# A STUDY OF THE RELATIONSHIP BETWEEN CONSERVATION EDUCATION AND SCUBA DIVER BEHAVIOR IN THE FLOWER GARDEN BANKS NATIONAL MARINE SANCTUARY

A Dissertation

by

JULIA BELKNAP

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2008

Major Subject: Recreation, Park and Tourism Sciences

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Approved by:

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December 2008

Major Subject: Recreation, Park and Tourism Sciences

# ABSTRACT

A Study of the Relationship between Conservation Education and Scuba Diver Behavior in the Flower Garden Banks National Marine Sanctuary. (December 2008)

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Scuba diver impacts on coral reefs are causing many threats to reefs. One solution is to change divers' behaviors through on-site environmental education. The Flower Garden Banks National Marine Sanctuary developed an education program in an effort to achieve this goal. The purpose of this study was to describe the education program, understand how it affected divers' knowledge of and value orientation toward coral reefs, and examine two teaching approaches conducted in a recreation/tourism setting.

Two theories were tested in this study. Orams' model was used to develop the "Naturalist Onboard" program and describe how the model played out in a diver education situation. The work Bransford's team did was tested to see how their teaching approach works in a recreation/tourism setting.

Evaluating this program was achieved through pre- and post-questionnaires, participant observation and semi-structured interviews. They were used in the first article to provide a description of how Orams' model played out in the real world. In the

second article they were used to determine: 1) the value orientation of the divers, 2) how much knowledge divers gained via participation in this program, 3) the relationship between value orientation and knowledge gained, and 4) the degree their value orientations affect knowledge acquisition. In the final article they were used to see how two teaching approaches affected divers' knowledge and value orientations about coral reefs, and how the divers responded to the two approaches.

The program aroused divers' curiosity, engaged their emotions, and motivated them to minimize their impacts while visiting the coral reef. However, suggestions for making changes in their behavior at home were not received well. Most divers had a "biocentric" value orientation and gained a significant amount of knowledge. These divers were also more open to learning and changing their behaviors. There was no significant difference between the two approaches regarding the divers' knowledge and value orientation. This may be due to validity threats. Due to time constraints and divers' lack of interest in actively acquiring knowledge, the constructivist teaching approach did not work well in this setting.

# ACKNOWLEDGEMENTS

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Thanks also go to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience. Finally, and most especially, thanks to my family for their encouragement, patience, and love.

# NOMENCLATURE

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| FGB | Flower Garden Banks National Marine Sanctuary |
| NOAA | National Oceanic and Atmospheric Administration |

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# CHAPTER I

# INTRODUCTION

## 1.1 Objectives

One of the primary conservation education programs the Flower Garden Banks NMS (FGB) operates is called the "Naturalist Onboard" program, which runs on weekend trips throughout the summer and early fall dive season. The goal of this program is to get scuba divers who visit the Sanctuary to develop a sense of ownership and stewardship toward the FGB. Before 2006, scuba divers who volunteered to be the Naturalists learned how to identify the most common fish species, were given some reference materials, and then went out on the weekend trips to share their knowledge with the other divers. There was no structure to this program so each Naturalist did what they were comfortable with; some Naturalists doing more than others. Most of the Naturalists announced their presence during the orientation session on the way out to FGB and then answered any questions that were posed to them throughout the weekend.

In 2006, the education coordinator decided to upgrade the program so that it would have two aspects to it. The first aspect, which was very popular with the divers, would continue to meet the divers' need for help with identifying fish and other fauna species they saw during their dives. Because each diver's query is unique, helping the divers is best done on an individual basis. Thus, the Naturalists' job was to be available

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This dissertation follows the style of *The Journal of Environmental Education.*

at all times to help with species identification. Divers often approached the Naturalists for help as they got out of their gear from a dive, during meals, and any other time they found the Naturalist free to help them.

The second aspect, which is the new part of this program, was more formal. In addition to helping divers identify species, the Naturalists held 20-30 minute "sessions" in the salon to cover material that discusses risks to the coral reef, such as teaching their fellow divers about FGB, coral reef ecology, as well as direct and indirect human impacts on corals. The education coordinator's goal for this part of the program was to encourage divers to act on what they learn and voluntarily do what they can to minimize their impacts on coral reefs.

In 2006, during the orientation on the way out to FGB, the captains and divemasters stressed appropriate diver etiquette and the fact that this sanctuary has a "no touch, no take" policy. For the rest of the trip, they focused on the divers' wellbeing. The Naturalists' took over the education of the divers for the rest of the trip through helping individual divers with species identification and holding sessions on risks to the coral reef.

The overarching question, from the education coordinator's perspective, was to determine the effectiveness of this new part of the program in providing knowledge and changing divers' value orientation so they would voluntarily want to do what they could to minimize their impact on the coral reefs. From my perspective, I wanted to use two

theories to help elucidate the Naturalist Onboard program. The first theory is Orams' (1996 and 1997) "Features of an Effective Education/Interpretation Programme" model. The second theory is Bransford et al.'s (2000) work based on how people learn.

Orams' (1996 and 1997) model was used to provide the framework for developing the new "Naturalist Onboard" program because it contains both cognitive and affective elements when teaching. It also has elements to encourage scuba divers to act on what they learn, which is FGB's goal. This model also provided me with a framework I could use to describe the interactions between the Naturalists and the divers as well as provide a context for the study's results.

It was important to the education coordinator to have a clear idea what the divers knew, how much knowledge they gained, what their value orientation was, and whether these factors resulted in divers voluntarily doing what they could to minimize their impacts on the coral reefs. I was interested in seeing if there was an association between a diver's value orientation and how much knowledge that diver gained; namely to see if value orientation affected the acquisition of issue-relevant knowledge. Vaske and Donnelly's (1999) study, "A Value-Attitude-Behavior Model Predicting Wildland Preservation Voting Intentions," provided a nice framework for determining the divers' value orientation, which is achieved by asking them about their basic beliefs.

Ground breaking neuro-cognitive research done in the 1990s led the National Research Council to request Bransford et al. (2000) to synthesize this research with education's constructivist paradigm and create a learning model based on how people learn. This model is being used in the classroom. However, the classroom is not the only

place where environmental education occurs. So, I wanted to test this model in a non-formal education situation and see if this model can work outside of the classroom. The education coordinator and I worked together to develop two teaching approaches for the program, traditional and constructivist, and train the Naturalists in one of these approaches; half of them learning the constructivist approach and half of them learning the traditional approach. The goal was for me to observe the Naturalists using the teaching approach they had been trained to use.

I observed eight Naturalists on ten weekend trips from July through October 2006. Both qualitative, participant observation and semi-structured interviews, and quantitative, pre- and post-questionnaires, data was collected to determine: 1) the interactions between the Naturalists and the divers, 2) to what degree divers gained new knowledge, 3) the divers' value orientation and to what degree it shifted after participating in the program, 4) whether there is a correlation between value orientation and knowledge acquisition, and 5) how well Bransford et al.'s theory works outside the classroom.

**1.2 Study Area**

The Flower Garden Banks (FGB) are comprised of three coral reef beds located in the northwestern part of the Gulf of Mexico approximately 70-115 miles off the Texas and Louisiana coast (Figure 1). These coral reefs, having developed on salt domes, are the most northern reefs in the United States. There are about 23 hard coral species that have settled on the salt domes and form the basis for the ecosystem with sponges

interspersed among them. The reef platform goes from 53 feet deep to below 150 feet. There are approximately 300 fish and 300 invertebrate species that live among the corals.

Figure 1: Location of Flower Garden Banks NMS

These reefs were originally discovered by fishermen in the late 1800's when they snagged and brought to the surface brightly colored sponges, plants, and other marine life in the area. Continued interest in the biological diversity and beauty of the reefs led to them being added to the National Marine Sanctuary system, which is administered by the National Oceanic and Atmospheric Administration (NOAA); East and West Bank in

1992, and Stetson Bank in 1996. These reefs are considered to be in excellent health (Turgeon et al., 2002) even though they were hit hard by a disease outbreak, bleaching event and a close encounter with Hurricane Rita all in 2005. Fortunately, the reef has since recovered and was almost back to its previous level of health in 2006 (http://flowergarden.noaa.gov).

Recreational scuba diving is very popular at the FGB. Given the distance from shore, live-aboard charter dive vessels take divers out to the FGB on two-day and three-day trips to the Sanctuary during the dive season. It is estimated that 2,500 to 3,500 divers visit the Sanctuary each year (http://flowergarden.noaa.gov). Due to the sanctuary's remote location and the lack of resources, maintaining a physical presence on-site at the FGB for enforcement purposes is difficult. As a result, FGB relies on indirect management techniques to safeguard the sanctuary. The FGB uses an integrated research-and-education approach to manage and protect this natural resource. Research is used to provide the information needed for making decisions regarding the protection of the resource, and education and outreach are used as the conduits for getting information to the public (http://flowergarden.noaa.gov).

Because education is FGB's major management tool, the education coordinator wants to reach as many divers as possible. A good way to reach these divers is to educate them where they congregate; namely onboard the dive boats. Consequently, the Naturalist Onboard program is an important program to FGB, in spite of its costs, because it reaches a significant portion of the people who visit the coral reefs. Also, the education coordinator hopes this program will help to bring more divers to FGB to

explore the Sanctuary, learn more about it, and develop a sense of stewardship for the coral reefs.

### 1.3 Significance of the Study

Collectively, this research provides a clearer picture of the interactions between the Naturalists and divers, what value orientation the divers hold and the knowledge they have before the program, as well as how much knowledge the divers gained and the degree to which their value orientation changed. Additionally, this research explores whether Bransford et al.'s (2000) work is suitable for a non-formal education setting such as that found onboard a scuba diving boat.

Orams' (1996 and1997) model includes components for incorporating both the divers' intellect as well as their emotions. It also includes components for motivating them and providing opportunities to act on what they learn. Consequently, it provided the overall framework for developing and implementing the new education program. The results of this research show that this model is a useful tool for developing a non-formal education program although the motivation and opportunities to act part of the model proved troublesome to implement.

Vaske and Donnelly's (1999) study provided the framework for determining the divers' value orientation. This information as well as knowledge gained was used to see if there is an association between value orientations and the acquisition of issue-relevant knowledge. The result of this research found that there is a small association.

Finally, Bransford et al.'s (2000) model was tested to see if it is appropriate to implement the constructivist teaching approach in nonformal education settings. Due to threats to validity, such as having no control over the Naturalists' and divers' actions as well as time and space constraints, the questionnaire results were inconclusive. Consequently, threats to reliability come from the questionnaires being inadequate and/or inappropriate instruments for measuring the difference between the two teaching approaches. However, my observations found that the divers were not interested in actively searching for new knowledge, which is a foundational premise of the constructivist approach. As such, it appears that the constructivist approach is not the best approach to use in this non-formal setting. Future research could explore whether other components of Bransford et al.'s (2000) work can be effective in this educational setting. One major component is learning with understanding, which is making sure that information students acquire are connected together and centered around core concepts thus enabling them to understand a body of knowledge.

### 1.4 Limitations of the Study

The biggest limitation of this study is the fact that FGB is a unique diving experience due to several reasons. First, the coral reefs' distance from shore helps to reduce the number of people who visit them, which has helped to keep these reefs healthy. Second, the coral formations are fairly deep so all of the dives are considered to be deep dives. Third, the Gulf of Mexico's currents can change direction and velocity quickly, which makes it more challenging for divers to pace themselves and not get lost.

Finally, there is no divemaster who takes all of the divers in one group and guides them around the coral reefs. Instead, divers go down to the reef in pairs or in teams of three and dive independently of everyone else. Consequently, the results found here may not be applicable to the wider diving population.

Another limitation is the diver sample; namely, I did not pick the people who participated in the program. I had no control over diver assignment because the divers booked their berths through various dive shops who had already signed up for a particular boat. Also, diver participation in the program was strictly voluntary so divers were free to participate in as many or as few sessions as they wanted. Consequently the sample for this study was a convenience, self-selection sample.

Having no control over how the Naturalists conducted their sessions was another limitation. The last limitation comes from the fact that I did not collect any data on changes in divers' behavior. I did not collect this data because I did not have the time or funding to establish a baseline of diving behavior by observing divers' diving behavior during a previous diving season so any observations I made during 2006 could be compared to see if there was a change in behavior.

### 1.5 Organization of the Dissertation

The overall format for the content of this dissertation is three articles. The first article, Chapter II, is a case study of what I observed as well as an evaluation of how well Oram's (1996 and 1997) model works in reality. The second article, Chapter III, looks at the divers' value orientation, their knowledge, and explores whether a diver's

value orientation influences his or her knowledge acquisition. The third article, Chapter IV, looks at the two teaching approaches and explores whether Bransford et al.'s (2000) theory is more effective than the traditional approach in a recreation/tourism setting. The last chapter is a summary of this dissertation, recommendations for improving the Naturalist Onboard program, and my final conclusions.

# CHAPTER II

# A CASE STUDY OF SCUBA DIVERS AT FGB

## 2.1 Introduction

The FGB are coral reefs in the northern part of the Gulf of Mexico that were originally discovered by fishermen in the late 1800's when they snagged and brought to the surface brightly colored sponges, plants, and other marine life in the area. Continued interest in the biological diversity and beauty of the reefs led to them being added to the National Marine Sanctuary system, which is administered by the National Oceanic and Atmospheric Administration (NOAA); East and West Bank in 1992, and Stetson Bank in 1996. Due to the sanctuary's remote location and the lack of resources, maintaining a physical presence on-site at the FGB for enforcement purposes is difficult. As a result, FGB relies on indirect management techniques to safeguard the sanctuary. The FGB uses an integrated research-and-education approach to manage and protect this natural resource. Research is used to provide the information needed for making decisions regarding the protection of the resource, and education and outreach are used as the conduits for getting information to the public (http://flowergarden.noaa.gov).

The goal of FGB's education coordinator is to get scuba divers to voluntarily do what they can to minimize negative human impacts on coral reefs; both while diving at FGB and while at home. The education coordinator has found the best way to accomplish this is to get divers to feel a sense of ownership, become emotionally attached to the FGB, as well as learn how people impact coral reefs. Because the divers

can do up to five dives per day, there are plenty of opportunities for them to minimize their impacts while on the reef, which is the Sanctuary's goal. However, the education coordinator also wants to teach the divers how to minimize their impacts while at home because indirect impacts are doing as much if not more damage to FGB than direct impacts. There is no way to monitor or control people's behavior while on land, so getting divers to actively desire to preserve the reefs is the only way the education coordinator can get them to help minimize indirect impacts.

With these objectives in mind, the education coordinator wanted to use an environmental or conservation education model developed for non-formal settings to help devise an effective education program for FGB. Ideally the program will engage the divers' curiosity and emotions, and provide them with opportunities to act on what they are learning; namely to behave in a more environmentally responsible way. One model that incorporates the intellect, emotions, and opportunities to act is Orams' (1996 and 1997) model, which is called "Features of an Effective Education/Interpretation Programme" and has been published in the journals of Journal of Sustainable Tourism (1996) and Progress in Tourism and Hospitality Research (1997). This model provides a promising framework for achieving the education coordinator's goals because its main message is that for an education/interpretation program to be effective it must incorporate both the cognitive and affective domains (Orams 1996 and 1997) as well as provide participants with opportunities to act so "effective behavior change can be prompted 'on the spot'" (Orams 1996: 90 and 1997:298). By doing so, there is a greater probability that participants will be more likely to behave in an environmentally

responsible way (Orams 1997). Consequently, it was used to develop a conservation education program that runs on weekends throughout the summer diving season at FGB.

I am a PhD. student in the Recreation, Park and Tourism Sciences department at Texas A&M University. My area of study is marine tourism with an emphasis on conserving natural resources so my coursework focused on ecotourism and environmental education. The FGB education coordinator and I became acquainted when we took a class together. She told me that she wanted to improve her "Naturalist Onboard" program and asked if I would be interested in evaluating it for her. I agreed. So the purpose of this study is to evaluate this education program using two theoretical frameworks to help with the evaluation. This paper is the case study of my fieldwork and describes what I observed in the field.

## 2.2 Literature Review

Orams' (1996 and 1997) model (Figure 2) has five main features that can be effective in prompting behavior change in a tourism setting. They are curiosity, the affective domain, creating motivation to act, giving opportunities to act, and assessment and feedback. According to Orams (1996 and 1997), *curiosity* is creating questions in people's minds. Namely, the program needs to arouse curiosity and get people thinking about the subject matter. The *affective domain* is concerned with people's emotions. When people's emotions are invoked, the program's messages are more effectively internalized and thus are more likely to be acted upon. *Creating motivation to act* is when the program presents solutions and actions that can be taken to reduce impacts.

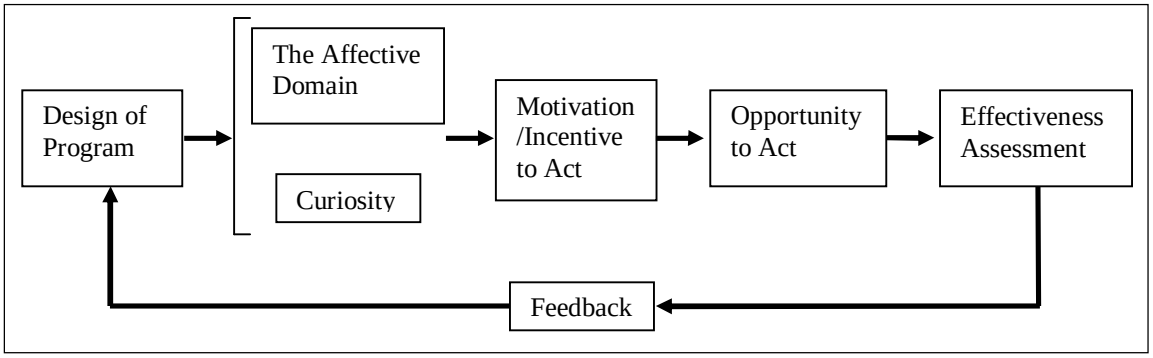


Figure 2: Effective Education/Interpretation Program for Tourists Model (Orams 1996 and 1997)

Orams notes that the program needs to personalize the overall message. *Giving opportunities to act* is when the program actually provides immediate opportunities to take action. Orams (1997:298) states, "By providing opportunities for participants to take action, effective behavior change can be prompted 'on the spot'." *Evaluation and feedback* is an assessment of the program and is important because it allows for future planning and refinement of the program (Orams 1997).

In order to gain a clearer perspective of the divers' feelings about coral reefs and the need to preserve them, I chose to use Vaske and Donnelly's (1999) work to provide a way for me to determine how a diver values coral reefs and thus anticipate how they will probably behave in the future. This research study focused on determining the divers' value orientation, which is defined as: "complex but definitely patterned principles, resulting from the transactional elements of the evaluative process – the cognitive, the affective, and the direct elements – which give order and direction to the ever-flowing stream of human acts and thought as these relate to the solution of 'common human' problems" (Kluckhohn and Strodtbeck 1961 p. 4). With regard to natural resources,

these value orientations can be arrayed along a continuum ranging from anthropocentric (a human-centered, utilitarian view of the nonhuman world) to biocentric (a nature-centered view of the nonhuman world). Attitudes about specific concepts or objects arise out of the value orientations and have been shown to be predictors of specific behaviors by helping to determine behavioral intentions, which is an important component of Orams' (1996 and 1997) model.

