*Activity #1*

# Coral Reef Monitoring Simulations

## ● ● ● Class Period One *Observing Reef Fish Underwater*

### Materials & Setup

- *Hawai'i's Reefs: Oceanic Oasis* video (included with this curriculum)

*For each student*

- Student Page "Reef Fish Checklist" (pp. 12-14)
- "Reef Fish Identification Chart" (master, p. 11 — Options: laminate these charts for durability, divide students into small groups to share a chart.)

### Instructions

1) Show the video, *Hawai'i's Reefs: Oceanic Oasis* (8 minutes). Rewind the tape when you finish, so it's ready to be played again later in the class.

2) Hold a brief discussion about the video: Did students learn anything new? What struck them from the video?

3) Pass out a copy of the Student Page "Reef Fish Checklist" to each student and review the instructions. Also pass out the "Reef Fish Identification Chart" to each student or small group.

4) Play the video again, this time with the sound off. Students will be filling in the 1st Survey Column of the "Reef Fish Checklist" as they watch the video. Once again, rewind the tape when you finish, so it's ready to be played again.

5) Briefly discuss students' experience with this exercise by asking, "What are some of the challenges facing divers who do underwater fish surveys?"

   Some of the answers might include the numbers of fish to count, the fact that the fish are moving, uncertainty about whether a particular fish has been counted before, and having to recognize species quickly.

6) Ask students whether they think it would be easier to accurately count fish if they could see the video again.

7) Test their predictions by playing the video again (with the sound off) and having students fill in the 2nd Survey column of the "Reef Fish Checklist."

8) Ask students whether they see a difference in their counts. If so, do they think their counts were more accurate the first time or the second time? Why?

   For anyone conducting fish surveys, there is a learning curve during which they become more familiar with the species of fish they are likely to see. Their observations become more accurate as they learn.

9) Have students pair up with a partner and compare their findings by filling in the second page of the Student Page "Reef Fish Checklist." Students should simply compare observations with each other. Each student should fill in his or her partner's tallies from the *second* video survey where indicated on the student page. Students should not complete the calculations at this time.

10) Bring the class back together and ask whether they saw differences in their partner's observations and theirs. If so, why do students think these differences might occur? How do they think that differences between observers might influence the results of a coral reef monitoring study? How could researchers compensate for those effects?

    This effect is called "observer bias" in research studies. Even with extensive training, underwater observers generally do not record exactly the same data. One way to compensate for observer bias is to pair researchers to make observations and adjust the data to reflect the differences in data sets.

11) Assign the remainder of the student page as homework.

## ● ● ● Class Period Two *Coral Reef Monitoring Simulations*

### Materials & Setup

*For each student*

- Student Page "Estimating Percent Cover" (pp. 15-17)
- Ruler (If you do not have enough rulers to go around, have students share in small groups.)
- Black pen

*For each pair of students*

- Student Page "Get the Point" Note: Color photocopies are best for this activity, but black and white will work, as well. (pp. 18-21)

### Instructions

1) Hand out the Student Page "Estimating Percent Cover."

2) Tell students that researchers often use "percent cover" as a way of estimating the species composition of a coral reef. This means they are looking at how much of the ocean's floor is covered by corals, and which types of corals. Tracking changes over time helps them describe and evaluate the health of the coral as well as growth and change within the reef community. Changes in the relative proportions of coral reef species, as well as in total coral coverage, are both important. Percent cover is used to evaluate other types of marine and terrestrial habitats, as well.

3) Have students work through the activity, making all estimates and calculations.

4) Write the actual percent black cover for each of the figures on the board. Figure #1 is 36 percent black. Figure #2 is 34.5 percent black.

5) Review student results using the following discussion questions:
   a) Were students more accurate at estimating cover when the shapes have straight sides or when they are rounded? What implications might this have for the study of coral reefs?

      Coral reef researchers must estimate percent cover of irregularly shaped coral, adding difficulty to an already tricky task.

   b) Were students more accurate at estimating cover with or without the grid? What might explain this? What implications does it have for studying percent cover on coral reefs?

