CANADA C3
COAST TO COAST TO COAST

Canada C3 Digital Classroom Learning Module

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Name of Educational Organization(s): Ocean Networks Canada, The Fish Eye Project

Learning Module Title: Richness, Abundance, and Transects, Oh My!
Grade(s)/Teaching Division(s): Grades 6-10
Subject(s)/Course(s): Science, Social Studies, Environmental studies, Math
Time: 3 classes, approximately 75 minutes each. Please note that the order of these lessons is flexible. Lessons can be combined together or done individually over time, though they are interconnected as a unit.

Learning Module Topic & Description

In this module, biodiversity is explored using Arctic ocean life. This set of lessons demonstrates how scientists and researchers categorize and monitor biodiversity, species richness, and other environmental factors within an ecosystem. Students participate in mock-up transects, species collections and surveys. The lessons give students a feel for how researchers might operate in the field. Students and teachers should keep in mind, these examples are intended to demonstrate the process of science, and have been simplified for the classroom environment.

To download hard copies of the lessons and find a French translation please visit the Ocean Networks Canada webiste: http://www.oceannetworks.ca/arctic-species-richness-and-abundance.

Essential Question(s)

- What is biodiversity?
- What is species abundance?
- What is species richness?
- How does species abundance compare to species richness?
- How do species abundance and species richness relate to biodiversity?
- What is a transect?
- What is a quadrat?
- How are transects and quadrats used to measure biodiversity?
- Does benthic biodiversity change with ocean depth?
- What is it like to dive in Cambridge Bay?
- How does ocean life in Cambridge Bay compare to ocean life where you live?

Canada C3 Central Theme(s) Addressed

- Youth Engagement
- The Environment

Learning Objective(s)/Goals

- Students will experience how biodiversity is quantified by researchers.
- Students will explore the difference between species abundance and species richness.
- Students will explore what transects and quadrats are and how researchers use them.
- Students will explore how benthic diversity changes with depth.
- Students will experience and explore examples of Arctic ocean life.

Essential Concepts/Knowledge/Skills to be Learned/Applied

- Species richness and species abundance are necessary for biodiversity.
- Transects and quadrats are scientific methods used to measure species abundance and species richness and therefore biodiversity.

Curriculum Connections/Big Ideas

Taken from Alberta Science 7-10 and Nunavut Experiential Science 20 Foundations: Nature of science, life science, performing and recording, analysing and interpreting, communication and teamwork, appreciation of science, science inquiry, collaboration and stewardship.

Teacher Goals

- To demonstrate how researchers in the field may study the environment and or species present.
- To help students understand that research is a “skill” and follows prescribed steps and methods.
- To convey the vocabulary and definition of Species Richness, Biodiversity, Species Abundance, Transect and Quadrat.

Lesson 1 of 3: "Are you Abundant or Rich?" (~65 minutes)

Student Groupings *(e.g., whole class, small groups, pairs, independent work)*:	**Materials/Resources** *(e.g., equipment, PowerPoint/Keynote slides, manipulatives, hand-outs, games, assessment tools)*:
• The motivational hook, opening and closure is done as awhole class. • The activity will be completed in small groups of students. See "considerations" for group sizes.	• 4 x 4 sets of coloured animal cards (each set has 16 cards) • Red – Tube dwelling anemones • Yellow – Arctic saxicaves/nestler clams • Green – Green sea urchins • Blue – Arctic shannies • Field or open space • Whistle or signal
Instructional Strategies *(e.g., direct instruction, demonstration, simulation, role-playing, guest speaker, etc.)*:	**Considerations** *(e.g., contingency plans re: technology failure, student absences or groupings, guest speaker cancellations, or safety concerns)*:
• Opening: Direct instruction • Activity: Role playing/simulation as the students collect data and share in their groups. • Additional strategies suggested include questioning, discussions and mantle-of-the-expert role playing.	Divide students into groups so that the number of groups is divisible by 4. For example, 8 groups of 3 is ideal. Set up boundaries for safety. • Designate a large playing area for students to collect cards in. • Spread the coloured cards out, with the colours randomly distributed throughout the space. • Divide students into smaller working/relay groups.

