Activity #2

Impacts of Aquarium Fish Collecting on Coral Reefs

● ● ● **In Advance** *Student Assignment*

• As homework, assign the Student Pages "Impacts of Aquarium Fish Collectors on Coral Reef Fishes in Kona, Hawai'i" (pp. 34-41) and "Questions About the Reading" (pp. 42-45).

● ● ● **Class Period One** *Discussing Study Designs*

Materials & Setup

For each student

• Student Page "Impacts of Aquarium Fish Collectors on Coral Reef Fishes in Kona, Hawai'i" (pp. 34-41)
• Student Page "Questions About the Reading" (pp. 42-45)

Instructions

1) Beginning with student questions and responses to the homework assignment, hold a class discussion about the study, its design, conclusions, and implications for managing coral reef fisheries.

2) For advanced classes, move from the general discussion to a more detailed discussion of experimental design. For guidance and background, use "Impacts of Aquarium Collectors on Coral Reef Fishes in Kona, Hawai'i" (complete original report in appendix) and "Notes for Class Discussion on 'Impacts of Aquarium Collectors on Coral Reef Fishes'" (pp. 28-29).
   The class discussion should get into the details of experimental design at an appropriate depth for the level of students. Students should be prepared for this discussion based on their reading and answering the homework questions.

3) Wrap up the discussion by focusing on the final homework question, how students would go about learning whether aquarium collecting is a current problem on Maui and what they would do to prevent it from becoming a problem in the future.

Journal Ideas

• If you were in charge of regulating aquarium fish collecting, what would you do based on reading the Tissot and Hallacher study?
• Do you think that people should be allowed to collect native Hawaiian fish for the aquarium trade? Why or why not?

Assessment Tools

• Student Page "Questions About the Reading" (teacher version, pp. 30-33)
• Participation in class discussion
• Journal entries

Teacher Background
Notes for Class Discussion on "Impacts of Aquarium Collectors on Coral Reef Fishes"

To make the main points of this paper easier for students to grasp, several parts of the study and discussion were left out of the simplified student version of the paper. Depending upon the level of student and the nature of the course you are teaching, you will want to go into details of the study that will help students understand experimental design.

Below are the main elements of the paper, along with page references to the full version of the paper (see appendix). First, make sure that students understand the results of the study as presented in the student version. Then, with the time remaining, go into the elements of experimental design, emphasizing the first three sections of the paper.

1) Introduction/statement of the problem (pp. 4-5)
   The context for this study is the growing global and Hawaiʻi-based trade in marine aquarium fishes collected from the wild. The authors identified a lack of conclusive studies documenting the magnitude of impacts on natural populations.

2) Scope/purpose of the study (p. 4)
   This study had two main purposes. Only the first is covered in the student version of the paper:
   a) Obtain quantitative estimates of the impact of aquarium collectors on reef fishes;
   b) Evaluate evidence for destructive harvesting methods and changes in the reef community associated with reductions in herbivory (predation on plants).

3) Methods (pp. 5-7)
   a) The authors explain their experimental design (a paired control-impact design) and its major assumptions. The student version of the paper deals very little with the assumptions of the design and how they were tested/addressed. The main assumptions and how they were tested and addressed in the study and report are:

Assumption	How addressed, tested
Prior to the onset of aquarium harvesting, there was no difference in abundance of aquarium fishes between the control and impact sites. (The study was begun after the impacts had begun.)	• Paired control and impact sites were geographically close together (p. 10). • The survey was conducted on corals, macroalgae, and the general substratum of each transect. Analysis showed remarkable similarity between the paired control-impact sites (pp. 8, 10). • The survey included ecologically similar species not targeted by aquarium collectors. A prediction of this assumption is that non-collected species should not differ between control and impact sites. This prediction was supported by study data (pp. 6, 8-10).

Assumption

All differences between the control and impact sites are due to aquarium fish collecting and not other factors, such as fishing.

How addressed, tested

- Impact sites were largely inaccessible from shore, minimizing shore-based recreational fishing (p. 10).
- There was no significant control-impact variation in abundance of a nontarget species (not collected for aquariums) subject to commercial and recreational fishing (p. 10).
- Introduced piscivorous (fish-eating) fishes that may cause significant mortality among aquarium species were rare at the study sites (pp. 10-11).

b) The authors also describe their research sites, methods, personnel, and timing of the surveys, as well as steps they took to minimize bias (pp. 6-7). Much of this detail has been left out of the student version of the paper.

c) Methods of analysis are described (p. 7). Only the basic calculation of percent change in abundance is described in the student version of the paper. The analysis for statistical significance is not described in the student version, nor were the factors included (impact, location, and impact-location).

4) Results (pp. 6-9)
In the student version of the paper, this section is condensed and combined with the discussion section, primarily because so many of the results had to do with analyses not covered in the student paper.

5) Discussion (pp. 9-13)
In this paper, the discussion of results has four sections:
-Evaluation of assumptions (see table above)
-Magnitude of impacts (eliminated from the student version)
-Indirect effects (eliminated from the student version)
-Implications for fishery management

6) Acknowledgments (p. 13)

7) References
References in the student version have been modified based on editing the original.

8) Tables and figures
Only some of the tables from the original paper are in the student version.

Teacher Version
Questions About the Reading

Answer the following questions. Attach additional sheets if necessary.

1) What was the purpose of the study?

> To examine the effects of aquarium collecting on reef fish populations in Hawai'i

2) Why did the researchers choose to survey both fish species that are commonly collected for the aquarium trade and those that are not?