      Breaking up a larger area into smaller areas typically increases accuracy. For even more accurate analysis, many studies of coral cover use a system in which slides of the reef taken at designated locations along a transect are projected over an image containing many randomly selected coordinates. At each set of coordinates, the substrate/cover is recorded and an average made based on those data.

   c) Which was more accurate, using all of the cells in the grid, or just a sample?

      Although using all of the cells may be more accurate than just a sample, it is not feasible for researchers to examine every bit of the extensive coral reefs they study. The trick is to make the sample size large enough to estimate coverage with confidence but small enough to be manageable. Researchers have spent much effort testing the validity of their sampling schemes.

6) Divide students into pairs. Give each pair one copy of the Student Page "Get the Point."

7) Explain that researchers collect data about the presence and abundance of marine species in different ways.

   - One way is to set up a "transect" (a line across the reef) and swim along it, counting and recording fish and other species, or stopping at predetermined points to make and record observations. The exercise with the video observations was something like this, only there was not a continuous transect.

     In the "visual strip-transect search" method, for example, two divers swim side-by-side down either side of a transect, counting all fishes seen within a corridor three meters wide and extending to the surface. In another method, divers make one pass along the transect, recording fish they see swimming above the reef and a return pass to search for organisms sheltered in cracks and crevices.

   - Another approach, most often used when looking at coral cover or at invertebrate species that live on the reef, is to set up a transect and then to sample at points along that transect.

     One sampling method, called the "point-intercept" method, involves identifying the type of cover at various sampling points along the transect.

     Another sampling method is called the "photoquadrat" method. With this method, researchers use an underwater camera fitted with a square frame that enables researchers to take a

picture of a small square portion of the ocean bottom, and then to analyze what is in that photograph later. Researchers may set up fixed locations for these photoquadrats that they return to again and again to track changes over time. This is called the "fixed photoquadrat" method.

When researchers analyze the photographs, they generate a number of points that they overlay onto the photograph, recording the type of cover that lies directly underneath each point. Researchers then extrapolate percent cover of various corals based on this sample.

8) Have student partners work through the photo analysis exercise on the student page. (Note: The area in the photo not covered by the blue leather coral is the rock substratum and small growths of algae, sponges, or other organisms.)

9) If there is time left, briefly discuss the photo analysis by asking, "Why is this a good way to estimate percent cover?" and "What do researchers need to know or do to make this technique accurate?"

Photo analysis is a good way to estimate percent cover because the analysis itself takes place out of the water and can be more rigorous than analyses conducted underwater. It also allows researchers to track changes in particular areas over time. To make this technique accurate, researchers must take all photographs from the same distance away from the ocean bottom and must be able to identify organisms based on the photographs.

10) If students need more time to finish their photo analysis, have each partner take home the photo he or she was working on during class, and allow partners some time during the following class period to compare results. During this time, you may also wish to discuss student responses to the questions in the Student Page "Get the Point."

## Journal Ideas

- In traditional Hawaiian society, fishing areas were declared *kapu* (off-limits) either seasonally or as they became depleted and needed time to recover so they could support fishing again. What would you look underwater for if you were determining when the *kapu* would begin and end?
- Do you think it is possible to eliminate observer bias in underwater research? If so, how? If not, why not?

## Assessment Tools

- Student Page "Reef Fish Checklist" (teacher version, p. 9)
- Student Page "Estimating Percent Cover" (correct answers in unit instructions, p. 7)
- Student Page "Get the Point" (teacher version, p. 10)
- Participation and conduct during pairs exercises
- Journal entries

*Teacher Version*

# Reef Fish Checklist

## Questions

1) Which set of observations—your first or your second—do you think is more accurate? Why?

   The second is likely to be more accurate because students are likely to become more familiar with the species of fish they are likely to see. Their observations may become more accurate as they learn.

2) If you had to use both data sets for a study, how confident would you be in the precision of your results (i.e., in how well they reflect the real underwater situation). Explain your answer.

