Awash

■ KidsPost Reprint: “Scientists probe mystery of ‘ghost nets’”

■ Post Reprint: “Turkey launches massive effort to vacuum up thick layer of ‘sea snot’ choking its coast”

■ Student Activity: A Blanket of “Sea Snot”

■ KidsPost Reprint: “‘My Octopus Teacher’ shows a rare bond between a human and a sea creature”

■ KidsPost Reprint: “That sand between your toes may start as rock. But it may also be fish poop.”

■ Student Activity: It’s a Shore Thing … Sun, Sand and Science — A Closer Look at the World’s Second Most Valuable Natural Resource
Awash

Articles, suggested activities and the lab in this resource guide take us to water’s edge and into the depths.

Students learn of ghost nets that threaten sea life and the detective work done by researchers to locate owners of the nets. Just listing the damage wreaked by them should awaken students to think beyond plastics to the many other sources that endanger sea creatures and pollute our waters.

A little more quirky and certainly eliciting a big yuck is sea snot. Pull out a map to locate Turkey, read the article and photographs, use the discussion questions and do a follow-up to see how successful efforts have been to remove a sea awash in mucus.

A more touching relation is found in “My Octopus Teacher.” Do students sense a similar bond with their pets? What lessons have they learned through observing and interacting with them? What makes the octopus a special kind of teacher?

Lisa Wu, former oceanography lab director at Thomas Jefferson High School for Science and Technology, wrote It’s a Shore Thing … Sun, Sand and Science activity. See Teachers Notes for additional suggestions from Wu. In her more than 30 years of teaching, she worked with many STEM students on their projects in, on and under the sea including the Potomac River and Chesapeake and Delaware bays. Unable to give up the pipette for the pen, she continues her commitment monitoring water quality aboard the floating lab, Sea Dog, for the Potomac Riverkeeper Network and serves on the executive board of the Women’s Aquatic Network.

You may feel awash with possibilities. Remember some may be read and completed now while others could be done in spring — preparing students to be more observant of the shore and aware of the water’s depth.
"Ghost nets" drift among the Pacific Ocean's currents, threatening sea creatures and littering shorelines with the entangled remains of what they kill.

Lost or discarded at sea, sometimes decades ago, the fishing gear continues to harm marine life and coral reefs in Hawaii.

Now researchers are doing detective work to trace the debris back to fisheries and manufacturers, which takes in-depth analysis of tons of ghost nets.

The biggest concern is that the discarded gear kills fish and other wildlife such as endangered Hawaiian monk seals, seabirds and turtles long after it's gone adrift, said Drew McWhirter. McWhirter is a graduate student at Hawaii Pacific University and one study's lead researchers.

"These nets bulldoze over our reefs before they hit shore," McWhirter added. "They leave a path of destruction, pulling coral heads out, and can cause a lot of ecological damage."

Ghost nets foul oceans throughout the world, but the Hawaiian Islands are a central point for marine waste.

Efforts to identify origins of nets have been difficult because debris comes from many countries and nets have few, if any, unique identifying features.

Experts say that many nets are lost accidentally, but boaters occasionally ditch nets to avoid prosecution when fishing illegally.

The ghost net study is supervised by Jennifer Lynch, co-director of Hawaii Pacific University's Center for Marine Debris Research.

"We're going to have a very challenging time … trying to identify it back to its source," she said. "And if we fail, … that's going to be increased evidence for policymakers to see the importance of gear-marking and potentially bring those kinds of regulations to the front."

Lynch hopes the study will help find new ways to prevent damage to the ocean environment.

Hawaii Pacific University graduate student Drew McWhirter, left, and Raquel Corniuk, a research technician at the university's Center for Marine Debris Research, pull apart a massive tangle of "ghost nets" May 12 in Kaneohe, Hawaii. The two are part of a study that is trying to trace fishing gear that washes ashore in Hawaii to the manufacturers and fisheries that it came from.

The crew gets ghost nets from three sources around Hawaii. One is the shores of the uninhabited Northwestern Hawaiian Islands, which are part of Papahanaumokuakea National Marine Monument. An April cleanup expedition to Papahanaumokuakea brought back nearly 50 tons of nets and other lost gear.

