LOCAL ECOLOGICAL KNOWLEDGE, LIMITATIONS, AND PERCEPTIONS OF CONSERVATION AND MANAGEMENT OF SMALL-SCALE COMMERCIAL FISHERMEN IN BISCAYNE NATIONAL PARK

By

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By

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Decline in fish stocks and degradation of marine habitats are growing problems facing many areas of the world. In addition to quota restrictions, ecosystem-based approaches are being applied to management plans. Recently, there has been more attention placed of the value of studies on the fishermen, including documentation of local ecological knowledge, cultural aspects, factors influencing fishermen behavior, and projects involving co-management.

This study used qualitative data collection and analysis to examine the local ecological knowledge, limitations, and perceptions of the small-scale commercial fishermen working within Biscayne National Park, Florida. I collected data through interviews with fishermen in addition to participant observation and informal conversations documented in field notes. Local ecological knowledge was coded into life cycle, diet, predation, habitat, seasonality, and taxonomy.

The knowledge of the fishermen was broad and pertained to how and where they fish. When compared to existing scientific knowledge on the target species (blue crab, stone crab, spiny lobster, and bait shrimp), local ecological knowledge was similar except on the topics of spawning and age of sexual maturity or harvest size. External factors that affect or limit the fishermen's behavior included theft, environmental seasonality, and market. Within the fishing community, I found that secrecy and the social network play important roles in transmission of knowledge and how the fishermen work. Perceptions of conservation and management were also documented, including concerns discussed by the fishermen. While the fishermen understand the importance of conserving the marine resources of Biscayne National Park, they place more value on the continuation of commercial fishing in the park. Each major finding was discussed in the context of implications for fisheries management at the park and in the context of common property management. In addition, emphasis is placed on the importance of collaboration between managers and fishermen, and suggestions for improving this relationship are offered.

CHAPTER 1
INTRODUCTION

Statement of the Problem

Due to increasing pressure on the world's marine resources, fisheries management is becoming more important for the conservation of the resources. Since 1950, there has been a 400% increase in world fishery harvest (Food and Agriculture Organization of the United Nations 2004). However, fisheries management is a complicated process. Marine environments are dynamic and fisheries biologists may disagree on research findings. Furthermore, perfect satisfaction of data needs will rarely occur due to limited resources and time (Johannes 1998); managers must also consider economic and social consequences during the planning process (Walters and Martell 2004:6). Many marine systems are treated as open-access resources and common property, adding more stress to the duties of managers because they must address the issues and complications of ownership, access rights and availability (Rousefell 1975:249). Yet scholars still have confidence in the potential of fisheries management, as the science is evolving continuously (Johannes 1998).

Some fisheries management schemes have not produced the desired results of restored stocks and sustainability. New concepts have begun to emerge, including adaptive management, ecosystem management, and responsible fisheries. These types of management are based on participation from users, who may have useful knowledge of the ecosystem and who are more likely to support and comply with regulations when they are a part of the process (Jentoft et al. 1998). With local participation, managers can also

determine the conservation ethic of the user groups (to identify appropriate educational plans) and utilize fishermen in ongoing data collection and monitoring research (Johannes 1998).

Local fishermen have developed, over many years and from firsthand experience, an understanding of the ecosystem on which they rely (Baird 2001). In some cases, fishing communities have been able to reduce overfishing through self-management (Acheson 1988; Smith and Berkes 1991) and formed agreements among the local community members to avoid gear conflicts and assist one another during difficult times (Acheson 1981), based on local ecological knowledge. Combining local ecological knowledge with scientific data is an alternative for fisheries management that may help reach the desired goal (Gosse et al. 2001).

The marine resources at Biscayne National Park are also recognized to be in peril, based on scientific data and from observations of park users and staff (Todd Kellison, personal communication). A fisheries management plan is currently being developed by the park. Community participation in the planning process exists in the form of public meetings and via local representatives of the commercial fisheries appointed to the Biscayne Working Group—a panel made up of fishermen, scientists, divers, government officials and others—that was established to provide recommendations for and comment on the management plan. However, little research has been conducted on the local commercial fishermen at Biscayne National Park and their roles in the ecosystem (EDAW:6.3 2003). This thesis will examine what commercial fishermen at Biscayne National Park know about the ecology of the marine resources, internal and external

limitations that influence behavior and success, and perceptions of the current status of the environment and government management.

Research Objectives

The overall objective of the study was to characterize the Biscayne National Park fisheries in a natural and cultural context from the viewpoint of the fishermen. The specific objectives were to:

- document local ecological knowledge that contributes to fishing success.
- describe factors (other than government regulation) that affect behavior and limit harvest of the target species.
- identify fishermen's perspectives on conservation and management.

I did not set out to test hypotheses or compare the fishermen in terms of specific variables, but to document their knowledge about the resource, observations and concerns, and the basics of how each fishery functions on a cultural and economic level. Although much research has been conducted on the marine resource itself over the past few decades, there has not been an in-depth study of the Biscayne fishermen themselves.

Limitations of the Study

The first limitation of the study was my status as an outsider. I was in the field for three months, and although welcomed into the community, I constantly had to reassure my informants that I did not work for the park. Seldom was I able to walk into an interview without a full explanation of my motives. In addition, I am sure that all of the responses given were not always truthful; at times, I was requesting my informants for their secrets of success, and I am certain I was not given all the details in every response.

One aspect not covered by this study is my interaction with Hispanic captains. From resources on the commercial fisheries in the park, I was under the impression that

there were very few Latinos working in Biscayne National Park and had not prepared an informed consent document in Spanish. Once I realized that this status had changed over the past year, I submitted a request for permission to use a consent document in Spanish to the University of Florida Internal Review Board, but did not receive approval in time to approach any Hispanic captains for interviews. Therefore, the study focuses on the body of knowledge of longtime Anglo fishermen.

I conducted my research during the hurricane season of 2005, which was the most active hurricane season in the history of the United States. While there were no direct hits during my fieldwork, south Florida did experience harsh weather at several times throughout the summer. Scheduled interviews took a back seat to preparation for and recovery from these events, at which time I was not able to contact the fishermen for periods ranging from a few days to two weeks.

Finally, the most substantial limitation is that the research only captures the fishermen of Biscayne National Park as a snapshot in time. The fisheries have been established for many decades and subsequently, as people come and go, information may be lost or forgotten.

Overview of Thesis

The manuscript will describe knowledge about the local biophysical environment from the viewpoint of the commercial fishermen of Biscayne National Park. Chapter 2 is a literature review of approaches to the study of local ecological knowledge and marine anthropology and considers the implications for management of engaging the knowledge and participation of fishermen. Chapter 3 describes the background and current situation of the marine resources and commercial fisheries, and a description of Biscayne National Park. Chapter 4 explains methodology used for collecting and analyzing data, which

included interviews, participant observation and reviewing secondary data. Chapter 5 provides the results of my study, including local ecological knowledge, internal and external factors limiting the fishermen, and perceptions of the current situation of the resource and management. Chapter 6 includes implications for management and scientific research based on the observations and knowledge of the fishermen, plus suggestions for further involvement of the fishermen in research and planning. Overall, my thesis will provide a closer look at the culture of the fishermen, what they know and how they know it, and hopefully provide a additional base of knowledge to the scientific research being conducted in the bay.

CHAPTER 2
LITERATURE REVIEW

Despite progress in fisheries science, the majority of the world's fisheries continue to decline. A paradigm shift in how marine resources have traditionally been managed is needed and focus is shifting towards both ecosystem-based management and collaboration with resource users (Hilborn et al. 2004; Link 2002; Mackinson and Nottestad 1998; Spain 2000), particularly small-scale commercial fishermen.

The following theoretical framework provides support for my research conducted on the Biscayne National Park fishermen. It examines these new directions for fisheries management and how research on and with local fishermen can be used in planning. The framework also examines concepts and previous studies on local ecological knowledge, and how this knowledge is useful by expanding the information base of a specific area. Next, it outlines how documentation of local ecological knowledge provides insight on fishermen's strategies, success, and behavior. The discussion of ecological knowledge is followed by a review of literature on the self-management of fishing culture. The chapter concludes with a summary of how research on fishing communities is useful for fisheries management.

Fisheries Management

The Magnuson-Stevens Fishery Conservation and Management Act was amended in1996 to include the goal of maximizing fisheries benefits but also sustain the industry for long-term viability. It recognizes the economic and social potential of United States fisheries, but also the limitations of exploitation (U.S. Congress 1996). In 2005, the act

was modified with the Fisheries Science and Management Act. The enhancement included improved use of science, training for council members, and equal representation of user groups on councils. Furthermore, the amendments encourage an ecosystem-based approach and increased collaboration with fishermen for cooperative research (U.S. Congress 2005).

The Enhancement Act calls for more emphasis on an ecosystems approach. Contemporary fisheries management is often based on a single-species approach and is grounded in scientific data, which is sometimes leads to little or no improvement in the resource following implementation of management plans (Link 2002). Finding a stock to be below its expected population level, then placing limitations on harvest might seem to be the logical route to conserve a species, but this only treats a symptom of a larger problem within the entire system (Hilborn et al. 2004). Resource users are not the sole source of any problem in a marine environment. The system in which a target species lives is complex and connected. Often, changes in the habitat or food web are also the results of degradation caused by pollution, development, man-made water flow restrictions, and other anthropogenic factors. These changes most likely have a similar or greater impact on the marine organisms than fishing, and should also be considered when developing a management plan (Spain 2000).

Fisheries do not exist without the resource users, and managers must take into account the social, cultural and economic aspects of a fishery in addition to the biological and ecological factors, i.e., the human ecosystem. A human ecosystems approach to fisheries management would consider the human and non-human components, system dynamics, and resilience of the resource and resource users (Abel and Stepp 2003). A

system so complex with so many working factors cannot be evaluated with focus on a single stock of fish; all facets must be examined.

Despite its importance and attention, ecosystem-based management must overcome a major obstacle: funding. Monetary resources for data collection in fisheries management are inadequate, even to carry out basic research (Spain 2000). A shift to ecosystem-based management, which considers complex interactions of all organisms within a system, is even more expensive (Link 2002). Considering not only the population of a target species but also its predators, prey, habitat, migration, life cycle, etc., requires much more time, money, and manpower. However, there is a largely untapped resource available to fisheries managers that is based on years of observations, easily consolidated and as accessible as the target species themselves: local ecological knowledge of the fishermen.

Local Ecological Knowledge

Local ecological knowledge is defined by Olsson and Folke (2001) as "knowledge held by a specific group of people about their local ecosystems…[and] may be a mix of scientific and practical knowledge." Studies have been conducted on local ecological knowledge of many different biophysical environments and in many different areas of the world. In the past few decades, the value of local knowledge to conservation measures and resource management plan has received more attention by anthropologists, ecologists and other interest groups (Berkes et al. 2000). Likewise, conservation of marine resources has spawned an interest and recommendation for documenting local ecological knowledge of small-scale fishermen.

The knowledge systems of fishermen are specific to their locations and conditions, and are an accumulation of information over long periods of time (Table 2-1). They are

based on empirical information about the biophysical environment, habitat, behavior of the target species, and ecological interactions (Ruddle 1994). Local ecological knowledge is developed over many years and comes from firsthand experience, and is also transmitted orally between the fishermen and to subsequent generations (Baird 2001) or through shared experiences (Berkes et al. 2000). Along with general observations, fishermen commonly formulate theories on the processes that they witness: the 'why' in addition to the 'what' (Gasalla 2001).

Documenting local ecological knowledge is a useful way to broaden the resource management knowledge base and therefore strengthen the logic behind fisheries management (Figure 2-1). Although it may not be collected, analyzed, or interpreted in the same way as scientific knowledge, it is still a viable source of information that can be used in addition to studies conducted by trained marine researchers to fill in gaps and suggest emerging problems (Scholz et al. 2004). Local ecological knowledge comes in a compiled form; it is the accumulation of previous generations and the present network of fishermen working in an area (Mackinson and Nottestad 1998). Finally, the opportunity to share knowledge, and possibly gain a better understanding to improve their own fishing abilities, generates local fishermen's enthusiasm for involvement (Baird 2001).

The complex qualities of ecosystems requires a complex understanding, including dynamics, interactions and adaptation, in order to properly manage them. Local knowledge systems are in themselves complicated and ever-changing (Acheson and Wilson 1996) and consider all aspects of the resource: cultural, economic and ecological. Several studies have examined the value of local ecological knowledge for management

of the complex marine resources (Acheson and Wilson 1996; Aswini and Lauer 2006; Berkes et al. 2000; Olsson and Folke 2001).

A benefit from documenting local ecological knowledge is that it also leads to understanding the behavior of the various user groups (Mathiesen 2004). What a fishermen knows will dictate when and where he fishes, in both the long and short term, and he must have a profound understanding of the resource to be successful (Acheson 1981).

Informal and Co-management

There have been many studies of the role of local ecological knowledge in the development of co-management schemes for marine resources, both in the United States and other areas of the world. Examples include the development of marine protected areas (Aswini and Lauer 2006; Scholz et al. 2004; Well et al. 2004), data collection on spawning and migration (Gosse et al. 2001), population monitoring (Baird 2001), and biodiversity sampling (Poizat and Baran 1997).

Informal self-management at the community level is based on local ecological knowledge of the group and a product of social mechanisms of a culture (Acheson and Wilson 1996, Berkes et al. 2000). Some examples of self-management are similar to conventional management, such as monitoring, temporal restrictions, and single-species selection; examples usually not part of conventional management include ecosystem-based approaches and resource rotation (Berkes et al. 2000).

There is a growing body of literature on a variety of social mechanisms and local ecological knowledge of fishing communities. Acheson (1988) discussed informal territory among lobster fishermen in Maine and how these informal ‘property rights’ affect the sustainability of both the resource and the lobster industry. Temporal

restrictions of harvest of sea urchins in the West Indies allow populations to recover during the socially enforced closed season (Smith and Berkes 1991). Johannes (1998) pointed out the value of local ecological knowledge of Indonesian fishermen in the planning of management schemes based on local knowledge of spawning location and times. In Brazil, fishermen not only recognize changes in the ecosystem, but also formulate their own theories about them (Gassala 2001). Religious beliefs are found to be the basis of many fishermen's perceptions of ecological processes in Chesapeake Bay (Paolisso 2002). Studies have been conducted in many parts of the world, and also cover other resource management areas such as forests and wildlife (Berkes 1999; Pinkerton 1998).

One of the most prevalent themes in this literature is that local management tends to regulate "how" fishing is done, including limitations on seasons, location access, technology, and harvest during a specific stage in the life cycle of a species. This is in contrast to the method of quotas, in which fisheries managers regulate resource use by limiting "how many" fish can be caught. The use of quotas is the most important concept in fisheries management, but absent in almost all local management (Acheson et al. 1998; cf. Walters and Martell 2004:65).

The 'tragedy of the commons' is a popular topic of debate for anthropologists studying fishing communities (Hardin 1968). Berkes (1985) outlined the three assumptions of the 'tragedy': users are selfish and personal gain trumps public interest; resources are limited and harvest exceeds regeneration; and the resource at stake is open-access and public property. Commercial fishermen may fit these assumptions and contribute to degradation of the resource. However, many communities have sustained

stocks and marine ecosystems without formal regulation or introduction of private property. Social factors and cultural norms can also influence the behavior of the fishermen and thus, limit harvest (Berkes 1985).