   Well reasoned answers are acceptable. If there are significant differences between the two sets of data, one possible answer is that the second set of data could reflect the underwater situation more accurately than the first set, leading to questionable precision.

3) Name two factors that could help explain differences between your counts and your partner's counts. Describe how each might influence the accuracy of an underwater fish survey that is conducted as part of a scientific research project.

   Well reasoned answers are acceptable. Possible responses include:

   - There could be difficulties in seeing and recording every fish, especially when there are many fish congregated in an area.
   - Different observers may tend to see certain kinds of fish, or fish in certain parts of the transect, and miss others.
   - There may be difficulties counting fish accurately when they move in and out of the area being observed.

   All of these factors could cause imprecision in scientific research. These sources of imprecision may be partially countered by comparing or compiling data from more than one observer.

*Teacher Version*

# Get the Point

3) Do you think that one method was more accurate than the other? Why or why not?

Well reasoned responses are acceptable.

4) How would you test to see whether one method was more accurate than the other?

Well reasoned responses are acceptable. A possible response is to analyze cover in the photograph using a large number of points to achieve a response of greater precision against which to compare the results of both methods used.

5) How could you make both of these methods more accurate?

Well reasoned responses are acceptable. One way to increase accuracy is to increase the number of sampling points used.

6) How do you think this kind of analysis could help scientists studying coral reefs? Why?

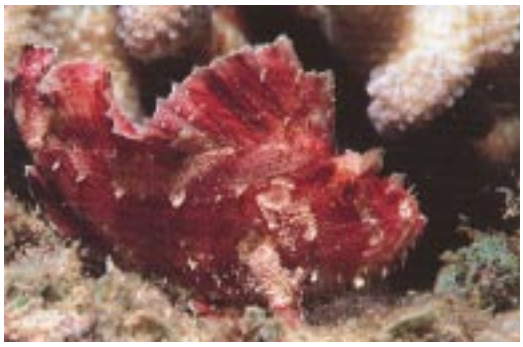
Well reasoned responses are acceptable. A possible response is that this kind of analysis can help scientists monitor changes in the composition of the coral community over time.

# Reef Fish Identification Chart

*Photos: Leaf scorpionfish, Marjorie L. Awai, all others John P. Hoover,* Hawaii's Fishes, *Mutual Publishing*

Hawaiian cleaner wrasse
*Labroides phthirophagus*

*Pākuʻikuʻi* or Achilles tang
*Acanthurus achilles*



Leaf scorpionfish
*Taenianotus triacanthus*
(color varies from grayish white to yellow, red, brown, or black)

*Manini* or Convict tang
*Acanthurus triostegus*

*ʻŪʻū or* Big-scale soldierfish
*Myripristis berndti*

*Lauʻīpala* or Yellow tang
*Zebrasoma flavescens*



# Reef Fish Checklist

Based on the video *Hawai'i's Reefs: Oceanic Oasis*, fill in the following reef fish checklist. For each "survey" or fish count that you do, tally the number of separate times you see each species, and how many fish you see each time. If you need to estimate how many fish you see, do so. Use hash marks to keep count, rather than numerals (e.g., Ⅲ instead of 3).

| | 1st Survey | | 2nd Survey | |
|---|---|---|---|---|
| | # of Sightings | # of Fish | # of Sightings | # of Fish |
| Hawaiian cleaner wrasse *Labroides phthirophagus* | | | | |
| Leaf scorpionfish *Taenianotus triacanthus* (can be grayish white, yellow, red, brown, or black) | | | | |
| *ʻŪʻū* or Big-scale soldierfish *Myripristis berndti* | | | | |
| *Pākuʻikuʻi* or Achilles tang *Acanthurus achilles* | | | | |
| *Manini* or Convict surgeonfish or tang *Acanthurus triostegus* | | | | |
| *Lauʻīpala* or Yellow tang *Zebrasoma flavescens* | | | | |



