



## Exploring Marine Debris in Papahānaumokuākea National Marine Monument

### Lesson Specifications

#### Age

8–12

#### Timeframe

One 45-minute classroom session  
One 90-minute pool mission

#### Materials

##### Lesson:

- Computer w/ internet
- Projector
- Scrap paper
- Printed bolus images

##### Scuba:

- All required scuba gear
- 5 lb. weights (or similar)
- Lift bag with strap

#### Key Words

marine debris, bolus, lift bag

#### Standards

PADI, SSI, NAUI, Ocean Literacy Principles 1 & 5



A Hawaiian monk seal. Photo: Karen Bryan/HIMB



The beach and reef at Laysan Island in Papahānaumokuākea Marine National Monument. Photo: James Watt/NOAA

### Activity Summary

This lesson introduces students to Papahānaumokuākea Marine National Monument and the important living and nonliving resources it protects. Students simulate the dissection of an albatross bolus and make observations of the presence of marine debris. Students practice buoyancy control, awareness of their environment and buddy, and air management while removing “marine debris” with a lift bag.

### Learning Objectives

Students will be able to:

- Explain the importance of Papahānaumokuākea Marine National Monument, by using examples.
- Explain the impacts of marine debris.
- Describe how an albatross bolus can be used to monitor ocean health.
- Use a lift bag to bring simulated marine debris to the surface.

### Essential Questions

1. What important resources are protected by Papahānaumokuākea Marine National Monument?
2. What is marine debris and how does it negatively impact ocean ecosystems?
3. How can an albatross bolus be used to monitor ocean health?

# National Marine Sanctuary Diver Performance Requirements

At the surface, students will:

- Streamline gear prior to entry.
- Perform a comprehensive buddy check.
- Review necessary hand signals.
- Establish an air management plan.
- Perform a weight check and adjust weighting as necessary.

Underwater, students will:

- Demonstrate proper descent techniques and awareness of the environment.
- Demonstrate proper buddy awareness and air management.
- Demonstrate appropriate use of hand signals.
- Safely use a lift bag to bring simulated “marine debris” to the surface.
- Demonstrate appropriate buoyancy control.



A map of the National Marine Sanctuary System in the U.S. and its territories.