Summary of the Literature

Fisheries management requires research, planning, and implementation. Each aspect of management has the opportunity to utilize and collaborate with the resource users, especially small-scale commercial fishermen. A compilation of years of experiences and intergenerational transmission, local ecological knowledge contributes to the database of information about the resource, from biodiversity to habitat change to effects of human impacts. Additionally, knowledge dictates fishermen behavior and can help fisheries managers identify fishing effort by the fleet and areas subject to greater exploitation. Finally, cultural aspects of a fishing community, including internal and external factors that limit the fishermen or affect their behavior, should be considered by fisheries managers when planning to assess potential economic and social impact on the user group. Fisheries are made up of fish and fishermen; both species should be equally as important when making management decisions.

Table 2-1: Summary of main characteristics of local ecological knowledge of fishermen (Ruddle 1994).

1. Knowledge is based on long-term, empirical, and local observation, and is adapted to local conditions.
2. Knowledge is based on practicality and drive fishermen behavior.
3. Knowledge systems have structure; this complements scientific concepts.
4. Knowledge systems are dynamic and adapt to changes in the system (environmental or economic).

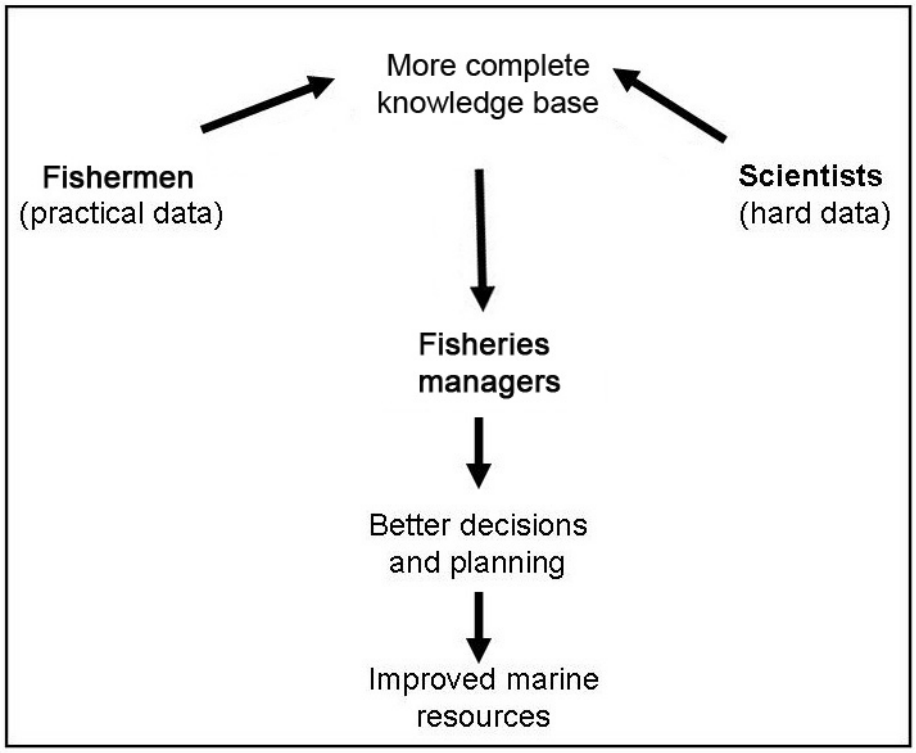


Figure 2-1: Combining information sources of fishermen and scientists to increase knowledge of the marine resource (adapted from Mackinson and Nottestad 1998).

CHAPTER 3
RESEARCH CONTEXT AND STUDY SITE

This chapter provides background information on fishing in Florida, including current commercial fishing regulations and the ongoing struggle between small-scale commercial fishermen and recreational anglers. A brief description of the history, environment, and marine resources of Biscayne National Park follows. The chapter concludes with a summary of scientific literature on life histories of each target species, which will be compared to the local ecological knowledge of the fishermen in the discussion section.

Fishing in Florida

Florida has a coastline of over 1,900 km, and saltwater fishing has figured as a prominent way of life since the earliest people inhabited these shores. Recreational fishing is of major economic importance to the state, spawning activity from local bait shops to charter guides to national fishing equipment companies. Commercial fishing also contributes to the economy to a lesser extent, but continues to be particularly salient in the social and cultural aspects of the state's past and present.

The Florida Fish and Wildlife Conservation Commission (FWC) was established in 1999 and resulted from a merger of several state agencies responsible for overseeing fish and wildlife (FWC 2005a). Along with the Division of Marine Fisheries, the FWC regulates and monitors the marine resources of Florida and of all commercial and recreational activities in Florida's coastal waters.

Current Commercial Fishing Regulations in Florida

Several permits are required for commercial fishermen in Florida (Table 3-1). All fishermen must obtain a Saltwater Products License, which can be purchased for an individual or for a vessel. Harvest of many species—including blue crab, stone crab, spiny lobster, and shrimp—entails a Restricted Species endorsement. This endorsement requires that the fisherman previously reported landings through the trip ticket program. The four crustaceans also require additional specific certificates, and crab or lobster traps must have appropriate tags attached to them. Federal permits are required for some species and to participate in limited entry fisheries (FWC 2005b).

The Marine Fisheries Trip Ticket system was established in 1984 in an effort to track commercial landings. The program requires wholesalers to complete a trip ticket with each purchase from a fishermen (Figure 3-1). Information recorded on the ticket include license numbers for the buyer and seller; date; location; species; amount caught; gear; and payment, among other information. Wholesalers can use paper copies of tickets or enter information using a computer program (FWC 2000).

The Net Ban

In 1994 Florida voters approved a constitutional amendment to discontinue use of entanglement nets and all nets over 500 square feet. Usually, the issue would have been addressed in the state congress, but extensive media campaigns by recreational fishing lobby groups put the decision into the hands of Florida residents. In an effort to educate Floridians on the negative impacts of gillnets, conservation and recreational advocates advertised heavily; the commercial fishermen could not compete with them (Duff and Harrison 1997). Over 1,500 fishing families were negatively affected by the ban (Smith et al. 2003), despite buyback programs (Duff and Harrison 1997). Six years later, some

target stocks had improved, although it is unknown if the net ban contributed to this (Adams et al. 2000).

Although conservation was the stated goal of the amendment's advocates, the campaign might be interpreted as a matter of resource allocation, a common issue for small-scale fishermen (Smith et al. 2003; Thunberg et al. 1994). Additionally there appears to have been little focus on the social consequences of banning gill nets (Smith et al. 2003). The net ban did not directly affect the Biscayne fishermen but is an example of the ubiquitous struggle between Florida's commercial fishermen and the recreational anglers and environmental groups. In addition, commercial activity within a protected area generates opposing views on access rights and resource allocation.

Study Site: Biscayne National Park

Established as a national monument in 1968 and later as a national park in 1980, Biscayne National Park is located between Miami-Dade County and the upper Keys community of Key Largo (Leynes and Cullison 1998) (Figure 3-2). Because it encompasses most of Biscayne Bay, the park itself is also commonly referred to as Biscayne Bay or often simply Biscayne; references to the area in this thesis also use those designations. The park occupies about 700 km^2, of which 95% is water. Approximately 500,000 people visit Biscayne each year with the most common activities being nature viewing, walking/hiking and fishing (Simmons and Littlejohn 2001). The most significant pressures the park faces comes from urban development, discharge and thermal pollution from a nearby nuclear power plant, and the changes in water quality of Biscayne Bay (EDAW 2003:6.3). Humans have utilized the marine resources at Biscayne for at least 10,000 years, according to archeological findings (Biscayne

National Park 2004). Currently, the commercial fisheries include blue crab, stone crab, food shrimp, bait shrimp, finfish and spiny lobster (EDAW 2003:4.2).

Environment of Biscayne National Park

Biscayne National Park is a diverse ecosystem of land and water (Figure 3-3). Where it is not developed, the coast is outlined by mangroves that provide habitat for larval and juvenile fishes (Ault et al. 2001). Within the bay, there are seagrass beds and hardbottom, and the outer eastern area is part of a coral reef system that extends south into the Florida Keys.

Biscayne is home to 14 federally protected species and 39 state-protected species, which includes sea turtles, birds, mammals, fish, and plants. Ten are listed as endangered by the federal government (Table 3-2). The park also utilizes the Park Resources Protection Act, which allows resource managers to pursue monetary compensation for environmental damage. Often prosecution usually is not possible due to the difficulty in identifying the responsible party. The most common damage is the scarring of seagrass beds by boat propellers (Figure 3-4). In 2000, the park won a $1 million lawsuit against a negligent tanker that caused major damage to a coral reef. The money will be used for restoration (National Park Service 2000).

Population Growth of Nearby Miami-Dade County

The 2000 census reported that Miami-Dade County had a total population of 2,253,362 people. Historical data show that the population sharply increased in the 1940s and has continued to grow into the 21st century (Figure 3-5) and now has a density of 1,158 people per square mile [compared to the state's average of 296 people per square mile] (U.S. Census 2000). In addition to the resident population, south Florida has eight million visitors each year (Biscayne National Park 2004). Along with a growing

population comes urban development, including buildings, bridges, sewer systems and landfills (Figure 3-6). In addition, because of the likelihood of flooding in south Florida came the drainage project.

Canals and Freshwater Flow

The Central and South Florida project was authorized by the U.S. Congress in 1948 with the goal of flood control for the state (Comprehensive Everglades Restoration Plan 2005). In 1947, a major hurricane hit south Florida and put 80% of the area under water (Parks 1981). The state requested funding and authorization to construct a system of about 1,000 miles of levees, 720 miles of canals, and 200 structures for water control (Comprehensive Everglades Restoration Plan 2005). The canals are now under the jurisdiction of the South Florida Water Management District (Figure 3-7).

The floodgates are opened under the advisement of the South Florida Water Management District when the canals reach capacity following heavy rainfall. Smaller canals in neighborhoods flow into larger canals that eventually carry the water to the coast (South Florida Water Management District 1997). The influx of freshwater causes a lower salinity gradient in the western part of Biscayne Bay, which is where several canals enter the bay (Alleman 1995). Studies have been conducted on the effects of water flow from the canals and found changes in natural hierarchy of the flora (Irlandi et al. 2002; Lirman and Cropper 2003) and animal biodiversity (Lirman et al. 2003).

Other Pressures for Biscayne National Park

The Turkey Point Power Plant, located in the southwestern part of the park, added nuclear units in 1972 and 1973 (Cantillo et al. 2000) (Figure 3-8). The plant provides power for 450,000 homes. A canal system is used to cool water before it is circulated for re-use. The main concern with the plant is thermal pollution from the cooling canals,

although the power plant reports a viable population of the endangered American Crocodile (*Crocodylus acutus*) and a wide variety of birds living in or near the canals (Florida Power and Light 2005). The canals are also rumored to be superb fishing spots, but strict security measures prevent anyone from being in close proximity to the plant.

Homestead Air Force Base was constructed in 1942 as an airfield and activated as a base in 1955 following its closing due to hurricane damage (Cantillo et al. 2000). In 2001, a proposal to create a commercial airport on the base, only two miles from Biscayne National Park boundaries, was struck down (Department of the Air Force 2001). Environmentalists, concerned with the potential trash and noise pollution from an airport, were pleased with the decision, but the developers continued to fight for the airport, including a lawsuit against the Air Force. The lawsuit was overturned but airport supporters plan to appeal (Viglucci 2006).

Status and Management of Marine Resources at Biscayne National Park

The waters of Biscayne Bay are clear enough to see the bottom, but there are other factors at work that are affecting the quality of the bay's biophysical environment and marine resources. In addition to changes in salinity and the effects of pollution (specifically trash and fertilizer runoff), exploitation of fish stocks also has come into the spotlight. An analysis based on records of harvest lengths shows that 77% of the 33 target species were analyzed to be overfished (Ault et al. 2001).

Jurisdiction of commercial and recreational fishing in the park belongs to the state of Florida, as indicated in the enabling legislation of the park (U.S. Congress 1980). A major attractant for visitors, fishing contributes to the economy and plays an important role in the social connection of visitors to the area (EDAW 2003). However, with the

decline in fish populations and the growing population of the surrounding area, a fisheries management plan was formulated in 2000 (Table 3-3).

The first phase in planning for the fisheries management plan for Biscayne National Park was a public comment period to obtain recommendations from resource users in 2002 and 2003. A main suggestion was to form a working group of local residents who represented user groups. The Biscayne National Park Fishery Management Plan Working Group was assembled with the purpose of making recommendations for the plan and providing input on the desired future conditions (Todd Kellison, personal communication). The members were chosen with recommendations from Florida's Fisheries Management Division, who had formed an advisory board for the establishment of the marine reserve in the Dry Tortugas. Participants of the Working Group included commercial fishermen, recreational anglers, charter captains, divers, biologists, and representatives of enviromental groups.

Resource managers at Biscayne National Park have to meet the requirements of Florida and the National Park Service, and the management plan must be evaluated by federal and state entities. In the spring of 2005, the first draft of the plan was sent out for review. The park reports that it will be published in the Federal Registry and made available for public comment again when copies are made available on the Registry.

The main changes that will be implemented include additional permits, changes in lobster fishing and spear fishing, and revisions in bag limits (Table 3-4). Under the plan's 'preferred alternative' [four alternatives were presented in previous drafts of the plan], special permits from the park will be required for commercial fishermen and charter guides. All recreational anglers and boaters would have to obtain an annual

permit to fish in park waters. The two-day "mini season," during which recreational lobster fishing occurs prior to the opening of the official season, would no longer be allowed in park boundaries. Use of trigger guns and SCUBA equipment while spearfishing would be prohibited under the plan, and bag limits for some fish species would be increased or decreased.

Summaries of Scientific Knowledge of Each Target Species

Blue Crab

Blue crabs (*Callinectes sapidus)* are found along the Atlantic coasts of Nova Scotia south to Argentina (FWC 2005c). They are benthic omnivores and also serve as a food source for many marine and terrestrial animals. They occupy a variety of habitats, depending on life stage and environmental conditions, which include estuaries, offshore waters and shallow lagoons (Perry and McIlwain 1986).

Mating for blue crabs is not immediately followed by spawning. A male crab will inseminate a newly molted female and carry her until her shell hardens, at which time she will release the eggs (Perry and McIlwain 1986). Mating has been observed year-round but mostly takes place from March to December (FWC 2005c). Larvae develop offshore and move into estuaries with currents. A blue crab reaches sexual maturity at about one year following birth (Tagatz 1968).

Salinity is an important factor in migration and distribution. An inverse relationship between salinity and abundance was observed by More (1969) and sexual distribution depends on the salinity of the water (Perry 1975). Temperature also has an effect on the species, especially cold snaps that can cause mortality (Couch and Martin 1982).

Stone Crab

Stone crab (*Menippe mercenaria*) is different from the other fisheries in Biscayne National Park because only the claws (chelipeds) are harvested. The strong chelipeds are used as defense against predators, which include octopi, sea turtles, and horse conchs (Bert et al. 1978). Stone crabs are mostly carnivorous and the claws are used to crush mollusk shells during feeding (Lindberg and Marshall 1984). After claws are removed, they take about one year to regenerate (Sullivan 1979). A study on mortality after claw removal reported that 28% of stone crabs died after loss of a single cheliped, and 46.5% died when both claws were removed (Davis et al. 1978).

Stone crab spawning occurs April thru September, with peaks in August and September (Lindberg and Marshall 1984). As temperatures drop following the peak, spawning decreases (Savage and Sullivan 1978). Sexual maturity is reached in approximately two years, and adults are found in shallow flats, where they burrow into the substrate (Lindberg and Marshall 1984).

