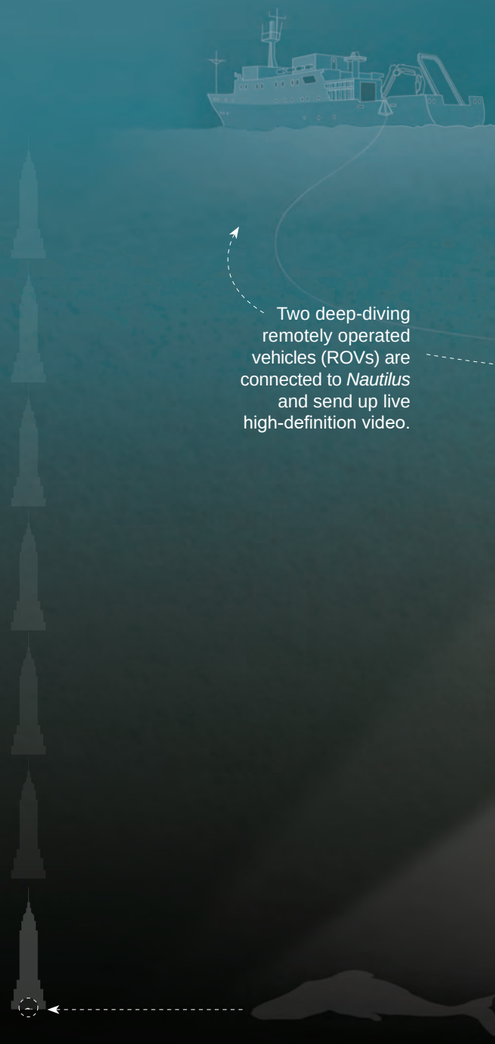
EXPEDITION:

MONTEREY BAY NATIONAL MARINE SANCTUARY

The artwork in the whale fall poster is loosely based on a whale fall that was found in Monterey Bay National Marine Sanctuary during an expedition in partnership with Ocean Exploration Trust in October 2019. Not all organisms depicted were present at this encountered whale fall depth. The surprise discovery was found in the area surrounding Davidson Seamount.



Nautilus

Live video of the discovery was streamed to the world via the Exploration Vessel *Nautilus*.

Two deep-diving remotely operated vehicles (ROVs) are connected to *Nautilus* and send up live high-definition video.

ROV *Argus*

Argus is directly connected to *Nautilus* and absorbs the ship's movements. Powerful lights allow it to provide a bird's-eye view of *Hercules* and the seafloor.

ROV *Hercules*

Hercules is connected to *Argus* and is controlled by pilots located on *Nautilus*. It collects video with high-definition cameras, and takes samples using two manipulator arms.

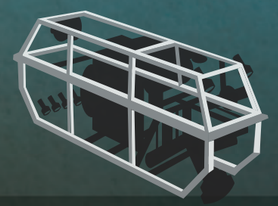
10,623 Feet

The whale fall was found at a depth of 10,623 feet – equivalent to seven Empire State Buildings stacked end to end.

Nautilus

Type: ..... Exploration vessel
Built: .....1967, retrofitted 2008
Length: ..... 211 feet
Beam (width): ..... 34.5 feet
Endurance: ..... 40 days at sea
Maximum Speed: ..... 12 knots

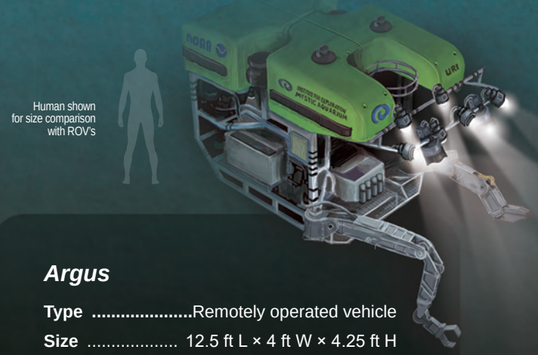
E/V *Nautilus* is operated by Ocean Exploration Trust to explore the unknown ocean and make new discoveries. The ship is equipped with telepresence technology, allowing scientists from around the world to participate and contribute to the success of its missions.



Hercules

Type: ..... Remotely operated vehicle
Size ..... 12.8 ft L × 6.2 ft W × 7.2 ft H
Weight: ..... 5,200 pounds
Max Transit Speed: ..... 2 knots
Ascent/Descent Rate: ..... 98.4 feet/minute
Maximum Operating Depth: ..... 2.5 miles

Hercules has been in operation since 2003. The ROV carries lighting, cameras, and acoustic sensors that are used to gather video and other data during dives. *Hercules* also has two manipulator arms to gather samples and collect artifacts as needed.