Orams' (1996 and 1997) model's importance comes from the combination of engaging the divers' curiosity and emotions as well as providing incentives and opportunities for the divers to behave in a more environmentally responsible way. The purpose of this paper is to describe the education program and how the components or features of this model actually play out in the real world. While using questionnaires to measure outcomes are useful tools for researchers, they are limited in the information they provide. There is a need to attain a deeper understanding of how tourists, in this instance scuba divers, respond to an education program. Thus, I used ethnographic data to understand how this model plays out in the real world.

In the following sections, I will provide the background, setting, and methods used to give a context for the observations noted for the components of the model. Then I will describe how each component of the model, beginning with curiosity and ending with evaluation and feedback, really worked with the divers. I will include ethnographic evaluations of the following questions: 1) Were the Naturalists able to grab the divers' curiosity and engage their emotions? If so, then how? 2) When the Naturalists discussed how the divers could behave more environmentally responsibly, were the divers

motivated to change their behavior? How did they respond? 3) What particular aspects of the program engaged divers the most? or What aspect of the program got the strongest response from the divers? Lastly, I will present some conclusions about the effectiveness of this model.

## 2.3 Methods

To gain an understanding of the education coordinator's goals and the education programs she runs, I did a series of in-depth interviews with her. Her goal was to develop an education program for scuba divers that promotes a sense of ownership and stewardship of the FGB so that they will minimize their impacts on the coral reef while diving and while living at home. Given that before 2006 the Naturalist Onboard program was not organized, she wanted to make the program more structured so the Naturalists can educate the divers about the Sanctuary, coral reef ecosystems, and help with species identification. Once I gained that understanding, she and I then worked together to develop a conservation education curriculum for her Naturalist on Board program. As part of that work, I also did in-depth interviews with the Naturalists and observed their training.

When I did my preliminary observations in 2005, I saw that the Naturalists acted like they were a regular diver who had resources and knowledge to help with species identification. One Naturalist spent the whole weekend answering divers' questions when they approached; often as part of normal conversations during meals or cleaning gear. In addition to answering divers' questions when they approached, the other

Naturalist I observed tried to gather divers together just before a dive briefing to talk about what they could expect to see below. Up to this point, the program had never been evaluated. It was not known what kind of information, how much of it was imparted, or how many divers wanted to learn more about the coral reefs and/or learn how to minimize their impacts. Based on Orams' (1996 and 1997) model, several important considerations were also unknown: 1) whether divers' curiosity was engaged, 2) whether their emotions were involved and 3) whether they were motivated to behave more environmentally responsibly.

In order to assess whether the divers' curiosity was aroused and emotions were involved, and they were motivated to minimize their impacts on the coral reefs, I operationalized these key constructs in the following ways. Given the voluntary nature of the program, determining whether divers were 'into learning' in general was based on whether or not they showed up to the sessions. Determining whether their curiosity was aroused was based on whether they were asking the Naturalist questions during the sessions and actively participated in the session discussions as well as whether they spent time outside of the sessions asking the Naturalists questions. Behavior I looked for to indicate the divers' curiosity was not aroused include fidgeting, not looking at the Naturalist, tuning out during the discussions, and signs of boredom or impatience.

The emotions the program was hoping bring out in the divers include awe, a sense of wonder, and arousing a desire to preserve the coral reefs. Deciding whether the divers' emotions were involved was based on divers' exclamations expressing these emotions made during the sessions as well as comments made on the post-questionnaires

and during the interviews. Motivations to behave more environmentally responsibly also came from divers' comments made during the sessions and interviews, and on the post-questionnaires. I looked for phrases such as: "I want to," "I plan to," "I will," and "I have to."

Throughout each trip, I took notes on what I observed. Outside of the Naturalists' sessions, I took general notes on what was going on around me and the interactions I could see between the divers and the Naturalists. Because I was focused on these interactions, I do not have notes for what went on in other parts of the boats. However, by the end of the ten weekends, I gained a general sense of what other divers were doing such as taking naps, downloading pictures from their dives, reading books, and/or talking with friends on the upper deck. During the sessions, I used a time allocation method to record in greater detail what the Naturalists did and how they interacted with the divers. The time allocation method measures the behavioral "output" of decisions, values, attitudes and emotions by providing a microscopically detailed behavioral record. This is done by recording the amount of time a subject engages in an activity (Gross 1984). During the session, I continuously recorded the Naturalists' and divers' actions and noted the time at each instance of activity change. In addition, as a participant on a scuba diving boat, I dove with the Naturalists and divers.

The post-questionnaires were handed out to the divers after the last session was finished on Sunday morning. The last section of the post-questionnaire asked the divers to evaluate the program and was composed of both close-ended and open-ended questions. The comments the divers made in the open-ended questions were used to help

determine whether the program aroused the divers' curiosity, engaged their emotions, and motivated them to minimize their impacts on coral reefs. I also conducted semi-structured interviews with twelve divers who had participated in the program on the trip back to port after the program was finished. The interviews were fifteen to thirty minutes long and focused on the divers' evaluation of the education program; asking the same questions as on the post-questionnaire. Because the interview format was fairly straightforward and the boats' engines made it very difficult to hear a taped conversation, I did not tape the interviews and relied on my notes of the divers' responses.

While there were approximately 525 scuba divers who went on weekend trips that had a Naturalist onboard in 2006, they are not this study's population. The population for this study is comprised of the scuba divers who participated in the Naturalist Onboard program. There were 13 weekends when a Naturalist was onboard in 2006. However, data was collected on ten weekends from July 2006 through October 2006. A total of 453 divers went out to FGB on those ten weekends. One-hundred-sixty-six (166) divers filled out pre- and/or post-questionnaires, which were administered by the Naturalists. This is 37 percent of the total divers on those ten weekends. Extrapolating these numbers, I estimate that the total population for this study was approximately 195 divers.

The sample for this study was a convenience sample. There were two factors that made this type of sample the only option. First, the divers booked their berths through various dive shops who had signed up for a particular boat before the diving season

began. Second, the divers self-selected themselves to participate in the program. Consequently, I had no control over diver assignment. In order to minimize the dangers of this sample type, I made the sample size as large as possible. Approximately 100 divers participated in the sessions when I took observation notes. This is almost half of the study's population. One-hundred-eighteen (118) divers filled out the evaluation section of the post-questionnaire for the ethnographic part of this study. This represents 60.5 percent of the population. Finally, I interviewed twelve divers who had participated in the program, which is six percent of the population.

Given that participation in this program was voluntary, the divers were free to participate in as many or as few sessions as they wanted. Consequently, on eleven out of fifteen weekends, there were fewer divers who filled out the post-questionnaire and than those who filled out the pre-questionnaire. This raises the question of why some people chose to not participate in parts of the program. I postulate there are three reasons. The first, and foremost, reason is due to fatigue. The fatigue begins with the short night's sleep on Friday night after a long day at work. In addition, the dives themselves are physically challenging because of the number of dives (five on Saturday and two on Sunday), all dives are deep dives, and many times there is a current the divers have to swim against. Consequently, divers often took naps in between dives. Another reason is divers who took pictures during their dives wanted to download them onto their computers and edit them before the next dive. The third reason is the divers lost interest or decided they would rather spend time talking with their friends or read a book, work on a suntan, or work on their gear on the back deck.

I am sure my presence had some impact on the divers but I feel that it was minimal for three reasons. First, the demographic data collected from the pre-questionnaires revealed the diver population was predominantly white and 76 percent of them had at least a Bachelor's degree and 39 percent had an advanced degree. As a result, my race and education matched most of the divers. In addition, I scuba dived the reefs with them, so I fit in with the culture on the boats. Second, aside from the questionnaires, the only tools I used to collect data were a stenographer's pad, a pen, and a watch. Consequently, I could sit in the back of the salons and observe the interactions between the Naturalists and the divers without the divers being consciously aware of my presence. Finally, some people noticed what I was doing and briefly asked me about my research after which they paid little attention to what I was doing.

## 2.4 Data Interpretation

### *2.4.1 Curiosity/Cognitive Domain*

Arousing scuba divers' curiosity can be done in two ways. One way is to allow divers to experience an exciting, new phenomenon, such as a beautiful coral reef. This experience creates questions in their minds about what they had just observed and a desire to learn. This "teachable moment" is the Naturalists' opportunity to respond by providing the desired information (Forestell and Kaufman 1990). For the other way, the Naturalist creates questions in divers' minds by asking interesting questions that get them to think (Orams 1997).

This education program used both ways to arouse divers' curiosity. The primary way was to allow the divers to experience the coral reefs first and then answer questions that popped up from their diving experience. This way was used the most because the scuba divers were diving into an alien world that is full of life and vivid colors. The FGB coral reefs are healthy so there is a lot to see. Even though there are only 23 types of coral and sponges, there are hundreds of fish and invertebrate species for the divers to observe and interact with. On Stetson Bank in particular, there is so much food available that the fish tend to be huge for their species. For example, the angel fish often are the size of dinner plates. With this sensual feast before them, the divers often came onboard after almost every dive excited about what they saw.

In the sessions, the Naturalists took advantage of this phenomenon by asking open ended questions about what the divers saw during their dive. The divers responded by talking about things they saw and often concluded by asking, "What was it I saw?" or "What was going on?" The Naturalists in turn answered their questions. For example, many divers were concerned about coral bleaching and wanted to know what it looks like and how or why it happens. They talked about patches they saw that they thought were bleached coral but were not sure that it was bleached coral. So the Naturalists pulled out photographs of bleached coral and talked about the particular locations of bleached coral below. Then the Naturalist would go on to explain how corals function and why bleaching can occur. Other examples include coral mounds being eaten away by fish, explaining how cleaning stations work and how to recognize a nursery.

By beginning the sessions with the divers asking their questions, the Naturalists were able to keep them engaged and actively participating in the session discussions. The divers appreciated learning about the coral reefs this way as can be seen in many of their comments when they were asked what they liked best about the program. Typical comments include: “asking questions,” “being able to ask a knowledgeable person about the reefs,” “having the Naturalist available to answer questions and provide information,” “the personal interaction with the Naturalist [allowed] the information presented [to be] tailored to the requestor,” and “the exchange of information and opinions.”

At other times, the Naturalists would introduce a topic such as human impacts on the reef. One way they did this was to ask the divers if they had noticed a phenomenon while diving and ask them to postulate why the phenomenon had occurred. Opening questions included asking if the divers had seen any anchors or steel cable lying on the reef, or if they had seen any white patches in the coral. One weekend, the Naturalist I was observing brought out some samples of different kinds of coral skeletons and encouraged the divers to handle and explore them. The Naturalists then asked the divers to guess what had happened and why the coral responded as it did. This led to a discussion about the fragility of corals and how they are affected by various human impacts.

Most of the Naturalists talked about direct impacts on the reef and how divers can minimize their impact while diving. Some of the Naturalists managed to also talk about indirect human impacts. They had slides and pictures of the watersheds (most

notably the Mississippi River watershed which drains most of the area between the Rocky Mountains and the Appalachian Mountains) that impact the FGB coral reefs and talked about how human activities while on land also impact the reefs. Most of the divers knew about the direct impacts but did not know about the indirect impacts. And learning about these impacts often made a big impression on them.

Arousing the divers' curiosity this way was also appreciated by the divers as can be seen in their comments when they were asked what they liked best about the program. Typical comments include: "the way the presentations let you dive with a focus and purpose," "honing the ability to better understand what was going on on the reef before we saw it," "informative slides and presentations," "the Naturalist knew a lot of information about ecosystems and s/he was very willing to share it with everybody," and "it was easily understood and addressed issues that I was not aware of." However, there were times when I observed some divers fidgeting, not looking at the Naturalist, or tuning out for short periods time during the presentations when the Naturalist was talking about something they were not interested in.

When asked if the education program changed their knowledge about coral reefs, many divers said, "Yes," and continued with comments like these: "I learned a lot. Especially how nice the FGB is and how important it is," "It increased my knowledge about coral reefs and their biodiversity," and "It was nice to understand how the systems are being impacted." There were other divers who said, "Not really. But then with my marine biology background, I wouldn't expect to," "Not a lot. I'm in a club that gets a

lot of speakers about coral reefs," "Not really. I've done a lot of diving," and "I had a lot of knowledge before coming on these trips but I always pick up something more."

Arousing the divers' curiosity was easy to do. The primary way the Naturalists did so was to answer the questions scuba divers' had from their diving experiences in a beautiful alien world. The Naturalists often used the second way to introduce the topic of human impacts on coral reefs. For the most part, the presentations were successful in arousing the divers' curiosity but there were times when some divers showed signs of boredom and impatience. Visiting the coral reef got the divers thinking about what they saw and created a desire to understand their observations, which made them receptive to learning more about the coral reef. The divers appreciated having the Naturalist Onboard program while they were diving as can be seen in these comments: "It gives the dive a meaning. Otherwise, all you're doing is looking at pretty fish and not learning about what you see and why you do what you do. It took recreation into education and that is an excellent thing," "That it actually occurred where people are willing to listen and participate and [it helped] having it on the dive boat [which] puts the program in the right place," and "I've never heard of any program like this anywhere. It's a definite plus because your head is in the game right now. It's the right time to do a program like this because people will give their most undivided attention while on the dive trip."

### *2.4.2 Affective Domain*

In order to engage visitors emotions and value systems, or their affective domain, instructors or interpreters in the recreation and tourism fields typically connect their

topic to fundamental human experiences and values such as family, birth, death, love, awe, wonder, etc. (e.g. Beck and Cable, 2002:21-25; Tilden, 1977:13-14). The emotions the FGB's education coordinator chose to appeal to was the divers' sense of awe and wonder from scuba diving these reefs, and arousing a desire to preserve the coral reefs.

The sense of awe and wonder happened quite naturally from scuba diving these healthy reefs. Repeatedly, I observed divers coming back onboard after a dive with smiles on their faces and talking animatedly with each other about the incredible things they saw and experienced below. Examples include: 1) a large school of creole fish that did not swim away when divers swam slowly into their midst, 2) seeing a large manta ray eat a fish just twenty to forty feet away, 3) sighting silky sharks, southern rays, and large rock lobsters, and 4) the larger than normal sized fish found at Stetson Bank.

The education coordinator decided to arouse the divers' desire to preserve coral reefs by educating them about coral reef ecology and human impacts on them; the hypothesis being that increased knowledge about coral reefs' fragility and their importance to the fauna in the ecosystem leads to increased concern for coral reefs and a desire to preserve them. Consequently, the Naturalists talked about the coral reef's ecology and how outside influences, namely humans, impact it. For example, many divers did not know that hard corals are made of both plant and animal, and that it is the algae living in the coral that gives it its color. Two divers in particular said, "I didn't know coral was an actual critter. I thought it was just a formation." Once they knew corals are alive (not inanimate) and delicate, the divers could appreciate and understand the need to keep off the coral. This knowledge also allowed them to understand how and

why coral bleaching occurs as well as its impact on the rest of the coral reef community; especially the fish, which is the main focus of the divers' interests.

With this newly gained knowledge, the divers expressed whether it influenced their concerns about coral reefs with comments such as: "Increased interest and concern," "More concerned about on-land factors," "Now, I'm more conservation conscious about behaviors on land," "I know that reefs are endangered, but this reinforced the need for more work," and "I'm more concerned about it now because I'm more aware and knowledgeable." When asked, what was the one thing they learned that stood out in their minds, some divers commented: "The value of coral and how and why it should be protected," "How important it is to learn more and communicate about the FGB and to realize our responsibility. We have to persevere and educate all those we can about the FGB," and "The coral reef cannot be sustained without responsible stewardship."

The emotions the program was hoping bring out in the divers included awe, a sense of wonder, and arousing a desire to preserve the coral reefs. Based on my observations, the sense of awe and wonder happened quite naturally from scuba diving these healthy reefs. The program was designed to take advantage of the divers' awe and wonder and encourage them to want to preserve the coral reefs. The Naturalists did this by explaining the coral reef's ecology. With the increased knowledge about coral reefs' fragility and their importance to the fauna in the ecosystem, divers expressed an increased concern for coral reefs and a desire to preserve them.

### *2.4.3 Motivation/Incentive to Act*

According to Orams' model (1996 and 1997), once the divers' curiosity is aroused and their affective domain is engaged, it is time for the Naturalists to motivate the divers and provide incentives to act appropriately. The primary incentive was to keep the coral reef healthy by minimizing human impacts. The challenge was to figure out the best way to get the divers involved in the wellbeing of the reef so they would become more attached to it and thus be willing to change their behavior. Success was determined by whether or not the divers participated in the activities and phrases such as "I/we want to," "I plan to," "I will," and "I have to" on the post-questionnaires.

The education coordinator developed a couple of teaching aids to motivate the divers. The first teaching aid was a set of three by five inch cards, called "Discovery Cards." Their purpose was to provide a focus for divers' observations about what was happening on the reef. Each card (see Appendix C) had one thing the divers could observe, such as 1) trying to find anchors and steel cables, 2) observing other divers' inappropriate behavior, 3) looking for signs of coral bleaching and/or disease, etc. The objective was for divers to come to the sessions with the observations they had made during their dives and for the Naturalists to use these observations as starting points to talk about coral reef ecology and human impacts. Some of the divers said they appreciated having the cards to give them something in particular to look for during their dives, but most of them ignored the cards. No one made any comment about why they ignored the cards, so I have no data on this matter. However, it is possible that they were

too juvenile in nature to connect with the divers and/or there was enough time between the session and the next dive so they just forgot about the cards.

The divers were also encouraged to count species when they dove, but very few did so. This activity required a diver to have a fairly good ability/skill to identify the species and a willingness to count what was seen instead of just swimming around and watching the life on the reef as it happens. Another bit of citizen science dealt with sea turtles, but I did not see anyone participate in this program. The advanced skill/knowledge level required to do these activities may have been the factor that limited divers' participation. Overall, these activities were not successful in getting the divers involved in the wellbeing of the reef.

One of the FGB's education coordinator's goals was to educate divers how to change their behavior on land in order to minimize their indirect impacts on coral reefs. The Naturalists talked about changing behavior while diving on Saturday and talked about what people can do when they are on land on Sunday. The divers responded positively when the Naturalists led discussions about changing divers' behavior while visiting the reef. This can be seen in their comments when asked to identify the one outstanding thing they learned: "Don't touch!" "Need to be sensitive to marine life and take great care not to hurt coral, animals, etc.," "The way the presentations led you to dive with focus and purpose," and "To realize a person's recreational fun could be damaging to other species."