Low temperatures, particularly cold snaps, cause the animals to burrow and become inactive. Stone crabs are typically found in areas with lower salinity, perhaps due to inverse relationship of salinity to growth periods (Lindberg and Marshall 1984).

Spiny Lobster

The spiny lobster (*Panulirus argus*) fishery in Florida is of major economic importance, both commercially and recreationally. Lobsters reproduce from late spring to early summer, with a peak from April to May (Marx and Hernnkind 1986). Juveniles move inshore after metamorphosis in offshore waters. Adults are found near coral and rock overhangs, where they can find shelter (Davis 1981) and food. Sexual maturity is

reached in about two years, depending on environmental conditions. Spiny lobsters are nocturnal foragers and mostly carnivorous (Marx and Hernnkind 1986).

Adult lobsters congregate, especially in shelters, for protection and mating (Eggleston and Lipcius 1992). They are social animals and attracted to areas with higher concentrations of other lobsters, and respond as a group when a predator, usually a large fish or nurse shark, is near. When mass migration occurs, spiny lobsters have been observed traveling in single-file lines (Marx and Hernnkind 1986). Although adults can tolerate cold snaps in south Florida, lower temperatures can trigger movement (Little and Milano 1980).

Brown and Pink Shrimp

Brown shrimp (*Penaeus aztecus*) and pink shrimp (*Penaeus duorarum*) have similar life histories. Both are harvested in the bait shrimp fishery in Biscayne National Park, but pink shrimp are the most prevalent in the southeast Atlantic region (Bielsa et al. 1983). Adults move offshore to deeper, cooler waters when water temperatures rise, and subsequently spawn. Pink shrimp have been reported to spawn in waters of 4-48 m in depth (Williams 1955) and brown shrimp in depths of 18 m (Shipman et al. 1983), which occurs mostly during the summer months, although it is not conclusively known if the warm waters of south Florida are an overwintering area. A pink shrimp spawns several times during its lifetime, but a brown shrimp will die after reproducing once (Bielsa et al. 1983; Larson et al. 1989).

Shrimp larvae are moved inshore via tides and winds, where they continue development in estuaries where seagrass provides protection and food. They are sexually mature and of preferential harvest size in about nine to ten weeks following hatching (Bielsa et al. 1983). Adults move out from the estuaries and are found in mud, sand, or

seagrass beds. These types of habitat allow the shrimp to bury up in the sand during the day to avoid predation from the many species of fish that feed on them (Larson et al. 1989). Adults are omnivorous, feeding on detritus to small invertebrates, and nocturnal (Hunt et al. 1980).

Water temperature and currents dictate most migration patterns of both species of shrimp. A rise in temperature will cause them to move offshore and water movement pushes them into different areas, and lower temperatures result in the shrimp burrowing. Adult pink and brown shrimp prefer saltier waters and will move to areas of higher salinity if there is too much freshwater (Bielsa et al. 1983; Larson et al. 1989). It has been reported that turbidity causes higher concentrations of shrimp, most likely due to increase in nutrient availability and decreased visibility of the shrimp to their predators (Kutkuhn 1966).

Table 3-1: Current costs of licenses and endorsements for commercial fishing.

Fishing License	**Price**
Saltwater Products License (individual)	$50-$300
Saltwater Products License (vessel)	$100-$600
Restricted Species Endorsement	Free, but must have reported landings in previous years
Blue crab endorsement	Free (moratorium)
Stone crab endorsement	$125
Spiny lobster endorsement	$100-$150
Blue crab trap tag	$0.50
Stone crab trap tag	$0.50
Lobster trap tag	$1.00

Table 3-2: Federally listed endangered species in Biscayne National Park.

Common Name	**Scientific Name**
Green Sea Turtle	*Chelonia mydas*
Hawksbill Sea Turtle	*Eretmochelys imbricata*
Leatherback Sea Turtle	*Dermochelys coriacea*
Kemps Ridley Sea Turtle	*Lepidochelys kempii*
West Indian Manatee	*Trichechus manatus*

Table 3-2. Continued

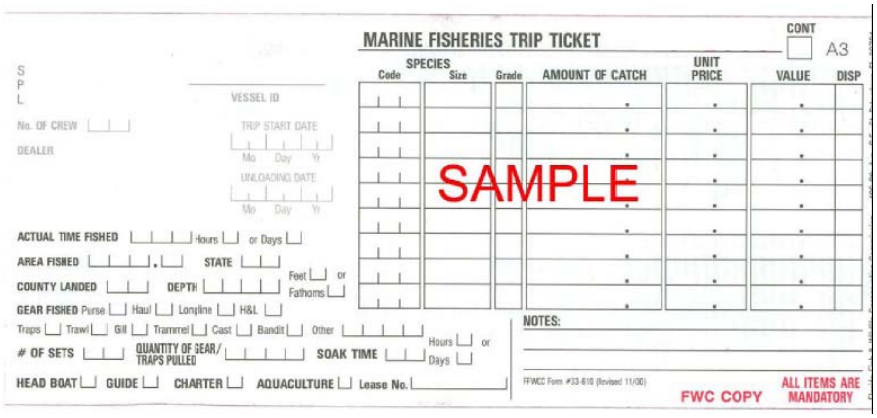
Common Name	**Scientific Name**
American Crocodile	*Crocodylus acutus*
Bald Eagle	*Haliaeetus leucocephalus*
Peregrine Falcon	*Falco peregrinus*
Wood Stork	*Mycteria americana*
Schaus Swallowtail	*Papilio aristodemus ponceanus*

Table 3-3: Summary of the development of the fisheries management plan at Biscayne National Park.

2000	Collaboration with Florida Fish and Wildlife Conservation Commission to determine longterm goals for the fisheries resources.
2002	First public comment period includes concerns about overfishing, habitat degradation, and enforcement issues.
2003	Second public comment period includes suggestions for formation of an advisory group.
2004	The Working Group provides input over a series of six meetings to provide recommendations on the proposed alternatives of the draft plan.
2004-05	The draft plan is reviewed by the National Park Service and the Florida Fish and Wildlife Conservation Commission.
2006	The plan is approved for inclusion in the Federal Registry and a final public comment period is planned. The Working Group also meets again to review how its recommendations were considered and provide comments on the current version of the plan.

Table 3-4: Summary of elements of the Biscayne fisheries management plan.

special-use permits for commercial fishermen and charter captains
annual permits for recreational fishermen and boaters
elimination of lobster “mini-season” within park boundaries
prohibition of spearguns with triggers and use of SCUBA equipment while spearfishing
establishment of coral reef protection areas
changes in bag limits for some species


MARINE FISHERIES TRIP TICKET

CONT A3

S P L

VESSEL ID

No. OF CREW

DEALER

TRIP START DATE Mo Day Yr

UNLOADING DATE Mo Day Yr

SAMPLE

SPECIES Code	Size	Grade	AMOUNT OF CATCH	UNIT PRICE	VALUE	DISP

ACTUAL TIME FISHED Hours or Days

AREA FISHED STATE

COUNTY LANDED DEPTH Feet or Fathoms

GEAR FISHED Purse Haul Longline H&L

Traps Trawl Gill Trammel Cast Bandit Other

OF SETS QUANTITY OF GEAR/TRAPS PULLED SOAK TIME Hours or Days

HEAD BOAT GUIDE CHARTER AQUACULTURE Lease No.

NOTES:

FFWCC Form #33-610 (Revised 11/00)

FWC COPY

ALL ITEMS ARE MANDATORY

Figure 3-1: Sample trip ticket.

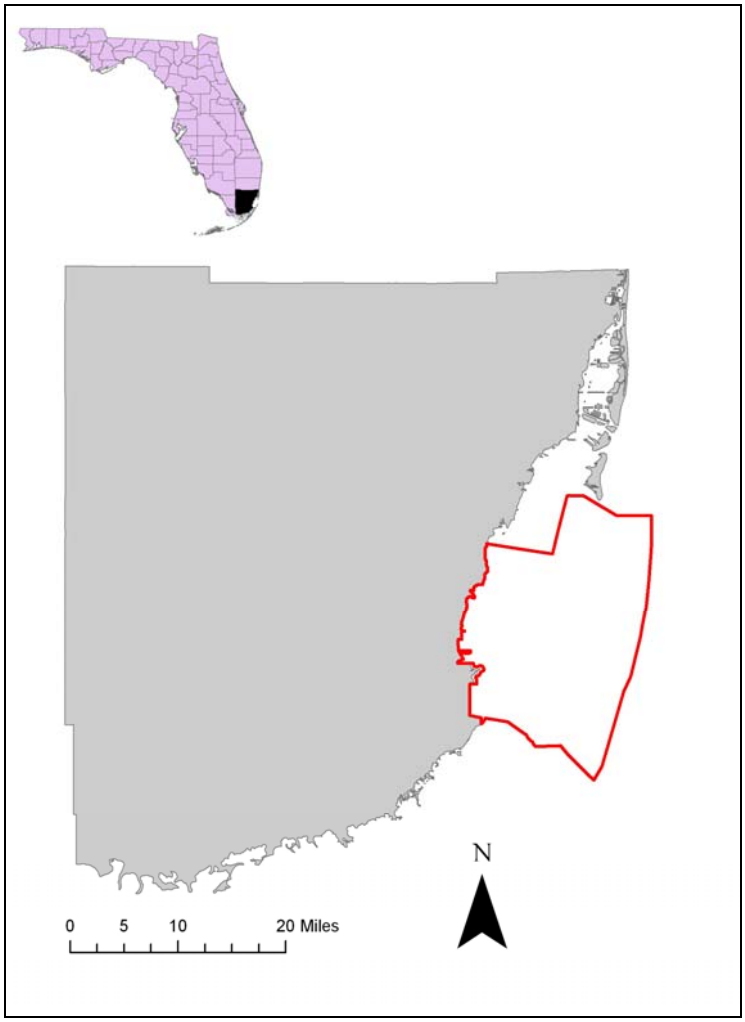


Figure 3-2: Map of Biscayne National Park (red outline). Data source: Florida Geographic Data Library.

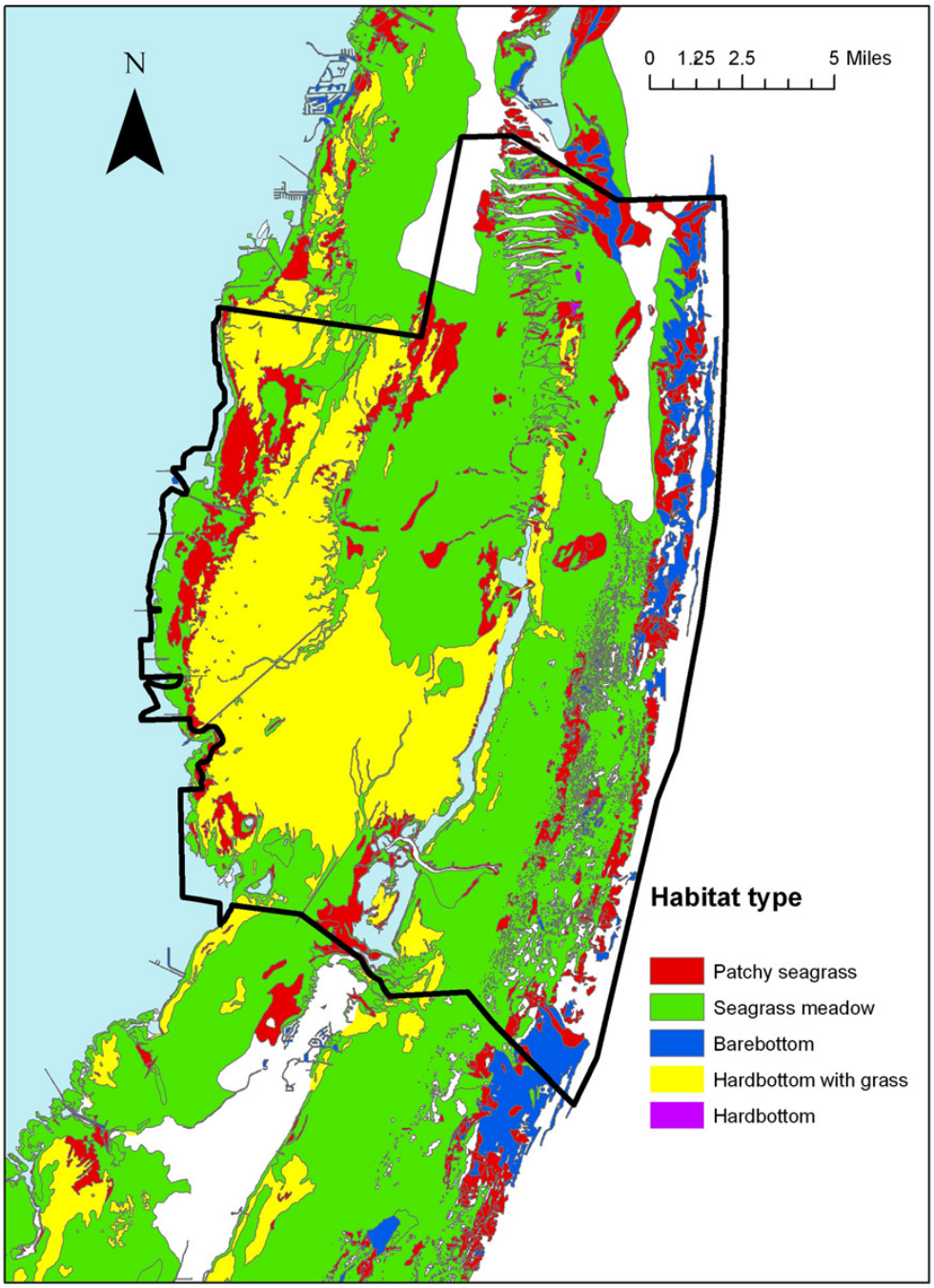


Figure 3-3: Habitat distribution in Biscayne National Park (outlined in black). Data source: Florida Geographic Data Library.

Figure 3-4: Propeller scars on a seagrass bed in Biscayne Bay.

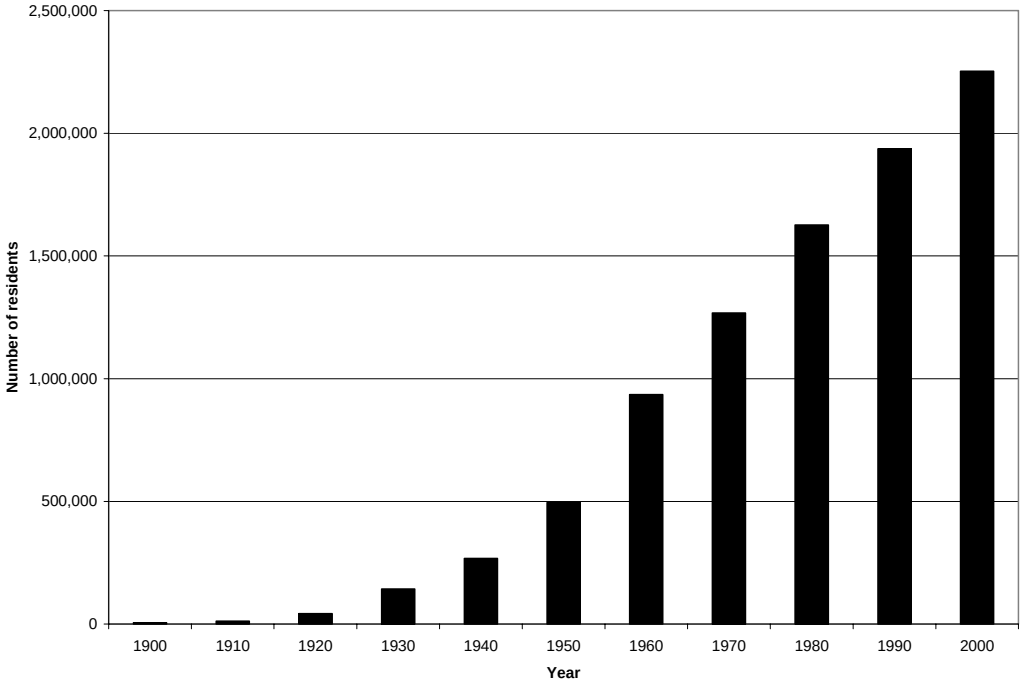


Figure 3-5: Population of Miami-Dade County from 1900 to 2000 (U.S. Census Bureau).

