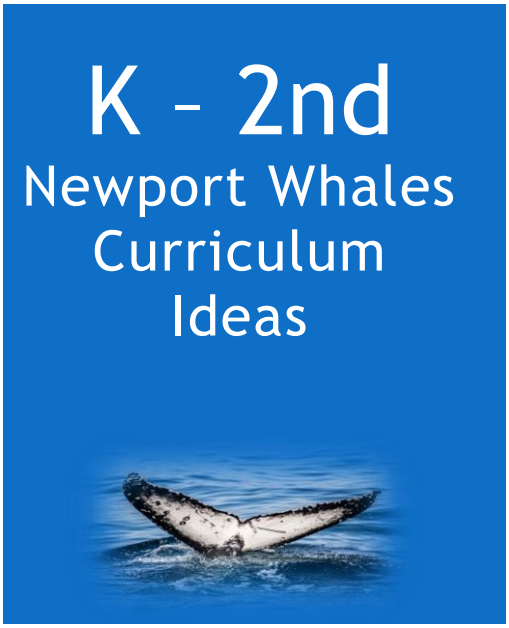


Learning with Whale Watching

Newport Beach is perfectly situated near a submarine deep water canyon, allowing nutrient rich upwelling to occur. Upwelling is when ocean currents are cycled from the bottom of the sea to the surface. This flow of nutrients feeds billions of plankton and the fish that thrive in our coastal waters; in turn whales congregate here to feed on these plentiful organisms. Our whale watching tours are only $11 per passenger, and allow one of the best educational outdoor experiences in Southern California.

This packet is designed for kindergarten through second grade students, based on the content standards adopted by the California State Board of Education and the Next Generation Science Standards. Our vision is that the content listed here, combined with a whale watching tour, will not only allow you to educate your students about our local marine life, but also to meet your NGSS classroom science needs, and have fun while doing it. We have included web links to scientific multi-media resources, curriculum, and ideas for in-classroom activities to help enhance your day on the water with us.

Newport Whales is also staffed with knowledgeable and friendly marine science educators that are familiar with the standards outlined in this curriculum packet. We highly encourage including one of our marine science educators on your excursion for a more hands-on and engaged learning approach. Please inquire with our education team for additional information on pricing and availability.

The Marine Environment

The Pacific Ocean is the largest ocean on Earth! It provides life to thousands, even millions of aquatic species. We are so lucky to be on the water daily to enjoy the year round whales, dolphins and marine animals that live within.

As a scientist working in the marine environment, it's not all fun and games. Field work can have long hours in varying weather conditions. Researchers who work in environments like this regularly deal with changing tides, sea state, weather, wild animals on the move, and mechanical wear and tear on their scientific equipment which can make the job very difficult. At the same time, these challenges make every day unique and exciting.

Even with the challenges that these scientists face, it is essential to study this environment as it is one of the least understood environments on planet Earth. Despite the fact that 73% of our planet is covered by water; scientists have only explored and mapped about 5% of our oceans.

Given these facts, it's easy to see the importance of educating students at an early age about our oceans in the hopes of inspiring some future marine scientists.

IN THIS CURRICULUM IDEA PACKET

NEXT GENERATION SCIENCE STANDARDS

NGSS Alignment

This curriculum idea packet will provide information and ideas on how to meet the following list of standards in conjunction with a whale watch excursion with a Naturalist.

Echolocation

Vibrations and Sounds in the Ocean

1-PS4-1 / PS4.A Wave Properties
2-LS4-1 / LS4.D Biodiversity

Echolocation means "Sound Location." Animals that use echolocation can seek out their prey and explore their surroundings by generating sounds and using the echo they receive back to understand their environment.

Toothed whales (which include dolphins) have adapted the ability to echolocate. At times it can be difficult to see underwater in areas with a lot of ***turbidity*** (measurement of how murky the water looks), in deep waters where the sunlight can't reach, and at night where sight is often of little use. Sound also travels four and a half times faster in water than it does in air, making echolocation a useful tool for toothed whales.