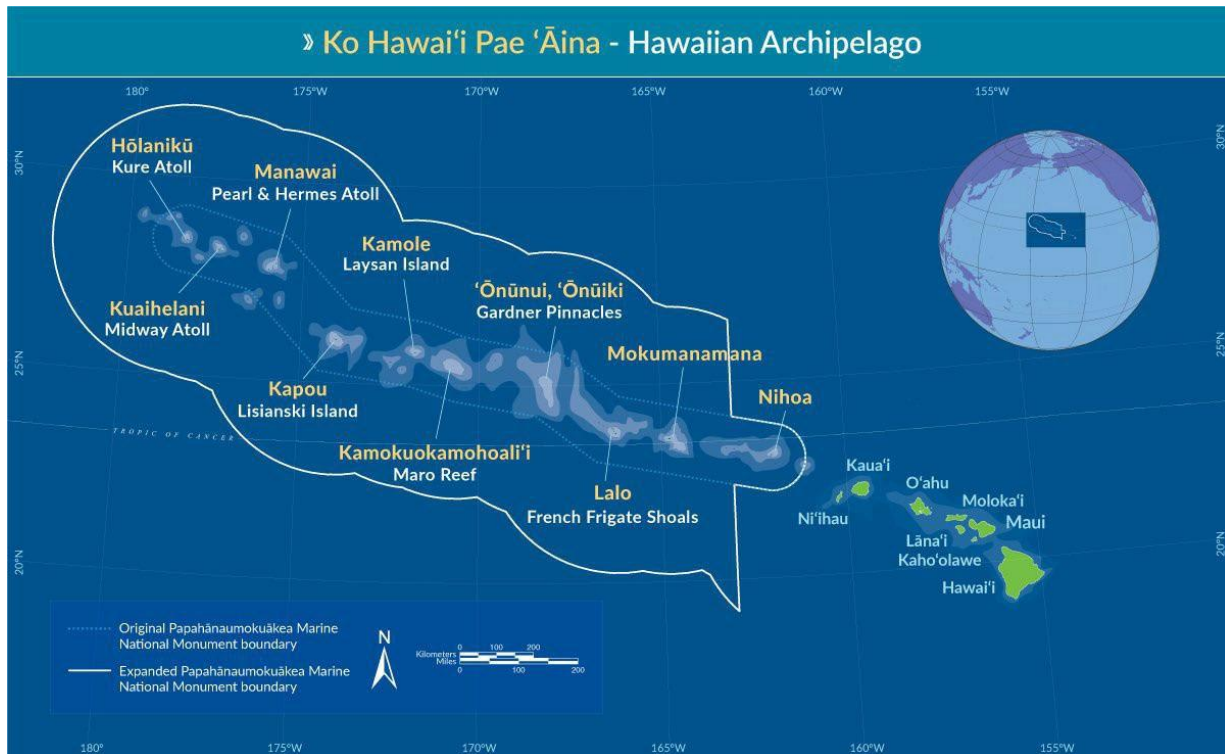
## Background Information

### Papahānaumokuākea Marine National Monument

Since 1972, NOAA's Office of National Marine Sanctuaries has served as the trustee for a network of underwater areas encompassing more than 620,000 square miles of marine and Great Lakes waters. The network includes a system of national marine sanctuaries, as well as Papahānaumokuākea and Rose Atoll marine national monuments. Few places on the planet can compete with the diversity of the National Marine Sanctuary System, which protects America's most iconic natural and cultural marine resources. The system works with diverse partners, treaty holders, and stakeholders to promote responsible, sustainable ocean uses that ensure the health of our most valued ocean places. Healthy

aquatic ecosystems, whether fresh, brackish, or marine, are the basis for thriving recreation, tourism, and commercial activities that drive coastal economies.

Papahānaumokuākea Marine National Monument is located in the Northwest Hawaiian Islands. The Hawaiian Archipelago is the most remote island chain on the planet, with the closest continental land mass over 2,600 miles away. The Hawaiian Islands are also the world's longest archipelago, stretching approximately 1,500 miles from southeast to northwest. There are eight inhabited islands, ranging over approximately 300 miles from southeast to northwest: Hawai'i, Maui, Kaho'olawe, Lāna'i, Moloka'i, O'ahu, Kaua'i, and Ni'ihau. These islands are "high" islands, meaning that they are above sea level.



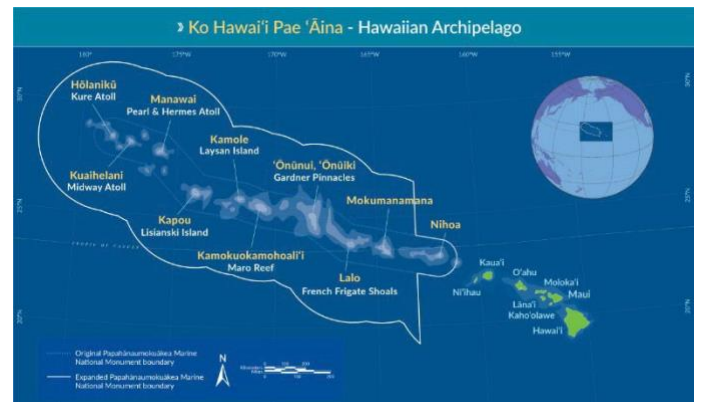
A map of the Hawaiian Archipelago and Papahānaumokuākea Marine National Monument.

