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| **Traditional Ecological Knowledge and Natural History:**  **Sharing Knowledge about the Natural World** | Natural History Collection |

**Pre-Lab Activity**

1. Watch the video, [A Year in the Life of a Bowhead Whale](https://arcticcurrents.wordpress.com/see-the-film/)[[1]](#footnote-1) (24 minutes) to learn more about the bowhead whale biology, ecology, and behavior. This video includes insights into how the Indigenous knowledge held by Alaskan Native Whalers guided Western Scientists towards understanding of the bowhead whale biology and ecology. The Inuit Alaskan Native Whalers imparted their traditional ecological knowledge, dating back thousands of years and shared across generations. Inuit taught their knowledge of biology, ecology, and sustainable whaling practices to western scientists, while managing bowhead whale for sustainable use and maintaining Inuit Native culture, practices, and traditions.

The map below is provided to help contextualize some of the locations in the video.

Map

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1. Spend some time looking around the *Arctic Currents* website and learn the details of making this film.
2. Review the Alaskan Native Knowledge Network [Guidelines for Respecting Cultural Knowledge](http://www.ankn.uaf.edu/publications/knowledge.html)[[2]](#footnote-2). (Hint: This information will help you answer the CER question).
3. Use the Claim-Evidence-Reasoning framework to answer the following question:

*Is this video respectful of the collaboration with and shared knowledge of the Inuit people?*

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| **Topic/Theme/Question:** What question are you trying to answer?  Is this video (and the museum) respectful of the collaboration with and shared knowledge of the Inuit people? |
| **Claim:** This is your answer to the question. It should be just a *single complete sentence* and it should incorporate part of the question.  This videographer takes care to respect the contributions of the Inuit people and engage the Inuit community in the production of this film. |
| **Evidence:** What information or evidence supports your claim? How do you know this? Include five pieces of evidence. *Evidence can take a variety of forms: research, facts, observations, lab experiments, or even quotes from interviews or authorities.*  Available in Inuit tribal languages  Uses Inuit names for locations  Uses Inuit voices  Traveled to Barrow to observe firsthand the striking weather, environs and atmosphere.  Sharing film clips with scientists and artists and whalers for critique and feedback,  Collected accounts of encounters with bowheads, gaining a better understanding for the deeply engrained culture surrounding the bowhead whale  Collaborative in language and intent  Respects the Inuit contributions and way of knowing  Inuits critiqued quotes/interpretations  Representation of cultural content is accurate, contextually appropriate and explicitly acknowledged  Drawing upon Elders and other cultural experts in the surrounding community to make sure all resource materials and learning activities are culturally accurate and appropriate.  Establish multiple levels of review to ensure that all publications are culturally accurate and appropriate  Consideration to the cultural perspectives of all groups represented in documents subjected to review.  Obtaining informed consent, accurately representing the cultural perspective and protecting the cultural integrity and rights of all participants in a research endeavor.  Exercise informed critical judgement about the cultural authenticity and appropriateness of the materials they utilize. |
| **Reasoning:** Why and how does the evidence support the claim? How does the evidence lead you to the claim? *This section will be the majority of your writing.*  The inclusion of the Inuit people in the co-development, production, review, and execution of the film, respecting languages and tribal differences, and crediting the Inuit tribes with their contributions nee knowledge of science brings the community into the discussion and provides an opportunity for the whalers to frame the discussion of their own contributions. The authors are careful to respect the people and the nature, discussing the science and the TEK in a holistic way. |

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We wish to recognize the Anishinaabe people on whose traditional land Central Michigan University resides upon today and the land on which the [Saginaw Chippewa Indian Tribe](http://www.sagchip.org/)have resided on for over 200 years. To recognize the land is an expression of gratitude and appreciation to those whose territory you reside on, and a way of honoring the Indigenous people who have been living and working on the land from time immemorial (existing since beyond the reach of memory). It is important to understand the long-standing history that has brought us to reside on the land, and to seek to understand our place within that history.