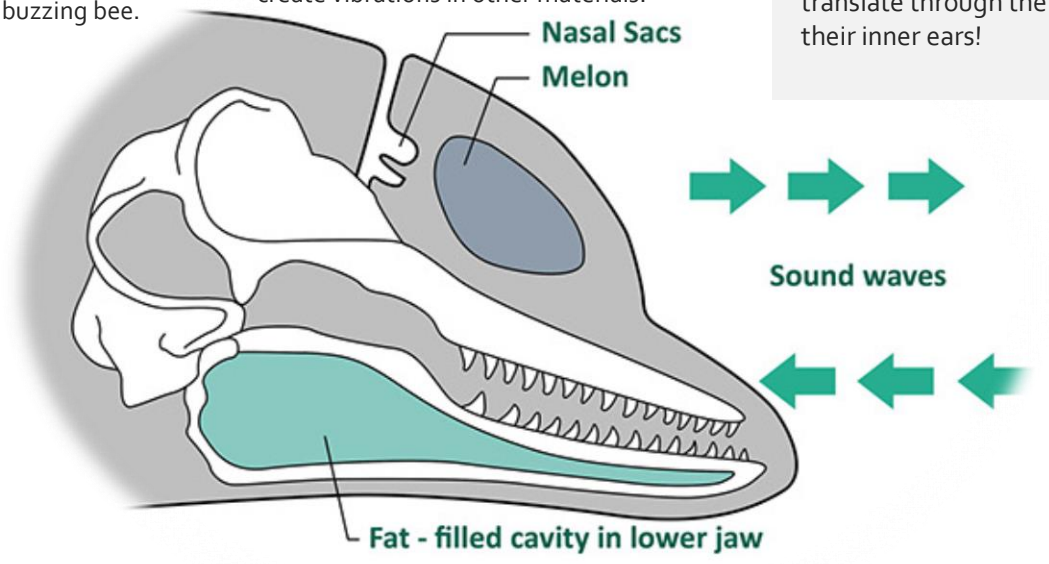
All sounds are made by ***vibrations*** (continuous quick, slight shaking movements), think of a buzzing bee. That bee is moving its wings so fast that the air moves and creates vibrations and you hear the BUZZZZZZ.

Dolphins make clicks and whistles by vibrating their ***Nasal Sacs*** (shown in diagram below) by passing air from their lungs in and out of this sac. The air rushing through shakes the tissues, which creates noise.

Try This

You can show how vibrations make sound with a balloon. If you blow up the balloon and pinch off the neck, it is very similar to a dolphin filling its lungs. Then, grab either side of the neck and pull the opening to make it long and stretched. The air will try to escape through the small opening and the stretched plastic will vibrate as air pushes through. The membrane of the balloon vibrating results in that squealing sound.

The toothed whale's anatomy then directs the noises (vibrations) straight out of the front of the forehead through an organ called the ***Melon*** (fatty forehead), which focuses the sound into a narrow beam. When these sounds strike an object, some of the energy from that sound wave travels back towards the dolphin. The vibrations are not heard as they come back, but instead the dolphin "feels" the vibrations as they come in contact with the lower jaw. The lower jaw then carries the vibrations straight to the animal's inner ear, where finally the vibrations are received as a sound. This shows that vibrations make sounds, and sound can create vibrations in other materials.



If you've ever stood near a building or large surface and heard the way it affected your voice, you've experienced an example of what dolphins can perform biologically at much higher resolution.

The echolocation system of the dolphin is extremely sensitive and complex. The dolphins' brain devotes a much higher proportion of its surface area to sound processing than our own human brain does. This extra area in toothed whales' brains allows dolphins to turn the noises they hear into a picture, enabling accurate hunting and avoidance of obstacles in their watery environment.