Many divers did not know the number of ways coral reefs are impacted by human activities while on land. For example, when the Naturalists showed a map of the

Mississippi River drainage basin and indicated that river's water drains into the Gulf of Mexico and then currents push this water toward the FGB, the divers began to see how widespread indirect human impacts can be. Consequently, the divers responded very positively when the Naturalists presented facts about indirect human impacts. This can be seen in their comments when asked to identify the one outstanding thing they learned: "The impact of hurricanes and water temperature," "The impact we have on the coral," "The various marine animals that exist in the Gulf and the impact humans have on them. – Never knew anything!! Thank you," "That what happens on land also hugely affects how well the coral reefs do," "How large the [Mississippi] watershed feeding into the Gulf of Mexico is. Seeing the prop makes it easy to understand how small things I do at home can have a big impact on the Gulf," "The watershed map was an eye opener!" "Waste from hundreds of miles upstream can affect a coral reef ecosystem," "Life cycle and interdependent relationship between coral and man's influence," "Pollution and its role in this environment," "That everything in life helps or hurts the oceans. That is something I think people need to know – that little choices made everyday make a big difference," and "I'm going to think about coral at home and how I live my life affects coral. I'm going to be seeing coral in my kitchen sink from now on."

Another indicator that the program motivated the divers to act came from comments that included phrases such as "I want to," "I plan to," "I will," and "I have to." A sampling of these comments include: "I've always been concerned about the reefs. However, this program has made me more determined to educate others," "Makes me want to actively protect the reefs," "I need to reach out to non-diving friends and

share how we impact the reefs," "I need to learn more about the reef systems," "I will be more aware of my impact on the environment," "I will keep myself more informed," and "I need to do more to preserve this ecosystem."

Up to this point, divers had been expressing their enthusiasm for changing their behavior and saving the reef. However, when the Naturalists talked about specific ways people can help minimize their impact while on land, such as practicing xerescaping (minimal water and pesticide use) and organic gardening, buying organic foods, and practicing good citizenship, I could feel the divers become very still and saw faces close down. I felt uncomfortable when this happened and, during their debriefing after each trip, the Naturalists said they also felt uncomfortable. It was as if a line had been crossed that should not have been. However, the divers themselves never said anything about this so I do not have any data from them. When I interviewed the owner and captain of one of the boats, he suggested that the divers' response may be due to the way the material was presented. Namely, that talking about what people can do to save the environment works well for K-12 teachers and their students but it does not work for divers on these trips. These divers are well educated adults who are capable of making their own decisions without being propagandized. His conclusion was the message needed to focus on the facts and let the divers decide on their own what they were willing to do.

So, the results were mixed for motivating the divers to act. The Discovery Cards and the citizen science projects did not garner diver participation. Talking about simple or easy ways to take care of the coral reef while diving and talking in general about

indirect human impacts was more successful in motivating divers to act. However, when the Naturalists talked about specific ways divers could make a bigger commitment in changing their behavior at home, the divers were not receptive. Consequently, the program was effective in encouraging divers to change their behavior as long as the material was factual and ineffective when the material tried to get the divers to make bigger changes in their daily lives.

### *2.4.4 Opportunity to Act*

Orams' (1997 p. 298) defines giving opportunities to act as providing "opportunities for people to take action, then and there." His examples of providing opportunities to act include, signing petitions, joining environmental organizations, and buying environmentally friendly products. Due to administrative constraints, the FGB cannot sponsor activities such as signing petitions and joining organizations. However, the divers do have an opportunity to buy T-shirts, baseball hats, and other souvenirs on the way back to port.

In addition, the divers have opportunities to act on what they learn every time they dive. What observation I managed to do during the dives revealed that most of the divers were very good about not touching the reef. Given the "no touch, no take" policy of the FGB, there was no attempt made to collect anything besides photographs. However, there were several times when I noticed divers who touched or clung to the reef when engaged in getting a photograph. Also, I saw two inexperienced divers who

momentarily lost control of their buoyancy and inadvertently touched the coral or stirred up sediment.

Beyond the informal observation I did during the dives, I did not collect any data on changes in divers' behavior. This is because I did not have the time or funding to establish a baseline of diving behavior by observing divers' diving behavior during a previous diving season so any observations I made during 2006 could be compared to see if there was a change in behavior. Additionally, for the same time and funding reasons, I did not collect data on whether the divers actually changed their behaviors while at home.

## 2.5 Discussion and Conclusion

Given that scuba divers come to the FGB for a weekend of fun and exciting diving, it is important that an education program enhance their satisfaction and enjoyment of the trip. Based on the divers' comments, the Naturalist on Board program was successful in achieving this goal as can be seen in this sample: "This is great!" "Thank you so much! This truly made a difference for my trip!" "I really enjoyed this," "I learned and enjoyed as a result of the presentations," "It is a wonderful idea to have a Naturalist onboard. You get so much more than just fish identification," and "This trip was more enjoyable with the program." However, an effective environmental or conservation education program also increases knowledge, motivates people and provides opportunities for them to act on what they learn.

Orams' "Features of an Effective Education/Interpretation Programme" model (1996 and 1997) provided a good framework for developing a conservation education program for the FGB. The first part of his model suggests that it is important for a program to include both the intellect and emotions. For this part of the model, the results of the Naturalist on Board program were good. The divers' curiosity about the beautiful alien world they were exploring engendered numerous questions about what they saw and created a desire to learn more about coral reefs. The Naturalists were able to take advantage of this and talk about how coral reefs work and how humans are impacting them in addition to helping divers with species identification. The Naturalists used the divers' emotions of awe and wonder to encourage them to want to preserve the reefs. They did this by talking about the coral reef's ecology. Once the divers gained a better understanding about coral reefs and how they support the many fish and other animals on the reef, they expressed an increased concern for the coral reefs' wellbeing and a desire to preserve them.

The second part of Oram's model (1996 and 1997) suggests that it is also important to motivate and provide opportunities for visitors to act on what they have just learned. The Naturalists found this part of the model harder to implement successfully. According to Orams (1997), the measure of effectiveness for this part of the model is to create intentions to change behavior. With regard to direct impacts, the divers were willing practice appropriate behavior while diving. Most of the divers did not touch the coral reef or stir up sediment. The exception to this occurred when a diver would touch the coral in order to capture a photograph of something. However, the changes the

Naturalists suggested divers make while living at home were not received well even though indirect impacts are as important as direct impacts. One possible reason for this is the manner in which the Naturalists presented the material.

Researchers have found that in addition to acquiring knowledge, emotions and values are an important part of what shapes behavior (e.g. Hungerford and Volk, 1990; Iozzi, 1989; Vaske and Donnelly, 1999). Orams' (1996 and 1997) model provides a good framework for developing an effective environmental or conservation education program because it incorporates both of these aspects. Fortunately, environmental education literature is available to help with developing a program that engages the intellect and emotions. That's the easy part.

The hard part is to develop ways to motivate and entice visitors to act in an environmentally appropriate manner. Orams' model (1996 and 1997) stresses the importance of this step and provides some examples of how a program can achieve this goal by making the opportunities to act easy to do, such as signing petitions and joining environmental organizations (Orams, 1996). Because FGB cannot sponsor any petitions or organizations, the education coordinator had to devise other opportunities to act. Given the goal of decreasing divers' direct impacts, the immediate opportunity to act was changing divers' behavior while visiting the reefs. The education coordinator also wanted to try to decrease divers' indirect impacts by promoting lifestyle changes the divers could make when at home.

The challenge was to develop teaching aids or tools that would motivate divers to get involved in the wellbeing of the reef. None of the tools that were developed, such as

the Discovery Cards and citizen science projects, worked. This is possibly due to their juvenile nature or the necessary skill set and/or knowledge level was too advanced for the divers to do them.

What worked were the discussions and presentations that occurred during the sessions. The divers who chose to participate wanted to learn. As long as the Naturalists presented the facts about direct and indirect impacts, the divers responded positively. But, when the Naturalists promoted different ways divers could change their lifestyle at home, the divers became very still and their faces closed down. This response may have been due to the culture of this group. Most of these divers have a college education, many with some form of advanced or graduate degree. All of them were mature, competent adults capable of analyzing information and making their own decisions. So, the divers were open to learning when the material was presented in an objective, factual manner because they were free to take in what information they wanted to and make their own decisions about how their behavior. When the material was presented in a way that made it feel as if the information being presented was for the purpose of promoting a cause, it insulted their intellect and sense of competence in making their own decisions.

This study found that talking factually about simple ways divers can minimize their impacts while diving, and why it is important to do so, is a successful way to get scuba divers to behave appropriately while visiting the coral reef. However, given the trouble the Naturalist ran into when they talked about indirect impacts on coral reefs, I recommend that the Naturalists discuss the subject matter in such a way that it is just

another factual bit of information. The only time a Naturalist should talk about ways an individual change his/her lifestyle is when a diver asks the Naturalist how he or she can make some changes.

# CHAPTER III

# CONSERVATION EDUCATION FOR SCUBA DIVERS

## 3.1 Introduction

Coral reefs have high levels of marine biodiversity and provide many socio-economic benefits to humans (Agardy, 2004; Bell, Ratner, Stobutzki, and Oliver, 2006). Unfortunately, human impacts, both direct and indirect, have degraded coral reefs so much that 30 percent of reefs are seriously damaged (Agardy, 2004). Experts anticipate that 60 percent or more will be lost by 2030 (Hughes et al., 2003). The stressors that are causing this damage stem from the increasing number of people who reside in coastal counties and islands next to coral reefs. A major consequence of this migration is the development of the coast for the purpose of supporting the population and tourists who visit the coast. This is a major threat to coral reefs because coastal development produces runoff and sedimentation during and after construction as well as increases pollution and boat traffic. Additional stressors include recreational and commercial use of reef resources, which are considered to be moderate and major threats respectively (Turgeon et al., 2002).

Tourism to coral reefs has generated significant financial gains for coastal communities (Moberg & Folke, 1999). Forty-five million visitors come to fish, dive, and otherwise enjoy coral reefs in the United States each year (Turgeon et al., 2002). Scuba diving has become an especially popular marine tourism activity. There are over three million people currently certified to dive in the United States (Bruckner et al., 2005). In

2000 4.8 million scuba divers, who comprise ten percent of tourists visiting the Caribbean, spent approximately US$4.7 billion, which contributed about 17 percent of all tourism revenue in the Caribbean region (Burke & Maidens, 2004). Southeast Florida's population is between 5.09 million and has approximately 29 million visitors each year. In 2000 both residents and visitors spent 18.1 million person-days fishing and diving around coral reefs as well as viewing them from glass-bottom boats. This activity produced 44,500 jobs and provided a total annual income of $1.2 billion (Turgeon et al., 2002).

Given all of this activity, divers are causing many threats to reefs. Direct damage from divers consists of breaking coral at rates greater than regeneration (Rouphael & Inglis, 1997 and 2002; Zakai & Chadwick-Furman, 2002), bruising coral, which increases incidents of disease and bleaching (Hawkins et al., 1999), and stirring up sediment from the sea floor, which can suffocate the coral (Walters & Samways, 2001). Some researchers have concluded that damage to the coral comes from inexperienced divers who struggle to maintain buoyancy control or use proper finning techniques, and from both inexperienced and experienced divers who are focusing on taking photographs (Davis & Tisdell, 1995; Rouphael & Inglis, 1997). The anchors on the boats divers use to get them out to the coral reefs also cause damage during setting, retrieval and while at anchor (Dinsdale & Harriott 2004).

The impacts on each coral reef are dependent on its location relative to shore, the volume of people visiting it, plus other factors. The coral reefs in Florida, Puerto Rico and the U. S. Virgin Islands are considered to be in very poor condition because they are

close to population centers and deal with large numbers of tourists. As a result, they are experiencing major threats from global warming and coral bleaching, increased incidences of diseases, coastal development and runoff, coastal pollution, over fishing, and ship and boat activities. These same reefs are experiencing moderate threats from tropical storms, marine debris, and tourism and recreation activities (Turgeon et al., 2002).

In contrast, FGB has few human-induced pressures and remains relatively pristine because of its remote location. Being located in the northwestern part of the Gulf of Mexico over 100 miles from shore protects them from many of the problems associated with coastal development. The distance from shore has also kept the volume of visitors down to approximately 2,500-3000 each year. Consequently, scuba divers are considered to be of little threat to the reefs. The biggest threat the FGB has comes from offshore oil and gas exploration as well as the anchoring of large industry vessels, freighters, and fishing vessels (Hickerson and Schmahl, 2005).

Even though scuba divers are not considered a threat to FGB's coral reefs, these divers also dive at other sites around the world where scuba diving activities are serious threats. Given the amount of damage from divers at other coral reefs, solutions are needed. If we accept the premise that motivation for minimizing negative impacts can be internally driven by environmental values and ethics (e.g. Kollmuss & Agyeman, 2002; Kraus, 1995; Stern, 2000) and that knowledge acquisition affects values (Stern et al., 1995), then divers with values consistent with the conservation of natural resources should be more willing to make a concerted effort to decrease their negative impacts

without any external prompting or supervision once they gain the appropriate knowledge.

## 3.2 Literature Review

Several researchers have focused on whether dive briefings that instruct divers in how to modify their behaviors so as to reduce reef damage have any impact. For example, Medio, Ormond, and Pearson (1997) found that a more extensive program that covered coral reef ecology, diver impacts, and the concepts of conservation and marine protected areas were effective in influencing appropriate diver behavior. Townsend (2003) found short, sharp messages on appropriate dive behavior supported by posters, portraying the same messages, hanging in prominent places on the dive boat were effective in increasing appropriate diver behavior. By contrast, Barker and Roberts (2004) showed that brief, one sentence environmental instructions had no effect on diver behavior; however, they found that dive leaders can provide effective modeling of behaviors during dives, which helps to enforce appropriate diver behavior (Barker and Roberts 2004).

These studies examined the immediate, short-term impacts of education programs on diver behaviors. They did not, however, address whether or how education programs affected scuba divers' environmental values and ethics. Scholars in general have argued that appropriate education can improve public support for conservation and improve how people behave in compliance (or not) with environmental regulations (Jacobson, McDuff, & Monroe, 2006). Essentially, education can influence decisions

tourists make and thus reduce inappropriate behaviors (Manning, 1999). Education can also “inform, motivate, and empower people to support conservation” and is thus an important tool for achieving conservation goals (Fien, Scott, & Tilbury, 2002 p. 153).

Researchers studying various aspects of scuba diver characteristics and environmental attitudes reiterate the general consensus. McCawley and Teaff (1995) state that gaining a better understanding of coral reefs and the link between them and our existence are correlated with a pro-environmental disposition. Meyer (2002) found that increased knowledge of coral reef ecology resulted in increased pro-environmental behaviors. She found that the strongest correlation came from divers’ general behaviors such as reading books or magazines and/or watching TV programs about the environment/the ocean/conservation. In addition, divers who participated in behaviors that minimize their impacts on coral reefs were also positively correlated to their knowledge about coral reefs. Finally, Cheng, Thapa, and Confer (2005) found that when people increase their environmental knowledge, they can change their attitude and behavior toward a more pro-environmental stance.

Stern et al.’s (1995) research studied how individuals form attitudes as a result of newly discovered or publicized environmental conditions, such as global climatic change and the decreased concentration of stratospheric ozone over Antarctica. They determined that “the link to values is important because attitudes toward new objects must be built on something more stable and relatively enduring value orientations might provide this foundation” (Stern et al., 1995 p. 1615) because they “act as general guiding principles in life, and as such are likely guideposts for action in unfamiliar conditions, including

the condition of forming attitudes about new social objects" (Stern et al., 1995 p. 1615). Consequently, values are used as filters to interpret information an individual acquires so that environmentalists are willing to believe claims about adverse consequences of environmental change and those opposed to the environmental movement are predisposed to believe contrary (Stern et al., 1995).

Kluckhohn and Strodtbeck (1961) define fundamental values as basic abstractions created out of finding solutions to universal human problems. Rokeach (1973) defines fundamental values as enduring beliefs that specific modes of conduct are preferable, namely better for one's wellbeing, to a converse mode of conduct. A short list of values includes a sense of belonging, excitement, fun and enjoyment in life, warm relationships with others, security, and self-respect (Homer and Kahle 1988). Values that can inform value orientations about the environment include unity with nature, protecting the environment, respecting the earth, equality, social justice, sense of belonging, authority, social power, wealth, enjoying life, curious, honesty, self-discipline, obedient, politeness, and social order (Stern et al., 1995). As can be seen by these examples, fundamental values are abstract social cognitions and serve as prototypes out of which come basic beliefs, value orientations, attitudes, and behavior (Vaske and Donnelly 1999).

Kluckhohn and Strodtbeck (1961) define a value orientation as: "complex but definitely patterned principles, resulting from the transactional elements of the evaluative process – the cognitive, the affective, and the direct elements – which give order and direction to the ever-flowing stream of human acts and thought as these relate

to the solution of ‘common human’ problems” (Kluckhohn and Strodtbeck 1961 p. 4). With regard to natural resources, these value orientations can be arrayed along a continuum ranging from anthropocentric (a human-centered, utilitarian view of the nonhuman world) to biocentric (a nature-centered view of the nonhuman world (Kluckhohn and Strodtbeck 1961). Given the stable and relatively enduring nature of value orientations, they do not change easily. However, humans are endlessly simplifying, organizing, and generalizing their view of their environment. So, as circumstances and the environment change, people can and do change the direction of their value orientations (Kluckhohn and Strodtbeck 1961).

While these researchers conclude there is a correlation between value orientation and knowledge, they did not look at how value orientation affects how much knowledge is acquired. The purpose of this exploratory study was to evaluate the effects of an on-site conservation education program in the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico. The goal was to understand how the education program affected scuba divers’ knowledge and values associated with coral reef values and coral reef conservation. The broader goal was to understand how shifts in knowledge might be correlated with divers’ value orientations in ways that might ultimately lead to more environmentally appropriate behaviors. The research questions were: 1) what is the value orientation of recreational divers who visit the Flower Garden Banks?, 2) how much knowledge do scuba divers gain as a result of participating in an onboard conservation education program?, 3) what is the correlation between value orientation

and knowledge gained?, 4) to what degree do value orientations affect knowledge acquisition?

### 3.3 Methods

Data was collected on ten weekend trips to the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico in July through early October of 2006. A total of 453 divers went out to FGB on those ten weekends. However, the scuba diver population for this study is comprised of the divers who participated in the Naturalist Onboard program.

Pre- and post-questionnaires were administered to all of the divers who were present at the beginning of the first session (before the program began on Saturday morning) and after the last session (at the conclusion of the program on Sunday afternoon). Given that participation in this program was voluntary, the divers were free to participate in as many or as few sessions as they wanted. As a result, there were 75 divers who filled out only the pre-questionnaire, 27 divers who filled out only the post-questionnaire, and 91 divers who filled out both pre- and post-questionnaires. There were a total of 193 divers who filled out either one or both of the questionnaires, which comprises this study's population.

