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A case study of the effect of the 1976 Sanibel Island comprehensive land use plan

Lynn B. Thomas
University of Tennessee

To the Graduate Council:

I am submitting herewith a thesis written by Lynn B. Thomas entitled "A case study of the effect of the 1976 Sanibel Island comprehensive land use plan." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Planning.

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A CASE STUDY OF THE EFFECT OF THE 1976 SANIBEL ISLAND COMPREHENSIVE LAND USE PLAN

A Thesis

Presented for the

Master of Science in Planning

Degree

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Lynn B. Thomas, Jr.

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Finally, it is with great appreciation that I acknowledge with thanks all the individuals and groups from Sanibel Island who provided me with much of the information necessary to complete this thesis.

ABSTRACT

In 1963 Sanibel Island, Florida, a barrier island on Florida's Gulf Coast, was connected to the mainland by a causeway. This allowed more people than ever before to visit and settle on the island. This sudden influx of humanity was having adverse impacts on the natural environment of Sanibel. In 1974 when Lee County released a plan which would have allowed a population of up to 90,000, the residents decided to take their fate into their own hands by becoming an incorporated city. On 5 November 1974, they voted to do just that.

Throughout much of 1975 and part of 1976 the newly created Sanibel Planning Commission worked on the first Comprehensive Plan for the city. They were assisted in their efforts by the consulting firm of Wallace, McHarg, Roberts, and Todd, The Conservation Foundation, and numerous local groups and individuals. The end product was the 1976 Comprehensive Land Use Plan for Sanibel Island. It was designed to accommodate growth in a manner that would have the least possible detrimental effects on the island's natural systems. It was the intent of this thesis to examine more closely the planning process used in Sanibel and discover what effects the plan has had on the people and resources of the island.

The thesis first gives a brief overview of the history of Sanibel. The next chapter examines environmental planning process theory. Finally, a closer examination of the Sanibel planning process, an assessment of the effects of the plan to date, and a discussion of what can be learned from the Sanibel case was given. In doing this, the

methodology used was a case study. Specifically a literature review and personal interviews were conducted to answer the research questions.

The study found that low density development has been profitable and has in fact increased tourist growth. A case is made for preserving barrier islands in their natural state. Finally this thesis found that a significant contribution of the original plan was that it provided future leaders of Sanibel with an effective guide to decision making.

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CHAPTER I

INTRODUCTION

Problem Setting

Sanibel Island (see Figure 1 and Table 1), a 12-mile-long barrier island located in Lee County on Florida's Gulf Coast, is a unique community. One unique feature is its physical orientation. Most barrier islands in this area have a northwest-southeast orientation. Sanibel Island is different. A large portion of this island faces south before arching into the more common NW-SE orientation. This unusual position is the reason for another unique characteristic. That is the abundance of sea-shells which are deposited on the island's shores. The most important unique feature of Sanibel, however, has nothing to do with its physical qualities but rather with human activities.

On 5 November 1974 the citizens of Sanibel Island said no to becoming just another overdeveloped beach resort. On this date the people of Sanibel voted to incorporate their island as a city. This action was the result of a series of events.

The first major event in this series was the construction of a causeway in 1963 that linked the island to the mainland. The result was a building boom which, "was depleting the island's resources."[1] Under the governance of Lee County, Sanibel would have been allowed to be

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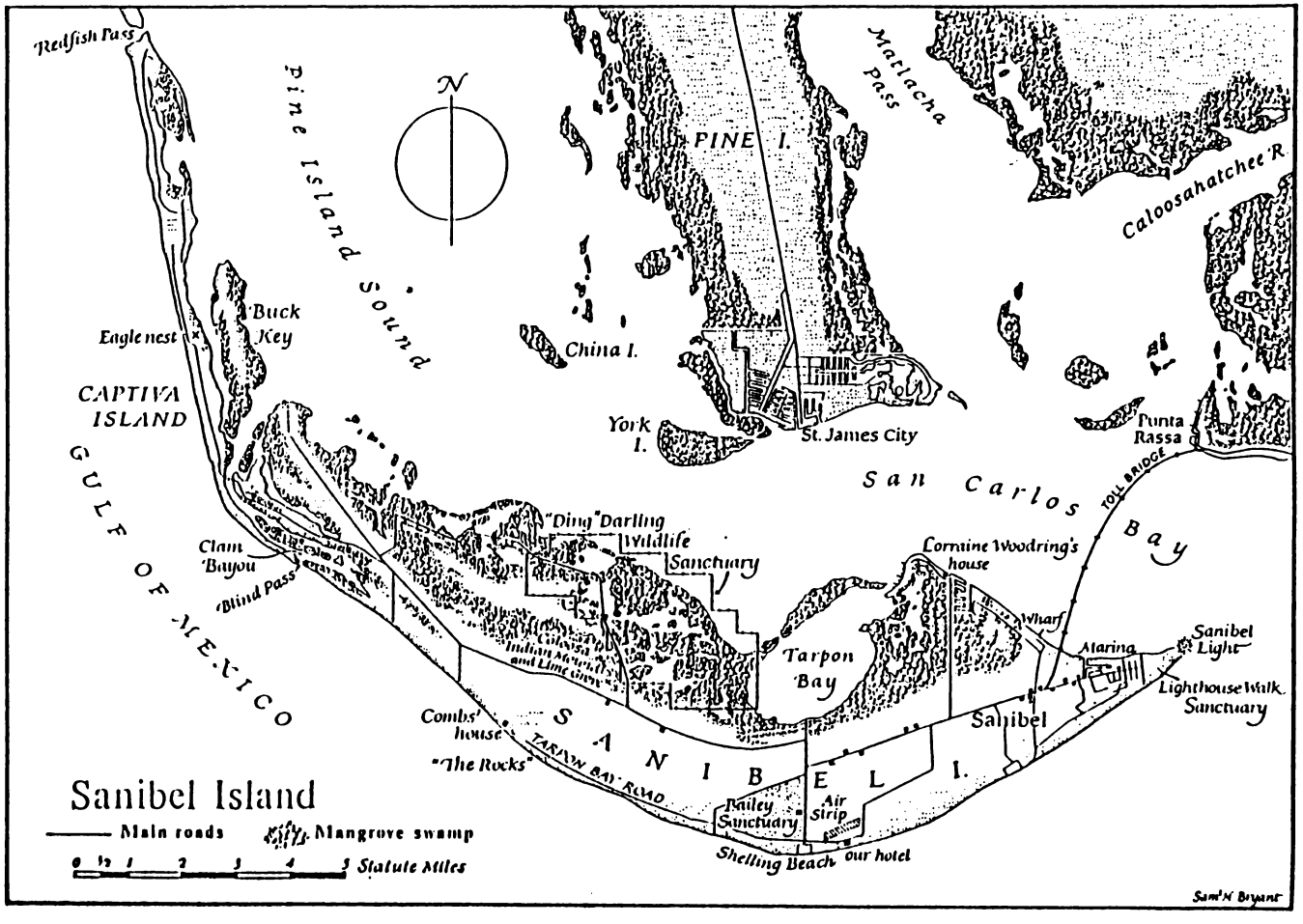
[1]John C. Clark, The Sanibel Report (New York: The Conservation Foundation, 1976), p. v.



Source: Katherine Scherman, Two Islands: Grand Manan and Sanibel.

Figure 1. Map of Sanibel

Table 1. City of Sanibel Miscellaneous Statistics

Natural Features:		
Land Area	10,730	Acres
Shoreline:		
Beach Frontage Gulf Of Mexico.	11.75	Miles
San Carlos Bay.	3.75	Miles
Mangrove Frontage	9.0	Miles
Island Elevation		
Average Above Sea Level	4.0	Feet
Maximum Above Sea Level	13.0	Feet
Annual Precipitation	42.3	Inches
Temperature (Degrees Farenheit)		
Annual Average	74	
August Average	83	
January Average	64	
Demographics:		
Resident Population - 1986	4,696	
Seasonal Population Peak (Approx.)	15,600	
Registered Voters	3,292	
Resident Average Age - 1984	51.8	
Public and Conservation Land Total.	6,120	Acres
J.N. "Ding" Darling Wildlife Refuge	5,013	Acres
Sanibel-Captiva Conservation Foundation	800	Acres
Lee County	196	Acres
City Of Sanibel	111	Acres

Source: City of Sanibel Finance Department.

developed to the extent necessary to support a population of 90,000. However in 1974 the people decided that their home was too special a place to allow this to happen.

On 16 December 1974, only 40 days after the vote to incorporate, the new Sanibel government took over. Among the first acts of the new government was the issuance of a moratorium on new building permits. Also at this time the Sanibel Planning Commission began working on a new comprehensive plan. To provide professional assistance in formulating this plan, the Philadelphia planning firm of Wallace, McHarg, Roberts, and Todd was hired.

The culmination of this series of events occured on 19 July 1976 when the new plan received final approval, ordinances were passed, and the general moratorium on development was lifted.[2] This plan was quite different from that proposed by Lee County. Under the new plan there would indeed be growth, but not nearly the amount that would have been allowed by Lee County. The plan and the planning method adopted would:

1. Set a future limit on population consistent with natural resources, notably those imposed by water resources and by the imperative of evacuation before hurricanes;
2. Distribute the permitted number of new structures (about 2000) over the developable land in accordance with the carrying capacity of the natural systems;
3. Establish a strong set of performance standards for all development;
4. Develop a scientific plan for restoration of past ecological damage (particularly to the water systems); and
5. Provide for the highest level of continuing public participation.[3]

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[2]Ibid.

[3]Ibid., p. vi.

This was obviously a change in policy for the island. Yet even with these changes questions remained, such as would it really work and what effects would it have.

Problem Statement

The purpose of this thesis is to study these questions. Specifically it will answer the research question: what effect has the 1976 Comprehensive Land Use Plan for Sanibel Island had on the physical development of the island?

Before answering this question it is necessary to know something about the specific events that led to the decision to develop such a plan. Therefore one subsidiary question is: who were the major actors responsible for the initiation of the environmental planning process in Sanibel Island? A related question is: how do these groups view the effects of the plan to date?

Any land use plan will affect more than just the land uses of an area. There are spin-off or side-effects as well. Thus a third subsidiary question is: how has the 1976 Plan affected the island's social, political, and economic climates?

In the book Design with Nature, Ian McHarg, one of the partners in the planning firm that developed the Sanibel Plan, asserts that "it is possible to claim conservatively that planned growth is at least as profitable as uncontrolled growth."[4] The planned growth to which he

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[4]Ian McHarg, Design With Nature (Garden City: The Natural History Press, 1969), p. 92.

refers was that which would be allowed under his plan for an area just to the northwest of Baltimore, Maryland. Since McHarg's method was followed in Sanibel Island, the opportunity exists to test his assertion about controlled vs. uncontrolled growth. Specifically the question to be answered is: how does Sanibel Island compare today to other barrier island communities? To answer this question, such things as property values, build-out rates, number of building permits issued, etc. will be examined for Sanibel Island. These figures will then be compared to those for Lee County, South Florida, the State of Florida, and the Southeastern United States. This will show whether or not Sanibel differs from its region in these respects.

There are a number of questions to be answered concerning the effect of the plan on the environment of Sanibel Island. Since the 1976 plan was an environmentally sensitive plan, it is assumed that the environment has not been adversely affected by allowed development. But this may not be the case. Therefore several questions could be asked regarding the effect of the plan on the environment of the island. For example, the Wallace, McHarg, Roberts, and Todd study called for distributing future development on the island by zones based on suitability for development. One subsidiary question is: has the development of Sanibel exceeded that which was originally envisioned in 1976 (2000 new structures) and if so, has this growth continued to be distributed as described in the study? Then there is the question of the effect on the environment. Previously it was noted that the 1976 plan was, at least in part, a scientific plan for the restoration of

past ecological damage. Thus one subsidiary question is: what was this past ecological damage and has it been restored? Another environmentally related question is: have there been any side-effects on the environment as a result of the 1976 Land Use Plan? Finally, because this plan may not be the only action designed to protect the environment, another question is: what has the state of Florida done in the way of Coastal Zone Management on Sanibel?

Barrier islands are being developed all over the United States' Atlantic and Gulf coasts at rapid rates. It is hoped that the Sanibel Island experience can be of use in developing other barrier island communities. Thus the final subsidiary question is: what can be learned from the Sanibel Island experience that might be applicable elsewhere?

This last question is the main reason that this research was undertaken. Growth in the United States is occuuring more rapidly along the coasts than in any other region and poorly planned development in this area can be very damaging. This is reflected in the fact that the annual coastal property damage due to erosion, flooding, and wind damage is approximately $3 billion.[5] This number becomes even more significant when one considers that the annual amount has presumedly been reduced in recent years under the advent of Coastal Zone Management.

Another reason that this research was undertaken is given by the 1969 report Our Nation and the Sea, which was the report which called for the establishment of Coastal Zone Management. In this report it is

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[5]Kathryn Cousins and David Godschalk, "Coastal Management: Planning on the Edge." Journal of the American Planning Association, Summer 1985, p. 264.

stated that "the problems of conflicting use and resource management in coastal areas have grown beyond local government's capacity to deal with them."[6] If the Sanibel Plan has truly been successful, then this assertion will have been refuted, at least by one community. If the local government of Sanibel Island has been able to deal with the problems of conflicting use and resource management, then perhaps other local governments could do the same.

Another reason for undertaking this research is the urgency of the problem. Coastal areas are growing rapidly. If national trends continue, by the year 2000 three out of every four Americans will be living within fifty miles of a shore.[7] To be certain, some of these people will be living on the shores themselves and those that are not will be using them for recreational purposes. Thus it is imperative that any information that may be helpful to developing coastal communities be made available.

Methodology

The methodology employed was a case study. More specifically, by literature review and personal interviews information was gathered to answer the research and subsidiary questions.

The questions concerning the events leading to the initiation of the planning process were answered through a review of the literature

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[6]Thomas R. Kitsos, "Coastal Managemnet Politics: A View from Capitol Hill." Journal of the American Planning Association, Summer 1985, p. 277.

[7]Cousins and Godschalk, "Coastal Management." p. 265.

and by interviewing people involved in this process. The question of how the social, political, and economic climates have changed was answered by interviewing social, political, and economic leaders of the Island.

To answer the question of how Sanibel compares to other barrier island communities, the information from the above question was used as a basis for comparison to other communities. The information on the other communities was gained primarily through literature review.

When answering the questions concerning the effects of the plan on the environment, personal interviews were conducted with the political leaders, as well as with local conservation groups. The final question of what can be learned from the Sanibel experience that might be applicable elsewhere was answered by a more thorough understanding of the situation which came from the case study.

Organization of This Thesis

This thesis is composed of five chapters. Chapter II is an overview composed of two parts. Part one outlines the history of Sanibel from its discovery until the opening of the causeway in 1963. Part two covers the period from 1963 through 1975 when the plan began to be formulated. Chapter III discusses environmental planning in general. Chapter IV then discusses the planning process used in Sanibel and examines the efffects of the 1976 Comprehensive Land Use Plan. Finally, Chapter V offers conclusions.

CHAPTER II

AN OVERVIEW

This chapter gives an historical overview of Sanibel. The first part deals with the period from the discovery of Sanibel to 1963. The second part covers the period of 1963 to 1975, which is the time during which the events that led to the adoption of the 1976 Comprehensive Land Use Plan occured. The period from 1975 to the present is the subject of Chapter IV of this thesis.

Early History

Geologically Sanibel is a young island--only about 5000 years old.[1] The first known inhabitants of the island were Indians known as the Mound People, the Pile Dwellers, or as they later came to be known, the Caloosas. The first two names are descriptive of these people's homes and villages. They constructed thatched homes on platforms secured by sturdy pilings. Above these homes rose labouriously erected mounds of shell and marl which came to resemble cement when exposed to air.[2] A temple, village storehouse and the chief's home were built on top of each of these mounds. On the next lower level were the thatched dwellings of the servants of those at the top, and at the bottom, around

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[1]John Clark, The Sanibel Report (New York: The Conservation Foundation, 1976),p.3.

[2]Florence Fritz, The Unknown Story of Sanibel and Captiva (Ybel y Cavtivo)(Parsons, West Virginia: McClain Printing Company, 1974), p. 11.

the water, lived the fishermen and their families in their pile dwellings on floating platforms.[3]

No one is quite sure when the Caloosas first came to Sanibel and her sister island Captiva. Radiocarbon evidence shows that there was an extensive civilization of at least 100 of these mound cities as early as about 1200 AD.[4]

In 1513 Sanibel Island was "discoverd" by the Spanish explorer Juan Ponce de Leon who was searching for the elusive fountain of youth.[5] He named the point on which he landed after the late Queen of Spain, Isabella. Today that point is still known as Point Ybel and the name of the island itself, Sanibel, is derived from this early designation.