TRY THIS WITH YOUR STUDENTS!

A tuning fork (440 Hz works well) can be used to show students how dolphins can't hear the noises they make for echolocation with external ears, but instead they feel the vibrations come back through the lower jaw. A fat filled jaw then directs and amplifies the sound to the inner ear.

Instruct your students to close their ears (place their fingers in them, or pinch close)

Strike the tuning fork and quickly place it on the chin of the student (be sure to place directly on the jaw bone).

The Students should hear the ringing noise inside their heads as the vibrations from the tuning fork translate through the jaw bone to their inner ears!

WHALE & DOLPHIN MULTI-MEDIA RESOURCES

Gray Whale Education Video

Video on Gray Whales

https://youtu.be/Zn7b-KCz9T4

Blue Whale Education Video

Video on Blue Whales

https://youtu.be/IsyGoPKQ4do

Article on behavior of parents and offspring

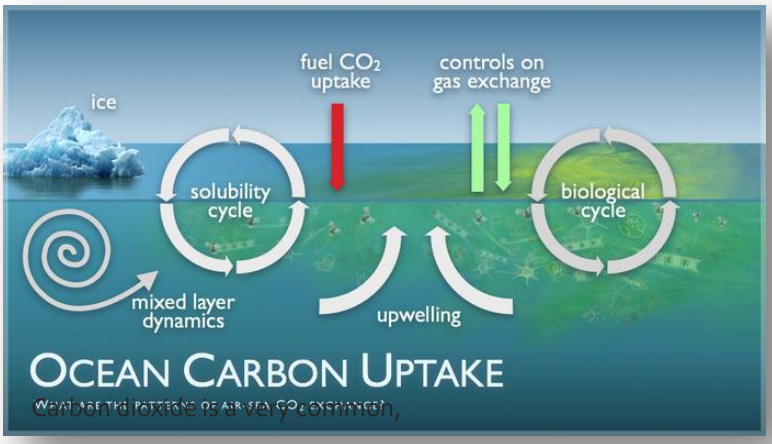
https://www.livescience.com/55699-mother-dolphins-teach-babies-signature-whistle.html

USING RESOURCES WITH NGSS

Above are links to videos and published articles that can be used as observations, evidence, and texts as listed in the NGSS for your students to utilize in making evidence-based arguments.

These resources can assist with:

K-ESS3-1
1-LS1-2
1-LS3-1
2-LS4-1



This graphic is from NOAA and can be found at https://www.pmel.noaa.gov/co2/story/Ocean+Carbon+Uptake The Pacific Marine Environmental Laboratory works to monitor the effects of CO_2 on the ocean

CO_2 - Humans and the Ocean

Carbon Dioxide

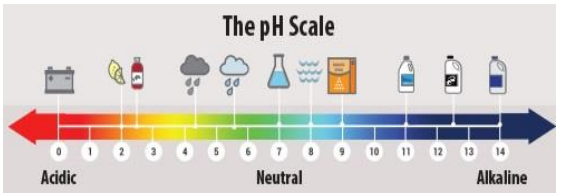
K-ESS3-3 / ESS3.A Natural Resources / ESS3.C; ETS1.B

naturally occurring gas that is an important part of Earth's carbon cycle. All humans and animals exhale carbon dioxide when they breathe, where plants absorb it during a process called photosynthesis. This important gas traps energy from the sun and keeps it in our atmosphere, which is essential to the livable temperatures on planet Earth. There is excess CO_2 produced from natural sources like volcanic eruptions, but there is also CO2 production associated with human activities, for example: the burning of fossil fuels. Together, this surplus of CO2 gas builds up in the atmosphere, and can be troublesome for the organisums who live there. Some of these worries include increasing climatic instability, which results in major changes in weather patterns, and over absorbtion of CO2 by the oceans.

Can you think of ways to reduce the amount of CO_2 that is released?

