Deep Sea Transect Data Questions (Teacher Answer Sheet)

Note: It is recommended that the teacher go over the "ROV Transects of Deep Sea Coral Communities: Habitat Type, Species Abundance and Diversity" BEFORE the activity to become familiar with the species composition of the chosen transects. If students did NOT complete Channel Islands transects, have them skip question #4. If students did NOT complete Greater Farallones questions, have them skip question #5.

1. Compare and contrast the various habitats you observed on each transect.

This will depend greatly on which transects you choose to show your class. In general, rocky reef and ledge habitats will contain greater diversity and abundance than soft bottom habitats. Rocky surfaces provide hard substrate for invertebrates such as sea stars, urchins and sea cucumbers to settle out on, while also providing shelter for groundfish such as rockfish and lingcod. Ledges offer extra overhead protection and shelter for fish and invertebrates.

2. What species were most abundant in each habitat? Why do you think this is?

This will greatly vary depending on the transect(s).

3. Which transects had the most species diversity, or number of species? Why do you think this is the case?

This will vary depending on the transect(s). In general, rocky and ledge habitats will have more species diversity (see answer to question #1).

4. *For Channel Islands transects only*: Use the table to answer the following questions:

Transect Name	Depth (meters)	Temperature (^{O}C)
Shallow 1 Carrington	65	12.1
Shallow 2 Carrington	68	10.9
Shallow 3 San Miguel	77	10.4
Deep 1 The Footprint	174	9.4
Deep 2 The Footprint	153	9.5
Deep 3 PiggyBank	309	8.7
Footprint Alternative	176	8.7
PiggyBank Alternative	288.6	8.7

    a. How did species abundance/diversity change with depth? Why do you think this is the case?

Shallow transects are dominated by the soft coral sea fans, while the deep transects show a higher density of sponges and sea stars. Both depths show dense populations of rockfish. The difference in species abundance with depth likely has to do with temperature tolerance and availability of food. Sponges are better adapted to live in deeper waters while sea fans are better adapted to live in shallower waters.

Deep water organisms are adapted to cool temperatures, and they are sensitive to warm temperatures. We expect deep water habitats to have more stable temperatures, and we would expect shallower habitats to have higher temperature variability. Currently scientists are testing this hypothesis.

Deep-water sponges may have a different diet than sea fans. The sponges generally specialize in picoplankton (very small plankton) which can be abundant at depth. The sea fans are generalists, but typically feed on surface originated phytoplankton and small zooplankton.

But this does not mean they are limited in their distribution - we do see some sea fans thriving in deeper waters, just as we see some sponges thriving in shallower waters.

   b. Did temperature change with depth? Why do you think this is the case? Do you think that temperature has an impact on deep sea coral communities? Why or why not?

Temperature definitely changed with depth. In general, shallower waters were warmer and deeper waters were colder - even just a few degrees can change the distribution of species. The temperature difference is caused mainly by sunlight and air temperature heating shallower waters. Different species of fish and invertebrates have different tolerances for depth and temperature in terms of physiological response or stress and food availability.

5. *For Greater Farallones transects only*: How did species abundance/diversity change with each habitat type? Which habitat has the highest biodiversity or are they all similar?

Both the rocky bottom and ledge show greater biodiversity and higher abundance of invertebrates and rockfish than the soft bottom habitat. Hard substrate allows a surface for invertebrates to attach to and settle onto and shelter for invertebrates and fishes. Because of this, rocky bottom areas tend to have a higher abundance and diversity of life than soft bottom areas. There are also many soft bottom areas that are very abundant with life, such as our practice transect! Many (but not all) species found in soft bottom areas are detritivores, which means they feed on the dead and decomposing organic matter found on the bottom of the ocean.

6. Throughout each transect, how did the abundance for each species vary? Did the habitat vary minute to minute? Describe what you saw in a few sentences.

Answers will vary. Some transects have a high abundance of species in just one segment and none in the next, others stay consistent. Habitat occasionally varies. If desired, the teacher may have students graph their data by one minute segments to study the changes within a transect more in depth (Optional Transect Activity Extension - see Program Outline).

7. Based on the video transects and the graphs you created, what species are most abundant in the deep sea habitat of each of the Sanctuaries you viewed?

Answers will vary. Please refer to the "ROV Transects of Deep Sea Coral Communities: Habitat Type, Species Abundance and Diversity" sheet for teachers.

8. What variables exist in doing a study like this?

Environmental variables - visibility, currents and obstructions in the pathway - can all have an impact on the speed of the ROV and the field of view. The ROV will often stop to record interesting species or habitat. ROVs can occasionally become entangled in derelict fishing gear, large rocks or pinnacles. Consistency among observers is a big variable and likely one that your students will experience. It is important to recognize these variables and understand how they may impact a transect and the data that researchers collect.

9. What challenges did you encounter while viewing the transects and taking data? Do you think that scientists face similar challenges?

Answers may vary - students may experience challenges with the speed of the ROV and recording data at the same time. Often species density can be overwhelming when trying to count individuals. Identifying species can be difficult and time consuming. Scientists face all the same challenges!

10. What human activities might impact these habitats? How would deep sea ecosystems be harmed by these activities?

Marine debris and derelict fishing gear can physically damage deep sea corals and communities. Harmful fishing methods such as bottom trawling can have devastating impacts on deep sea communities and centuries of coral growth can be wiped out in minutes. Exploration for oil and natural gas can cause direct physical damage or even destruction for entire deep sea communities, as well as increase the risk that oil spills may occur. Ocean acidification from human carbon emissions is an emerging threat that may potentially have a negative impact on coral growth and survival. Research helps us understand the extent of these impacts and how we can better plan to manage deep sea communities.

11. Why is it important that we help protect these habitats?

Deep coral communities serve as important habitat for invertebrates and fish. When they are damaged or destroyed, species abundance is reduced. Protecting them and keeping them thriving ensures both a healthy ocean and vibrant fisheries for us.

12. What are actions that individuals and communities can take to ensure these habitats are protected?

Beach clean ups, not littering, using less plastic, reducing carbon emissions, designating Marine Protected Areas and National Marine Sanctuaries to protect special ocean habitats, supporting organizations that help spread awareness about the ocean, working with regulating agencies and fishermen to establish environmentally friendly fishing methods and reduce the risk of derelict fishing gear. There are numerous answers to this question - we encourage teachers to take a lot of time on this question to extract student's ideas and thoughts.

Ecosystem Monitoring Questions (Teacher Answer Sheet)

1. Why do you think it is important to monitor a marine ecosystem?

We need to have documentation over time to be able to tell how an ecosystem has changed, whether due to natural reasons or human-induced impacts. Monitoring programs collect scientific data that can be measured over time. We can evaluate this data to identify changes or trends related to natural or human-caused events or processes. Managers can use scientific data to better protect these areas.

2. If designing a study around a habitat you know nothing about, what pieces of information would help you to best set up a study?

Knowing the bathymetry, or contours of the seafloor, is very helpful to give researchers an idea of the depth of the study area and natural features of which they should be aware. It is important to be aware than the tether on an ROV can become entangled or the electronics can be damaged on pinnacles or large rocks. It is also important to examine weather patterns to best prepare for calm seas for the research vessel.

3. Based on what you observed on your transect, what further questions would you want to address in an ecosystem monitoring program?

Researchers are interested in monitoring the abundance and diversity of fishes, corals and other invertebrates over time in order to better inform Sanctuary managers and other regulating agencies about ecosystem health. Student answers may vary.