Argus

Type ..... Remotely operated vehicle
Size ..... 12.5 ft L × 4 ft W × 4.25 ft H
Weight: ..... 4,000 pounds
Max Transit Speed: ..... 2 knots
Ascent/Descent Rate: ..... 65–98 feet/minute
Maximum Operating Depth: ..... 3.7 miles

Argus has been in operation since 2000. It is typically anchored to E/V *Nautilus* and to the ROV *Hercules*. *Argus* carries many cameras, one of which is typically focused on *Hercules*, and uses bright lights to illuminate the area around *Hercules.*

Whale Fall

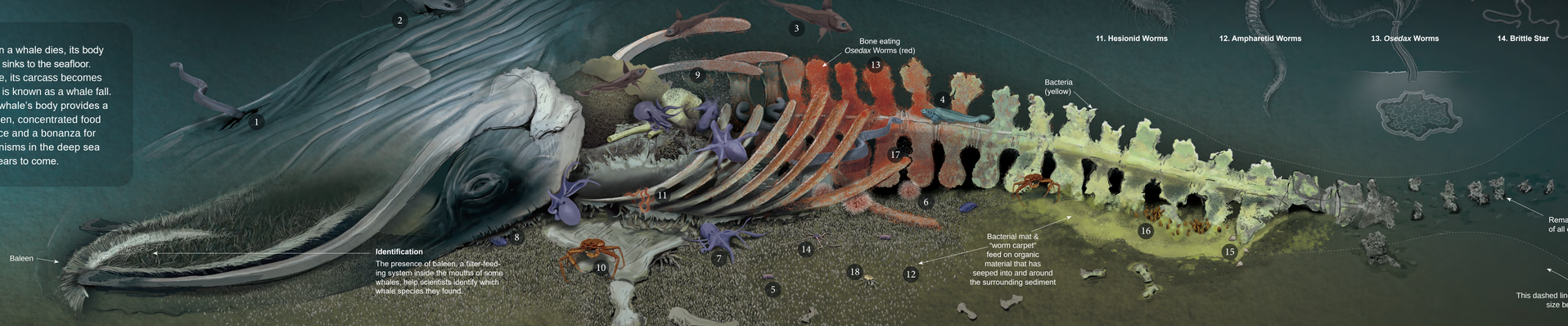
Discovery

When a whale dies, its body often sinks to the seafloor. There, its carcass becomes what is known as a whale fall. The whale's body provides a sudden, concentrated food source and a bonanza for organisms in the deep sea for years to come.

Timeline

Common Organisms Found on a Whale Fall

1. Hagfish
2. Sixgill Shark
3. Rattail Fish
4. Eelpout Fish
5. Sea Pig
6. Pom-Pom Anemone
7. *Muusoctopus*
8. Giant Isopod
9. Amphipods
10. Grooved Tanner Crab
11. Hesionid Worms
12. Ampharetid Worms
13. *Osedax* Worms
14. Brittle Star
15. *Rubyspira* Snails
16. Mussels
17. Hooded Shrimp
18. Squat Lobster



Identification

The presence of baleen, a filter-feeding system inside the mouths of some whales, help scientists identify which whale species they found.

Stages of a Whale Fall

Scientists have identified four stages of a whale fall. The stages – which often overlap or blend together – are shown above, starting with the head (Stage 1) and ending at the tail (Stage 4). The duration of these stages is estimated, and varies depending on the size and species of the whale.

STAGE 1: MOBILE-SCAVENGER STAGE, MONTHS-5 YEARS

Free-moving scavengers, like rattails, hagfishes, sharks, and octopuses, remove and consume the whale's soft tissues.

STAGE 2: ENRICHMENT-OPPORTUNIST STAGE, MONTHS - 2 YEARS

A great number of polychaete worms, crustaceans, and other organisms colonize the bones and enriched sediments surrounding the whale fall.

STAGE 3: SULPHOPHILIC STAGE, UP TO 50 YEARS

Once the soft tissue is removed from the bones, bacteria, *Osedax* worms, clams, and other organisms break down lipids within the fatty bones and produce sulphides, which other organisms can then consume.

STAGE 4: REEF STAGE, UNKNOWN

Whale falls have only been studied for a few decades, but scientists believe the hard, mineral skeleton left behind after nutrients have been consumed eventually provides structure for deep-sea suspension feeders.

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For a full list of references, visit sanctuaries.noaa.gov/magazine/S/whale-fall

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CREATURES

OF A WHALE FALL

Grooved Tanner Crab

Scientific Name: *Chionoecetes tanneri*

Average Size: .....0.08-6.3 inches

Depth Range: .....174-6,378 feet

One of three species sold as snow crab for consumption, grooved Tanner crabs have a deep groove running down the center of their shells. These crabs have four pairs of long thin legs and one pair of shorter legs equipped with pincers.