The ocean is a natural ***carbon sink*** which means that carbon dioxide is absorbed out of the atmosphere into the water and dissolved. This process has helped slow the effects of climate change, but also has a negative effect on marine ecosystems living in those waters.

The pH scale is a way to determine if a substance is an acid or a base. *(The scale runs from 1 to 14; 7 is pure water and is neither acidic nor basic.*



**Students should be familiar with the idea that either end of the pH scale is harmful to most life on earth, but a deep knowledge of acids and bases is not required at this point.*

It's important to note that ocean life is adapted to exist in the pH range (7.6 to 8.6), and rapid changes to the oceans chemistry could result in harmful effects to marine life.

Try This in the Classroom

What are the effects of CO_2 in the Ocean?

Students can see the effects of extra CO_2 in the ocean, in the classroom with this easy experiment. Gently blowing bubbles into a cup of water with an indicator solution can simulate the oceans' CO_2 absorbing capabilities.

Watch as your students turn their water from blue to yellow to help visualize CO2 absorption in our oceans!

Materials Needed:

Clear plastic cups
Paper straws*
Bromothymol Blue, 0.04%**
Water

Set up:

Fill plastic cups HALF FULL with water. (Half Full is important to prevent splashing into your students faces)

Add Bromothymol Blue to each cup until the color of the water is just prominent enough for a good color change. This is about a dropper full for small cups. The water will appear blue if it's from the tap as the salts within the water make it slightly basic.) If your tap is closer to pure water, or you use water from a filter or water service, the color might be green. The Bromo is green in a pH of 7.

*We suggest using a slightly basic water source for a more visual effect and to give the illusion of the ocean.

Establish a control for your experiment by placing an additional cup with water and Bromo aside.

Instruct the students to use the straws to add CO_2 to their mini oceans by blowing GENTLE bubbles into their solutions. The example of blowing bubbles into chocolate milk seems to work well.

*If your students do not know that we exhale CO_2, be sure to quickly cover that topic)

As the students add CO_2 they should observe a color change compared to the control. The Bromo will change from blue, to green, to yellow as the pH drops with the excess CO_2.

Critical Questions:

Did adding CO_2 change anything in the water?

If Bromo is an ***acid indicato***r, is there acid in the water after you blew CO_2 in it?

Remember that ocean life is adapted to live in a pH that is similar to the conditions of your initial water color.

Will adding CO_2 to the ocean change the conditions that those critters need?

Ocean Acidification:

Scientists around the world are studying the effects of excess CO_2 in the ocean. This excess CO_2 is quickly creating a more acidic environment that negatively affects animals with shells, (like plankton) and the delicate coral reef ecosystems around the world. This acidic environment breaks down the calcium these animals use to make their shells and coral structures, causing these animals to die. One can only imagine the devastating effects on the marine food web from this as it continues to be a problem.

*If your cups are shorter, please cut the straws in half to use fewer resources

Please use paper straws to minimize the amount of single use plastics that are used. Even if they are disposed of properly, the amount of plastic straws we use is creating an environmental impact

** This is an acid indicator and can be purchased from chemical supply stores; teaching supply stores; and online

Example of Marine Plankton with a Calcium Shell. This animal is very vulnerable at this time of its life. You can see that its shell is so thin that it's translucent. Any changes in the water's pH could affect the development of the shell, which would

Life in the Ocean

Looking at patterns of life and diversity

K-ESS3-1 / ESS3.A Natural Resources
K-LS1-1 / Energy Flow in Organisms
2-LS4-1 / LS4.D Biodiversity

All living things (plants and animals, including humans) need four (4) things to survive:

1. Water
2. Food
3. Shelter
4. Space

How the organisms meet these needs changes based on where they live or their ***habitat***. Habitats provide the water, food, shelter, and space for organisms to survive. Different living things have adapted to survive based on the conditions of the habitat; this is what gives ***diversity*** to lifeforms on land, and especially in our oceans.

