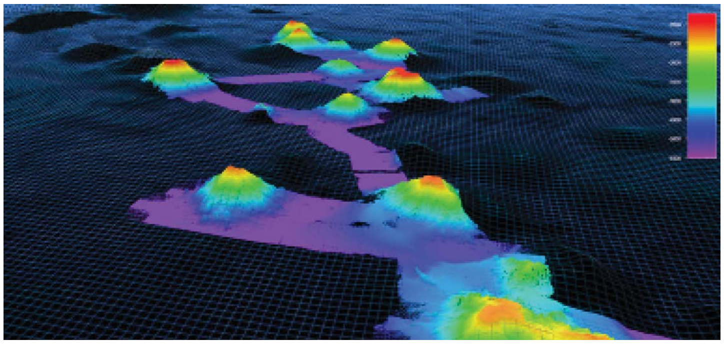
Sonar: Seeing with Sound

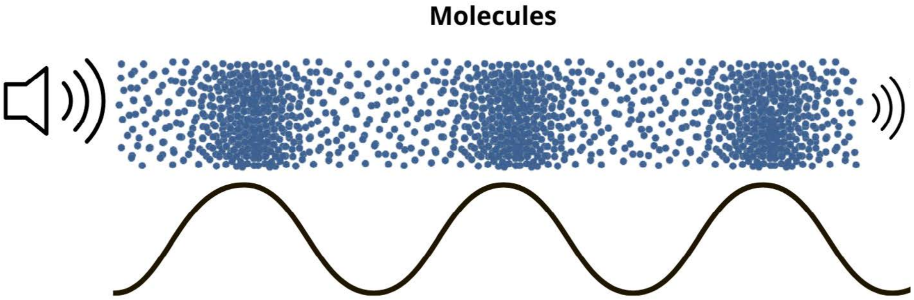
Imagine if we could drain the ocean – we would see dramatic seafloor features such as seamounts (undersea mountains), trenches, canyons, ridges, and more! Because we cannot directly view the ocean floor, we use sophisticated mapping tools that use sound to "see" these formations deep below the surface of the ocean.



Seafloor mapping data of the New England Seamount chain.
Image courtesy of NOAA Ocean Exploration, 2021 North Atlantic Stepping Stones: New England and Corner Rise Seamount Expedition.

Sound and Sonar

Sound travels through a medium, like water, in the form of waves. Sound waves are formed when something causes the nearby molecules in a medium to vibrate (for example, the call of a toadfish is produced by contracting muscles along its swim bladder - the muscle contractions cause the air filled bladder to vibrate). The vibrating molecules bump into their neighbors, causing them to also vibrate. The vibration spreads from molecule to molecule, which allows the sound wave to travel. It is important to note, however, that the molecules in the medium do not travel *with* the wave; they vibrate back and forth, or oscillate, as the sound wave moves.



Explore more about the science of sound with *Discovery of Sound in the Sea*.

SONAR, short for **SO**und **NA**vigation and **R**anging, is a tool used to explore the ocean and locate objects underwater. Since sound waves travel greater distances in water when compared to radar or light, underwater acoustics (e.g. sonar) are a more effective tool for ocean exploration. Scientists use modern sonar technologies to develop nautical charts, locate underwater hazards for navigation, search for and identify objects in the water column or on the seafloor, and to map the seafloor itself.

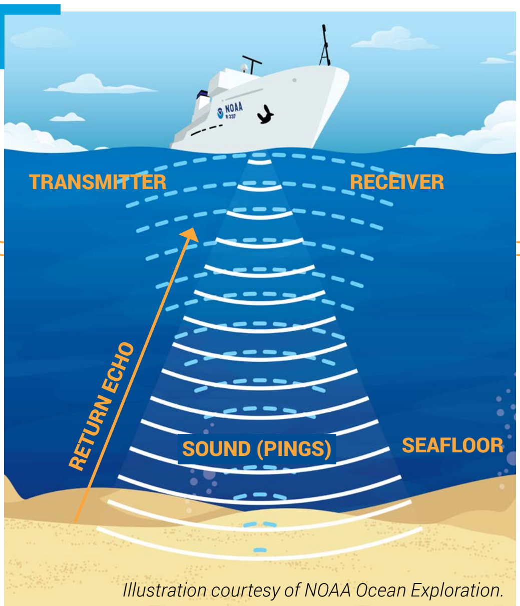


Illustration courtesy of NOAA Ocean Exploration.

How does sonar work?

A sonar system can consist of one or more transducers, which are made up of a transmitter and a receiver. The transmitter sends pulses of sound energy (pings) through the water, similar to an underwater speaker. The receiver is like our eardrums. It detects return signals (echoes) that are reflected back from the seafloor or other objects in the water and/or on the seafloor, including living organisms. Depth is calculated by first knowing how fast sound travels in water (approximately 1,500 meters per second) and then measuring the time (round trip) between the transmitted ping and its returning echo. Sonar data can also be used to determine the shape and orientation of an underwater object.

How does sonar work? cont.