It is believed that de Leon returned several times to capture Indians for the slave markets of the Antilles.[6] He was not the only Spaniard to visit Sanibel for this reason. At one time or another Diego Miruelo, Cordova, and Alonza Alvarez de Pineda all came "bent on slavery, conquest, profits."[7] Ponce did not, however, welcome all of this company to the land he considered to be his by right of discovery. Thus in 1521 he set sail again from Cuba for Sanibel intent on conquering and colonizing.[8] However as his expedition was unloading, the

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[3]Ibid.

[4]Priscilla Murphy Realty, Inc., "The Story of the Islands" (Pamphlet, Sanibel, Florida, 1983), p. 2.

[5]Clark, Sanibel Report, p. 3.

[6]Fritz, Sanibel and Captiva, p. 20.

[7]Ibid., p. 21.

[8]Ibid.

Caloosas attacked and wounded de Leon. He quickly returned to Cuba but the wound would prove to be fatal.

It would be several years before any more invaders would come to the island. The last big effort came in 1566 when Pedro Menendez de Aviles approached with "the blessing of the Spanish Crown, `to pacify the southern coast, locate a harbor necessary as a port of refuge around the southern coast, and to protect the shipwrecks of treasure ships and galleons.' "[9]

Menendez would return several times, leaving behind Jesuit priests to convert the Caloosas and establish colonies of religious natives among them. Menendez had a lot to gain by colonizing the Caloosas, as the king had promised that he could keep almost everything he could take in his conquest. Thus when it became dangerous for him to venture off Sanibel into the "great bay northward where lived the fiercest defenders of the Carlos capital,"[10] Menendez resorted to drastic measures. He, "had the chiefs of eighteeen of the embattled provinces of Carlos rounded up at the capital across from Ybel, and there they were beheaded."[11] However this did not quell the Caloosas. In fact it made them so hostile that no Spanish military power was ever again able to establish the slightest foothold on their coast.[12]

In the years that followed, Sanibel was visited only by missionaries, slave-seeking Spaniards, and pirates. Tales of pirates

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[9]Ibid., p. 24. [10]Ibid. [11]Ibid., p. 25.

[12]Priscilla Murphy Realty, "Story of the Islands," p. 3.

such as LaFitte, Blackbeard, Black Caesar, Black Augustus,and Gasparrilla still linger after more than 200 years.

It is not known how long the pirates and the Caloosas co-existed on Sanibel. There were no pirates to be found in 1823 when, one year after Florida became a territory of the United States, Commander McIntosh of the U.S. Navy came to see just what was to be found on the Charlotte Harbor Islands. Instead of pirates he found only Indian villages and their fisheries. This was again the case when in 1831 William A. Whitehead, the Key West Collector of Customs, reported that he found four fisheries. Half the inhabitants at this time were Indians. Thirty were women and another fifty to one hundred were children. The men could not be counted as they were away fishing.[13]

In 1831 Sanibel Island was purchased by a group of New York investors known as the Florida Peninsular Land Company.[14] By this time the area had been extensively explored and surveyed. A few homes were built in 1833 on Point Ybel so that newcomers could hunt and fish, and a crop of sugarcane was raised at this time. In the following year, under the Florida Territorial Act of 1833, two settlements were incorporated for Sanibel by men named William Bunce, Colonel D. Murray, W.R. Hackley, and P.B. Prior.[15] The settlements, however; were short-lived with many

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[13]Fritz, Sanibel and Captiva, p. 32.

[14]Clark, Sanibel Report, p. 3.

[15]Fritz, Sanibel and Captiva, p. 32.

settlers leaving because of a final series of Indian raids in 1836. In 1850, Fort Casey was erected on the site of a former settlement.[16]

The State of Florida seceded from the Union in 1861. At this time there was no one living on Sanibel.[17] During the Civil War, cattle from upstate became a valuable commodity. The Confederates paid $8 a head, but in Cuba the price was two ounces of Spanish gold. Thus Punta Rassa, across the bay from Sanibel became a major shipping point. Even though Federal forces were established at point Ybel and Punta Rassa, many cattlemen found ways to slip through the inside waters of Sanibel and around the Federal blockades, as did the pirates of earlier days.[18]

Settlers returned to Sanibel soon after the Civil War ended. In 1868 William Smith Allen, an ex-Union soldier, began farming and Terevo Padilla, a fisherman from the Canary Islands opened fishing camps on Sanibel and Captiva.[19] Still the island was largely uninhabited. When the Sanibel lighthouse was built in 1883, only five families lived on the island.

In 1889 there were twenty-one houses and forty families living on Sanibel for a total population of 150. It was in this year that Flora Sanibel Woodring became the first white child to be born on the island.[20] It was also around this time that the first tourists came to Sanibel. Seashells, sport fishing, and wildlife helped to attract such

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[16]Clark, Sanibel Report, p. 5.

[17]Priscilla Murphy Realty, "Story of the Islands," p. 4.

[18]Ibid. [19]Ibid., p. 5. [20]Ibid.

visitors as Theodore Roosevelt, Edna St. Vincent Millay, Charles and Anne Lindbergh, and Thomas Edison who had once been a night watchman for the International Ocean Telegraph Company on the island.[21]

In 1900 one of the first rural free delivery mail routes in the United States was established on Sanibel. This mail service was vital to the islanders as it was their only contact with the outer world. Through it they received, "seeds, food, medicine, clothes, lumber, nails, and fertilizer. Their lives depended on it."[22]

Agricultural development had started on Sanibel in about 1883 and grew to encompass the majority of the island's arable land.[23] Among the chief crops were citrus fruits and vegetables such as tomatoes, squash, and eggplants. By 1910 steamers were regularly transporting both vegetables and passengers.[24] In 1926 the last of a series of severe hurricanes effectively ended farming on Sanibel. So severe was this storm that almost half of the island's residents were forced to leave. Those that remained did so to serve winter visitors and tourists.[25]

Between 1927 and 1944, the island's population remained at about 100. The only growth was a gradual increase in the number of tourists visiting Sanibel. In 1945 Sanibel was made a State Wildlife Refuge and

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[21]Clark, Sanibel Report, p. 5.

[22]Priscilla Murphy Realty, "Story of the Islands," p. 7.

[23]Clark, Sanibel Report, p. 6.

[24]Priscilla Murphy Realty, "Story of the Islands," p. 7.

[25]Clark, Sanibel Report, p. 6.

a large portion was designated a National Refuge.[26] This would become known as the Ding Darling National Wildlife Refuge and today it occupies about 5000 acres. After World War II, development accelerated. Electric service was started and roads were paved.[27]

In the 1950s Sanibel's reputation for shell collecting and abundant wildlife once again spured an increase in tourism and related services. This, however, was nothing compared to the growth that would occur beginning in 1963 when the causeway was completed linking Sanibel to Punta Rassa on the mainland.

Recent History

On 26 May 1963 the three-mile causeway was officially opened. In that same year, "the right of Sanibel's existing independent zoning authority was successfully challenged in court, leaving the islanders with no control over the extensive growth which was to result."[28] Thus in 1967 the residents began to take actions designed at preserving the character of their island. The first action in that year was the successful opposition by Sanibel and Captiva residents to a proposal for a large trailer park on Sanibel by claiming that it would have an adverse impact on wildlife and would further overcrowd the island.

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[26]Priscilla Murphy Realty, "Story of the Islands," p. 8.

[27]Ibid.

[28]Clark, Sanibel Report, p. 92.

In 1968 Lee County planning consultants recommended Sanibel and Captiva for "intensive use, high-density urban development including a four-lane expressway which would bisect the wildlife refuge."[29] Even though these recommendations were successfully opposed by residents and civic organizations, the islands were zoned for high-density development and increased business and commercial use. Some unfavorable zoning was prevented and the residents began petitioning Lee County to enact a 35-foot height limitation for buildings on Sanibel. In 1970 this limit was granted, albeit on a temporary basis. In 1971 it became permanent, but an accompanying ordinance for low density construction and a 100-foot beach setback line was not approved.[30]

The Lee County Commissioners established the Sanibel-Captiva Planning Committee in June of 1971. The purpose of this group was to "formulate a comprehensive proposal for designation of the islands as areas of environmental concern with comprehensive zoning and land-use provisions."[31] One month later the county adopted an interim density limit of 18 apartment units or 22 motel units per acre.

In 1972 Lee County came out with its comprehensive land-use plan. In December a series of public hearings on the plan were held and it was modifed by the Sanibel-Captiva Planning Committee. This modified plan proposed a population ceiling of about 41,000 people and called for no more than 14,852 housing units. This is in contrast to the population densities anticipated by the Lee County Planning Commission. Zoning

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[29] Ibid. [30] Ibid., p. 13. [31] Ibid.

ordinances in effect at the time would have allowed housing for a population of up to 90,000.[32]

From 1972 to 1973 construction on Sanibel and Captiva increased by 72%. This construction caused environmental problems as "freshwater rivers were filled in and mangroves obliterated."[33] Also saltwater intrusion and sewerage problems began to be noticed. In September of 1973 the Sanibel-Captiva plan was finally adopted, but quickly halted by a court order that required it to be part of a county-wide plan. The island's civic groups requested that a building moratorium be enacted until this plan could be implemented.[34]

It was at about this time that the Sanibel-Captiva Planning Board began to consider home-rule. A straw vote and a town meeting of island residents indicated to the board that the incorporation sentiment was favorable. Because of the need for county support of beach erosion protection, Captiva dropped out of the home-rule movement. By December the movement was strong enough for funds to be raised to hire an expert to explore the island's alternatives.[35]

In March 1974, after public hearings were held to discuss the framework and implications of becoming a city, Sanibel Island residents voted 436 to 358 to place the incorporation referendum on the November election ballot.

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[32] Ibid.

[33] Ibid.

[34] Ibid.

[35] Ibid., p. 14.

The proposed city charter would establish a five-person city council and a city manager, and would give the city zoning power and authority to implement a land-use plan that controlled growth and preserved environmental values.[36] Two groups were formed to garner support for the referendum, Sanibel Tomorrow and Save Our Sanibel. The opposition consisted of the Sanibel-Captiva Chamber of Commerce and Lee County. At this time Lee County was one of the fastest growing counties in the country and a full 70% of the dollar value of building permits came from construction on Sanibel.[37]

When election day came on 5 November 1974, 85% of the Sanibel voters turned out to cast their ballots. The result: 689 in favor of the referendum and 394 against. The City of Sanibel was created. On 16 December 1974, the government officially took office. One of the first actions of the new government was to issue an order that no new building permits would be issued for at least ninety days or until a comprehensive land-use plan was adopted. There was, however, a sixty day period during which construction was allowed to continue. In this interim forty-two new building permits totalling $9,618,400 in construction costs were issued by Lee County, thus preventing the halting of all new development.[38]

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[36] Ibid.

[37] Interview with Jack Thomas, Realtor and Richard Workman, Coastplan Inc., Ft. Myers, Florida, 2 April 1987.

[38] Clark, Sanibel Report, p. 15.

Replanning became a top priority for the new city government. Toward that end, the planning consultant firm of Wallace, McHarg, Roberts and Todd was selected by the City Council to design the plan and recommend land-use regulations.

CHAPTER III

ENVIRONMENTAL PLANNING

This chapter will discuss environmental planning in general. The three basic concepts which are embedded in all environmental planning methodologies, land capability, land suitability, and carrying capacity will be discussed. Following that a number of the analysis techniques will be discussed. Included in this discussion will be examples of how they are used. Sanibel Island is not discussed in this chapter because it will be covered in detail in Chapter IV.

> Environmental Planning may be defined as: the systematic analysis of environmental factors relevant to the program; evaluation of anticipated environmental effects caused by the program; and the implementation of an effective course of action resulting in minimizing the adverse environmental effects and maximizing the environmental benefits associated with program development.[1]

The field of environmental planning has two distinct characteristics. First of all, while the philosophy of considering the natural environment when formulating land use plans has been around for quite a while, methodologies for such an analysis did not appear until the mid to late 1960s. Second, the field is multidisciplanary. Among those who have contributed to the field are planners, architects, geographers, biologists, landscape architects, ecologists, lawyers, and foresters, to name a few.

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[1]Martin N. Fabrick and Joseph J. O'Rourke, Environmental Planning For Design and Construction (New York: John Wiley and Sons, 1982), p. 1.

Advocates of the consideration of the environment in land use plans have been around for more than a century. The earliest advocates of this view include:

> George Perkins Marsh, a lawyer, diplomat, and scholar, who synthesized numerous theoretical and empirical findings on how human actions affect the environment; Frederick Law Olmsted, often referred to as the "father of landscape architecture," who designed numerous parks in ways that demonstrated the advantages of considering natural features in land use planning; Sir Patrick Geddes, a Scottish biologist and planner, who made pioneering efforts to sensitize city planners to the importance of considering interactions between people and the natural environment; and Benton MacKaye, an American forester, who used geologic and hydrologic parameters to identify land areas worth preserving on environmental grounds.[2]

Despite the presence of these early proponents of environmental planning, the tools of the trade have only recently appeared, perhaps encouraged by the increased environmental awareness of the 1960s and early 1970s. In addition to the relative newness of the field, environmental planning is also difficult because of the following:

1. the complexity and interrelatedness of environmental problems and solutions,
2. the frequent omission or discounting of environmental goods and services during conventional value analysis,
3. lifestyle changes, which are often required to resolve environmental conflicts, are difficult to accomplish,
4. environmental goals often appear to conflict with other community development goals,
5. the difficulty in establishing environmental priorities and defining tradeoffs,
6. the lack of commitment of resources to environmental quality control programs, and

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[2]Leonard Ortolano, Environmental Planning and Decision Making (New York: John Wiley and Sons, 1984), p. 231.

7. a general lack of sufficient and accurate information for proper decision making.[3]

These difficulties undoubtedly contribute to the fact that there are so few environmental planning methodologies today. The remainder of this chapter will examine the three general environmental planning processes from which the methodologies have been developed, and then look specifically at some of the procedures that have been used in the past quarter of a century.

Environmental Planning Processes

For the purpose of developing land use plans, all environmental planning techniques are derived from three processes. These are land capability, land suitability, and carrying capacity.

Land Capability

> Land capability has been defined as: the extent to which the environment of a natural system can be modified without the necessity for extensive artificial measures to redevelop or maintain a natural balance within the system (or in its place among other systems), once the new environment is established.[4]

A land capability study examines the natural environmental features of an area in order to determine the extent to which these features can accommodate different types of development or land uses without creating

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[3]John H. Baldwin, Environmental Planning and Management (Boulder, Colorado: Westview Press, 1985), p. 5.

[4]Boyd R. Dethero, "Development Planning in Environmentally Sensitive Barrier Islands: A Case Study of Kiawah Island" (Master's Thesis, The University of Tennessee, Knoxville, 1983), p.22.

problems for either the inhabitants or for the environment of the area.[5] The studies used for the land capability analysis tend to vary according to the level of detail required, time constraints, and financial support. Land capability analyses yield information which can be translated into development standards (i.e., performance standards and specification standards). These development standards are applied in such areas as sedimentation control, stormwater runoff, clear cutting, and wastewater treatment.[6]

Land Suitability

Land suitabilty analyses are similar to land capability analyses. The basic differnce is that the former considers human and social factors in addition to the physical characteristics of a study area. Land suitability is defined as:

> the ability of a natural system to accomodate a desired use of the human community without the necessity for extensive artificial measures to develop or maintain the human use desired.[7]

A land suitability analysis takes the results of the capability analysis and links them with the social and cultural features of the study area. Such features as foundation stability requirements, septic field regulations, drainage provisions, proximity to schools and recreation areas, the adequacy of transportation systems, and the compatibility

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[5]Ibid.

[6]Ibid., pp. 22-23.

[7]Richard W. Zelinski," Evaluative Dichotomies in Resource Development" (Major Paper, The University of Tennessee, Knoxville, 1977), p. 12.

with present and future land uses are considered in the suitability analysis.[8]

One of the major difficulties which often prevents both land capability and land suitability from being translated into more than mere concept, is that unless it is revealed that no development should occur, estimates must be made of just how much can occur without permanently degrading the environment. The next concept, carrying capacity, provides a means for such a quantification.

Carrying Capacity

A carrying capacity analysis differs from both a capability and a suitability analysis in that it recognizes that there are limits to the amount of growth that an area can accomodate. It determines what level of growth can be attained before socially acceptable levels of environmental quality and public welfare are violated.[9]

> Carrying Capacity may be defined as: the level of human activity (including population dynamics and economic activity) which a region can sustain (including consideration of import and export of resources and waste residuals) at acceptable "quality of life" levels, in perpetuity.[10]

Carrying capacity is the product of the interaction of environmental, sociopsychological, and institutional factors. Determing the amount of

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[8]Dethero, p. 24.

[9]Ortolano, Environmental Planning and Decision Making, p. 244.

