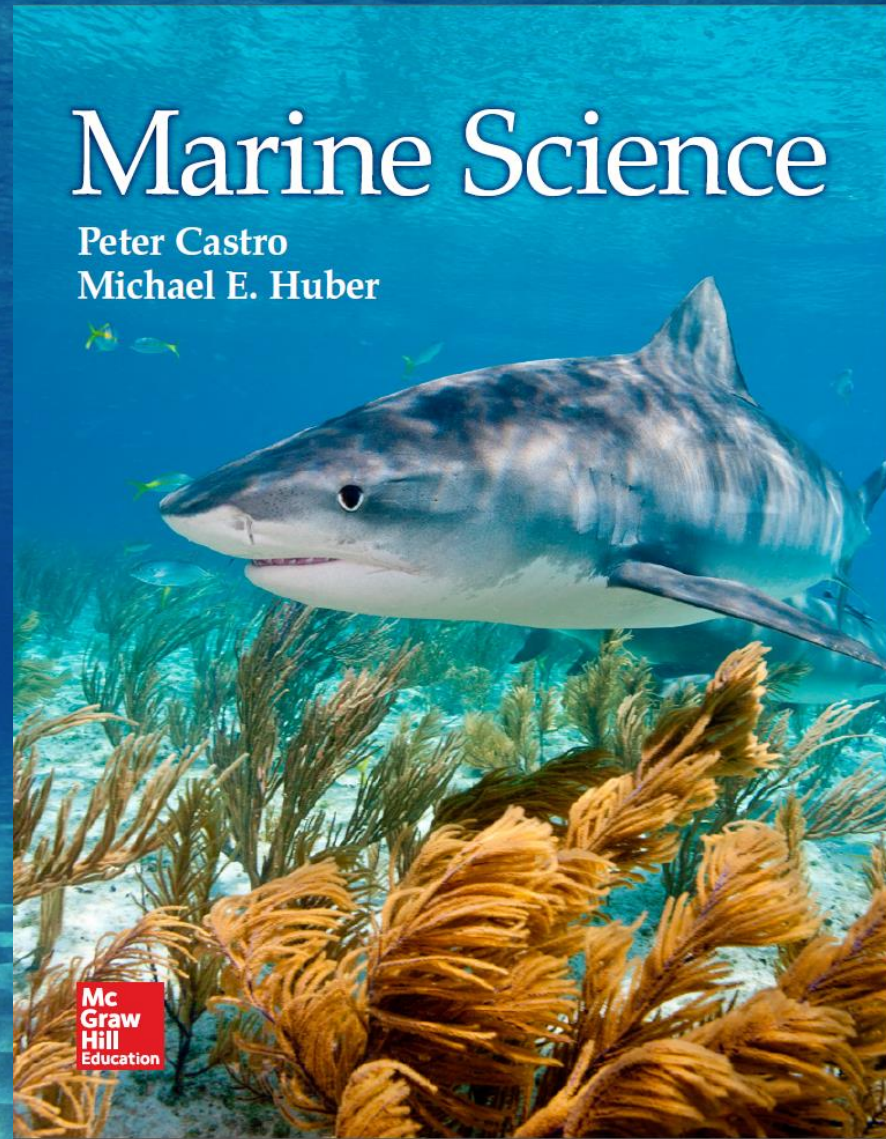


Chapter 1

Principles of Marine Science



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What is Marine Science?

- Marine science is a broad field that covers the link between oceanography and marine biology.

Physical
Chemical
Biological
geological

Why Study Marine Science?

1. Since life is believed to have arisen in the sea, **studying marine life can provide clues about early life on Earth.**
2. **Many products come from the sea including food resources, medicines** derived from marine species, and other items for human use.

Why Study Marine Science?

3. **Marine organisms produce oxygen** used by all kinds of organisms, including humans.
4. The marine environment provides **recreation** and supports **tourism** worldwide.

Why Study Marine Science?

5. The oceans help regulate climate.

Water is slow to change in temperature, which keeps coastal land masses more stable year-round.

History of Marine Science

- Evidence suggests that humans have been using the sea since early times.
- **Clam shells**, which are approximately 165,000 years old, have been discovered in a cave previously inhabited by humans in South Africa.
- Shell **harpoons** and **fishhooks** that are estimated to be **110,000** years old also have been found.



Gifts from the Sea



Pro Osteon



Provides a natural scaffold for new bone growth when placed in contact with viable bone.

Bone Void Filler

Cone Snail

The toxic venom of the cone snail is strong enough to paralyze instantly.

Toxin is 500x more powerful than morphine



AWWWWWWW!!!!