*chi Miigwech* (thank you very much)

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| “*Science is what scientists do, and there are as many scientific methods as there are individual scientists.”*  *- Percy Williams Bridgman*  *“Science can be a way of forming intimacy and respect with other species that is rivaled only by the observations of traditional knowledge holders. It can be a path to kinship.” ― Robin Wall Kimmerer* |

## Objectives

Upon completion of this module, each student should be able to:

* Defend the different ways of knowing and understanding the natural world.
* Incorporate both the process of Western Science and Traditional Ecological Knowledge to better understand biology and the conservation of natural resources.
* Identify strategies for respectful and successful collaboration when working with Native communities.
* Interpret graphs and apply data to biological questions.
* Describe examples of how scientists’ backgrounds and biases can influence science.
* Evaluate how science is enhanced through diversity.

**Introduction**

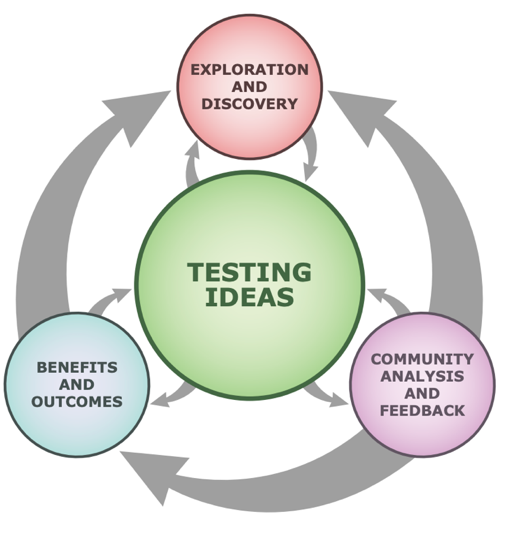
In this module, you will be learning about the nature of science as we explore what we know about the bowhead whale and how we know it. You will explore Western Science (WS) and Traditional Ecological Knowledge (TEK) and review a case study of how the TEK of the Inuit provided a way of knowing and understanding the biology of the bowhead whale in the Alaskan arctic. Throughout this series of activities, you will integrate the shared TEK and the efforts of Western science. We will listen to the Inuit perspectives, explore how Inuit knowledge provides insight into the biology and ecology of the bowhead whale, and investigate specific examples of how the shared TEK advanced the way WS researched bowhead whales.

Western Science

Science is both a set of practices (way of knowing) and the historical accumulation of knowledge (body of knowledge). Western Science represents one set of practices for investigating and explaining the natural world. Within the framework of Western Science, the **Nature of Science** is a set of characteristics that describe the values and beliefs inherent to the development of scientific knowledge. These characteristics are that science knowledge is:

* About the natural world
* Tentative
* Empirical
* Subjective (theory-laden and influenced by the body of scientific knowledge)
* Influenced by human inference, imagination, and creativity
* Socially and culturally embedded

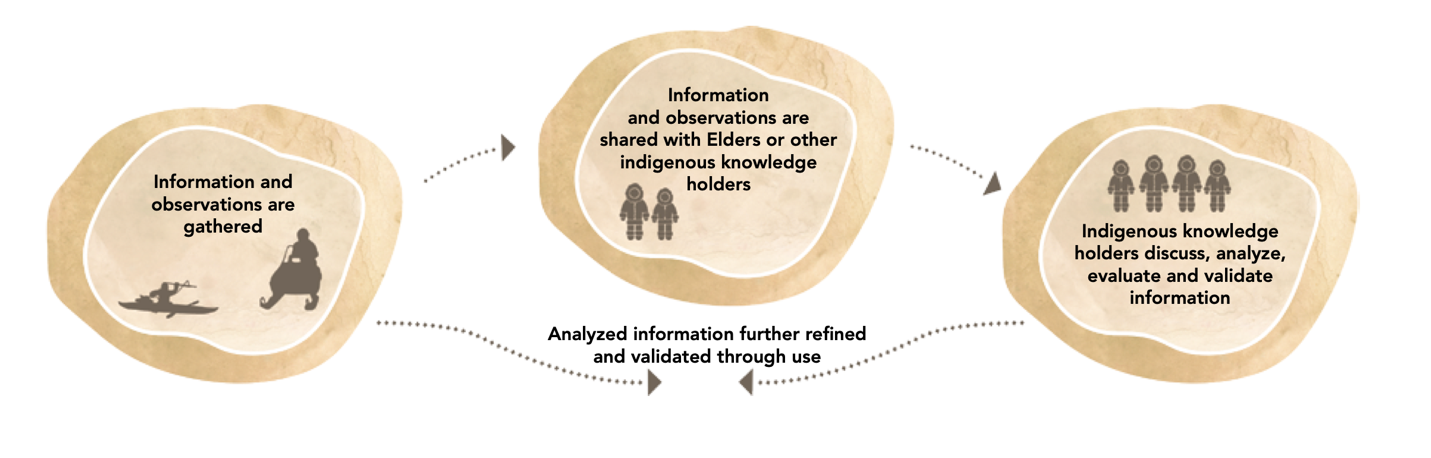
The **Process of Science[[3]](#footnote-3)** is how inquiry occurs in western science. Contrary to many depictions of the process of science as a linear progression, there is actually *no set sequence*. Science circles back on itself and science is a *collaborative* and *creative* process. Science is *iterative* and doesn't stop at a conclusion, but continues with further testing, new ideas, and new questions about the natural world. A simplified How Science Works diagram is provided below.[[4]](#footnote-4)