## Reef Fish Checklist Comparison Table

Compare the results of your second survey with a partner. Notice whether there are differences between your tallies. Fill in the first two appropriate columns in this table with your results (following the "Y") and your partner's results (following the "P"). If there is not time in class, you may complete the "Quantifying Comparisons" section and the questions that follow as your homework assignment.

| | 2nd Survey Results | | Percent Difference | |
|---|---|---|---|---|
| | # of Sightings | # of Fish | %Difference # of Sightings | % Difference # of Fish |
| Hawaiian cleaner wrasse *Labroides phthirophagus* | Y<br>P | Y<br>P | | |
| Leaf scorpionfish *Taenianotus triacanthus* (can be grayish white, yellow, red, brown, or black) | Y<br>P | Y<br>P | | |
| *ʻŪʻū* or Big-scale soldierfish *Myripristis berndti* | Y<br>P | Y<br>P | | |
| *Pākuʻikuʻi* or Achilles tang *Acanthurus achilles* | Y<br>P | Y<br>P | | |
| *Manini* or Convict surgeonfish or tang *Acanthurus triostegus* | Y<br>P | Y<br>P | | |
| *Lauʻīpala* or Yellow tang *Zebrasoma flavescens* | Y<br>P | Y<br>P | | |

## Quantifying the Comparisons

Fill in the third and fourth columns of this table using the numbers from the first two columns. Use the formula below to calculate the percent difference between your results and your partner's results.
Note: Your calculations may result in negative or positive numbers.

Percent difference = (Your result – Partner result/Your result) x 100



## Questions

1) Which set of observations—your first or your second—do you think is more accurate? Why?

2) If you had to use both data sets for a study, how confident would you be in the precision of your results (i.e., in how well they reflect the real underwater situation). Explain your answer.

3) Name two factors that could help explain differences between your counts and your partner's counts. Describe how each might influence the accuracy of an underwater fish survey that is conducted as part of a scientific research project.

