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Blue Whale Flipper Box 003

Customized lesson plan and specimen information

Welcome to the Blue Whale Flipper Beaty Box!

This outreach kit is intended to provide you and your students with the opportunity to connect with the Beaty Biodiversity Museum's (BBM) unique biological collections. The Beaty Box contains touchable scientific objects to stimulate inquiry and discussion within the classroom, enhancing the student learning experience.

Theme

The theme for this Beaty Box is **blue whale flipper bones**, with a focus on observing and comparing blue whale flipper bones to the bones of the human hand. Under this theme, students can learn more about:

- The texture, structure, and weight of blue whale flipper bones
- The similarities and differences between blue whale flipper bones and human hand bones
- The lifestyle, behaviour, and importance of blue whales in our ecosystem

By the end of the lesson, your group should feel more comfortable with identifying features of blue whales and communicating these observations through drawing and assembly.

How can I integrate the Beaty Box into my curriculum?

- We encourage you to adapt the contents of the Beaty Box and its lesson plan to best fit your curriculum.
- Before you begin your lesson, please take the time to familiarize yourself with the contents of the Beaty Box.
    - Both sections of this manual contain useful background information on the contents of this Beaty Box.
    - It is highly encouraged that you convey material about the Beaty Box contents to your group before or during the x-ray activity.
- Use the online resources that are referenced throughout the manual to help compliment your lessons.
    - See 'Additional Resources' for links to additional worksheets and activities.
    - Show some videos of blue whales before or during the activity to help bring the specimen to life.
- If possible, consider taking your group to the BBM before or after using the Beaty Box to add to their biodiversity experience.

Whale Bones X-ray Lesson Plan

Close observation of specimens is a way of highlighting the biodiversity of living things. Holding the whale bones in their hands and laying them out on the x-ray allows students to understand the scale and structure of the flipper in a memorable way. Students can inspect the bones from all angles while feeling the weight and texture of the material, showcasing the sheer size of blue whales. In this section, we have included a suggested blue whale flipper lesson plan for you and your group. Please feel free to modify these activities to best suit your needs.

Some of the "big ideas" and core concepts this Beaty Box touches on are:

Arts Education

- K-1: Develop processes and technical skills in a variety of art forms to nurture motivation, development, and imagination
- Arts Education 2: Develop processes and technical skills in a variety of art forms to refine artistic abilities, reflect on creative processes and make connections to other experiences
- Arts Education 3-5: Connect knowledge and skills from other areas of learning in planning, creating, and interpreting works of art
- Arts Education 6-7: Demonstrate an understanding and appreciation of personal, social, cultural, historical, and environmental contexts in relation to the arts; interpret creative works using knowledge and skills from various areas of learning
- Arts Education 8-12: A variety of content links can be explored during this program.

Science Education

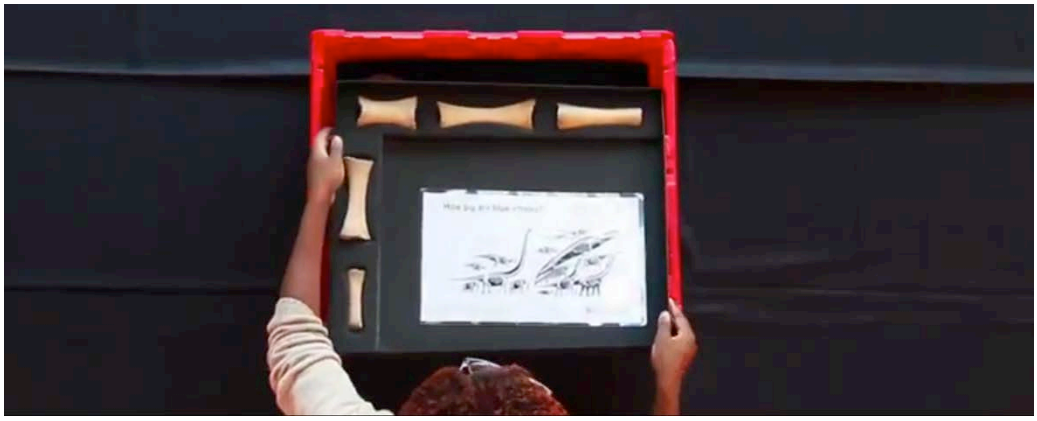
- Kindergarten: Plants and animals have observable features; daily and seasonal changes affect all living things
- Science 1: Living things have features and behaviours that help them survive in their environment
- Science 2: All things have a life cycle
- Science 3: Living things are diverse, can be grouped, and interact in their ecosystems.
- Science 4: All living things and their environment are interdependent
- Science 5: Multicellular organisms have organ systems that enable them to survive and interact within their environment
- Science 6: Multicellular organisms rely on internal systems to survive, reproduce, and interact with their environment
- Science 7: The theory of evolution by natural selection provides an explanation for the diversity and survival of living things
- Science 10: Genes are the foundation for the diversity of living things
- Biology 11: All organisms have characteristics that define them as living and interdependent. Life can be organized in a functional and structural hierarchy ranging from cells to the biosphere; living things are interdependent; living things are diverse and evolve over time
- Biology 12: Cells are the basic unit of life

Photos: Unpacking Your Beaty Box

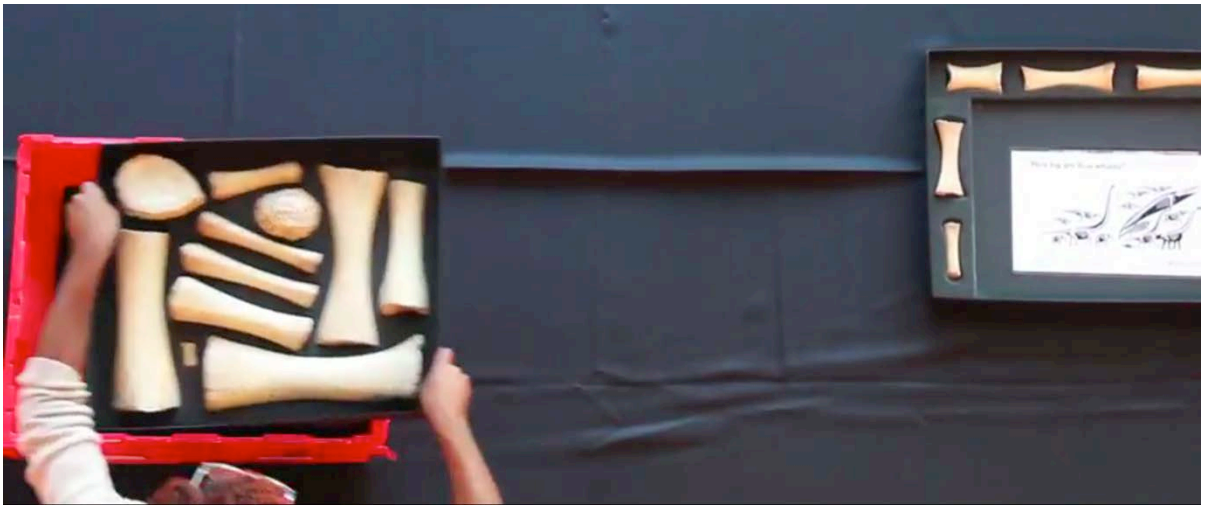
We recommend watching our unpacking video at https://youtu.be/LUPvSZMk0UE
Set aside space for the whale puzzle before you unpack the box. Estimate that you will use floor space roughly the size of a large table. Move the trays of bones directly to your activity area to keep your space tidy.

Tray 1:

Remove the x-ray first, set it aside. Lift out the tray and move it to your activity area. You will remove the bones gently when you are ready to complete the puzzle.



Tray 2:
Lift out the tray and move it to your activity area.



Tray 3:
The tray is glued to the box. Simply remove the bones from the foam when you are ready.

Unfolding the X-ray Sheet

The video will help walk you through each step. Be gentle and follow the folds!