In a shed on the university's campus, researchers pull apart bundles of fishing gear. Then samples are taken to a lab for analysis. Researchers look at about 70

By Associated Press

• Originally Published May 30, 2021
aspects of each piece of net.

“We look at how it’s twisted. Is it twisted versus braided? We are trying to look at how many strands does it have, its twine-diameter, mesh-stretch size,” said Raquel Corniuk, a research technician at the university.

The information is entered into a database, which will help scientists find patterns that could lead to manufacturers and then fisheries or nations.

The researchers have spent about a year collecting data and hope to publish it this year.

They have found debris from all regions of the Pacific Ocean, including Asian countries and the U.S. West Coast.

Much of the ghost-net problem lies with nations that have few fishing regulations and sometimes buy or manufacture low-quality nets, according to a longtime fisherman who works for a net-maker in Washington state.

“Theyir products tend to be weaker,” said Brian Fujimoto, of NET Systems.

Fujimoto said his company uses technology, colors and other construction techniques that make their products easily identifiable.

Making that an industry standard, he said, is “only going to happen with the more industrialized nations, say for example, the U.S., Canada, Japan.”

Clamping down on those whose ghost nets harm marine life is important, said Daniel Pauly, a marine biologist and professor at the University of British Columbia’s Institute for the Oceans and Fisheries. “We kill fish for fishing and for consumption, but these fish that are killed by lost gear are killed for no reason, not to mention the marine mammal and turtles and other animals that we like.”
WORLD

Turkey launches massive effort to vacuum up thick layer of ‘sea snot’ choking its coast

Hundreds of workers to be sent to provinces on Sea of Marmara

A diver inspects mucilage in waters off Istanbul. Scientists blame untreated sewage and other pollution but say rising water temperatures caused by climate change appear to be making the problem worse.

BY ANTONIA NOORI FARZAN

- Originally Published June 10, 2021

Turkish president Recep Tayyip Erdoğan pledged Tuesday to rid the Sea of Marmara of the “scourge” of marine mucilage, as workers embarked on a massive effort to vacuum up the foul-looking substance that has been plaguing coastal communities.

Thick layers of the viscous, slimy mucus colloquially known as “sea snot” have been wreaking havoc along Turkey’s coastline for months, choking harbors and clogging up fishermen’s nets while suffocating marine life. Scientists say that untreated sewage, agricultural runoff and other forms of pollution are responsible for the phenomenon, but that warming water temperatures caused by climate change appear to be making it even worse.

The unappetizing muck has become a source of national embarrassment and rising anger. On Tuesday, Erdoğan vowed to designate the Sea of Marmara, which is between the Black and Aegean Seas, as a conservation area. Meanwhile, government officials launched a massive cleanup operation, using tanker trucks with suction hoses that park along the shoreline and effectively act as giant vacuum cleaners. Similar methods have been used to remove toxic blue-green algae from waterways in Florida.

“My fear is, if this expands to Black Sea … the trouble will be enormous. We need to take this step without delay,” Erdoğan said, according to the BBC.

Turkey’s environment minister, Murat Kurum, said Tuesday that hundreds of workers would be deployed to every province that borders the Sea of Marmara in the largest marine cleanup effort that the country has ever seen. To prevent the problem from reoccurring, officials will take steps to reduce pollution and improve wastewater treatment, he said.

While some scientists applauded the plan, others said that the Turkish government should have cracked down on pollution decades ago. The number of people living in Istanbul and other cities along the Sea of Marmara has exploded, marine biologist Mert Gökalp told Turkish newspaper Cumhuriyet. “Why did we go on with our lives without thinking about where our wastes go?”

Marine scientists have also warned that merely removing the top layer of “sea snot” will not solve the problem, because...
thick bands of mucus are floating below the water’s surface and settling on the sea floor, where they pose a hazard to coral and other marine life. It is not clear how the underwater mucus could be removed, but officials in Istanbul suggested last month that it might be necessary to bring in dredging boats.

The mucus that has been surrounding marinas and washing up on beaches in Turkey is secreted by phytoplankton populations that grow to out-of-control numbers when high levels of nitrogen and phosphorous upset the ocean’s ecological balance. Though the mucus itself is not necessarily dangerous, it can carry toxic microorganisms and dangerous bacteria such as E. coli, and authorities have warned against touching it.