Protection

MANGROVES

FLORIDA'S COASTAL PROTECTORS
at
KENNEDY SPACE CENTER

MANGROVE HABITATS

REDUCE
THE
HEIGHT OF
INCOMING
WAVES
BY
90%

provide
800%
more
Coastal Protection

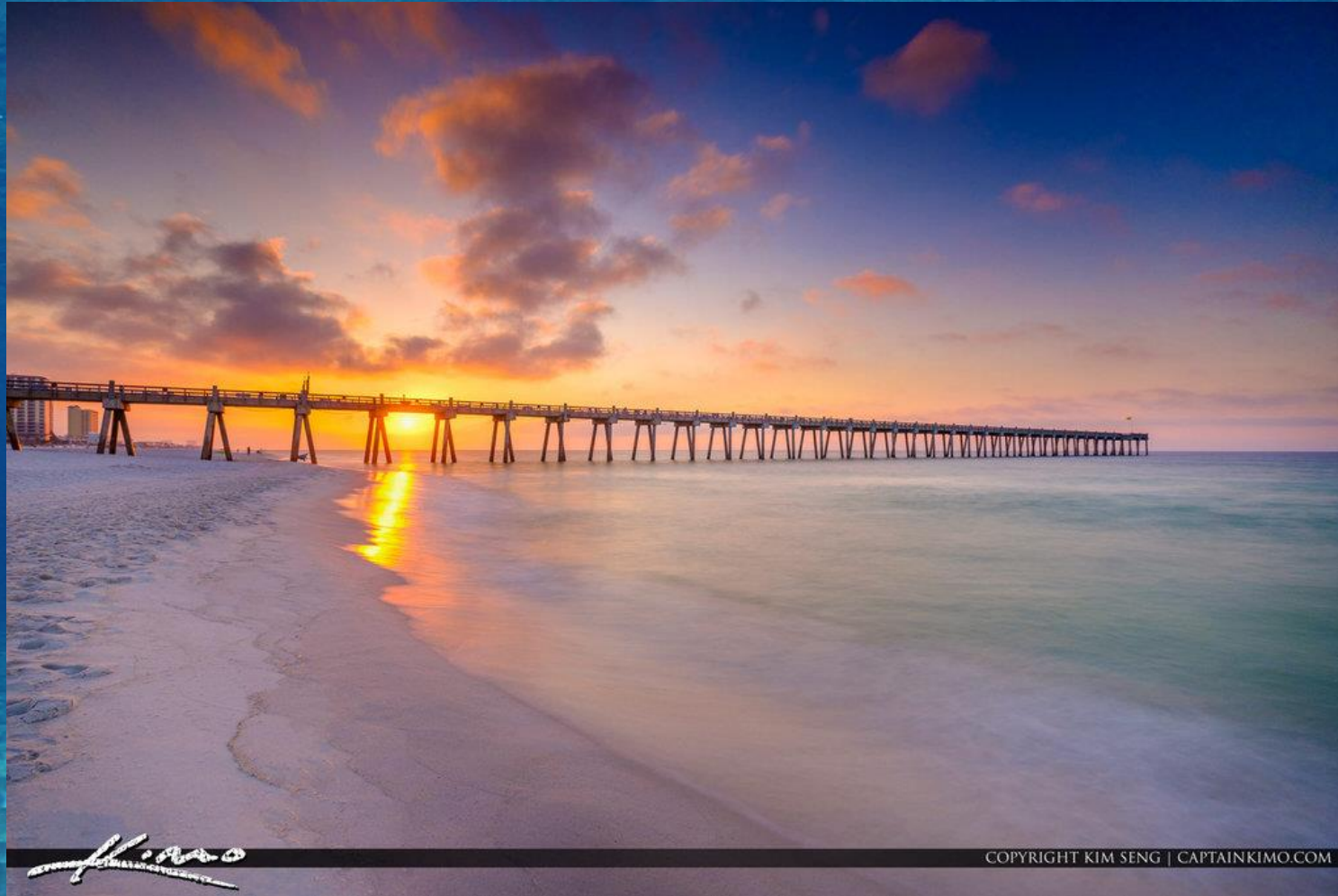
and
470%
more
Erosion Prevention

than salt marshes



would provide
**4.9 mill.
USD**
of coastal protection
more than
manmade barriers

The intangible things in life





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Sunsets



Whelk casing

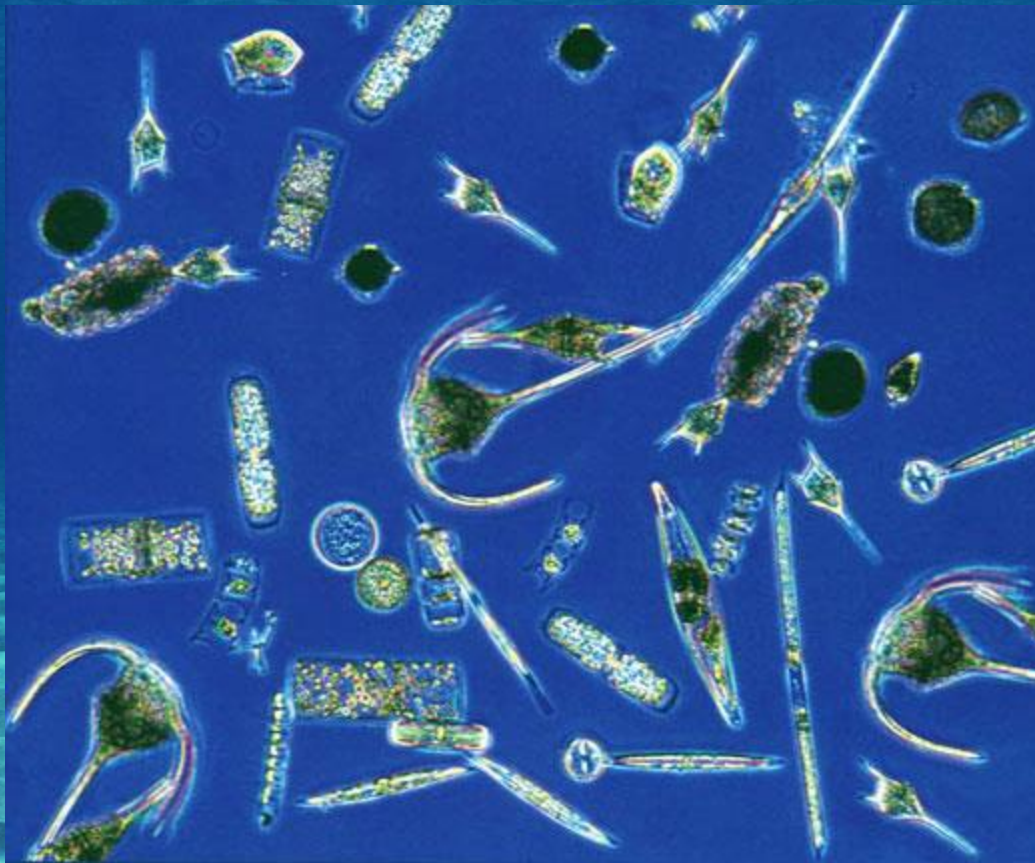
Drift seeds - Drift seeds (also sea beans) and drift fruits are seeds and fruits adapted for long distance dispersal by water. Most are produced by tropical trees, and they can be found on distant beaches after drifting thousands of miles through ocean currents. This method of propagation has helped many species of plant such as the Coconut colonize and establish themselves on previously barren islands.

Conch

Horseshoe crab

Got O₂?

Thanks, Plankton!



Chill out!

The negative ions in sea air accelerate your ability to absorb oxygen, and balance your serotonin levels, a body chemical linked with mood and stress.





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Historical Context

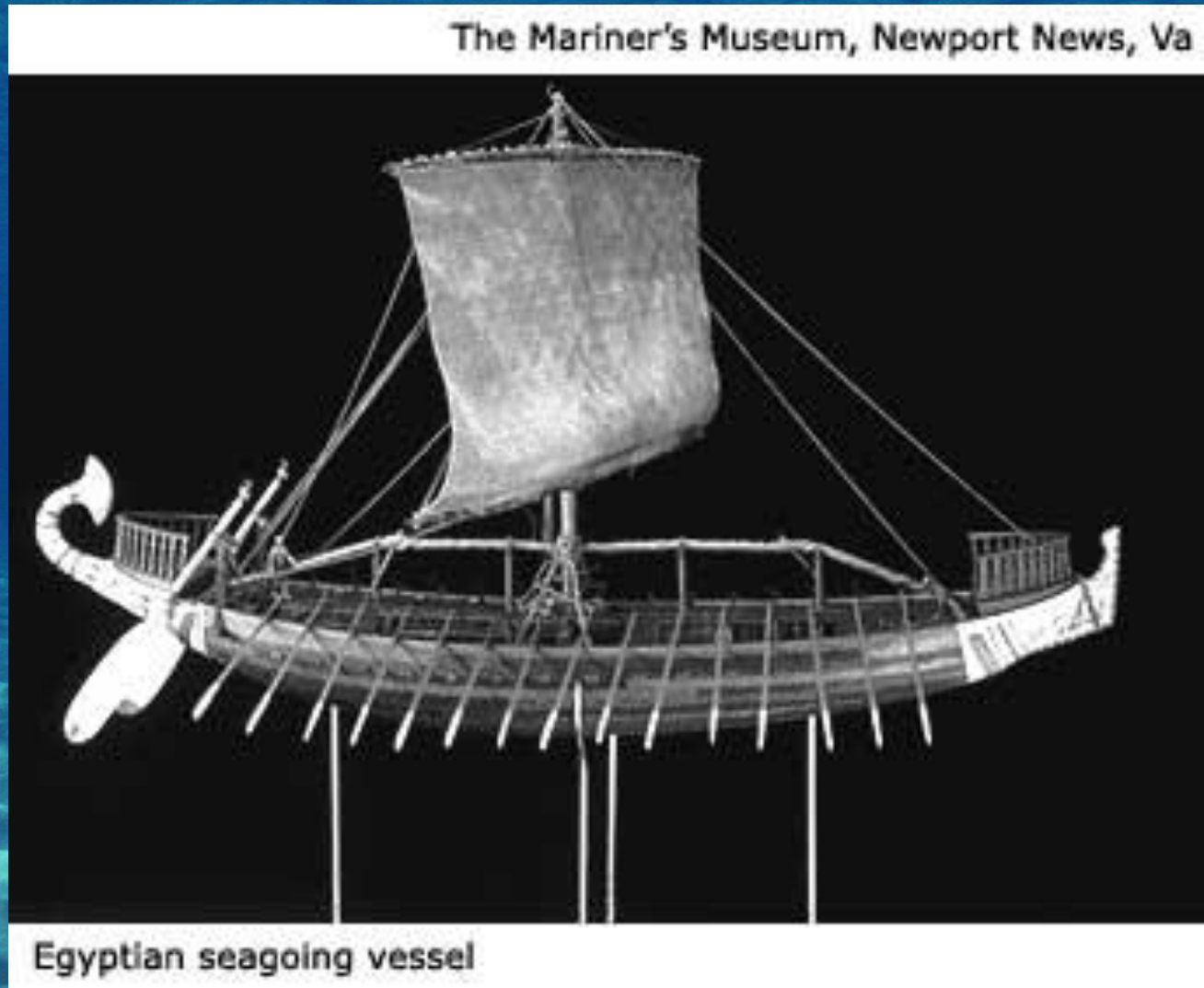
- People have studied the ocean for millenia
 - Food
 - Shells for trading, monetary value
 - Fishing tools: Harpoons & hooks
 - Jewelry
 - Navigation (esp. Ancient Pacific Islanders)

The History of Oceanography

Divided into 4 stages:

- 1. Ancient uses and explorations**
- 2. The Middle Ages**
- 3. European Voyages of discovery**
- 4. Birth and growth of Modern
Marine Sciences**