About the Blue Whale Flipper Beaty Box

Beaty Box Dimensions

Height: 33 cm (13″)
Length: 61 cm (24″)
Width: 50 cm (19.5″)
Weight: 13.1 kg (28.88 lbs)

What's in the Beaty Box?

Blue Whale Flipper Bone Casts

These 22 life-sized flipper pieces are replicas of the flipper bones from the BBM's very own blue whale specimen. These replica casts are made of resin and foam, and were poured into molds made from the real flipper bones. In this document, we will refer to the replicas as bones.

During the May 2008 dig of the blue whale specimen, the intact (bones attached by tissues and covered with skin) flipper was removed whole and shipped with the rest of the skeleton from Prince Edward Island to Vancouver. The intact flipper was run through a machine at the UBC hospital to generate 3D images of the bones.

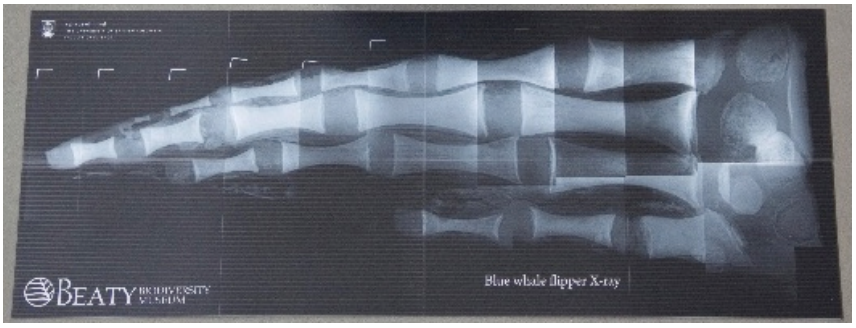
After capturing these images, the flesh was removed from the bones before being separated and de-greased. Molds were taken of all the flipper bones so that resin casts for the museum could be made before re-articulation.

If you would like to learn more about the reconstruction of the BBM's blue whale skeleton, check out the Discovery Channel documentary Raising Big Blue at vimeo.com/19403399.

Handling the Bones

- Hold one bone at a time using both hands for support. Handle the bones as if they were real specimens.
- Place them gently on the x-ray sheet rather than dropping them.
- Do not rub the bones together or on other surfaces.
- Do not throw the bones or hit them in any way.

X-ray Sheet



The blue whale flipper x-ray was created using an x-ray machine to generate images of the bones within the flipper. They were used as a guide for spacing and positioning when re-articulating the real blue whale flipper in the museum.

Approximate dimensions of x-ray sheet:
Length: 182.7 cm (1.827 m)
Width: 70.9 cm

Introduction to Blue Whales

Habitat & Geographic Range

Map by Derek Tan, Beaty Biodiversity Museum

- Mainly found in cold waters in the open seas
- Blue whales are found in all oceans except the Arctic. It is also absent from some seas such as the Mediterranean, Okhosk, and Bering.

Observable Features

Physical Characteristics

- Blue-gray mottled coloration
- Blue whales are the biggest animals to have ever lived on Earth – bigger than the largest dinosaur!
- Adult whales average 78.25-88.5 ft (24-27 m), which is the same as two school buses parked end to end
    - The BBM's blue whale is 85 ft long (26 m)
- Calves are 20-23 ft (6-7 m) long
- Adult blue whales weigh 100 to 200 tons while calves weigh 2-3 tons
- The blowhole at the top of their head is large enough for a human baby to crawl through
- Their hearts are the size of a car, with arteries about 9 inches in diameter

Sound

- The loudest animals to live on Earth
- A blue whale's call is 190 decibels, louder than a jet (140 decibels), much louder than a human can shout (70 decibels). They sing at a very low frequency, and this, combined with the loudness of their voices, allows their songs to travel thousands of kilometers.

Speed

- Average swimming speeds are 2 to 8 km/h while feeding and travelling
- Can attain maximum speeds of 32-36 km/h

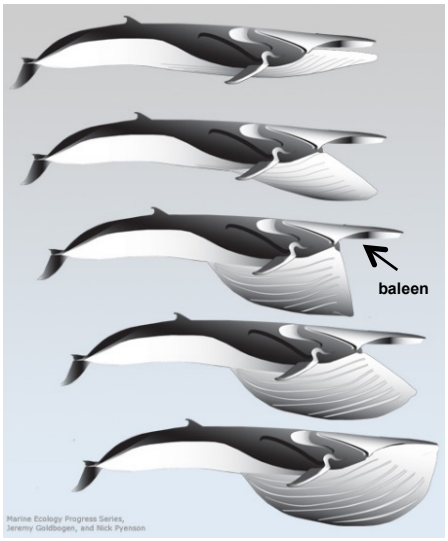
Life Cycle

- Females generally give birth to a calf every 2 or 3 years after a gestation period of 11 months
- Calves are primarily born in winter and are approx. 6-7 meters long, weighing about 2-3 tonnes
- Calves nurse on up to 50 gallons (189 liters) of milk a day for up to 6 months
- Blue whales can grow up to 200 pounds or 90 kg a day (8 pounds or 3.6 kg per hour)
- After 6 months, calves have roughly doubled in size. They start to wean and travel alone.
- Age of sexual maturity: 8-10 years (but can be as early as 5 years or as late as 15 years)
- These whales travel alone or in pairs
- Blue whales live 80-90 years. The oldest recorded blue whale, dated using its ear bone, was found to be approx. 110 years old.

Diet/Feeding

What it eats

- Feed exclusively on krill (shrimplike invertebrates that are 1 to 2 cm long). This means blue whales are 1250 times bigger than their food!
- Blue whales eat 4-6 tons of krill per day (about 40 million krill), which is the weight of an entire elephant
- Blue whales are filter feeders that eat the krill stuck between their **baleen** plates. The baleen is black and made out of keratin, the same material in our fingernails and hair. It hangs down from their upper jaw (like teeth) and has a maximum length of 1 meter



- A blue whale's throat extends from its chin to its navel, and is made of a stretchy tissue that can expand to four times its original width. Incredibly, they can fill their throats with a volume of water greater than the volume of their entire body.
- Once its mouth is full of water and krill, a blue whale will force the water out through the sieve-like baleen that it has in place of teeth, pushing the water out and leaving tens or hundreds of kilograms of krill behind in its mouth.

What eats them

- Although too large and tough for most predators, their calves can fall prey to killer whales and large species of sharks.

Evolutionary Relationships

- Blue whales are rorqual whales - Family Balaenopteridae. Other members of the family include the minke whale, Bryde's whale, humpback whale, sei whale, and fin whale.
- Whale ancestors moved from the land to the ocean about 50 million years ago, called the early Eocene period
- Blue whales are most closely related to hippopotamuses (land animals). Although they currently live in the ocean, their ancestors lived on land more than 54 million years ago. This is evident because blue whales:
    - Breathe air through their blowhole (don't have gills)
    - Have similar circulatory and respiratory systems to land animals
    - Have tiny pelvic bones and femurs
    - Have flipper bones that are similar to hand bones in land mammals

Adaptations

- Lungs are adapted for diving
- Streamlined bodies allow them to swim quickly in the ocean
- Insulated with blubber for warmth
- Their senses (such as their extraordinary hearing) are well-adapted to the ocean environment
- They have highly developed throat grooves that allow for a huge expansion of the mouth while feeding.
- Forelimbs have adapted to become a flipper to help them move through the water

Photo: flickr user MarcoPolo Rejsebureau, used through a creative commons license

Human Effects

- Whales have been hunted since the late 19th century for their blubber and "whalebone"
- Blubber was used by humans in lighting, fine soapmaking, and machine lubrication
- Whalebone, the keratin baleen plates that whales use to strain food out of the ocean, was prized for corset stays, umbrella ribs, and carriage springs; applications where plastic or steel would now be used.
- For decades, the ocean giants were hunted without restraint, and their numbers dwindled from an estimated 350,000 to 1000-2000. The blue whale hunt peaked in 1931, with a take of over 29,000 animals.
- In 1966, the International Whaling Commission banned hunting of blue whales, and today their numbers are estimated at 4,500. Blue whales are on the IUCN Red List of Endangered Species, and are listed as Endangered under the Canadian Species-at-Risk Act.
- Noise pollution and – most critically – the incidents of death by ship strike are threats to the blue whale population.