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Traditional Ecological Knowledge[[5]](#footnote-5)

Traditional Ecological Knowledge (TEK) goes by several names, including Indigenous knowledge and Native science. TEK is different in every single Indigenous community - it is highly localized, place-based, and relational. Every group will have a different set of methodologies, a different process for refining their methodologies, and a different way of describing their bodies of knowledge. For the purpose of this activity, we are focusing on how TEK is defined by the Inuit Circumpolar Council as: *a systematic way of thinking applied to phenomena across biological, physical, cultural, and spiritual systems. It includes insights based on evidence acquired through direct and long-term experiences and extensive and multigenerational observations, lessons, and skills. It has developed over millennia and is still developing in a living process, including knowledge acquired today and in the future, and it is passed on from generation to generation*.

In this case study, we will be exploring TEK generated by the Inuit. For the Inuit, TEK is essential for food security and sustainability of their way of life. The Inuit have worked together to address the challenges associate with climate change and its impact on their culture and food sources. Working together, they call for holistic information based on Indigenous Knowledge. One Inuit way of knowing is shown in the figure below.[[6]](#footnote-6)



**Activity I: Nature of Western Science and TEK**

1. Review the Nature of Science and TEK definitions and examine the diagrams of the Process of Science and the TEK way of knowing.

How would these two processes work together to create a deeper understanding of the natural world? *Your answer can be in any written form (paragraphs, drawing, model, FlipGrid, etc.). The goal is to communicate how the two ways of knowing can work together to improve knowledge and understanding about the natural world.*

The answer here (as I see it) is that the TEK flow follows similar processes but the emphasis is holistic and centered on shared knowledge. The sharing of information is oral and embedded in historical environmental context. The knowledge holders are Native elders. TEK is not embedded in the western science literature, theory, and body of knowledge. So, the nature of TEK is about the natural world, tentative, empirical, subjective (as is WS), it can be theory-laden and influenced by body of scientific knowledge; it is aligned with Indigenous knowledge holders); Involves human inference, imagination, and creativity, and socially and culturally embedded. For the Process of Science portion, TEK is very similar, though there is a component of supernatural (beyond scientific understanding). The TEK way of knowing is observation based and not embedded in statistics and technology.