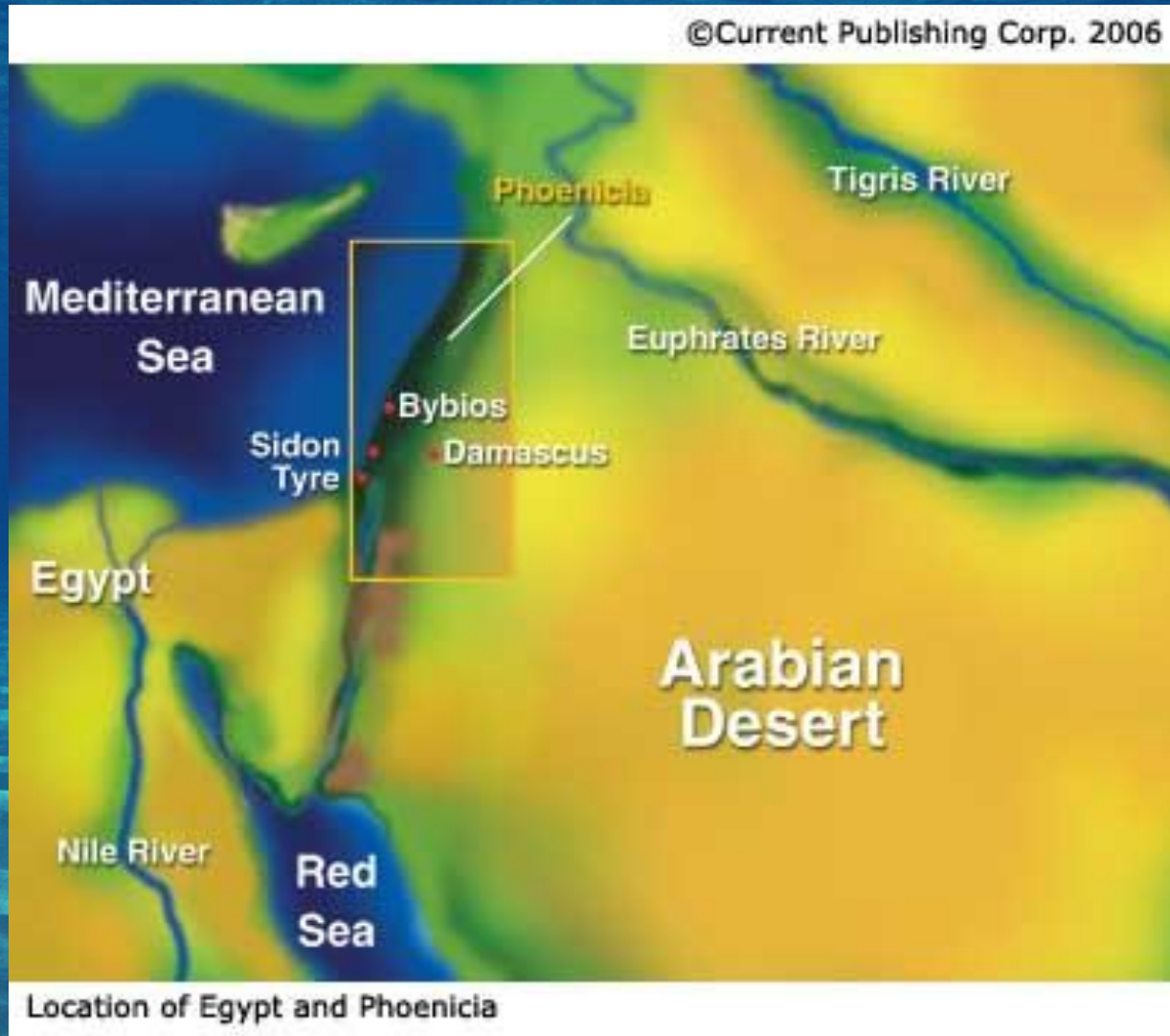
The earliest recorded voyage was by the Egyptian Pharaoh Snefru in 3200 BC



History of Marine Science

- Ancient Pacific Islanders and Phoenicians had detailed knowledge about marine life and navigation.
- Ancient Greeks and Romans had extensive knowledge of near-shore organisms in the Mediterranean Sea.

Phoenicians established the first trade routes throughout the **Mediterranean** and as far North as Great Britain. They traveled by day or observed North Star(Phoenician Star), when traveling at night.



While Europeans were sailing within sight of land, the **Polynesians** were crossing thousands of miles of open ocean in dugout canoes, colonizing the islands of the **South Pacific**.



It's all Greek...

- Ancient Greeks calculated the circumference of Earth and invented latitude/longitude system
- **Aristotle**, the Greek philosopher, described many forms of marine life and recognized the function of marine organisms' body parts.

The Dark Ages

- scientific inquiry come to a halt in Europe.
- **Vikings**, Arabs, Pacific Islanders, and Asians continued their ocean studies during the Dark and Middle Ages.

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Global warming in the 9th Century freed the North Atlantic of Ice. This allowed the **Vikings to discover Iceland, Greenland**, and Newfoundland, where Leif Eriksson actually landed, in North America.



CORBIS-BETTMANN

The Birth of Marine Science

- **Captain James Cook** and his crew, which included naturalists, sailed around the world beginning in 1768, and were the first Europeans to view the Antarctic ice fields, and land on Hawai'i, Tahiti, and many other **Pacific islands**.
- **first major expeditions launched with science and exploration as their only goals.**
- His crew did extensive mapping and brought back many specimens.

Charles Darwin

- Sailed on the *HMS Beagle* from 1831–1836 as a naturalist
 - Darwin's observations during the HMS Beagle expedition led him to propose the theories of Natural Selection and Evolution of Species. “That species evolve or change over time”. - He also hypothesized that coral reefs form and grow upward, in relatively shallow warm water as the seafloor recedes.

History of Marine Science

- Lt. Charles Wilkes
 - Commanded a United States exploratory expedition from 1838–1842 that laid the foundation for government spending of scientific research
 - The team charted the coasts of Antarctica

History of Marine Science

- Edward Forbes
 - Extensively studied the seafloor around the British Isles, Aegean Sea, and other locations in 1840s and 1850s

Challenger Expedition (1872–1876)

- R/V specifically designed for marine studies
- First major exploration devoted to the study of marine organisms
 - The crew discovered thousands of species previously undescribed and published 50 volumes of information from the data collected over the next 19 years.

Some of the accomplishments of the four year voyage of the Challenger included:

- a. The first soundings deeper than 4,000 meters,
- b. The collection of biological samples and marine organisms including plankton, at all depths
- c. The discovery of deep sea hydrothermal vent communities
- d. The collection of physical, chemical, geological and biological information from 362 stations.

HMS Challenger Volumes/NOAA

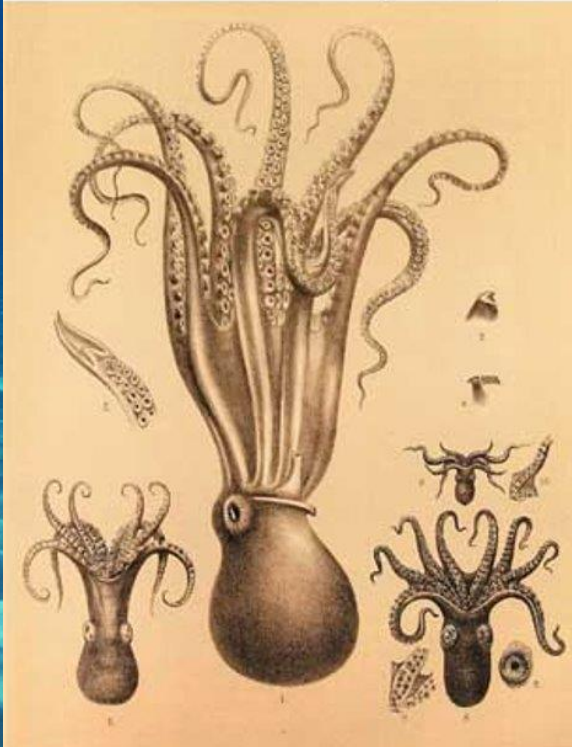


Illustration plate of Octopi from Challenger expedition report



Modern Marine Science

- Many marine biology research stations exist in locations around the world.
- Several facilities also exist in the United States:
 - Woods Hole Oceanographic Institution and Marine Biological Laboratory, Massachusetts
 - Scripps Institution - La Jolla, California
 - Friday Harbor Laboratories, Washington state