Mucus removed from the Sea of Marmara will be trucked to waste disposal facilities, officials said, though some communities are experimenting with drying it out on land to see whether it can be used as a fertilizer or animal feed.
A Blanket of “Sea Snot”

When layers of a slimy substance spread along Turkey’s Sea of Marmara coastline, choking harbors, clogging fishermen’s nets, and raising doubts about the safety of eating fish from these waters, scientists were called to help. Read “Turkey launches massive effort to vacuum up thick layer of ‘sea snot’ choking its coast” and respond to the following.

1. Identify the following locations mentioned in the article on a map.
   - Aegean Sea: Greece
   - Black Sea: Istanbul
   - Mediterranean Sea: Italy
   - Sea of Marmara: Turkey

2. Why is Istanbul considered such a strategic location and so critical in the clean up efforts?

3. Define the following words as they relate specifically to this article.
   - Blue-green algae
   - E.coli
   - Marine muscilage
   - Mucus
   - Phytoplankton
   - Sea snot
   - Toxic

4. Explain how reducing pollution and improving wastewater treatment will decrease the chances of the sea snot from reoccurring. Use the terms untreated sewage, dredging, nitrogen, fertilizer run off, phosphorus and wastewater in your response.
Extension
As you research the following suggested areas, find a minimum of two articles and two images.
Define any new terms. Be ready to share your research with the class.
1. Research other possible contributors to the slimy layer and explain how they would stimulate the build up of sea snot along Turkey’s coast. Consider the following:
   a. Weather conditions
   b. Salinity of the waters

2. What is the ecological impact of the mucus?
   Consider the effect on benthic organisms such as corals, sponges, mollusks.

3. You probably are more familiar with mucus as it relates to other specimens including yourselves. If you have touched a fish, you felt that slimy coat. It is their protection from parasites and disease. It protects the gills from pollutants, and in some species the young fish consume the mucus on the parent for early nutrition. Too large to fit within the crevices of a reef, parrotfish produce a mucus “sleeping bag” each night when they rest to mask their scent and protect them from predators. Mucus is considered a marvel of biological engineering. It lines more than 200 square meters of our bodies. If you have had a COVID test, you know, there is a lot of information in our mucus about our health.
   a. In a small group of four or five, research the uses of mucus in different organisms.
      Consider the following:
      Amphibians
      Bacteria
      Fish
      Humans
      Mollusks — oysters, snails, “slugs”
   b. Explain the concept of biofilms. How does mucus act as a biofilm in your specimen?

4. Explore the field of Biological Engineering. Recognizing the broad importance of mucus to microbiology and medicine, discover how Katharina Ribbeck, at the Massachusetts Institute of Technology, proposed a new study of mucus using bioengineering, tissue science, microfluidics and more.
A unique story of connection,” is how South African filmmaker and naturalist Craig Foster refers to his underwater adventures with a wild common octopus documented in the film “My Octopus Teacher.”

Filmmaker Craig Foster spent a year interacting with an octopus in a South African kelp forest.

The Netflix film shows the bond that develops between Foster and the eight-legged creature during a year of diving in a kelp forest in the Atlantic Ocean. It won this year’s Academy Award and British Academy Film and Television Arts Award for best documentary.

Foster thinks that “My Octopus Teacher” has captured hearts worldwide because few of the many wonderful natural-history films are about a human’s relationship with the wild.

“I think people around the world are yearning to have some kind of real connection with the natural world, and this film speaks to that need,” he said.

Foster said he has had many such experiences with nature: “Having a fish

‘My Octopus Teacher’ shows a rare bond between a human and a sea creature

By Heather Djunga

• Originally Published August 11, 2021
swim into your hand, or a cuttlefish approach you, or an otter swim with you and reach out and touch you, are all such incredible gifts.”

Still, he said, these strong bonds weren’t easily forged, often requiring years of patience and perseverance. “I go into the water every day and spend a lot of time learning, studying and researching.”

Foster said he learned many lessons from the San masters, native people of South Africa’s Kalahari region.

“They taught me to track on land and to look for signs. I applied those same lessons to looking in the water,” he said.

Tracking involves knowing the animals well and recognizing their behavior and movements, Foster said.

