Final Capstone Deliverable: Polar Science at a Human Scale

The University of Washington's School of Marine and Environmental Affairs

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Environmental Change and Hazard Response in Kivalina, AK

Polar Science at a Human Scale Capstone Project

Engaged Ethnography Lab

Abigail Ames, Kate Loy, Chase Puentes, Kayla Stevenson, Nicolette Worrell

With Colleen Swan, Reppi Swan, Charlie Hahn, and P. Joshua Griffin

Executive Summary

The Strategic Plan on Environmental Change and Hazard Response report is a summary of climate related environmental changes and their potential impacts on life in Kivalina, AK. It is especially focused on potential activities of Kivalina Volunteer Search and Rescue (KVL-SAR)which is playing an important role in helping the community adapt to such changes. It is based primarily on conversations during a virtual seminar hosted in the Spring of 2020 that brought together Polar Scientists across disciplines and leaders from KVL-SAR.

The purpose of this report is to document current knowledge about a broad range of environmental changes that affect the waters, ice, land, plants, animals and other aspects of Kivalina's environment important for life and activity. The report then moves on to the potential hazards presented by these changes and the development of Search and Rescue capacity as one of the important means by which the community is responding to these changes for the continuation of their life and culture.

The report is organized as follows:

- **Introduction:** First we introduce Kivalina as a distinct location, including its geographical, community, and institutional context and current SAR capacity and planning. Additionally, we consider the relationship between search and rescue and autonomous climate change adaptation strategies.
- **Environmental changes by area:** Second, we provide a survey of environmental focal points and their associated changes over time in Kivalina, covering Ocean/Ice, Land, and River-based areas and changes. This is meant to provide a broad overview of Western scientific information in conjunction with local observational knowledge.
- **Hazard identification:** Third, we identify hazards associated with environmental change that follow from our discussions of changing environmental conditions.
- **Action items:** Fourth we provide a proposed list of action items based on ways to increase search and rescue capacity to prevent and respond to increased hazards associated with climate change. This list includes potential action items within the scope of search and rescue on a categorized time scale, including short- and long-term items, and additional items outside of the scope of search and rescue to consider for capacity building.

Summary of Findings:

Kivalina's ice, waters, and lands, along with the plants and animals that inhabit them, are changing quickly in response to shifting atmospheric conditions. The specific effects of these changes vary widely with regards to community activities, however for the most part the specific effects of these changes are already providing objectively more dangerous conditions for subsistence activities. Thinning ice, changing migration patterns and increased land erosion all increase the risks of breakdown or injury as well as the costs associated with travel and subsistence activities. However, even where the objective hazards of changing conditions are less discernible, the swiftness itself of the changes poses a challenge to the knowledge and expertise of Kivalina and thus a general increase in unpredictability and risk in travel and subsistence endeavors.

Kivalina's Search and Rescue is therefore well-poised to respond both proactively to objectively dangerous new conditions, for example with a collective weather observation and dissemination program or dangerous sea ice event monitoring system, as well as reactively, with increased capacity to respond to the the predicted increases in lost hunters, injuries and breakdowns generally associated with more challenging and unpredictable conditions.

Science and Culture Workshop General Syllabi for Modules 1, 2, and 3

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Engaged Ethnography Lab

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Purpose

These modules focus on the tundra, river, and coastline of Kivalina, AK, specifically focusing on the scientific and local knowledge of these systems. It draws on knowledge gained through the Polar Science Seminar from Spring 2021 and the literature review by the Capstone Team in Summer 2021. Elements of permafrost, hydrology, and oceanography are influenced by changes in atmospheric and surface water and/or soil temperature, directly impacting those living in Kivalina's hunting and other use of the tundra, river, and ocean/sea ice.