Scientists may choose to use a single transducer (single beam sonar) or a group of them, called a transducer array (multibeam sonar). Transducers can be attached to a variety of platforms, including the bottom of a ship, or attached to underwater robots like remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs), such as gliders.

From Sonar to Maps

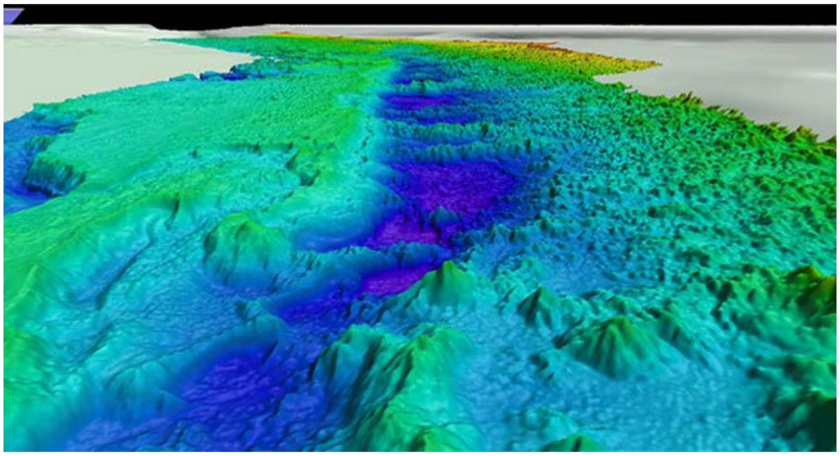
Sonar data can be used to create detailed (high resolution), 3D **bathymetric** maps. Bathymetry is the measurement of “submarine topography” or the depths and shapes of underwater terrain. In the same way that topographic maps represent 3D features (or relief) over land, bathymetric maps illustrate land underwater.

Seafloor mapping is the first step in exploring our vast ocean. Once scientists or resource managers have identified an area they would like to know more about, they can use multibeam sonar to collect data and create high-resolution bathymetric maps of that part of the seafloor.

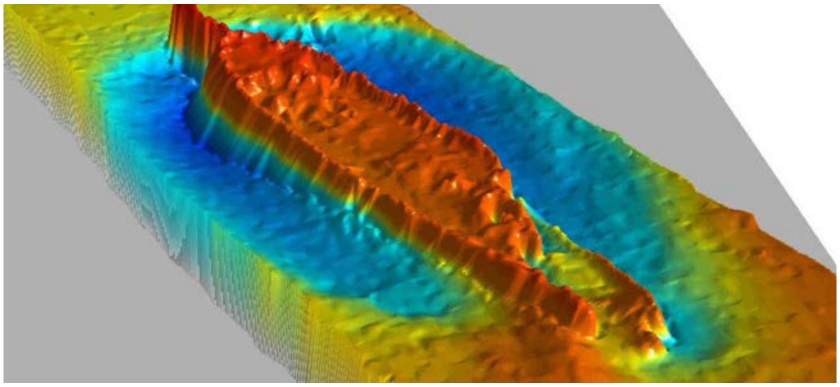
These maps help us make better decisions about how and where to do targeted, more-detailed exploration using tools like remotely operated vehicles (ROVs). Seafloor maps also save both time and money and increase chances for significant discoveries, while ensuring that ships and submarines are able to safely maneuver around natural and human-made structures on the ocean bottom.

Overall, bathymetric data can help us:

- Characterize marine habitats to make well-informed management decisions
- Identify geologic faults and submarine landslides
- Establish baseline information for long-term monitoring of environmental changes
- Develop models to determine risks of hazards to coastal communities
- Increase public awareness of ocean and coastal issues



Multibeam sonar data collected by NOAA Ship *Okeanos Explorer* showing the three-dimensional topography of the Gulf Stream and the Million Mounds coral region off the southeast US coast. Many of the coral mounds discovered here rise over 30 meters (100 feet) above the seafloor and create important habitat that supports a diversity of marine life. *Image courtesy of NOAA Ocean Exploration.*



A map of the shipwreck *Herbert D. Maxwell* created from multibeam sonar data. The *Maxwell* was a four-masted schooner built in 1905 that sank on May 16, 1910, east of Annapolis, Maryland, after colliding with the SS *Gloucester. Image courtesy of NOAA.*

New England Seamounts (image): https://oceanexplorer.noaa.gov/image-gallery/welcome.html#cbpi=/okeanos/explorations/ex2104/features/mapping/media/bathymetry.inc

Discovery of Sound in the Sea (video): https://dosits.org/science/sound/what-is-sound/

Sonar illustration: https://oceanexplorer.noaa.gov/edu/materials/sonar-pings-illustration.png

Bathymetric Mapping (fact sheet): https://oceanexplorer.noaa.gov/edu/materials/bathymetric-mapping-fact-sheet.pdf

Multibeam Sonar (fact sheet): https://oceanexplorer.noaa.gov/edu/materials/multibeam-sonar-fact-sheet.pdf

Multibeam Data (image): https://oceanexplorer.noaa.gov/ex10years/stories/media/stetson-north-800.jpg

Shipwreck (image): https://celebrating200years.noaa.gov/transformations/hydrography/image11.html

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