Figure 3-6: Elevated landfill near Black Point Marina, nicknamed “Mt. Trashmore.”

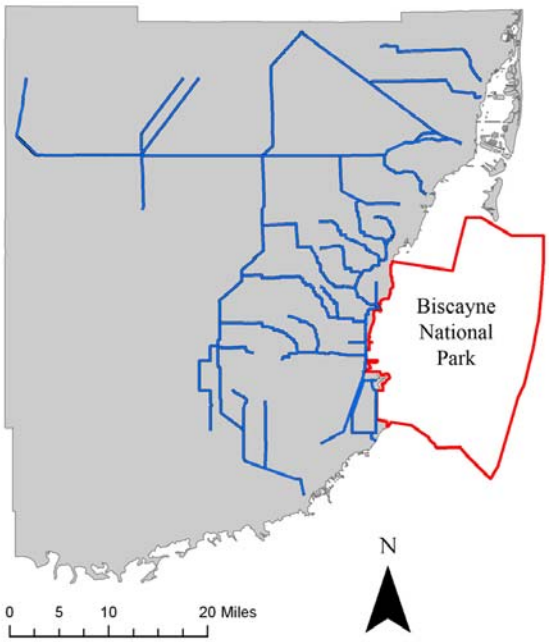


Figure 3-7: Canal system (in blue) in Miami-Dade County. Data source: Florida Geographic Data Library.

Figure 3-8: A view of Turkey Point Nuclear Power Plant from Biscayne Bay.

CHAPTER 4
METHODOLOGY

The overall methodology involved collection and analysis of qualitative data. Interviews and field notes were coded by prevalent themes, and participant observation was used to supplement responses. The data were organized into four major fields: fishing technique and gear, local ecological knowledge, limitations, and conservation/ management.

Locating Informants

Prior to and during the first weeks at my study site, I contacted several people from Biscayne National Park, Florida Sea Grant, and the Rosenstiel School of Marine and Atmospheric Science at the University of Miami for suggestions for finding commercial fishermen in Biscayne Bay. Those inquiries provided no contacts, but online information about the Biscayne National Park Fisheries Management Plan Working Group provided names of a few local captains, and I finally was able to contact some of them. I also visited bait shops to ask how to get in touch with the fishermen, and was pointed to one of the local marinas.

After making initial contacts, I found that snowball sampling (Bernard 2002) worked best, as expected. Typically, the initial interviews included information about other fishermen or stories heard from other fishermen. In this way, I could inquire about additional informants and acquire additional information regarding the status of a potential interviewee within the fishing community. Many fishermen, once they felt comfortable with me, were willing to pass along names and phone numbers of others.

Often, when I would get in touch with the new informant, he would tell me that he had been told I would be calling and ask why did it take so long for me to follow through and contact him. As I met more fishermen, the networking among them became easier.

Interviews with Fishermen

I conducted over 30 hours of semi-structured interviews with 13 commercial fishermen. I also had countless hours of informal conversation from my time at the docks and fish house, and during social time spent with the informants, which was documented in my field notes. Upon consent, I tape-recorded the semi-structured interviews and later transcribed them. Initially I used a list of questions as a guide but found out that carrying out the interviews as relaxed conversations typically led to the informants being more comfortable and thus, more open with me. I also found that some topics, (e.g., bycatch and pollution) were more easily approached using different questions that allowed the conversation to somewhat naturally veer into the touchy subject without being directly introduced by me.

Because I was an outsider and the fishermen did not know be well initially, I formatted each interview to be as similar to a conversation as possible. I also found that when I asked a direct question about certain subjects, they would either not be able to answer it on the spot or tell me that they did not know. However, whenever information was solicited in the form of a story, they would volunteer a substantial amount of information. Stories, included in responses, were found to be one of the most important sources for obtaining information relevant to my interests.

Because I was unable to obtain permission from Biscayne National Park to conduct research within park boundaries, I conducted 16 interviews at Black Point marina (n=4), restaurants (n=2), fish houses (n=2), and at the fishermen's homes (n=8).

With three of the informants, I conducted a second interview. My preference for interviews was at the fisherman's home to maximize comfort and convenience, and also to include wives, who were useful in reminding the fishermen of events (Neis 1999), and whom I found to be as knowledgeable as the fishermen, even if the wives had never worked in the fishing industry. However, I would also agree to meet them in restaurants or their place of work such as the fish house or marina.

Communication with Fisheries Management Staff at Biscayne National Park

Prior to my field work, I contacted the fisheries manager at the park and informed him of my upcoming research. He updated me on the status of the fisheries management plan and gave me contact information for past researchers and for local residents who might know the commercial fishermen. Later, I conducted a short interview with him about the Fisheries Management Plan Working Group and how the participants were selected, and also about the fisheries management plan. I documented that interview with written notes.

Participant Observation

In addition to interviews, I used participant observation to build trust, provide concrete examples of topics discussed in interviews, and to fill in gaps in baseline data (Bernard 2002:333-335; Paolisso 2002). I spent time at the marina when the fishermen were preparing for an evening trip and while they were working on boats and equipment. I also spent social time with the fishermen, when invited, which included dinners and visits to their homes.

I spent approximately 30 hours on the boats with shrimpers and one lobster fisherman. I asked the blue crab fishermen during the interviews if they would allow me to join them when they went out; each of them consented, although none contacted me on

the days of the planned outing, so I was unable to observe the techniques and locations they visited. I did not go out with any stone crab fishermen because my fieldwork took place when the season was closed.

Participant observation proved to be an important source of data, since fishermen typically transmit ecological knowledge orally—sometimes unintentionally—frequently during the course of fishing. Furthermore, local ecological knowledge of fishermen is part of everyday life, and becoming involved with this lifestyle helped me reveal additional information not discussed in interviews (Neis et al. 1999), especially pertaining to sensitive issues and conflict (mostly hearsay concerning a personal disagreement between two fishermen). Each time I interacted with fishermen, I documented my findings and observations in my field notes.

Interview Protocol

I primarily used informal semi-structured interviews to obtain the study data from the fishermen. I had a list of specific topics that I wanted to address either with direct questions or that would naturally come up in the conversation (Appendix). I used a small notebook to jot down topics that I wanted to remember to bring up later. I typically found that the same themes came up in each interview without prompts by me. The questions were based on topics included in other researchers' studies of local ecological knowledge of fishing communities and basic ecological concepts.

I always opened the interview asking about the informant's experience in the fishery: how long have you been doing it, how did you learn, etc. This typically led into questions about how the fisherman knows where to set his traps or drag his trawls, followed by inquiries about the target species' biology and ecology, plus information about the ecosystem as a whole, including effects of weather and seasonality. I also

asked about pollution and other human impacts that the informant had observed or heard about. Each interview included some discussion about resource management that is carried out by the local, state, and federal governments. Finally, I also noted answers to basic close-ended questions concerning age, marital status, boat and motor types, technology used, and alternative incomes.

Often, if an informant did not know the answer to a specific question, he would use the phrase "I don't know, but I heard…" I used these responses to solicit information about other possible informants and also to construct a basic net of social relationships of the fishing community at Biscayne National Park.

At the end of each interview, I asked the informant to tell me his "best fisherman story." Partly out of my own interest, the stories were also documented and ended up revealing additional cultural aspects of their fishing behavior and knowledge. These are discussed in the results.

Interview Schedule and Constraints

The semi-structured interviews were conducted from May through July of 2005. Each interview typically lasted one to three hours, although the entire time was never spent addressing my research questions and often involved small talk or questions directed at me. This was not a problem, as informal conversations, even if straying far from the topic, sometimes led to interesting discussions that would not have taken place otherwise. I feel that casual conversation, plus answering questions about myself, helped build rapport with my informants. Also, during small talk, my lack of background in marine ecology was made obvious, which I felt was an advantage for me as an interviewer; my informants always knew more than me and thus, were willing to share their knowledge.

As an outsider, it took several weeks to locate my informants. However, the community was open to me once I began speaking with the fishermen. I was questioned several times about my motives but, for the most part, the fishermen were interested in my work and willing to assist me. I started, not necessarily by design, with several central figures in the community who led me to additional informants. The tightness of the fishermen's network also helped me develop rapport, as I was told many times by an informant that he already knew my name and project through another informant. Nonetheless, I was asking questions about secrets and did not expect to always be told the truth. However, I feel that my informants gave me generally reliable information.

Secondary Data

Wholesalers in the commercial fishing industry in Florida are required to report daily through the trip ticket system, which includes information on weight, location caught, buyer and seller of the catch. I obtained the data from the FWC of reported landings from 2000 to 2004, including preliminary data for 2005. The data are for the zones within Biscayne National Park (see Figure 4-1) and include landings in pounds for the blue crab, stone crab, spiny lobster, and bait shrimp fisheries. The captains' names were not given to me to maintain confidentiality, but numbers of fishermen reporting each year are included. Finally, I also received information on the Biscayne National Park fisheries management plan from park staff and from the park website, including a rough draft of the plan and briefings on the status of its enactment.

Data Analysis

Fishermen Interviews and Field Notes

I used an inductive coding approach for the transcriptions of fishermen interviews (Bernard 2002). Some themes recurred during my research, and during analysis I

reviewed each transcript and added each informant's responses to notes regarding each theme. For example, whenever a fishermen spoke about pollution, I made notes of what he said in the 'pollution' section of my theme notes. Because I wanted a broad representation of the culture as a whole rather than each individual's knowledge, I added all responses together. However, I did make a note of each theme that was mentioned by a majority of the informants, and a note of conflicting responses concerning the same issue. Because my field notes were typically documentation of informal conversations, I used the same approach and compiled the data with information from the interviews.

The main themes that I coded for were organized into three groups: local ecological knowledge, limitations, and perceptions of conservation and management (Table 4-1).

Taxonomic Data

Each organism mentioned during interviews and recorded in field notes was added to one list of species. Scientific names were assigned as best I knew and I enlisted the help from the Fisheries and Aquatic Sciences Department at the University of Florida to identify plant and algae species that I could not identify. The local names were then each labeled as generic, specific, or varietal according to lexemes (Berlin et al. 1973). I also noted if the organism was discussed as 'trash', predator, or impediment. I calculated the frequency of each taxonomic level and the context in which the organism was mentioned.

Secondary Data

Secondary data on commercial and recreational landings were entered into Microsoft Excel. Graphs were generated for visual presentation, and to get a sense whether there were any seasonal and annual trends. I also used the data on commercial

landings to estimate the number of commercial fishermen working within park boundaries.

Table 4-1: Themes used in coding interviews and field notes.

Local ecological knowledge
life cycles
diet/bait
predator and defense
seasons
habitat
migration
taxonomy
Limitations
theft
seasons
market (supply and demand)
cultural (secrecy, territory, network)
Conservation and management
perceptions of impacts by fishermen
perceptions of other anthropogenic impacts
sustainability
concerns and suggestions for management

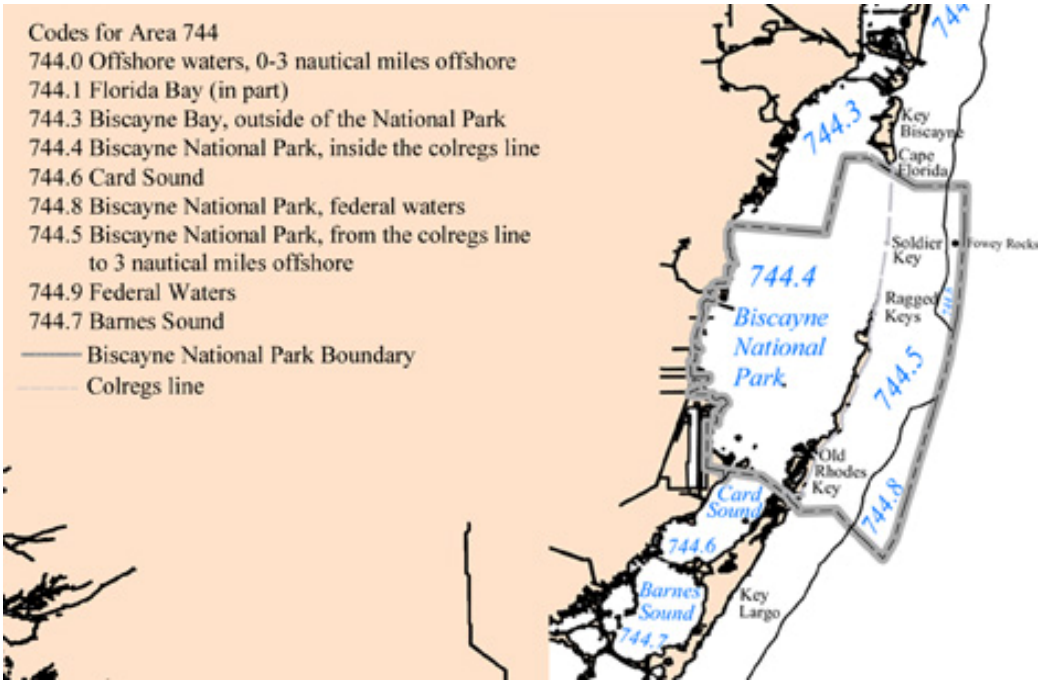


Figure 4-1: Trip ticket area codes for Biscayne National Park. (Source: Florida Fish and Wildlife Commission)

CHAPTER 5
RESULTS

The commercial fishermen working in Biscayne National Park represent a group of people affected by a mix of cultural, social, economic, ecological, and political factors. Long past are the days when a Biscayne fisherman's main concern was simply how and where to find the target species. The system has become much more complex, and he faces pressure from a growing metropolitan area, dynamic market, and increased regulations. He must know how external factors work as much as how ecological factors affect his catch.

In this chapter, I will cover the major results from my study. All information is taken from interviews and field notes unless otherwise noted as being from a secondary source. I will begin with a demographic overview of the fishery participants and descriptions of each fishery. Next I will outline local ecological knowledge of each group of fishermen, discussing information they have about the marine resources at Biscayne National Park. The chapter will continue into the results from responses about limitations for fishing, considering both internal and external factors. Finally, I will present ideas for conservation and management from the fishermen's viewpoints.

Demographics of the Biscayne National Park Fishermen

The demographics of the fisheries participants is based on information about the informants and personal observation during my time at the marinas. Most information is relevant to all target fisheries studied; specific information is noted as such.

Most of the trap fishermen and shrimpers are Anglo, and the estimated average age is 45, although the Hispanic captains of the bait shrimp fishery (not included in this study) were observed to be in their mid- to late 20s. Almost all are male, but stories of the past and present indicate that some wives work in the fishery also. Several are currently married and have families, but many are divorced. Those with wives lived in double-income households. Children of the fishermen ranged from ages 6 to 25. The majority of fishermen have lived most of their lives in south Florida; if they were not born there, they had moved to the area at a young age. Most finished high school but none of the fishermen I met or knew of had attended college or technical school.