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   •

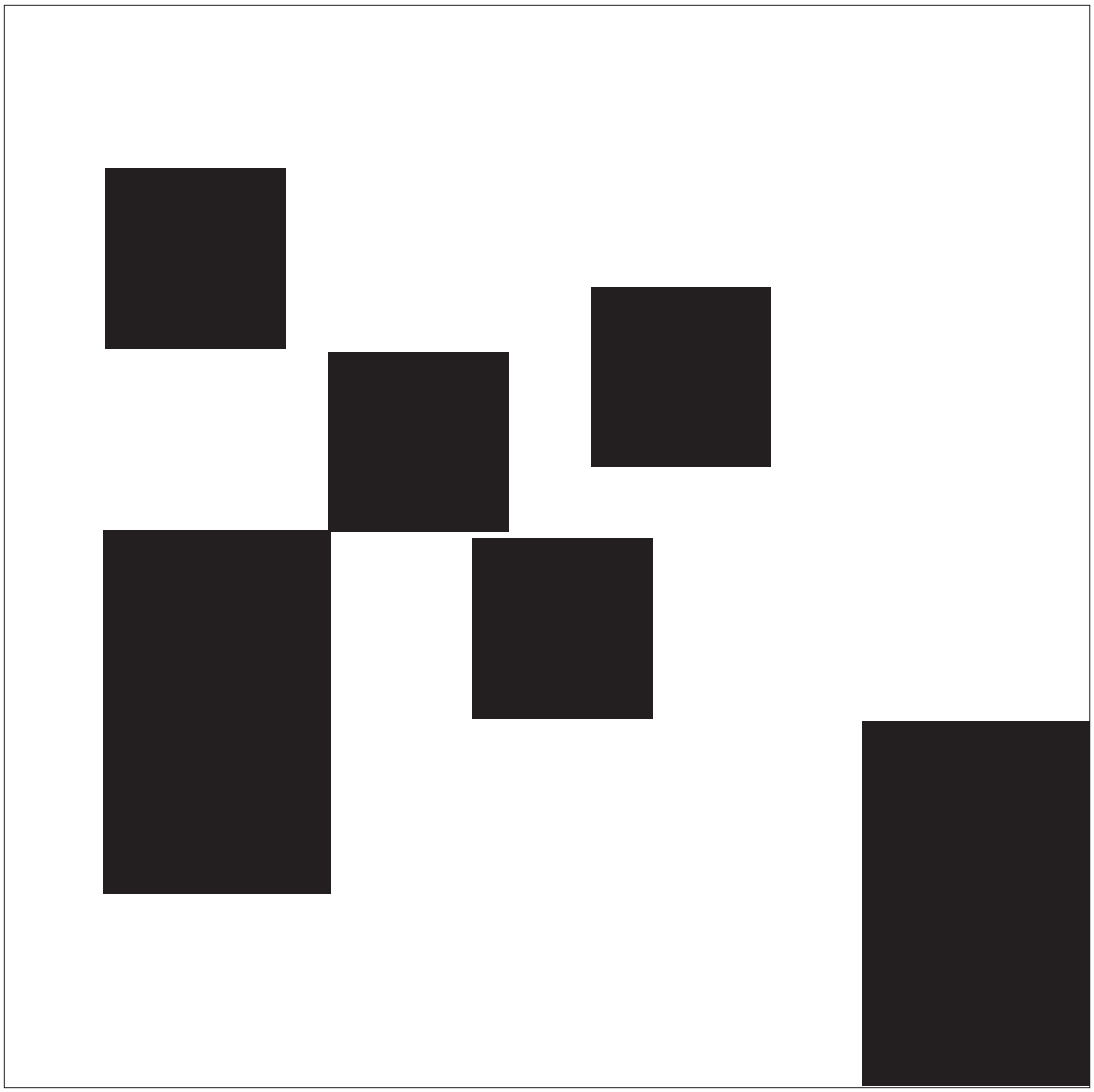
# Estimating Percent Cover

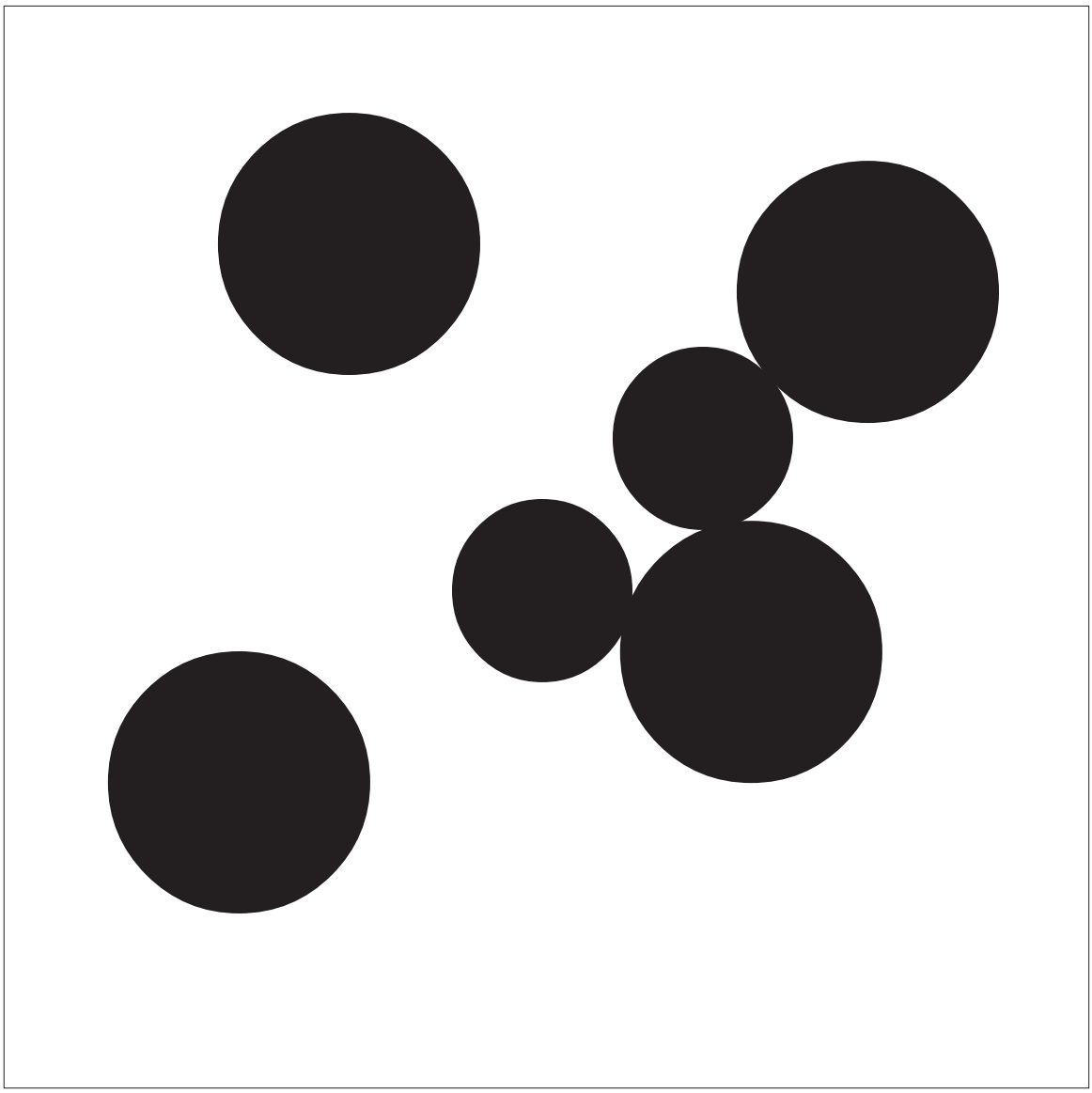
Researchers often estimate "percent cover" as a way of approximating the species composition of a coral reef. Percent cover simply refers to the proportion of a given area covered by a particular species of coral.