The Northwest Hawaiian Islands comprise a stretch of coral atolls, banks, shoals, and seamounts stretching over 1,300 miles. If this distance were overlaid on the continental U.S., these islands would stretch from Boston to Miami or from New York City to Omaha. The most southeasterly islands are high islands of rocky basalt (a type of volcanic rock), while the most northwesterly islands are coral atolls. The land masses in the middle portion of the chain are low and sandy, consisting of banks and shoals. The Northwest Hawaiian Islands are currently uninhabited other than Midway Atoll, which hosts a small number of U.S. Fish and Wildlife staff. The 12 major land masses, from southeast to northwest, are: Ka'ula, Nihoa, Necker Island (Mokumanamana), French Frigate Shoals (Kānemiloha'i), Gardner Pinnacles (Pūhāhonu), Maro Reef (Ko'anako'a), Laysan Island (Kauō), Lisianski Island (Papa'āpoho), Pearl and Hermes Atoll (Ko'anako'a), Midway Atoll (Pihemanu), and Kure Atoll (Kānemiloha'i).

The Hawaiian Islands were formed from a volcanic hot spot in the center of the North Pacific Ocean. This hot spot has been creating islands for at least 80 million years. The islands transition from younger, high islands in the southeast, to atolls and seamounts in the northwest. Corals grow in rings around high volcanic islands. Over time, islands erode and subside, while the corals continue to grow,

staying near the surface. After millions of years, the island sinks beneath the surface and only coral skeletons and live coral remain, creating atolls. The atolls seen in the Northwest Hawaiian islands today are the remnants of former high volcanic islands. As the Pacific Plate continues to move, and erosion and subsidence continue, the islands will eventually sink beneath the ocean, resulting in seamounts. As a result of their geologic origin, the Hawaiian Archipelago has never been connected to any continent. This isolation has resulted in the evolution of many unique ecosystems and species. The island's unique biodiversity makes them a "living laboratory" for scientists. In the northwest Hawaiian Islands, strict protocols are in place to prevent introductions of non-native species, which can become invasive and harm native ecosystems.

Papahānaumokuākea Marine National Monument is the largest conservation area in the United States and one of the largest in the world. Large-scale conservation is important for the protection of highly mobile species, like seabirds, sharks, and sea turtles. The monument covers approximately 580,000mi<sup>2</sup>, an area larger than that of all U.S. national parks combined and nearly the size of the Gulf of Mexico. The monument was designated by presidential proclamation in 2006 by President George W. Bush. It was given a Hawaiian name in 2007. Papahānaumokuākea commemorates the union of two Hawaiian ancestors – Papahānaumoku and Wākea – who gave rise to the Hawaiian



A map of Papahānaumokuākea Marine National Monument.

Archipelago and the Hawaiian people. The monument was enlarged by President Obama in 2012. The Northwest Hawaiian Islands have been afforded various protections since the early 1900's to mitigate the region's overuse by fishermen, feather and guano (bird dropping) hunters, and whalers.

Papahānaumokuākea Marine National Monument provides protection for a tremendous amount of biodiversity. The monument's reefs are arguably the healthiest and least disturbed on the planet and possibly the last remaining predator-dominated reef ecosystem to exist. The region provides nesting and foraging grounds for approximately 14 million seabirds, representing 22 species, making it the



Hawaiian green sea turtle at Pearl and Hermes Atoll. Photo: John Burns/NOAA

largest tropical rookery on Earth. Over 7,000 species are found here, 25% of which (approximately 1,700) are endemic, resulting in one of the highest rates of endemism anywhere. The monument is home to numerous species of fish, sea turtles, birds, mammals, and invertebrates, including many that are threatened, like the Hawaiian green sea turtle, and endangered, like the Hawaiian monk seal. Recent deep-sea surveys have resulted in the discovery of many new species including a species of black coral thought to be 4,500 years old, making it the oldest known organism alive!