[10]David R. Godschalk, Carrying Capacity: A Basis for Coastal Planning (Chapel Hill, North Carolina: University of North Carolina, 1974), p. 2.

development which may be allowed to take place is a difficult process. It will depend on at least three factors:

1. the area's natural characteristics that limit development,
2. the perception and values of area residents as expressed in their preferences for lifestyle and environment, and
3. the ability of the area's governing body and management agencies to provide the services and impose the controls necessary to insure that the desired quality of life is maintained.[11]

One recurring problem with the use of carrying capacity to limit development is the notion that there exists a magic number which will establish the ultimate carrying capacity of a region forever.[12] Carrying capacity, however, is not a fixed number. It fluctuates with lifestyle, technology, and infrastructure availability. It can also be influenced by changes that occur outside of the area in question. So long as these limitations are kept in mind, carrying capacity analysis can be an effective tool for growth management and environmental protection.

While there is little uniformity in describing how to conduct a carrying capacity analysis, two concepts are generally present in all such studies. The first is growth variable. "A growth variable can represent either population or a measure of human activity, such as the number of new housing units per year or the number of park visitors per day."[13] The second common element in carrying capacity analyses is limiting factors. These include "natural resources, physical

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[11]Ibid., pp. 1-2.

[12]George H. Nieswand and Peter J. Pizor, "How to Apply Carrying Capacity Analysis," Environmental Comment (December 1977), p. 8.

[13]Ortolano, Environmental Planning and Decision Making, p. 244.

infrastructure and other elements that, because they are not available in infinite supply, may restrain growth."[14]

There are four types of frequently used limiting factors in carrying capacity analyses. They are environmental, physical, psychological, and institutional. The environmental limiting factors are biophysical measures. The physical concern infrastructure systems capacity. The psychological deal with the way individuals perceive their surroundings, and the instituitional measure the ability of the governing bodies to provide the services and impose the controls necessary to insure maintenance of the desired quality of life. Each of these types of factors will generally be found in most carrying capacity analyses in one form or another. These limiting factors are used to determine the environmental, physical, psychological, and institutional carrying capacities of a study area.

In order to determine the carrying capacities, a maximum (or minimum) value must be set for each of the limiting factors. Maximum (or minimum) for environmental limiting factors are often determined by political processes or the judgement of experts. For physical limiting factors, the existing capacities of the relevant infrastructure systems are often used. Psychological limiting factors are determined either by professional judgment or by a survey of individuals in the study area.[15] Institutional factors are generally determined by the budget of the government(s) for the study area and by existing land use controls.

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[14] Ibid.

[15] Ibid.

Environmental carrying capacity. Environmental carrying capacity, based on the premise that the natural environmental features of an area serve as constraints to development, can be defined as the threshold at which development activity will create an undesirable change in the environment.[16] The environmental carrying capacity concept should be applied in three situations:

1. devlopment in an environmentally sensitive area,
2. development guided by environmental protection standards, and
3. development in areas where there are extreme limitations.[17]

In the first case, development in environmentally sensitve areas, only minor development activity can be withstood by the environment before changes occur in the physical, ecological, and biological features of the development area.[18] Given the highly dynamic nature of the environment in such areas, little or no development is acceptable.

The most common situation is the second, development based on environmental protection standards. The underlying premise in this case is that development is allowable, but only in accordance with predetermined environmental protection standards which are designed to protect against environmental degradation and to set allowable limits of

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[16]Dethero, p. 26.

[17]Ricky L. Morris, "A Case Study of The Cost Factors Associated With The Development of Gardner Matthews Plantation, Hilton Head Island, South Carolina: An Environmentally Fragile Area" (Master's Thesis, The University of Tennessee, Knoxville, 1984), p. 32.

[18]Ibid.

change.[19] Once the standards are set they are applied to existing conditions and the amount of unused capacity is determined for the study area.

Development in areas where extreme limitations exist, the third situation, involves the environment's ability to handle a new activity until this activity becomes self-limiting. In this case, "the environment imposes a self-limitation on development activity when the addition of one consumptive unit or more leads to the depletion of resource availability."[20]

Physical carrying capacity. Physical carrying capacity might be defined as the threshold at which development activity exceeds the capacity of the infrastructure systems of the study area. Such systems include highways, water supplies, wastewater treatment plants, and solid waste disposal facilities. Physical carrying capacities are the simplest of the four to compute and also the easiest to manipulate. For example, if it is determined that the carrying capacity of , say a road, will be approached in the near future, simply building another road or adding another lane will increase its capacity. However, this may have impacts on all three of the other carrying capacities. For this reason physical carrying capacity is not often used as the only measure of the overall carrying capacity of the study area.

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[19] Ibid., p. 33.

[20] Dethero, pp. 27-28.

Psychological carrying capacity. Psychological, or perceptual carrying capacity is defined as the amount of activity or degree of change which can be tolerated before one perceives the environment as different than before.[21] This type of analysis is highly subjective in nature as it is based on expressions of public attitudes and values. Public surveys are often used to obtain the information for a perceptual carrying capacity analysis. Respondents are typically shown photographs of differing levels of urbanization. The reactions or perceptions of the respondents are noted and applied to areas which are under consideration for development. The end product of these analyses is a composite map of the respondents' perception's toward different environments and how they perceive future development taking place in these environments.[22]

Perceptual carrying capacity analyses have been used to determine recreation absorption rates in wilderness areas. An early study of this type was conducted by Robert C. Lucas in 1960 and 1961 for the Boundary Water Canoe Area of the Superior National Forest in northeastern Minnesota. This area is a semi wilderness area meaning that it provides a refuge from mechanized recreation, but also permits other uses such as logging.[23] A questionnaire was administered to both resource managers and recreationists. The recreationists were further subdivided into

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[21] Ibid., p. 27.

[22] Ibid.

[23] Ian Burton and Richard W. Kates, eds., Readings In Resource Management and Conservation (Chicago: The University of Chicago Press, 1965), p. 364.

eight groups such as paddling canoeists and private cabin users. A large portion of the questionnaire was devoted to wilderness resource protection. One finding was that there was a great deal of variation among groups regarding what constituted wilderness implying that the resource managers should adopt a more flexible concept of "the wilderness" both in area and in content.[24]

Institutional carrying capacity. Institutional carrying capacity can be defined as a community's ability to direct and guide development towards public goals and objectives.[25] The overall ability of the community to govern development will depend on the strength of three groups of sub-institutional agencies. These groups are:

1. agencies involved in the planning function of the community,
2. specialized agencies that deal with health, services, education, etc., and
3. all other private and/or public agencies and organizations that are involved in or are interested in community development.[26]

Generally two of the three groups of sub-institutional agencies must be strong and active in the daily community decision making process in order for the community to have a high institutional carrying capacity.[27] Institutional carrying capacity analyses in the past have considered such factors as land ownership, municipal incorporation, the

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[24]Ibid., p. 374.

[25]Morris, p. 34.

[26]Dethero, p. 31.

[27]Morris, p. 34.

economic base, interest groups, and citizen participation in the study area.

Current carrying capacity. In response to the previously mentioned problem of the dynamic nature of carrying capacity, the concept of current carrying (or planning) capacity evolved. This approach is basically a combination of the physical carrying capacity approach, the environmental carrying capacity approach, and the institutional carrying capacity approach.

Current carrying capacity is defined as "the measure of a region's ability to accommodate growth and development within limits defined by existing infrastructure and natural resource capabilities."[28] Three factors determine an area's current carrying capacity. These are water supply, water quality, and air quality. Each of these factors are included because they are significantly influenced by four selection criteria--natural resource availabilty, technological capacity, public fiscal capability, and the police power perspective of health and safety. These four criteria were used in order to insure the scientific and legal defensibility of the factors included.[29]

Current carrying capacity is estimated by determining the carrying capacity for each of the three component factors. The most restrictive of these values is used to define the current carrying capacity. In order to establish this value, a five step process is utilized.

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[28]Nieswand and Pizor, "Carrying Capacity Analysis," p. 8.

[29]Ibid.

The first step is to delineate the appropriate resource area for each of the three factors. Natural features, such as a watershed, or man-made features, such as those that are made by utility suppliers, can be used to determine the resource boundaries.

Step two of the current carrying capacity analysis is to determine both the quantity and the quality of the resource in order to arrive at its availability. For water supply, a flow through a pipeline system, the safe yield of an aquifer, or an allocation from a reservoir might be used as the determinant of availability. Water quality might be estimated by soil septic suitability, sewage treatment plant capacity, or the assimilative capacity of a stream. Air quality might be determined by measuring levels of sulfur dioxide or particulates and comparing these values to predetermined deteriorative standards.

The third step involves converting each of the capacity limits found in step two into its population equivalent. In order to do this, estimates of per capita water consumption rates, per capita wastewater or waste load generation rates, and per capita air pollution generation rates are used. The current carrying capacity analyst is cautioned at this point to take local experience into consideration rather than rely solely on national estimates since these may vary substantially depending upon the amount and type of industrial activity and residential characteristics in the study area.

The fourth step is the easiest. It is simply the selection of the lowest population equivalent for use as the estimate of the area's gross carrying capacity.

The final step is to compare the estimate from step four to existing demand (expressed in population equivalents) in the study area. This produces an estimate of net assignable current carrying capacity for the community. If it is negative or very small, then development limits have been reached or exceeded. If it is positive then there is an excess capacity which the community can allocate through planning.[30]

Current carrying capacity, it must be remembered, is not a magic number etched in stone. Rather it serves the planner as a yardstick indicating the relationship between the supply of resources and the demand placed upon this resource by growth and development.[31]

Environmental Planning Methodologies

The final part of this chapter will examine some of the environmental planning methodologies that have been developed to date. Despite some differences between the techniques, all are derived from the concepts discussed above of land capability, land suitability, and carrying capacity.

Map Overlay Technique

The map overlay technique is "a procedure for synthesizing the spatial data used in land use planning."[32] It consists of a four step process. These steps are:

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[30] Ibid., p. 9.

[31] Ibid.

[32] Ortolano, Environmental Planning and Decision Making, p. 232.

1. identify those factors which will be included in the planning exercise,
2. prepare an "inventory map" for each factor which shows how it varies over the study area,
3. create composite maps by overlaying two or more of the inventory maps, and
4. analyze the composite map to make inferences relevant to land use planning.[33]

This technique has been traced back to the early part of this century, but it never gained wide use in environmental planning until the 1960s. An example of its use is given by Stanford University's Planning Office. They used the map overlay technique to determine whether or not 355 acres of open space should be developed. The study identified, through map overlays, portions of the land which were environmentally sensitive and therefore less suitable for development. In this case the technique was used to make preliminary observations of a general nature, but it can also be used in detailed site planning for individual facilities or even to help lay out whole new towns as was the case in Woodlands, Texas.[34]

Land Suitability Using Map Overlays

A common extension of the basic map overlay technique is to combine it with a land suitability analysis. This may be accomplished by assigning ranks or scores for each factor, rather than simply

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[33]Ibid.

[34]Ibid.

inventorying them. The composite map created by this method indicates areas that are least and most suitable for each particular land use under consideration. This is the technique which has been come to be widely known as the "McHarg method," as it was in Ian McHarg's Design with Nature that it became popularized as a method of environmental planning.

This approach to environmental planning has been said to be important for four particular reasons. These are:

1. it requires an understanding of nature as a process,
2. it requires the analyst to interpret natural processes as resources and hence to predict and prescribe compatible communities of prospective land uses,
3. it provides an insight into the given or natural form of the environment and thus provides implications for the man-made form of design through a better understanding of the forces at work, and
4. with the addition of demand and investment, a land use plan can be produced for a wide range of areas.[35]

In their book, Three Approaches to Environmental Resource Analysis, Raymond Belknap and John Furtado provide a useful diagram and outline of McHarg's analysis procedure. Figure 2 is a reproduction of this diagram and the coding of the outline which follows corresponds to its coding.

A. Given the total study area, define and delineate subareas. These may be defined by either political or natural boundaries. McHarg often uses physiography to isolate internally homogenous areas.

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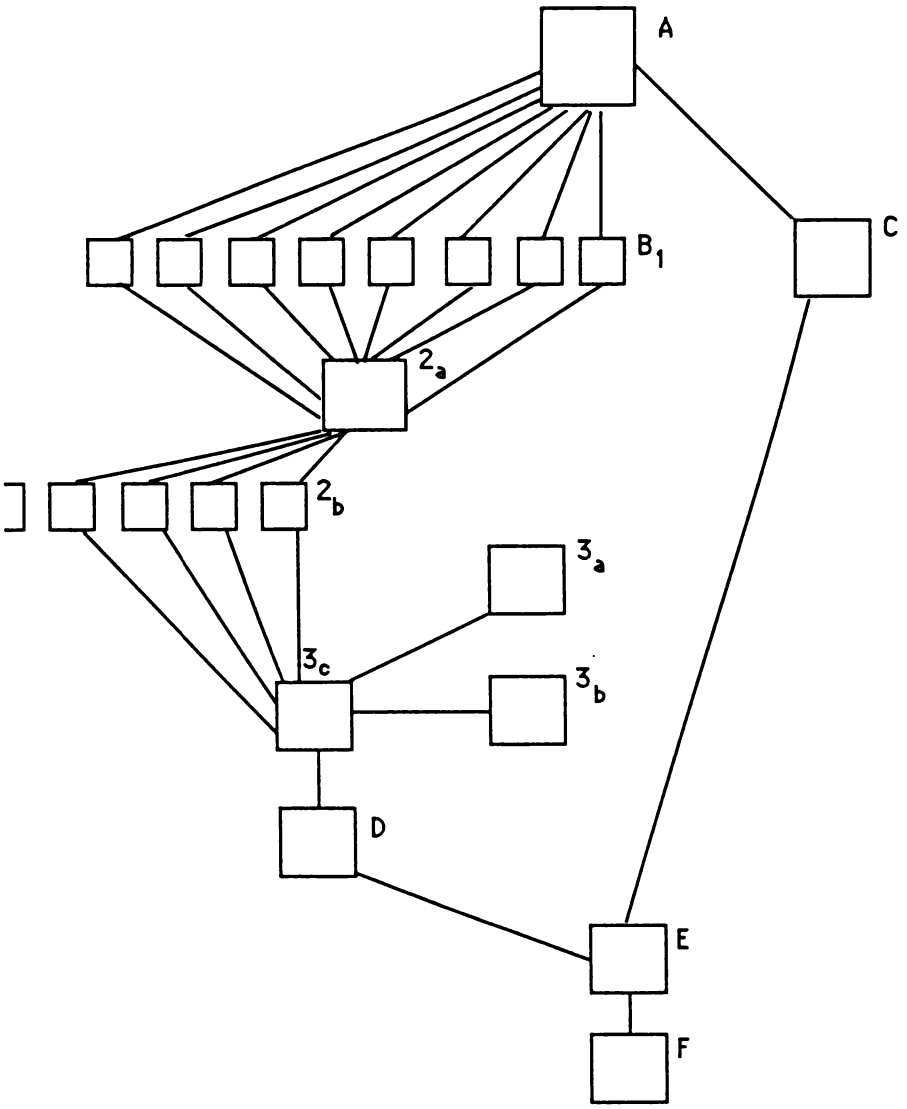
[35]Raymond Belknap and John G. Furtado, Three Approaches to Environmental Resource Analysis (Washington, D.C.: The Conservation Foundation, 1967), p. 62.



Source: Raymond Belknap and John G. Furtado, Three Approaches to Environmental Resource Analysis.

Figure 2. Diagrammatic Outline of McHarg's Analysis Procedure

B. An ecological inventory is conducted and interpreted.

1. Natural and cultural features are inventoried and mapped based on data from eight categories which McHarg considers of primary importance for planning. The categories are:

1. Climate
2. Historical Geology
3. Physiography
4. Hydrology
5. Pedology
6. Plant Associations
7. Animals
8. Land use

McHarg feels that it is important to collect the data in this sequence because it implies causality and this allows the analysis to be based upon the historical reasons for an area's identity and the pattern and occurance of its resources.

2. Inventory data is interpreted to reveal dominant prospective land uses for each discrete sub-area within the total study area.

a. The data from the eight category's discussed above, is analyzed to determine each categories positive, neutral, or negative effects on each prospective land use, keeping in mind that the same data may have different values for different land uses. For example, a high precipitation level may be positive in terms of agriculture, but would have a negative effect on recreation activities. The effect of the eight possible land uses on each resource is analyzed through the use of

a comprehensive matrix. Then, in addition to the eight categories above, economic minerals, scarce or unique features, water resources, slope, and accessibility are also considered for their relevance to potential land uses.

b. Intrinsic suitability maps are created. These are a series of maps which show the location of economic minerals, unique sites, water resources, slope and exposure. Intrinsic suitability maps are also produced for agriculture, forestry, recreation, and urbanization. These maps are constructed on transparencies using tones of different colors and are overlaid to indicate a single dominant prospective land use for each sub-area in the total study area.