Accommodations & Differentiation Strategy *(to address different needs & preferences of students)*

- This lesson can be done in a gym, which can be more accessible for students with mobility impairments.
- Patterns have been used to differentiate cards if colour is not available or accessible.
- For students who are visually impaired, stickers of differing textures can be added to the cards.
- For students who may struggle with a relay, students can be paired up to find the cards.
- Writing and speaking can be minimized or maximized for students as needed.

Assessment for Learning, Checking for Understanding, Success Criteria & Feedback

- Class mind map/student participation.
- Assessment can be done as a question and answer with students, or students can document their findings for deeper analysis (for example, writing concepts and or features of recording/note taking).
- Feedback can come from peer to peer, teacher to student or combination thereof.
- Success criteria: Participation can correctly define species abundance and species richness.

Motivational Hook *(process for acquiring & focusing students' attention), 10 minutes*

Brainstorm with students: what does it mean to be "rich?"; what does it mean to be "abundant?"
Record the students' ideas on the board. In this activity, students will find out how these terms apply to biology. The teacher is encouraged to record ALL the students' ideas as the class will refine them at the end of the activity. This can help students identify their own misconceptions and how they change as they learn.

Open *(process for introducing/framing module & agenda), 5 minutes*

Take the students into the playing area where the abundance and richness cards have been spread out. Explain that the end goal is for students to explore the concept of biodiversity, which includes richness and abundance by picking up cards for each round. The students will need to listen for cues as to which cards to collect. Note: each colour represents a different species.

Body *(main instructional & learning processes to build understanding, skills, attitudes), 20 minutes*

Part 1 – What is Species Abundance?

1. During this round of the game, groups will gather an abundance of the same colour/species but not a variety representing high species abundance and low species richness.
2. Assign each group a colour (multiple groups can have the same colour, as this is a group dependent, not class dependent activity). On "go," each group has to find their colour in a relay fashion. One person from each group finds one coloured card and comes back before the next person can go. They have two minutes to collect as many of the same coloured cards as possible.
3. After two minutes, have the students count how many cards of their colour they have. This number represents species abundance as it is the same species and we are counting multiple individuals of the same species.
   a. Each group could have up to 16 cards.

Part 2 – Species Richness

1. During this round of the game groups will gather a variety of colours/species but not more than one of each, representing high species richness and low species abundance.
2. Return the cards to the field (students can distribute them randomly). Tell each of the groups that they are now tasked with collecting one of EACH colour of cards. Similar to above this will work in a relay. One person from each group can only collect one colour card at a time. They need to pay attention as so not to collect the same coloured card more than once. The number of different colours they collect represents species richness. This time, the students have an example of a "rich" but not very abundant ecosystem.
   a. Each should have on collected 4 cards, one of each colour.

Consolidation *(processes for application & practice of knowledge, skills, attitudes), 10 minutes*

Part 3 – Biodiversity

1. Have the students return the cards to the field, again, trying to distribute them randomly.
2. During this round of the game groups can collect any cards. Continuing in a relay fashion, one student from each group can go at a time and bring back a card to the group. After the two minute period, have the students determine which species are abundant and if the ecosystem is rich.
3. Tell the groups that biodiversity is achieved by finding a balance of species abundance and species richness. Discuss if they think they achieved biodiversity or what they might need to do to have a more "perfect" ecosystem.
   a. Students may want to strategize and try again.

Closure *(processes for recapping, looking ahead), 10 minutes*

- Revisit the students' original brainstorm about richness and abundance. After the activity, what ideas do they want to reshape, change, or eliminate?
- Listen for and add as needed: Rich in a biological context, means to have lots of different species in one area. Students may need help remembering that "rich" refers to the number of species, so even if only one individual is present from multiple species it may still be a biologically rich area. One example that may help is your classroom. The classroom is NOT biologically rich as (likely) the only species present are humans.
- Abundant refers to the number of individuals present per species. So, in the classroom, there would be an "abundance" of humans, but very little species richness.
- The two terms are not mutually exclusive. The healthiest ecosystems have a high species richness and high abundance.
- Ask the students to reflect on natural environments they have visited. Do they have high abundance and/or diversity of organisms? Why or why not?