Papahānaumokuākea Marine National Monument also protects many important aspects of Hawaiian culture. The first discoverers of the Hawaiian Archipelago, Native Hawaiians, inhabited the islands for thousands of years prior to Western contact. Even the remote Northwestern Hawaiian Islands were explored, colonized, and, in some cases, settled by Native Hawaiians during pre-contact times. Radiocarbon data estimates that Nihoa and Mokumanamana were inhabited between 1000 to 1700. Native Hawaiians continue to maintain strong cultural ties to the ocean, seeing it as a source of resources, as well as physical and spiritual sustenance. In Hawaiian traditions, the Northwestern Hawaiian Islands are considered a sacred place, the region from which life springs and spirits return after death. The monument contains significant cultural sites. Mokumanamana has the highest concentration of heiau (spiritual altars) of anywhere in the archipelago and Nihoa is a training location for apprentice navigators learning the ancient skill of way-finding (navigating without instruments).



The island of Mokumanamana has the highest concentration of cultural sites in Hawaii with 34 document heiau, or sacred sites, most of similar design and whose purpose is yet to be determined. Photo: Andy Collins/NOAA

Papahānaumokuākea is also home to a variety of post-Western-contact historic resources, including those associated with the Battle of Midway, widely considered the turning point in the Pacific campaign of World War II, and with 19th-century commercial whaling. There are hundreds of reported lost shipwrecks and aircraft within monument waters, many of which have been explored.



The USS *Macaw* ran aground at Midway during WWII while attempting to rescue a submarine. A diver filming the bow of the USS *Macaw* at Midway Atoll. Photo: Robert Schwemmer/NOAA

In 2010, Papahānaumokuākea was designated by the United Nations as a World Heritage Site, a place determined to have “cultural and natural heritage considered to be of outstanding value to humanity.” In order to be included on the World Heritage List, a site must meet criteria under either natural or cultural categories. The monument met multiple criteria for both categories and is one of only 39 global locations inscribed as a “mixed” site for both natural and cultural importance, out of over 1,000 sites worldwide. Papahānaumokuākea is one of only 50 marine sites on the World Heritage List.

#### Diving Papahānaumokuākea Marine National Monument

Recreational activities, such as diving and snorkeling, can be enjoyed at many sites within the National Marine Sanctuary

System; however, Papahānaumokuākea Marine National Monument is one of the few sites that is not dive-friendly due to hazardous conditions (remote geographic location, strong currents, etc.), as well as the lack of onshore infrastructure and medical support to facilitate diving operations.

Visitation to the monument is granted by permit for activities such as research, education, and cultural practices. General visitation by the public is not allowed at this time. Visitation options for Midway Atoll National Wildlife Refuge and Battle of Midway National Memorial are under consideration for the future.

### Impacts of Marine Debris

Marine debris is defined as any persistent, manufactured solid material that is directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes. The majority of marine debris comes from land-based sources, like storm drains and sewers, and coastal recreational activities. Some debris is ocean-based, like derelict fishing gear or trash lost from vessels.



Marine debris in Papahānaumokuākea Marine National Monument. Photo NOAA

Much marine debris is made from plastic, which is long-lasting in the environment, sometimes taking hundreds of years to break down. Large pieces of marine debris entangle and kill a significant number of animals every year. As plastics decay, they become microplastics, very small pieces 5mm or less in diameter, mostly invisible to the naked eye. Microplastics, and the toxins that adhere to them, are easily consumed by organisms either by passive uptake via filter-feeding or by active consumption when mistaken for food. Evidence of microplastics and associated toxins have been found in the tissues of a variety of organisms, including humans. Consumption of plastics, including microplastics, by wildlife has been shown to block digestive tracts, diminish the urge to eat, and alter feeding behavior, all of which can lead to death.



A NOAA Marine Debris team member disentangling a Laysan albatross chick from a small derelict fishing net. Photo: NOAA

Wind, waves, and ocean currents all contribute to the movement of marine debris. As a result, marine debris isn't spread evenly across the ocean. A combination of factors causes debris, free-floating organisms, and a variety of other things to collect in certain parts of the ocean. In the Pacific Ocean, there are a few areas of varying sizes where marine debris is known to accumulate. The North Pacific Subtropical Convergence Zone is one such place. This convergence zone, a location where multiple currents come together, is located north of the Hawaiian Islands but moves seasonally and regularly dips south. A large amount of marine debris ends up deposited on the shores of the Hawaiian Islands as a result of this zone dipping southward.