3. A value is attributed to every land area in the total study area for all prospective land uses. This differs from step two in that the former ascribes a single dominant land use to every sub-area, while this step ascribes all possible compatible uses to every sub-area. This is done because it is, of course, possible to achieve several distinct objectives simultaneously.

a. A system for rating intrinsic resources is established. Each resource receives a value, then all intrinsic resources are mapped in a scale of values. These maps are superimposed to produce a composite map indicating areas of least social value, indicated by the lightest tones, and areas of highest social value, indicated by the darkest tones.

b. Next, compatible and incompatible land uses are separated through the use of a matrix which shows all prospective land uses on

each coordinate. This matrix allows a measurement of land use inter-compatibility for both existing and prospective land uses. The most compatible land uses are revealed by grouping compatible and co-existent land uses for each sub-area in the total study area.

c. The final step in this phase is to synthesize and interpret the data to "reveal the maximum conjunction of coexisting, compatible land uses that can be sustained by every area in the total study area."[36] The product of this synthesis is a combined suitability map which is grouped into four possible land uses: agriculture, forestry, recreation, and urbanism and their subdominants. This map represents the natural environmental supply aspect of the total inventory and analysis.

C. At this stage an economic inventory is prepared and interpreted. McHarg feels that this work should be performed by a regional scientist or economic planner. This step is included to provide information on locational values and the spatial relationships of demand. Once complete, this locational and demand information is compared to the supply of the natural resources.

D. Criteria are established for visibility. Visual values are taken into account based on the following considerations:

1. the path of the viewer,
2. the fact that the visibility of the area will vary with physiographic regions,

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[36]Ibid., p. 69.

3. the degree to which vegetation provides a visual barrier independent of physiography, and
4. the degree to which forest cover can absorb development while preserving its forest aspect. This factor could aid in the determination of density controls for development.

E. Criteria for form and design are established. This step brings the environmental, economic, and visual considerations of the planning process together to develop alternative plans varying the location and intensity of compatible land uses. This step produces development plans for prospective land uses.

F. Powers necessary to realize the plan are acquired. McHarg's implementation strategy emphasizes the need for adequate capital for land acquisition or improvement. He also stresses the need for the procurement and enforcement of necessary regulatory and zoning ordinances.[37]

McHarg's methodology is significant in that "the causes and consequences--related policies, limitations, and prohibitions--provide the means to select the best alternatives for orderly growth and development."[38] Also determining the basic limitations of land rather than determining its true potential is advantageous because it allows one to assign values to each parcel of land, change the values to reflect possible policy decisions, and predict the consequences of alternatives.[39]

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[37]Ibid, pp. 66-74.

[38]Ibid., p. 75.

[39]Ibid.

There are several examples of the use of map overlays in land suitability analysis in McHarg's Design with Nature. Case studies included are from the Richmond Parkway in New York City, Green Spring and Worthington Valleys in Maryland, Staten Island, New York, The Potomac River Basin, and Washington, D.C. Since Design with Nature was published, an analysis of this type was done for Medford, New Jersey. It was undertaken because leaders there had come to realize that "traditional planning and zoning had been totally incapable of averting destruction of neighboring communities."[40] In the hopes of avoiding this in Medford they suggested that an ecological study be undertaken to lead to the formulation of appropriate ordinances.

Criticism of McHarg's approach generally focuses on five aspects. The first is that he seems to have failed to include the behavioral aspects of man in his analysis. He assumes that the economic study, done by someone else, can produce data compatible in form to that prepared in the environmental process, so that recommendations can be made. He also assumes that the resource supply determination can be achieved and that the economist will be able to relate this supply to the natural, locational, and spatial characteristics of demand. Critics have been less certain.[41] Another criticism is that of the subjective ranking of suitability. Particularly some people feel that it is

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[40]Narendra Juneja, Medford: Perforfance Requirements for the Maintenance of Social Values (Philadelphia: University of Pennsylvania, 1974), p. 1.

[41]Belknap and Furtado, Three Approaches, p. 91.

inappropriate for planners to decide which factors to consider and how each is defined and ranked.[42] There are two criticisms which concern the problem of dealing with the maps themselves. The first is that even a few categories and factors yield large numbers of possible combinations when mapped. Thus, there is a question of what to do with the intermediate values. Then there is the criticism that manipulating and updating a large number of overlays is particularly difficult.[43]

Another objection is that unless the factors used in the suitability analysis are independent of one another, the same factor can be counted inadvertently several times. A final objection concerns the addition of quantities, through the overlays, which are measured in incommensurate units.[44] It is in response to these final two objections that another methodology evolved--land suitability analysis using weighted scores.

Land Suitability Using Weighted Scores

In order to improve upon the basic land suitability method, a technique was developed which transforms the scores associated with the nominal types for each factor into one common unit of measurement. The solution was to weigh the factor scores before performing any addition.[45]

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[42]Ortolano, Environmental Planning and Decision Making, p. 238.

[43]Baldwin, Environmental Planning and Management, p. 78.

[44]Ortolano, Environmental Planning and Decision Making, 239.

[45]Ibid.

A land suitability analysis using weighted scores is performed as follows. The first step is to divide the study area into grid cells. The size and shape of these cells is determined by professional judgment and are assumed to be homogenous. Next the factors relevant to assessing the suitability of land for the prospective land use are selected. For each of these factors, nominal types are defined and an inventory map is produced. Some criteria must be selected for rating these nominal types for each factor. For example, if slope is the factor, the nominal types might be high, medium, and low, and the corresponding ratings might be 1, 3, and 5 respectively. The highest numerical score is always associated with the areas that are most suitable for the prospective development. The next step is to assign weights to each factor indicating their relative importance in determining the suitability of the land for the proposed land use. For example, in assessing the suitability of land for residential development, slope may be determined to be twice as important as soil type. The final step of the analysis is to compute the sum of weighted factor scores for each grid cell. The cells with the highest scores are considered more suitable for the particular land use in question.[46] This procedure is depicted in Figure 3.

Because there are numerical values associated with the cells in this approach, the problem of distinguishing between various shades of the same color is eliminated. This combined with the fact that existing

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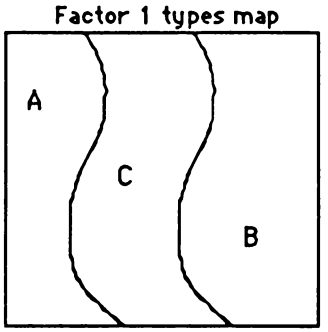
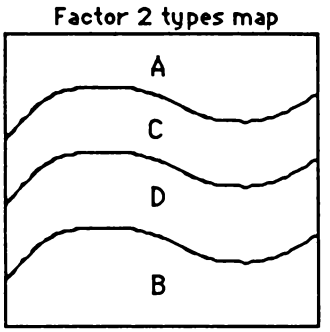
[46]Ibid.

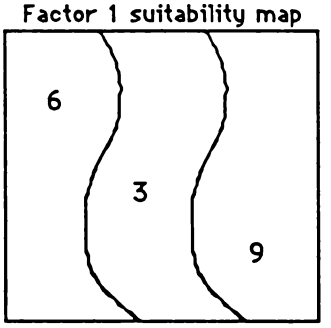


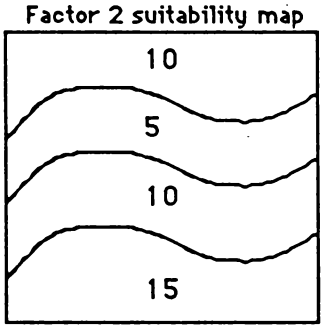
Factor types	Land uses R1	R2	R3	R4	• • •
Factor 1 weight	3				
Type A	2	•	•	•	
Type B	3	•	•	•	
Type C	1	•	•	•	
Factor 2 weight	5				
Type A	2	•	•	•	
Type B	3	•	•	•	
Type C	1	•	•	•	
Type D	2	•	•	•	

Step 2: rate each type of each factor and weight each factor for each land use

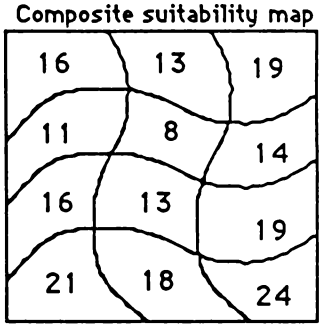


Step 1: map data factors by type





Step 3: map ratings for each land use, one set of maps for each land use



Step 4: overlay single-factor suitability maps to obtain composite, one map for each land use

Source: Lewis D. Hopkins, "Methods for Generating Land Suitability Maps: A Comparative Evaluation," AIP Journal (October 1977).

Figure 3. Diagram of Procedures for Land Suitability Using Weighted Scores

computer mapping procedures can perform land suitability analysis through weighted scores with relative ease, has led to an increase in the popularity of this technique over that of the map overlay technique.[47]

An example of the use of the weighted scores approach to land suitability is provided by Palo Alto, California. During the late 1960s, the city engaged a firm of city planning consultants to conduct a land suitability analysis, including an assessment of the impacts of alternative land use patterns. The study area was approximately 7500 acres in size and was largely undeveloped foothills. Palo Alto anticipated receiving several development proposals which would require variances from the one dwelling unit per acre zoning density in existance at the time. The city thus hired the planning firm.

The first step of the study identified the portions of the area which were most suitable for residential and other development. This analysis excluded land which was already developed as well as a 1400 acre city-owned park. The remaining area was divided into a rectangular grid composed of 330 cells of twenty acres each. Next the consultants chose twenty-five factors for consideration in the suitability analysis and developed a five point rating scale for each. Two of the twenty-five factors were later dropped when it was found that there was essentially no variation in scores between all the cells.

The next step in the analysis was the assigning of weights to each of the remaining twenty-three factors. These weights indicated the

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[47] Ibid.

relative importance of factors in land development. For example, average slope had the highest weight (ten) and proximity to present development had the lowest (one).

The final step was to compute the sum of the weighted scores for each grid cell. This resulted in a range of values from a maximum of 480 to a minimum of 94. The 480 indicated that cell which was most suitable for development. The final product of this phase of the study was a map of six classes of land ranging from the most to the least suitable for development. These classes were chosen so that approximately equal land areas were included in each group.

In subsequent phases of the study, twenty-four scenarios of alternative patterns for future land development were examined. Each was evaluated in terms of its ecological, economic, and social impacts. A few of these scenarios recieved more detailed consideration. The final advice from the consultants to the city was to preserve the foothills as open space. The city council later implemented new zoning measures to protect the foothills from intensive development.[48]

Impact Analysis

The final environmental planning methodology to be examined in this chapter is that of impact analysis (or assessment) which was developed largely in response to the National Environmental Policy Act of 1969. One of the leaders in the use of this technique is William Marsh.

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[48]Ibid., p. 243.

Marsh emphasizes the analysis of impacts over time. To this end, he frames his discussion of impact assessment within a simple version of the planning process.[49] He breaks down the planning process into four principal activities: problem definition, formulation of alternatives, impact analysis, and evaluation of trade-offs.[50]

Each of these four steps are interrelated and occur, in essence at the same time. The only change from step to step is in emphasis. Placed within this context of the planning process, an impact assessment analysis consists of six steps:

1. identification of evaluative factors,
2. identification of systems and dependent/independent relationships among evaluative factors,
3. development of alternative scenarios of desired features,
4. prediction or identification of impacts of each alternative,
5. identification of trade-offs among alternatives and scenarios, and
6. evaluation, by either a matrix or listing approach, of each of the differences among alternatives or scenarios.[51]

The final product of this analysis is a longitudinal impact assessment approach that identifies both the impacts of each alternative or proposal as well as the optimum combination of proposal elements.[52]

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[49] Morris, p. 48.

[50] William M. Marsh, Environmental Analysis for Land Use and Site Planning (New York: McGraw-Hill Book Company, 1976), p. 268.

[51] Dethero, pp. 48-49.

[52] Morris, p. 49.

The National Environmental Policy Act directed federal agencies to prepare a statement of environmental impacts for every major federal action significantly affecting the quality of the human environment. Therefore impact analysis is in fairly wide use. Other methods for environmental planning analysis include combinations of the three basic concepts of land capability, land suitability, and carrying capacity. One example is the tandem use of carrying capacity and land suitability analysis. This approach was used by the Tahoe Regional Planning Agency to provide the basis for an agency ordinance which established for each capability level identified, a maximum allowable percentage of the land that could be covered with buildings and other physical facilities. This same approach was used in Sanibel Island.

Ian McHarg was a partner in the planning firm hired as consultants by the city of Sanibel, however, the "McHarg method" was not used there. Instead carrying capacity and land suitability were used in tandem, as was the case in Tahoe.

While the technique most associated with McHarg was not followed in Sanibel, the philosophy behind the consultants' work can be found in earlier works. In the case of Sanibel, the consultants recommended to the Conservation Foundation and local participants in the planning process, that the island be described in terms of ecological zones. Six zones were defined for Sanibel and each was described by the consultants in terms of an inventory, their functions, and management guidelines.

The earlier work in which this philosophy can be found is Design With Nature. In the second chapter, "Sea and Survival," McHarg

discusses a study of a part of the New Jersey Shore. Like Sanibel it too is a barrier island. McHarg proceeds to describe the barrier island in terms of community types such as primary dune, trough, and backdune. He talks about each of these sub-areas in terms of their importance in maintaining the island as a whole. Next he talks about each sub-area's tolerance for development. In this section he points out those sub-areas which are too fragile to support development, those which can tolerate different levels of recreation, and those which can tolerate different levels of development.

The Sanibel case was more complex. Since Sanibel is larger than the barrier island in the New Jersey example, more ecological zones were identified. One zone, Mangrove, is identified with climates like that of Sanibel and will not be found in those like New Jersey. Also the Interior Wetlands zone is fairly unique to Sanibel among barrier islands. The basic philosophy, however, was the same in the two cases.

Just as in the New Jersey example, Sanibel's ecological zones were discussed in terms of their functions and their tolerance for development. Because the consultants, as outsiders, may have presented a case that was too idealistic, the findings were presented to the Sanibel Planning Commission, City Council, and the public at large through several hearings. This allowed those with a better knowledge of local conditions to incorporate the findings of the consultants into a final product which was more sensitive to what was and was not appropriate for Sanibel at that time. This final product was the 1976 Comprehensive Land Use Plan. A more detailed discussion of the planning process in Sanibel is the subject of Chapter IV.

CHAPTER IV

ENVIRONMENTAL PLANNING IN SANIBEL

This chapter examines the environmental planning process used in Sanibel. It consists of essentially two parts. The first part looks specifically at the methodology used to develop the 1976 Comprehensive Land Use Plan. The second part examines what has happened since the adoption of this plan.

The Planning Process

At the end of Chapter II it was noted that when the new city government took over political control of Sanibel, planning was a top priority. One of the first acts of the government was to hire the planning firm of Wallace, McHarg, Roberts, and Todd (WMRT) to provide assistance in formulating the plan and to recommend possible land-use regulations.

In order to assist WMRT, the planning commission appointed ten task forces to ensure the involvement of Sanibel residents in the planning process. In turn, these task forces used the knowledge of over fifty people familiar with various aspects of the island. The task forces assisted in data acquisition and evaluation of the findings of WMRT, and provided (through regular meetings) public input throughout all phases of the planning process. These regular meetings were public work sessions in which goals and objectives were discussed, as were

alternative planning recommendations for realizing these goals and objectives.[1]

At approximately the same time that the task forces were appointed, The Conservation Foundation was selected by citizen organizations to assist the city in providing a detailed description of the natural systems of the island, and by suggesting means for their conservation.[2] In March of 1975 a campaign was initiated by the Sanibel-Captiva Conservation Foundation (SCCF) to solicit funds from charitable organizations to be used for the natural systems study. Initial funding became available in May and the Conservation Foundation's work began.[3]

The Conservation Foundation's work consisted of four elements: analysis of the island's ecosystem, identification of the principle ecological zones, diagnosis of the condition of these zones, and suggestions for management requirements to conserve the island's natural systems and resources.[4]

A carrying capacity analysis was used by the Conservation Foundation in their natural systems study. Assisting the Foundation with this study was a team of experts in such areas as law, planning, ecology, economics, and administration. The goal of the Foundation was "to develop principles and requirements for future development which could prevent damage to the remaining natural systems, and principles

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[1]Comprehensive Land Use Plan, City of Sanibel, Florida, 1987, p.1.

[2]John Clark, The Sanibel Report (New York: The Conservation Foundation, 1976), p. 15.

[3]Ibid.

[4]Ibid., p. 18.

and requirements for restoration of past damage to the natural systems."[5]

The first step in this natural systems study was the collection of data. This consisted of examining the existing knowledge of the ecosystem and natural resources and then conducting a preliminary survey of the island. The work was then divided and assigned to survey teams. These teams were organized along disciplinary lines, such as hydrology and botany. Eighteen technical consultants and a panel of special technical advisors were involved in this process. Their efforts were coordinated and, when necessary, reevaluated, by the Conservation Foundation through workshops, informal meetings, circulation of relevant progress information, and encouragement of direct communication between the teams.[6]

A number of data base reports were prepared by the teams. These helped in the formulation of the six natural systems reports. These six reports covered the following subjects: hydrology, vegetation, beach geology, wildlife ecology, estuarine ecology, and the natural energy system.