**Activity II:** **Inuit Perspectives** *[read all four questions before beginning]*

1. Read [The Native Whaler's View](https://www.boem.gov/about-boem/public-engagement/native-whalers-view) where whaling captain Burton "Atqaan" Rexford provided testimony on what it means to be a subsistence hunter and whaling captain.
2. Read pages 2&3 and 112&13 of the [Alaskan Inuit Food Security Conceptual Framework](https://iccalaska.org/wp-icc/wp-content/uploads/2016/05/Food-Security-Full-Technical-Report.pdf) to see quotes from the Inuit people regarding their subsistence culture.
3. Go to the [Northwest Arctic Borough School District website](https://www.nwarctic.org/Page/4188) and watch some of the interviews. Listen to the words of the Inuit. What do you hear?
4. Find 5 examples from the readings or interviews of statements that provide knowledge and observations that can inform about the natural world in the arctic. List the quote and the knowledge gained in the table below:

|  |  |  |
| --- | --- | --- |
| Example | TEK Quote | Knowledge of Natural World |
| 1 | This is section has many answers; there is no single set of answers is correct |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**Activity III: Case Study -** **Bowhead Whale Migration**

The Iñupiat people (Inuit community in Alaska; the traditional territory includes [Norton Sound](https://en.wikipedia.org/wiki/Norton_Sound) on the Bearing Sea all the way to the northernmost Canadian-United States Border) are dependent on subsistence harvesting of marine and land mammals. Of particular importance to their survival and culture is the bowhead whale. Whaling by outsiders (non-Inupiaq) drove population levels down and jeopardized Inupiaq subsistence harvesting. In 1977, fewer than 1000 bowhead whales were observed by NOAA scientists in the Bering-Chukchi-Beaufort Sea. As a result, the International Whaling Commission put a moratorium on harvesting the bowhead. Western scientist were making incorrect assumptions about the whale behavior. They conducted their census by counting whales in the open water and assumed the whales did not travel under the large sheets of arctic ice.

Harry Bowser, Sr., an Iñupiat whaling captain, questioned the results and conclusions of the NOAA scientists. He stated that, “*There are a lot of bowheads out there that the scientists aren’t counting. Many are out in the ice and therefore are not seen when they pass by Barrow. As a result of poor counting, the scientific community helps put these unfair quotas upon us.*” The NOAA scientists and International Whaling Commission were making decisions that affected Iñupiat subsistence and culture. Western science and scientists making decisions and laws that affect indigenous people within a study region, and not working with the Native community, sets up uneven power dynamic. In addition, decision did not take into account the Iñupiat people and their more nuanced knowledge of the arctic region and bowhead whale. For years, the Iñupiat whalers had been telling researchers the whales would migrate under the ice. The elders led an effort to preserve their land, traditions, and ways of being by conducting their own census with their Iñupiat scientists, and determined that the NOAA scientists had been undercounting the whales.

The Iñupiat results and shared knowledge prompted the Western scientists to revisit their assumptions and revise their methods of counting whales. Using acoustic technology that could monitor bowhead calls, scientists learned that bowhead whales would migrate under the ice up to 20 km from the sea edge. As a result, the Western scientists learned that bowhead whale numbers were closer to 16,000 and the recovering population was increasing annually by 3.5%.

A picture containing indoor, ray

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Bowhead Whale

Public domain CCO image from www.rawpixel.com

1. If the Iñupiat people were required to cease all bowhead whale hunting, what would be the impact to their subsistence-based culture (this question builds from the Bowhead Video and Inuit perspectives)?

It would impact the health, subsistence, and culture of the Iñupiat people.

1. In the writing above, what does the Iñupiat Traditional Ecological Knowledge teach about Bowhead whales?

The Iñupiat whalers knew the Western scientists were undercounting whales by not counting whales migrating under the ice. The elders nuanced understanding of whale biology had the Iñupiat whalers knowing the whale populations were larger, and large enough to allow for harvesting. This is important! For generations the Iñupiat whalers monitored bowhead whale populations as they relied on the whales for their livelihood. They knew the populations were “Large enough to allow for harvesting” and sustainable using their traditional methods.

1. How did the Iñupiat scientists TEK inform the Western scientists? How did the Western Scientists change their study design and methods after Iñupiat scientists shared their knowledge?

The Iñupiat whalers’ TEK indicated bowhead were traversing under the ice. Western scientists used acoustic technology to detect the presence of bowheads under the ice. This allowed Western Scientists to count the whales, and determine an annual increase in population size. The Inuit knew details of the life history that informed Western sciences "study design."