The Aquarius – FL Keys

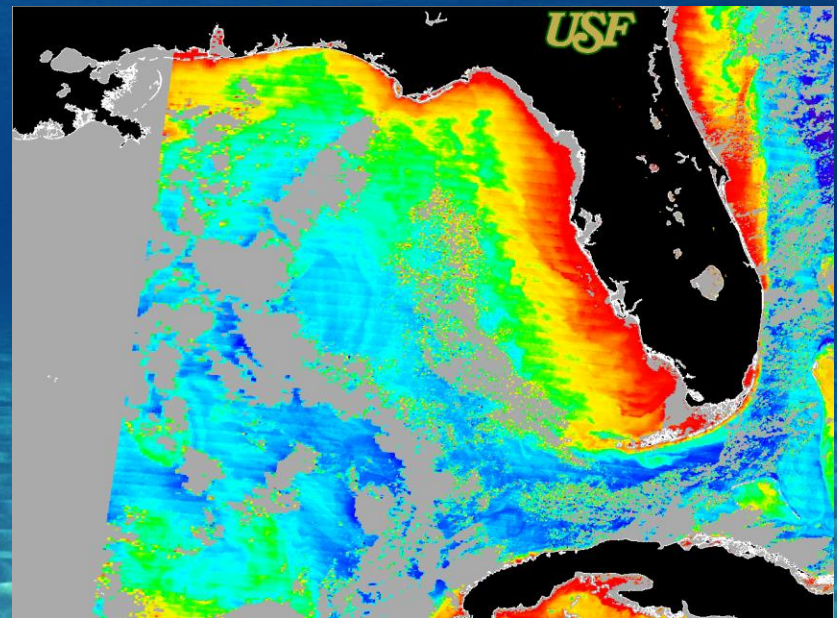
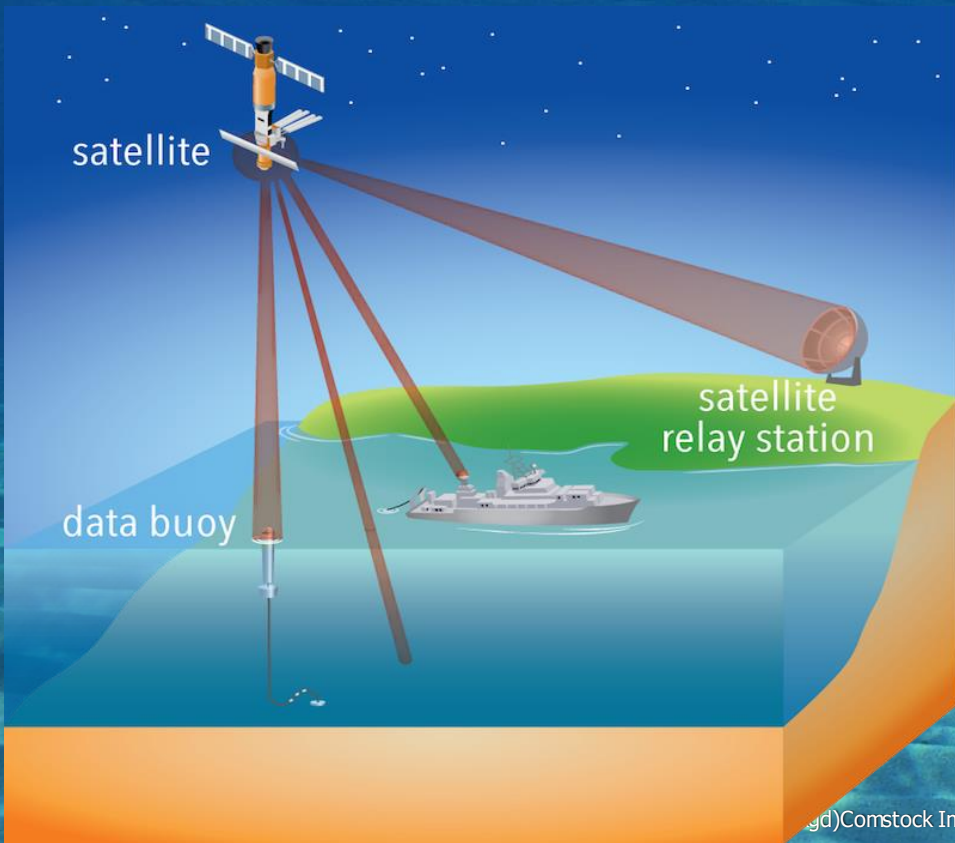
- <https://youtu.be/i1Wk1uddPko>



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Tools in Modern Marine Science

- **Remote sensing** – Satellites are used to study large expanses of the ocean surface.

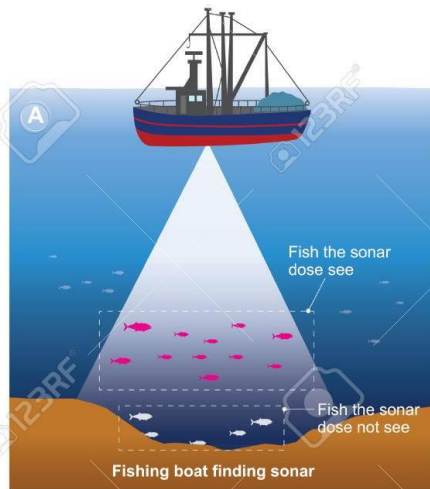


Sonar – Used to map seafloor depths and formations

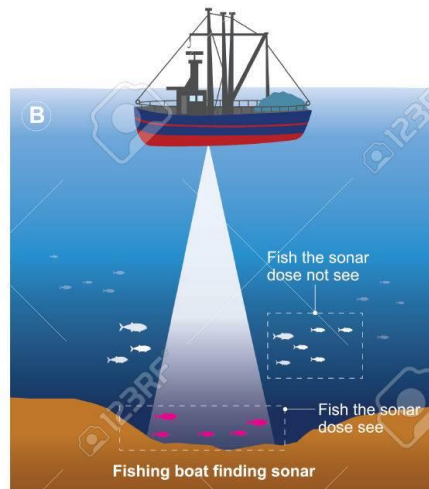
Fish Hunter Sonar Technology

(Using frequency, wide and narrow beam coverage)

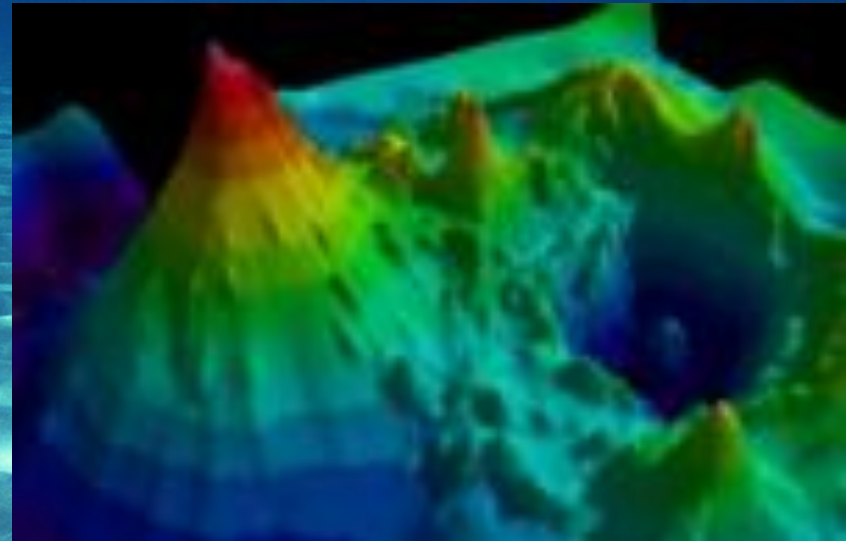
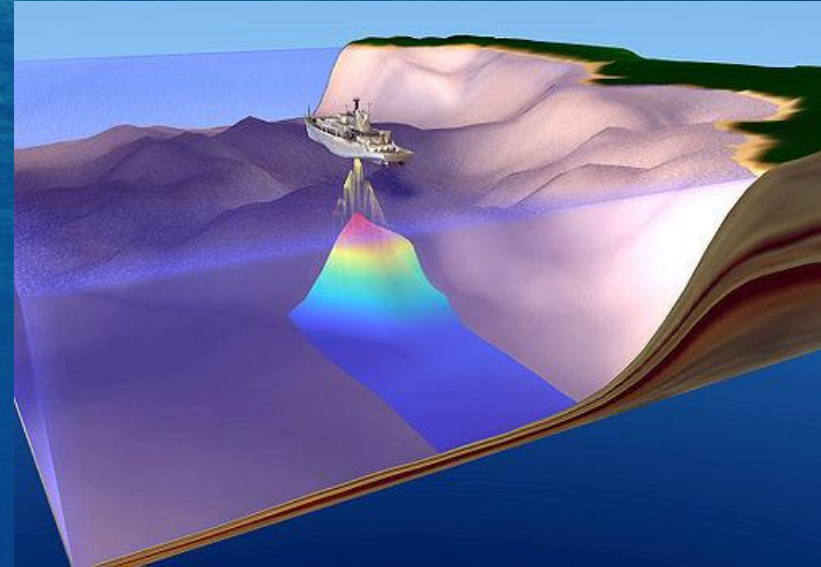
Low frequency (50 kHz Beam)



High frequency (200 kHz Beam)



- A. A wide beam transducer (50 kHz) covers a larger area but provides less bottom detail.
B. A narrow beam (200 kHz) covers less area but offers better bottom definition.