“The San trackers learn to do what they do from childhood. They also rely on shared memories,” he said. “Connecting with nature is basically their lives, so one lifetime of mine would not be enough to explore the rich scope of what they know and can do.”

Observing his special octopus, part of a species known for its intelligence, has been a life-changing experience for Foster. One of the most remarkable moments was when the creature that initially hid in crevices allowed him to join her on a hunting expedition. How does Foster account for this? “When the same animal interacts with you every day over a long period of time, you can assume that there is trust involved.”

Foster said he learned that you can’t force this trust. “Everything must happen at the animal’s pace, comfort and convenience. In their eyes, we are big and predatory. They make themselves vulnerable in allowing us into their space because trusting the wrong human could mean death. So it’s an immense privilege when they show trust.”

— August 11, 2021

Learn more
Craig Foster offers advice on connecting with nature:
Spend at least 20 minutes in nature every day.
Feel the air you are breathing.
Let your bare feet connect with the ground.

If you are lucky to have a garden, spend time there.
Most of the greatest explorers, wildlife filmmakers and writers started out curious about their own backyards.

Even if you live in a city, there are parks or trees that you can explore.

Be curious.
Be observant.
Ask questions.

Begin with learning the names of five of your local trees, five birds and five animals. See what you can find out about them.
That sand between your toes may start as rock. But it may also be fish poop.

By Jason Bittel

Some people enjoy the way it feels to sit on warm sand, while others dislike how the gritty particles always seem to find a way inside a swimsuit. Sand is great for building castles, but just a few grains can ruin a bite of even the best sandwich.

Whether you love it or hate it, if you go to the beach this summer, there’s no way to avoid sand. So, what is sand, and where does it come from?

“Sand is basically small rocks,” says Matt Kendall, a marine biologist with the National Oceanic and Atmospheric Administration.

While we tend to associate the material with beaches, most sand begins its “life” high in the mountains, says Kendall. As tree roots, wind and ice break larger rocks apart, those pieces sometimes wind up in streams and rivers. Once there, the constant flow of water churns the rocks up, as if they’ve been put in a blender that never turns off and can span thousands of miles. Eventually the itty bitty pieces of rock are washed all the way to the ocean, where waves break them further and push them back onto the shore.

There are other kinds of sand, too. Black sand comes from ground-up lava, for instance. And in the Caribbean, much of the sand you see comes from tiny creatures called foraminifera.

“They’re like little amoebas with a shell,” says Kendall. “And they make these beautiful structures that are sand-size particles. And when they die, the shells are left over, and they make this beautiful pink sand.”

But the best backstory for a sandy beach relates to the magical, white sand beaches of Hawaii, which you may have seen in movies and pictures. With turquoise water on one side and vibrant green palm trees on the other, the pristine shores look like they’re made of powdered diamonds and pearls. However, the beaches are actually made of parrotfish droppings.

Parrotfish eat coral. With super strong beaks, they crunch through the coral’s skeleton like it’s a candy apple in an attempt to get at the nutrients inside. More teeth in the parrotfish’s throat grind the coral up further, and by the time the bits pass through the digestive tract and out the other end, what was once hard, rocklike coral has been turned into a cloud of white dust. Waves wash the stuff onto shore, where tourists pay thousands of dollars to take selfies upon it, perhaps never realizing where the luxurious sand comes from.

“If you’re lying on your towel and you look around and see white sand, that’s parrotfish poop,” says Kendall with a laugh.

— June 21, 2020
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VOLUME 21 ISSUE 3

It’s a Shore Thing … Sun, Sand and Science — A Closer Look at the World’s Second Most Valuable Natural Resource

Whether your memories are of building sand castles in a school playground or of brushing off sandy feet at the beach, everyone can identify with sand. As a biologist on my first dives in the tropics, we worked on fish identification and behaviors. I clearly remember focusing on a coral mound and my attention being drawn to poofs of white dust arising from behind the coral and a noise that sounded like someone munching a bag of chips. Stealthily swimming to view the area in question, I saw several fish biting and scraping the coral — not to feed on the coral themselves but to process the dinoflagellates (microalgae) within the soft tissue of the coral. These fish are herbivores. The coral skeleton is excreted as waste from their digestive system. It then dawned on me that the beautiful white sand beaches of the Bahamas that I (and everyone else) sunned on and sifted through our fingers had been processed through the gut of a parrotfish.