To reach these goals, we will use a combination of interactive powerpoint presentation, infographics communicating core environmental processes, group discussion, and conversations/observations on the land. We will split our time between "indoor" learning and "outdoor" learning (Part A and Part B, respectively), with the majority of this time allocated to the outdoor/field portion. If possible, we will round out all modules with "Part C," where we can discuss with participants their feelings, what they learn, and any remaining questions. For more detail on the structure of this workshop, see Figures 2-4 in the Appendix.

Statement of intent: We will ground this module in respect, responsibility, and reciprocity by honoring all ways of knowing, engaging with the community, and applying knowledge to the land. Each element of the workshop will be relevant to the Kivalina community to facilitate learning and engagement.

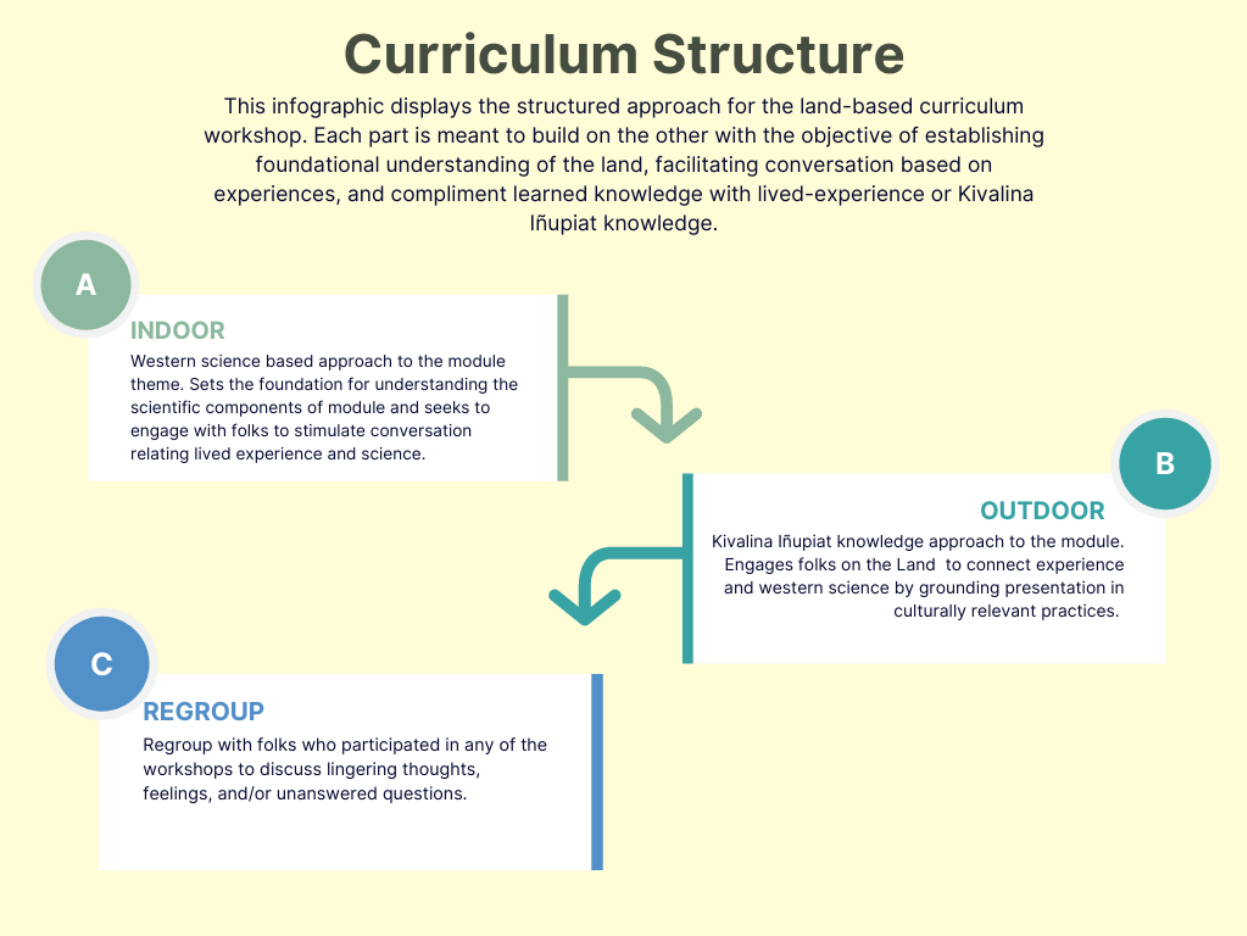

Figure 1: The visual design of the curriculum structure.