Tracking changes in percent cover over time helps scientists describe and evaluate the health of the coral as well as growth and change within the reef community. Changes in the relative proportions of coral reef species, as well as in total coral coverage, are both important because they help scientists understand the natural life cycle of coral reefs and may be signs of changes in factors such as water quality, temperature, numbers and types of predatory marine animals on the reef, or disease.

In this exercise, you'll practice estimating percent cover using different techniques.

1) Estimate the percentage of the area inside the box covered by black without doing measurements.





2) Estimate the percentage of the area inside the box covered by black (no measuring).

3) Go back to the figures used in #1 and #2 above. *For each figure*, make a new estimate of percent cover using the following method:
   a) Draw a four -by-four grid that divides the box into 16 sections of equal size. Estimate percent cover in each of these sections, writing your estimates in or next to each cell of the grid.
   b) Average these estimates to come up with a total percent cover estimate.

   Figure #1 percent black cover estimate:

   Figure #2 percent black cover estimate:



4) Pick three numbers between one and 16. Write them down here.

Now, go back to the figures used in #1 and #2 above. Your grids divide the box into 16 equal sections. Using the following numbering scheme, select the percent coverage for the sections that correspond to the numbers you selected above.

| | | | |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 |
| 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 |

Write the corresponding percent cover estimates below and average them:

| | Figure 1 | Figure 2 |
|---|---|---|
| Section number ____ | _____ percent cover | _____ percent cover |
| Section number ____ | _____ percent cover | _____ percent cover |
| Section number ____ | _____ percent cover | _____ percent cover |

Average percent cover (include your calculations)



# Get the Point

When researchers analyze photographs of coral reefs, they may use a method in which they generate a number of points that they overlay onto the photograph. The easiest way to generate these points is to use special computer software designed for this purpose. They then record the type of cover that lies directly underneath each point. Researchers then "extrapolate" or predict percent cover of various corals for the entire reef based on this sample. Comparing changes in coverage over time can help researchers track the growth of corals, damage to corals, and how well different species of coral are doing relative to each other.