Although continuing to focus on marine life, I found myself collecting and comparing sands from the mid-Atlantic, New England, Bermuda, California and Hawaii. I created a lab related to the pink sands of Bermuda and soon found students and staff bringing me samples from their travels. Although I did not create a psammophile club at school, my interests led me to discover this is a hobby among some of the foremost geoscientists of our time. I also found it a great way to engage students not only in being better observers when we were in the field but also in working across disciplines in school — including biology, geology, chemistry, physics, art and even a physical education study on the effect of sand versus grass training surfaces in team sport athletes. These activities are designed to introduce students to an amazing, yet underappreciated natural resource we all depend upon.

Lisa Wu, former oceanography lab director at Thomas Jefferson High School for Science and Technology, wrote this activity. In her more than 30 years of teaching, she worked with many STEM students on their projects in, on and under the sea including the Potomac River and Chesapeake and Delaware bays. Unable to give up the pipette for the pen, she continues her commitment monitoring water quality aboard the floating lab, Sea Dog, for the Potomac Riverkeeper Network and serves on the executive board of the Women’s Aquatic Network.

Lisa has collaborated on other Post NIE curriculum guides including The Depth and Breadth We Seek, Plankton — The Drifters and “The Caribbean: An Introduction to a Large Marine Ecosystem” found in Where in the World Is Cuba?
It's a Shore Thing | continued

Teacher Preparation

If you have a collection of sand – welcome to the club! If you don’t have any samples, ask colleagues or students – you will be surprised. Try to collect as many different sand samples as possible such as “Atlantic Coast sand,” “Pacific Coast sand,” or “Gulf Coast sand,” and “Beach sand,” “Desert sand” and “River sand.” Consider your locality. You might have several samples from the mid-Atlantic. Or if you are in the field collecting with students, you could collect samples on a transect from near shore to beach to dune for comparison. If you can plan a semester ahead, here is another idea.

I used to give my students a summer assignment of sending me two or three pictures of something they did during the summer. Since I taught at a STEM-focused school, I called the assignment, My Scientific Summer and created a slide show using their photographs. This was incredibly fun (and appreciated) for open houses, back-to-school nights and alumni homecomings. Why not add an additional request for extra credit: Ask students to bring back a sample of sand that would fill a sandwich baggie. The sample would need to be accompanied by pictures of the area, coordinates, surroundings and notes describing the area, being as specific as possible: low tide mark, high tide mark, upper beach area, left of pier, etc. If more than one sample is taken from the same place, mark it as such (variety #1, variety #2). Students should provide as much information about that sample’s origins as possible. Pictures collecting the sand sample are also great to have.

Your collection will grow and so will interest in the project!

Prepare students by sharing a podcast or articles for discussion prior to doing the lab. This could be the KidsPost article, “That sand between your toes may start as rock. But it may also be fish poop.” There are several resources listed that you can use to find images of sand. You might put these into a PowerPoint that you can use to point out shape, sorting and composition. You can add questions to these and later use the same slides for a quiz.

The materials and technology are listed with optional materials that can be used for more advanced work. You will need a shape and size identification chart that can be printed out and laminated or put in a protective sleeve for each group. Check out the Education Program at the New Jersey Sea Grant Consortium for an excellent example, Grain Size — How Big Are the Sand Grains.

Sand grains can be put in a Petri dish to view under the microscope. In most cases, the students will see a range of sizes. Size generally indicates how long a particle has been eroding and moving. The longer time, the smaller the particle will be.