The BBM's Blue Whale Specimen

This specimen is a part of the Tetrapod Collection.

Worldwide, only 21 blue whale skeletons are available to the public for viewing. The Beaty Biodiversity Museum is home to Canada's largest blue whale skeleton (26 metres), a magnificent specimen that illustrates the interconnectedness of all living things. Moving the skeleton from the coast of PEI to the inside of the Museum's glass atrium, 6000 km away, was a challenging project. To find out more about the Blue Whale's journey, watch *Raising Big Blue,* available on the Discovery Channel's website. A written account can also be found on our website, beatymuseum.ubc.ca/blue-whale-project.

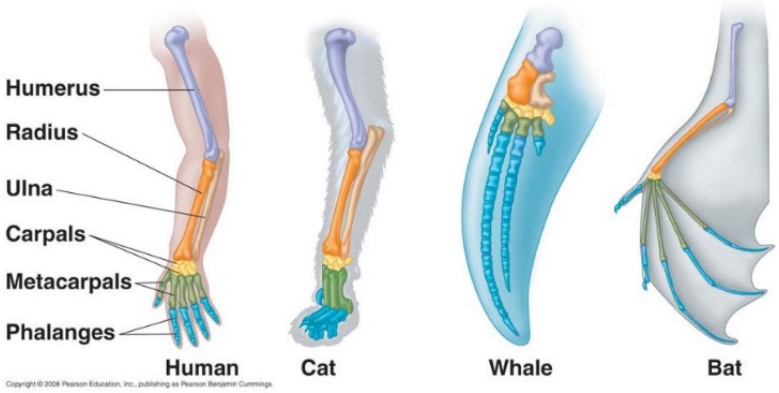
References

- Whales, Dolphins and Porpoises. Mark Carwardine. Dorling Kindersley Handbooks. 2000.
- Whales, Dolphins and Other Marine Mammals of the World. Hadoram Shirihai and Brett Jarrett. Princeton Field Guides. 2006.
- "About". *Beaty Biodiversity Museum.* www.beatymuseum.ubc.ca/research/whale/about
- "Blue Whales". *National Geographic.* http://animals.nationalgeographic.com/animals/mammals/blue-whale.html
- "Fun Facts About Blue Whales". *Blue Whale Project.* http://sites.google.com/site/bluewhaleproject/Home/fun-facts-about-the-project
- Dr. Andrew Trites

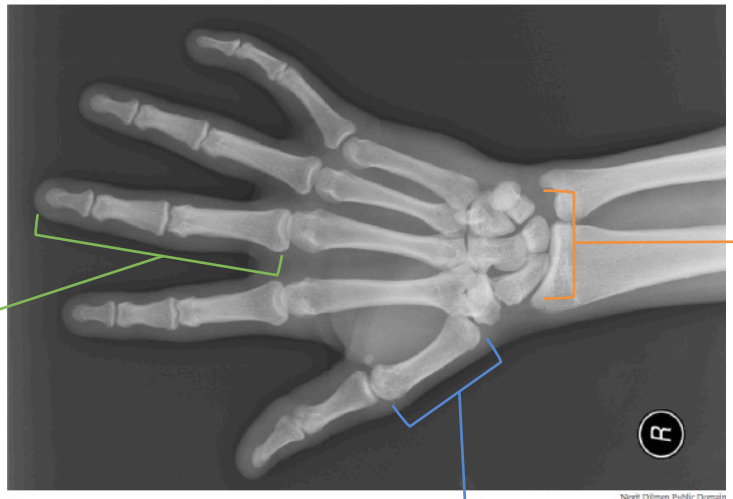
Human Hand Bones vs. Whale Flipper Bones

What are homologous structures?

- **The human hand and the blue whale flipper are homologous structures.**
- Homologous structures are structures (such as bones or organs) that are found in animals of different species. These structures are anatomically similar because they are descended from a common ancestor with the original structure – providing strong evidence for evolution.
- Although they are similar in structure, the functions of homologous structures may have evolved differently depending on the organism. For example, human hand bones have evolved to grasp and hold onto objects, while blue whales have developed their bones into flippers for swimming.



The Human Hands

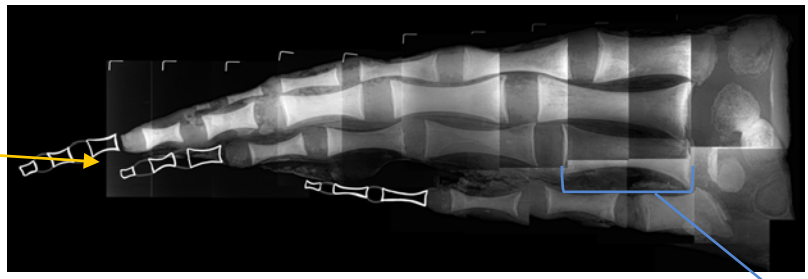


Phalanges: 14 bones

Carpals: 8 small bones

Metacarpals: 5 bones

The Blue Whale Flipper



Blue whales have 4 digits/fingers (3^{rd} digit is missing)

Carpals: Varies in number; lacks mobility

Phalanges:

- The number of phalanges varies based on flipper size
  - Long, slender flippers: digits are closer together and phalanges are elongated; number of phalanges is greatest in the middle three digits
  - Broad flippers: digits are separated and the phalanges are less numerous

Metacarpals: similar in shape and size to the phalanges, so the two are often counted together; buried in the flesh of the whale flipper

References

1. "Whale of a Tale – Homologous Structures". *Bamfield Marine Sciences Centre*. http://www.oceanlink.info/wot/homologous.html <Site has been removed as of September 5, 2017>
2. Whales of the World. Spencer Wilkie Tinker. Press PR Inc. 1988.

Blue Whale Flipper Lesson Plan

Learning Objectives

After this lesson, students should be able to:

- Recognize the shape, texture, and structure of blue whale flippers
- Describe the similarities and differences between human hand bones and whale flipper bones
- Discuss homologous structures in relation to the human hand and blue whale flippers
- Communicate observations and ideas by drawing and by using oral and/or written language

Big Ideas & Concepts

Arts Education

- K-1: Develop processes and technical skills in a variety of art forms to nurture motivation, development, and imagination
- Arts Education 2: Develop processes and technical skills in a variety of art forms to refine artistic abilities, reflect on creative processes and make connections to other experiences
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- Kindergarten: Plants and animals have observable features; daily and seasonal changes affect all living things
- Science 1: Living things have features and behaviours that help them survive in their environment
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- Science 3: Living things are diverse, can be grouped, and interact in their ecosystems.
- Science 4: All living things and their environment are interdependent
- Science 5: Multicellular organisms have organ systems that enable them to survive and interact within their environment
- Science 6: Multicellular organisms rely on internal systems to survive, reproduce, and interact with their environment
- Science 7: The theory of evolution by natural selection provides an explanation for the diversity and survival of living things
- Science 10: Genes are the foundation for the diversity of living things
- Biology 11: All organisms have characteristics that define them as living and interdependent. Life can be organized in a functional and structural hierarchy ranging from cells to the biosphere; living things are interdependent; living things are diverse and evolve over time
- Biology 12: Cells are the basic unit of life

Materials & Supplies

- Foldable x-ray image (provided)
- Blue whale flipper bone casts (provided)
- Size comparison chart (provided)
- Coloured pencils (blue, red, green)
- Paper
- Sharpeners
- Erasers
- Whiteboard and coloured markers (blue, red, green, and black)
- Hand lenses (optional)
- An iPad or similar technology to show videos of the blue whale in real life (optional)