There are three possible reasons for this. One is the reality that doing seven dives in two days on minimal hours of sleep is physically exhausting. Hence the divers chose to take a nap instead of participating in the last session. Another possible reason is divers wanting to do other things such as download their photos onto their computers or clean

their equipment before the next dive. Finally, some divers may have felt they had gotten all they wanted from the program.

The sample for this study was a convenience sample. There were two factors that made this type of sample the only option. First, the divers booked their berths through various dive shops who had signed up for a particular boat before the diving season began. Second, the divers self-selected themselves to participate in the program. Consequently, I had no control over diver assignment. In order to minimize the dangers of this sample type, I made the sample size as large as possible. The demographic data was collected from 166 pre-questionnaires, which makes the sample size 86 percent of the population. The rest of the statistics are based on data collected from the 91 divers who filled out both pre- and post-questionnaires, which makes the sample size 47 percent of the population.

We used the questionnaires to determine the divers' demographics, value orientations, knowledge about coral reefs, and also to get their evaluation of the education program. Each questionnaire consisted of three sections. The pre-questionnaire included a section on divers' value orientation in relation to coral reefs, a second section on their knowledge of basic coral reef ecology and human impacts, and a final section on demographic data. The content of the value orientation and knowledge sections of the post-questionnaire were identical to the pre-questionnaire while the final section asked divers' to evaluate the program.

The material for determining the divers' value orientation was adapted from Vaske and Donnelly's (1999) basic belief statements. Vaske and Donnelly (1999) used

five anthropocentric basic beliefs statements and four biocentric basic belief statements to determine their study's participants' value orientations. I chose this article because it has been cited at least 27 times in various social science journals and the variables in their instrument were easy to adapt to basic beliefs statements about coral reefs. I adapted three "anthropocentric" and three "biocentric" basic beliefs and put the responses in the Likert Scaling format and the divers had five options to choose from that ran the spectrum from strongly agreeing to strongly disagreeing with the statement (see Appendix A).

The Flower Garden Banks' education coordinator and I developed the knowledge questions based on the content that the Naturalists were expected to cover (see Appendix A). The first body of knowledge dealt with direct impacts divers have on coral reefs. This body of knowledge covers the same ground as the previous studies done on diver education (Barker and Roberts, 2004; Townsend, 2003). The second body of knowledge dealt with the indirect impacts divers have on coral reefs when they are at home. The third body of knowledge dealt with basic coral reef ecology and their overall health. A test run of the questionnaires was conducted with the Naturalists during their training session to help refine the measures.

The demographic questions were adapted from research conducted by Sorice, Oh, and Ditton (2005) who examined scuba diver management preferences for coral reef conservation (see Appendix A). In the evaluation section, we gathered information about the effectiveness of the program from the divers' perspective. One question asked to what degree divers would be willing to change their behavior in order to see how well

the divers' change in value orientation and increased knowledge leads to their intention to change behavior. Two questions focused on divers' willingness to learn more about the Flower Garden Banks and coral reef ecology, and one question asked whether the program enhanced their trip to see if it is worthwhile to continue with, and add to, the program.

On the trip back to port after the program was finished, I conducted semi-structured interviews with twelve divers who had participated in the program, which is six percent of the population. The interviews were fifteen to thirty minutes long and focused on the divers' evaluation of the education program (see Appendix B).

Except for the diver demographics, the data does not have a normal distribution. Thus nonparametric tests were used in SPSS 14.0 for Windows for all of the statistical analysis below.

## 3.4 Results

### *3.4.1 Diver Demographics*

As can be seen in Table 1, there were more than twice as many males (n = 112 or 70%) as females (n = 49 or 30%). While there were children who came diving with their families, I collected data only from adults. The ages of the adult divers ranged from eighteen to 65. The ages of the divers were spread out fairly evenly with the average age of the divers being forty years. Most of the divers had a minimum of a Bachelors degree (n = 123 or 72%) with 48 (28%) of them having an additional advanced degree. Dive certification ranged from beginner, with some divers being newly certified the weekend

before, to advanced certification with other divers who have dived for decades and had logged hundreds of dives. There were 55 divers (34%) who had only the Basic certification, which is the beginner skill level. Sixty-nine divers (42%) had either the Advanced or Rescue certification, which is the intermediate skill level. Forty divers (24%) had either the Master or Divemaster certification, which is the advanced skill level. Finally, there is a positive correlation between divers' certification level and the number of times the diver visited FGB in 2006 ($r$ = .180, $p$ = .02) suggesting the higher the certification level the more times a diver visits FGB in a given year.

Table 1: Divers' Demographics

| Gender | Age | Education | Diver certification |
|---|---|---|---|
| Males = 112 or 70%<br>Females = 49 or 30% | 18 to 65<br>mean = 40 | Bachelors = 123 or 72%<br>Graduate = 48 or 28% | Beginner = 55 or 34%<br>Advanced = 69 or 42%<br>Master = 40 or 24% |

These statistics are similar to the demographics of other studies that have been conducted. The average ratio of male (70.7 percent) to female (29.3 percent) of these other studies (Thailing and Ditton, 2001; Meyer, 2002; Musa, 2002; Todd, Graefe, and Mann 2002; Barker and Roberts, 2004) are the same as found in this study. The age ranges of the other studies are slightly different. Todd, Graefe, and Mann's (2002) study had the widest range going from age twelve to eighty. The other four studies' (Thailing and Ditton, 2001; Meyer, 2002; Musa, 2002; Barker and Roberts, 2004) ages ranged from eighteen to over sixty, which is the same as this study. The mean or average for

these studies either fell somewhere in the thirties (Thailing and Ditton, 2001; Meyer, 2002; Musa, 2002) or in the forties (Todd, Graefe, and Mann 2002; Barker and Roberts, 2004). The age statistics is very similar to the other studies' age statistics. Four of these studies show that the diving population is well educated in that all of them found that at least 71 percent of their samples had some sort of college education (Thailing and Ditton, 2001; Meyer, 2002; Musa, 2002; Todd, Graefe, and Mann 2002), which matches the education level of the divers in this study. Finally, only Musa's (2002) study collected data on diver certification. She found that 31 percent of the divers had a beginner certification level and 69 percent of the divers had some sort of advanced diver certification, which matches the data found in this study. Consequently, divers who visit FGB are similar to divers found in other locations around the world.

### *3.4.2 Diver Knowledge*

Table 2 presents the frequencies for the divers' knowledge before and after the education program. The Wilcoxon Signed Ranks test was used to determine the difference in the divers' knowledge as a result of the education program. There were two questions the divers knew best before the education program. These concerned the impacts divers have on corals when they touch them (86.8% correct) and the fact that corals are not hardy (81.3%). While there was an increase in the number of divers who answered these questions correctly after the education program, the difference was not

Table 2: Divers' Pre- and Post-Knowledge

| | Pre* | Post* | Wilcoxon Signed Rank Test | | |
|---|---|---|---|---|---|
| | | | T statistic | *Z*** | *P* **** |
| Scuba divers touching corals can impact them by interfering with or destroying their protective secretions and making them more susceptible to natural and human generated diseases | 86.8 | 92.3 | 2 | -1.667 [b] | .096 |
| Corals are not hardy | 81.3 | 86.8 | 5 | -1.291 [b] | .197 |
| A coral is made of animal, plant, and mineral | 73.6 | 83.5 | 8 | -1.800 [b] | .072 |
| Stony/hard corals get most of their nutrition from the symbiotic algae's photosynthesis | 53.8 | 74.7 | 6 | -3.413 [b] | .001 |
| Individual divers can impact reef animals by taking flash photos while turtles sleep, feeding the fish, and touching manta rays and sharks | 54.9 | 71.4 | 6 | -2.887 [b] | .004 |
| Some of the stressors and impacts that coral reefs are being subjected to include warming ocean temperatures and sea level rise, hurricanes, soil erosion and agricultural runoff, household pollution, boats dropping anchor, and scuba divers touching the corals | 17.6 | 31.9 | 6 | -2.600[b] | .009 |
| Coral reefs around the world today are unhealthy to very Unhealthy | 74.7 | 61.5 | 4 | -3.683[a] | .007 |

* percentage of divers who correctly answered the questions
** Z results: a = based on positive ranks and b= based on negative ranks
*** P value = asymp. or 2-tailed significance

as significant ($p$ = .096 and $p$ = .197) as in the other questions. This is probably due to the fact that because most of them knew these answers before the education program there was less room for improvement. Fewer divers knew the correct answers to three questions dealing with what hard corals are made up of (73.6% correct), how they get their nutrition (53.8% correct), and the impacts that divers have on reef animals (54.9% correct) before the education program.

After the education program, there was a significant increase in the number of divers who answered these questions correctly ($p$ = .072, $p$ = .001, and $p$ = .004

respectively). Divers' written comments on the questionnaire support these findings. When asked to identify the one thing they learned that stood out in their minds, many divers responded with comments like: "how coral is constructed," "learned about coral diseases," "color of coral is from algae," "I'm more aware of the reef's ecosystem," and "learning about coral being both plant and animal (and mineral)! I always paid more attention to the fish. Now I appreciate the coral much more."

The two questions that deal with the number of stressors that can decrease coral reef health and the global, overall health of coral reefs proved to be troublesome for the divers. The question that deals with the number of coral reef stressors listed numerous ways in which coral reefs are impacted by natural forces and human behavior. For the most part, the divers did not choose all of the correct impacts, indicating that they didn't realize how many ways coral reefs can be impacted. As a result, only sixteen divers (17.6%) answered the questions correctly before the education program. After the education program, 29 divers (31.9%) answered the question correctly, showing a significant increase in their knowledge ($p = .009$). However, the low number of divers who answered correctly still indicates a relatively poor understanding of the problem; even though divers' written comments seem otherwise. When asked to identify the one thing they learned that stood out in their minds, many divers responded with comments like: "how hurricanes affected the coral reefs," "impacts of warm water on the reef," "how accumulated damage occurs to reefs," "how many things humans can do to negatively affect the marine life," "waste from hundreds of miles upstream can affect a

coral reef ecosystem," and "my actions hundreds of miles inland can affect reefs in the ocean."

The question dealing with the unhealthy state of coral reefs worldwide was the only question that had fewer divers answering it correctly after the education program and the decrease was significant ($p$ = .007). A possible explanation for this anomaly may come from their experience with the Naturalist Onboard program. During the weekend, the divers had the opportunity to see a very healthy coral reef and listen to and talk with the Naturalists and the captains about the fluctuating health of the reefs. These discussions often began with talking about how, in the previous year, the Flower Garden Banks had been hit hard by a disease outbreak, a serious bleaching event and a close encounter with Hurricane Katrina in 2005. Then the discussions would continue with noting how well the reefs have recovered from all of these impacts and talking about how healthy they are this year. After spending a weekend discussing this topic, it is possible that the divers transposed these discussions about the Flower Garden Banks to the worldwide situation.

To gain an overall picture of the divers' increased knowledge, I combined the statistics of the individual knowledge questions into one number and tested it. Overall, there was a significant increase in the divers' knowledge about coral reefs (based on Wilcoxon Signed Ranks test: T = 22, Z = -3.378 based on negative ranks, and $p$ = .001). When divers were asked whether the education program changed their knowledge, they responded with comments that ranged from, "Yes. My knowledge did change. In particular, the fragileness of corals and all the variables that can impact them as well as

that you can damage coral globally. This is so easy to forget when you're on land" to, "I had a lot of knowledge before coming on these trips but I always pick up something more." When asked what they liked best about the program, they often responded with comments such as: "That it helped me become more educated about coral reefs and the different marine life that exists in the Flower Garden Banks," "Hands-on learning! Stuff I'd never have known or likely read," "Honing the ability to better understand what was going on on the reef before we saw it," "Being able to ask a knowledgeable person about coral reefs," and "It makes us think and be aware to be better divers. We're a lazy group of people out to dive and the program helps us to change focus. So, it's not all about us; the reef is important too." The divers also wrote comments that indicate they want to learn more about coral reefs. When asked what they liked the least, many divers' comments were "the program was not long enough." Several divers wrote, "I would like to learn more specific information about the ecosystem that exists on the specific reefs that we visited."

### *3.4.3 Basic Beliefs for Determining Value Orientation*

The six basic beliefs statements in the Table 3 are adapted directly from the variables Vaske and Donnelly (1999) used to measure anthropocentric and biocentric basic beliefs. When coding the responses, the response categories were translated into the following categories: 1 = very anthropocentric, 2 = somewhat anthropocentric, 3 = neutral, 4 = somewhat biocentric, and 5 = very biocentric. The value orientation is constructed by averaging the divers' basic beliefs (Vaske and Donelly 1999).

Cronbach's alpha was used to test for reliability of this scale and the result is $\alpha = .695$, which is acceptable (Field, 2005).

Table 3: Divers' Basic Beliefs

| | Not Biocentric* | | Biocentric* | | Wilcoxon Signed Ranks test | | |
|---|---|---|---|---|---|---|---|
| | Pre | Post | Pre | Post | T statistic | Z** | *P* *** |
| Coral reefs are valuable only if they produce jobs and income for people. | 3.3% | 4.4% | 96.7% | 95.6% | 11 | -.307[a] | .759 |
| Coral reefs' primary value is to provide products useful to people. | 9.9% | 5.5% | 90.1% | 94.5% | 17 | -1.478[b] | .139 |
| The value of coral reefs exists only in the human mind. Without people coral reefs have no value. | 12.1% | 3.3% | 87.9% | 96.7% | 9 | -2.674[b] | .007 |
| Coral reefs have as much right to exist as people. | 12.1% | 11% | 87.9% | 89.0% | 8 | -1.174[b] | .240 |
| Coral reefs and people have equal rights to live and develop. | 29.7% | 25.3% | 70.3% | 74.7% | 14 | -1.448[b] | .148 |
| Coral reefs have value, whether people are present or not. | 13.2% | 5.5% | 86.8% | 94.5% | 11 | -1.824[b] | .068 |
| Overall value orientation | 11.4% | 9.2% | 86.6% | 90.8% | 71 | -3.523[b] | .000 |

* Percentage of divers who hold this basic belief before (pre) and after (post) the program
** Z results: a = based on positive ranks and b = based on negative ranks
*** P value = asymp. or 2-tailed significance

The data was grouped into two categories "Biocentric" (categories 4 and 5) and "Not Biocentric" (categories 1, 2, and 3) so statistics could be run. Table 3 presents the frequencies for the divers' basic beliefs before and after the education program. The results show the majority of the divers held biocentric basic beliefs. The Wilcoxon Signed Ranks test, the nonparametric equivalent of the dependent *t*-test (Field 2005), was used to compare the pre- and post- basic beliefs and test the degree to which each

diver's basic beliefs shifted. While all of the basic beliefs, except for the first one which stayed essentially the same, became more biocentric after the education program, most of the shifts are not significant. In order to determine the divers' value orientation, the basic beliefs were averaged together. The results show that most of the divers (86.6%) held a biocentric value orientation before the education program. After the education program, the divers' became even more biocentric (90.8%) in their value orientation. The comparison of the pre- and post- value orientations shows a significant shift. However, based on Cohen's scale (Field 2005), the effect size is small ($r$ = 23.216). These results are not surprising given the stable nature of basic beliefs and value orientations, and yet the results show that they can change after participating in an education program.

When asked to comment on how their views about coral reefs changed as a result of the education program, divers responded with statements such as "makes me want to actively protect the reefs," "I've always been concerned about the reefs. However, this program has made me more determined to educate others," "made me more aware of the importance of preserving coral reefs," and "It enhanced my awareness. I'm going to think about coral at home and how I live my life affects coral. I'm going to see coral in my kitchen sink from now on."

### *3.4.4 Correlation between Value Orientation and Knowledge*

In order to see whether there is linear relationship between value orientation and the sum of knowledge, I ran a bivariate correlation test. The results show that value orientation is positively correlated to knowledge, with a coefficient of $r$ = .251 and $p$

*value* = .016 (2-tailed). In addition, I wanted to see if there is a relationship between value orientation, knowledge, and specialization. The number of years a scuba diver has participated in this sport is the surrogate for specialization. The results between value orientation and years dived does not show a correlation, with a coefficient of $r = .07$ and *p value* = .512 (2-tailed). The results between knowledge and years dived does not show a correlation, with a coefficient of $r = .085$ and *p value* = .426 (2-tailed). A partial correlation controlling for years dived shows the association between value orientation and knowledge as $r = .247$ and *p value* = .019 (2-tailed).

Squaring the correlation coefficient ($R^2 = .063$) for value orientation and sum of knowledge indicates that six percent of the value orientation's variability is explained by the sum of knowledge variability. In addition, the number of years an individual has dived has no relation to value orientation and knowledge. The weakness of these statistics indicate that there is a weak association between value orientation and knowledge acquisition and no association between the number of years an individual has been scuba diving and his/her value orientation and knowledge acquisition.

As previously noted, there was some change in the divers' value orientation. I ran a regression analysis to see if value orientation and sum of knowledge have any predictive power for determining these changes. The model I used was VOdif = 1.716 + .049SumKnow - .418VOpre. VOdif stands for the difference between the value orientation a diver held before and after participating in the program. SumKnow is the sum of knowledge. VOpre is the value orientation a diver held before participating in the program. The residuals are very close to normal. The value orientation a diver holds

before the program and the sum of knowledge accounts for eighteen percent of the change in value orientation ($R^2$ = .183, Sig. F Change = .000).

## 3.5 Discussion and Conclusion

This study explored an onboard conservation education program conducted in the Flower Garden Banks National Marine Sanctuary from July through October of 2006. The research questions were: 1) what is the value orientation of recreational divers who visit the Flower Garden Banks?, 2) how much knowledge do scuba divers gain as a result of participating in an onboard conservation education program?, 3) what is the correlation between value orientation and knowledge gained?, 4) to what degree do value orientations affect knowledge acquisition?

The results of this research indicate most of the divers who chose to participate in an onboard education program tended to have a "biocentric" value orientation. Before the education program, 86.6 percent of the divers had a biocentric value orientation and after the education program, 90.8 percent of them had a biocentric value orientation. Also, the divers gained a significant amount of knowledge and many divers expressed the desire for more education. The relationship between having a biocentric value orientation and the amount of knowledge acquired was also explored. A correlation of six percent indicates that value orientation has a minimal effect on knowledge acquisition. A regression analysis indicates that the value orientation a diver holds before the program and the sum of knowledge accounts for eighteen percent of the change in value orientation. These results indicate the small relationship between value orientation,

knowledge gained, and shifts in value orientation. This observation is reinforced by comments from the divers indicating that the education program played a part in shifting their value orientation even more toward biocentric values.

Vaske and Donnelly's (1999) work shows the biocentric/anthropocentric value orientation continuum is capable of predicting scuba divers' attitudes toward protecting coral reefs, which in turn mediates the relationship between value orientation and behavioral intention. Given the majority of the divers in this study hold a biocentric value orientation, their value orientations bode well for future behavior. Namely, they should be willing to make a conscious effort to minimize their impacts on coral reefs, which was also indicated in their comments.