Schedule:

Land-based science curriculum
June 1-3, 2022

Day 0: UW team set up, climate change processes

Tues May 31, 2022

7pm: Orientation; evening get together with participants to build relationships
Climate change overview information

Weds June 1, 2022

Day 1: First module: Tundra and Permafrost

Breakfast & concepts (1-2 hr)
break
Travel to field site (time TBD)
Conversation with Elders on the land (~1hr)
Engage with landscape: observations, experience, feelings, question, lunch! (1.5 hr)
Discussion & conversations (~ 1-2 hr)
Travel home (time TBD)

Thurs June 2, 2022

Day 2: Second module: Wulik River

Breakfast & concepts (1-2 hr)
break
Travel to field site (time TBD)
Conversation with Elders on the land (~1hr)
Engage with landscape: observations, experience, feelings, question, lunch! (1.5 hr)
Discussion & conversations (~ 1-2 hrs)
Travel home (time TBD)

Fri June 3, 2022

Day 3: Third module: Ocean and Sea Ice

Breakfast & concepts (1-2 hr)
break

Travel to field site (time TBD)
Conversation with Elders on the land (~1hr)
Engage with landscape: observations, experience, feelings, question; lunch! (1.5 hr)
Discussion & conversations (~ 1-2 hrs)
Travel home (time TBD)

1: Tundra Module Outline

The learning objectives for this module are:

1. to understand what permafrost is, how warming temperatures affect permafrost, and how/why it is relevant;
2. to understand the ways in which thawing permafrost manifests as landscape features;
3. to facilitate understanding of the landscape through intergenerational knowledge transfer;
4. to increase ability to read the landscape for safety (with Elders);
5. to imagine new ways to navigate this changing landscape with increased safety.

Location:

New school site and pond below

Schedule

Breakfast & concepts powerpoint
Travel to field site
Conversation with Elders & community on the land
Engage with landscape: journaling observations, experience, feelings, questions, lunch!
Discussion & conversations
Travel home

Part A: Indoor Learning

Part A Mission Statement: We aim to create a lesson plan that incorporates Western scientific knowledge of permafrost and its potential impacts on Kivalina, AK while prioritizing engaging with the youth participants to ensure that the format and information is relevant, engaging, and respectful.

Section Outline

- Open with introduction of topic and guideposts
    - How presentations will be formatted and how we hope to engage in discussion together
    - Discuss relationships with tundra and permafrost, hazards of hunting on the tundra with emphasis on permafrost thaw

- Present objectives of presentation

1. Frozen water in the tundra
    a. Intro: Characteristics of arctic tundra
        i. Annual average temperatures
        ii. Underlain continuously with permafrost
        iii. Sediment?
    b. How permafrost shapes the tundra
        i. Overview of some land features caused by permafrost (e.g. ponds, empty ponds; local pics would be perfect!)
        ii. Introduce bog/pond beneath the new school site (inupiaq name? We'll come back to this topic)
    c. What makes up permafrost?
        i. Constituents of permafrost
        ii. Diagram of tundra in cold season, define permafrost, active layer, other characteristics
        iii. Begin to transition to flowing water in the tundra
2. Flowing water in the tundra
    a. Diagram of warm season permafrost changes
        i. Thaw & climate change
    b. Where does the water go?
        i. Development of features
        ii. Underground water flow
    c. In-depth look and discussion about the pond beneath new school
3. Essential details
    a. Discussion of hazards caused by permafrost thaw & flowing water on the tundra
        i. Impassable trails
        ii. Invisible sinkholes
        iii. Unstable banks
        iv. Development of new features (drainage, etc.)
    b. Impacts on river ecology
        i. Juvenile fish success
        ii. Outflow into lagoon & marine mammal impacts?