Fishing was the dominant occupation for most fishermen in Biscayne National Park, although some had worked in other areas of the southeast or on the west coast of Florida. Most fishermen entered the industry after high school, around the age of 18. Some of them became interested in fishing when they began working as helpers for other fishermen, and eventually bought their own boats and worked alone. A few fishermen reported additional income from other jobs, including farming, electrical work, and odd jobs.

Homes of the fishermen in this study were spread out, from south Miami to Key Largo. The trap fishermen typically kept their boats at home and launched them at Black Point marina, which was usually not more than a 20-minute drive from where they lived. Shrimpers that worked on boats at Dinner Key usually lived nearby in Miami, and those at Black Point resided in Homestead. The few fishermen that lived in Key Largo had residences located directly on channels and were able to dock their boats at their homes.

Overview of the Fisheries

Blue Crab

The target species for the blue crab fishery is *Callinectes sapidus* (Figure 5-1). The blue crab fishery in Biscayne National Park has the least number of participants, although it once had many fishermen involved. From interviews, there are only five blue crabbers working in the park. However, data from the FWC lists seven fishers with reported landings in 2004 within a single zone (trip ticket area code 744.4). The remaining two may have come from areas north (Miami) or south (Key Largo) of the park, versus those who typically launch their boats at Black Point marina or Card Sound. All blue crab fishermen are part-time. Alternative incomes include working at fish houses and participating in the other, more lucrative, trap fisheries.

The blue crab fishery is open year-round. There is a moratorium on the licenses at this time so the number of participants in the fishery cannot grow. Blue crabs must be 5 inches from the tip of one lateral spine to the other to harvest legally. They are sold to local fish markets (commonly called fish houses) in the Miami and Keys areas.

Blue crab traps are composed of a variety of materials, such as wood, plastic or wire. They can be purchased pre-made or constructed by the fishermen. Many are double-layered (Figure 5-2). The crab comes into the trap in an entrance on the bottom, attracted to bait placed inside. Once it enters, the crab moves to the top part of the trap and cannot exit. All traps have o-rings to allow small crabs and other bycatch to move out. There is also biodegradable cord, required by law, that ensures escape by any animals caught inside should the trap be lost and become a ghost trap.

Traps are marked with individual tags, purchased from the state, and buoys that float on the water surface. They are placed in lines for ease in harvest. Blue crabbers typically place their traps in shallow water (three to five feet) and do not use GPS.

In 2004, blue crab landings within Biscayne National Park (710 km^2) equaled 7,303 pounds. According to trip ticket data, this is barely half of what was caught in the Chicken Key area (0.5 km^2), a small inlet located immediately north of the park boundary. Although the Biscayne National Park Ethnographic Overview and Assessment (EDAW 2003) summarizes landings reported from the FWC as having an increase from 1991 to 2001, the blue crabbers say that there has been a sharp decrease in the number of fishermen over the past decade. They note movement of the crabs due to habitat change, but no decline in catch, which indicates an increase in effort by the fleet.

Stone Crab

The target species for this fishery is *Menippe mercenaria*. The stone crab fishery reported 11 participants at most in 2004, but I was only able to locate three of the fishermen. Most combine stone crabbing with other fisheries, particularly lobster.

The stone crab season is October 15 to May 15. Only the claws can be harvested, and must be removed in a specific way to avoid mortality of the crab. The legal harvest size for a claw is 2.75 inches, and no egg-bearing female may be in possession. The claws are sold to local fish houses.

Stone crabs are caught in traps similar to blue crab traps, with little or no escape by the crabs. They are made of plastic (Figure 5-3) or wood, although the crabs can break out of the wooden traps. Many stone crab traps have cement or some other form of weight in the bottom to maintain placement. Each trap is baited and placed in a line with

buoys on each trap, or sometimes just on the traps at the end of the line. Some stone crabbers use GPS to keep track of trap placement.

The state reported 8,621 pounds of stone crab claws landed in 2004. Most were harvested in the outer eastern areas of the park. Only about a quarter of the landings were harvested within the bay. Compared to the park's Ethnographic Overview and Assessment (2003), this is a remarkable increase from landings in 2001, but similar to landings from 1996 to 2000.

Spiny Lobster

The target species for this fishery is *Panulirus argus* (Figure 5-4). Data from the FWC suggest that there are 14 to 18 lobster fishermen working in the park, according to reports from 2004. One lobster fishermen noted that there were possibly illegal immigrants working in the fishery. Therefore, some participants may not be reporting their landings and the state may not be aware of them. Estimates by other informants who participated in the fishery suggest there are less than ten lobster fishermen.

Because of the popularity of lobsters among both commercial and recreational fishermen, a lobster sanctuary was established in the bay and includes most of the western waters of Biscayne National Park (Figure 5-5). Lobster fishermen work further east outside of the sanctuary, near the reefs, which is coded as area 744.5 for trip tickets.

There is a closed season for commercial lobster harvest from March 31 to August 6. The season is preceded by a two-day "mini season," which occurs during the last weekend in July and is only open to recreational harvest (a limit of six legal lobsters per person each day).

Lobster traps are made of wood and most are customized by the fishermen (Figure 5-6). They come in different sizes, depending on where they are intended to be placed.

Unlike crab traps, lobster traps do not confine the animal with little or no escape. Instead, the funnel is large and acts as an entrance to a new home. Lobster fishermen do bait the traps, but for the most part depend on the social characteristics of the lobster; i.e., lobsters congregate inside the trap, and the more inhabitants of the trap, the higher the catch.

Each trap has a tag and buoy, and is placed in a line. Some lobster fishermen use GPS to mark the locations of traps because the animals are usually found in deeper waters. Because traps are usually weighted, they are heavy and many lobster fishermen have installed hydraulic systems on their boats to hoist the traps onto the deck.

Legal lobsters must be three inches on the carapace (from posterior part of the head to the anterior part of the tail) and have a tail length of 5.5 inches. If a small lobster, known as a short, is found in the trap, it is placed back inside to serve as an attractant. While some researchers feel that using shorts as attractants should not be allowed, lobster fishermen note that they will most likely return to the trap anyway if the trap is placed into a nearby location. Also, because any lobsters are free to move in and out of a trap, there is no requirement for escape o-rings. There is, however, a mandatory minimum size for the funnel to allow the animals to exit.

Commercial lobster landings for 2004 reported 21,698 pounds, of which 90% was harvested east of the reefs. All of the lobster fishermen I interviewed reported a steady catch since they began fishing, and some mentioned an increase over the past few years.

Bait Shrimp

The target species for the bait shrimp fishery includes brown shrimp (*Penaeus aztecus*) and pink shrimp (*Penaeus duorarum*). The bait shrimp fishery in Biscayne has been established since the 1950s (EDAW 2003). There are two main docks, Dinner Key

in Miami and Black Point in Homestead. Some bait shrimpers dock south of the park, in Card Sound or Key Largo. Data from trip tickets in 2004 report 18 to 30 shrimp fishermen harvesting in Biscayne National Park; my estimate from interviews is 25 fishermen. Most captains are Anglo, but over the past year several Hispanic captains were hired after one boat owner purchased several boats from a fisherman who left the industry.

There is a quasi-hierarchy among the shrimpers at Biscayne National Park, in which a more seasoned and successful shrimper typically moves up. Most shrimpers follow this path but few reach the top. The hierarchy is based on experience and how much money that position earns. The first level is as a helper on another shrimper's boat, and he will be paid accordingly by the captain. Eventually, a helper will be hired by a boat owner as a captain, at which time he will take home half of the profit each night and allocate a portion of that to his helper, if he has hired one. The next step is to purchase his own boat. Both profits and costs are the fisherman's responsibility at this level, and this is the terminal point for most shrimpers. The highest level is the wholesaler, who buys from the shrimpers and sells to the local bait shops. Most wholesalers also own boats and hire captains. Usually wholesalers no longer run the boats, but will work if a captain is not available one night.

Bait shrimpers work from sunset to near sunrise. There is no closed season for shrimping and many work at least five nights a week. Often one or two boats will supply one wholesaler, but the shrimpers will sell to other wholesalers if another captain cannot meet his order, although these are informal agreements and do not occur on a regular basis. There are a few captains who work as substitutes for other captains, and sell to

several different wholesalers, depending on which boat they are running. The bait shrimpers of Biscayne National Park supply shrimp to bait shops from Miami to Key West.

Bait shrimping in the bay utilizes the rollerframe trawl (Figure 5-7), reportedly designed by an oldtime shrimper from Black Point. Previously, the bait shrimpers used door nets, which were two pieces of plywood that are pulled apart by the water pressure and collected up anything along the way. With the current gear, the bottom of the frame is a metal roller and allows the trawl to run along the bottom and ideally roll over anything in its path, such as rocks or grass. The front of the trawl includes stainless steel bars, called fingerbars, that are spaced at most three inches apart. The fingerbars keep out any large animals and plantlife. Any bottom-dwelling organisms that can fit through the bars will be pushed into the net by the water pressure. The trawls are hoisted using hydraulics installed on the boat.

Once a shrimper has made a drag, anywhere from 15 to 45 minutes, the catch is brought on deck and placed into holding tanks with continuously circulating water (Figure 5-8). Some shrimpers first remove as much grass as possible by swirling a stick through the water. Then a scoop of the catch is placed on the picking tray and sorted by hand (Figure 5-9). The target shrimp are thrown into a separate tank and the bycatch is pushed overboard. The shrimpers make an attempt to keep the bycatch alive by returning it to the water as soon as possible. Any plant, algae, or animal caught in the net that is not a shrimp is known as “trash.”

Some captains take mates with them, known as “pickers,” to help sort the shrimp. These are typically fishermen with less experience. Most captains work alone, especially

in the summer when supply is low, in an effort to save money. Autopilots on the boats allow the shrimpers to pick simultaneously while making a drag.

Most boat owners have one or two boats and several work as captains as well. The boats are sometimes purchased from other shrimpers, or the fishermen buy recreational vessels and renovate them into working shrimp boats. Due to high costs of labor for welding, electrical and hydraulic work, the shrimp fishermen design and construct all gear on their boats by themselves. The boats are simple, usually consisting of a cabin and fishing equipment (Figure 5-10).

GPS units are commonly found on shrimp boats, but used mostly to mark hazards, such as buoys or rocky areas, and for documentation of locations fished at previous times. Many shrimpers use lineups from radio towers and Turkey Point for navigation, relying on the lights from the shore to guide them to certain locations or back to the marina. One fisherman noted that the increase in cellular towers and a changing skyline means less dependency on the lineups because the fishermen are no longer certain that the points of light are the same ones as before.

When shrimpers sell to wholesalers, the shrimp are counted by the thousands. The method used to estimate catch is to count out about 550 shrimp, weigh that group, and then calculate the number by weighing all the catch. Trip tickets are also completed using individual numbers of shrimp, which is converted to pounds for data entry by the state.

In 2004, shrimpers reported 48,190 pounds of shrimp caught in Biscayne National Park. No informants felt there was a decrease in catch, but noted that the shrimp are not in the same locations they usually are at this time of year. The recent active hurricane

seasons affected both supply and demand, which has an impact on the cycle of landings reported.

Local Ecological Knowledge

The local ecological knowledge of the informants is reported collectively and organized into the trap fisheries and the bait shrimp fishery. The information presented is based on responses during interviews and field notes that documented informal conversations.

Trapped Species (Blue Crab, Stone Crab, Spiny Lobster)

These species are omnivores and are attracted to almost anything. Fish heads are common bait with a preference for native species such as yellowtail snapper (*Ocyurus chrysurus*). Blue crabs will not eat old fish heads so they are changed out regularly, even if they are not eaten. Lobster and stone crabs are attracted to pork bones, pigs' feet, and cowhide. Cowhide is widely used because it only attracts the target species rather than fish and other animals. One lobster fishermen reported using a 'special bait' but would not reveal what it was. However, it is an animal and was discovered with trial and error based on "what the lobster usually eats in its natural environment."

Blue crab and stone crab traps are set in muddy, grassy areas. Crabs prefer the grass because it provides protection and a habitat for many small animals that serve as a food source for the crabs.

Lobsters typically live near rocks or coral, which provide them with protection. Lobster traps are set near the ledges on sandy bottom (to avoid falling or tipping), and are 'homes' for the lobsters. Once one lobster has discovered a trap, it will send out messages to other lobsters with its antennae. The more lobsters in a trap, the more will be attracted to it. Because eventually lobsters become their own attractants, lobster

fishermen will keep a few ‘shorts’ in the trap to lure in others, and some fishermen reported that they discontinue use of fish heads or cowhide after the trap is occupied.

Of the three species, only blue crab can be fished throughout the year. The fishermen mentioned that there was “talk of a closed season” for the blue crab but did not feel it was necessary. The blue crabs tend to move out of the bay in the summer, due to higher temperatures and increased rain, and therefore have a natural closed season. Some blue crabbers do continue fishing but with fewer traps, and for the most part “it’s not worth going out and wasting the time.”

Stone crabs are only legal to harvest from October 15 to May 15. Fishermen feel that the closed season is meant to allow the stone crabs to regenerate claws, and some mentioned that it was the spawning season. However, stone crabs have also been observed with eggs during harvest, so the regulated closed season may not overlap with spawning.

Once a blue crab is hatched, it grows quickly and is of legal harvest size in four months. A stone crab may take one or two years to reach legal size, and lobsters are legal to harvest about a year after they hatch.

Blue crabs have many predators, especially during molting season when their shells are soft. Stone crabs, however, were reported to only have one predator (besides humans): the octopus (*Octopus* spp.). Each fisherman reported that octopi are found in traps along with dead stone crabs, and octopus eggs have also been observed in the traps. While there are certain times of the year when there are more octopi found in the bay, they have never caused a major impact on the stone crab fishery.

Sea turtles also break into the traps, although not as often as other humans (discussed later). One informant told me that the evidence of a sea turtle is that the wood will be broken inward, because a turtle will use its nose, versus a human who will pull the wood slats out. Sea turtles are not a major problem for the trappers, breaking traps only on occasion.

Because there is little defense against humans or octopi regardless, stone crabs do not need even one claw to survive, although as one fishermen put it, “it sure does make it easier.” When claws are removed, the animals will hide and filterfeed on small organisms until the claws regenerate.

As the environmental conditions change, the animals will move. Blue crabs will move outward when there is an abundance of rain or the canals are opened, although immediately following rainfall there will be a larger harvest because they prefer somewhat brackish water. Both stone crabs and blue crabs respond to changes in barometric pressure; they will move if the pressure is high. Cold snaps will cause them to move or bury up in the sand or mud.

The size of traps and type of material used can affect a fisherman’s harvest. Different sizes are used in different habitats. Also, depending on the bottom, traps can be made of wire, wood, plastic, and be of different colors. One fishermen pointed out that perhaps vision is important in the crab’s decision to enter the trap. Some blue crab traps have double layers in which a crab enters the trap and then moves to the top, where there is no exit. The fishermen could not explain why the crabs always move to the top layer.

One fisherman reported modifying his traps in a particular way and achieving positive results, but I promised not to divulge the details of his secret.

Bait Shrimp

Shrimp are omnivores and will eat anything, but primarily have an herbivorous diet. Much of what they eat is microscopic. Likewise, anything will eat a shrimp, which is why they are a popular bait for recreational anglers. Because of the universal appeal, shrimp bury up in the sand for protection during the day, when they are easily seen in the shallow, clear waters of the bay.