Hydrology

The hydrology of Sanibel Island underwent modification during the time of rapid tourism and urban development. Such changes as the excavation of drainage ditches for mosquito control, the excavation of canals for boat access to tidal waters, the excavation of lakes to

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[5]Ibid.

[6]Ibid., p. 19.

provide fill material for raising the land surface altitude, the construction of paved roads, the construction of shallow wells for irrigation, the construction of deep wells for municipal water supplies, and the implacement of septic tanks all took place during this time.[7] While most of the changes to the hydrologic system were for population purposes, they also had "numerous detrimental effects on the natural environment."[8]

The hydrology natural system report did not provide a detailed analysis of the data but rather it summarized some of the data and emphasized establishing criteria for proper management of the water resources of Sanibel. The report arrived at six conclusions and offered five recommendations.

The first conclusion of the hydrology study was that the channelized water system of Sanibel was in poor condition, due, in part, to leaky control structures which allowed highly saline water to enter the system. Also dissolved oxygen levels were found to be low.[9]

The next two conclusions concerned excavation and construction. The first was that it appeared "necessary to prohibit excavation-construction of tidal canals."[10] This conclusion was made because some of the canals on the island were cut too deep, well below sea-level. The report stated that the water-table aquifer in the vicinity of the eastern-part of Sanibel, where the most damage was done, probably

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[7]Thomas M. Missimer, "Hydrology," in The Sanibel Report, John Clark (New York: The Conservation Foundation, 1976), p. 167.

[8]Ibid. [9]Ibid. [10]Ibid.

contained no freshwater. The second conclusion regarding excavation was that any future interior excavation should be discouraged and if allowed should be designed in accordance to strict standards.

The fourth conclusion was that liquid waste should be prohibited from entering the surface water system. To that end it was suggested that the use of septic tanks be discontinued.

The fifth conclusion was that the Sanibel River system could be improved. One improvement suggested was the upgrading of existing control structures. Improvements to the channel, such as clearing organic detritus was also suggested.

The final conclusion dealt with deep artesian wells. The report suggested that all wildly flowing, or damaged or improperly constructed wells be plugged and a permitting system be developed regulating any newly proposed deep artesian wells. Finally it suggested that permissible water use criteria be developed.[11]

The first recommendation was for the continuance and strengthening of cooperative programs between the U.S. Geological Survey and the city in order to continue with the collection of pertinent hydrologic data. The second recommendation called for a detailed investigation to be done concerning the deep artesian aquifers. The third recommendation was that all deep artesian wells be located and investigated.

The final two recommendations were for further studies. The first one was for a feasibility study of the disposal of liquid waste by

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[11] Ibid.

either deep-well injection or land application. The second concerned the feasibility of maintaining a three or three and one-half foot water stage in interior wetlands.[12]

Vegetation

The vegetation natural systems study was prepared with the help of Tropical BioIndustries Development Company. This group was commissioned by the Conservation Foundation to assist the study by conducting a reconnaissance survey of the upland vegetative communities, the interior wetland complex, and the mangrove communities of Sanibel. This work and that of the rest of the task force, was combined to produce baseline documentation of the natural resources of the island.[13]

This report was based on the experiences of its authors in environments of South Florida, including Sanibel Island, and on site visitations made in June 1975. The focus of this report was on the wetland systems as, "these are often severely threatened and easily disrupted natural communities."[14]

The report was compiled by the team in the following manner. First the available literature was assembled and reviewed. Next a field verification was conducted and a base vegetation map and community descriptions were produced. Then the recommendations made in the report

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[12]Ibid., p. 192.

[13]Durbin C. Tabb, Eric J. Heald, Gory L. Bendsley, Martin A. Roessler, and Taylor R. Alexander, "Vegetation," in The Sanibel Report, John Clark (New York: The Conservation Foundation, 1976), p.197.

[14]Ibid.

were developed as a result of discussions among the task force members and John Clark of the Conservation Foundation, following the analysis of the field observations.

The first of these recommendations concerned the restoration of the vegetative communities of Sanibel. It noted that these communities had been severely impacted during the previous seventy years or so and suggested that it would be practical to restore only limited parts of the system to the predevelopment state, and that such areas should be selected with great care.[15]

A number of recommendations concerned mangrove communities. One was that all tidal mangroves be preserved. These areas are very important to the maintenance of ecosystems on Sanibel. Three very significant roles they perform are storm wave dissipation, aquatic and terrestrial wildlife habitat, and estuarine food chain contribution. Another recommendation concerning mangroves was that one particular area of mangrove communities be preserved as they were found to be effective contributors to the resource base of Pine Island Sound. Another recommendation addressed mangrove communities that should be preserved, as well as areas which could be considered expendable.

There were also a number of recommendations concerning the hydrology of Sanibel made in the vegetation natural systems study. For example, one of these suggested that the bottom of the Sanibel River and tributaries should be leveled to eliminate sediment traps and inhibit

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[15]Ibid., p. 225.

development of anaerobic conditions. It should not be a surprise to see references to the hydrology in other natural systems studies as water is "the major factor in all ecological zones on Sanibel Island. It sets the conditions that distinguish the zones, and it affects the soils, vegetation, and wildlife in each."[16]

A final group of recommendations concerned the removal of exotic plant species. One of these recommendations was to remove all exotic vegetation which contributed debris to the water in canal areas. Especially this applied to the Brazillian pepper and Australian pine. Another recommendation was to control the tree Casuarina by fire and poison and to remove Brazillian peppers and cajeput by a continual cutting program. The final recommendation was to undertake a program of controlled burning to remove invading shrubs from areas of Spartina and associated graminoid communities.[17]

Beach Geology

The third natural systems study concerned the geology of Sanibel. Sanibel is a barrier island, which are by nature dynamic. This study repeatedly made reference to the fragile, constantly changing nature of barrier islands like Sanibel. It is this characteristic, perhaps more than any other, which makes it essential that any development on Sanibel be environmentally sensitive.

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[16]Clark, Sanibel Report, p. 25.

[17]Tabb et al., "Vegetation," p. 226.

The recommendations in this study were designed to meet three criteria. They were intended to:

1. recognize the natural geologic processes that are continuously operating along the coastal systems of Sanibel Island,
2. establish a set of specifications necessary to preserve the coastal system in a healthy, stable and nonstressed state, and
3. allow man to develop and use this unique natural system within the bounds and limits established by the processes of the system itself; i.e., in a fashion which will allow the greatest safety for life and property.[18]

The first recommendation was that rigid "stress limits" should be established to stabilize the disproportionate growth and development of Sanibel. This was, of course, what the Sanibel Comprehensive Land Use Plan was designed to accomplish.

The second recommendation called for the establishment of a setback plan. This plan was to include setbacks on both the Gulf and estuarine shorelines. It was noted that the estuarine setback line would be variable due to the lesser degree of uniformity along these shores. It was also suggested that all structures, including roads and seawalls, located seaward of the setback line be declared nonconforming and planned for eventual termination. The revitalization of the beach dune system would also be addressed in this plan. This would include reestablishmnet of the dune field and revegetation of the natural vegetation line wherever necessary. It was also suggested that Sanibel enter the National Flood Insurance Program under which the city would agree to adopt and enforce floodplain management regulations.

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[18]Stanley R. Riggs, "Beach Geology," in The Sanibel Report, John Clark (New York: The Conservation Foundation, 1976), p. 252.

The third recommendation was for the reestablishment of the shoreline equilibrium as quickliy as possible by terminating the use of any buildings or roads that become threatened by erosion. This, together with the setback plan, would insure that the dynamic beach process of erosion and accretion would not need correction.

The fourth recommendation of the beach geology natural systems study was for the reestablishment of vertical and lateral equilibrium profiles on the beach through beach nourishment if shoreline erosion should become a dominant process. This was not anticipated as being necessary, but should it become so this recommendation suggested that fixed structures which distort the natural shoreline profile, such as groins, jetties, seawalls, or bulkheads, not be used.

The fifth recommendation addressed Blind Pass, an especially dynamic area. It suggested that this area be declared a natural hazard area in which no further development would be allowed and existing structures would be relocated.

The final recommendation in the beach geology natural system study called for Sanibel to become a part of the decision-making process on Captiva with regard to the sister island's beach erosion control. This was justified because the two islands are "intimate partners of a single interacting coastal system and Sanibel will experience and share the long-term consequences, whether good or bad, of whatever is done on Captiva."[19] It also suggested three erosion control proposals for

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[19]Ibid.

Captiva. One was a repeat of the previous suggestions that no modifications be made to Blind Pass. The second called for the relocation of the shoreroad from the gulf side to the backside of the island. The final recommendation was for the beach erosion measures outlined for Sanibel to be implemented on Captiva.[20]

Wildlife Ecology

This natural system study was somewhat different from the previous ones because it was basically an inventory of existing conditions and little more. The wildlife population was described for each of Sanibel's major ecological subsytems, as defined by the Conservation Foundation. These subsystems are the Gulf Beach, the uplands, the interior wetlands, and the mangrove-estuarine subsystems. It also noted that while the wildlife would be discussed in terms of these separate subsystems, there is certainly a high degree of interplay between subsystems.

The first part of this study is a brief summary of previous findings on Sanibel's wildlife. Included is a table indicating the species on the island that are either endangered, threatened, rare, or of special concern. The Wood stork and the Florida panther are the only endangered species listed for Sanibel. This table is reproduced here as Table 2.

Little wildlife activity was noted in the Gulf Beach subsystem due to its relative harshness. The only permanent residents of this

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[20]Ibid.

Table 2. Sanibel Wildlife

Species:	Status:
Amphibians	
Little grass frog	Special Concern
Florida cricket frog	Special Concern
Florida chorus frog	Special Concern
Reptiles	
Gopher tortoise	Threatened
Florida brown snake	Threatened
Florida ribbon snake	Threatened
Eastern indigo snake	Special Concern
American alligator	Special Concern
Birds	
Wood stork	Endangered
Brown pelican	Threatened
Magnificent frigate bird	Threatened
Southern bald eagle	Threatened
Osprey	Threatened
American oyster catcher	Threatened
Least tern	Threatened
Roseate spoonbill	Rare
Mangrove cuckoo	Rare
Little blue heron	Special Concern
Louisiana heron	Special Concern
Yellow crowned night heron	Special Concern
Least bittern	Special Concern
White ibis	Special Concern
Caspian tern	Special Concern
Black skimmer	Special Concern
Snowy egret	Special Concern
Great egret	Special Concern
Burrowing owl	Special Concern
Mammals	
Florida panther	Endangered
Round tailed muskrat	Special Concern
Sanibel Island rice rat	Rare

Source: John B. Morrill et al., "Wildlife Ecology." in The Sanibel Report, John Clark.

subsystem are highly specialized species, such as ghost crabs, beach fleas, and coquinas. The majority of activity here comes from species which are merely visitors to this subsystem. These include such species as the many shorebirds and diving birds, sea turtles, and raccoons.

This subsystem also includes the near and inshore areas, as well as the open water. In these areas are found such species as rays, loggerhead turtles, predaceous mollusks, a great number of shellfish, menhaden, anchovy, terns, skimmers, cormorants, pelicans, and osprey to name a few.

Because of the historically stable nature of this subsystem on Sanibel, the greatest direct threat to wildlife there was found to be from the growing number of visitors who disturb the subsystem by walking, wading, and collecting shells.

Also a part of this subsystem are the backshore beach and primary dune ridges. There was not a lot of wildlife activity to be found in the backshore beach area, but it was found to be absolutely critical for one species in particular, the loggerhead sea turtle. It is vital to the preservation of this species because this area is the home of its nesting grounds. This zone also helps preserve another species--man. The backshore together with the offshore bar serve together as the islands first defense against storm waves. Thus, the backshore protects the interior of the island and its species, including man, from innundation by the sea.

Where the primary dune systems still existed, some of the shorebirds were found nesting and roosting. However, human activity as well

as the invasion of the area by dense stands of Australian pine, were found to have had a deleterious effect on the wildlife in this area. In order to restore this habitat, the report recommended the adoption and adherence to a coastal construction setback line, the construction of crosswalks, and a program of dune restoration.[21]

Moving inland the next subsystem encountered is the uplands or interior ridge subsystem. This is an area of parallel subsets of ancient beach ridges. These ridges reach an elevation of about three to six feet above sea level, and are usually densely vegetated.

The habitats of this subsystem vary greatly from desert-like conditions to dense hammocks of West Indian vegetation. There is a corresponding diversity of wildlife in this subsystem, with many species visiting the area. However species recognized as upland, are those that have adopted lifestyles that in some manner tie them to this habitat. Burrowing animals, such as the gopher tortoise are examples of this type of species. Snakes are also fairly abundant in this area.

The report noted that this subsystem was the one where future development on Sanibel was most likely to occur. For this reason it was predicted that due to habitat alteration, wildlife would be displaced and their numbers reduced in this region.[22]

The greatest number of wildlife on Sanibel were found in the interior wetland subsystem. It is this subsystem which sets Sanibel

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[21]John B. Morrill and William K. Byle, Jr., and Richard Workman," Wildlife Ecology," in The Sanibel Report, John Clark (New York: The Conservation Foundation, 1976), p. 264.

[22]Ibid., p. 265.

apart from other barrier islands because there are very few, indeed if any, which possess areas of fresh water collected in seasonally innundated marshes and perennial channels and ponds.

This study noted that others have found that of the eighty-five species of reptiles, amphibians, and mammals of Sanibel, thirty-five species and subspecies are dependent on this subsystem. Also sixteen species of birds are common to this habitat.

The interior wetlands subsystem was also found to be the most vulnerable to intensive development. Increasing salinity due to dredging, excavation, and channelization, as well as the introduction of pesticides, were cited as apparent contributors to a lowering of reptile and amphibian populations. It was also noted, however; that the present mix of birds, mammals, reptiles, and amphibians, showed an increase in the number of species able to tolerate people, developed land, and saline water conditions.[23]

The final subsystem examined in the wildlife ecology natural system study was the mangrove subsystem. This area was identified as transitional, as it separates the land from estuarine waters. The mangrove-estuarine complex comprises 5,400 acres, nearly one half of the total area of Sanibel. The portion identified as mangrove was 2,800 acres.

The mangroves are important for large numbers of marine species as either habitat, nursery, feeding area, or hiding place. Crabs, snails,

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[23]Ibid.

and fish such as snapper, snook, and tarpon can be found there. There are also a large number of birds to be found in the mangroves. Some species such as diving ducks, pelicans, cormorants, gulls, terns, skimmers, and osprey feed on the mosquito larvae and fish of this subsystem. Some species, such as the brown pelican, cormorant, herons, and egrets, rest in the Austarlian pines found along the bayous.

In addition to serving as home and feeding ares for several species of aquatic birds and fish and shellfish, Sanibel's mangrove-estuarine complex is also visited by and is home to reptiles, amphibians, and mammals. A number of species of frogs and snakes make these areas their home, and such species of wildlife as the raccoon, opossum, alligator, and otter utilize the mangroves when their food or environmental space is limited or stressed in other habitats on the island.

Fortunately a very large portion of this subsystem is protected, as it is a part of the Ding Darling Wildlife Refuge. However, as the natural system report pointed out, the mangroves could become the home to more and more species as their habitats in other ecological zones become altered by human activity.[24]

Estuarine Ecology

The estuarine ecology natural system study consisted of two parts. First a literature search was conducted of a large number of published and unpublished materials. This information was reinforced by interviews. The second part of the study was a series of field studies

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[24]Ibid., p. 269.

conducted during the second and third weeks of June 1975. This included several daytime boat trips, walking, wading, snorkeling, aerial photograph interpretation, and one night boat trip.

This natural systems study begins with a discussion of the physical elements of the estuarine environment. The first part of this section deals with circulation. It notes that the Sanibel Island Marine Ecosystem is subjected to a complex combination of circulatory mechanisms. The circulation is determined by geographical location, tides, adjacent land forms, prevailing winds, rainfall and runoff, temperature, and bathymetry. After a discussion of some of these factors, two recommendations were made. The first was that no access channels which cut across the shoals protecting the mangrove shoreline from wave generated erosion should be permitted. The second was that high rise construction should be discouraged along the bay side because such development could affect the circulation of the adjacent estuarine waters by altering the wind pattern. The final part of the physical environment section of the estuarine ecosystem study addressed water quality and sediments, though no recommendations were made.[25]

The second part of this report concerned biological-ecological considerations. It began by noting that three of the most important amenities for attracting tourists to Sanibel are shelling, fishing, and birding and that, at least in the case of the first two, things were not

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[25]John B. Morrill and William K. Byle, Jr., "Estuarine Ecology," in The Sanibel Report, John Clark (New York: The Conservation Foundation, 1976), p. 282.

as good as in the past. Each of these amenities were then discussed separately. No recommendations were made concerning shelling. Under fishing, the only recommmendations were that forethought be given to the "potentially inflammable socioeconomic problem" of possible increased commercial fishing competing with water fowl and with sport fishing, and conflicting with the esthetics of the island's residents along the shore.[26] The section on birding recommended that all remaining estuarine shorelines and associated mangrove forests be protected, possibly through strategic purchase under the State's environmentally endangered land program. The second recommendation was for a complete plan of protection for the shallow water behind the Sanibel Shoals and at the mouth of practically every bayou inlet. One suggested approach was for the city to request the State Department of Natural Resources to declare these areas as a bird sanctuary and allow no shell collecting or power boating in the shallows, that is water less than three feet below Mean Low Water, around the length of Sanibel.

