can be taken from the ecosystems without having a negative impact on other species in the ecosystem. As well to investigate how quickly the kelp recovers after being harvested, and what factors influence how quickly kelp recovers to understand whether commercial kelp harvesting is a sustainable activity, and if so, how best to manage it.

Methods:

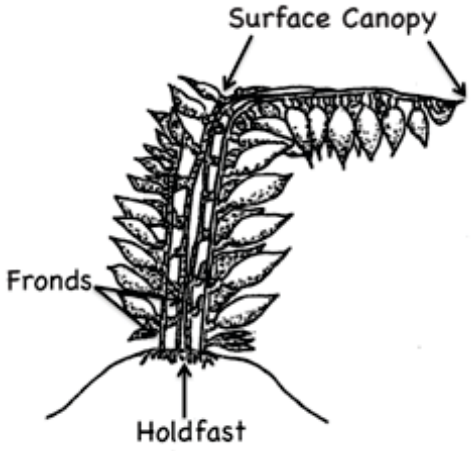
- 5 sites near Bella Bella on the Central Coast of BC
- Plots measuring 30 by 30m

How:

Harvest kelp (cutting the surface canopy portion of the kelp) and measure how quickly the kelp regrew (meters of canopy growth per day) to understand what factors influence the regrowth following the harvest.

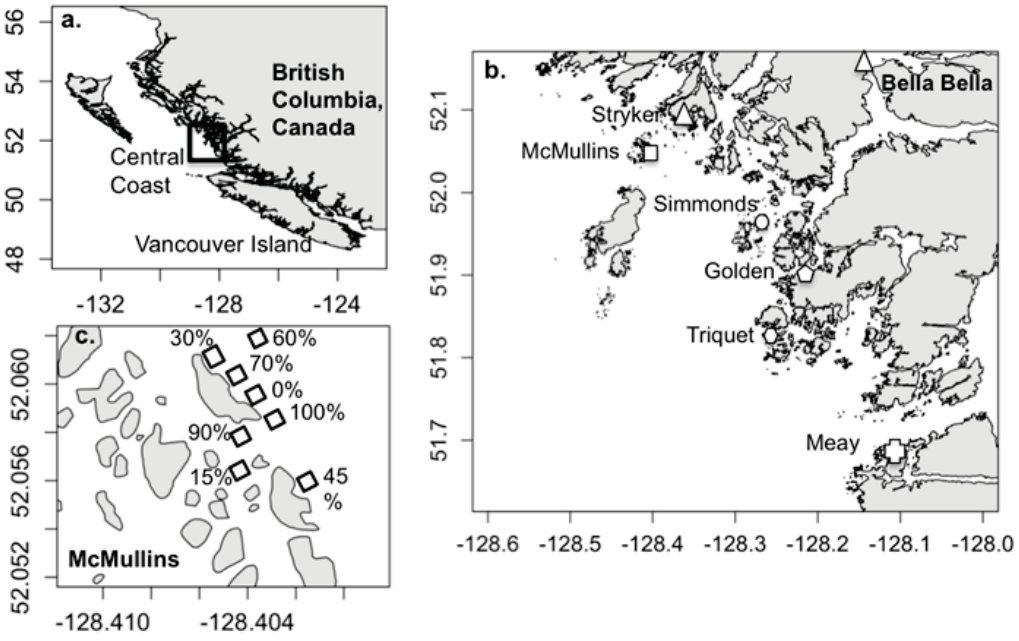
Questions: I Want To Know More About…

4.2: Kelp and Map of Sites



Giant kelps are anchored to material that the plant grows on (for example rocks) via a root-like structure known as a **holdfast**. Each holdfast has multiple stems or **frond** that grow up through the water column towards the surface of the water. Once the frond reaches the surface, it grows along the surface to form a **surface canopy**. This surface canopy is where most of the kelp's photosynthesis occurs, and is visible from a boat. **Harvesting** involves cutting the **surface canopy portion** of the kelp.

Kelp was harvested at 5 sites on the Central Coast of BC near Bella Bella in 2014.



4.3: Kelp Data

Site	Average Water Temperature (^0C)	Kelp Density at Site (m^{-2})	Initial Kelp Size (m)	Kelp Growth Rate (m per day)
Golden	12.4	0.336	10.9	0.067
Golden	12.4	0.336	6.4	0.051
Golden	12.4	0.336	10.9	0.068
Golden	12.4	0.336	6.4	0.028
Golden	12.4	0.336	3.8	0.049
Meay	12.12	0.147	9	0.065
Meay	12.12	0.147	5.4	0.042
Meay	12.12	0.147	7	0.051
Simonds	11.96	0.233	7.6	0.067
Simonds	11.96	0.233	2.15	0.053
Simonds	11.96	0.233	4.4	0.043
Simonds	11.96	0.233	2.05	0.046
Simonds	11.96	0.233	7.3	0.101
Stryker	12.425	0.464	4.85	0.012
Stryker	12.425	0.464	7	0.047
Stryker	12.425	0.464	3	0.055
Stryker	12.425	0.464	2.8	0.074
Stryker	12.425	0.464	2.5	0.034
Triquet	12.702	0.486	4	0.007
Triquet	12.702	0.486	4.7	0.004
Triquet	12.702	0.486	6.05	0.012
Triquet	12.702	0.486	5.95	0.014

NOTE: Permission was granted to use the data in the context of this lesson. The data are not available for publication or use outside of the classroom.

Name:_____

4.4: Research Questions for Kelp Data

Question One
Did kelps grow back at the same rate at each site? Find the average growth rate at each site. What is the range of the average kelp growth rate for each site?

Question Two

Is the water temperature the same at each site? What is the range of average water temperatures? What is the average water temperature?

Question Three

Is the kelp density the same at each site? What is the average kelp density?

My Group is responsible for Research Question: # _____

Hypothesis: Our predictions are...

Results: Our Findings…

Our new questions…