Sometimes the four needs can be hard to see, especially for marine algae, and ocean animals that live their lives beneath t. Here's a great example of how these four needs are met by a baleen whale in our ocean.

How does a blue whale meet these needs?

1. A blue whale gets its water from the food it eats, because it can't drink saltwater.
2. It needs up to 8,000 pounds of krill a day to maintain its size, so the space it needs spans vast areas of the ocean.
3. Whales carry their shelter with them (much like a shelled animal) in the form of blubber. Blubber is a special fat that keeps them warm and helps them float.
4. And of course, the ocean covers over 70% of the planet, so there is plenty of space and room for this animal to survive and grow to its titanic 80-100ft size!

On the next page, you'll notice a representation of the uniquely different ocean habitats (rocky shore, kelp forest, and open ocean) near Newport Beach with some of the special marine organisms that live there.

TRY THIS WITH YOUR STUDENTS!

Print out the following page, and have your students locate an organism on the graphic. Ask them to describe how each of the four needs are met within this image.

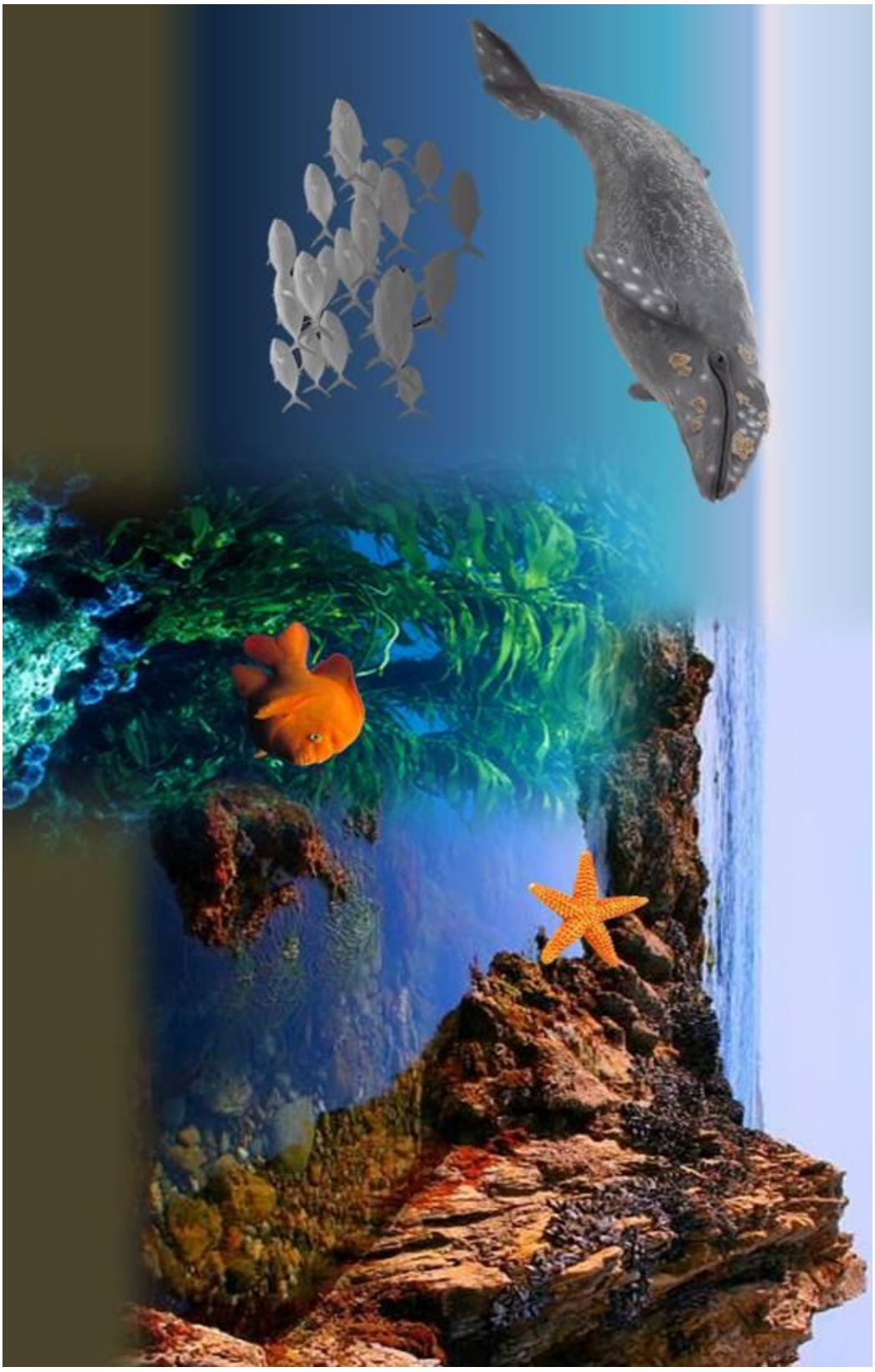
From Left→Right:

1) Gray Whale
2) School of Fish
3) Garibaldi Fish
4) Sea Star

To help you communicate this idea to your students, the following page will contain a table with suggestions on how to describe the ways in which these four needs are met within this ocean ecosystem in Newport Beach.

Blue Whale

Krill



Newport Beach Ocean Habitat

	Water	Food	Shelter	Space
Gray Whale	Marine Mammals cannot drink salt water. They actually get all the water they need from the fresh water within their food.	Gray Whales eat Amphipods (bug-like creatures that live in the mud). These whales have to migrate 6,000 miles from where they have their babies in Mexico to where they are able to find their food in the rich waters of Alaska.	Gray Whales protect themselves from the coldness of the water with blubber, a special fat that surrounds their body. When their babies are born, they do not have thick blubber, so Gray Whales migrate to warmer waters to provide them that shelter from the cold	Gray Whales need to eat 100's of pounds of food a day; that takes a lot of mud to search through to find their prey. They also need lots of space for their migration of 12,000 miles round trip along the Pacific Coast
School of Fish	Fish are able to drink seawater, and so they have all the water they need. But, they need to make sure that the water they do have is clean and healthy.	This School of Fish would probably eat smaller fish or plankton that venture out into the open ocean away from shelter.	In the open ocean, there's no place to hide, the fish ball up together creating a congested mass of fish. They make their shelter from predators by sticking close together. This makes it harder for predators to single out one fish from the school to eat.	Schools of fish have to travel across wide stretches of open ocean to find enough food to sustain sometimes thousands of fish that might be schooling together.
Garibaldi Fish	These kelp forest fish are able to drink seawater, and so they have all the water they need. But, they need to make sure that the water they do have is clean and healthy	The Garibaldi fish like to eat small animals that stick to the kelp (bryozoans). They live among the kelp forest.	The rocky reef and kelp forest provides shelter for the Garibaldi. Just like land animals can hide in a forest of trees, the Garibaldi hide in the kelp blades and rocky reef.	Garibaldis are very territorial and protective of their space on the rocky reef. This is because there is a lot of competition for food and shelter in the kelp forest
Sea Star	Sea Stars are able to drink seawater, and so they have all the water they need. But, they need to make sure that the water they do have is clean and healthy	Sea stars do not have eyes, so they find their food by tasting the water and ground with their tubed feet. They move along the bottom and over rocks searching for food, like shelled mussels, and waste from other organisms.	The waves can beat hard against the rocky coasts where sea stars live. They seek shelter in cracks, and by holding tight to the rocks with thousands of their tubed feet	The rocky shore can be a very productive environment, meaning there is plenty of food for several different types of animals. Sea Stars need just enough space to find food, so they do well in these intertidal ecosystems.