This study concluded with a description and assessment of the inshore-estuarine benthic communities. The only recommendation made in this section was that segments of the Blind Pass area be protected from development and over-utilization by people.[27]

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[26]Ibid., p. 284.

[27]Ibid., p. 285.

Natural Energy Systems

The final natural systems study was on the natural energy systems of Sanibel. It noted that in the future, as Sanibel develops, the concern for planners is:

> insuring long-range values and high quality of life by insuring that lands are put to their highest and best use, that different land uses do not conflict, that energy for productivity is available in the quantities needed, and that there is sufficient high-quality water for the needs of the population as well as natural systems of the area.[28]

The study uses a number of models and diagrams to analyze Sanibel's land use trends, energy requirements, and economy. It calculated the island's "energetic" carrying capacity and described alternative futures for Sanibel.

The final part of the study offered six recommendations for achieving a steady state economy. The first was to limit high power density usages such as high rises, high density condominiums, and concentrations of heavy industry. The second recommendation called for maximizing the diversity of the region. This was based on the principle that added value would come from the interaction of a variety of land uses in the area. The next recommendation was to develop incentives to maintain and improve existing areas of development by placing higher taxes on new development and lower taxes on undeveloped land and extending municipal services to existing development before doing so to newly developed areas. The next recommendation was that special

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[28]Mark Brown," Natural Energy Systems," in The Sanibel Report, John Clark (New York: The Conservation Foundation, 1976), p. 297.

incentives should be established to encourage development of low energy communities. The fifth recommendation was to reevaluate existing zoning policies, which was of course being done at that time. The final recommendation was to not allow land to be cleared of native vegetation simply in anticipation of development because if it does not occur, the cleared land that is left lowers species diversity, increases runoff, reduces total energy flows through the natural systems, and, in general, needlessly stresses these systems.[29]

These natural systems reports placed WMRT in a unique situation as it provided the firm with a more complete documentation of the environmental condition of the island than would usually be available in planning programs of this type.[30]

At about the same time that the Conservation Foundation natural systems reports were being formulated, in June 1975, WMRT began to develop base maps and obtain socioeconmic data pertaining to the past and projected future urbanization of Sanibel. Throughout the Conservation Foundation's work WMRT assisted by giving spatial definition to various conditions found in the field studies. For example, while the Conservation Foundation developed their studies, WMRT began interpreting aerial photographs to show plant type distributions, and a vegetation map of the entire island was produced. This was then compared to a topographic map to examine the correlation between vegetation and topography. Similiar maps and testing procedures were developed for surface waters, groundwaters, and historic geology.[31]

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[29]Ibid., p. 305. [30]Ibid. [31]Ibid.

WMRT proposed that Sanibel be described by ecological zones. It was these zones upon which the plan and the zoning ordinance would eventually be based. They were defined by the Conservation Foundation as regions possessing distinct ecological conditions and functioning systems.[32] WMRT dismissed the Conservation Foundation's original idea of identifying distinct habitats saying that this would be too specifically tied to wildlife. Eventually six ecological zones were identified: Gulf Beach, Gulf Beach Ridge, Interior Wetland Basin, Mid-Island Ridges, Mangroves, and Bay Beach. The Gulf Beach Zone was further subdivided into Gulf Front Beach and Gulf Back Beach and the Interior Wetland Basin was broken down into Upland and Lowland sub-regions. There were also four special ecological subsystems identified: Blind Pass area, Filled Land, Preservation Spot Zones, and Refuge areas. Each ecological zone is described below in terms of its characteristics and functions. Unfortunately though the only maps of these zones are at a scale of one inch equals 200 feet. No maps exist at a scale small enough to include in this thesis.

Gulf Beach Zone

The Gulf Beach Zone is composed of all land seaward of the Coastal Construction Setback Line. It is subdivided into two areas--Gulf Front Beach and Gulf Back Beach.

Gulf Front Beach. The Gulf Front Beach sub-area of the Gulf Beach Zone is the most dynamic region on Sanibel. It includes the area

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[32] Ibid.

between high water and the city's boundary some 300 feet offshore. This zone is characterized by motion, as sand constantly migrates between the berm and offshore bars and is transported littorally by longshore currents. Aerial photographs taken over the past thirty years indicate that erosion and accretion of sand along the beaches are cyclical, in many places taking twenty to forty years before the process is changed. It is this sub-area which is Sanibel's first defense against storms. It also supports the marine life for which Sanibel has become famous.

Gulf Beach Back. This zone consists of the area between mean high water and the Coastal Construction Setback Line. It is not as active a zone as is the Gulf Beach Front, but it also serves to protect the island from storm generated wind and wave activity. This area contains the dunes which are so vital in protecting the inland areas from storm surges. These dunes are also important nesting areas for wildlife, especially the loggerhead turtle. The vegetation in this area is particularly important as it is the agent which stabilizes and holds the sand.

Both subareas of the Gulf Beach Zone are very intolerant of human activity. Too much of man's influence in the form of sand removal, excessive foot traffic, etc.., can lead to detrimental effects such as major beach erosion and loss of storm protection. Thus this zone must be strictly regulated, including an absolute prohibition of any sand removal or construction which would alter the configuration of the beach or inhibit sand migration. Access to the beach should be controlled,

with wildlife having total access, while the public should be confined to elevated walkways.[33]

Bay Beach Zone

The Bay Beach Zone, like the Gulf Beach Zone, is also dynamic in nature, though much less so. This zone extends all along Sanibel's bay shoreline. It is important for storm and flood protection, shoreline stabilization, and marine life and wildlife habitat and feeding. Because the natural processess here are similar to those in the Gulf Beach Zone, the constraints to development are also similar. Strict performance standards, similar to those recommended for the Gulf Beach Zone, are required to maintain the functions of this zone.[34]

Mangrove Zone

The Mangrove Zone includes all areas of red, black, and white mangrove, buttonwoods, and the tidal flats within and around them. It includes most of the bay areas of Sanibel. This zone is the most valuable and efficient in terms of ecology and energy. These mangrove areas protect public health, safety, and welfare by absorbing and dissipating storm winds and water, by stabilizing and building the shoreline, by maintaining and improving water quality, by maintaining the highly productive marine ecosystems, and providing food, refuge, and nesting areas for wildlife. This zone also has a low tolerance for

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[33]Clark, Sanibel Report, p. 124.

[34]Ibid.

human alteration. Its continued existence depends not only on regulation of clearing and filling in the mangrove areas, but on regulation of activities in adjacent areas as well.[35]

Interior Wetland Basin Zone

The Interior Wetland Basin Zone is an especially important zone as it is the major aquifer recharge area on the island. It is composed of parallel systems of ridges and swales with corresponding bands of tolerant vegetation. It is further subdivided into lowland wetlands and upland wetlands; the former consisting of low ridges and wide swales and the latter composed of higher, broader ridges and narrower swales.

Lowland Interior Wetland. The Lowland sub-area is typically subjected to extended annual periods of flooding. Because it is lower than the surrounding area, it serves as a reservoir for flood waters until they can be absorbed into the aquifer. This sub-area is important because it protects the ridge areas from flooding and maintains recharge to the fresh water lens. It should continue to do so as long as elevations there are not substantially increased by filling. Periodic fires are dangerous for human settlements in the lowlands, but are of vital importance in maintaining the ecological balance in the area. These fires burn off accumulations of dead plants, release nutrients to the soil, and kill invading woody shrubs and trees. The area is important for maintaining and improving water quality and for providing

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[35]Ibid., p. 126.

food, refuge, and nesting areas for much of Sanibel's wildlife population. Strict regulations, therefore, should exist in this sub-area. Excavation of the aquiclude (the clay layer separating the saline and fresh water aquifers), filling, alteration of natural water drainage, and the use of septic tanks is largely restricted. Impervious paving and the clearance of native vegetation is regulated.[36]

Upland Interior Wetland. This area is subject to less frequent flooding than the lowlands and displays more upland vegetation types. It is more tolerant to human activities and development. However, filling, excavation of the aquiclude, and the use of septic tanks are still restricted, and the alteration of natural water flow/drainage patterns is controlled.[37]

The original Sanibel Comprehensive Land Use Plan called for a study to be done to determine the optimum water level elevation in this zone. As of the writing of this thesis, this report was nearing completion and unavailable for review.

Gulf Beach Ridge Zone

The Gulf Beach Ridge Zone is the major ridge separating the Gulf from the Interior Wetland Basin. It is a dynamic zone subject to drastic change. It is important as a buffer against flood tides and storm winds. As such it prevents increased flooding in the interior and helps to stabilize the shoreline. To maintain these functions, the

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[36]Ibid.

[37]Ibid.

elevation and vegetation of this zone must be preserved. This zone is also important because a lot of fresh water runoff enters the ground here and acts to retard the inward intrusion of sea water. Still this zone is fairly tolerant to residential development as long as there is no excavation which lowers the elevation of the ridges or penetrates the aquiclude. Disruption or alteration of the drainage system, the use of septic tanks, impervious paving, and clearing of native vegetation, must also be controlled in this zone.[38]

A portion of this zone is so highly dynamic that it has been designated a special zone. It is the Blind Pass Zone. It is composed of the area between the two islands of Sanibel and Captiva. As such it is subjected to strong currents and severe erosion. Because it is so susceptible to change, this zone should be restricted from permanent human settlement or at least confined to very low density development.

Mid-Island Ridges Zone

This zone consists of the major ridges along the central axis of Sanibel which includes the island's highest elevations. In most places it separates the Bay-Mangrove watershed from the Interior Wetlands watershed. This zone is important for providing storm and flood protection and for preventing the degradation of water quality. It is this zone which, under proper regulations, is the most tolerable for human activities and urban development. The restrictions on excavation, paving, natural drainage pattern alteration, septic tank use, and

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[38]Ibid., p. 127.

clearance of native vegetation as described for previous zones are applicable here as well.[39]

These ecological zones were first described by the Conservation Foundation in initial maps produced in June and July 1975. WMRT then produced maps and zone descriptions which were evaluated by the Conservation Foundation teams to ensure that no mistakes had been made in data interpretation and to recommend minor modifications.[40] Further refinements were made by the Planning Commission. Three illustartions referring to the ecological zones were produced by WMRT at one point or another in the planning process. The first was an inventory of each zone, the second a discussion of their functions, and the third provided management guidelines. Each of these are reproduced in the appendix to this thesis. These illustrations and discussions provided the basis for the permitted uses, density limits, and performance standards in the Sanibel Comprehensive Land Use Plan.

At this point the planners had an idea of the island's present conditions as well as its capacities in a number of areas. The next step was to make projections of urbanization trends and the island's capacity to accommodate further growth. Alternate levels of future growth were projected and the corresponding demand for land and public services was determined. Among the chief constraints to future development were the ability to dispose of treated effluents, the capacity of the causeway to accommodate evacuation of residents in the

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[39] Ibid.

[40] Ibid., p. 86.

event of a hurricane, the availability of potable water, and the capacity of the island's road system.[41]

WMRT presented options of 6,000, 8,000, 16,000, and 24,000 total dwelling units to the Planning Commission to allow the city to consider alternative levels of commitment of public funds. The Planning Commission selected the 6,000 dwelling unit option as the plan's basis. This figure represented 2,000 more dwelling units than existed at that time.

With this target level of development in mind the next task was to determine how to allocate the development among the ecological zones. In order to arrive at this allocation procedure, WMRT and the Conservation Foundation first described the intrinsic functions of each ecological zone in maintaining the natural systems within each zone, and then described the interrelated systems between zones. The second of the three previously mentioned illustrations, that of the ecological functions of each zone, was a major product of this part of the planning process.[42]

The Conservation Foundation provided input to WMRT concerning the relative tolerance of each zone and what guidelines would be necessary to protect and restore the island's environment. With this information WMRT prepared a complex formula to distribute the additional units. It took into consideration the following:

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[41] Ibid.

[42] Ibid., p. 88.

1. the relative suitability of each ecological zone to accommodate dwellings,
2. the proximity to human support systems such as existing services and water lines, fire stations, and egress routes in the event of evacuation,
3. the level of private investment in terms of development improvements, and
4. the level of build out in established subdivisions.[43]

The formula used to determine this allocation procedure is presented in Figure 4 and Table 3. Two limitations of the technique used in Table 3 must be pointed out. First, these ranked scores give no indication of the differnce between values. For one factor the difference between a score of 1 and a score of 4 may be minute, but for another factor it may be quite large. The second limitation is in the definition of the sectors. By merely changing the boundaries, the scores could easily change.

This formula is used only for residential units. Hotels and motels are treated as commercial uses and are therefore addressed under the commercial uses section of the plan.

Now that the general parameters of the plan had been determined, the Planning Commision conducted public hearings to specifically address the proposed densities of future development. This process took four months and included hundreds of hours of public hearings. Through this process the 6,000 dwelling unit target was modified, in order to avoid

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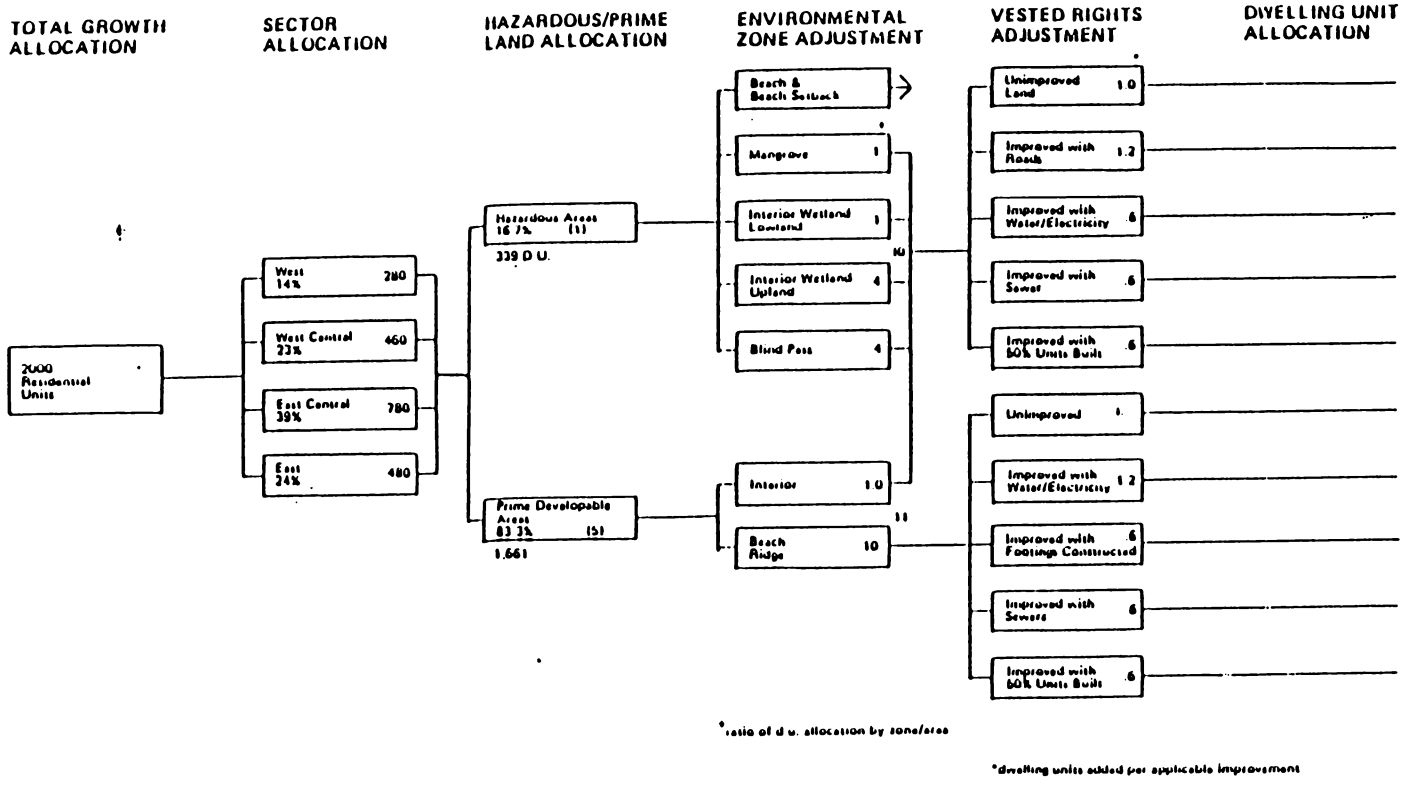
[43] Ibid.