The investigation can be done in several ways with questions depending upon samples used. I have students work in pairs, but groups could be larger, or this can be done by a single student working from home.
# It's a Shore Thing | continued

## Materials and Technology Needed

<table>
<thead>
<tr>
<th>Materials</th>
<th>Optional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assorted samples of sand</td>
<td>Mineral Identification Kit (one per group)</td>
</tr>
<tr>
<td>10X Magnifiers (one per group)</td>
<td>Sieve Kit (minimum of one, preferably one per group)</td>
</tr>
<tr>
<td>Shape Identification Chart (one per group)</td>
<td>Dilute Hydrochloric Acid or Acetic Acid (vinegar)</td>
</tr>
<tr>
<td>Magnet (one per group)</td>
<td>Low Power Binocular Microscope</td>
</tr>
<tr>
<td>Safety Goggles (one per student)</td>
<td>Digital Camera</td>
</tr>
<tr>
<td>Ruler</td>
<td>Digital microscope with camera</td>
</tr>
<tr>
<td>Forceps</td>
<td>One balance capable of measuring a larger mass ≈ 1,000 g per group</td>
</tr>
<tr>
<td>Petri dish</td>
<td>Glass dropper bottle</td>
</tr>
<tr>
<td>Wentworth Scale (for size)</td>
<td>Test tubes</td>
</tr>
</tbody>
</table>

### Technology

Computers with access to the internet

Another option for measuring sand grain size is for students to design and print their own mm graph paper to plot and measure the average size of the particles in the sample by placing grains on this paper. From very angular to very rounded, sand angularity charts and images can be found on the internet. The angularity provides information about how the sand was eroded (wind or water).

For determining if the sand has calcium carbonate, acetic acid or diluted hydrochloric acid can be used. Goggles must be worn when doing acid testing on the grains. Teachers can rotate between groups to add a drop of solution on a glass slide to see if carbon dioxide bubbles form. Another option, is to have a small bottle of the dilution that the students can drop the sand into to see if it bubbles. Test tubes can also be used for testing the acid on the sand.

Magnets should be kept in plastic bags when testing samples to prevent the grains from adhering to the magnet’s surface too tightly.

If paper maps are not available, students can use the internet to find a detailed map of the location where their sample was collected.

The distribution of samples is going to determine the guiding questions. If you have a selection from an entire coastline, the Atlantic Ocean for example, you can have them hypothesize how the sand will change as they go from farthest point north to farthest point south. If you have samples from two different coasts, you could have them hypothesize what the difference will be between Atlantic and Pacific, or Atlantic Ocean and Caribbean Sea.

If possible, students should take digital images of their sand and add these to their report. Size should be indicated on the image. There are inexpensive microscopes that can be connected to cell phones as well as adapters that can connect cell phones to microscopes.

For students to compare their sample with others, the data sheet could be placed on a white board or large paper so that everyone has access to all the data.

Decide if you want the lab written up formally or if you just want to hold a discussion for students to share their ideas on the discussion questions.
It's a Shore Thing | continued

Objectives and Learning Outcomes

Basic Objectives

Given a sample of sand, and working in pairs, students should be able to complete the following:

1. Compare sand to a sorting chart and determine the degree of sorting based on the general size distribution of the grains. Note: If the sand grains are mostly one size it is well sorted. If there is some mixture, the sand is moderately sorted; if there are many different size grains in the sample, it is poorly sorted.

2. Identify minerals in the sample using a mineral identification kit, 10X magnifier, magnet, and glass dropper bottle with hydrochloric or acetic acid.

3. Determine the shape and coarseness of the grains using a 10X magnifier and a shape identification chart.

4. Create a hypothesis on the origin of the sand and how the sand might change over time using a map showing the geologic features of the area where the sand was collected.

Advanced Objectives (depending on materials)

5. Take a macro image of the sample (using a digital camera) and post the image, noting magnification and scale, to a webpage created for collection of the data.

6. Take a magnified image of the sand sample using a digital microscope and post the image to a webpage, indicating size of grains and magnification.

7. Determine the total mass of the sample using a scale.

8. Determine the mass of each grain size component by pouring it through the sieve kit.

9. Calculate the percentage of those size components in the sample of sand.
COASTAL BEACH SAND LAB

OBJECTIVE  Considering the location of your sand, size of components and other observations, determine the source of the sand sample and describe its journey and how sand in the area it was collected is likely to change in the future.

PROCEDURE

1. Select a sand sample and record any identifying information you have. Put a few grains in a Petri dish and using a magnifying lens or microscope write a general description of the sample by recording the overall color or shade of the sand, and if the sand is well or poorly sorted. Note unique characteristics that you observe.

(If all of the grains are about the same size the sample is “well sorted.” If there are a great variety of grain sizes, the sample is “poorly sorted.”)