The target species can be found in areas with seagrass, but the fishermen's preference for trawling is on the hardbottom, which is in front of Black Point. They define hardbottom as a sandy bottom with little or no plant life. This allows the drags to be cleaner, i.e., less seagrass and algae in the nets.

Shrimp are larger and more abundant in the wintertime, with January and February typically being the best months for harvest. During the summer, they move offshore towards the cooler water; the bay warms quickly and they prefer lower temperatures. Basically, the summertime is when "the old crop's moved out and the new crop hasn't shown up yet."

There is little agreement among the fishermen on where the shrimp spawn. Some fishermen feel that they head to the waters offshore to breed, and the eggs float into the bay with the easterlies. Others, based on observations of the earliest small shrimp appearing in the bushes nearshore first, believe that they spawn inshore, or the eggs are scattered in the bay. One fisherman, doubtful of the theory that shrimp are born offshore and float in, said,

> But to me, you're talking about something this big [~three inches] going all the way back out there to find a piece of grass to lay eggs in that's going to float all the way back here? I don't buy it.

Once a shrimp is born, it matures in three to nine months. It grows quickly, doubling its size each month. The shrimpers note that the animals must reproduce quickly because shrimping has occurred for many decades and there has not been a decline in catch.

In addition to water temperatures, choppy weather also affects the movement of the shrimp. Winds produce wave action on the top and bottom, and habitat can change quickly under the surface. With exception to strong winds that make navigation difficult, the fishermen prefer some wind to “stir up everything” and cause the shrimp to be more available as the trawl passes. An overcast sky also helps because less moonlight will bring the shrimp out of hiding in the sand.

One important environmental condition that affects shrimp is the east wind. When storms come from the east, they push the shrimp inshore, and this increases catch rates because more shrimp are available. Conversely, a west wind will push the shrimp out of the bay, limiting the abundance that is accessible to the shrimpers. However, the winds change rapidly and the fishermen know that with every west wind, there will be an east wind to bring the shrimp back into the bay. For this reason, they never appear to worry about availability of the stock.

Hurricanes play a major role in the availability of the shrimp. As mentioned before, the direction from which the hurricane comes is an important factor. Following Hurricane Andrew in 1992, which came from the east, there was a surprise increase in shrimp during a normal and slow summertime. After Hurricane Dennis in July 2005, a hurricane originating in the Gulf of Mexico, the Black Point shrimpers ‘lost’ the shrimp for approximately ten days (e.g., the shrimp were not in the usual places they are found

during the summertime). However, the following week an easterly pushed them back inshore and they were able to resume trawling.

Two informants mentioned problems with Cassiopeia jellyfish (*Cassiopeia frondosa*); not as predators but with the jellyfish stinging the shrimp while in the holding tank. While typically more abundant in the summer, they have not been a major problem. However, one informant noted that they "are the biggest threat, and getting worse."

Freshwater, from abundant rain or opening of the canal gates, causes the shrimp to move offshore. Shrimp prefer saltier water, and the shrimpers will wait to fill the holding tanks until they are far from the dock to avoid too much freshwater and thus, higher shrimp mortality. Also, over the years the influx of freshwater into the bay—from canals or run-off from development—has changed the habitat. Areas that were once prime shrimping spots are no longer viable, such as around Black Point marina.

Biodiversity

During interviews, informal conversations, and participant observation, the informants discussed 70 marine animals (Table 5-1). To organize the names of animals, I used methods for folk taxonomies by Berlin et al. (1973), based on the number of lexemes. These species included 41 fishes, 17 crustaceans, eight non-crustacean invertebrates, two reptiles and two marine mammals. The majority (58.6%) were mentioned at the generic level (one lexeme used), such as damselfish, sponge, and sea turtle. Twenty-three (32.9%) were at a specific level (two lexemes), such as spiny puffer, and six (8.6%) were at a varietal level (three of more lexemes), such as bonnet-head shark and shovel-nosed lobster. Most of the fish were at the generic level, but conversely, only two crustaceans were mentioned in generic terms. As suggested by Berlin et al. (1973), animals discussed at the generic level are the most numerous.

Thirty-seven (53.6%) organisms were noted or observed as bycatch. Larger animals, such as horseshoe crabs and grouper, were cases of trap bycatch. Smaller organisms, or at least slimmer animals that can fit through the finger bars on a shrimp boat, were mentioned or observed with shrimpers. For example, common trawl bycatch include trumpetfish, pinfish, juvenile lobsters, and other shrimp, which are easily swept into the shrimp trawls. However, on occasion, larger animals like flounder and sting rays (that appear as if their size would let them avoid being swept into the nets) are caught, presumably because they were sideways at the time of the drag. When this happens, they fit perfectly through the fingerbars. When questioned about the natural history of different species during participant observation, the shrimpers knew many aspects, including diet, life cycle, and obstacles for captivity. Many shrimpers admitted to keeping interesting species in their home aquariums, where they observed the animals.

Twenty (29%) of the animals were mentioned as predators of the target species, although no serious problems in a year's harvest has occurred due to abundance of any predators. Most were mentioned during interviews with the shrimpers, boasting the universality of shrimp as bait for recreational fishing in the bay. Two species from the family Cnidaria, the Cassiopeia jellyfish and Portuguese Man O' War (*Physalia physalis*) were mentioned as not only harmful to the catch but also the fishermen. Octopi were mentioned as seasonal impediments for stone crab fishermen, and sea turtles were noted as breaking into the lobster and crab traps.

The informants also discussed eight types of algae and six types of marine plants (Table 5-1). Many were local names and some had multiple names. For example, *Sargassum* spp. is known as sargassum or berry grass; *Thalassia testudinum* is called

turtle grass or blade grass; and *Giffordia* spp., a brown algae, is referred to as snotgrass or gumbo. Of the algae, all were mentioned as impediments to traps (growing on or inside the traps and deterring catch) or clogging up shrimp trawls. The marine plants were all included in responses to questions about habitat, although the bait shrimpers consider grass in their nets as trash and detrimental to upkeep of the nets or interfering with sorting out the shrimp.

Factors Affecting Effort and Catch

In addition to regulations from local, state, and federal governments, the commercial fishermen of Biscayne National Park are subject to several aspects of limitations that may prevent them from their maximum exploitation of the resources. In this section, I will describe two main external factors that affect trappers—theft and seasonality—and the social aspects of territory and conflict that limit space. For shrimpers, the main limitation is environmental and economic seasonality. Internal limitations include secrecy, networking, and aspects of working without a picker.

Trap Fishermen

Theft

The most substantial problem for the trap fishermen was theft. Every informant who participated in one of the trap fisheries brought up this issue, and once mentioned theft was mentioned, went into details and personal experiences (which all reported having). Theft, at this point, is simply part of being a crab or lobster fisherman.

Although stealing is not a new phenomenon, the trap fishermen blame the population increase of adjacent Miami-Dade County for the growing problem. As more people move in, the higher the likelihood that traps will be stolen or vandalized. Molestation of traps is a third-degree felony, entailing a fine up to $5000 and

imprisonment of a maximum of five years (Florida Senate 2006), but it is hard to enforce the law and theft continues to be an issue.

Crab and lobster traps are kept at the commercial dock at Black Point. There is little security at the dock and one lobster trapper reported that some of his best traps had been stolen during the night before the interview. He said that they are taken to be used as decorations for patios. Because he has no other place to store hundreds of traps, he must depend on enforcement from the marina staff.

Most occurrences involve robbing a trap, which almost always includes damaging it in some way. A blue crabber told me, “they don’t steal the traps, they just take what’s there out of there and leave it.” One informant reported that he can tell if the thief was a human versus a sea turtle: the wood will be pulled out instead of pushed inward. He also noted that robbing from a trap was the equivalent to robbing a store. Another informant stated that “it’s one thing to steal from you, but kill [obstruct] your trap from not being able to catch?” Damaging the traps only adds insult to injury. Also, many time the lines are cut or the traps moved, causing it to become a ghost trap if the fishermen is unable to find it.

Because the trappers are required to mark each trap or line with buoys, it is not difficult for recreational anglers, divers, and other passersby to locate the traps. A boat trip in the bay will provide several instances where passengers will see trap buoys. Blue crabs, which are fished for in shallow inshore waters, are especially easy to find. In an area the size of Biscayne National Park, with open boundaries, there was seldom another boat in sight during my excursions out in the bay. Not being seen robbing a trap is even easier at night.

To combat theft, one fisherman is considering using time-release buoys made of zinc, available from a fishing supplies company. The zinc erodes in saltwater over a course of two weeks and releases the buoy. Another response is to only place buoys on the ends of each line, but this method requires knowing exact placement of traps or use of GPS.

Another way to cope with theft is through the network, which was mentioned by one of the trappers: “All of us around here, we try to watch for stuff like that, which helps”. When I accompanied a lobster fisherman on a harvest, he was communicating with other fishermen using a Nextel walkie-talkie, discussing an unknown boat near an area popular for lobster traps. Because the boat was not checking any other traps, the fisherman was worried that someone was waiting for him to leave. He asked another trapper, who was on his way to the area to check his own traps, to keep an eye on the boat.

Several fishermen relayed stories they had heard of thieves being arrested and prosecuted, and all had personal accounts of theft of their own traps. One informant stated, “I will never go for restitution, I’ll just go for jailtime.”

One informant told me that because there was little chance of catching a thief, in the past the trappers had handled anyone caught or suspected of robbing traps by their own means. The responses to thieves in these stories were very severe; it was revenge. Robbing from a fisherman’s trap is nothing to be taken lightly, as indicated in the stories of the fates of thieves.

Seasonality and weather

The lobster and stone crab fisheries have closed seasons imposed by the state of Florida. The best time of the season is in the first few months, and then there is a

decrease in catch. The blue crab fishery does not have a closed season but, as mentioned above, less harvest occurs in the summer months as a result of an increase in temperature (i.e., it is too hot to fish) and a decrease in availability of blue crabs.

Similar to effects of hurricanes on bait shrimp availability, one trapper reported problems following strong westerlies but little impacts from easterlies, even a major hurricane such as Andrew. The most substantial concern is the loss of traps and lack of demand following extreme weather events.

Territory and conflict

While there are no rules about where a fisherman may place his traps, several informants mentioned attempts to find less crowded areas and not informing other fishermen of a new location. Territoriality is difficult, however, when traps must be marked with buoys and are visible on the water surface. One trapper spoke of his location:

> It's not that anybody else can't go there, it's that you have to maneuver around the trap without hitting another trap, and you have to have a certain amount of space. And out of courtesy, whatever, etiquette of the blue crabber…if you see a guy's line well, you give him a certain amount of distance to let him fix that area. That's what I do.

Keeping a distance between one's traps with another fisherman's traps appears to benefit both parties, but informants reported instances when trap lines were crossed by another crab or lobster fisherman. However, no unwritten rules of territory were mentioned. As one trapper stated, "my license is as good as anybody else's."

Each trapper interviewed mentioned shrimp trawlers potentially damaging crab traps (lobster traps are typically set further out in the bay, in deeper water, and near coral reefs—not desirable locations for shrimpers). One informant reported that he keeps a local shrimper who frequently fishes the same area as he does updated on where he

placed his traps in an effort to minimize damage. Another crabber stated that he keeps his traps closer inshore to keep the lines from being run over by the shrimp trawls. Although mentioned in the interviews, conflict does not seem to be a major issue. Interestingly, none of the shrimpers brought up a problem with the crab traps; the only mention was included in a description of the mechanics of a trawl, and how they should roll over the top of a trap.

Shrimpers

Seasonality

The environmental and economic seasons that affect the bait shrimpers of Biscayne are interesting in how they parallel one another. The environment affects the supply; the local economy—mainly recreational fishing tourism—affects the demand. Both are at their lows in the summer and highs in the winter.

The changes in environment include basic weather patterns, and have impact on both the shrimp and the shrimpers. In the summer, the shrimp are less available because of their spawning and movement towards deeper waters once water temperature in the bay begins to climb, according to some shrimpers.

During this time, a variety of factors change the normal routines of the fleet. The shrimpers go out less (one shrimper reports that he takes the entire summer off), and spend less time on the water. Also, nights are shorter in the summer, and because a captain will “wait until the water looks good and black [no sunlight],” he will not go out until at least 8 pm. Likewise, the sun begins to rise earlier in the summer, which causes the shrimp to bury up in the sand sooner than in the winter. Longer daytime hours mean less shrimping hours.

The summer precipitation and winds also alter the activities of the shrimpers. When weather is rough, the informants reported that shrimping is better. However, potential damage to the boats and personal safety are considered if the weather is too rough, which it often is during the rainy summer months.

The recent active hurricane seasons of the past two years have caused some problems for the shrimpers. Hurricane season is June 1 through November 30, with the most active period in August and September. The years of 2004 and 2005 saw an unusually high number of major hurricane landfalls, and 2006 has been predicted to be an active season as well (Klotzbach and Gray 2006). While extreme weather can increase catch during a usually slow time for the shrimpers, it also can cause problems. In addition to storms from the west pushing the shrimp offshore, the shrimp boats can sustain considerable damage if not properly secured. Also, rising gas prices that follow the storms, particularly the spike after Katrina in 2005, deterred some shrimpers from going out if they did not feel they could catch enough shrimp to make a profit. Gas prices also play a role in the smaller number of tourists visiting south Florida.

The local economy of south Florida is driven by tourism, the primary income for the state. When there are fewer tourists, there are fewer orders for shrimps from the bait shops. Even if the shrimpers are catching an abundance of shrimp (e.g., following a storm from the east) they do not always have an outlet for selling them. Shrimp are typically not kept for more than a day if not sold immediately and therefore the fishermen do not catch excess shrimp.

Secrecy

Bait shrimpers only harvest during the night and are sometimes difficult to see once a certain distance is reached. Because of this, they can explore other areas of the

bay in search of their catch with other fishermen having little knowledge of where they are. Several informants mentioned maintaining secrecy if they came upon a good spot, particularly in the summertime. One shrimper said,

> I'm kind of a sneaky shrimper. I don't let a lot of people know where I'm working or know where I'm going. I keep to myself…because every time I ever let somebody know something, next thing I know there's ten shrimpboats there, pounding my area. Oh, what happened? There goes a month's worth of shrimp in two days, wiped out.

Another shrimper told me that summer is when the captains are especially protective of their spots, even if it means extra effort to deter them from following him. He said, "If I caught ten thousand tonight, tomorrow night I'd go in a different direction. I'd take the whole fleet somewhere else."

During my time on the boats, I noticed that the shrimpers used the CB radio often to check in with other fishermen and see how their nights were going. When asked if they divulge good locations, I was told that if a shrimper finds a spot like that, he does not tell anyone else. One shrimper was known for being easy to figure out: if he was not on the CB radio as usual, he had come upon a prime location and did not want the others to ask where he was working.

The network of the bait shrimpers

The Anglo, longterm bait shrimpers at Black Point, where I spent a majority of my time, were a close group of people. Many had known one another for decades, and sometimes through means other than the fishery. While many of them spoke of the old days, there seemed to be a closeknit network still functioning in the community. However, when asked about the new captains, mostly Hispanic, my informants admitted

that they did not converse with them on a regular basis. The segregation at the dock seemed no more than a language barrier.

Being a part of, and especially being a central figure, in the network is beneficial to the fishermen for the most part. Through the network, information about catches, problems, and stories of previous years passes. Often during interviews I heard the phrases, “I heard,” or “they say.” Information flows freely among the fishermen.

Working alone

Most shrimpers work alone, especially during the summer months when catch is low and an effort is made to maintain as much of the profit as possible. Autopilot on the boats are useful when shrimping solo, as the captain can pick while he drags, only having to check where he is going on occasion.