Many organisms are negatively impacted by marine debris.

Albatross, far-ranging seabirds that nest in Papahānaumokuākea, are one affected species. Every day, albatrosses travel hundreds of miles scouring the open ocean for squid, fish eggs and larvae, and krill to bring back to their large, rapidly growing chicks. Albatrosses feed their chick by regurgitating the partially digested food they have gathered. The bolus is the indigestible material that was gathered along with the food. In an albatross bolus, you might find squid beaks and small bits of pumice and

wood. You might be surprised to know that it is common for plastic to be found in albatross boluses. Albatrosses accidentally ingest plastic while feeding. Fortunately, adult albatrosses can expel plastic, but it is not uncommon to find dead albatross chicks with plastic debris in their stomachs. Sadly, even though albatrosses nest on remote islands, far away from people, they are still impacted by human actions. The contents of their boluses can provide important insights into ocean health.

NOAA and its partners are working hard to reduce marine debris in Papahānaumokuākea. Marine debris is removed from monument waters and shoreline clean-ups are conducted regularly. Scientists with special permits work to disentangle impacted organisms. Since 1994, over 900 tons of marine debris have been removed from the monument. That's equivalent to more than 200 elephants! People can help reduce marine debris by being planet-friendly consumers. One can consider reducing reliance on single-use plastics and being mindful of packaging. Proper recycling and waste disposal also reduces marine debris. Lastly, people can help educate others about the problem of marine debris and its potential solutions.



Laysan albatross chick full of plastic marine debris on Kure Atoll State Wildlife Refuge. Photo: Claire Fackler/NOAA



In 2016, the NOAA Marine Debris team removed 1,268 flip-flops from the shorelines of Midway Atoll. Photo: NOAA.

## Removing Marine Debris While Snorkeling or Diving

It may surprise you to know that sometimes you should not remove debris. Marine organisms often make a home in pieces of marine debris. In these cases, you should carefully consider whether to remove an item or leave it in place. Sometimes, it is worth a small, temporary disturbance to remove potentially harmful marine debris; other times, it may be better to leave the item where it is. Safety should always be the primary consideration. If there is uncertainty about if it is safe to remove an item, leave it in place.

If debris is found among or on coral, assess the situation prior to picking it up. Use a reef-saver to cautiously lift the item and check for potentially hazardous marine life underneath and around it. If it is safe to remove the debris, do so slowly and carefully, so as not to cause any further damage. Take care when removing fishing line from branching corals. Don't try to pull the line free as it can snap the branches. Go slowly and unwind the line from around the coral. Use a mesh bag to collect debris instead of putting it into your buoyancy compensator device (BCD) pockets and wear gloves to protect your skin.

Heavy objects, more than 10lbs, should be removed with a lift bag. One should not use their BCD to bring heavy objects to the surface. If one accidentally drops the object when using a BCD to offset the object's weight, one will be at risk of an uncontrolled ascent. The lift of an object should never supersede the importance of maintaining good buoyancy and a safe ascent rate.



NOAA divers using lift bags to remove derelict fishing gear. Photo: NOAA



<b>Vocabulary</b>	
archipelago	an area that contains a chain or group of islands scattered in lakes, rivers, or the ocean
atoll	a ring-shaped coral reef that encircles a lagoon
bolus	indigestible material evacuated from a bird's digestive system; boluses provide a record of the items ingested
convergence zone	a location where multiple currents come together; often the site of high concentrations of marine debris
derelict fishing gear	any discarded, lost, or abandoned fishing gear in the marine environment
endemic species	a type of organism found only in one geographic location
hot spot	a place on the Earth's surface where magma from the mantle comes through the crust to the surface; hot spots are independent of tectonic plates, thus, as the plate moves over them, chains of volcanoes often form
marine debris	any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned, into the marine environment or the Great Lakes
seamount	a submarine mountain

## **Preparation – Classroom**

Review slide deck. Be aware of important information, as well as suggestions for instruction, located in slide notes.