1. Why is it not correct to say, “Western scientists confirmed the findings of the Iñupiat scientists TEK?”

Traditional Ecological Knowledge is based on millennia of shared knowledge. It does not need to be confirmed to be “correct” or “confirmed.” It is legitimate in its own right and should be respected without the need for “confirmation” by Western scientists and science.

**Activity IV: Case Study – Bowhead Whales’ Sense of Sound**

Due to climate change caused by oil drilling and burning, the arctic ice has retreated. The reduction in ice and changing climate have affected the delicate ecology of the arctic and the Inuit subsistence culture. The impact on the Inuit has been further impacted as the reduced ice shield has resulted in increased traffic and energy exploration for offshore oil and gas. Western scientists have been deploying seismic vessels in the arctic in order to locate the best possible areas for oil drilling. The seismic vessels emit loud sonic explosions that provide a map of the seabed floor which can then be used to find oil and gas deposits. Oil companies employed ships and seismic guns in the migratory paths of arctic mammals, including the bowhead whale.

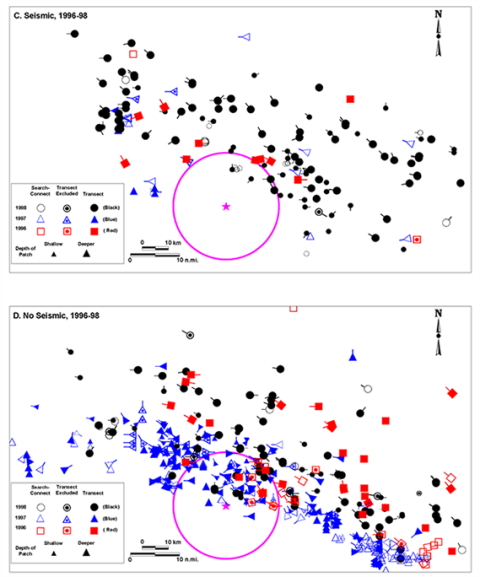
Scientists believed the seismic activity was not a significant deterrent for the migrating arctic whales. They did not consult with the indigenous communities before deploying their seismic guns nor work with the Inuit people who occupied the region. The Inuit hunters were convinced the seismic guns were having negative impacts on the bowhead migration. The whalers had always been careful to keep low noise levels during their hunts to avoid warning the bowhead whale of their approach. After the arrival of the seismic vessels, hunters were noticing a change in the whale behavior. whales were moving away from the ships and hunters were having to move further out to more dangerous waters to hunt whales. After the Inuit whalers communicated their concern, the Western scientists decided to take a closer look at the whale responses to the seismic vessels.

1. What did the Inuit Whalers know that Western Scientists did not?

Whales can sense noise

Below is a set of two graphs showing the results of a study by Richardson et al. (1991).

*In the figures below, the pink star represents the position of a seismic vessel; the pink circle represents a 20 km radius for reference. All dots represent whale sightings. The top graph shows the presence of whales when a seismic vessel is operating seismic air guns; the lower graph shows the presence of whales when the seismic vessel is NOT operating air guns*[[7]](#footnote-7).



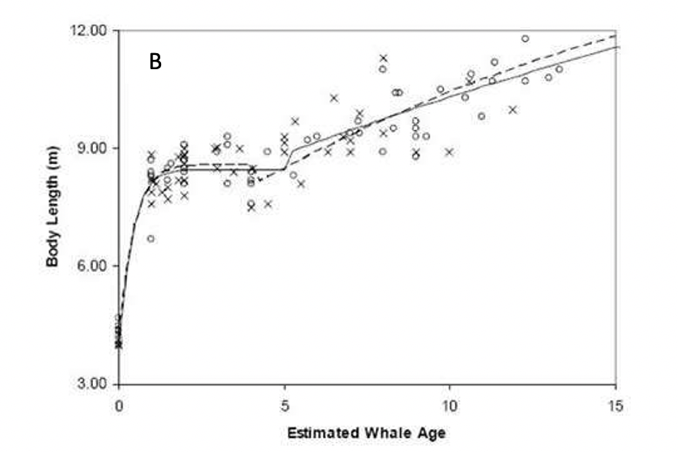
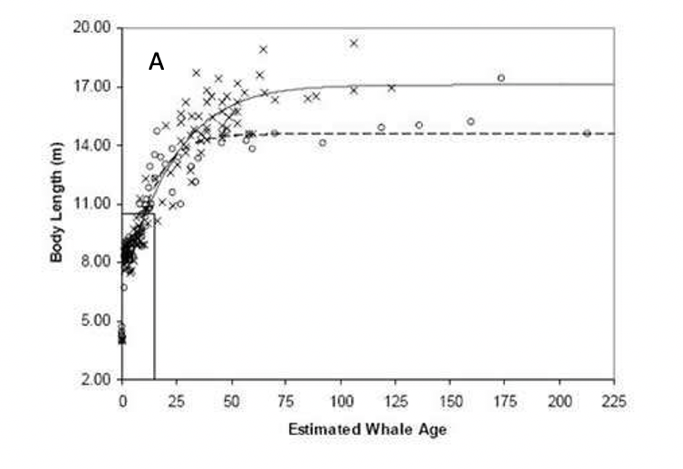
1. What do these graphs tell you about noise disturbance and migrating bowhead whales?