In this exercise, you'll work with a partner to determine the percent coral cover in a photograph using two different methods. Each of you will use a different method, and then you will compare findings.

1) You take one of the two photo assignment sheets, and your partner takes the other. Follow the directions on your sheet, and when you are finished, compare your findings with your partner's findings below.

2) Fill in the following table with your findings.

| | Percent Coral Cover | Percent Other Cover |
|---|---|---|
| Grid method | | |
| Random method | | |

3) Do you think that one method was more accurate than the other? Why or why not?



4) How would you test to see whether one method was more accurate than the other?

5) How could you make both of these methods more accurate?

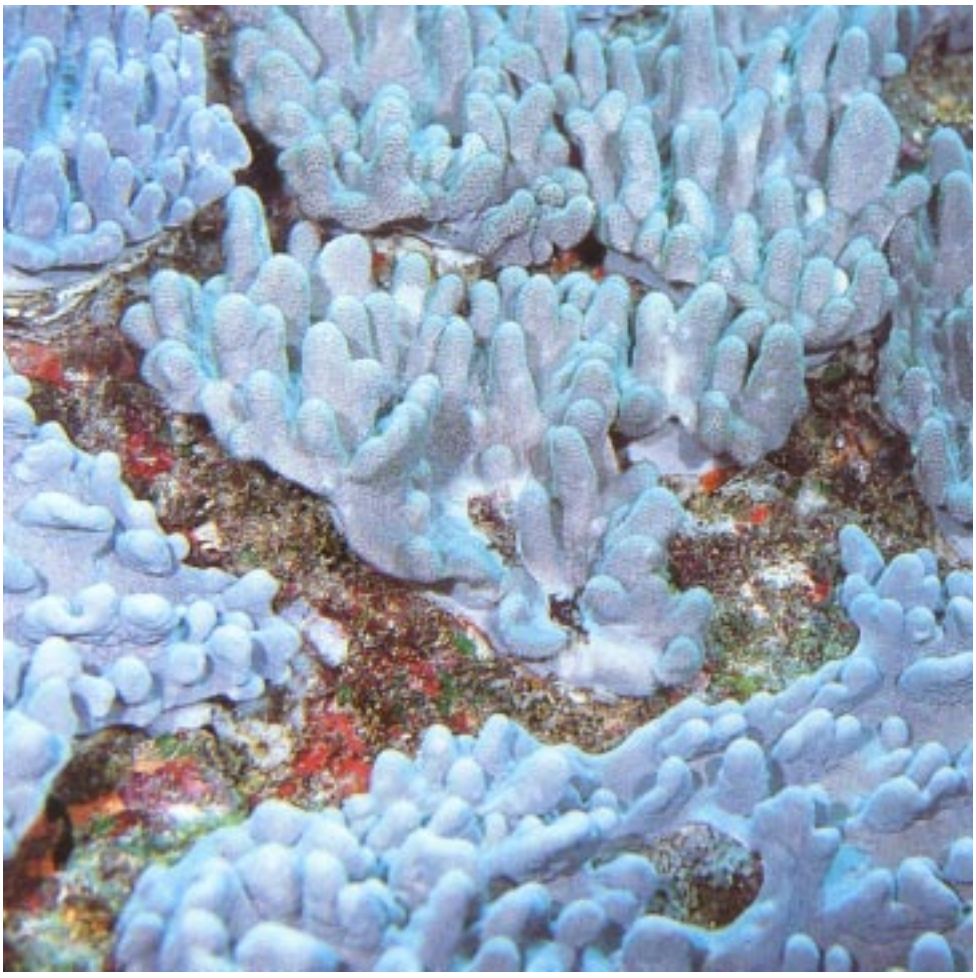
6) How do you think this kind of analysis could help scientists studying coral reefs? Why?

# Photo Assignment Sheet #1: Grid Method

1) Draw a five-by-five grid over this photo that divides it into 25 equal sections. Number the intersection points on this grid from one to 16, and write the numbers near each intersection.