The drawback to working alone is the possibility of getting behind, i.e., finishing a drag before a shrimper has the chance to complete picking the last drag’s catch. This is a common occurrence because there are two sets of trawls on each boat. It is plausible to have two or more drags’ worth of catch in the holding tanks at a time, but chances of encountering a problem increase. For example, if there is already one drag in the tank and the second drag contains a Cassiopeia jellyfish, both catches might be lost from the stinging. Most shrimpers try their best to keep ahead of each drag.

However, there is only so much one person can do when working alone, and this decreases the effort for harvest. There is only a certain amount of time in which the shrimpers are able to work, and more time is spent at the picking tray when there is only one person aboard.

With years of experience, many fishermen learn quicker ways to pick. It is desirable to be as swift as possible. This is not only beneficial to the time management of

the shrimper, but also to the chance of survival for the bycatch. The faster a scoop is sorted through, the faster the bycatch are placed back into the water. A slow picker may be detrimental to the bycatch.

Conservation and Management

The informants in this study all expressed a desire to conserve the resource. Some of them have children that are interested in following in their parents' footsteps, but even the immediate future of the industry is a concern for them. However, many were more focused on the uncertainty of being allowed to continue fishing within the park rather than the sustainability of the fishery.

One prominent theme was that the fishermen felt like they were the target of unfair accusations of destroying the habitat. They noted other sources of degradation, such as freshwater influx, runoff, urban development, and recreational anglers. Many also pointed out that they had not experienced a decline in catch, indicating that the fisheries are sustainable.

When government regulations were discussed, almost all of the informants stated that lack of enforcement was the main problem. Several relayed stories of law enforcement approaching them and checking for permits and safety requirements, but no one recalled a time when fishing gear was inspected, which seemed to bother those fishermen that felt they followed all regulations when other fishermen did not adhere to the rules. Verification that equipment was in good condition and functioning properly was a common suggestion for improvement of management and for conservation of the resource.

Table 5-1: Organisms mentioned during interviews and documented in field notes.

Fishermen Term	Scientific Term*	Folk Taxonomic Rank
Animals		
amberjack	*Seriola* spp.	generic
angelfish	Family Pomacanthidae	generic
ballyhoo	*Hemiramphus brasiliensis*	generic
barracuda	*Sphyraena* spp.	generic
batfish	*Ogcocephalus cubifrons*	generic
black drum	*Pogonias cromis*	specific
black-tipped shark	*Carcharhinus* spp.	varietal
blood shrimp	**	specific
blue crab	*Callinectes sapidus*	specific
bonefish	*Albula vulpes*	generic
bonnet-head shark	*Sphyrna tiburo*	varietal
boxfish	*Lactophrys tricornis*	generic
brown shrimp	*Penaeus aztecus*	specific
cassiopeia jellyfish	*Cassiopeia frondosa*	specific
conch	*Strombus* spp.	generic
cowfish	*Lactophrys quadricornis*	generic
crocodile	*Crocodylus acutus*	generic
damselfish	Family Pomacentridae	generic
dolphin	*Coryphaena* spp.	generic
fan	*Gorgonia ventalina*	generic
flounder	*Paralichthys* spp.	generic
glass eel	**	specific
grass shrimp	*Hippolyte* spp.	specific
green moray eel	*Gymnothorax funebris*	varietal
grouper	Family Serranidae	generic
grunt	Family Haemulidae	generic
hermit crab	*Pagurus* spp.	specific
horseshoe crab	*Limulus polyphemus*	specific
humpback shrimp	**	specific
jewfish	*Epinephelus itajara*	generic
kingfish	*Menticirrhus* spp.	generic
lace murex	*Chicoreus florifer*	specific
mackerel	*Scombermorous* spp.	generic
manatee	*Trichechus manatus*	generic
mantis shrimp	*Squilla empusa*	specific
minnow	Family Cyprinidae	generic
mud crab	**	specific
mullet	Family Mugilidae	generic
nurse shark	*Ginglymostoma cirratum*	specific
octopus	*Octopus* spp.	generic
parrot fish	Families Labridae/Scaridae	generic
permit	*Trachinotus falcatus*	generic
pinfish	*Lagodon rhomboides*	generic
pink shrimp	*Penaeus duorarum*	specific

Table 5-1. Continued.

Fishermen Term	Scientific Term	Folk Taxonomic Rank
pompano	*Trachinotus falcatus*	generic
porpoise	Order Cetacea	generic
Portuguese man ‘o war	*Physalia physalis*	varietal
puffer fish	Family Tetraodontidae	generic
red drum	*Sciaenops ocellatus*	specific
rock shrimp	*Sicyonia brevirostri*	specific
scorpionfish	*Scorpaena* spp.	generic
sea cucumber	Class Holothuroidea	generic
sea turtle	Order Testudines	generic
seahorse	*Hippocampus* spp.	generic
sharp-nosed eel	**	varietal
snapper	Family Lutjanidae	generic
snook	*Centropomus* spp.	generic
soldier crab	*Coenobita clypeatus*	specific
Spanish lobster	*Scyllarides aequinoctialis*	specific
shovel-nosed lobster	*Scyllarides aequinoctalis*	specific
spider crab	*Libinia emarginata*	specific
spiny lobster	*Panulirus argus*	specific
spiny puffer	*Diodon holacanthus*	specific
sponge	Phylum Porifera	generic
sting ray	*Dasyatis* spp.	generic
stone crab	*Menippe mercenaria*	specific
tarpon	*Megalops atlanticus*	generic
trout	*Cynoscion nebulosus*	generic
trumpetfish	*Aulostomus macalatus*	generic
yellowtail snapper	*Lutjanus chrysurus*	specific
Plants and algae		
berry grass	*Sargassum* spp.	specific
blade grass	*Thalassia testudinum*	specific
eel grass	*Zostera marina*	specific
fern	*Udotia* spp.	generic
gumbo	*Giffordia* spp.	generic
herring grass	*Halodule* spp.	specific
kelp	Phylum Phaeophyta	generic
lettuce grass	**	specific
mangrove	Family Rhizophoraceae	generic
rolling grass	*Gracilaria* spp.	specific
sargassum	*Sargassum* spp.	generic
snot grass	*Giffordia* spp.	specific
turtle grass	*Thalassia testudinum*	specific
wire grass	*Syringodium filiforme*	specific

*Common names listed with higher scientific taxa than genus or species are common terms that could indicate several species of fish, and were not distinguished by the fishermen.

** denotes insufficient information.

Sources: Alden et al. 1998; Tom Frazer, personal communication; Gosner 1978; Humann and DeLoach 1995; Katz 1998; Voss 1976.

Figure 5-1: Blue crab (male).

Figure 5-2: Blue crab trap with two levels.

Figure 5-3: Stone crab trap.

Figure 5-4: Spiny lobster.

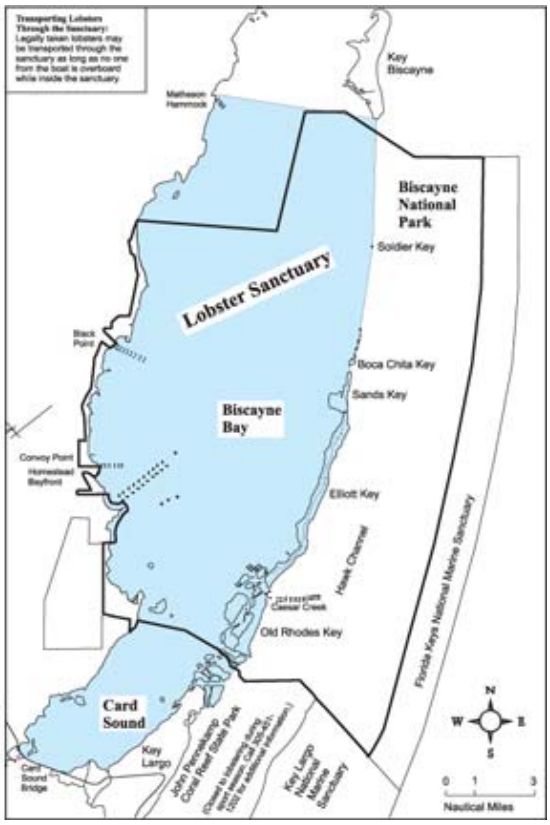


Figure 5-5: Lobster sanctuary boundaries (in blue) within Biscayne National Park.

Figure 5-6: Lobster trap (in repair).

Figure 5-7: Rollerframe trawl on a bait shrimp boat. Identification on the boat has been hidden to maintain privacy.

Figure 5-8: Holding tanks on a bait shrimp boat.

Figure 5-9: Picking tray on a bait shrimp boat with seagrass “trash.”

Figure 5-10: Bait shrimp boat. Identification has been covered to maintain privacy.

CHAPTER 6
DISCUSSION

The overall objective of the study was to characterize the Biscayne National Park fisheries in a natural and cultural context from the viewpoint of the fishermen. The specific objectives were to:

- document local ecological knowledge that contributes to fishing success.
- describe factors (other than government regulation) that affect fishermen behavior and limit harvest of the target species.
- identify fishermen's perspectives on conservation and management.

In Chapter 5, I presented the results as applied to these objectives. In this chapter, I provide a brief summary of the results, followed by a discussion the implications of the results, specifically the utility for management planning of having such information about resource and user groups and of applying anthropological concepts to fisheries. I conclude the discussion with suggestions for how this study can be used in management at Biscayne National Park and by giving some suggestions for integrating cultural studies of the fishermen into park research and planning.

Knowledge of the Fishermen

The information presented from my study regarding local ecological knowledge encompass the biology and ecology of the target species (diet, predators, and life cycles) and the habitat of the bay. Knowledge was concentrated on information that was pertinent to commercial fishing success, although some information about other species

and fisheries was reported by the informants, which suggests dialogue among fisheries, plus an interest of fishermen in the entire ecosystem.

The knowledge of users harvesting crabs, lobsters and shrimp is useful to not only monitor stocks but to assess changes in the ecosystem, using the animals as bioindicators. A change in the abundance of adult animals that are harvested might indicate a change in population at the larval stage, which could affect biodiversity of the bay because of the position of crustacean zooplankton in the food web.

Knowledge about the life cycles and migration of the target species provide insight on how the informants make decisions on where to fish. Depending on the time of year and weather, the fishermen will move to different areas of the bay, and knowledge based on experience is the most important source of information about catch availability. By documenting ecological knowledge of life cycles and migration, fisheries managers can understand the patterns of use and can make use of the long-term monitoring of the resource by the fishermen.

Information about predation on the target species reflects the compilation of knowledge from years of experience and from interaction among the informants. Predators affect the movement and abundance of the animals and are of concern to the fishermen, especially if there is a period when predators affect catch. The only predation emphasized in this study was octopi on stone crab, and of which the impact on catch was minimal. However, the possibility of changes in the octopus population, continuously monitored by the stone crab fishermen, can alert fisheries managers of changes in biodiversity and possibly other issues.

Information recorded about changes in the bay, especially from fishermen who have worked there for long periods, is valuable for assessing changes in habitat. Because fishermen use information on habitat to make decisions on where to place their traps or make a drag for shrimp, they are constantly taking mental notes of the location of the target species and what is particular about that place that attracts the animals.

Comparison of Scientific Knowledge and Local Ecological Knowledge

When the local ecological knowledge of the fishermen in this study was compared to documented scientific knowledge of the target species, the two sources agreed for the most part, which was similar to findings from a comparison study on yellowfin tuna between fishermen and managers (Miller et al. 2004). The few differences were mostly on the life cycles and spawning of each species. Table 6-1 reviews how scientific knowledge and local ecological knowledge diverge on these aspects.

One notable difference was that the information that fishermen knew typically only pertained to adults, and little or no information on the other life stages was included in the responses. This is perhaps because adult animals are what the fishermen are in search of and primarily deal with. Larval stages were not discussed at all by the fishermen, and juveniles were mentioned only by the shrimpers when they spoke of smaller shrimp showing up near the shore during late summer.

Another difference concerns the age of the animal that is reported. In scientific literature, the age at which the animal reaches sexual maturity is the focus because recruitment is important for fisheries scientists (Wilson 2003). However, the fishermen were more concerned and knowledgeable about how long it takes a crab or lobster to reach legal harvest size, and the time for a shrimp to be a good size to catch. The divergence reflects a difference in motives for each group.

Limitations on the Fishermen

There are internal and external factors that affect the ability to harvest crab, lobster and shrimp. Internal factors are a product of the culture and include secrecy, social networks and some fishermen territoriality. External factors originate from social, economic and environmental sources.

Understanding how the fishermen interact with each other and what influences the way that the other fishermen work together or not is useful to managers because it provides insight on fishing effort of the fleet (Salas and Gaertner 2004). In the case of the Biscayne fishermen, knowledge about mediocre locations is commonly shared, but locations of abundance are often withheld. Knowing the areas that are more exploited than others (mediocre locations) allows resource managers to assess impact more thoroughly.

The external factors that affect the Biscayne fleets include theft, market, and weather. Theft is a major concern for the crab and lobster fishermen and enforcement is lacking. Information from the trappers on when and where this is happening could help law enforcement officials to better address the situation.

The market also affects how the fishermen work. Understanding that the dynamics of harvest are a result of not only supply but also demand is important in planning for regulation, especially should the park decide to make seasonal changes.

Finally, the environmental factors that are affecting the Biscayne fishermen should be taken into account during planning, and allow managers to work with limitations that are already in place and influencing fishing effort.

A factor not directly mentioned, but discussed as the fishermen spoke of the rapid development in south Florida, was urbanization and its effects on the fishermen. Johnson

and Orbach (1990) examined the impacts of urbanization on the spiny lobster fishery in the Florida Keys, and found that most pressure came from new participants, who recently moved to the area, entering the fishery; increased living expenses; and tourism growth. While the Biscayne National Park fishermen do not have a problem with an influx of new fishermen, they are subject to the expensive and growing cost of living in south Florida and opposition from recreational fishing tourism. However, one fisherman told me that it was the high cost of real estate in the area that kept new fishermen, who he perceived to be middle class at most, from moving to south Florida and working in the park.

Fishermen and "Commons" Assumptions

The three assumptions of Hardin's 'tragedy of the commons' outlined earlier by Berkes (1985) included selfish users, limited resources, and common properties. In this section, I will discuss how the Biscayne National Park fisheries apply to each assumption.

Selfishness

Regarding a group of people who all depend on the same resource and deal with the same problems, at some point they will have to depend on the community in some way, and the community will come to depend on them, which helps structure the expression of selfishness. There are two specific realms in which this occurs: 1) information transmission, and 2) response to change or difficulty.

In the realm of information transmission, fishermen seek to find answers to questions about the resource through their networks (e.g., one fishermen asking another where he worked the day/night before and how the catch was). Other fishermen are the only resource for knowledge when personal experience is not sufficient. A shrimper cannot consult the literature to decide where he will take his boat that night, nor can a

trapper watch the evening news to see where the crabs are showing up this week. He depends on his own knowledge and at some point, the knowledge of others. In return, a Biscayne fishermen will tell other members what he knows, albeit only under circumstances of medium-level success. Desire to maintain the secrets of real success keep fishermen from transmitting everything they know to one another. In this way they fulfill the assumption of selfishness, but at the same time, limit the fishery as a whole by not crowding prime locations.

The other aspect is cultural response to change or difficulty. Typically, the Biscayne National Park fishermen are affected individually, but respond culturally. The following example describes the Black Point shrimpers' preparation and response to a hurricane.