Blue Whale Flipper Activity

Before the Lesson

- Lay out the x-ray image and place the whale bones box (unassembled) on the floor in the desired space. Carpet or mats work well. Ensure there is plenty of room for the group to sit around the x-ray.
- Clean the white board for drawing
- Have drawing material such as papers and coloured pencils ready for the students
- Have iPad or similar technology ready to show blue whale videos during the activity (optional)

Introduction

1. **Introduce blue whales:**
    - Point to the x-ray image and whale bones.
      What organism do you think this is?
    - Today we will be learning more about blue whales and their flippers. What do you know about blue whales?
        - Brainstorm ideas
    - Blue whales are the biggest animals to have ever lived – heavier than the biggest dinosaur! Some dinosaurs may have been a bit longer, but blue whales are much bigger all around.
    - Give students more information about blue whales based on your curriculum or topic of study (refer to 'Introduction to Blue Whales' on pg. 35).
    - Show videos of the blue whale to help bring the specimen to life. (see Additional Resources on pg. 51)

2. **Talk about evolution and homologous structures:**
    - What kind of animal is a whale? Whales are mammals, just like humans. What features make an animal a mammal?
    - Today, we have many fossil skeletons to show us exactly how whales evolved from land animals. Whale ancestors moved from the land to the ocean about 50 million years ago, called the early Eocene period. That means that whales evolved from an ancestor that lived on land, just like humans!
    - The human hand and the blue whale flipper are *homologous structures*. What does that mean? (Refer to 'Human Hand Bones vs. Whale Flipper Bones' on pg. 39)
        - It means that since whales and humans are both mammals, they have very similar bone structure in their hands and flippers.
        - They are both descended from a common ancestor that had an ancestral version of this same hand/foot bone structure.
        - The "hands" of blue whales have evolved to become flippers over time to help them swim, yet the bones inside are similar in structure to the bones of a land mammal.

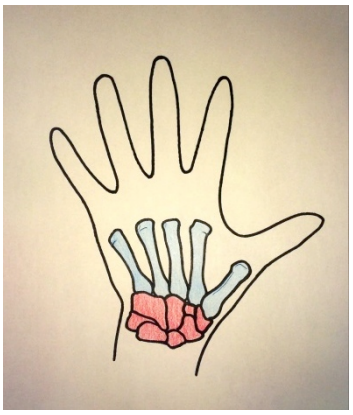
Sketching Homologous Structures

1. **Draw the human hand (demonstrate using a whiteboard):**
    - Hand out blank sheets of papers to students and title one page "The Human Hand". Have students trace the shape of their hand onto a piece of paper. Demonstrate this on your own hand using a whiteboard and have students follow along.

    - We're first going to draw in the bones inside our wrist. These small bones are called the carpal bones, and there are eight of them inside our wrist.
    - Draw and label two rows of four small bones in the wrist area and colour them **red**)

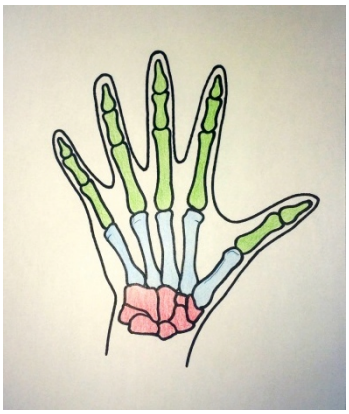
    - Have students feel their bones in their own hands
    - Observe the mobility in the wrist. The bones are the joint where the movement happens; muscles create the movement. Think of the hinges on a door. See resources (page 50) for a website all about joint movement.
        - To isolate the carpal bone movement, place your elbow on the table with your forearm and hand up towards the ceiling (like you are waving).
        - Your hand moves front to back really well, from left to right a medium amount, and an oval between these directions. If you rotate your palm towards your face, this twist comes from the two bones in your forearm, not the carpals.

- The bones underneath the wrist are called the metacarpal bones. We have five of them, with one in each finger.
- Draw and label the metacarpal bones and colour them **blue**



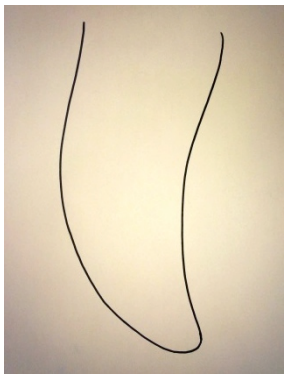
- Observe the movement in this part of your hand. There is not a lot! You can fold the thumb side of your palm towards the pinky side. Which bone seems the most mobile here?

- Finally, the bones underneath the metacarpals are called the phalanges. They are smaller than the metacarpals and there are three of them in each finger and two in the thumb.
- Draw and label the phalanges and colour them **green**



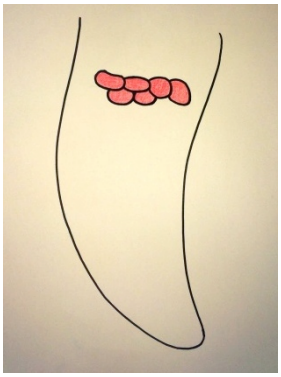
- Observe the movement in your fingers. Can you twist your fingers or only move them back and forth? What about side to side? You can feel each finger joint as you move your hand.

2. **Draw the blue whale flipper (demonstrate using a whiteboard):**
    - Title a separate blank page "The Blue Whale Flipper". Have students trace the shape of a flipper onto a piece of paper. Demonstrate this yourself using a whiteboard and have students follow along.
        - Whale flippers can be as tall as a person! Feel free to draw it very large.
        - Refer to The Blue Whale Flipper diagram in the 'Comparative Anatomy' page on pg. 39

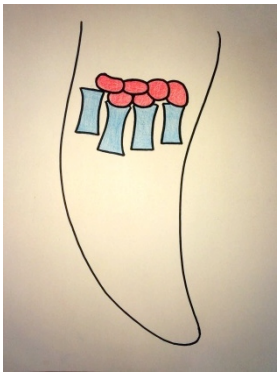


- The human hand and blue whale flippers are homologous structures, so whales also have similar bones in their flippers called carpals, metacarpals, and phalanges.

- The carpal bones of blue whales are circular and much bigger than our own carpals. Hold up one carpal bone cast, and then pass around for children to have a look. Remind them to be gentle with the bones.
- Draw and label the carpal bones and colour them **red**

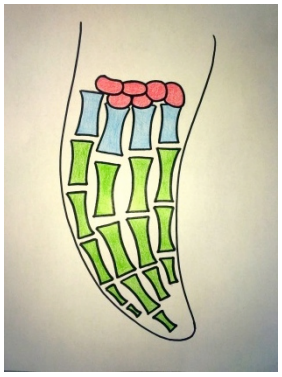


- Blue whales only have four "fingers" in their flipper, so they have only four metacarpal bones. Hold up a metacarpal bone, then pass around.
    - Blue whales are missing the third digit (middle finger). Can you find a carpal bone that shows this evidence when you are assembling the puzzle?
- Draw and label the metacarpals and colour them **blue**)



- Lastly, we have the phalanges. The number of phalanges varies based on the flipper size – the longer the flipper is, the more phalanges there are. (Hold up one of the phalanges, then pass around) Don't worry about drawing the phalanges perfectly.

- Draw as many bones as you want to the best of your ability! They should get smaller towards the tip of the flipper. Draw and label the phalanges and colour them **green**.

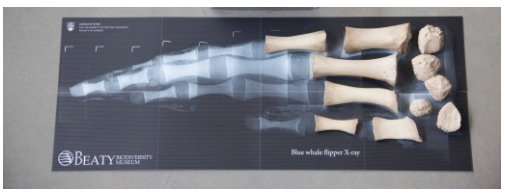


- Have students hypothesize and predict how they think a blue whale flipper will move, based on the similarities between human hands and the flipper. Will they move all together (like our palms) in a paddle movement, or will they be able to move more like our fingers? What would be the most effective in the water? Watch some whale videos to see flippers in action!