Connecting Questions

These questions are tailored to each section within the presentation and will be asked at the end of their respective section. We hope to use them to facilitate discussion and engagement within the presentation. The questions are posted at the top of the slides for their sections to

allow students to think about them while we talk, and have a more developed discussion by the time we pause for conversation rather than ask on the spot. The questions are as follows:

- Do you have to consider permafrost or permafrost thaw when you go out on the land?
- What experiences do you have with permafrost in the region?
- Are there any permafrost thaw features you interact with often? If so, what is your experience like?
- What questions do you have about this type of landscape?

Part B: Outdoor Learning

Part B Mission Statement: We aim to create a safe, respectful, and intentional environment for youth to cultivate a relevant understanding of the present landscape and its history through discussions of experiential knowledge between Elders, youth, and other members of the community, all in context of permafrost.

Section Outline

- Ask Elders to introduce where we are & what this area is used for to start
- Use open-ended questions (below) to guide storytelling/sharing from Elders
- Create space for participants to explore landscape (SAFELY), use journals to make observations, practice integrating what Elders have shared

Connecting Questions/Concepts

- Why do you use this area (for *x*)?
- **How can you tell if an area is safe to explore or what do you look for to determine safety in this environment?**
- How has the tundra landscape or bog/pond changed in your experience?
- Have you experienced any accidents in this area or rescues?
- What are the dangers/risks in this type of landscape?

2: River Module Outline

The learning objectives for this module are:

1. To understand processes contributing to hazardous conditions on the Wulik and surrounding area and how climate change affects conditions;
2. To understand how shifting seasonal changes may impact the Wulik;
3. to facilitate understanding of the landscape through intergenerational knowledge transfer;
4. to increase ability to read the landscape for safety (with Elders);
5. to imagine new ways to navigate this changing landscape with increased safety.

Location:

To be determined

Schedule

Breakfast & concepts powerpoint
break
Travel to field site
Conversation with Elders & community on the land
Engage with landscape: journaling observations, experience, feelings, questions, lunch!
Discussion & conversations
Travel home

Part A: Indoor Learning

Part A Mission Statement: We aim to create a lesson plan that incorporates Western scientific knowledge of riverine processes and how these dynamics are affected by climate change. This module will draw even more heavily on participants' lived experiences as there is not a lot of published science on the Wulik River. Through discussion, we will introduce and apply general concepts of hydrology and climate change to thinking about the Wulik. We will prioritize engaging youth participants to ensure that the format and information is relevant and respectful.

Section Outline

- Open with introduction to topic, discuss why hydrology is relevant

- What the river and sea ice provides, what hazards are present

- Introduce objectives of presentation
  - 1. Frozen river
  - 2. Flowing river
  - 3. Details
  - 4. Application and discussion

1. Frozen river
   a. Freeze up
      i. Travel, fishing (winter), dangers, reliability, hazards, ducks (spring)
   b. Break up
      i. RDM discharge (creek, river?), timing (temps), precipitation (rain)

   Pause for experience-based question and discussion - What is the river like in winter and spring?
2. Flowing river
   a. Flooding potential
      i. Historical levels
      ii. Precipitation changes
         1. Precipitation records
      iii. Water hazards
         1. Breakup timing
   b. Erosion and sediment
      i. Discussing erosion due to increase river flow, influence of permafrost melt, change in nutrient levels

   Pause for experience-based question and discussion - What do you remember about the Spring 2021 flooding event?
3. Details
   a. Influence of climate change
      i. Erosion of sediment
      ii. Temperature of water (and change)
      iii. Change in species behavior
   b. Elaborate on changing water temperatures
   c. Elaborate on change in species behavior
      i. Discuss swimming animals
      ii. Discuss land animals