Hurricanes are a part of life for the fishermen of Biscayne National Park. Prior to a hurricane, they move the boats into the canal where there is a windbreak [the informants reported that the marina will not allow them to move the boats into the recreational dock, which is a more protected area]. All loose items are removed from the deck of each boat and they are tied together to secure them. Following a hurricane, the fishermen move the boats back out onto the dock and assess any damage.

Extreme weather alters the habitat in the bay, and typically the shrimpers will not immediately be able to locate the shrimp after a storm. When Hurricane Dennis passed on the west, none of the Black Point shrimpers made significant catches for a week. One informant told me that the drivers, who are paid daily regardless of quantity, often lie to the shrimpers about others' catches. For example, if a shrimper refuses to fish one night because the catch will not be worth the while financially, the driver will tell him that

another shrimper had a success the night before. However, one phone call verifies or disproves the claim; this would not happen without the tight-knit network of the shrimpers. Furthermore, word travels quickly when a shrimper locates the target and within days all the fishermen are updated on the status of the shrimp.

However, some boat owners and captains are not so fortunate following a storm, and damage to boats might cause a delay in the return to fishing. Because each boat supplies only one wholesaler, a lack of supply could mean an unfilled order. When this occurs, other shrimpers will either catch extras or provide leftovers to wholesalers without working boats.

Do the Biscayne fishermen meet the assumption of selfishness? In some ways the answer is no. They rely too heavily on one another for information and for assistance following a disturbance. In other ways, the answer is yes. Perhaps information is transmitted in hopes of receiving information as well, and it is possible that help is given with the expectation that the favor will be returned.

However, there is one other aspect that appears to be overlooked in most studies: the fishermen are humans. They have names, faces, families, stories, hopes and fears. Ramírez-Sánchez (2006) wrote that emotion plays a heavy role in cooperation within social networks of fishermen—the binds that tie are more important than 'winning'. Likewise with the Biscayne National Park fishermen, there are ties that no social network analysis can show. Sometimes, it is not lack of selfishness or any other kind of cultural force at work. Sometimes, it is simply because the fishermen are friends.

Overexploitation and Limited Resources

In many cases regarding a marine resource, it is hard to determine if a stock is overfished. Typically a lack of insufficient data to provide an actual number of the

animals leads to the need for a model to estimate population, but limitations on harvest, based on models do not always produce an improvement in stocks, which might indicate a flaw in the model. The situation is similar in Biscayne, although current records of commercial landings and information from the fishermen show that at this time there is not a decline in target species. This is most likely due to the small number of fishermen working in the bay and at such a small scale.

Common Property and Open-access

Biscayne National Park is considered a common property resource, as federal lands are considered to be owned by the people. Likewise, it is open to all users, recreational and commercial alike. Recreational visitors participate in diving, boating, and fishing, and until recently (due to moratoria on licenses) anyone could become a commercial fisherman.

It is the open-access concept that is not as easy to apply to this situation. Clearly the park is available to commercial fishermen if they meet the government regulations, which play the most significant role in limiting access. Without proper permits, endorsements and tags, there might be more participants than the fishery could sustain. At this time, the government provides restriction to the resource.

However, exactly how much do federal and government regulations maintain that restriction? From the outside, Biscayne National Park is more of a state-regulated property regime than open-access with myriad rules and regulations in place for the fishermen. Feeny et al. (1996) distinguishes between two types of regimes, *de jure* and *de facto*, which also apply to Biscayne National Park. The government (state and federal) regulate resource use on paper. However, because there is little enforcement of regulations that directly affect the fishermen's behavior and fishing effort (such as gear

specifications and harvest size restrictions), the situation is *de facto* more likely to be open-access. In this case the behavior of the fishermen will dictate fishing effort moreso than government regulations. According to this, I am presenting a discussion on the open-access nature of the Biscayne National Park fisheries with little regard to government regulations. The two sides to the debate are discussed below, the first from a single-species approach, and the second from an ecosystems approach.

Although anyone person with fishing permits could participate in the commercial fisheries at Biscayne National Park, he would still have to know the area fairly well to be successful. Local ecological knowledge and familiarity with the gear are necessary and only come with years of experience. In another context, if the target species was soup in a can with no label and Biscayne Bay was a members-only warehouse (e.g., Costco or Sam's Club), it would be a similar situation. A participant would have to pay to be a member, and once he got in, would never find the soup can unless he knew where it in the store, and along the way probably pick up a lot of cans he did not want (bycatch). Only by trial and error or perhaps, if he knows the right person to ask, information he received from other members. This is a simplified example, but representative of the basics of how the fisheries work within the park. Without knowledge of the resource a person would have little access, and the park becomes not as open-access as it appears on the surface.

On the other side, from an ecosystems approach, is that the resource is open to other forms of exploitation. For example, any person can place a crab trap in any area of the park. In doing so, even if he is not successful at catching a crab, he has potentially made an impact on the resource. He has not affected the stock but he has affected the

habitat, which may eventually affect the crabs and other organisms living there. When examining the assumption of open access, we must consider different means of access for the users to determine if the situation could possibly become a 'tragedy'.

Could Biscayne National Park Become a "Tragedy?"

It is difficult to assess if the commercial fisheries of Biscayne National Park are sustainable with the little information available, both as natural and cultural resources. However, it is important to know that there are factors at work that limit exploitation of the resource beyond existing government regulations.

The fishermen experience a variety of factors that affect their success and limit their activities beyond the scope of formal management. Internal cultural limitations include secrecy, knowledge, and community status. External limitations include environmental and social factors, such as ecological seasonality, supply and demand, and theft. It is important for marine resource managers to consider these components of the fishery to make informed decisions on management.

The Future of the Fisheries at Biscayne National Park

Is conservation of marine resources an important goal for the fishermen of Biscayne National Park? I would argue yes, although not nearly as important as conservation of the fisheries and fishermen. Interviews and conversations revealed that the fishermen are not particularly worried about the stocks but more concerned with the possibility that they will no longer be allowed to work within the park. They do not feel that they are overfishing and they do not consider their activities to have a major impact on the habitat.

When asked about the future of the fisheries, specifically when discussing whether or not their children would follow in their footsteps, most fishermen expressed doubt or

stated that did not encourage their children to become fishermen. This was mostly because of their uncertainty that there would even be a fishery for the children to participate in. The end of commercial fishing within the park is perceived as being a very real possibility in the very near future, and often the fishermen mentioned options that they had been contemplating should commercial fishing in Biscayne National Park no longer be allowed.

Often the fishermen referred to how they feel that they are perceived as: the bad guys. Also noted in Smith and Jepson (1993), they feel that small-scale fishermen are a dying breed, even though they see themselves as hard-working good people. They also believe that much of the opposition comes from scientific studies, which portray the fishermen, especially the bait shrimpers, as obstructions to resource protection due to the damage caused by fishing gear. Several mentioned that scientists conducting research on the marine resources within the park were not to be trusted, and "will find whatever results they are paid to find." Clearly, the fishermen are wary of the motives of the scientific community, and most of all, concerned with the reactions of the public to the results of these studies.

The uncertainty of the continuation of commercial fishing in Biscayne National Park is valid. Similar to many other small-scale commercial fishermen in Florida, they face public scrutiny and are unsure of how and if they can refute the viewpoints (Smith and Jepson 1993). Without time, funds, and ability to come together as a group, they have little means to provide a counter argument.

Recreational Fishing

Although this thesis focuses on the commercial fishermen of Biscayne, I cannot ignore the role of the recreational anglers that visit the park, and their relationship to the

commercial fisheries. A visitors' survey conducted in 2001 found fishing to be the primary reason for visiting the park for 31% of the respondents (Simmons and Littlejohn 2001). The park's Ethnographic Overview and Assessment (EDAW 2003) emphasized user groups participating in recreational angling and its importance in how the general public is linked to the area. Furthermore, the Miami Herald has a weekly fishing report for the area and regularly publishes articles on recreational fishing, including coverage of tournaments and other topics.

At a simple glance, there should be little conflict between recreational and commercial fishermen, at least from a competition point of view. Although the number recreational trap fishermen is much higher than that for commercial fishermen, there does not appear to be a problem with competition between the two user groups. This is perhaps because fishermen harvesting crab or lobster recreationally are allowed too few traps to compete with commercial trap fishermen. Shrimpers are targeting species not pursued by the recreational anglers, and they work only at night as recreational anglers typically fish during the day.

However, a broader viewpoint could reveal other forms of competition. In a study on competition between recreational and commercial fishermen on Lake Erie, Berkes (1984) mentioned the effect on the food web by each fishery as a more likely problem than overlapping territory or competing for a single species. In the case of Biscayne National Park, the competition, at least on the surface, seems to be on who should take the blame for decline in quality of the bay.

Many of my informants are concerned with the recreational anglers, mostly stating that they are not educated on regulations and enforcement is difficult. Also, some

commercial fishermen note that recreational anglers do not depend on the resource for their livelihoods, and are less likely to think about conservation when they are only in the park for a brief period. Finally, the overall viewpoint on impact from recreational use in the park is that the number of anglers in the park far outweighs the number of commercial fishermen, and therefore should be the focus in management plans.

Biscayne Fishermen in the National Park Service Context

The National Park Service defines a cultural resource as:

> an aspect of a cultural system that is valued by or significantly representative of a culture or that contains significant information about a culture. A cultural resource may be a tangible entity or a cultural practice. Tangible cultural resources are categorized as districts, sites, buildings, structures, and objects for the National Register of Historic Places and as archeological resources, cultural landscapes, structures, museum objects, and ethnographic resources for NPS management purposes (National Park Service 2001).

In 1998, the service created a management plan for cultural resources that covered six types of cultural resources and provided guidelines for research, planning and stewardship. Included in the plan was information for ethnographic resources, which are physical attributes (e.g., a site, landscape or natural resource feature) assigned significance by a cultural group.

Ethnographic data on the traditional use and management of culturally important natural resources helps inform ecosystem management, programs of consumptive use, the Man and the Biosphere program, and global climate change research about relationships between environmental issues and local resource uses.

The National Park Service knows the value of ethnographic studies for both sides. Why are there not more conducted, especially prior to development of management plans? One obstacle is lack of funding for staff or contracting external researchers to complete the studies. Management and budget would have to be modified to make

ethnographic studies a priority for funding. Additional staff would be required to assess, plan and manage cultural resource studies. Management of cultural resources is an important goal for the National Park Service, even if natural resources remain superior in priority. Half of the annual budget allocated to natural resource management is assigned to management of cultural resources, and many parks only have one or two members of the staff assigned to cultural resource management (Gamble 2003). Of the four south Florida parks (Biscayne, Everglades, Big Cypress, and Dry Tortugas), Biscayne has the only cultural resource manager. Despite shortcomings in natural resource management staff as well, cultural resource management is hardly represented in park units with such rich cultural history.

Still, if the National Park Service truly wants to provide an interdisciplinary program and satisfy its requirements for management of natural and cultural resources, a new approach must be developed in which resource management can be combined. The Ethnographic Overview and Assessment for Biscayne National Park (EDAW 2003) emphasized the importance of fishing as a cultural activity of the park users (commercial and recreational), and my study provides more information of the commercial fishermen working in the park. However, my study is only skimming the surface. Imagine an ongoing effort of documenting local ecological knowledge and information about the commercial fisheries from the participants' point of view. What park management knows about the resource would greatly increase, and the fishermen would be involved in the process. A well-rounded approach to collecting data and planning would be a significant contribution to both types of resource management.

Biscayne should press for more funding for ethnographic research and, if that fails, develop creative ways to combine forces—for example, recruit fishermen for assistance with research projects. Through this, park staff will develop relationships with park users and be collecting ethnographic data through participant observation. It would also involve the fishermen in the research and planning process.

Another suggestion is to not only solicit or recommend information from the fishermen, but to require it. In addition to licenses to work in the park, include a rule that fishermen must attend meetings, report to park staff on the status of the target species, or make recommendations for improvement of management on a regular basis. Even simple informal conversations once or twice a year (such as when they renew the pending special permit licenses to fish in the park), during which they could inform park staff of problems or concerns that they have noticed, would at the very least open up a dialogue between the managers and the fishermen.

The park is a unique and beautiful area that faces increasing pressure for potential loss of its natural resources. All information that can contribute to knowledge about the bay and how it is affected by human activities is important--scientific and local knowledge alike. Biscayne must be willing to accept help and knowledge from the fishermen, who depend on the resource for their livelihoods and of whom many expressed deep connections to the bay. Perhaps with different motives, the fishermen and managers share the same goal: conserving the resource.

Table 6-1: Some comparisons of scientific knowledge and local ecological knowledge of the biology and ecology of the target species.

Species and concept	**Scientific Knowledge**	**Local Ecological Knowledge**
Blue crab		
spawning	males carry females until eggs are released, spawning occurs year-round but most from March-December	occurs year-round
age of sexual maturity/harvest size	sexual maturity at about 1 yrs.	legal harvest size in 4 months
Stone crab		
spawning	April to September, peaks in August and September	occurs during the closed season (May 16-October 14), but has been observed during the open season also
age of sexual maturity/harvest size	sexual maturity at 2 yrs.	legal harvest size in 1-2 yrs.
Spiny lobster		
spawning	late spring to early summer, peaks in April and May	n/a
age of sexual maturity/harvest size	sexual maturity at 2 yrs.	legal harvest size in 1 yr.
Shrimp		
spawning	occurs offshore in the summer months	offshore, inshore, throughout the bay [no consensus]
age of sexual maturity/harvest size	sexual maturity in about 10 weeks	preferable size in 3-9 months

APPENDIX
FISHERMAN INTERVIEW PROTOCOL

General
How old are you?
How long have you been fishing?
What do you fish for commercially?
How did you learn how to fish?
Have you taught anyone else how to fish?
What kind of boat and motor do you have?
What kind of gear do you use? How does it work?
Do you use GPS or other technology?
Who do you sell to?
Do you know anyone else who fishes commercially in Biscayne?
Do you have any other sources of income?

Local ecological knowledge
What time of year do you fish? Why?
What time of day do you fish? Why?
What do you use for bait (trap fishermen)?
Where do you get the bait?
How old are the shrimp/crabs/lobsters that you catch?
What kind of habitat does a shrimp/crab/lobster live in?
What does a crab/shrimp/lobster eat?
What eats a crab/shrimp/lobster?
How does a crab/shrimp/lobster defend itself?
Has there ever been a problem with predators affecting catch?
What is the strangest thing you ever caught in your trap/trawl?
How does weather affect crabs/shrimp/lobsters?
How does tide affect your catch?
Have the populations of crabs/shrimp/lobsters changed?
What other problems have you noticed in the bay?
Are there places in the bay with pollution?
Are there places in the bay with too many boats?

Behavior
How do you know where to fish?
Do you tell other fishermen about your catch?
How do you maintain your own fishing spots?
Is there conflict with other fishermen?

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BIOGRAPHICAL SKETCH

I was born and raised in Stockbridge, Georgia, attended Stockbridge High School and graduated with honors in 1996. I acquired my bachelor's degree in ecology from the University of Georgia in 2000. Until I began the master's program in enterdisciplinary Ecology at the University of Florida in 2003, I traveled throughout Central America, where I studied Spanish in Guatemala and worked at an eco-lodge in Punta Banco, Costa Rica. The focus in my graduate studies includes ecological anthropology and environmental education. After graduation, I will continue at the University of Florida in the Ph.D. program in interdisciplinary ecology, focusing on the use of ecological anthropology to improve environmental education in the United States. Following my Ph.D., I hope to have the opportunity to teach at the university level and design research plans that allow for collaboration with external institutions.