Assembling the Blue Whale Flipper

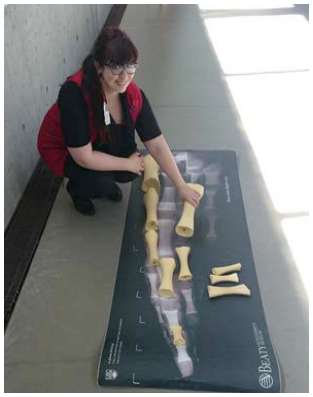
- Students now have the chance to assemble their own life-sized model of a blue whale flipper. First, remind them about handling and safety: hold one bone in your hand at a time and handle it as if it was a real, fragile bone. Do not throw the bones or use them to hit others.
- Divide students up into groups of 4-6 and send one group at a time to the whale bones puzzle.
- Give groups of students plenty of time to explore different angles of bones, directions, and cooperate as a team.
    - Scientists who assembled the real skeleton used each other's expertise to make sure the bones were all assembled correctly. They also used clues from the whale tissues and took photographs of how the bones were found in the soil to help them assemble it later. You may choose to watch some of the films about the blue whale assembly, located on page 51.
    - This is a good opportunity for students to practice constructive criticism, brainstorming, sharing and other collaborative skills.
        - Try one turn at a time: The group will sit in a circle, when it is their turn, each student can either place a new bone or change a bone that was already on the x-ray.
        - Voting: once the bones are placed, if the group feels like changes need to be made, have them vote with hands to change or leave it.
        - Constructive comments: Students can use the format of "I think that this bone might be better placed here because…" Giving a reason for their action will help students understand their motivation. Other students can rebut with comments like "I like your thought process, but I think this bone should stay because…"
        - Free form: allow students to develop their own rules for the puzzle
    - After the group finishes, ask them to place the bones in the box for the next group.
    - If they are struggling, use Appendix 1 to help assemble the flipper.
    - Students may want to continue working on their hand and flipper drawings while they wait for a turn with the whale bones. You may also wish to pass around the Size Comparison Chart or hand out worksheets such as the Blue Whale Colouring Sheet (see Additional Resources for links to worksheets).

*See **Appendix 1** for full images on how to assemble the blue whale flipper.*



Debrief

- All of the students should have had a chance to sketch human hand bones and whale flipper bones, as well as attempt the bone puzzle.
- What have we observed today? Discuss the theme for the day.
- Did you learn something new about blue whales?
- What are some of the similarities/differences between human hands and blue whale flippers? Discuss the similarities in bone structure.
- What are some uses of the human hand? How about the whale flipper?
- What did you notice about the blue whale flipper bones? How did they look/feel/weigh?
- You may choose to set up the hand and blue whale flipper drawings as a self-curated gallery. Get each student to put their drawings on designated tables and have students walk around the tables, observing and talking. Sharing can increase their confidence as an artist and allows them to take ownership for their work.



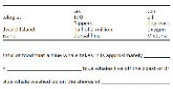
Additional Resources for Blue Whale Flipper Activity

Worksheets and Activities

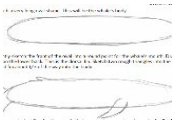
Our website contains a number of supplementary resources to help add to your Beaty Box experience. These museum-developed activities, which include worksheets and nature guides, are a great resource for bringing the museum experience into your classroom.

For use in the classroom without a museum visit:

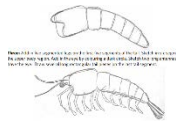
A Skeleton Story by Numbers | Beaty Biodiversity Museum
beatymuseum.sites.olt.ubc.ca/files/2016/01/BBMASkeletonStorybyNumbers.pdf



Raising Big Blue Worksheet | Beaty Biodiversity Museum
beatymuseum.sites.olt.ubc.ca/files/2016/01/BBMRaisingBigBlueWorksheet.pdf

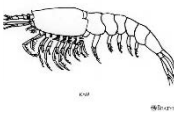


How to Draw Blue Whales | Beaty Biodiversity Museum
beatymuseum.sites.olt.ubc.ca/files/2016/01/BBMHowtoDrawABlue-Whale.pdf



How to Draw Krill | Beaty Biodiversity Museum
beatymuseum.sites.olt.ubc.ca/files/2016/01/BBMHowtoDrawKrill.pdf

Blue Whale Colouring Sheet
beatymuseum.sites.olt.ubc.ca/files/2016/01/BBMColouringSheetWhale.pdf



Krill Colouring Sheet
beatymuseum.sites.olt.ubc.ca/files/2016/01/BBMColouringSheetKrill.pdf

General Information About Blue Whales

About Blue Whales | Beaty Biodiversity Museum
beatymuseum.ubc.ca/whats-on/exhibitions/permanent-exhibits/blue-whale-display/about-blue-whales/

Fun Facts About Blue Whales | The Blue Whale Project
sites.google.com/site/bluewhaleproject/Home/fun-facts-about-the-project

Species at Risk: Blue Whale (Atlantic population) | Parks Canada
www.pc.gc.ca/eng/nature/eep-sar/itm3/eep-sar3y/1.aspx

General Information About Joints

Human Anatomy Fundamentals: Flexibility and Joint Limitations | EnvatoTuts+
design.tutsplus.com/articles/human-anatomy-fundamentals-flexibility-and-joint-limitations--vector-25401

Online Interactive Activities

Blue Whale Interactive | National Geographic
animals.nationalgeographic.com/animals/blue-whale-interactive/

Out of the Depths| Royal Ontario Museum
rom.on.ca/en/blue-whale

Videos

Raising Big Blue Documentary
vimeo.com/19403399

Blue Whale Expedition Videos | Beaty Biodiversity Museum
www.youtube.com/user/beatymuseum/search?query=blue+whale

Blue Whales | National Geographic
video.nationalgeographic.com/video/whale_bluecalls

Inside the Blue Whale | BBC Nature
www.bbc.co.uk/nature/life/Blue_Whale#p004t035

Blue Whale – Blue Planet – BBC Wildlife | BBCWorldwide
www.youtube.com/watch?v=1fzT6ifrhL8