   Pause for experience-based question and discussion - What changes have you recognized that could be due to climate change?
4. Application/discussion
   a. Make space to discuss topics, ask questions, tell stories

Connecting Questions

These questions are tailored to each section within the presentation and will be asked at the end of their respective section. We hope to use them to facilitate discussion and engagement within the presentation. The questions are posted at the top of the slides for their sections to allow students to think about them while we talk, and have a more developed discussion by the time we pause for conversation rather than ask on the spot. The questions are as follows:

- What is the river like in winter and spring?
- What do you remember about the Spring 2021 flooding event?
- What changes have you recognized that could be due to climate change?

Part B: Outdoor Learning

Part B Mission Statement: We aim to create a safe, respectful, and intentional environment for youth to cultivate a relevant understanding of the present landscape and its history through discussions of experiential knowledge between Elders, youth, and other members of the community, all in context of permafrost.

Section Outline

- Ask Elders to introduce where we are & what this area is used for to start
- Use open-ended questions (below) to guide storytelling/sharing from Elders
- Create space for participants to explore landscape (SAFELY), use journals to make observations, practice integrating what Elders have shared

Connecting Questions/Concepts

- Why do you use this area (for *x*)?
- **How can you tell if an area is safe to explore or what do you look for to determine safety in this environment?**
- How has the landscape changed in your experience?
- Have you experienced any accidents in this area or rescues?
- What are the dangers/risks in this type of landscape?
- Discussion about caribou
- Discussion about search and rescue
- Discuss what they see people (hunters, Elders) doing around that time of year/seasonally

- Engage with personal experience, relate to presentation and season, discuss with elders

3: Oceanography Module Outline

The learning objectives for this module are:

1. to understand the relevant elements of oceanography and how warming temperatures affect sea ice and oceanography, and how/why it is relevant
2. to understand the ways in which warming temperatures manifests as sea ice changes;
3. to facilitate understanding of the landscape through intergenerational knowledge transfer;
4. to increase ability to read the landscape for safety (with Elders);
5. to imagine new ways to navigate this changing landscape with increased safety.

Location:

77 Camp (tentatively)

Schedule

Breakfast & concepts powerpoint
break
Travel to field site
Conversation with Elders & community on the land
Engage with landscape: journaling observations, experience, feelings, questions, lunch!
Discussion & conversations
Travel home

Part A: Indoor Learning

Part A Mission Statement: We aim to create a lesson plan that incorporates Western scientific knowledge of sea ice and its potential impacts for Kivalina, AK while prioritizing engaging with the youth participants to ensure that the format and information is relevant, engaging, and respectful.

Section Outline

- Open with introduction to topic, discuss why oceanography is relevant
    - What the ocean and sea ice provides, what hazards are present
- Introduce objectives of presentation
    - 1. Open water

- 2. Closed water
- 3. Characteristics
- 4. Application and discussion

1. Open water (currents, wind)
    a. Discuss why currents/saġvaq are relevant
        i. Introduce Alaska Coastal Current (ACC)
        ii. Mention influence of Pacific water, winds, coastline
        iii. Related to upwelling

    Pause for experience-based question and discussion - What changes have you noticed about the main current?
2. Closed water (ice formation and breakup, seasonal changes)
    a. Discuss sea ice/siku
        i. Discuss freeze up/ice coverage
            1. Influence of ice on currents
            2. Freeze and melt of ice, ice thickness
        ii. Discuss graphs depicting ice freeze/coverage changes
    b. Discuss influence of seasons
        i. Driving changes of currents, sea ice, thermocline, upwelling
        ii. What has changed

    Pause for experience-based question and discussion - What changes have you had to implement in your approach to using the ice, if any?
3. Details (upwelling, thermocline, ecology)
    a. Introduce upwelling
        i. Discuss why upwelling is important
        ii. Connect to ACC from section 1
        iii. Plant seed for discussion on sea life

        Quick pause for experience-based question and discussWhy do you think it is important to know about these patterns?
    b. Introduce thermocline
        i. Discuss function and relevance of thermocline for oceanography as a practice, why it is important to understand
        ii. Break down what the thermocline is like in KVL
    c. Round off with ecological discussion
        i. Introduce and discuss phytoplankton/productivity
            1. Tie back to upwelling
        ii. Introduce and discuss fish
        iii. Introduce and discuss marine mammals

Pause for experience-based question and discussion - What changes have you noticed with the marine animals in the region, if at all?