FUN FACT: *Chionoecetes* means snow (chio) inhabitant (iokетes), which is why they are also referred to as snow crabs.

Rattail Fish

Scientific Name: ..... *Coryphaenoides acrolepis*

Size: .....1-3 feet

Depth Range: ..... 650 ft - 2.5 miles

Life span.....up to 70 years

Rattail fish, or grenadiers, are curious fish that have adapted to thrive in the dark ocean. They have large eyes that can detect bioluminescent organisms, and sensory structures on their heads to help sense food sources.

FUN FACT: Some rattails use their swim bladders to produce a drumming sound for communication.

Squat Lobster

Scientific Name: .....*Munidopsis spp.*

Squat lobsters have short, flattened bodies and long antennae that are used to locate objects and maintain distance from other lobsters. They typically eat small worms or crustaceans or scavenge on dead organisms. Squat lobsters have long claws that can be up to twice as long as their bodies.

FUN FACT: Squat lobsters look like lobsters, but they are actually more closely related to hermit crabs.

Sixgill Shark

Scientific Name: ...*Hexanchus griseus*

Size: ..... Up to 16 feet in length

Depth Range: ..... 656-3,280 feet

Sixgill sharks can be found around the world. These reclusive creatures are usually found in very deep water, making them hard to study. These sharks feed or scavenge on fish, crustaceans, rays, and sometimes seals and other sharks.

FUN FACT: As their name suggests, these sharks have six pairs of gills, whereas most sharks have only five pairs!

Sea Pig

Scientific Name: *Scotoplanes globosa*

Size: .....3-8 inches

Depth Range: ..... 3,300–19,500 feet

Sea pigs, also known as sea cucumbers, are common offshore in Monterey Bay. These animals crawl slowly along the seafloor on stilt-like tube feet and use tentacles around their mouths to dig for pieces of food.

FUN FACT: Sea pigs have long whip-like sensory structures that help them find food in the deep sea.

Hesionid Worms

Family:..... Hesionidae

Depth Range: ..... up to 2,132 feet

Hesionid worms are a type of segmented polychaete worm. Each body segment is equipped with a pair of leg-like extensions with spiny bristles. They will frequently form commensal relationships with sea stars, crabs, and other organisms, hiding on or within them.

FUN FACT: Some species of hesionids are known as "iceworms" due to their affinity for living near deep-sea cold seeps and frozen methane hydrates.

Giant Isopod

Scientific Name: ..... *Bathynomus giganteus*

Size: .....7.5-14.2 inches

Depth Range: .....550-7,020 feet

Giant isopods are relatives of crabs and lobsters. They have two sets of antennae, one for chemical sensing (food) and one for tactile sensing. They have a slow metabolism and don't move much unless they detect a meal or predator nearby.

FUN FACT: Their large size, called gigantism, may be an adaptation to extreme pressure in the deep ocean.

Hagfish

Scientific Name: *Eptatretus spp. & Myxini spp.*

Depth Range: .....52–3,937 feet

Hagfish are jawless, but have two rows of pointed teeth that are used to bore a tunnel through flesh, allowing them to consume their meal from the inside out. Hagfish also have an excellent sense of smell and touch via whiskers, or barbels, around their mouth.

FUN FACT: Hagfish have slime glands on the sides of their bodies, which secrete a mucous used to deter predators.

Octopus

Scientific Name: .....*Muusoctopus spp.*

Muusoctopus are a genus of deep-sea octopuses. *Muusoctopus* octopuses typically lack an ink sac. This genus is cosmopolitan, which means that these species inhabit every ocean in the world. They can survive in a variety of extreme deep-sea habitats, from hydrothermal vents to cold seeps.

FUN FACT: In 2018, scientists on the *E/V Nautilus* observed over a thousand *Muusoctopus* octopuses, the largest grouping of these octopuses ever recorded.

Ampharetid Worms

Family:.....Ampharetidae

Distribution:..... Worldwide

Ampharetid worms are a type of polychaete worm, a segmented worm with spines, or bristles, along their sides. These segmented worms live in a tube-like structure and can be found widespread in the sediments surrounding a whale fall.

FUN FACT: The tubes the worms live in are commonly made of sand grains and are open on both ends.

Osedax worm

Scientific Name: .....*Osedax spp.*

Range: .....Worldwide

Bone-eating *Osedax* worms are a translucent pink or white. The female worms secrete an acid that dissolves the bones and metabolize the lipids of the whale. Male *Osedax* worms are much smaller — up to 600 male worms can live within the gelatinous tubes surrounding a females' trunk.

FUN FACT: *Osedax* worms do not have a digestive system, and instead use symbiotic bacteria to aid in digesting the whale bones.