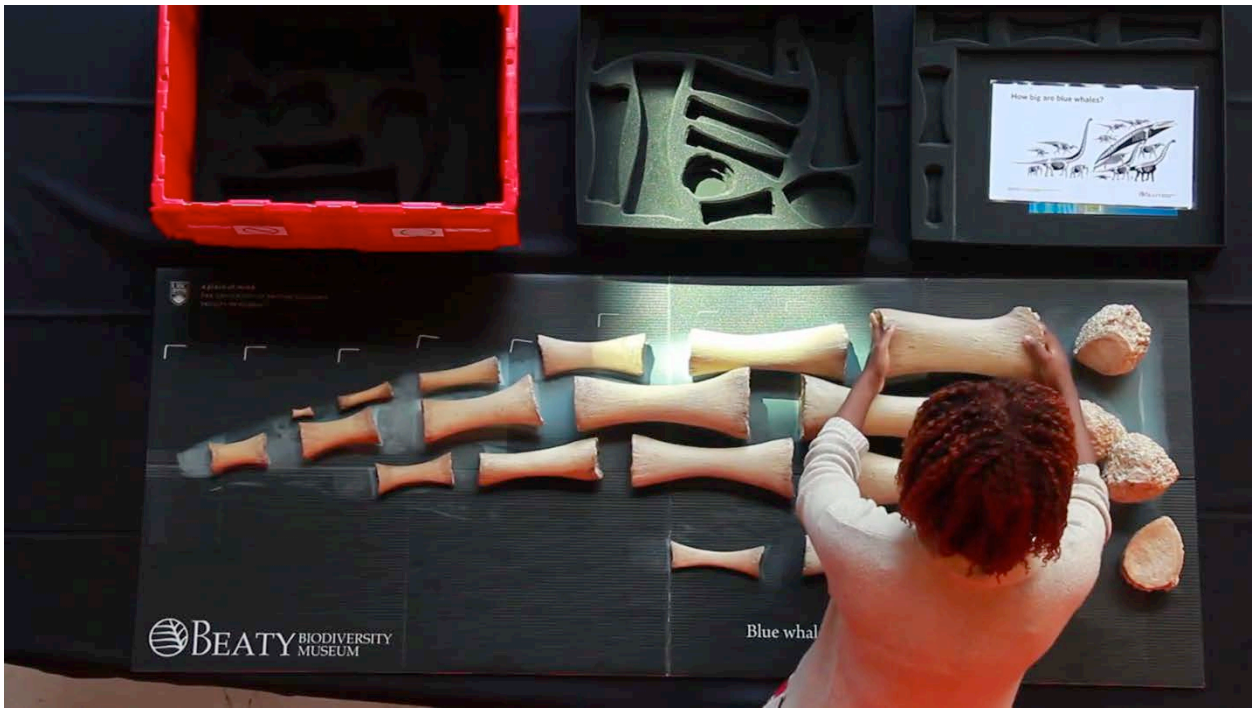
Photos: Repacking Your Beaty Box

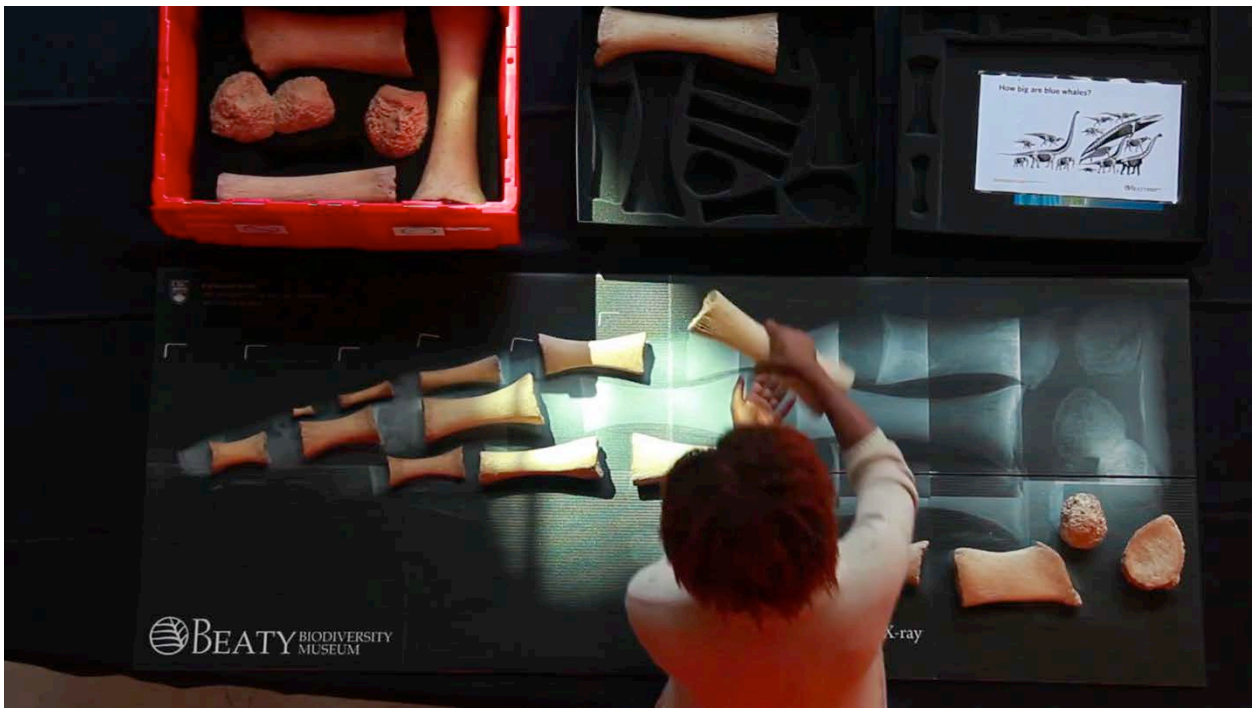
Repacking the Bones

We recommend watching our packing video at https://youtu.be/LUPvSZMk0UE. Each bone has a foam space that will protect it. Make sure the bones fit snugly in their space before adding the next layer.

All trays:

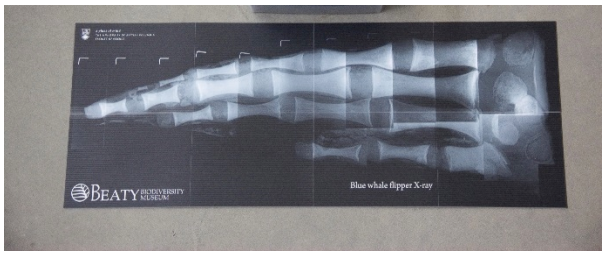
Match the bones to their foam spaces in each tray. Make sure they fit snugly in their spaces.

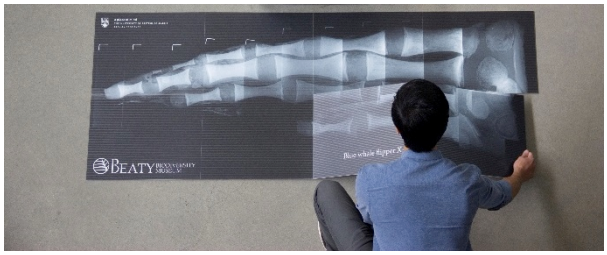
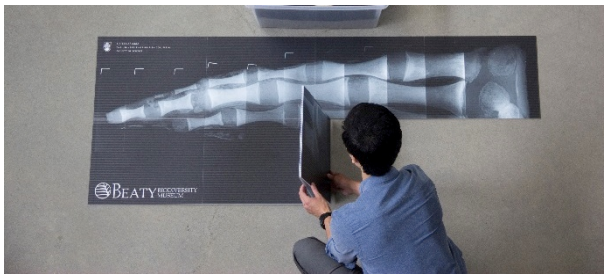


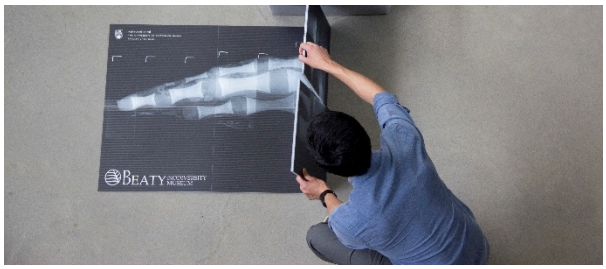

How big are blue whales?
BEATY BIODIVERSITY MUSEUM
X-ray

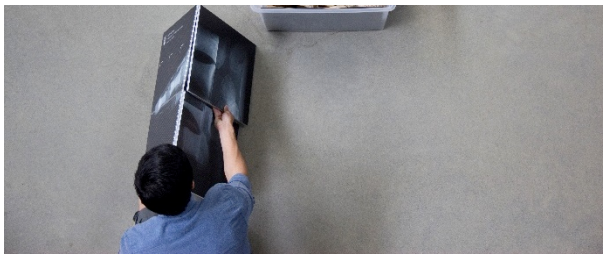
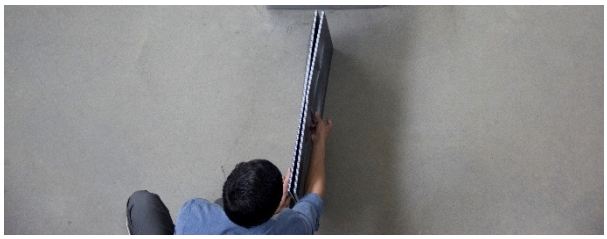

How big are blue whales?
BEATY BIODIVERSITY MUSEUM

Folding the X-Ray:
Fold the x-ray so that it is completely flat. Follow the folds and be gentle!