4. Application/discussion
    a. Make space to discuss topics, ask questions, tell stories

Connecting Questions

These questions are tailored to each section within the presentation and will be asked at the end of their respective section. We hope to use them to facilitate discussion and engagement within the presentation. The questions are posted at the top of the slides for their sections to allow students to think about them while we talk, and have a more developed discussion by the time we pause for conversation rather than ask on the spot. The questions are as follows:

- What changes have you noticed with the Alaska Coastal Current?
- What changes have you had to implement in your approach to using the ice, if any?
- Why do you think it is important to know about these patterns?
- What changes have you noticed with the marine animals in the region, if at all?

Part B: Outdoor Learning

Part B Mission Statement: We aim to create a safe, respectful, and intentional environment for youth to cultivate a relevant understanding of the present landscape and its history through discussions of experiential knowledge between Elders, youth, and other members of the community, all in context of permafrost.

Section Outline

- Ask Elders to introduce where we are & what this area is used for to start
- Use open-ended questions (below) to guide storytelling/sharing from Elders
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Connecting Questions/Concepts

- Why do you use this area (for *x*)?
- **How can you tell if an area is safe to explore or what do you look for to determine safety in this environment?**
- How has the landscape changed in your experience?
- Have you experienced any accidents in this area or rescues?
- What are the dangers/risks in this type of landscape?

- Discussion of search and rescue
- Discussion of whaling, etc.
- Discuss what they see people (hunters, Elders) doing around that time of year/seasonally
    - Engage with personal experience, relate to presentation and season, discuss with elders

Part C: Reflection

This section will be a time and space to regroup and have a conversation about all the topics we conversed about. Ideally over a meal or something similar, we hope to talk with the youth, Elders, and other community members about the experience, what they liked/disliked about it, and what additional questions or comments they may have. This is also a chance for Kivalina community members to discuss how these aspects of the land impact the Search and Rescue (SAR) team. This section is intended to discuss the question: what now?