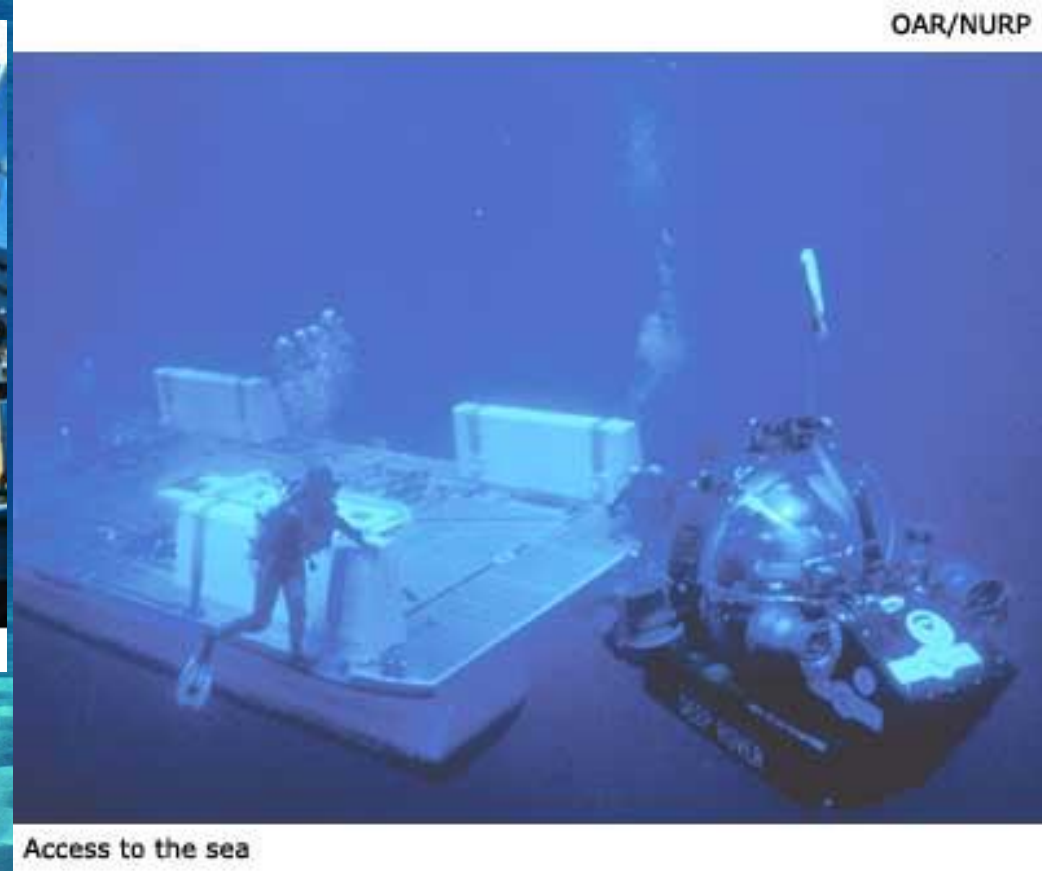
Tools in Modern Marine Science

- **Research vessels** – These floating laboratories allow oceanographers and marine biologists to explore the marine environments for weeks, months, or even years without returning to a land-based facility.
- Many types of electronic devices and other gear are currently used to study the marine environment and its inhabitants.

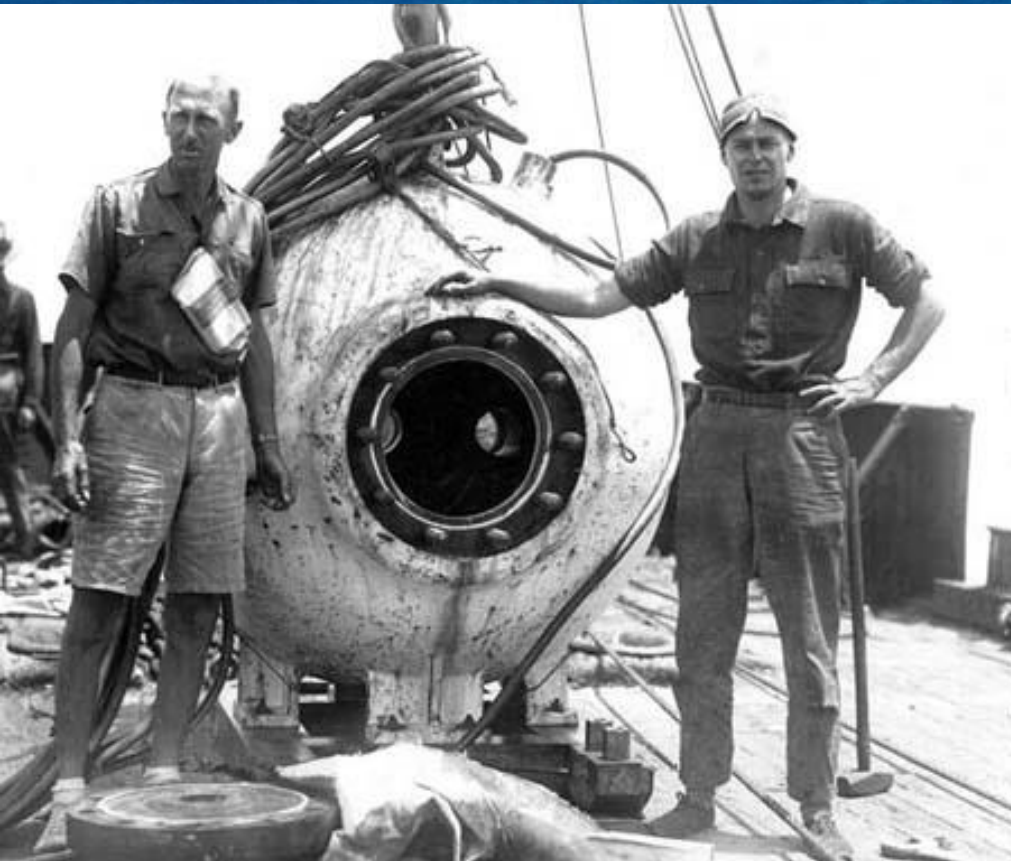
In 1931, the United States launched the “Atlantis”, which was the first ship specifically designed and built for ocean studies.



Submersibles and self-contained diving changed the study of the oceans by allowing scientists to pick specific samples while directly observing the organisms. They could now take living samples without killing them.



Pioneered in the 1930's by William Beebe and Otis Barton, the **Bathysphere** was essentially a steel ball with a window. It allowed the first deep-water visits by scientists as it was raised and lowered from a "Mother Ship".



The **Bathyscaphe**, “**Trieste**” with US Navy Lieutenant Don Walsh and Jacques Piccard descended to the bottom of “Challenger Deep”, 35,807 feet, in **1960**. The “**Trieste**” was a sphere attached to a large float and was raised and lowered with ballast and a liquid buoyant.

Courtesy of Space and Naval Warfare Systems Center of San Diego



Trieste

Courtesy of Space and Naval Warfare Systems Center of San Diego



Bathyscaphe Trieste

Scuba is used for the study of the marine environment for longer periods and at depths otherwise unavailable to humans

Self Contained Underwater Breathing Apparatus

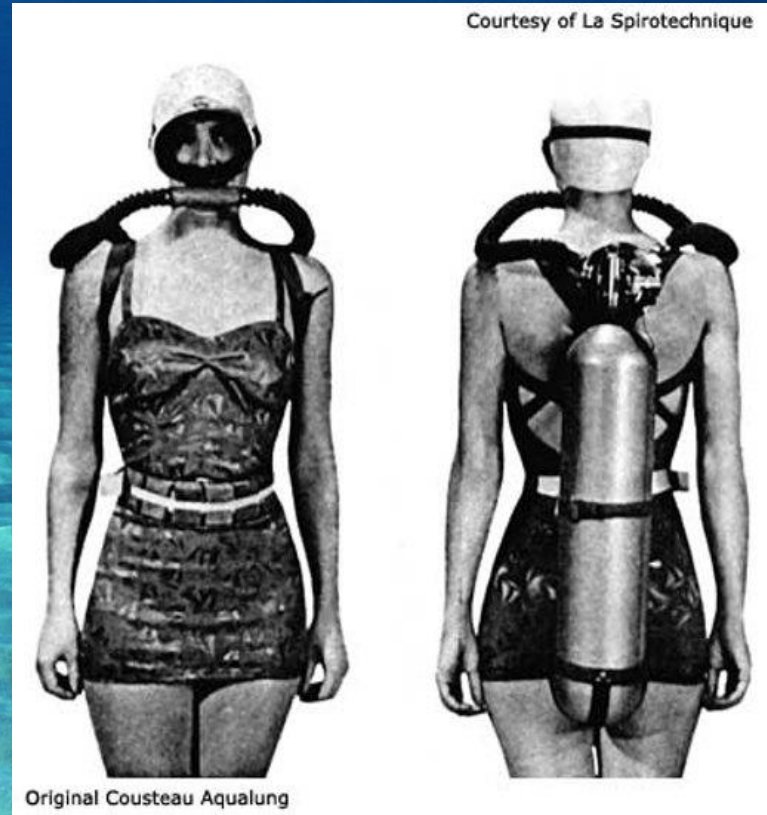
Courtesy of Historical Diving Society, USA



Henry Fleuss introduced the **first workable scuba** in 1878.