This study showed that migrating bowhead whales were essentially excluded from a circular zone (pink circle) with a 12-mile radius around a seismic operation. Sightings of bowhead whales were lower during seismic (figure C) activity than without seismic (figure D).

**Activity V: Case Study – Bowhead Whale Growth and Longevity**

Whaling captains told Western Scientists that bowheads grow rapidly through their first year and then slow or cease growing for a number of years. Ralph Aveoganna told biologists, “Bowheads start off as iŋutuks, then don’t grow, but grow their baleen and become qairaliq's.” *I*ŋutuk is an Iñupiat word that means a fat, young whale with a short baleen. *Q*airaliqis Iñupiaq for a skinny, young whale with a big head and longer baleen relative to an iŋutuk. This information prompted scientists to look at bowhead body size and life history. Below are two graphs showing the results of a study by Lubetkin, S.C. et al. (2008).

*The graphs below show the relationship between body length and age of bowhead whales, indicating their growth over time. In the figures below: graph A follows the growth of bowhead whales over their projected lifetime, the Graph B provides more detail for the first 15 years of a bowhead whale's life.[[8]](#footnote-8)*

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1. Western Scientists believed the bowhead whale lived between 50-70 years (similar to other large whales). The Inuit would tell the western scientists that they would see whales that lived for multiple Inuit generations. Looking at graph A, how old was the oldest bowhead whale used in the study? How does this study relate to the Inuit TEK?

215 years old; yes

1. Looking at graph B, what can you tell me about the growth pattern of bowhead whales in their first 5 years? How does this study relate to the Inuit TEK?

You can see the rapid growth during the first year and the "hiatus" until about age 5 when growth resumes at a slow but steady pace. This data is consistent with the TEK of the senior whaling captains.

**Assessment[[9]](#footnote-9)**

Use the Claim-Evidence-Reasoning model to answer the following question.

*Is science enhanced through collaboration and a diversity of individuals practicing science? Describe how scientists’ backgrounds and biases influence science. Use examples from research on the bowhead whale.*