Appendix

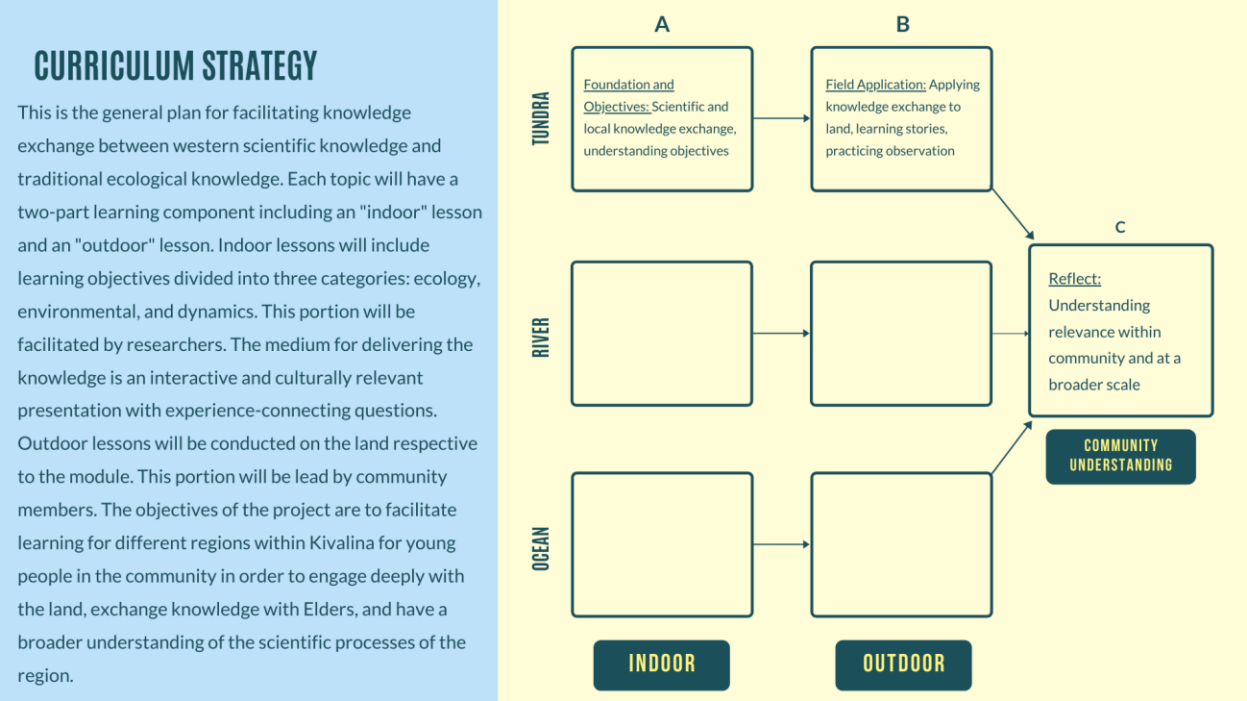

Figure 2: Curriculum strategy visual plan outlining the structure of the workshop, including Parts A, B, and C, and understanding the general components of each.