Student Reflection on Learning *(i.e., critical thinking questions to extend the learning), 10 minutes*

- Ask the students to reflect on natural environments they have visited. Do they have high abundance and/or diversity of organisms? Why or why not? Encourage them to use language from the lesson and provide "how they know" statements.
- Encourage students to describe alternative methods than those presented or to assess pros and cons of the presented methods.
- Encourage students to identify own lack of knowledge or errors in thinking before, during and after the activity.

Extension Ideas & Additional Resources

- Have the students calculate a simple biodiversity index from their data.

By dividing species richness by the total number of species you get a simple biodiversity index. Biodiversity indices are used by scientists to determine species variety in a specific area. A more diverse population has a larger chance of including individuals that may be able to adapt to a changing environment. A high biodiversity index is "1". As the number decreases so does biodiversity.

$$\frac{\text{Species richness (the number of colours collected in Part 3)}}{\text{Total number of species (the total number of cards collected in Part 3)}}$$

- Have the students discuss threats to biodiversity.
  - Bearly Any Ice activity
- Discuss the ideas of genetic diversity and ecological diversity.

Step It Up for Advanced Students:

- Usually when species abundance is seen in the natural environment individuals of the same species are found in groups. Being in a group provides safety, greater opportunity to find food, and easier access to mates. Even solitary species can be found in the vicinity of other individuals for the purpose of finding potential mates. This can be "set-up" for the students in Part 1 of the activity by grouping some of the same coloured cards together. Bring this to the students' attention and discuss why this may occur.
- In the natural environment species richness does not occur as perfectly as we have set it up in this example. This concept can be shown to the students by manipulating their chances of getting one of each species in Part 2 of the activity. One way would be to limit the number of coloured cards so that each group will not be able to collect one of each colour. This can lead to the discussion of threats to biodiversity. Another way would be to add one card of a fifth colour so only one group can obtain it. You can discuss the students' thoughts on the question: "Do you need one of each colour to have species richness?"
- You may also want to discuss or explore the concept of "keystone species" as this is also a strongly related topic in biodiversity and ecosystems.
    - Keystone species: a species that other species depend on and if removed would change the ecosystem drastically, for example, polar bears.

Teacher Reflection *(e.g., notes for next time)*

- Consider how the playing area could be set differently to teach different concepts.
- Consider using a similar approach to a wildly different topic such as math or art. Could this setup be used in other ways?

Lesson 2 of 3: "Transects and quadrats, Huh?" (~65 minutes)

Student Grouping *(e.g., whole class, small groups, pairs, independent work)*:	**Materials/Resources** *(e.g., equipment, PowerPoint/Keynote slides, manipulatives, hand-outs, games, assessment tools)*:
• The opening , data comparison and closure is done as a whole class. • The activity is done is small groups. It is recommended to divide the class into 4 total groups.	• 4 x 5 m ropes or string • 4 sets of species cards sets with coinciding depth markers (provided) • Shore and deep ocean signs • 2-4 hula hoops • Field or open space • Transect overview sheet (provided) • Pencil/pen and paper
Instructional Strategies *(e.g., direct instruction, demonstration, simulation, role-playing, guest speaker, etc.)*:	**Considerations** *(e.g., contingency plans re: technology failure, student absences or groupings, guest speaker cancellations, or safety concerns)*:
Direct instruction is needed to introduce concepts and the guidelines for each part of the activity. Set-up • Setup 4 transects, ropes approximately 1–2 m apart and running parallel to each other. At the end of each, place a depth marker accordingly, i.e., Rope 1 with Card Pack 1: 1–3 m. Set the cards along each coinciding depth transect randomly. It can be very helpful to establish other "area" markers for the students to imagine. For example, the shallowest rope could be near shore, and the furthest one is at depth. • Divide the students into working groups of 4–5 students.	Works best in four groups but can be more. Set up boundaries for safety. 

Accommodations & Differentiation Strategy *(to address different needs & preferences of students)*
• If students struggle with writing, have them draw the species they find or provide a list that they can check off. • This activity can be done in pairs. • Students can verbalize their findings. • Writing and speaking can be minimized or maximized for students as needed.