RESIDENTIAL UNIT ALLOCATION PROCESS

Source: John Clark, The Sanibel Report.

Figure 4. Dwelling Unit Allocation Process

Table 3. Planning Sectors Ranked by Availability or Proximity of Services

Factor	Sector			
	West	West Central	East Central	East
1. Accessibility to Causeway	1	2	3	4
2. Distance from existing Commercial and Institutional Faclities	2	1	4	3
3. Availability of Fire Protection	1	3	4	2
4. Availability of Police Protection	1	3	4	2
5. Proximity to Water Service	1	3	4	2
6. Proximity to Sewer Service	1	2	4	3
7. Relative Amount of Developable Land	3	2	4	1
Totals	11	19	31	13
Sector Index	14	23	32	24
8. Dwelling Units	280	460	780	480

Source: John Clark, The Sanibel Report.

potential lawsuits and in some csaes to preserve the character of existing neighborhoods, to 7800 units. A major accomplishment of this process was the garnering of public support for the plan.

During the time that this was occuring, Fred Bosselman and Charles Siemon of the Chicago law firm of Ross, Hardies, O'Keefe, Babcock, and Parsons developed performance standards for the environmental protection of each of the ecological zones based on the recommendations of the Planning Commission, WMRT, and the Conservation Foundation.[44]

Environmental factors were addressed primarily in a section of the plan entitled "Protection of Natural, Environmental, Economic, and Scenic Resources," but they influenced several elements of the plan including its land development regulations. The Planning Commission and WMRT went to great lengths to protect the environment while also accommodating the problems of property owners and builders.[45] For several months the Planning Commission held public meetings to hear opinions on alternative means of achieving the environmental objectives of the plan without creating unnecccessary hardships.

The final step of the planning process was to make the plan internally consistent so that future land uses and improvements could be planned and financed. Administrative regulations for the orderly consideration and issuance of building permits and the hearing of amendments to the plan were written. Five drafts of the plan were considered. Then the City Council obtained reviews from the state,

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[44]Ibid., p. 92.

[45]Ibid.

region, and county governments. More public hearings were then held by the City Council and on 19 July 1976 the final version was adopted.[46]

Under Florida law, all comprehensive plans are required to be updated every five years. Sanibel has complied with this law and has thus revised the 1976 plan twice since its adoption. As might be expected there have been changes. Perhaps the most notable is in how the plan treats commercial uses. In the process of revising the plan for the first time in 1981, the city conducted a reassessment of commercial needs and oppurtunities. The original plan noted that Sanibel was unique in that it was located in such a position that it would not attract any tourists who were merely passing through en-route to some other destination. Also it tended to attract tourists with special interests such as shell collectors, tennis players, and birdwatchers. These circumstances combined with rapid changes in the tourism industry led the 1976 plan to conclude that "it is difficult to make definitive, long-term projections about the need for various types of commercial uses in Sanibel." Accordingly it recommended that the city proceed cautiously by allocating enough, but not too much, land for future commercial uses.[47]

The 1981 study concluded that a very limited demand existed for additional retail development. It recommended changes in the plan to guide commercial development into clusters, rather than in a continous strip. It also encouraged the development of alternative land uses on

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[46] Ibid.

[47] Ibid., p. 146.

Periwinkle Way in order to discourage the expansion of commercial development on that thoroughfare.

By 1986 commercial development since 1981 had already exceeded the 1981 study's forecast of floor areas which could be supported on Sanibel at generally profitable sales volumes by 1990. The 1986 revision of the plan concluded that betwwen 1981 and 1985 commercial growth occured much more rapidly than residential, indicating that the commercial development was relying less on the community to support it. It also stated that this conclusion is supported by an examination of the types of businesses that developed on Sanibel between 1981 and 1985 (boutiques, t-shirt shops, gift, novelty and souvenir shops, etc.). These type businesses are those which depend primarily on the tourist/resort trade. This combined with the fact that the provisions incorporated in 1981 to discourage commercial development were not working, led to the conclusion that development between 1981-85 may not have been consistent with "the city's desire to maintain a balance between the residential and resort (tourist) segments of the community, so that Sanibel remains an attractive and desirable residential community."[48] This led to the incorporation into the 1986 version of the plan of a plan for commercial development consisting of thirteen elements.

Although other changes occured in the revisions of the 1976 plan, none were as extensive as these. Thus in the final analysis the 1986 Comprehensive Land Use Plan is a revised plan, but remains much like the 1976 version.

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[48]Comprehensive Land Use Plan, p. 262.

Effects of the Plan

Having discussed the planning process for Sanibel, it is now time to turn to an assessment of the effects of the plan. The first question addressed is the identification of the major actors responsible for the initiation of the planning process for Sanibel. The residents of Sanibel were largely responsible for the initial impetus for the movement to incorporate. Civic organizations such as the Sanibel Island Planning Board, SCCF,and the Audubon Society to name a few, became involved in supporting measures to preserve the environment of Sanibel at least as early as 1970.

Once the new government took office, a number of groups became involved in the planning process. Most notable among these groups were the new Sanibel Planning Commission, their consultants, WMRT, and the Conservation Foundation. Figure 5 provides a description of all the groups and individuals involved in this process.

There was little universal agreement, among those groups interviewed, however concerning the effects of the plan since its adoption. One area about which these groups agree, is that the plan has helped developers to realize that lower density development does make money, in fact more money than the typical high density development that is more characteristic of barrier island communities.[49] Another issue which brought nearly complete agreement is that the real test for Sanibel will

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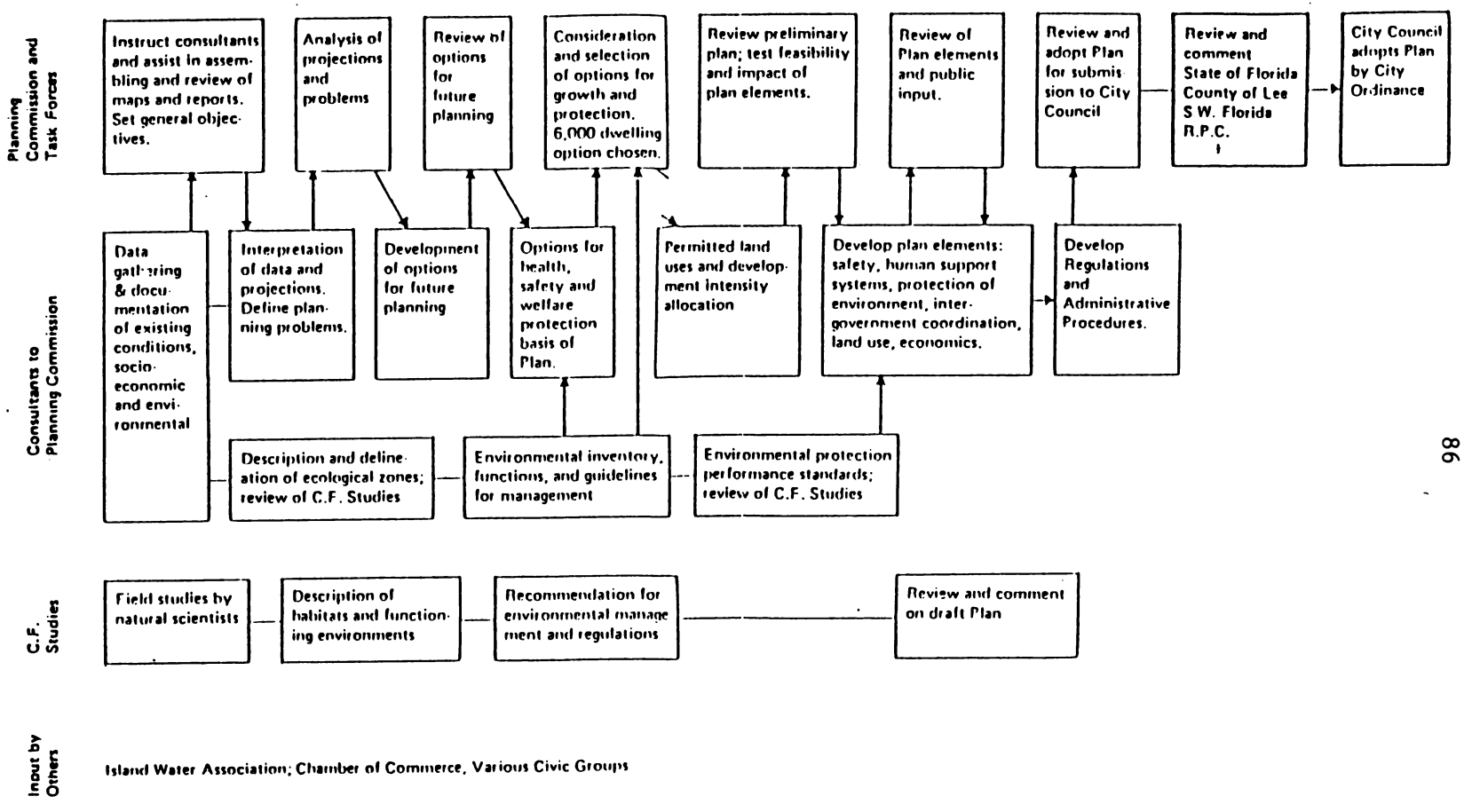
[49]Interviews with Jack Thomas, Realtor and Richard Workman, Coastplan Inc., Ft. Myers, Florida, 2 April 1987 and Bruce Rodgers, Planning Director, Sanibel, Florida, 1 April 1987.



Source: John Clark, The Sanibel Report.

Figure 5. Groups Involved in the Sanibel Planning Process

come in the near future. This is because build-out on Sanibel is only five to fifteen years away. It will be interesting to see whether the pressure to develop marginal land at that time will be great enough to force changes in the Comprehensive Plan and the Land Development Code.

It was also mentioned by more than one of the parties interviewed that there have been some sociological changes that have taken place since the plan's adoption. Whether or not the plan was responsible for these changes is questionable. One of the groups interviewed, however, said that the failure to anticipate these changes was "the biggest failing of the plan."[50] One of these changes is in the attitude of some of the newer residents of Sanibel. Everyone interviewed vehemently denied that the 1976 Comprehensive Plan came about because of a "raise the drawbridge syndrome." In fact one group pointed out that Sanibel was lucky because, from the beginning, people could see that environmental planning was good. However, one person pointed out that this may be changing with the people who are moving to the island. Erick Lindblad of the SCCF said that while the SCCF still gets requests for land acquisitions, the underlying reason of those asking is no longer concern for the environment, but rather because they want either to secure a buffer or to raise property values. The lack of environmental concern by these people is shown by the fact that while they continue to make

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[50]Interview with Jack Thomas and Richard Workman, 2 April 1987.

these requests, they are not contributing any money for such programs as occured in the past.[51]

One of the changes as a result of the plan, or more specifically the movement which resulted in the plan, was a change in the political structure of Sanibel. This was brought about with the incorporation campaign. Before the plan, civic groups like the SCCF and the Sanibel Island Planning Board were the political powers. Today the City Council of Sanibel holds this political power.

An economic and social change that occured on Sanibel was the tremendous growth in the number of tourists and the tourist industry. Some growth in this area was anticipated, but perhaps no one realized the amount that would develop. The seasonal population peak was estimated to be 15,000 in 1985. The total traffic volume crossing the causeway was 2,252,687 for 1984-85 up from 750,000 in 1974-75 and 110,000 in 1964-65. It appears that planning to control growth can accelerate tourist growth.[52] Perhaps part of the reason for this growth is explained by the fact that there are so few places like Sanibel that have decided to cater to the conservation oriented tourist by controlling growth.

The first environmental question posed in Chapter I concerned the distribution of future development by zones based on their suitability for development. New development in Sanibel is distributed as called

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[51] Interview with Erick Lindblad, The Sanibel-Captiva Conservation Foundation, Inc., Sanibel, Florida, 31 March 1987.

[52] Interview with Jack Thomas and Richard Workman, 2 April 1987.

for in the plan, but it has exceeded the 2,000 dwelling units recommended by WMRT. However, Bruce Rodgers, Director of the Sanibel Planning Department, says that the 2,000 figure was misleading because if the number of dwelling units that could be built under the plan were added to the number already in place in 1976, the total was about 7,500-7,800. The 2,000 he says, was wishful thinking.[53] At any rate 3,000 units have been added as Sanibel has developed much faster than envisioned. Now with density increases that have been granted the ceiling is 8,900 dwelling units. This number should be reached in five to fifteen years.

The next question to be addressed is what was the nature of the past ecological damage referred to in the Conservation Foundation's report and has it been restored? The past ecological damage has been described in this chapter in the discussion of the natural systems studies. The most notable problem concerned the water supply (quality and quantity) of the island. Excavation for mosquito control, to provide boat access to tidal waterways, for lakes which provided fill materials to raise surface elevations, the construction of roads, and wells, and the implacement of septic tanks all combined to adversely affect the hydrology of Sanibel. The major problem was intrusion of saline water from the sea into the aquifer. The excavation of lakes and ponds also led to upward leaking of high chloride water from the shallow artesian aquifer into the water table aquifer. Has this damage been

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[53]Interview with Bruce Rodgers, 1 April 1987.

restored? It is hard to say. At least the situation has probably not gotten any worse since the adoption of the plan. A better assessment will be possible when the Johnson Engineering study of the hydrology comes out later this year. One area that has probably improved in quality is the Interior Wetlands. This is because since the plan went into effect, an Interior Wetlands Conservation District has been created, within which there can be no construction within 200 feet of the Sanibel River.

Another ecological problem addressed in the natural systems reports was that of invasion of exotic plant species. The protection of native plant communities is important, especially in places like Sanibel where there is an absence of the natural controlling processes of frosts and freezes. Native plants are desirable because they have adapted to local conditions and therefore require no irrigation. This is important because at one point during the dry season, nearly a full half of the desalainated water supply was being used to irrigate exotic plant species. Native plants are now encouraged through regulations concerning clearing and revegetation of land. There is however one species which remains a big problem. This is the Brazillian Pepper and this leads to the next question, that of any side-effects created by the 1976 plan. There have probably been no problems as a result of anything contained in the plan, but the growth of the Brazillian Pepper may have become such a problem because it was underestimated in the plan. Today it represents the number one environmental problem on Sanibel.[54] It is

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[54]Interview with Erick Lindblad, 31 March 1987.

an exotic species which threatens native vegetation. A measure undertaken which will hopefully alleviate the problem is the requirement that this species be removed from any property before building is allowed.

The final question posed under the general heading of environmental problems concerned what actions have been taken by the State in the way of Coastal Zone Management. This question is easy to answer as Florida has not done anything formally through CZM. They have made one important contribution, however, that is the recommendation of the location of a minimal coastal construction setback line. This line was incorporated by the city into its Land Development Code. Another influence by the state comes from its adoption in 1985 of a number of strong planning laws. Under this legislation all cities and counties in Florida were required to revise their plans to include capital improvement programs and stricter coastal zone protection.[55] It also required local plans to conform with state and regional plans. Similar laws were enacted in 1975. The Sanibel plan may have been influenced by the 1975 legislation but the extent probably was not that great because in fact the restrictions in the plan were closer to the requirements of the 1985 legislation than those of 1975. What the new legisaltion will do though is strengthen the Sanibel plan by helping to ensure that the restrictions on development, at least along the coast, are preserved in future revisions.

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[55]Nancy E. Stroud and Daniel W. O'Connell, "Florida Toughens Up Its Land-Use Laws," Planning 52 (January 1986): 112.

The last question to be addressed here is that of the effect of the 1976 Land Use Plan on the growth and development of Sanibel. This is undoubtedly the most complex of all the research questions.

Part of the problem comes from determining what is meant by growth. One measure is population. The population of Sanibel (see Table 4) has grown from 818 in 1970 to 2,931 in 1977, to 4,696 in 1986. As a percentage of the Lee County population, Sanibel grew from .78% in 1970 to 1.6% in 1980. Projections for the population are given in Table 5. Figures for 2005 range from 5,652 to 7,205.

Another measure of growth is property values. Table 6 indicates that property values in Sanibel have grown from $184,313,840 in 1977 to $1,062,013,960 in 1986, an increase of 476%. This represents an annual increase of almost 50%, a rather dramatic change. To compare Sanibel to Lee County and other communities in the region, 1980 census data of Median Values for Owner Occupied Housing is used. This data is presented in Table 7. This shows that Sanibel (split into two tracts by the Census Bureau) ranks near the top among the cities included. Of particular interest is the comparison between Sanibel and Marco Island. One of the parties interviewed indicated that Marco Island would be a good comparison to Sanibel because it was developed under entirely different circumstances. It was cleared, subdivided, and developed with little regard for the environment. In the words of the interviewee, "while property values on Marco Island are high, they can't touch

Table 4. Sanibel Population

Fiscal Year	Population
1977	2931
1978	3968
1979	2817
1980	3363
1981	3642
1982	3820
1983	3950
1984	4120
1985	4237
1986	4696

Source: City of Sanibel Finance Department.