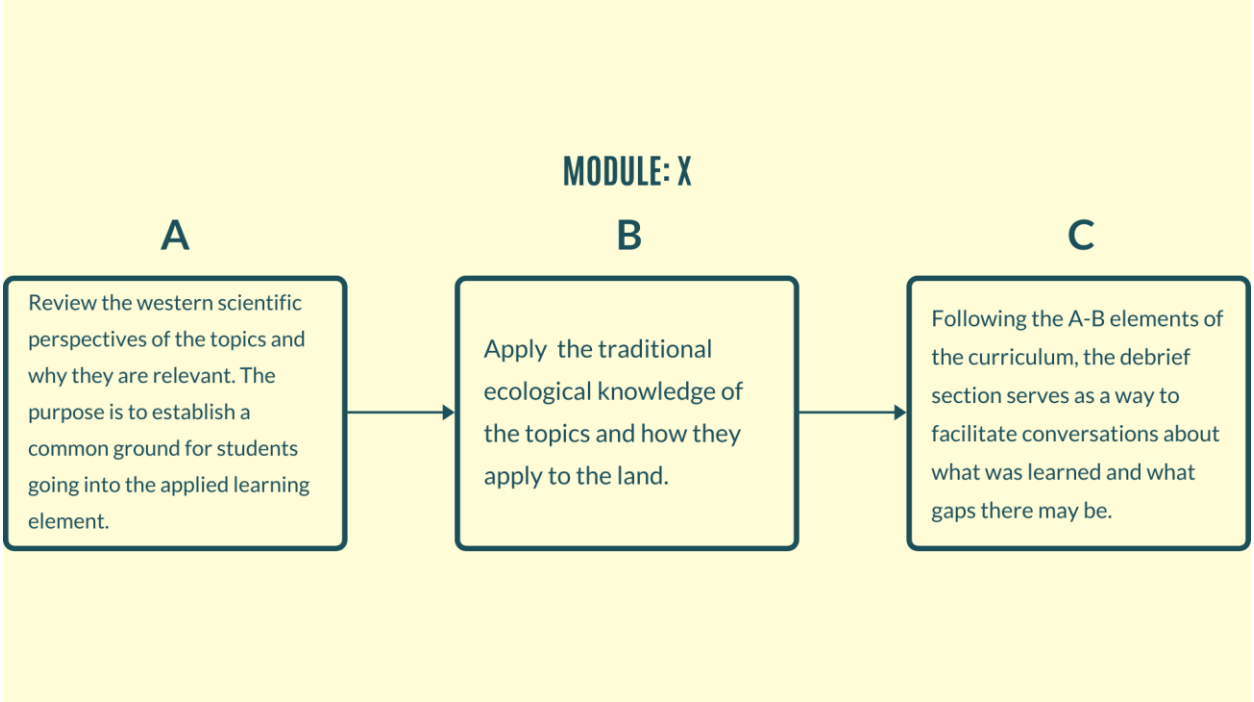

Figure 3: A zoomed-in breakdown of the structure of an individual module for the workshop. Parts A, B, and C relate back to the respective sections in Figure 2. This visual design elaborates on the general approach for each step of the workshop.

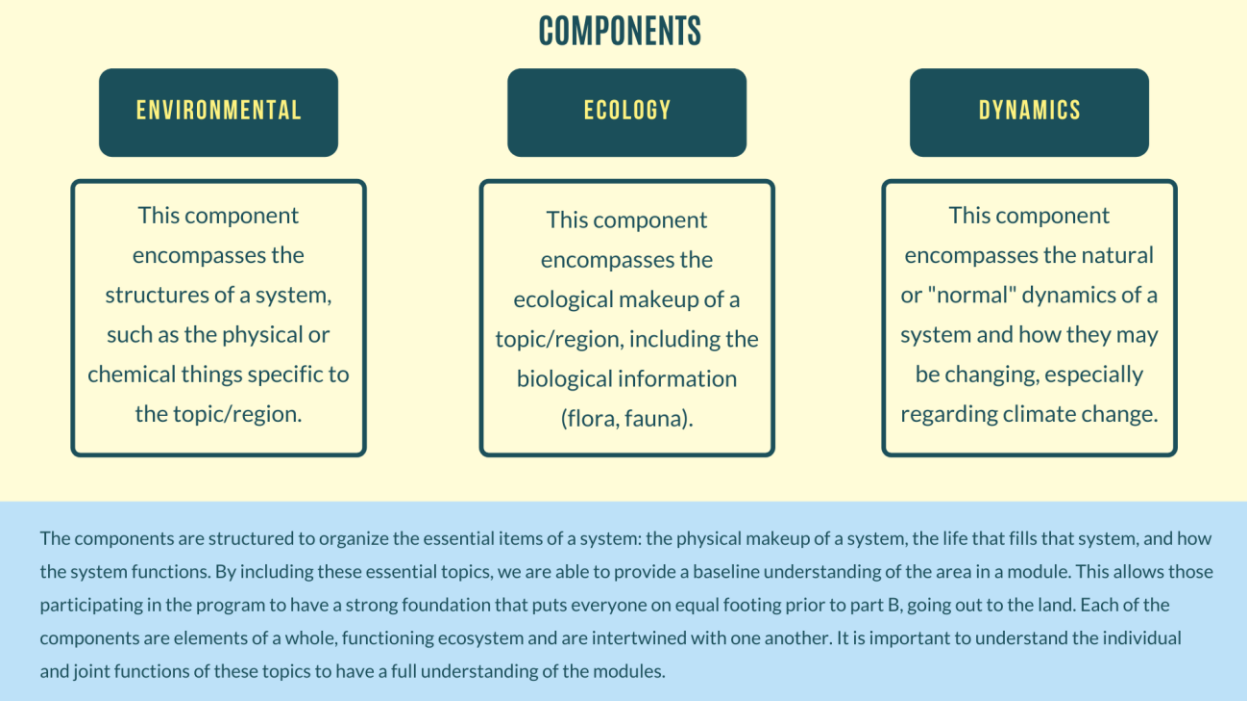

Figure 4: The visual breakdown of Part A for the workshop. This infographic elaborates on the approach for Part A of the workshop, detailing how the presentations are broken up into three general categories: environmental, ecological, and dynamic.