Prepare virtual bolus dissection activity. Decide on how the virtual dissection will be facilitated. If each buddy group can have access to internet-enabled devices, it is recommended that they compute the online virtual dissection linked in the digital materials list. Familiarize yourself with the procedure explained in the online version prior to conducting the activity with students. If buddy groups do not have access to internet-enabled devices, it is suggested that they perform the dissection using the images linked in the material section. These can be printed and distributed for student use or projected if printing is not an option. If images are projected, complete the virtual dissection as an entire group.

## **Procedure**

### ***Introduction***

Follow the prompts in the slide deck notes to introduce the following concepts:

- What are national marine sanctuaries and why are they important?
- Where is Papahānaumokuākea Marine National Monument and what resources does it protect?
- What is marine debris and how does it negatively impact ocean ecosystems?
- How can an albatross bolus be used to monitor ocean health?

**Activity** Adapted from *Winged Ambassadors Ocean Literacy Curriculum*

1. Brief students on how they will conduct the virtual bolus dissection: either using the online virtual dissection or using bolus images.
2. Have students make a data table on scrap paper like the one below. This table is also included in the slide deck. Inform them that they will be tallying the number of items in the assigned bolus sample.

Item	Number Identified
Prey Remains	
Natural: Non-Prey	
Plastic	
Unknown	

3. If completing the online virtual dissection, it is recommended that each group survey one quadrant. Assign different quadrants to different groups. The online virtual dissection includes a more involved way of collecting data. Feel free to use this method if you desire.
4. If using images, it is suggested that each buddy team survey one image. Each image is a quadrant from a bolus. There are two boluses, from two different birds, included in the images. It is at your discretion which images you use. It is suggested that different groups use different images from the same bird.
5. Make sure students feel confident identifying items in each category listed in the table. Consider identifying a few items together prior to allowing buddy teams to work independently.
6. Give students approximately 10 minutes to collect data. It is not essential that they survey the entire sample assigned.

**Debrief**

Discuss the activity using the questions below. These questions are also included in the slide deck. Accept all reasoned responses. The take home message is that even though albatrosses nest on remote islands, far away from people, they are still impacted by human actions. The contents of their boluses can provide important insights into ocean health.

- Did your survey contain mostly prey or non-prey items?
- What was the most abundant time in the bolus?
- Did the contents of the bolus surprise you? Why or why not?

## Preparation – Pool Mission

Distribute “marine debris” throughout the dive area.

## Procedure

Inform students that they will work in buddy pairs to use a lift bag to bring simulated marine debris to the surface. Each student will have the opportunity to be both the rigger and the filler. The rigger will attach the lift bag to the debris. The filler will add air to the lift bag and control its ascent.

## Dive Briefing

- Restate the objective and explain how to use a lift bag. Model the procedure above water prior to student participation. Demonstrate the skill underwater. Closely supervise each buddy pair while they are performing the task.
- Emphasize the importance of safety (air and buddy checks), good buoyancy control, and safe ascent rate. These objectives are more important than the objective of the mission.
- Prior to entry, perform all standard safety and weight checks.

## Dive

Participate in the dive mission as described above.

## Debrief

Upon completion of the pool mission, assess student understanding by asking the following questions. Accept all reasoned answers:

- How well did you pay attention to your buddy and air? How was your buoyancy control? Why do you feel this way?
- How successful were you in using the lift bag? Why do you feel this way?