Assessment for Learning, Checking for Understanding, Success Criteria & Feedback

- Explore and post definitions and steps.
- Work "one step at a time" to ensure understanding of process.
- Assessment can be done as a question and answer with students, or students can document their findings for deeper analysis (for example, writing concepts and or features of recording/note taking).
- Feedback can come from peer to peer, teacher to student or combination thereof.
- Success criteria: students can describe transect and quadrat and its uses in science.

Motivational Hook *(process for acquiring & focusing students' attention), 15 minutes*

1. Ask the students to think about their desks (or lockers, or cubbies) in the classroom for a moment. Choose 2–3 students as examples and have them list a few items from their space. Discuss with the class, are any items likely to be in other places, too? For example, if the students say they have a textbook, an eraser, and a pencil, how likely are these to be found in other cubbies/desks/lockers? How likely are these to be in places like a restaurant? Explain to students, a transect/quadrat is a scientific way of recording one space, and using it to make educated guesses about another. For example, the students cubbies might not be identical, but they will be reasonably similar. Likewise, the restaurant is so different, it's very unlikely to be like the kids cubbies/lockers.
2. Explain to students, in this activity, they will be completing a mock transect study for different areas of Cambridge Bay and the Coronation Gulf. This activity is based on real data from a study done by the Vancouver Aquarium and Polar Knowledge Canada in 2016.

Open *(process for introducing/framing module & agenda), 5 minutes*

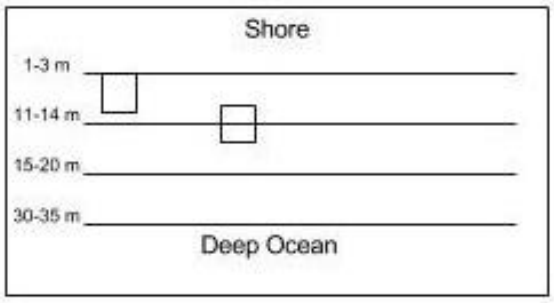
Take the students to the transect area and divide them into groups of 4. Each person in the group is responsible for 1 transect and will be expected to report back to their group.

Body *(main instructional & learning processes to build understanding, skills, attitudes), 20 minutes*

<u>Part 1 – What is a transect?</u>

1. Introduce activity to the students posing this question: "How do scientists actually study biodiversity?" (*If you have done the "Are you abundant or rich?" lesson you can refer to what the students did. In real life, scientists don't collect coloured cards.) One common way is to use transects and quadrats.
2. Explain what a transect is and that you have set out 4 parallel transects at 4 different depths (1–3 m, 11–14 m, 15–20 m and 30–35 m) along the "ocean floor". One person from each group will go along each transect and identify and count the species. After each person has collected their data, discuss why different people found different species on each transect. Ask how it might be different if the transects ran perpendicular to the shore, i.e., starting off shallow and going deeper.

Part 2 – What is a quadrat?



1. Review the concept of a quadrat (similar to a transect but different in that it is a confined, measurable area) and explain that students are going to use hula hoops as quadrats.
2. Explain that in order to compare their results the class has to decide as a whole, how they are going to place their hula hoops along the transect. Two common ways are to have the transect run through the middle of the quadrat or right beside the quadrat.
3. Using the transects from the previous activity, have one student per group place the hula hoop (quadrat) along their transect in the way determined by the class. Remember, they all need to be the same, for example, in the middle, to be scientifically sound. If they are random, it can impact the results and is not an accurate portrayal of how researchers use them.
4. Explain that their group's hula hoop is their study area. Have the students identify and count species in each quadrat. Compare results to the other groups in the class.
5. Compare and contrast the transect study to the quadrat study. Can the students conclude anything from their experiments? Anything related to biodiversity?

Consolidation *(processes for application & practice of knowledge, skills, attitudes), 10 minutes*

After each part you can have students calculate species abundance and species richness, as well as graph the data they collected.

Closure *(processes for recapping, looking ahead), 10 minutes*

Compare and contrast the transect study to the quadrat study.

Student Reflection on Learning *(i.e., critical thinking questions to extend the learning), 5 minutes*

Explore, question and/or discuss: Can the students make any conclusions from their experiments or their own past experiences related to biodiversity?