For reference: Sand is defined as small, loose grains of mineral, rock, or other naturally occurring material, with grain sizes between 1/16 mm and 2 mm.

<table>
<thead>
<tr>
<th>Size (mm)</th>
<th>Particle Type</th>
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<tbody>
<tr>
<td>&gt; 4mm</td>
<td>Pebble, cobble, boulder</td>
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<tr>
<td>4-2</td>
<td>Gravel</td>
</tr>
<tr>
<td>2-1</td>
<td>Very coarse sand</td>
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<tr>
<td>1-1/2</td>
<td>Coarse sand</td>
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<tr>
<td>1/2 - 1/4</td>
<td>Medium sand</td>
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<tr>
<td>1/4 - 1/8</td>
<td>Fine sand</td>
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<tr>
<td>1/8 - 1/16</td>
<td>Very fine sand</td>
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<tr>
<td>1/16 - 1/256</td>
<td>Silt</td>
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<tr>
<td>&lt;1/256</td>
<td>Clay</td>
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</table>

2. After the general description has been written, one or two people should take the sample and calculate the different percentages of grain sizes by passing the sample through a sieve kit Find the mass of each section of the sieve kit, and record the mass.

3. Arrange the sieves with the largest screen size (#5) on top, decreasing screen sizes in order below to the closed bottom container.

4. Pour the sand into the sieve, and separate it according to grain size.

5. Find the mass of each section of the sieve kit with the sand added.

6. Calculate the mass of each grain size.

7. Calculate the mass of the entire sample by finding the sum of the masses of all of the different grain sizes.

8. Determine the percentage of each sieve sample using the following equation:

   \[
   \text{Mass of specific grain size} / \text{mass of the entire sample} \times 100 = \%
   \]

9. Describe each sample as to its angularity by comparing it to the Angularity Chart.

10. Using a paper map or the internet, find the area that was the source of your sand sample. You should be able to see structures such as mountains, the shape of coastlines, river flow, and currents (depending on the type of map)

11. With your partner, form a hypothesis about the origin of your sand sample and how it might change over time.

12. Take a photograph of sand using the digital camera. Using the chart, be sure to include size.

13. Attempt to identify each of the different grains by looking at them under the 10X magnifier and comparing them to the mineral samples. Use the magnet on dark samples you suspect might be iron based. **Goggles must be worn when using HCl or Acetic Acid. The teacher will provide instructions on how to perform this test.**
<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Total Mass of sample in gms</th>
<th>Sieve # (Grain Size)</th>
<th>Mass of Empty Sieve (grams)</th>
<th>Mass of Sample Size Plus Sieve (grams)</th>
<th>Mass of Sample Size (grams)</th>
<th>% of Sample that is that Size</th>
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<th>Grain Identification</th>
<th>Color</th>
<th>Transparency</th>
<th>Angularity</th>
<th>%</th>
<th>Comment</th>
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COASTAL BEACH SAND LAB

1. What was the name of the beach, city and state where your sample was collected?

2. Sand is created by rocks being abraded. Where did the rocks originate that formed the sand on your beach? 
   Look at the map. Do research on the geology and land use of the region.

3. Compare your samples with other groups from a different location.
   a. Is the size of the sand grain controlled by the latitude?
      As you head from north to south, describe any patterns to the size of the sand grains.

   b. Was the color of the sand controlled by latitude. Do the sands get lighter as you go south?
      What controls the color of sand?

4. Explain what happens to the physical characteristics of sand as you head south.
   How confident are you in your answer? What would you need to do to prove it?

Discussion

• In The Washington Post article, “That sand between your toes may start as rock. But it may also be fish poop,”
  carbonate sands, comprised of calcium carbonate are mentioned. What other organisms besides the coral would
  be found in carbonate sands or biotic sands (formed by living organisms)?
  Research what organisms causes the pink sands of Bermuda and the White Cliffs of Dover.

• How else besides going through the gut of a parrotfish is sand created on beaches?
  Why do the beaches in New England look different from the beaches in Florida or California?
  How are desert sands different from beach sands?