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| **Topic/Theme/Question:** What question are you trying to answer?  Is science enhanced through collaboration and a diversity of individuals practicing science? Describe how scientists’ backgrounds and biases influence science. Use examples from research on the bowhead whale. |
| **Claim:** This is your answer to the question. It should be just a *single complete sentence* and it should incorporate part of the question.  Yes, science is enhanced through collaboration and through a diversity of perspectives and ways of knowing. |
| **Evidence:** What information or evidence supports your claim? How do you know this? Evidence can take a variety of forms: research, facts, observations, lab experiments, or even quotes from interviews or authorities.  Western Scientists studying the bowhead whale did not know or understand the biology of the bowhead whale. WS had access to broad biological knowledge from the western science perspective and technology. Inuit have broad biological knowledge (from 10,000 years of experience) and advanced tools include things like intergenerational knowledge retention & transmission, skills and ability to approach bowheads, observe and record bowhead behavior, etc. In the absence of the TEK, WS did not design research in a way that could assess population size accurately and manage the whale populations, assess impacts of seismic activity, determine the age of whales or distinct growth patterns. Inuit whalers had TEK that 1) could answer the questions posed by WS, and 2) inform study design if additional questions were asked. Western scientists were able to bring a body of knowledge from the science community and novel tools (technology, statistics, etc.) that, once WS utilized the information and knowledge from Inuit TEK, they could provide specific information (e.g., size of population, growth rate, age of whales, specific impact and range of impact from seismic guns, etc.).  \*What is not clear is how multidirectional the exchange of knowledge was in the case of the bowhead whale. Much of what is written is written about TEK is “consultation-like.” To further nuance this issue read [David-Chavez and Gavin (2018)](https://iopscience.iop.org/article/10.1088/1748-9326/aaf300/meta) to examine how Indigenous engagement ranks along the “ladder of [citizen] participation,” which ranges from contractual participation (exploitation) to Indigenous participation (community control). |
| **Reasoning:** Why and how does the evidence support the claim? How does the evidence lead you to the claim? *This section will be the majority of your writing.*  If you have a diverse set of scientists and knowledge keepers, they bring diverse knowledge, perspectives, experiences, and ways of knowing. This diversity of thought promotes new insight, novel solutions, and innovation. When diverse scientists work together, all ways of knowing gain more comprehensive and insightful knowledge. |

1. Arctic Currents: A Year in the Life of the Bowhead Whale, Accessed 17 November 2020 < https://arcticcurrents.wordpress.com/see-the-film/> [↑](#footnote-ref-1)
2. Guidelines for Respecting Cultural Knowledge, Accessed 17 November 2020 < http://www.ankn.uaf.edu/publications/knowledge.html > [↑](#footnote-ref-2)
3. Lederman, N.G., Lederman, J.S., & Antink, A. (2013). Nature of science and scientific inquiry as contexts for the learning of science and achievement of scientific literacy. International Journal of Education in Mathematics, Science and Technology, 1(3), 138-147. [↑](#footnote-ref-3)
4. How science works flowchart. Understanding Science. 2020. Used with permission by the University of California Museum of Paleontology. 26 October 2020 <https://undsci.berkeley.edu/lessons/pdfs/simple\_flow\_handout.pdf>. [↑](#footnote-ref-4)
5. Context for the discussion of the bowhead whale and Inuit culture can be found in the video:

   [A Year in the Life of a Bowhead Whale](https://arcticcurrents.wordpress.com/see-the-film/) [↑](#footnote-ref-5)
6. https://iccalaska.org/wp-icc/wp-content/uploads/2016/05/Food-Security-Full-Technical-Report.pdf [↑](#footnote-ref-6)
7. Richardson, W.J. (ed.) 1999.; Marine mammal and acoustical monitoring of Western Geophysical’s open-water seismic program in the Alaskan Beaufort Sea, 1998. LGL Rep. TA2230-3. Rep. from LGL Ltd., King City, Ont., and Greenridge Sciences Inc., Santa Barbara, CA, for Western Geophysical, Huston, TX, and National Marine Fisheries Service, Anchorage, AK, and Silver Spring, MD; 390 p. [↑](#footnote-ref-7)
8. Lubetkin, S.C.et al. 2008. [Age estimation for young bowhead whales (Balaena mysticetus) using annual baleen growth increments.](http://www.north-slope.org/assets/images/uploads/lubetkin_et_al_2008_can_j_zoo_age_estimation_baleen.pdf) Canadian Journal of Zoology 86:525-538. [↑](#footnote-ref-8)
9. *This lab draws from the content on the Traditional Ecological Knowledge of Bowhead Whales, Official Website of the North Slope Borough Accessed November 9, 2020* [*http://www.north-slope.org/departments/wildlife-management/studies-and-research-projects/bowhead-whales/traditional-ecological-knowledge-of-bowhead-whales*](http://www.north-slope.org/departments/wildlife-management/studies-and-research-projects/bowhead-whales/traditional-ecological-knowledge-of-bowhead-whales) Qayaannaqpauraq (Thank you) for sharing your knowledge [↑](#footnote-ref-9)