Consequently, an effective education program should: 1) encourage divers to become biocentric in how they value coral reefs, 2) cover enough material so that scuba divers can acquire a significant amount of knowledge about coral reef ecology, and 3) show or explain how they can minimize their impacts while diving and while on land. With divers' willing to voluntarily minimize their negative impacts, it would seem that effective environmental education programs are a good way to meet managerial goals to limit scuba diver damage in marine sanctuaries.

There are three limitations that must be acknowledged in this study. First, this is a case study and the Sanctuary is a unique diving experience, so the results found here may not be applicable to the wider diving population. Second, only half of the divers onboard the dive boat chose to participate in the education program. The majority of these divers held a biocentric value orientation and wanted to learn. If the divers who did

not participate in the education program had been included in the data collection process, there would probably be a stronger relationship between value orientation and knowledge gained. Finally, I did not collect any data on changes in divers' behavior. I did not collect this data because I did not have the time or funding to establish a baseline of diving behavior by observing divers' diving behavior during a previous diving season so any observations I made during 2006 could be compared to see if there was a change in behavior.

An implication for scuba diving businesses is to do what they can to expand their education programs. Most scuba divers want to visit healthy, vibrant coral reefs. If they learn what it takes to make a coral reef healthy, they will most likely be willing to do what they can to minimize their impacts. For researchers, future research is needed to determine whether these results can be duplicated with more divers at other coral reef destinations. There is also a need to empirically determine whether there are actual subsequent behavior changes. Once that is done, future research is needed to see if these results can be obtained from the wider diving population.

# CHAPTER IV

# COMPARING TWO TEACHING APPROACHES

## 4.1 Introduction

Neuro-cognitive research on the learning process in the mid to late 1990s has provided substantial insights into the nature of human development and of how people learn (Bransford, et al, 2000; National Research Council, 1999; Shore, 1997). It has provided educators with a greater description and understanding of specific aspects of the learning process (Bransford, et al, 2000,). The key findings of this research are fivefold. First, the learning process begins in infancy and is continuously active throughout a person's lifespan. Second, each person develops different explanations, or conceptions, for how the world works. Third, because people come to learning tasks with different conceptions, they learn different things from the same event. Fourth, if initial understanding is not engaged, people may fail to grasp new concepts and information. Finally, unless people undergo a process of change to restructure their conceptions, they will not assimilate new information that affects either their understanding or behavior (Bransford, et al, 2000).

Bransford et al. (2000) synthesized this research and incorporated it in a "constructivist" approach to education, which holds that people construct new knowledge based on what they already know and believe. They published a ground-breaking book titled *How People Learn*. In this paper, I examine potential linkages between this approach and environmental education. Of particular relevance is the fact

that environmental educators are striving to "construct" knowledge of the environment in ways that will affect attitudes and ultimately change the ways in which they interact with the environment (Ballantyne & Packer, 1996; Fien, Scott, & Tilbury, 2002; Jacobson, McDuff, & Monroe, 2006).

Environmental education is generally carried out in two fundamental types of settings: the formal or classroom setting and the non-formal or outside the classroom setting. Bransford et al.'s (2000) work was conducted specifically for the classroom setting. Scholars do not yet know how the constructivist teaching approach plays out in non-formal environmental education settings. In particular, we have little understanding of how the approach works in non-formal settings, such as those found in recreation and tourism.

In 2006, I carried out a study to explore how the constructivist educational approach works outside of the classroom in a recreation/tourism setting. The affects of two teaching approaches, constructivism and traditional, were compared in an onboard conservation education program in the Flower Garden Banks National Marine Sanctuary in the Gulf of Mexico. The goal was to understand how the two approaches affected scuba divers' knowledge and value orientation regarding coral reefs and coral reef conservation as well as how the divers responded to the two teaching approaches.

## 4.2 Literature Review

While the neuro-cognitive description of the learning process listed above may seem intuitively obvious, the constructivist paradigm is a departure from the dominant

traditional approach. The traditional approach posits that young children are 'blank slates' that have no initial conception, attitudes, and beliefs. It also does not perceive learners' initial knowledge and beliefs as affecting their ability to learn new knowledge. This perception holds true for older children and adults as well. Consequently, it is not important to discover what they know and believe and to build on them while they are being exposed to new knowledge.

Two fundamental aspects of the neuro-cognitive research are central to understanding a constructivist approach: 1) learning with understanding, and 2) active learning (see Table 4).

Table 4: Learning Process Assumptions for the Traditional and Constructivist Approaches

| | ***Traditional Approach*** | ***Constructivist Approach*** |
|---|---|---|
| ***Learning with Understanding*** | Discovering students' initial knowledge is unimportant | Discovering students' initial knowledge is very important |
| | Building on this knowledge is **unimportant** | Building on this knowledge is very **important** |
| | Knowledge and skills are disconnected; cover wide range of subject matter | Knowledge and skills are connected together; centered around core concepts |
| ***Passive vs. Active Learning*** | Locus of information creation and dissemination resides with the teacher | Locus of information creation and dissemination resides with the student |
| | Teacher's role is to lecture or to deliver the information | Teacher's role is to be a mentor and coach; use multiple teaching methods |
| | Student's role is to **passively** receive information | Student's role is to **actively** acquire information |

Learning with understanding focuses on how information is stored in an individual's brain. The results of this research show that it is important to cover a subject matter in depth in such a way that the factual knowledge is connected and organized around central and significant concepts. This enables key concepts to become transparent and easier to comprehend, and people will understand what they are learning and be able to use this knowledge in various contexts (Bransford, et al., 2000).

Given the time constraints in tourism programs, a constructivist approach suggests that it is best to focus on the 'broad strokes' or basic concepts and how everything fits together instead of providing a lot of detailed information requiring rote memorization (Forestell, 1993). Active learning focuses on the locus of information creation. Real learning is an active process in which individuals construct their own knowledge as they change their conceptual frameworks (Ballantyne and Packer, 1996; Bransford, et al., 2000). This means it is essential for people to take control of their own learning and be actively involved in acquiring new information and skills if they are to understand new concepts and information (Bransford, et al., 2000, p. 12).

In any educational setting, there are two loci for creating new knowledge (Table 4 page 63). One lies with the instructor who teaches the facts he or she wants to convey to 'students'. This teaching approach is called the traditional or conventional approach. The students, in turn, receive the information in relatively passive ways. The information that the teacher disseminates often consists of disconnected facts that cover a wide range or area of a given subject matter. Any activities or exercises used may or may not be in a series that progress toward a goal. The goal of this teaching approach is to have the

students repeat facts or perform isolated skills. Education scholars have shown that students will learn less with this approach, find little enjoyment in the learning process, and be disinclined to change their initial knowledge, attitudes, and beliefs (Pines and West, 1986; Ballantyne and Packer, 1996; Bransford, et al., 2000; Cocking Mestre and Brown, 2000). Also, Oliver (1991) has suggested this is the least useful approach when the goal is to increase tourist learning and understanding and change tourists' attitudes and behavior.

The second locus of information creation and dissemination lies with the student. A student-centered learning environment is a fundamental tenet of the constructivist approach. Here, students actively acquire the information they need to learn about the subject matter while the teacher acts as mentor or coach. However, the neuro-cognitive research found that it is important for the information the students are acquiring to be connected together and centered around core concepts, which enables them to understand a body of knowledge (Bransford, et al., 2000). Any activities or exercises used should expose students to major features of a body of knowledge and help them develop the necessary skills. The goal of this teaching approach is to have the students understand key concepts and apply acquired skills. Research on this approach has shown that students learn more, enjoy the learning process, and are inclined to change their initial knowledge, attitudes, and beliefs with this teaching approach (Bransford, et al., 2000; Cocking Mestre and Brown, 2000).

The purpose of this study was to compare a constructivist teaching approach to a traditional teaching approach and evaluate how well the constructivist educational

approach works outside of the classroom in a recreation/tourism setting. The goal was to understand which teaching approach had greater impact on scuba divers' knowledge and value orientation associated with coral reefs and coral reef conservation as well as how the divers responded to the two teaching approaches. The research questions were: 1) How do the two teaching approaches change divers' knowledge about coral reefs?, 2) How do the two teaching approaches change divers' value orientations about coral reefs?, and 3) How do divers respond to different approaches of an onboard conservation education program?

## 4.3 Methods

The differences in the locus of information creation for the two teaching approaches (Table 4) determined the formative model for this study (Figure 3). Theoretically, whether the divers are passively or actively engaged in the learning process should make a difference to how much they learn about and care for coral reefs. For the traditional approach, the FGB education coordinator created short PowerPoint presentations and put them on a CD for the Naturalists to use for their 'lectures.' Each session had a different topic the Naturalists were to cover although there was some overlap (see Appendix D). The topics covered were: 1) who administers the Sanctuary and the rules of conduct, 2) coral reef ecology, 3) direct and indirect human impacts on coral reefs, and 4) what individuals can do to minimize their impacts. Once the presentation was finished, the Naturalists invited the divers to ask questions.

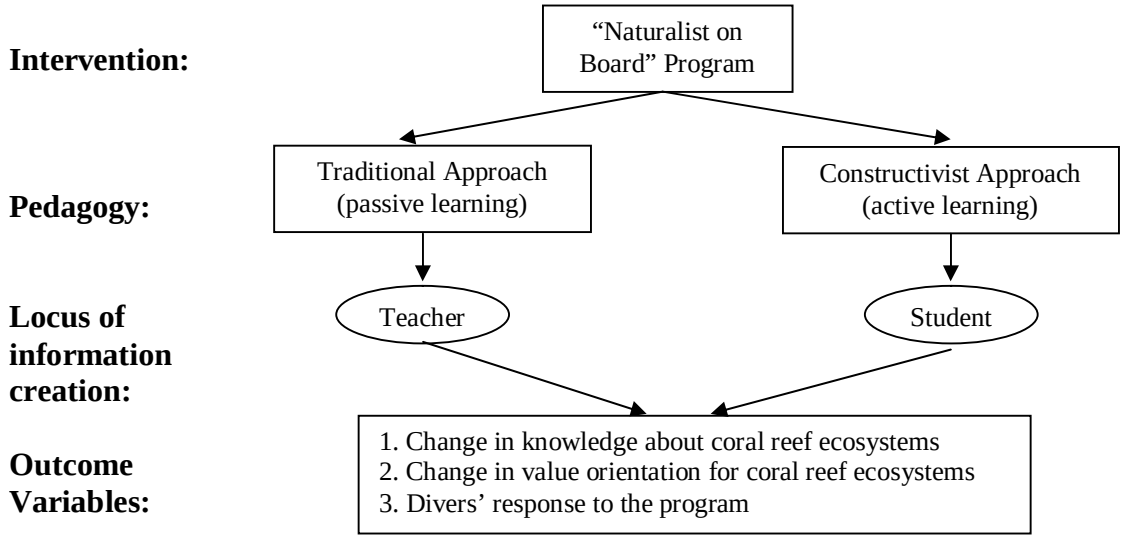


Figure 3: Formative Research Model for the "Naturalist on Board" Program

For the constructivist approach, the FGB education coordinator created "Discovery Cards" to use as the 'hook' in arousing the divers' curiosity. Each Discovery card invited divers to look for a sign of human impact on the next dive (see Appendix C). For example, one card invited divers to look for signs of reef damage from anchors and steel cables. Another card invited divers to find examples of coral bleaching and study it closely. The idea of these cards was that when the divers came back from their dives, they would have questions about their observations and be eager to search for the answers in the resources the Naturalists had on hand. The sessions were managed as an open forum where the Naturalist's role was to encourage the divers to search through the references to find the answers to their questions and to be available to help the find their answers. The divers were also encouraged to share their knowledge with each other and

help each other with finding answers. As a last resort, the Naturalist provided answers when the divers couldn't find them on their own.

The research study was conducted on ten weekend trips to the Sanctuary in 2006 and comprised a total of 453 divers. Of those divers, 166 participated in the Naturalist Onboard program, which represents 37 percent of the total number of divers. Given that participating in the education program was strictly voluntary, not all of the divers completed both pre- and post-questionnaires. As a result, 91 divers completed both pre- and post-questionnaires, which was used for the statistics calculated below.

I used pre- and post-questionnaires, participant observation, and semi-structured interviews to collect the data for this study. The pre-questionnaire was administered before the divers participated in the education program on Saturday morning after the first dive. During the weekend, the divers had the opportunity to participate in seven dives and four to five education sessions. The post-questionnaire was administered after the last session on Sunday. The questionnaires were used to determine the divers' demographics, value orientations, knowledge about coral reefs, and also to get their evaluation of the education program. Each questionnaire consisted of three sections. The pre-questionnaire included a section on divers' value orientation in relation to coral reefs, a second section on their knowledge of basic coral reef ecology and human impacts, and a final section on demographic data. The content of the value orientation and knowledge sections of the post-questionnaire were identical to the pre-questionnaire while the final section asked divers' to evaluate the program.

The material for determining the divers' value orientation was adapted from Vaske and Donnelly's (1999) basic belief statements. I adapted three "anthropocentric" and three "biocentric" basic beliefs directly from the variables Vaske and Donnelly used. The Flower Garden Banks' education coordinator and I developed the knowledge questions based on the Naturalist Onboard's program content she had developed and expected the Naturalists to cover. The first body of knowledge dealt with direct impacts divers have on coral reefs. This body of knowledge covers the same ground as the previous studies done on diver education (Barker & Roberts, 2004; Townsend, 2003). The second body of knowledge dealt with the indirect impacts divers have on coral reefs when they are at home. The third body of knowledge dealt with basic coral reef ecology and their overall health. These bodies of knowledge were most central to the research study because we wanted to see if there is a correlation between increasing divers' knowledge about the ecosystem and their value orientation.

A test run of the questionnaires was done with the Naturalists during their training session. The divers' data does not have a normal distribution so nonparametric tests were used in SPSS 14.0 for Windows for all of the statistical analysis below.

## 4.4 Results

### *4.4.1 Divers' Value Orientation*

The first section of the questionnaire began with a five-point Likert type scale from which divers could choose their basic beliefs about coral reefs. Six statements based on Vaske and Donnelley's (1999) work (see Table 5) were provided along with

the five response options that ran the spectrum from strongly agreeing to strongly disagreeing with the statement. When coding the responses, the response categories were translated into the following categories: 1 = very anthropocentric, 2 = somewhat anthropocentric, 3 = neutral, 4 = somewhat biocentric, and 5 = very biocentric.

Table 5: Comparing Divers' Basic Beliefs

| | Mann-Whitney* | | | Wilcoxon Signed Rank** | | |
|---|---|---|---|---|---|---|
| | *U* stat | *z*-score | *p* value*** | *T* stat | *z*-score | *p* value*** |
| Coral reefs are valuable only if they produce jobs and income for people. | 996.5 | -0.363 | .717 | 9 | -0.205a | .838 |
| Coral reefs' primary value is to provide products useful to people. | 873.5 | -1.337 | .181 | 10 | -1.306b | .192 |
| The value of coral reefs exists only in the human mind. Without people coral reefs have no value. | 868.5 | -1.464 | .143 | 11 | -0.412a | .680 |
| Coral reefs have as much right to exist as people. | 959.0 | -0.598 | .550 | 5 | -1.805b | .071 |
| Coral reefs and people have equal rights to live and develop. | 854.5 | -1.428 | .153 | 11 | -1.126b | .260 |
| Coral reefs have value, whether people are present or not. | 85.5 | -2.036 | ***.042*** | | | |

* = used to make sure basic beliefs are similar before the program
** = used to compare basic beliefs before and after the program
*** = Asymp. Sig. (2-tailed)
a = number of traditional ranks is smaller than constructivist ranks
b = number of constructivist ranks is smaller than traditional ranks

Before any comparisons can be made as to whether there is any significant difference between the two teaching approaches, it is necessary to make sure that the divers in both groups held the same basic beliefs statistically speaking. The Mann-Whitney test was used to compare the two groups' basic beliefs before the program and

the results show that there is a statically significant difference between the two groups for the last basic belief. Because the cause for this difference cannot be determined, only the first five basic beliefs were tested to see if there is any significant difference between the two teaching approaches. The Wilcoxon Signed-Rank test was used to compare the divers' basic beliefs before and after participating in the program to determine whether there is a significant difference in the divers' basic beliefs between the two teaching approaches. The results of this test show that there appears to be no significant difference between them.

### *4.4.2 Divers' Knowledge*

Many of the divers came to the program already knowing about the impacts divers have on corals when they touch them, that corals are not hardy, the overall unhealthy state of coral reefs worldwide, and what hard corals are made up of. Roughly half of the divers knew how hard corals get their nutrition, and the impacts divers have on reef animals. Finally, very few divers knew how many ways coral reefs can be impacted. After participating in the program, there was an overall significant increase in the divers' knowledge about coral reefs.

To determine whether there was any significant association between the teaching approaches and the divers' knowledge, I added all of the correct knowledge responses together for each diver and compared the two teaching approaches using the independent *t*-test. On average, divers who received the traditional approach gained a little bit more

knowledge ($M$ = .68, $SE$ = .217) than divers who received the constructivist approach ($M$ = .52, $SE$ = .231). However, this difference was not significant ($t(89) = -.507$, $p < .05$).

In addition, I set up a 2x2 matrix, consisting of right/wrong answer for the variables and constructivist/traditional approach for the categories, for each knowledge question and used the Pearson Chi-Square test to do the statistical analysis. As can be seen in Table 6, the frequencies show neither teaching approach consistently had more correct answers than the other teaching approach.

Table 6: The Frequencies of Correct Answers after the Program within each Teaching Approach

| | Contructivist Approach Percent correct | Traditional Approach Percent correct |
|---|---|---|
| Scuba divers touching corals can impact them by interfering with or destroying their protective secretions and making them more susceptible to natural and human generated diseases | 90% | 95.1% |
| Corals are not hardy | 88% | 85.4% |
| A coral is made of animal, plant, and mineral | 80% | 87.8% |
| Stony/hard corals get most of their nutrition from the symbiotic algae's photosynthesis | 79.6 | 70.7% |
| Individual divers can impact reef animals by taking flash photos while turtles sleep, feeding the fish, and touching manta rays and sharks | 68% | 75.6% |
| Some of the stressors and impacts that coral reefs are being subjected to include warming ocean temperatures and sea level rise, hurricanes, soil erosion and agricultural runoff, household pollution, boats dropping anchor, and scuba divers touching the corals | 34% | 29.3% |
| Coral reefs around the world today are unhealthy to very unhealthy | 66% | 53.7% |

The chi-square statistics (see Table 7) support this showing that the variables are not related. The Phi measures the strength of association between the two approaches and

reiterates the chi-square statistics. Thus, the results of this comparison show that there does not appear to be an association between the two teaching approaches and divers' knowledge.