Extension Ideas & Additional Resources

- Discuss why different species are found at different depths.
  - Discuss what human impacts could change where a species would live.
- Students can investigate a particular species to learn about its range and habitat.
- Discuss if the students think the biodiversity would change seasonally for different species.

References:

Heywood, J., Kent, D., Gibbs. D., Borden, L., Neale, M., Lisaingo, J., Banwait, R. Caughlan, D. (2016). 2016 Nearshore Ecological Survey Final Report, August 3–27, 2016, Cambridge Bay, Nunavut. Vancouver Aquarium Marine Science Centre.

Teacher Reflection *(e.g., notes for next time)*

- Consider doing these activities at a local beach or in a local forest with the species that are found there naturally.

Lesson 3 of 3: "Arctic Live Dive" (~90 minutes)

Student Groupings *(e.g., whole class, small groups, pairs, independent work)*:	**Materials/Resources** *(e.g., equipment, PowerPoint/Keynote slides, manipulatives, hand-outs, games, assessment tools)*:
This lesson involves whole class participation and independent work.	• Arctic Live Dive MS PowerPoint Presentation • Arctic Live Dive • Projector or Smart Board (etc.) for viewing • *Student Fish Eye Project Live Dive Log* – one copy for each student • Chart paper • Pencils/pens
Instructional Strategies *(e.g., direct instruction, demonstration, simulation, role-playing, guest speaker, etc.)*:	**Considerations** *(e.g., contingency plans re: technology failure, student absences or groupings, guest speaker cancellations, or safety concerns)*:
This lesson involves direct instruction through the PowerPoint and guidance throughout the live dive.	This lesson is based around a video. If a technology failure occurs, arrange to view the Arctic live dive at another time.

Accommodations & Differentiation Strategy *(to address different needs & preferences of students)*

- The Arctic live dive video and trailer can be viewed individually on a computer, tablet, or iPad, etc. for students who may be visually or hearing impaired, or are sensitive to noise, visual stimulus, or a large group situation.
- The Arctic live dive video and trailer are available in English or French.
- If students struggle with writing, they can draw their answers. If they struggle with drawing/sketching, they can verbally describe what they saw.

Assessment for Learning, Checking for Understanding, Success Criteria & Feedback

- Can the students describe what they saw?
- How would they rate their own level of engagement in the segment (e.g., 1 = paying attention, 5 = not interested)
- Student log can be further assessed for participation and/or writing conventions.

Motivational Hook *(process for acquiring & focusing students' attention), 5 minutes*

Have students watch the Arctic live dive trailer.

Open *(process for introducing/framing module & agenda), 10-15 minutes*

- Present Arctic live dive PowerPoint
- Have student to fill out the first 3 boxes of the *Student Fish Eye Project Live Dive Log*

Body *(main instructional & learning processes to build understanding, skills, attitudes), 40 minutes*

Play Arctic live dive video.

Consolidation *(processes for application & practice of knowledge, skills, attitudes), 10 minutes*

Have students complete the *Student Fish Eye Project Live Dive Log*.

Closure *(processes for recapping, looking ahead), 15 minutes*

- Divide the students into working groups of 4-5 students.
- Have the groups discuss what they saw and experienced.
- On a piece of chart paper have the groups write down 5 items, concepts, or questions they want to explore more.
- Put chart paper with the questions up around the room and have the students walk around and read some of the other groups questions/items/concepts.

Student Reflection on Learning *(i.e., critical thinking questions to extend the learning), 5 minutes*

- Ask the students, "Did you see examples of species abundance or species richness during the live dive?"
- Ask the students, "Can you determine if the diver was going parallel or perpendicular to the shore?" "Why or why not?" "Did the diver do a transect or quadrat study?"

Extension Ideas & Additional Resources

- Have students pick one of the questions/items/concepts written around the room on which to complete an inquiry project.
- http://www.fisheyeproject.org/education/

Teacher Reflection *(e.g., notes for next time)*

- Consider watching the next dive live, or going to a live dive event.