In **1943**, Jacques Cousteau introduced the **first practical, open circuit** (exhalation is breathed into water as bubbles) scuba.

Courtesy of La Spirotechnique



Original Cousteau Aqualung



Underwater archaeology



John D. Broadwater, PhD

OAR/NURP



1935 hardsuit



Modern one-atmosphere hardsuit

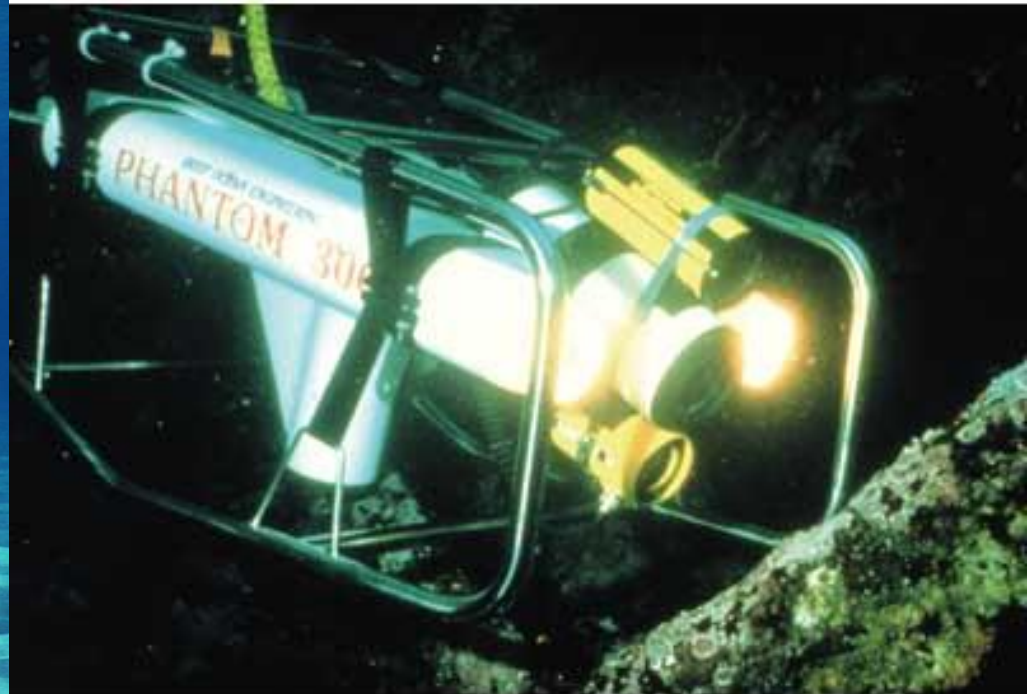
ROV's (Remotely Operated Vehicles) and AUV's (Autonomous Underwater Vehicles) have expanded under water research by bridging the gap between the submersibles and SCUBA capabilities.

NURP/NOAA



Cave diver towed by ROV

NURP/NOAA



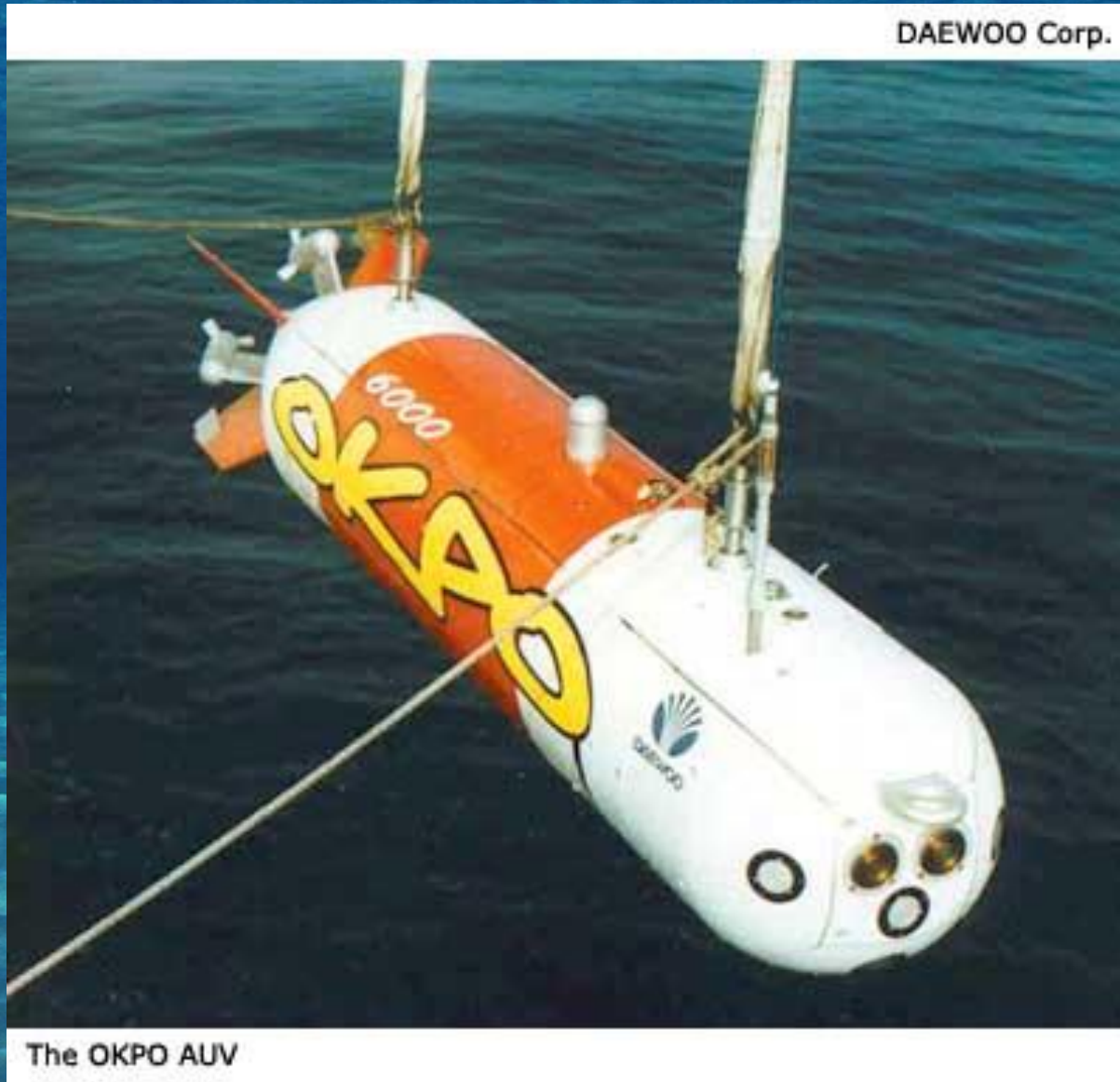
ROV Phantom

Rov's are essentially a small unmanned submarine with propellers, a video camera, and an umbilical connected to the surface ship. They are controlled from the surface.