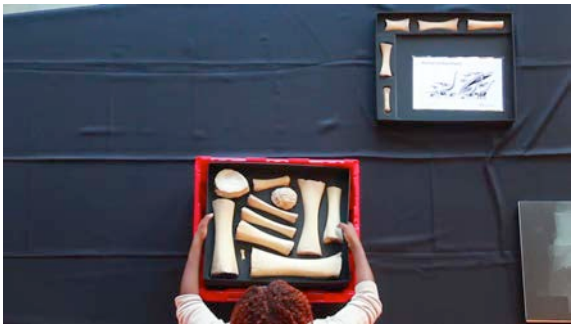
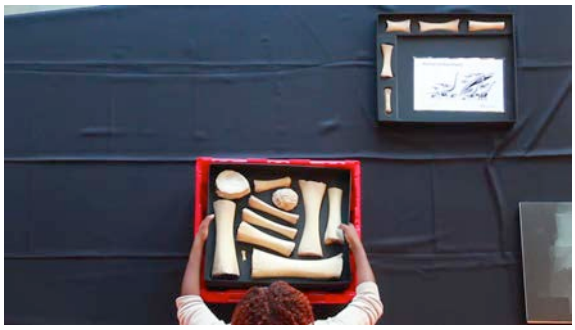
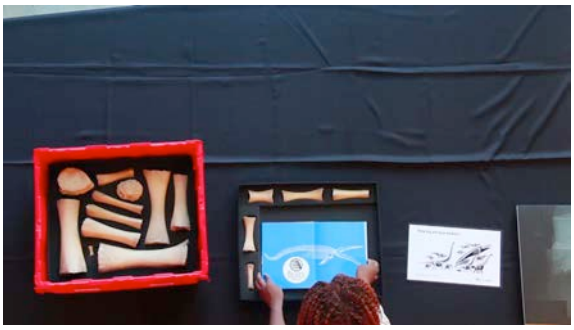






Packing trays into the box:
When all of the bones are in trays, place tray 2 on top of tray 3 in the box. Then, place tray 1 on top of tray 2. Check the x-ray and other materials for damage. Place the x-ray into tray 1, add the manual and book, and close up the box.

If you are returning the Beaty Box in the rain, remember to place a garbage bag or towel on top to prevent moisture from getting inside the box.


Blue Whale Flipper Box Inventory

Please make sure all of the components are properly put away inside the Beaty Box. See the 'Returning the Beaty Box Checklist' page in Beaty Box Basics for more information on sending the Beaty Box back to the museum.

Bones (Specimen T(m)70-82)

- ❑ **Four (4)** carpal bones (circular bones)
- ❑ **Eighteen (18)** Metacarpals & Phalanges (longer bones)
    - *Please note that there is one small, finger-sized bone that is easily lost*
- ❑ **Total number of bones = 22 bones**

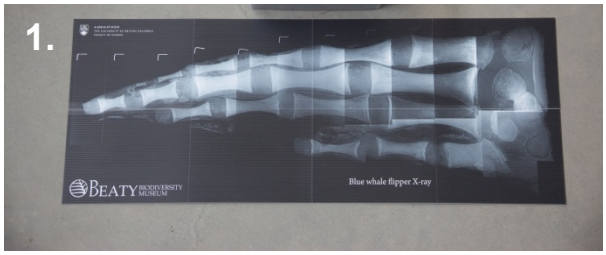
X-ray

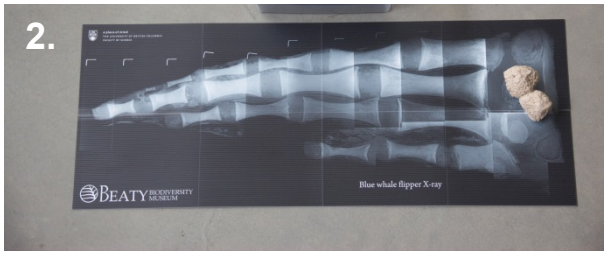
- ❑ **One (1)** X-ray sheet, folded

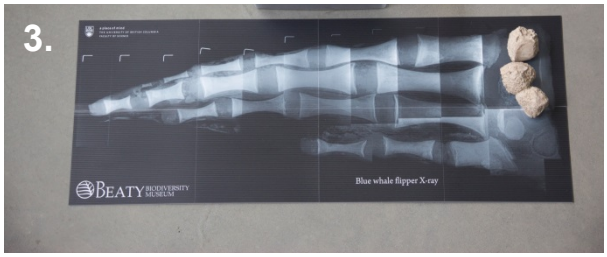
Manual and Materials

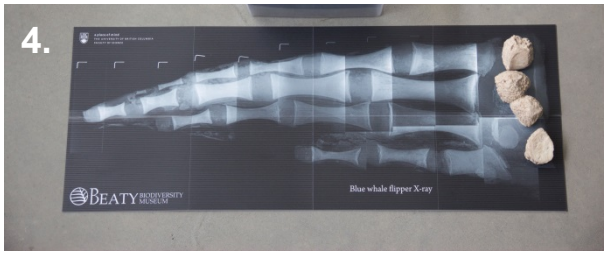
- ❑ **One (1)** storybook, *Big Blue Forever* by Anita Miettunen
- ❑ **One (1)** manual, including two sections
- ❑ **One (1)** USB key
- ❑ **One (1)** laminated size chart

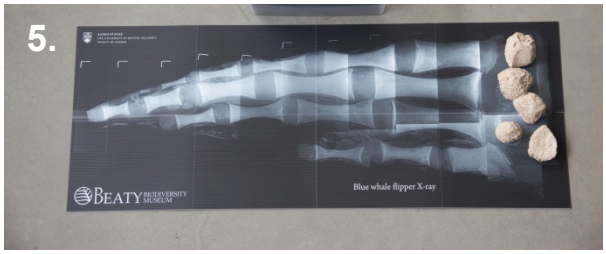
Appendix 1: Assembling the Blue Whale Flipper X-ray Puzzle