Table 7: The Association of the Divers' Knowledge between the Two Teaching Approaches

| | Pearson Chi-Square | | | Phi | |
|---|---|---|---|---|---|
| | $X^2$ | df | $p$* | value | $p$ |
| Scuba divers touching corals can impact them by interfering with or destroying their protective secretions and making them more susceptible to natural and human generated diseases | .832 | 1 | .362 | .096 | .362 |
| Corals are not hardy | .137 | 1 | .712 | -.039 | .712 |
| A coral is made of animal, plant, and mineral | .997 | 1 | .318 | .105 | .318 |
| Stony/hard corals get most of their nutrition from the symbiotic algae's photosynthesis | .949 | 1 | .330 | -.103 | .330 |
| Individual divers can impact reef animals by taking flash photos while turtles sleep, feeding the fish, and touching manta rays and sharks | .639 | 1 | .424 | .084 | .424 |
| Some of the stressors and impacts that coral reefs are being subjected to include warming ocean temperatures and sea level rise, hurricanes, soil erosion and agricultural runoff, household pollution, boats dropping anchor, and scuba divers touching the corals | .232 | 1 | .630 | -.051 | .630 |
| Coral reefs around the world today are unhealthy to very unhealthy | 1.435 | 1 | .231 | -.126 | .231 |

* = Asymp. Significance (2-sided)

### *4.4.3 Divers' Response to the Program*

My participant observation notes focused on the interactions between the Naturalists and the divers to reveal how the divers responded to the two approaches. Overall, the divers who chose to participate in the program were eager to learn more about what they were seeing down below and thus were open to how the material was being presented. This was also reflected in the evaluation section of the post-

questionnaire. However, there were some differences in the divers' response based on the two teaching approaches.

For the constructivist approach, the divers enjoyed the open forum and the discussions that ensued. However, very few divers used the Discovery Cards so the 'hook' that was supposed to get the program rolling did not work. More importantly, the divers were not interested in actively searching for the answers to their questions. They wanted the Naturalist to answer their questions instead. Some of the Naturalists managed to get the divers to look in the references as long as they were there to help the divers find what they were looking for. Some of the divers also stated that they wished there was some sort of formal presentation, like a PowerPoint presentation, that would give them the basic facts about the coral reef's ecology and human impacts.

For the traditional approach, the divers appreciated having the PowerPoint presentations and some of them asked for more detailed information than the Naturalists could give them. However, the last presentation on how people could change their lives at home to help preserve coral reefs was met with stony silence. This session often ended more quickly than the previous sessions indicating that the presentation adversely impacted the divers even though they never said anything about it. All of these sessions stayed within the given time frame of 20 to 30 minutes.

Finally, the Naturalists personality had an impact on how well the programs went. The sessions with Naturalists who had outgoing personalities and were enthusiastic and cheerful were enthusiastically attended by the divers. Throughout these sessions, the divers were fully engaged, animated, and most of them participated in the

discussions. These sessions often ran beyond the proscribed 20 to 30 minutes; some of them lasting well over an hour. In addition, the divers felt very comfortable asking these Naturalists to help with species identification outside of the sessions. Part of the evidence for this phenomenon comes from the many meals I observed where the divers clustered around these Naturalists to talk about various subjects, including species identification, and the number of times and individual diver asked the Naturalist about something. The other evidence comes from divers' comments when asked what they lied best about the program, such as: "The personality of the Naturalist," "Enthusiasm and passion of the Naturalist," "The Naturalists' eagerness to share information," "The Naturalist's friendliness," and "The Naturalist was very personable, had a good attitude and laughed a lot."

The Naturalists who were more quiet and self-contained did not garner the same amount of enthusiasm or participation. During their sessions, divers exhibited less animation and many of them tended to remain quiet while a handful of divers asked questions and engaged the Naturalist in a discussion. In addition, divers did not seek these Naturalists out for help with species identification. These Naturalists often ate meals either by themselves or with a couple of personal friends and were not interrupted by divers seeking help with species identification. Also, the number times an individual diver asked the Naturalist about something was fewer. Consequently, these Naturalists had free time to engage in some sort of personal activity such as downloading pictures from their camera, reading a book, etc.

## 4.5 Discussion

The results of the questionnaires indicate that there appears to be no difference between the two teaching approaches. The Pearson Chi-Square test used to determine whether there is an association between teaching approach and the number of correct answers shows there is no relationship between teaching approach and knowledge. The Wilcoxon Signed-Rank test, used to determine whether there is significant difference between the two teaching approaches in the divers' value orientation, also show there is no significant difference between them.

These results may be due to threats to validity, which had a bigger than anticipated impact. One of the threats consisted of having no control over the assignment of the divers into the two groups. The divers booked their berths through various dive shops and what boat the dive shop signed up for was the boat the divers got on. Another threat was the voluntary nature of participating in the program. Divers came to the sessions when they wanted and left or stayed away when they wanted.

Some of the threats came from the logistics of implementing an education program on live-aboard dive boats. Space is at a premium on boats, which meant that the education sessions had to be held in the main salon. The main salon is where meals are eaten, videos are watched, and individuals work on their computers. Consequently, the sessions had to be held when the salon wasn't being used for other group purposes. In addition, one boat had the appropriate technology to show the PowerPoint presentations for the traditional approach while the other boat did not. So, the Naturalists ended up holding up paper slides as they did their presentations.

There are several other threats regarding the program itself. One is I had little control over administering the program. Another aspect is logistics due to the time constraint. With the sessions lasting 20 to 30 minutes, the Naturalists using the traditional approach managed to get through their PowerPoint presentations and then have a general question and answer forum. However, the Naturalists using the constructivist approach found it difficult to cover all of the material and there was not enough time to work with individual divers as they pursued their own interests. So, they often ended up doing spontaneous lectures. One consequence of this is that the two approaches ended up being very similar. Finally, there is a threat to reliability from the questionnaires being inadequate and/or inappropriate instruments for measuring the difference between the two teaching approaches.

However, the study did generate some insights. One is the fact that the divers were not interested in actively pursuing the acquisition of new knowledge. They liked having the PowerPoint presentations providing canned knowledge and wanted the Naturalist to answer their questions. Between this fact and the fact constructivist teaching approach takes more time (which is in short supply) for the divers to accrue new knowledge than the traditional approach does, it should be accepted that employing the constructivist approach is not appropriate for this type of educational setting.

The second thing learned is the importance of the Naturalist's personality and the level of knowledge they need to do their job well. The divers were more eager to participate in the sessions when the Naturalists' personality was cheerful and outgoing. The conversations became extended and it was evident that the divers enjoyed them –

certainly much more than when the Naturalists were not as outgoing and cheerful. Given that the divers come from a wide variety of backgrounds, interests, and education (although FGB divers tend to be well educated so their level of inquiry tends to be more sophisticated than what you'd expect from the average person) and the Naturalists need to meet the divers where they're at, the Naturalists thus need to know a lot of information and be flexible in what, how much, and to what detail they present the information.

## 4.6 Conclusion

The purpose of this study was to explore whether Bransford et al.'s (2000) work, which incorporated recent neuro-cognitive research into the constructivist paradigm, can be implemented in a non-formal recreation/tourism setting. Two teaching approaches were used to see whether there was a difference in how they changed divers' knowledge and value orientation as well as how the divers responded to them. The difference in the locus of information creation in the traditional and constructivist approaches determined the formative model for this study. The traditional approach used PowerPoint presentations to impart knowledge. The constructivist approach used Discovery Cards to entice divers to ask questions about what they observed below and to search for the answers. Based on the data collected, there does not appear to be a significant difference between the two teaching approaches in the divers' knowledge and value orientation. This may be due to the validity threats mentioned above.

However, there was a difference in how the divers responded to the two approaches. The constructivist approach was not successful in getting the divers to actively acquire new knowledge and had a harder time covering all of the material the education coordinator wanted the Naturalists to cover. The traditional approach successfully covered the material through the PowerPoint presentations. However, there were divers who wanted to learn more than was presented. Another difference was in the length of the sessions. The sessions that began with the PowerPoint presentations had a question and answer period at the end but finished within the timeframe of 20 to 30 minutes. The constructivist sessions were more loosely structured and there was a lot more animated conversation involved. So, depending on the Naturalist's personality, these sessions tended to run over the 20 to 30 minute limit and some of them lasted over an hour.

Despite the limitations of this study, it raises areas for further consideration in efforts to understand the effectiveness of education programs in the recreation and tourism settings. Given that the divers were not interested in actively searching for answers to their questions and the time constraints of an onboard education program, using the constructivist teaching approach did not work well in this non-formal education setting. However, there is a need to further explore how learning with understanding (an important aspect of the neuro-cognitive research), implemented in a modified education program format would make a difference in the knowledge gained and value orientation of the divers. Namely, in what ways and how effectively can learning with understanding change scuba divers' conceptions about coral reefs, and in

turn change their value orientation and subsequent behavior toward same. Another important concept, active learning, could also be explored to discover ways in which the divers would be willing to take control of their learning. With this information, education coordinators and sanctuary managers would be better able to implement effective education programs.

# CHAPTER V

# CONCLUSION

## 5.1 Summary

This study explored whether an onboard conservation education program for scuba divers conducted in the Flower Garden Banks National Marine Sanctuary can significantly increase their knowledge, change their value orientation, and create intentions to change their behavior. In 2006, the FGB's education coordinator upgraded the "Naturalist Onboard" program in order to achieve her goal of promoting a sense of stewardship and ownership toward the FGB so scuba divers would willingly minimize their impact on the coral reefs. I agreed to evaluate the program. My objectives were to see to what degree the program impacted scuba divers and looked at the divers' knowledge, value orientation, if there is an association between knowledge and value orientation, as well as the divers' interactions with the Naturalists and two teaching approaches.

I used two theories to help elucidate this evaluation. The first theory is Orams' (1996 and 1997) model, which provided a framework for upgrading the program as well as describing the interactions between the Naturalists and the divers. The second theory is Bransford, et al.'s (2000) work based on how people learn. This theory was developed for the classroom and I wanted see if this theory can work in a non-formal education situation often found in recreation and tourism settings. In addition, I used Vaske and Donnelly's (1999) basic beliefs instrument in order to determine the divers' value

orientation. The tools I used to collect data were: 1) pre- and post-questionnaires, 2) participant observation, and 3) semi-structured interviews.

The results of this research indicate the people who dive at FGB are twice as likely to be male as opposed to female, are predominantly white, tend to be highly educated, ages range from the teens to mid-60s, and have diving certifications that range from beginner to very experienced. This profile is very similar to other researchers' demographic data.

Orams' (1996 and 1997) model provides a good framework for developing an effective program because it includes motivating visitors to act on what they learn and providing opportunities to act in addition to incorporating the cognitive and affective domains. The results of this study found the Naturalists had a relatively easy time arousing the divers' curiosity and engaging their emotions. Also, the divers were willing to practice appropriate behavior while diving. However, they were resistant to suggestions on how to change their behavior while on land.

The vast majority of the divers who participated in the program held biocentric value orientations, which was determined by their basic beliefs. They gained a significant amount of knowledge about FGB, coral reef ecology, and human impacts on coral reefs. Many divers expressed the desire for more education. There appears to be a small association between having a biocentric value orientation and knowledge acquisition. This possibly indicates that when a diver holds a biocentric value orientation, it bolsters how much he/she learns and his/her intention to protect and

preserve coral reefs. This bodes well for achieving FGB's education goals of getting divers to voluntarily minimize their impacts on the coral reefs.

There appears to be no difference between the traditional and Bransford et al.'s (2000) constructivist teaching approach with regard to diver knowledge acquisition and value orientation. Due to multiple validity threats, such as lack of control over program administration and participation as well as time and space constraints, the two approaches ended up being very similar. However, there was a difference in how the divers responded to the two approaches. First, the divers were not interested in actively acquiring new knowledge, which is a fundamental precept of the constructivist approach; they wanted the Naturalists to be the fount of information. Second, there was not enough time for divers to search for answers to all of the material the program was supposed to cover. Consequently, the traditional approach did better in covering the material and the divers gained the same amount of knowledge. However, the free-flowing discussions of the constructivist sessions were more animated than the traditional approach and often ran over the allotted session time, with a couple of them running over an hour. On the other hand, the traditional approach sessions stayed within the allotted time of 20-30 minutes. This appears to indicate the divers enjoyed participating in the constructivist sessions more than the traditional sessions.

## 5.2 Recommendations

By looking at what worked best and what did not work in this program, and taking into consideration divers' comments about ways to improve the program, a

picture of an education program that meets the divers' needs can be formed. The following recommendations will discuss the best way to structure the sessions and how to develop the subject material for the sessions.

There are two important aspects to the sessions. First, the divers want to have PowerPoint presentations, which represented the traditional teaching approach, to educate them about the coral reef because they were not interested in actively searching for answers to their questions, which is a fundamental tenet of the constructivist approach. Second, they enjoyed having the opportunities to ask the Naturalists questions, which is another fundamental tenet of the constructivist approach, so it is important to maintain this flexibility in the sessions. Consequently, each session should begin with a twelve to fifteen minute PowerPoint presentation. These presentations should help the divers to "see," or understand visually, what the Naturalists are talking about and provide a starting point for the open forum that follows. It is important that the Naturalists do not turn these presentations into formal lectures. Instead, they should share the information being presented and keep the atmosphere relaxed and informal. Once the presentation is finished, the Naturalists should open the floor and invite divers to ask any questions they may have. This allows the sessions to be interactive and meet each diver's needs. Accordingly, both teaching approaches are utilized to their best advantage when the sessions are structured this way.

The divers also mentioned that they enjoyed receiving the handouts and getting the opportunity to touch the coral skeletons. So, it would be a good idea to continue making them available to the divers and possibly add more things for the divers to have

"hands on" experiences with. This would enhance the constructivist aspects of the sessions by getting them actively involved in the learning process. Finally, given how some of the sessions lasted an hour or more, the length of the sessions can be made longer as long as the divers are engaged in them.

With regard to the program content, it would be best to remember that most of the divers are adults and highly educated. Thus, teaching techniques that work for school age children, such as the Discovery Cards, should not be used in this program. Also, given that these divers come to the program with different interests and levels of knowledge, it is best to create multiple presentations so any topic can be covered at different levels of detail. For example, some of the divers who participated in the program had degrees in geology or marine biology. The geologists were interested in learning more about the geology of the salt domes while the marine biologists were more interested in learning about the specific details of the FGB coral reef ecosystem. Furthermore, many divers commented on the relatively basic level of information that had been presented and expressed the desire for more specific and/or detailed scientific information. And yet, other divers stated the level of information was great for them. So, I recommend that the education coordinator create a series of PowerPoint presentations covering as many topics as possible, such as the various aspects of coral reef ecology, the geology of the salt domes they colonized on, and human impacts. These presentations should be written at different levels of detail or complexity, and put on a CD. That way the Naturalists would have the flexibility to use the most appropriate presentation based on the divers' questions and expressed interests. In addition, the more

detailed or complex presentations can be used as references for any individual diver who wants to learn more about a topic than the rest of the group.

The best way to cover the subject material would be to start out with briefly presenting the big picture, or the overarching issues to be covered, and then spend most of the presentations covering the scientific details. As one diver wrote, "educated clientele probably already eco-aware, thus can probably discuss this in more detailed terms because basic message already understood." This study found most of the divers already knew about minimizing their impacts while diving. So there is no need to do more than reiterate the Sanctuary's rules at the beginning of the program. The reasons for diving appropriately can come up when later sessions talk about the delicacy of corals and how they are impacted by humans. This study also found that the divers do not know much about coral reefs so coral reef ecology should be covered in detail. I also recommend using FGB for the topics' examples because divers stated they wanted to learn more about the specific details of FGB's ecosystem, how these reefs originated and their history, the differences between the three Banks and why they are different, the typical fish found on each bank, as well as the specific impacts FGB's reefs are experiencing. With regard to talking about changing divers' lifestyles, I recommend the program just present the scientific facts about indirect impacts, such as the Mississippi watershed, and let the divers make their own inferences as to whether or not they need to change their behavior at home. There could be a PowerPoint presentation on the CD, to be used as a reference, that presents the facts and makes some general recommendations

*just in case* someone specifically asks what he or she can do at home; but it should not be used during the sessions.

Several things became apparent with regard to the Naturalists. First and foremost, it is important for the Naturalists to be friendly, very approachable, and easy going, as well as enthusiastic and passionate about what they are teaching, and eager to share what they know with the divers. The one complaint the divers made was the fact that some Naturalists did not have enough knowledge to answer their questions. Thus, the Naturalists need to have a solid knowledge foundation on both fish identification and coral reef ecology. If they do not know the answer to a question, they should have the necessary references onboard so they can find the answer for the diver.

Finally, several divers made suggestions for expanding the program. One suggestion was to make the pre-dive briefings more detailed by including descriptions of what they should be able to see on that dive and include maps or diagrams of locations of noteworthy wildlife and formations. Another suggestion was to show a video about FGB and the Naturalist Onboard program on Friday night, after the orientation, to grab divers' attention to what awaited them on the trip. The final suggestion was to advertise the program more and make it a selling point for visiting the Sanctuary. In particular, interest could be created with the dive shops and the Gulf-Diving website so divers can anticipate the program when signing up for the trip.

## 5.3 Conclusions

Overall, this research provides a clearer picture of how a conservation education program works in a recreation/tourism setting. The divers want to learn about the coral reefs they are visiting and are willing to minimize their impacts while they dive. Given the time constraints, the Naturalists found it easier to cover all of the material when they used PowerPoint presentations. In addition, the divers appreciated the presentations and wanted the Naturalists be founts of information. But, they also enjoyed participating in free flowing discussions where they could talk about what interested them. In this non-formal learning environment, the divers gained a significant amount of knowledge. Additionally, after the program, many divers stated they were more committed to preserving the coral reefs, which indicates their value orientations were affected by what they had learned. However, their willingness to change did not hold true when the Naturalists talked about ways the divers could change their behaviors while at home. This indicates the divers are willing to change their behavior when it is easy to do so.

Given the divers' desire to learn about what they are seeing when scuba diving, scuba diving businesses should do what they can to expand their conservation education programs. Scuba divers want to visit healthy, vibrant coral reefs.  f they learn what it takes to make a coral reef healthy, they will most likely be willing to do what they can to minimize their impacts while scuba diving. Programs aimed at changing value orientations (rather than just increasing knowledge) may be more important in the long-run for limiting diver damage to coral reefs.

The limitations of this study have created areas for further consideration in efforts to understand the effectiveness of education programs in recreation/tourism settings. One limitation is the fact that data on behavior change was not collected. Consequently, I could not explore the relationship between value orientation and knowledge acquisition beyond determining there is a weak correlation. Determining whether value orientation moderates or mediates knowledge acquisition (Baron and Kenny, 1986) and to what degree would help to further understand this relationship. The finding that the constructivist teaching approach did not work well in this education setting does not mean that aspects of this approach cannot be explored further. In particular, an important aspect of Bransford et al.'s (2000) work is developing programs that focus on learning with understanding; specifically, the knowledge and skills taught are connected together and are centered around core concepts. Bransford et al. (2000) argue that learning with understanding should lead to neural networks changing which in turn should lead to behavior change. Focusing on testing this concept would help to determine whether and to what degree scuba divers' conceptions about coral reefs would change, which in turn should change their value orientation and subsequent behavior toward same. Finally, there is a need to empirically determine whether and to what degree there are actual subsequent behavior changes. Once that is done, future research is needed to see if these results can be obtained from the wider diving population at other coral reef destinations.