> Each nontargeted fish species was chosen because its habitat and food type are similar to one or more targeted species. These nontarget species provided a base of comparison that helped researchers determine whether the changes in population were related to aquarium collecting.

3) Explain what the "impact" sites were and what the "control" sites were and why they are important in this study.

> The impact sites were areas with high levels of aquarium collecting. The control sites were adjacent to impact sites, in areas where aquarium collecting is prohibited. Researchers could estimate the magnitude of impact by comparing population density and changes in population density at sites where aquarium collecting occurs and where it does not.

4) The researchers were interested in determining how much difference there was between fish abundance at the control and impact sites. They determined the mean density of fish at each of the sites. Then they calculated a percent change in fish abundance for each species, and for each species at each of the two study sites.

A negative percent change indicates fewer fish at the impact relative to the control site, while a positive value indicates the opposite pattern.

Species	Mean overall percent change
Aquarium fishes	
Achilles tang (*Acanthurus achilles*)	-57.1
Potter's angelfish (*Centropyge potteri*)	-46.1
Multi-band butterflyfish (*Chaetodon multicinctus*)	-38.2
Ornate butterflyfish (*Chaetodon ornatissimus*)	-39.5
Four-spot butterflyfish (*Chaetodon quadrimaculatus*)	-41.6
Goldring surgeonfish (*Ctenochaetus strigosus*)	-14.7
Longnose butterflyfish (*Forcipiger* spp.)	-54.2
Orangespine unicornfish (*Naso lituratus*)	31.2
Moorish idol (*Zanclus cornutus*)	-46.5
Yellow tang (*Zebrasoma flavescens*)	-47.3
Non-Aquarium Species	
Brown surgeonfish (*Acanthurus nigrofuscus*)	27.3
Blueline surgeonfish (*Acanthurus nigroris*)	67.2
Convict surgeonfish or tang (*Acanthurus triostegus*)	-4.3
Oval butterflyfish (*Chaetodon lunulatus*)	-70.0
Arc-eye hawkfish (*Paracirrhites arcatus*)	-36.4
Blackside hawkfish (*Paracirrhites forsteri*)	58.4
Blue-eye damsel (*Plectroglyphidodon johnstonianus*)	-31.3
Pacific gregory (*Stegastes fasciolatus*)	326.0
Saddle wrasse (*Thalassoma duperrey*)	17.4

4a) Which three species show the greatest difference between the number of individuals at control sites and impact sites? For each species, identify whether this difference indicates that there are fewer individuals at the control sites or the impact sites.

Pacific gregory *(Stegastes fasciolatus)* — fewer at control sites

Oval butterflyfish *(Chaetodon lunulatus)* — fewer at impact sites

Blueline surgeonfish *(Acanthurus nigroris)* — fewer at control sites

4b) Which four species show the greatest negative mean percent change—indicating fewer individuals at the impact sites relative to the control sites? Discuss the possible significance of these results based on whether these species are collected for the aquarium trade or not.

> Oval butterflyfish (*Chaetodon lunulatus*)
> Achilles tang (*Acanthurus achilles*)
> Longnose butterflyfish (*Forcipiger spp.*)
> Yellow tang (*Zebrasoma flavescens*)
>
> Three of the four species are targeted by aquarium collectors. This probably indicates that aquarium collection, which occurs at the impact sites and not the control sites, decreases fish populations.

5) What patterns do you notice when you compare the aquarium species with the non-aquarium species, looking at whether the percent change is negative or positive? What do these patterns suggest about the impact of aquarium collecting?

> All but one of the aquarium species show a negative percent change, while the results are mixed among non-aquarium species (three negative and four positive). This result suggests that aquarium collecting decreases populations of target species and that other factors might also have come into play (because of the mixed results among the non-aquarium species).

6) The experimental design that the researchers selected for this study makes two major assumptions:
   a) The study began after aquarium fish collecting had already started in the impact areas. Therefore, the design assumes that the natural abundance of aquarium fishes at the control and impact sites were similar prior to the onset of aquarium collection.
   b) The design assumes that all differences between the paired control and impact sites were due to aquarium fish collecting and not other factors, such as fishing.

Choose one of these assumptions and think of a way that the researchers could — or did — build into the study a way to test whether the assumption seems valid.

> There are many correct responses to this question, which should be evaluated based on student reasoning, as well as references back to the study:

a) One way the researchers controlled for the first assumption was to select control and impact sites that are close together, to lessen the likelihood of spatial variation. They also used a combination of nontarget species that were ecologically similar to target species, and other species that were indicators of particular habitats, as indicators of the ecological similarity of the control and impact sites.

Other ways of assessing the correctness of this assumption include comparing control and impact sites for factors such as species diversity and richness, and comparing the habitats by looking at coral and algae abundance and diversity, and non-living substratum composition.

b) One way to control for the second assumption is to select sites that are largely inaccessible from shore, to minimize the impact of shore-based recreational fishing. (The authors did this in the aquarium collecting study, but that may not be clear from the student background reading.)

Other ways of testing the assumption include looking at density variation in target and nontarget species that are subject to commercial and recreational fishing. If the density of nontarget species that are fished for does not vary between control and impact sites, this suggests that fishing impacts are not significant.

Another factor that could differentially affect reef fish populations could be the presence of predator fishes. Including predator fishes in the surveys would help determine whether this factor does influence reef fish populations.

7) Some people say that aquarium collecting is not a problem on Maui, while others believe that it is a problem in some areas or could quickly become one. Write one paragraph about what you would do to find out whether aquarium collecting is a threat to Maui reef animals. Write another paragraph about what you think should be done, if anything, to protect Maui reef fish populations from the impacts of collecting.

Well-reasoned responses are acceptable.