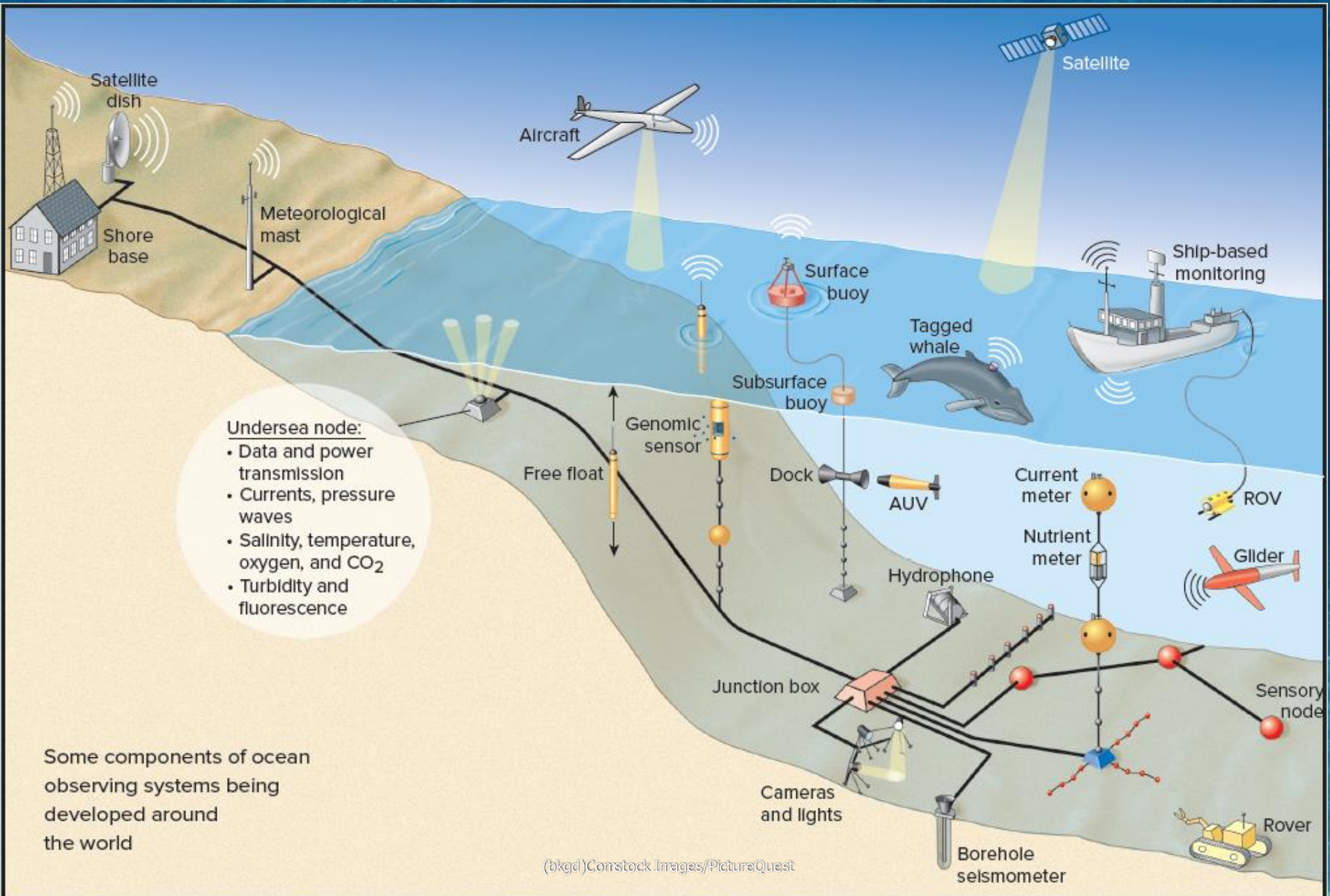


ROV Ventana

AUVs' are untethered robotic devices, propelled through the water by self-contained power systems and controlled and piloted by an onboard computer.



Tools in Modern Marine Science



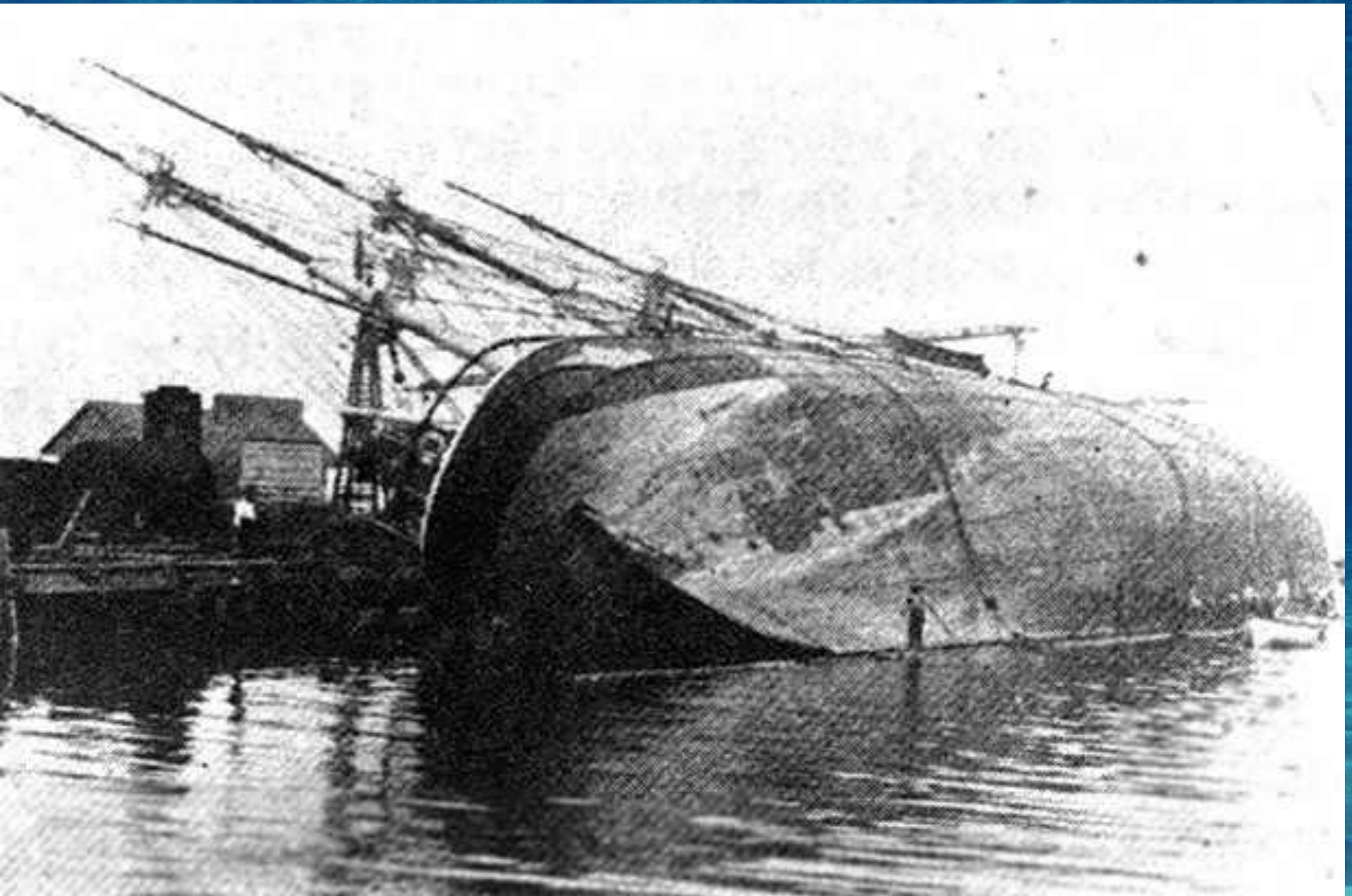
Port of Pensacola 1880-1890



In 1876 a yellow fever quarantine station for ships and a small quarantine hospital were located on Deadman's Island, Gulf Breeze.