2) For each intersection point, record what lies under it on the photo: coral or something else.

| | | |
|---|---|---|
| 1. | 7. | 13. |
| 2. | 8. | 14. |
| 3. | 9. | 15. |
| 4. | 10. | 16. |
| 5. | 11. | |
| 6. | 12. | |



*Leather Coral (Photo: John P. Hoover,* Hawai'i's Sea Creatures, *Mutual Publishing)*

# Photo Assignment Sheet #2: Random Method

1) Close your eyes and use your pen to mark dots on the photograph, as randomly as you can. Continue making dots until you have 16 of them on the photograph itself. Number these points from one to 16, and write the numbers on the photograph.

2) For each intersection point, record what lies under it on the photo: coral or something else.

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

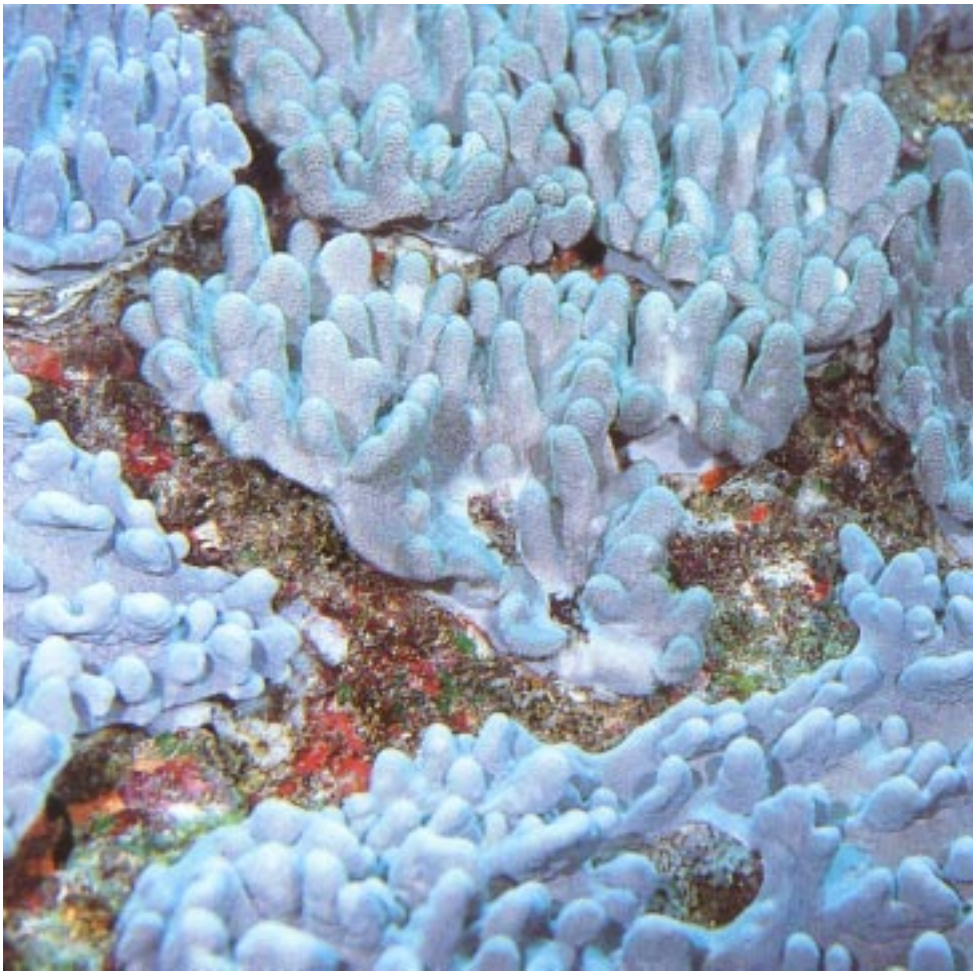
12.

13.

14.

15.

16.



*Leather Coral (Photo: John P. Hoover,* Hawai'i's Sea Creatures, *Mutual Publishing)*