• What is the economic importance of sand?
  Why would a country in the Middle East surrounded by desert need to import sand from Australia?
Extensions to Expand Your Horizons

Create a Collaborative Map by Plotting Sand Locations
On a wall or bulletin board, use a large map to plot the sand locations of your collection. Small vials of sample sands can be attached to the location with GPS labels for identification. A QR code can also be added to point to linked data related to the site including photographs. A good class project that spans multiple disciplines and student talents. I started one in the hall outside my lab that was affectionately called Diatom Alley.

Create a Permanent Collection of Sand by Making Sand Collection Cards
Cut a hole or window in an index card.
Place clear box tape on the back side of the card so the sticky tape is over the hole.
Sprinkle sand sample over the sticky surface of the tape.
Cover the sand with a second piece of tape to protect it.
Add identifying information to the sample.

Did you know that sand was the world’s second most consumed natural resource?
The glass in every window, windshield, and smart phone screen is made of glass-melted-down sand. The silicon chips inside our phones and computers — along with most all electronics — are made from sand. It is the primary raw material that modern cities are made from. The concrete used to construct roads, shopping malls, offices, and apartment buildings. Why is there a shortage of sand and how has this need created a black market, damaging infrastructure and the environment? What are some possible solutions for moving forward?

Listen to a Podcast and Write a Reaction to Share With Classmates
Sand Under a Microscope [GeologyLogic] Walks you through the analysis of the characteristics of two sand samples under a microscope. Shows the difference between sand grains transported by water and wind. 4 ½ minutes in length. https://www.youtube.com/watch?v=r5IB4xgMQAQ

Song of the Dunes
A four-minute listen to the singing sand dunes of Morocco. https://www.youtube.com/watch?v=4yFaMsUawi4

Fu-Go
Listen to 19 minutes of a 38-minute enlightening podcast based on real world events during World War II. Sand analysis and meteorology play a crucial role in a story you probably never heard. Introduces the concept of forensic geology. https://www.wnycstudios.org/podcasts/radiolab/articles/fu-go

### Wentworth Scale

<table>
<thead>
<tr>
<th>SIZE TERMS (after Wentworth, 1922)</th>
<th>PHÉ-mm COEVRSION $\phi = \log_{10} \left( \frac{d}{0.001} \right)$</th>
<th>SIEVE SIZES</th>
<th>Number of grains per mg</th>
<th>Settling Velocity (Quartz, 20°C)</th>
<th>Threshold Velocity for traction cm/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOULDERS ($\phi &gt; -8$)</td>
<td>$\phi$</td>
<td>ASTM No. (U.S. Standard)</td>
<td>Tyler Mesh No.</td>
<td>Quartz spheres</td>
<td>Natural sand</td>
</tr>
<tr>
<td>COBBLES</td>
<td>$-5$</td>
<td>2 1/2&quot;</td>
<td>2&quot;</td>
<td>100</td>
<td>50</td>
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<tr>
<td>PEBBLES</td>
<td>$-3$</td>
<td>1 1/2&quot;</td>
<td>1 1/2&quot;</td>
<td>90</td>
<td>90</td>
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<tr>
<td>SAND</td>
<td>$-2$</td>
<td>1 1/4&quot;</td>
<td>1.05&quot;</td>
<td>80</td>
<td>80</td>
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<tr>
<td>Silt</td>
<td>$-1$</td>
<td>1 1/8&quot;</td>
<td>0.742&quot;</td>
<td>70</td>
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<tr>
<td>Silt</td>
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<td>1 3/16&quot;</td>
<td>0.525&quot;</td>
<td>60</td>
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<tr>
<td>Silt</td>
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<td>1 5/32&quot;</td>
<td>0.371&quot;</td>
<td>50</td>
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<tr>
<td>Silt</td>
<td>$-1$</td>
<td>1 1/16&quot;</td>
<td>0.265&quot;</td>
<td>40</td>
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<tr>
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<tr>
<td>CLAY</td>
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<td>1 1/256&quot;</td>
<td>0.008&quot;</td>
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<tr>
<td>CLAY</td>
<td>$-1$</td>
<td>1 1/512&quot;</td>
<td>0.002&quot;</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: Some sieve openings differ slightly from phi mm scale.

Note: Some sieve openings differ as much as 2% from phi mm scale.

Note: Applies to subangular to subrounded quartz sand.

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Note: The relation between the beginning of traction transport and the velocity depends on the height above the bottom and on other factors.

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