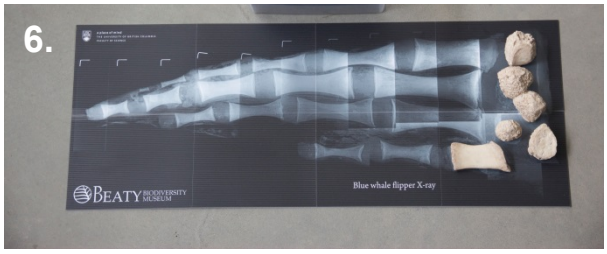


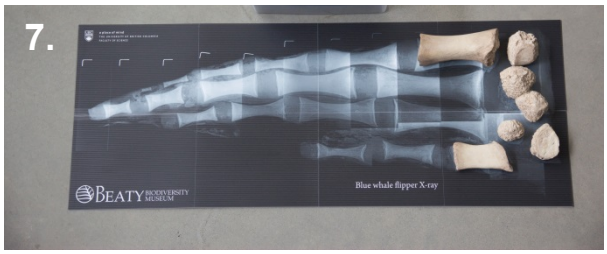


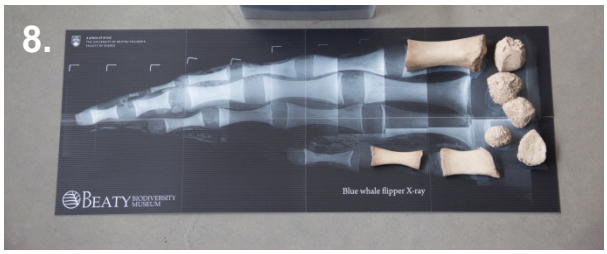


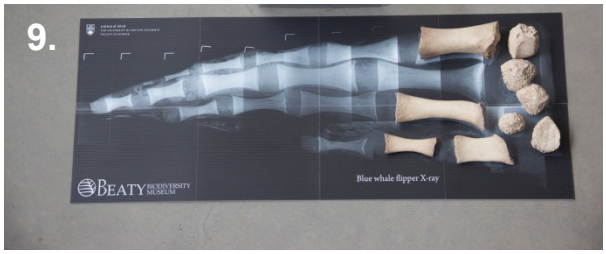


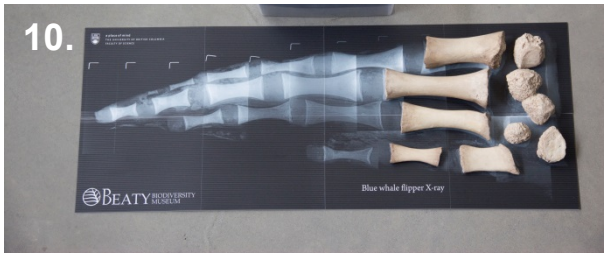












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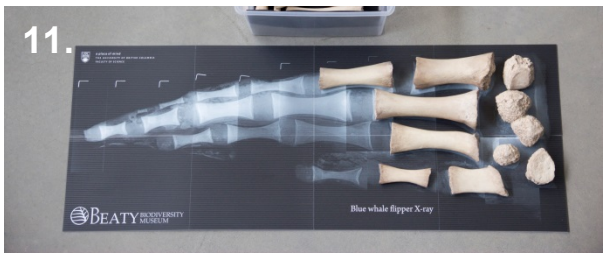

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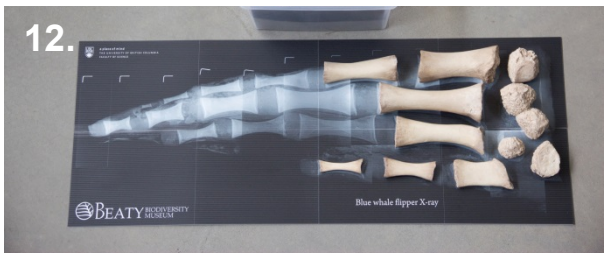

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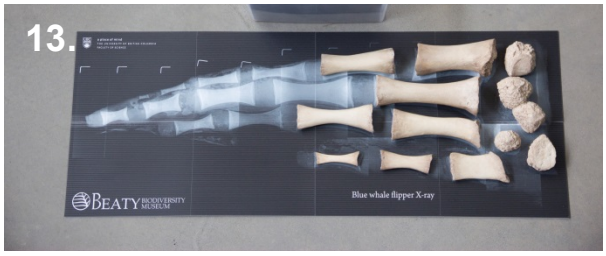

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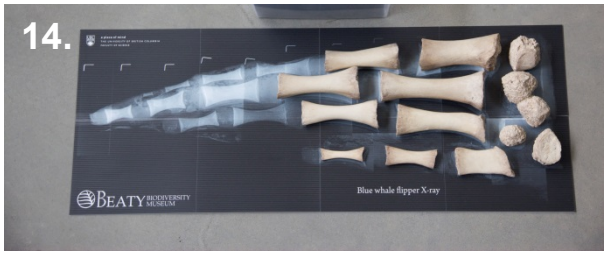

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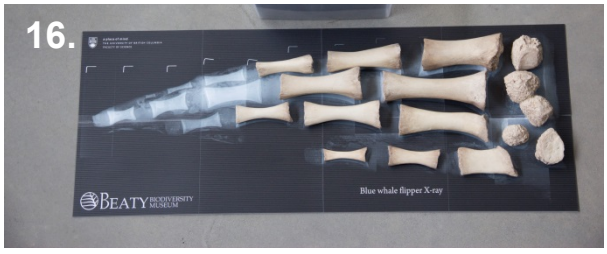

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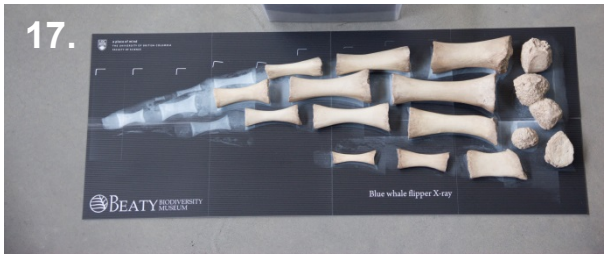

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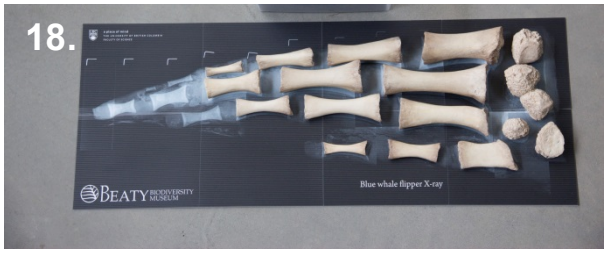

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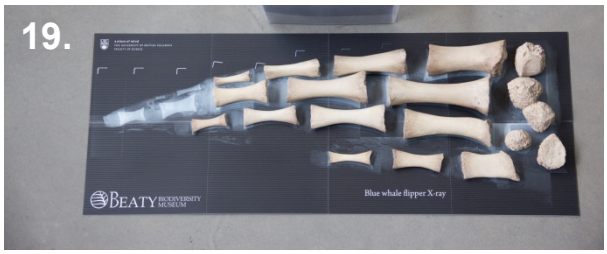

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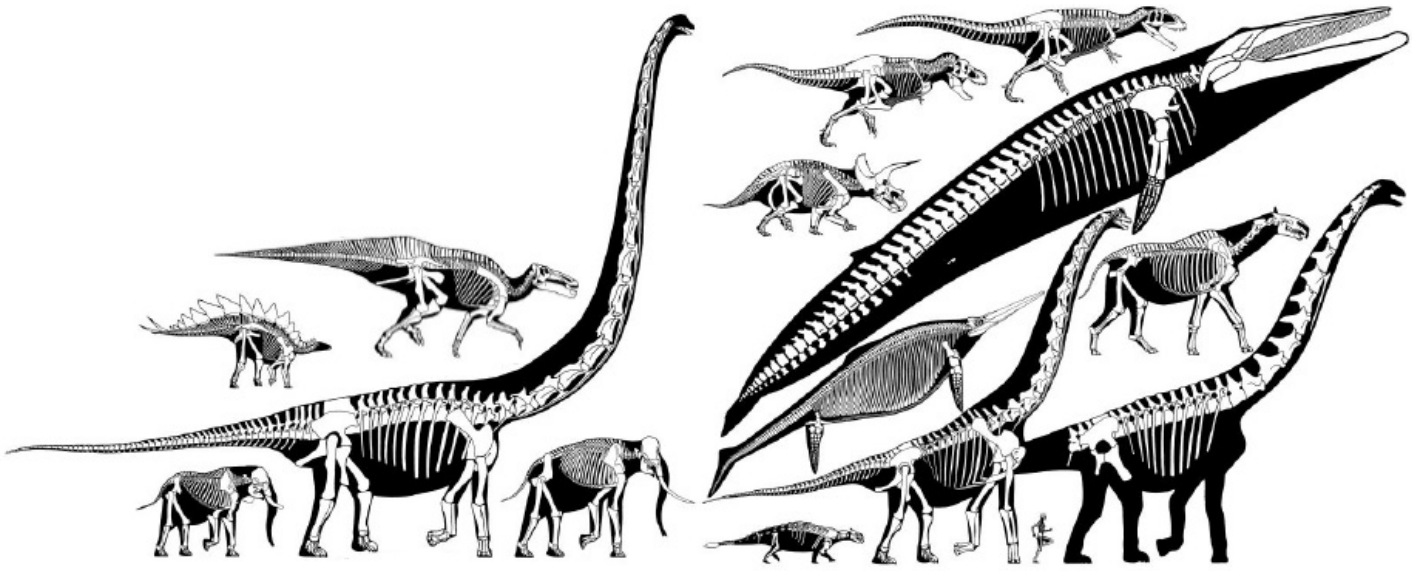
Appendix 2: Blue Whale Size Comparison Chart

How big are blue whales?



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