Careening at the Port of Pensacola 1897 – Scraping barnacles



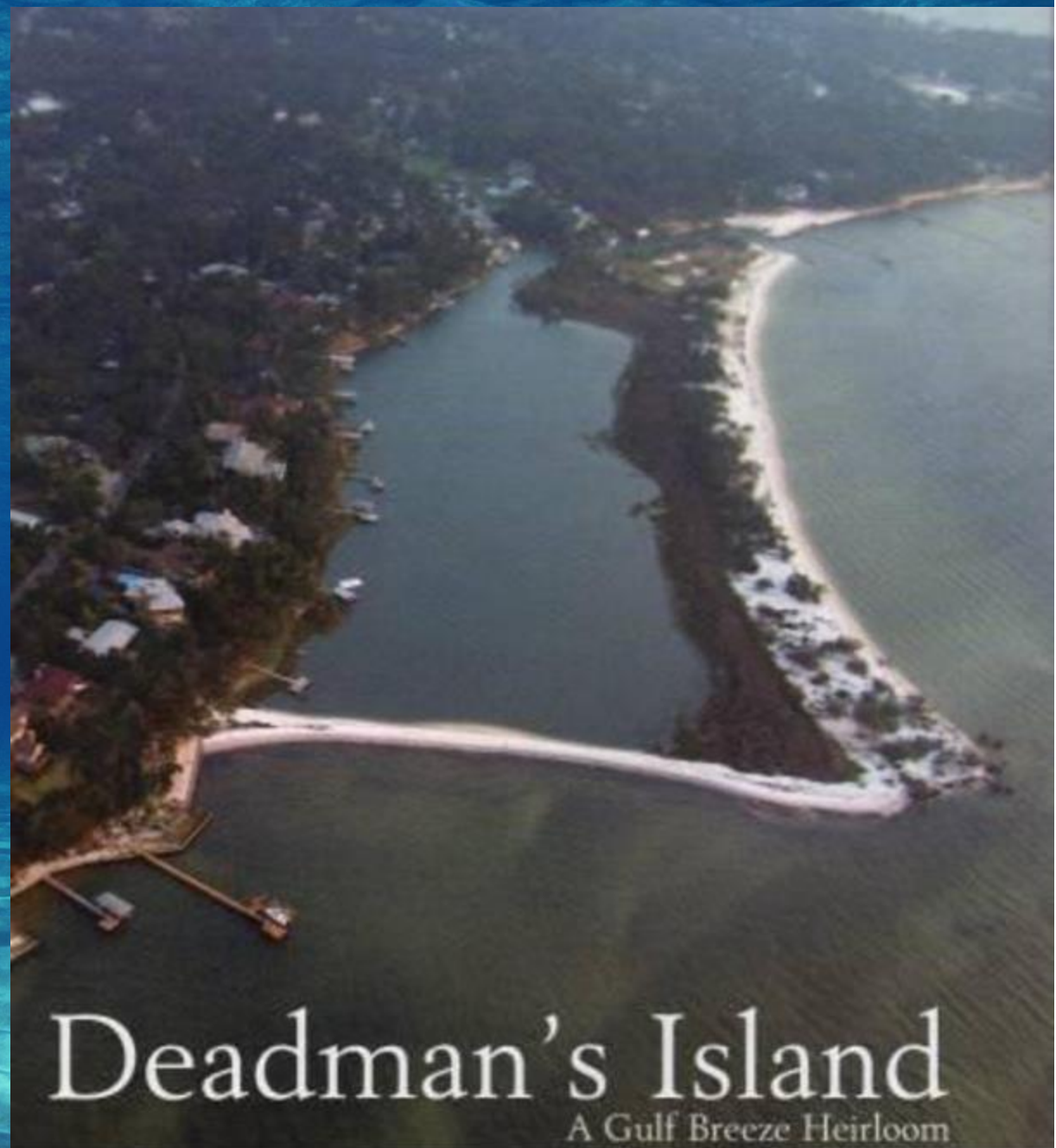
Possessing these qualities, the cove at Dead Man's Island was named Old Navy Cove and became a center of maritime industry in Pensacola. Over the years, a marine railway was constructed to assist with repairs and the island was used as a quarantine station for ships coming into Pensacola Bay to help prevent the spread of yellow fever and other diseases. A cemetery of disease victims located on the island may have inspired the name.



Remains of a naval railroad which served as part of ships' cargo unloading area



1946



Dead Man's Island



The Scientific Method

- Marine scientists, like other scientists, use the scientific method in research.
- The scientific method is a **systematic** way of testing ideas.
- The scientific method is a **flexible framework guiding the study of nature and not a rigid set of rules.**

The Scientific Method

- Observation is critical to all phases of the scientific method.
- Observations can be verified by others, which is an important part of the scientific method.

The Scientific Method

- The scientific method begins with a hypothesis, a testable statement constructed from observations and reasoning, both induction and deduction.
- The hypothesis must be worded so that it is testable by scientific means.

The Scientific Method

- One important aspect of the scientific method is that **you cannot prove a hypothesis**. You can only disprove hypotheses based on the evidence.
- Hypotheses that have been tested repeatedly and not disproved are considered to be true based on the available evidence.

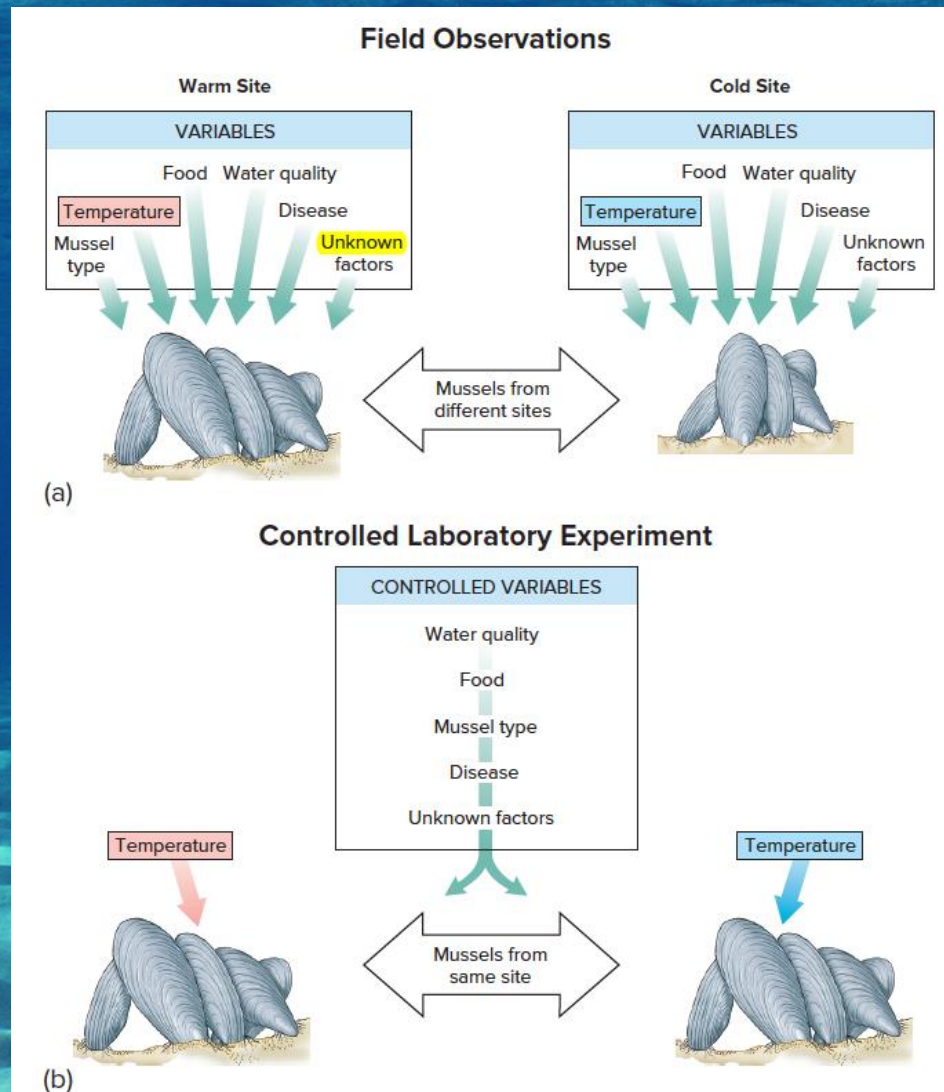
Considerations in Scientific Research

- A researcher must look at only one factor at a time. These factors that affect observations are the variables.
- If a researcher wants to study the effects of temperature on mussels, for example, they could acquire similar specimens of mussels from different locations.

Considerations in Scientific Research

- If only temperature is being tested, all other factors must be kept constant (amount of food given, age and size of mussels, oxygen concentration, salinity, etc.).
- If two tanks with mussels are kept at different salinities and different temperatures, for example, a researcher cannot attribute altered growth rates to only temperature. The results could be the combination of temperature and salinity.

Variables



What is a Theory?

- In scientific language, a scientific **theory** is a hypothesis that has been tested repetitively over time by many people and has not been disproven.
- If there is ample evidence to support the theory, it is then regarded as true in the scientific community.

Limitations of Scientific Method

- Due to the requirements for direct observations and/or measurements and a testable hypothesis, not all questions can be answered.
- Science can offer no answers on values, feelings, and beliefs. These are beyond the scope of the scientific method.