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# APPENDIX A

# QUESTIONNAIRES

## Basic Beliefs Section

Please indicate the extent to which you agree or disagree with each of the following statements.

| | | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|---|---|---|---|---|---|
| 1. | Coral reefs are valuable only if they produce jobs and income for people | | | | | |
| 2. | Coral reefs have as much right to exist as people | | | | | |
| 3. | Coral reefs' primary value is to provide products useful to people. | | | | | |
| 4. | Coral reefs and people have equal rights to live and develop. | | | | | |
| 5. | The value of coral reefs exists only in the human mind. Without people coral reefs have no value. | | | | | |
| 6. | Coral reefs have value, whether people are present or not. | | | | | |

**Knowledge Questions** *(The correct answers are in capital letters.)*

1. Scuba divers touching corals can impact them by:
   a. Interfering with or destroying their protective secretions
   b. Making them more susceptible to natural and human generated diseases
   C. BOTH A and B
   d. Displacing marine predators

2. Corals are hardy animals.
   True FALSE

3. A coral is made of:
   a. Animal b. Plant
   c. Mineral D. ALL OF THE ABOVE

4. Stony/hard corals get most of their nutrition from the:
   A. SYMBIOTIC ALGAE'S PHOTOSYNTHESIS
   b. Waste from the fish swimming above the corals
   c. Sunlight
   d. Plankton floating in the water

5. Individual divers can impact reef animals by:
   a. Taking flash photos while turtles sleep
   b. Feeding the fish
   c. Touching manta rays and sharks
   D. ALL OF THE ABOVE

6. Some of the stressors and impacts that coral reefs are being subjected to include: (*circle all that apply*)
   A. WARMING OCEAN TEMPERATURES and SEA LEVEL RISE
   b. Marine predators such as sharks and moray eels
   C. HURRICANES
   D. SOIL EROSION and AGRICULTURAL RUNOFF
   e. Protecting mangroves and other wetlands
   F. HOUSEHOLD POLLUTION (e.g. car oil, household cleaners, fertilizers)
   G. BOATS DROPPING ANCHOR
   H. SCUBA DIVERS TOUCHING CORALS

7. How healthy are coral reefs around the world today?
   a. Very Healthy – in close to "pristine" condition
   b. Somewhat Healthy – experiencing minor amounts of bleaching and disease
   C. UNHEALTHY – experiencing repeated, extensive bleaching and disease but will survive
   D. VERY UNHEALTHY – ultimate survival is questionable

8. Who runs the Flower Garden Banks National Marine Sanctuary?
   a. Texas Parks and Wildlife Department
   B. NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION
   c. National Park Service
   d. The Coral Reef Alliance

9. The overall health of the Flower Garden Banks is considered to be:
   A. VERY HEALTHY – in close to "pristine" condition
   b. Somewhat Healthy – experiencing minor amounts of bleaching and disease
   c. Unhealthy – experiencing repeated, extensive bleaching and disease but will survive
   d. Very Unhealthy – ultimate survival is questionable

**Demographics**

1. Of the following options, what is your highest level of certification? (*circle your answer*)
   a. Basic open water
   b. Advance open water
   c. Rescue diver
   d. Master scuba diver
   e. Divemaster

2. How many years have you been scuba diving in saltwater? _____
3. What is your age? _____ years
4. Are you: Male or Female
5. What is the highest level of education you have achieved? (*circle your answer*)
   a. Middle school
   b. High school
   c. Associate 2 year degree or professional certification
   d. Undergraduate college (Bachelor)
   e. Graduate college (Master)
   f. Postgraduate college (Ph.D., medical, law)

**Evaluation Questions**

1. Did you enjoy the education program? YES NO

2. Did the education program enhance your diving experience this weekend?
   YES NO

3. What was the one thing you learned this weekend that stands out in your mind?

4. The level of information presented in the program was:
   TOO BASIC JUST RIGHT TOO DETAILED

5. What did you like best about the education program?

6. What did you like the least about the education program?

7. Did the program change your concern for coral reefs? YES NO

8. If so – how or in what way?

9. Would you like to see this program continue next year? YES NO

# APPENDIX B

## INTERVIEW QUESTIONS

1. What are your reactions to the education program?
2. What did you like best about the program? Why?
3. What did you like the least about the program? Why?
4. What would you change?
5. Did the education program change your knowledge about coral reefs? How or in what way?
6. Did the education program change your concern for coral reefs? How or in what way?
7. Do you think the dive trip would be more enjoyable with or without an education program? Why?

# APPENDIX C

## DISCOVERY CARDS

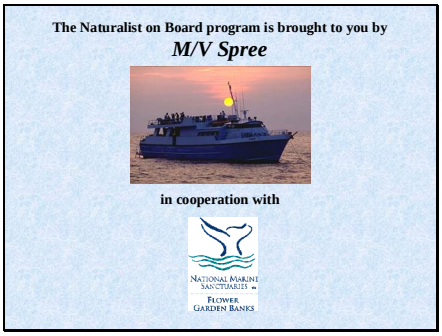
| | |
|---|---|
| Discovery 1<br><br>Observe and note your own, as well as fellow divers' behavior. Back onboard, compile observations on the form provided. | Discovery 2<br><br>Look for and note signs of coral bleaching and/or Disease. Back on board, compile observations on the form provided and compare results from different dive locations during the trip. |
| Discovery 3<br><br>Look for and note signs of trash. Note the type of trash (e.g. plastic bags, fishing line, cans, etc.) | Discovery 4<br><br>Look for and note signs of damage to reef from anchors, chains and associated gear. |
| Discovery 5<br><br>Note & record water temperature and visibility at depths of 15' (at safety stop), 40' (at bottom of weighted hang lines) and bottom at each of the three banks. | Discovery 6<br><br>Count the number of sea urchins and/or queen conch you see during each dive. Record your observations on the forms provided. Compare results from different dive locations during the trip. |
| Discovery 7<br><br>If you can do so safely, without breaking boat rules, note & record the pattern of markings on the underside (ventral side) of any manta rays you see. Back on the boat, complete an observation form & leave it with the captain. | Discovery 8<br><br>If you can do so safely, without breaking boat rules, note & record the pattern of barnacles on the upper side (dorsal side) of any sea turtles you see. Back on the boat, complete an observation form & leave it with the captain. |

# APPENDIX D

# POWERPOINT PRESENTATIONS

## Session One

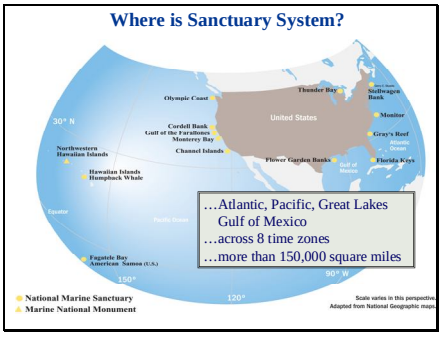
Slide 1



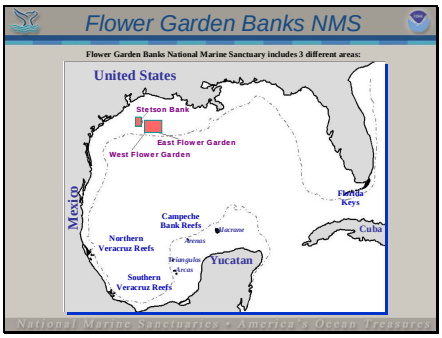

Title slide (emphasize that the Spree is sponsoring the program and the sanctuary helped by providing content and training for naturalists)

Slide 2


Slide 3



Slide 4



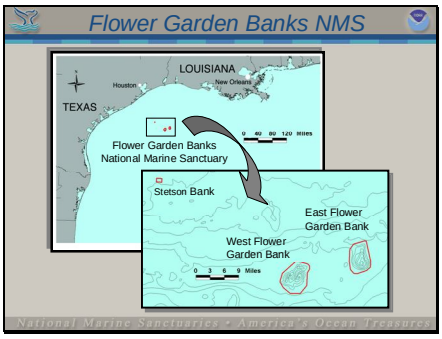

And we're in it - the Flower Garden Banks National Marine Sanctuary

it consists of three separate areas, each with its own boundary coordinates: East Flower Garden Bank, West Flower Garden Bank and Stetson Bank

the two Flower Garden Banks are 12 miles apart and are located 100 to 115 miles southeast of Galveston (almost directly south of the Texas/Louisiana border)

Stetson Bank is located about 70 miles south of Galveston

Slide 5

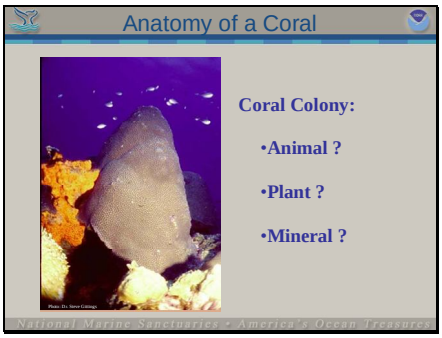



As you can see in this zoomed image, Stetson Bank is considerably smaller than either of the two Flower Garden Banks.

A very small part of the sanctuary, about 1%, is within recreational dive limits.

The primary habitat in that 1% is coral reef at the two Flower Garden Banks and a coral-sponge habitat at Stetson Bank.

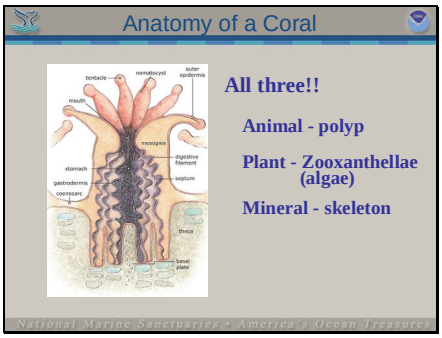
Slide 6




So before we go any further, let's talk about coral structure. This will help us understand why they are more susceptible to certain environmental conditions than are other habitats.

First, exactly what is a coral? Is it animal, plant or mineral?

Slide 7




When we are talking about a whole colony of a reef building species of coral, the real answer is all three.

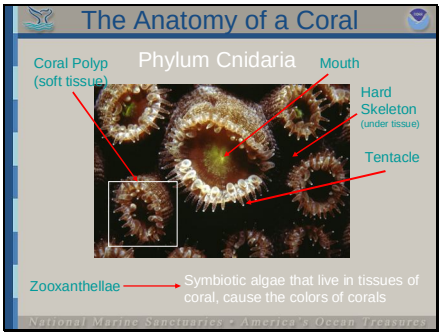
The actual coral polyp is an animal.

It has a plant - a type of algae called zooxanthellae (zoe-zan-thell'-ee) actually living inside it's tissue. This algae uses sunlight and the by-products of coral respiration to photosynthesize sugars which it then shares with the coral polyps. All of the coral polyps in a colony are connected by the layer of tissue that covers the entire colony. This allows the polyps to share nutrients throughout the colony.

The mineral component is the skeleton, which is made of calcium carbonate (i.e. limestone) secreted by the polyps.

Hard, reef building corals are very slow growing. At the Flower Garden Banks, they grow 1 to 2 inches every 2 to 3 years.

Slide 8



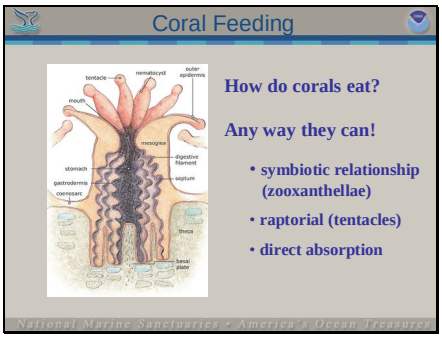

You can see here the structure of individual polyps.

In addition to providing nutrition, the algae is hard, reef building corals show through the translucent tissue of the polyp, giving the coral its color. Most of the corals at the Flower Garden Banks appear brownish green.

Each coral colony started with one individual polyp - about the size of a pin head - that reproduced by asexual methods (splitting in two and/or "sprouting" additional polyps - known as 'budding')

Thus, all of the polyps in a single colony are clones of the original polyp.

Slide 9



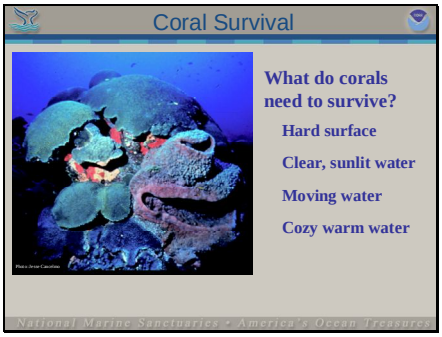

Knowing how corals eat helps us understand how they can be impacted by environmental conditions. Corals have evolved so they obtain their nutrition through several different avenues.

The primary source of nutrition for hard corals comes from the symbiotic relationship with the algae. Remember that plants require sunlight to photosynthesize sugar.

They can also, however, use their tentacles for "raptorial" feeding. Equipped with stinging cells on the tips of the tentacles, corals can reach out and zap tiny plankton floating past.

A third, very minor, nutritional source is direct absorption of nutrients from the water.

Slide 10




Now that you know how corals are constructed, you can probably guess most of what they need to survive:

Hard surface - for the first polyp in the colony to cling when is settles out after hatching so that it isn't washed away or covered with sand

Clear, sunlit water so that the algae have sufficient sun energy with which to photosynthesize sugar.

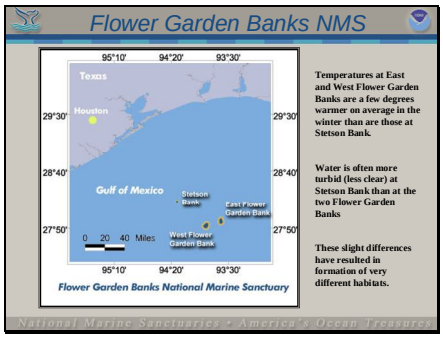
Moving water - to refresh the supply of plankton for raptorial feeding.

Warm, cozy water - although hard, reef building corals have evolved survival strategies that include multiple methods of both feeding and reproduction, they have a very limited range of temperature tolerance. They require temperatures between 68 and 85 degrees F. If temps drop lower than that for extended periods of time, corals will not grow well. If they exceed that for more than a few days at a time, corals will expel their algae - this is called "bleaching" because the color

provided by the algae is no longer there - the tissue is still living, but now it is the white underlying skeleton, rather than the colorful algae, that shows through the translucent tissue.

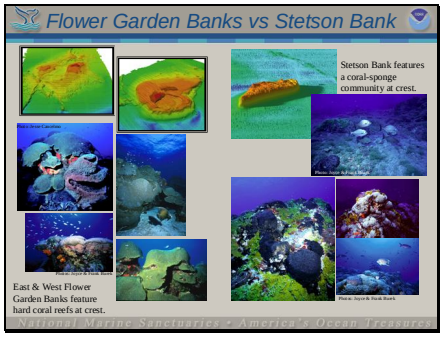
NOTE: soft corals, such as sea whips, tolerate a much greater temperature range and are found in places as cold as the north Pacific

Slide 11




The difference between Flower Garden Banks and Stetson Bank habitats illustrate how drastically a few degrees of temperature difference, combined with slightly higher turbidity, can influence the type of habitat that develops.

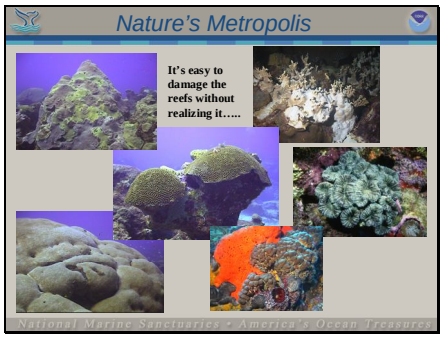
Slide 12




East & West Flower Garden Banks have ALL of the components necessary for healthy coral reef development. Fifty percent of the ocean floor footprint is covered in large, boulder type corals that pile on top of each other in fierce competition for space.

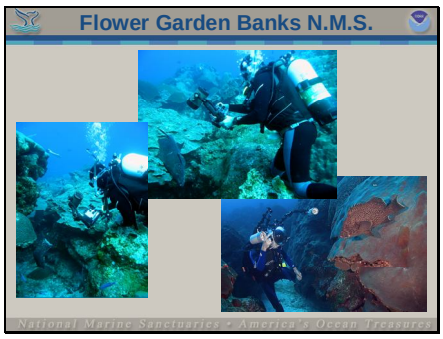
Only 30 miles further north, Stetson Bank's slightly cooler average winter temperatures and slightly higher turbidity make it tougher for reef building corals to thrive. The habitat here is dominated by small, fast growing encrusting corals and has much higher coverage by sponges. Algae is also more plentiful on the surface of the reef, providing a plentiful supply for plant eating animals.

Slide 13




Now that you know a little about how corals function, let's talk about diver impacts to corals. We all obviously appreciate the reefs, otherwise we wouldn't be here.
It's very easy to damage the reefs and their inhabitants without realizing it.

Slide 14




While an anchor crashing into a coral colony and breaking in two is an obvious impact, there are many more subtle impacts from physical contact.

Touching corals may remove protective secretions that help ward off bacterial infections.

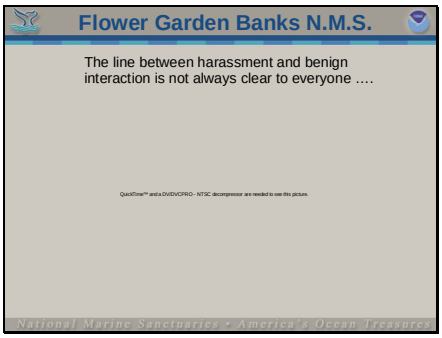
Inexperience divers often have trouble controlling their buoyancy and can crash into corals, damaging their delicate tissues. Or, they may stir up sand in the area, temporarily decreasing the amount of sunlight that can reach the coral colony.

Even experience divers can become so intent on taking that perfect photo or counting those elusive fish that they inadvertently lay across a coral or allow their gear to bump into the coral.

Slide 15


And, there's always the lost gear the ends up on the reefs! Here, you see the strip of dead coral where a diver's weight belt rested for an extended period of time. Even if the belt had been removed immediately, there likely would have been some damaged coral polyps, just from the initial impact.

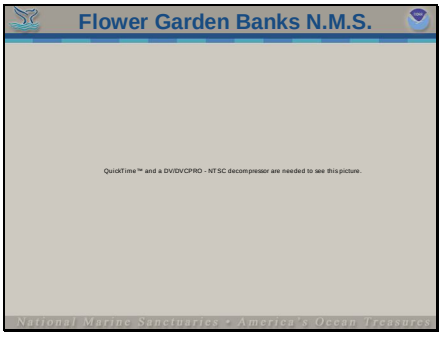
Slide 16




(*video clip)*

Many times, divers interact with the reef residents, not realizing that their actions can indirectly harm the animals. For example, a puffer fish must have some time to recover before it puffs up again. If we've just made it puff up so we can observe it, the fish is then more vulnerable to real predators for a certain amount of time.