Appendix A: "Abundance and Richness Cards PDF"

http://www.oceannetworks.ca/sites/default/files/teaching_resources/Abundance%20and%20richnes%20cards.pdf

Appendix B: "Background Information for Abundance and Richness"

Background information for the teacher:

Biodiversity: Biodiversity refers to the variety of living organisms in an ecosystem. In order to have and maintain good/strong biodiversity there must be a balance of species abundance and species richness. With high species abundance, individuals can easily reproduce and work together. However, abundance alone is not enough to ensure survival as individuals rely on other species for food, energy, and in some cases protection. If there is a large variety of species (species richness), but low abundance, the ecosystem may work fine for a while but without abundance to reproduce, eventually a species may die off.

Species: a group of organisms that can produce fertile offspring. Some examples are polar bears, caribou, arctic char or green sea urchins.

Species Abundance: number of individuals of a single species in an ecosystem or area.

Species Richness: number of different species in an ecosystem or area.

Ecosystem: a community in which biotic and abiotic elements interact.

Appendix C: "Transect Species List PDF"

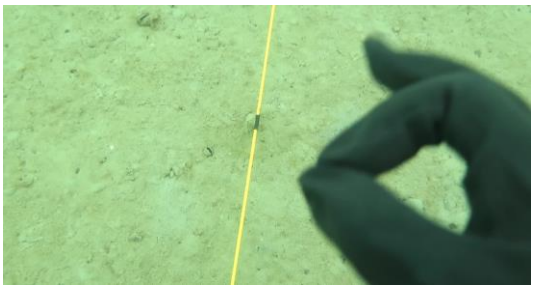
http://www.oceannetworks.ca/sites/default/files/teaching_resources/Transectspecieslist.pdf

Appendix D: "Transects and quadrats signs and pictures PDF"

http://www.oceannetworks.ca/sites/default/files/teaching_resources/Transects%20and%20Quadrats%20signs%20and%20pictures%202_0.pdf

Appendix E: "Background Information for Transects and Quadrats"

Background information for the teacher:



Transect: A survey line, sometimes defined by a rope of a predetermined length, that stretches between two identified marked points. The rope can have marked measurements for observation locations.

In this photo you can see an Ocean Networks Canada diver "okaying" the transect point or mark on a transect in Cambridge Bay. This 100 m transect ran parallel to the shore and was marked every metre. Transects are often used to establish plots for quadrats.

Quadrat: An item used to mark off a study area or sub-plot. Quadrats are often four-sided, such as a square metre, but can also be circular, like a hula hoop, as long as the total area of the marked region for data collection is known. Quadrats of the same size are used along a transect to quantify size of species, species distribution, species abundance, species richness, and biodiversity of an area.

Why use transects and quadrats?

Sub-plots are used to quantify observation in a small area in order to estimate the same variables over a larger area. For example, if you counted 20 students in one class in a school and you know the number of students per class is around the same, and there are 20 classes in the school, you can determine that there are approximately 400 students in the school without counting each individual student. If a scientist is on a beach with a transect running parallel to the shore for 100 m and in one 1 x 1 m quadrat they counted 80 barnacles, 78 barnacles in another, and 82 in another they can calculate the average as 80 barnacles. They can then multiply 80 by 100 and get an estimate that there are about 8000 barnacles along their transect.
(Please note: These are simplified examples, in practice, multiple samples would be taken to form a population estimate and a hypothesis.) They can also go back seasonally or yearly to the same places to see changes. They may notice that there are fewer barnacles but an increase in sea stars. This would provide data to investigate further questions about the behaviour of the sea stars and barnacles: for example, the hypothesis that the sea stars are eating the barnacles and impacting the population.

Appendix F: "Arctic Live Dive Trailers and Videos"

Trailer

https://youtu.be/6xjDuout7PE (English); https://youtu.be/VHFXTARhvj8 (French)

Video

https://youtu.be/0igKvKryyxo (English); https://youtu.be/ryx_uqnJFwI (French)

Appendix G: "Student Log for Live Dive"

https://static1.squarespace.com/static/56021b47e4b04aa9439c6fcd/t/574d0d00859fd022e5b5a3d4/1464667392978/Student-FISH+EYE+PROJECT+LIVE+DIVE+LOG.pdf

Appendix H: "Arctic Live Dive MS PowerPoint Presentation"
http://www.oceannetworks.ca/sites/default/files/teaching_resources/Slideshow_ArcticLiveDive.pdf