Education Standards	
Dive Industry Standards	PADI Seal Team SSI Scuba Ranger NAUI Junior Scuba Diver or Passport Diver
Ocean Literacy Principles	#1: The Earth has one big ocean with many features. (a,h) #5: The ocean supports a great diversity of life and ecosystems. (e,f,h)

## Additional Resources

Resources linked in the slide deck:

- [Introduction to National Marine Sanctuaries Video](#)
- [How Atolls Form](#)
- [Pew Charitable Trusts: Papahānaumokuākea National Marine Monument](#)

- [Endemism in Papahānaumokuākea National Marine Monument](#)
- [Trash Talk: What is Marine Debris?](#)
- [Whale Disentanglement](#)
- [Ocean Today: What are Garbage Patches?](#)
- [Ocean Today: What Can We Do?](#)
- [Albatross Barfing Plastic](#)
- [Online Virtual Bolus Dissection](#)
- [Bolus Images \(for print\)](#)
- [Bolus Images \(for projection\)](#)
- [United By the Ocean](#)

Additional Resources:

**NOAA's Office of National Marine Sanctuaries:** <https://sanctuaries.noaa.gov/>

**Marine Sanctuaries and Monuments What's the Difference**

<https://sanctuaries.noaa.gov/about/monuments-and-sanctuaries-whats-the-difference.html>

**Papahānaumokuākea Marine National Monument:** <https://www.papahanaumokuakea.gov/>

<https://www.papahanaumokuakea.gov/new-news/2020/06/15/14anniversary/>

Virtual visits and interactive map: [https://www.papahanaumokuakea.gov/education/virtual\\_visits.html](https://www.papahanaumokuakea.gov/education/virtual_visits.html)

Native Hawaiian Cultural Heritage: <https://www.papahanaumokuakea.gov/heritage/>

Maritime Heritage: <https://www.papahanaumokuakea.gov/maritime/>

### **Marine Debris**

NOAA Marine Debris Program: <https://marinedebris.noaa.gov/>

<https://oceanservice.noaa.gov/facts/marinedebris.html>

Trash Talk: <https://oceantoday.noaa.gov/every-full-moon/full-moon-trashtalk.html>

### **Marine Debris in Papahānaumokuākea**

Papahānaumokuākea Marine Debris Project: <https://www.pmdphawaii.org/>

<https://blog.marinedebris.noaa.gov/how-currents-carry-marine-debris-hawaiian-islands>

<https://www.papahanaumokuakea.gov/monsternet.html>

### **North Pacific Convergence Zone**

[https://response.restoration.noaa.gov/about/media/where-are-pacific-garbage-patches.html#:~:text=The%20North%20Pacific%20Convergence%20Zone,2009\).](https://response.restoration.noaa.gov/about/media/where-are-pacific-garbage-patches.html#:~:text=The%20North%20Pacific%20Convergence%20Zone,2009).)

## Winged Ambassadors

<https://www.downloadwingedambassadors.org/>

Unabridged Bolus Dissection Activity Procedure and Materials:

<https://www.downloadwingedambassadors.org/#lesson-3>

## Marine Conservation Institute

<https://marine-conservation.org/on-the-tide/thinking-beyond-the-reefs/>

## Ocean Guardians Dive Club Lessons

[https://sanctuaries.noaa.gov/education/ocean\\_guardian/dive-club/](https://sanctuaries.noaa.gov/education/ocean_guardian/dive-club/)

*\*The inclusion of links in this guide does not imply endorsement or support of any of the linked information, services, products, or providers.*

## For More Information

This lesson was developed by NOAA's Office of National Marine Sanctuaries in partnership with Ocean First Education. This lesson is in the public domain and cannot be used for commercial purposes. Permission is hereby granted for the reproduction, without alteration, of this lesson on the condition its source is acknowledged. When reproducing this lesson, please cite NOAA's Office of National Marine Sanctuaries as the source, and provide the following URL for further information:

<https://sanctuaries.noaa.gov/education>. If you have any further questions or need additional information, email [sanctuary.education@noaa.gov](mailto:sanctuary.education@noaa.gov).