Slide 17



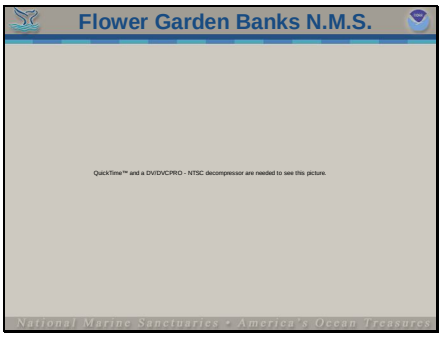

(*video clip)*

Many divers like to take photos or video of the reef animals, especially the larger ones. These animals can't just drive through the local Wendy's for their next meal; they expend great amounts of energy pursuing it. Disturbing their rest by flashing bright lights in the eyes can:

disturb their much needed rest

cause their respiration rate to increase due to the instinctive fight or flight response (think about how your body would react to being jolted out of a deep sleep by something strange shining bright lights around your bedroom!); increase respiratory rate means that air breathing animals such as turtles must surface more frequently, using valuable energy unnecessarily

Slide 18

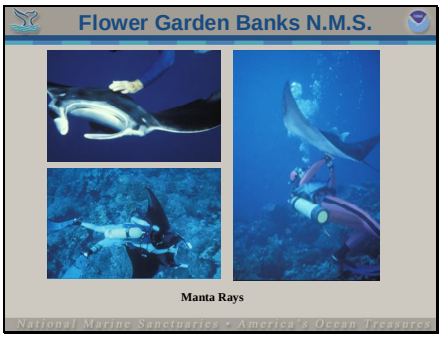



(*video clip)*

This turtle is obviously trying to move away from the videographer, who persists in following it with bright lights.

In addition to being detrimental to the turtle, this behavior on the part of the diver can be construed as harassment under the Endangered Species Act and is punishable with fines. (all marine turtles are protected under the act)

Slide 19

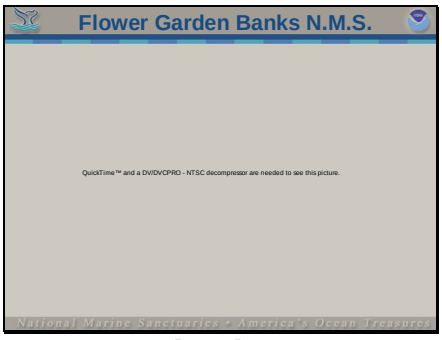



While most divers recognize that RIDING marine animals is likely to harm the animal, we are now beginning to realize that even touching animals can be detrimental to them. Fish, sharks and rays secrete a slime that is believed to protect them from bacterial infections. Anecdotal information from the Pacific indicates that manta rays in areas where they have a lot of interaction between divers exhibit increased incidence of lesions. While this may result all, or in part, from other impacts as well, we prefer to take the conservative approach and avoid touching the animals.

But, you argue - "the mantas in the sanctuary LIKE being petted!"

While this does seem to be true in some cases, remember…. Just because they LIKE it, DOESN'T mean it's GOOD for them! I like junk food, too ……

Slide 20

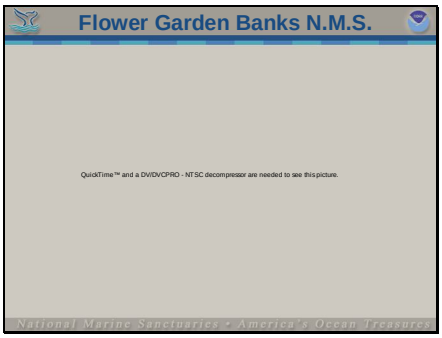



(*video clip)*

Just another example of inappropriate interaction….

While we can't know for certain (since we can't communicate with manta rays), it's possible that having a diver present above it, placing even a light pressure on its back, can make a manta respond by swimming ever closer to the reef in an effort to 'shake' the diver.

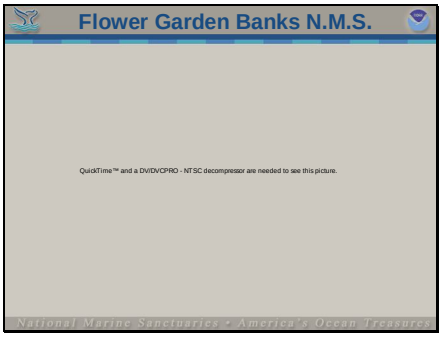
Slide 21




(*video clip)*

Again - whale sharks secrete a protective slime --- petting the shark can reduce it's natural protection.

Slide 22

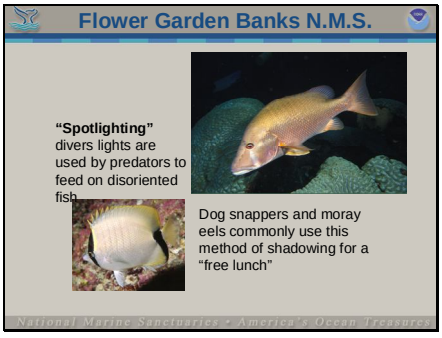



(*video clip)*

And, trying to cram a video camera into a whale shark's mouth interferes with it feeding, since it feeds by opening its mouth and allowing the plankton laden water to flow through, filtering the plankton out while allowing the water to flow on through.

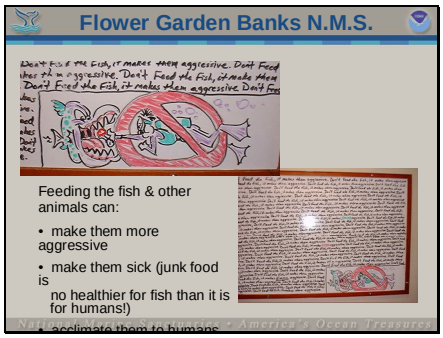
Also, while this whale shark is small enough that a diver is unlikely to have body parts inadvertently sucked into its mouth, that is not the case with all whale sharks. It just doesn't make sense to put yourself in front of a 30-foot-long animal evolved for the water environment and assume you won't be injured! If nothing else, a sudden movement by a large whale shark could knock a diver for a loop.

Slide 23



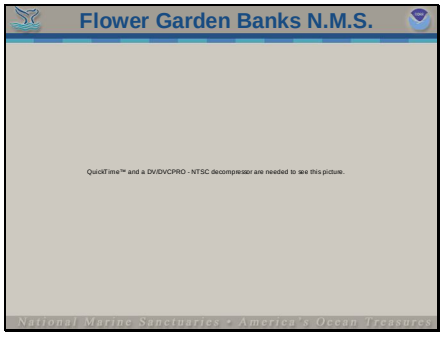

When divers focus their lights on fish such as this little reef butterfly fish (lower left), the sudden brightness can disorient the fish, allowing predators like the dog snapper to swoop in for a "free" meal. In addition to putting the butterfly fish in peril, this demonstrates how human actions can alter natural fish behavior.

Slide 24




Which leads us to feeding the animals!

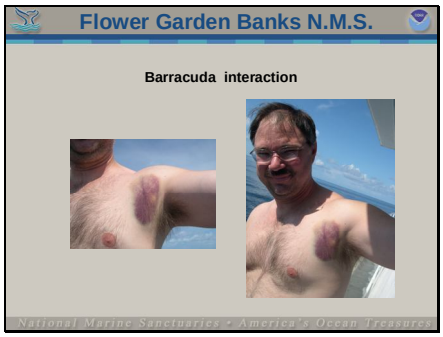
Slide 25




(*video clip)*

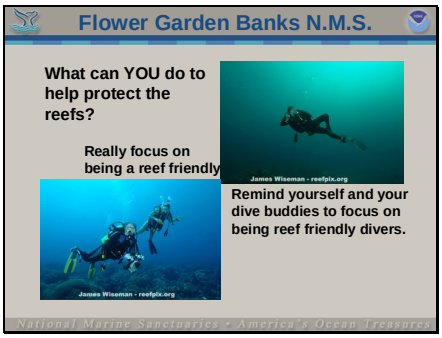
Here's a demonstration of how diver interaction with animals can also put the diver at risk. In this video, the barracuda is startled by the photographer's bright lights…….

Slide 26




And here's the result….. The 'cuda rammed the photographer, causing a nasty bruise. Luckily this was minor injury.

Slide 27



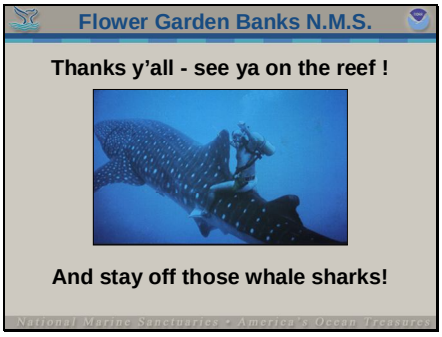

So, on your next dive - be aware of these issues and really focus on being a reef friendly diver.

We have some discovery activities that you may want to do during your next couple of dives. One of them is an exercise in observing your own and other divers' behaviors. This is not intended to embarrass or chastize anyone - it's simply an exercise to make us all more aware of how we dive.

If you are not interested in that particular discovery activity, there are a number of others. I encourage everyone to pick one of the activities and do it during your next dive. I'll be happy to go over them with you and provide additional explanation for anyone who's interested.

During our next session, we'll combine everyone's observations and talk about what we saw.

Slide 28



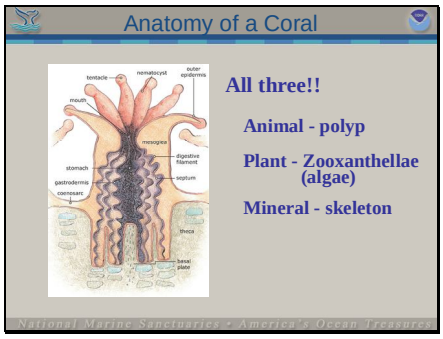

Slide 29


As always, thanks to all of our photographers for their generosity in sharing their work!

**Session Two**

Slide 1

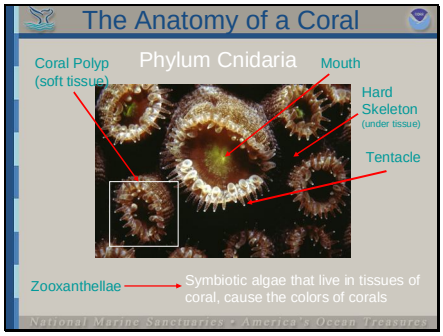

Slide 2




Start the session off with a discussion of what people observed during their previous dives on this trip. If they've filled out observation forms, compile their observations on a single form. Your choice as to whether you post it or just use it as a discussion prompt.

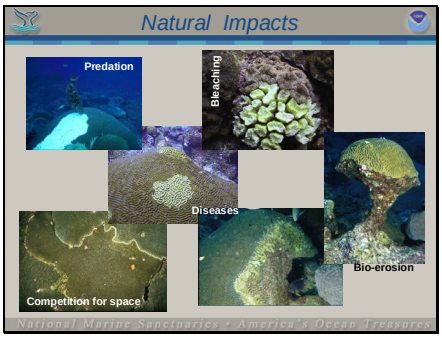
Review of coral anatomy (see Session 1 notes) - as you move into the slide about impacts, relate how coral structure and biology make corals vulnerable to these specific impacts. (e.g. the symbiotic relationship between coral and zooxanthellae means that zooxanthellate corals can't thrive in murky water.)

Slide 3




Review coral anatomy (see Session 1 notes)

Slide 4




Corals are subject to natural impacts, as well as those from humans.

Parrot fish eat coral, tissue & skeleton all (top left - predation)

Corals compete with each other for space on the reef, with the polyps along the outer edge of one colony reaching out to nibble on the adjacent colony and make room for their own colongy to gro (lower left)

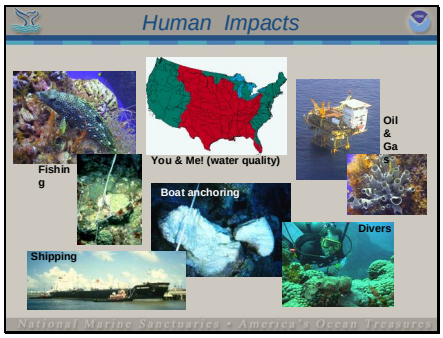
Coral colonies are shaped and impacted by a variety of factors, including bio-erosion from predation and worms anchoring themselves by boring into coral heads and physical erosion by waves and currents. (far right)

Like humans, corals are subject to typical diseases. Just as humans survive such dieseases as measles and mumps, corals can survive diseases typical to their species (middle and lower right).

Coral bleaching is also a natural phenomenon in which the coral polyps expel their symbiotic algae in response to elevated water temperatures.

Corals can generally recover from these natural impacts, provided their immune systems have not already been compromised by outside factors such as poor water quality or the removal of protective secretions.

Slide 5




Coral reef systems are also subject to both direct and indirect impacts from humans, including:

Careless fishing techiques that over harvest the populations, damage the corals directly and/or leave behind gear that entangles fish unnecessarily.

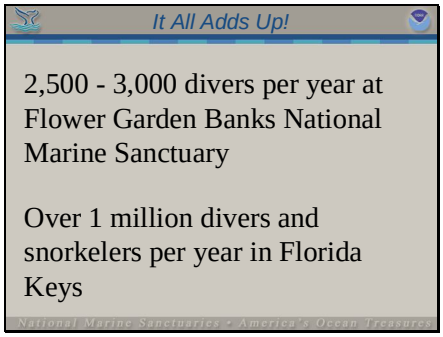
Damage from boat anchoring (from either direct users of the reef such as divers and fishers or indirect users such as large vessels that pull out of the shipping fairways to anchor on the shallower reef areas.)

Oil and gas exploration, production and transport have the potential to impact the reefs through chronic minute toxic discharges or single incidents such as spills.

Damage to the corals and other reef animals by divers that we've already discussed.

One of the most chronic and long term - yet not easily seen during a short time frame - impacts is poor water quality which is caused by human activities both in the water and on land. Note that 2/3 of the continental U.S. drains into the Gulf of Mexico!

Slide 6




While it may seem silly to be concerned about one diver touching a coral now and then, think about the cumulative impacts.

If each of the 2,000 divers in the sanctuary pick up just one shell, that's 3,000 shells removed from the sanctuary each year. Or, if each of those divers pet a manta ray just once, that's 3,000 times that protective slime has been removed.

So far, the Flower Garden and Stetson Banks have managed to remain relatively healthy. But, the annual minor bleaching episode from which our corals usually recover quickly was much more wide spread in the couple of years and was followed by the most severe

outbreak of coral diseases ever seen here.

And, think of other, more heavily visited places, such as the Florida Keys. What is good stewardship here is good stewardship for all of our reefs.

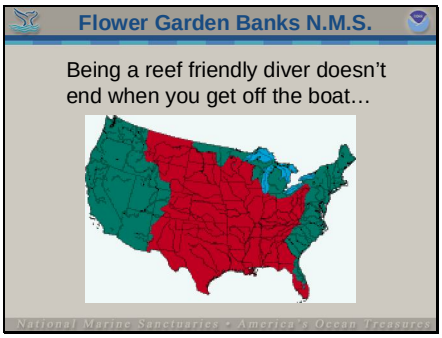
Slide 7


Thanks once again to our photographers.

**Session Three**

Slide 1

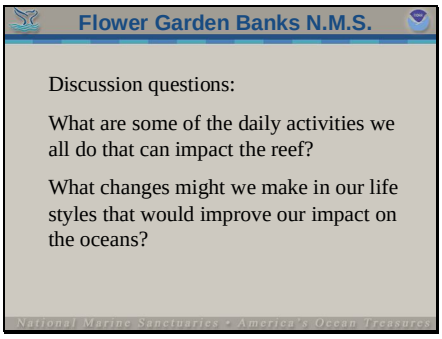
Slide 2




Our impacts to the reefs and ocean do not end when we dock. Our daily life styles have a lot more impact on the oceans than do our brief visits underwater.

If you live within the red area on this map, then every time you flush your toilet, it eventually ends up in the Gulf of Mexico. When you fertilize your lawn, or allow your vehicle to drip oil, or rinse household cleaners down the drain, it all ends up in the Gulf.

Slide 3




Allow participants to come up with their own ideas first. Emphasize that you don't have to change every habit all at once. Changing just one habit is a step in the right direction. If needed, you can prompt the conversation with some of the following suggestions:

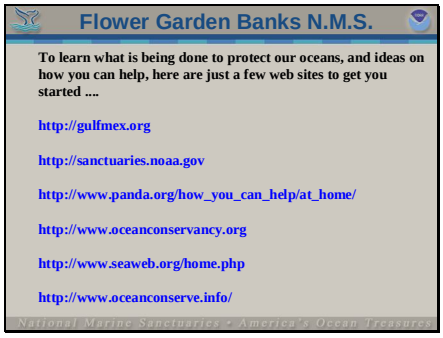
- turn off the water faucet while your are soaping your hands or brushing your teeth
- gradually convert your lawn/landscape to plants that require little or no watering, fertilizer, or pesticides - native plants are generally the best adapted to an area and require the least amount of maintenance; this can also reduce the need for mowing a lawn, thus reducing fuel consumption and air pollution
- carpool, walk, or bike whenever possible - not only will this reduce green house gas emissions, these days it mean some decent $$ savings that can then be used to pay for more dive trips!
- turn your thermostat up a few degrees in summer or down a few degrees in winter
- when you are upgrading or renovating your home, look into energy saving options
- use cloth grocery bags instead of getting a carload of plastic bags every time you shop; in addition to reducing consumption, this will help keep plastic out of the waterways

Slide 4


The myfootprint website asks you to enter some basic information about your lifestyle. Then, it calculates how many worlds it would take to maintain that lifestyle if everyone lived the way you do.

Cards in the naturalist kit have these web URLs on them = hand them out to those interested.

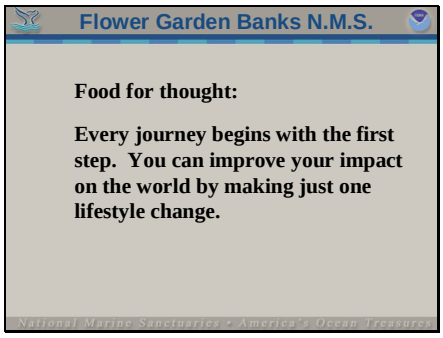
Slide 5




These are some interesting web sites you can visit to learn more. There are cards in the Naturalist kit that have all of these websites on them.

Also - refer to the list of ways to help the watershed, included in the Naturalist kits.

Slide 6




If you're comfortable with it, encourage people to pick one lifestyle habit they can change to reduce their impact on the oceans.

Don't want to be preachy - do want to make it clear that individual action is required if we expect to reverse the decline of oceans.

If you're not comfortable with it --- don't worry about it. Just leave the last image on the screen long enough for people to read it.

# VITA


| | |
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