Table 5. Population Projections

	1985	1995	2005
Low Projection	4,237	5,080	5,652
Medium Projection	4,237	5,692	6,681
High Projection	4,237	6,216	7,205

1985 figures based on University of Florida estimate.

Assumptions and Methodology

City of Sanibel estimate and projections for number of dwelling units:

1985 - 6678 dwelling units
1995 - 8000 dwelling units
2000 - 8900 dwelling units

8900 units represents the total number of dwelling units projected at buidout of the residential sector of the city at established densities.

Ratio of 1985 permanent residents to 1985 dwelling units = 0.63

Low projection assumes a continuation of the permanent population to dwelling unit ratio established for 1985.

Medium projection assumes the same permanent population for the 1985 housing stock, plus that 50% of the housing stock built after 1985 is occupied by permanent residents at 2.2 people per unit.

High projection assumes the same permanent population as the medium projection, plus that .5% of the 1985 non-resident units convert to occupancy by permanent residents, annually.

Source: Sanibel Planning Department.

Table 6. Property Values

Fiscal Year	Assessed Value
1977	$ 184,313,840
1978	221,053,520
1979	245,623,080
1980	323,963,020
1981	579,387,470
1982	623,140,490
1983	673,126,660
1984	775,710,790
1985	932,687,910
1986	1,062,013,900

Source: City of Sanibel Finance Department.

Table 7. Median Value of Owner Occupied Housing 1980

City	Value
Sanibel (Census tract 802)	$ 109,800
Sanibel (Census tract 801)	115,300
Cape Coral	65,700
Clearwater	50,900
Dunedin	50,400
Estero Bay	112,500
Ft. Myers	38,600
Ft. Pierce	35,600
Largo	45,400
Marco Island	112,500
Naples	122,800
St. Petersburg	35,800
Vero Beach	56,600
Lee County	52,200

Source: 1980 U.S. Census.

Sanibels'. (sic)"[56] However the census data indicates that property values in the two areas are essentially the same. This might be explained by increases in property values since 1980, because as was indicated above, Sanibel's property values have grown at dramatic annual rates. Another factor is the basic economic law of supply and demand. In Sanibel property values are high because there are a limited number of sites upon which to build. In Marco Island, there is a property glut, which has been caused by the dumping of property bought in the early 1980s onto the market by out-of-state and foreign investors. This has led to property valuse on Marco Island becoming perhaps the lowest of any waterfront community in the area.[57]

Another measure of growth which might be used is the number of building permits issued. Table 8 gives the number of commercial and residential building permits issued each year since 1977. This data reveals no real pattern. The number of residential building permits have ranged from a low of 148 to a high of 230, with the average number issued being 179.4.

The final growth indicator that will be examined is tourist growth. Table 9 shows projections for future levels of seasonal residents on Sanibel. It indicates that by the year 2005 the number could rise to between 19,580 and 26,700. This is up from an estimated 15,000 seasonal residents in 1986. Another measure is provided by the traffic coming

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[56]Interview with Jack Thomas and Richard Workman, 2 April 1987.

[57]Interview with John Hamblen, Collier County Property Appraiser, 8 June 1987.

Table 8. Building Permits Issued

Fiscal Year	Commercial		Residential	
	Number of Permits	Value	Number of Permits	Value
1977	8	$ 1,429,650	148	$ 17,223,167
1978	1	13,500	172	14,858,930
1979	7	1,159,000	169	12,307,907
1980	2	87,000	172	18,658,001
1981	1	70,000	222	13,793,828
1982	7	2,104,300	164	13,791,786
1983	1	2,086,073	230	18,362,097
1984	10	1,838,600	165	15,896,532
1985	5	2,430,000	156	17,600,035
1986	1	425,000	196	21,675,454

Source: City of Sanibel Finance Department.

Table 9. Projections for Seasonal Population City of Sanibel

	1985	1995	2005
Low Projection	14,692	17,600	19,580
Medium Projection	16,695	20,000	22,250
High Projection	20,035	24,000	26,700

Assumptions and Methodology

City of Sanibel estimate and projections for number of dwelling units:

1985 - 6678 dwelling units
1995 - 8000 dwelling units
2000 - 8900 dwelling units

8900 units represents the total number of dwelling units projected at buildout of the residential sector of the City at established densities.

Low projection - number of dwelling units at 2.2 people per unit.

Medium projection - number of dwelling units at 2.5 people per unit.

High projection - number of dwelling units at 3.0 people per unit.

Source: Sanibel Planning Department.

across the causeway. As indicated earlier this has risen from 110,000 in 1964-65 to 2,252,687 in 1984-85.

It appears as if the indicators of growth give mixed results. Population has increased but not too dramatically. Property values have displayed a large rise. The number of building permits issued has remained fairly constant. Finally tourist growth has been somewhat rapid, but this is the case for almost all of Florida. So what have been the effects of the 1976 Comprehensive Land Use Plan on the development of Sanibel? The only definite answer is that it is impossible to say that growth did or did not occur because of the plan. It would appear that the plan has done what any planner would hope a plan would do. That is to control growth and enhance property values. Did this occur as a result of the plan? In a way it did because reducing the number of allowable units limited the population. Also as the framework under which development takes place it certainly has had some, probably large, effect on the growth of Sanibel.

In two very important ways the plan has had a significant impact. The first is that while the Sanibel plan may or may not have induced growth, it certainly influenced how and where this growth was to occur. By encouraging growth in areas which have been deemed suitable for development and discouraging it in areas not suitable, the 1976 Comprehensive Plan has had a large role in determining the spatial distribution of growth. The second important result of the Sanibel plan is that it has provided the political decision making system with a framework for growth policy. It not only lays out where and how

development should take place, but it also spells out how the plan can be modified. The plan is required by Florida Law to be updated every five years. This is important because it provides a means for the voice of a changing society to be incorporated into the planning process. Because change is the only thing certain about the future, this is a significant contribution of the original plan.

CHAPTER V

CONCLUSIONS

This final chapter is devoted to the last subsidiary question of what can be learned from the Sanibel experience. It first lists the major findings of this research. Then it discusses lessons that can be learned from the Sanibel experience, first for other developing barrier island communities and then for planning in general.

One major finding of this research is that developing barrier islands at low densities can indeed be profitable.[1] It may in fact be more profitable than high density development.[2] For Sanibel this is not an important point. What is important is the fact that the people of Sanibel decided that low density development was what they wanted and the incorporation campaign and subsequent plan allowed them to obtain it. They wanted this type of development because they did not want to lessen the quality of their environment. That it also proved to be profitable is a bonus. However, this research also seems to add support to the contention that barrier islands should not be developed at all. One reason that supports this view is that, as this research has shown, barrier islands are very dynamic. Their natural role is to provide protection from storm surges to the mainland. If development is

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[1] Interview with Bruce Rodgers, Planning Director, Sanibel, Florida, 1 April 1987.

[2] Interviews with Jack Thomas, Realtor and Richard Workman, Coastplan Inc., Ft. Myers, Florida, 2 April 1987 and Bruce Rodgers, 1 April 1987.

extensive enough, for example if inlets are altered, this natural protection may be diminshed. Another reason that barrier islands should perhaps not be developed at all, is because when a hurricane does come and causes damage to the existing development, it will be society as a whole who will be asked to pay for the cost of restoring this damage through federal relief which comes from income taxes. This cost may be too much to ask society to bear.

Another finding concerns the people of Sanibel. Throughout much of the past, and particularly during the incorporation movement, the environmentalists have been a large and active segment of the Sanibel population. This is a somewhat unique situation. It, more than any other factor, is the reason that the incorporation campaign really took off. It is also an important reason why the applicability of the Sanibel experience may be somewhat limited.

One of the more interesting discoveries from this research was that if the provisions of the current Land Use Plan and Land Development Code remain unchanged, buid-out will be achieved in the near future. Will Sanibel at this time in the future be able to say we have grown as much as we want and we will not allow any more development or will development (and possibly legal) pressures cause the city to change the plan and development codes so as to allow more growth? This, of course, will only be able to be answered in the future, perhaps by a follow-up thesis.

This research also found that it is important to preserve native vegetation. Exotic species can be expensive to maintain. It was found

that in Sanibel a lot of water was required to keep exotic species irrigated. Native species would not require as much water because they have adapted to local conditions.

The last finding of this research was that the plan has had an influence on the spatial distribution of the growth that has occured since it went into effect. From completely prohibiting development on beach areas within closest proximity to the Gulf, to allowing limited development in varying degrees in each of the ecological zones, the plan has determined not only how, but also where development may occur.

As for what other developing barrier communities can learn from the Sanibel case, the answer will depend on two factors. One is the degree to which environmental planning, or even planning in general, will be accepted in the community. Sanibel was fortunate because when the incorporation movement began, there was already a long established tradition there of environmental awareness which dated back at least to the days of J.N. Ding Darling. Thus when the idea of placing strict controls on development came up, the residents of Sanibel were not as opposed as might be expected in other cases.

Another factor which will determine the applicability of the Sanibel experience is the degree to which the barrier island in question is already developed. While Sanibel was beginning to experience a development boom when the planning process started, it was still relatively undeveloped. This was another fortunate factor which may or may not apply to other barrier island communities.

With these possible limitations in mind, there are lessons for other developing barrier islands to learn from Sanibel. One is that if they want to encourage low density development, this can indeed be profitable.[3] Property values in Sanibel have risen dramatically since this policy went into effect there. The average asking price of single family homes on the market during one of the months that this research was conducted was $273,193.11[4] Finally, Sanibel's winter tourist occupancy rates are about 90%, the highest in Florida.[5] These figures indicate that low density development can be rather lucrative.

The finding concerning native vegetation provides a lesson for barrier island communities. This will be particularly important in areas, like Sanibel, where the climate is such that the natural controls of frosts and freezes do not exist. For barrier islands, the use of native vegetation may be especially pertinent when selecting species for dune revegetation.

The planning process used in Sanibel included an assessment of not only the present condition of the island, but also its past. This is important for any place formulating a plan, but is especially so for barrier islands. Because barrier islands are so dynamic, it is

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[3]Interview with Jack Thomas and Richard Workman, 2 April 1987.

[4]A. Keith Johnson, "Sanibel and Captiva: Real Estate," Brochure provided in personal correspondence from Executive Services, Inc., Sanibel, Florida, 10 April 1987.

[5]Wallace Kaufman and Orrin H. Pilkey, Jr., The Beaches Are Moving: The Drowning of America's Shoreline (Durham, North Carolina: Duke University Press, 1983), p. 269.

important to realize that their condition at any given time is merely temporary. By studying past conditions, perhaps a clue as to future conditions can be gained.

The final two lessons provided by Sanibel apply not only to barrier islands but to all communities. The first is that it may be wrong to assume that strong regulations are unappealing to developers. According to Dick Workman:

> We have found here in Sanibel that you can really turn the screws down tight as long as it applies across the board and fairly so everyone's playing under the same rules. Not only will they (developers) abide by it but after they get over their initial revulsion they'll start taking credit for it. (sic)[6]

The important point here is that they need to be applied fairly and across the board. If this is the case, then developers and planners can work together for the good of the community, rather than oppose one another to the overall detriment of the community.

The final, and perhaps most important lesson to be learned from Sanibel, is that a plan can be successful if it provides planners and politicians with a framework for decision making.

According to The Practice of Local Government Planning, "if the first function of a plan is to express goals and objectives, then the second is to serve as a guide to decision making. A plan needs to make

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[6]Richard Workman, "Quality of Life and Growth," (Transcript of Public Radio Program aired in Bemidge, Minnesota, 1977), p. 7.

a difference. Those who make decisions about the city need to take account of what the plan says."[7]

The zoning process is the most common way that the plan is used as a guide to decision making. This is certainly the case in Sanibel where the zoning ordinance and the Land Development Code is based on the Comprehensive Land Use Plan. In fact the ecological zones which describe the island in the plan, have become the basis for the zoning ordinance. Because Sanibel's Land Development Code is based on a carefully developed plan, those who seek to develop in Sanibel, as well as those who make decisions about development, will do so in accordance with the the Comprehensive Land Use Plan. This is a goal of any planner.

What becomes of Sanibel in the future remains to be seen, but the 1976 Comprehensive Land Use Plan will have had an important effect on how it turns out. When it was adopted the people were very environmentally sensitive. Future residents of Sanibel may or may not be. They will, however, know up front what the ground rules are in Sanibel and if they so desire, they will have the means to change the plan so that their point of view becomes reflected in it. That is so, because the Plan and Land Development Code spell out carefully what may or may not be built in each zone and because the plan may be ammended and is required to be updated every five years. The original 1976 plan

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[7]Frank Beal and Elizabeth Hollander, "City Development Plans," in The Practice of Local Government Planning, ed. David S. Arnold et al., (Washington: International City Management Association, 1979), p. 166.

was based on much research and citizen input. It laid the framework for the present and future plans and because it clearly identifies how it may be ammended and because it will be revised every five years, it provides the means for future, possibly different, points of view to be considered. In a world in which the only thing certain is change, there is perhaps no greater contribution a plan can make.

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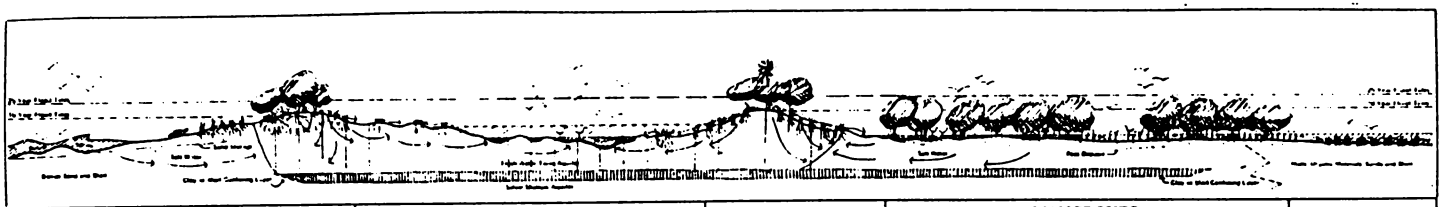
APPENDIX

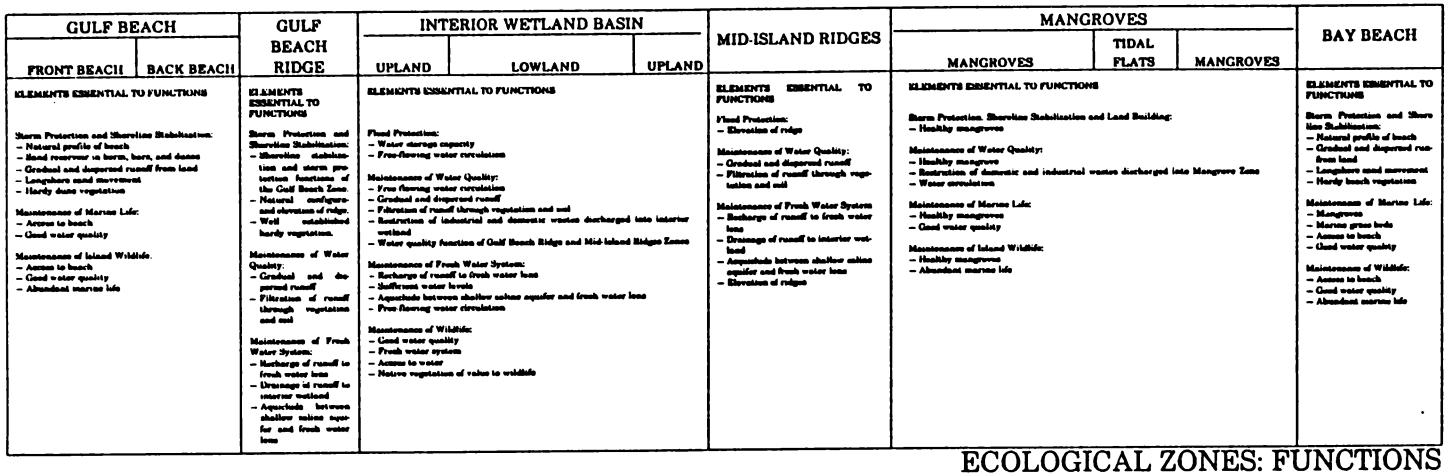


GULF BEACH		GULF BEACH RIDGE	INTERIOR WETLAND BASIN			MID-ISLAND RIDGES	MANGROVES			BAY BEACH
FRONT BEACH	BACK BEACH		UPLAND	LOWLAND	UPLAND		MANGROVES	TIDAL FLATS	MANGROVES	
The Gulf Beach Zone includes the area between the state setback line and the city boundary 200' offshore. There are two subareas within this zone—the Front Beach and the Back Beach. The Front Beach extends from the city limit to Mean High Water. Sand migrates between the berm and offshore bars and is transported by long-shore currents. The Back Beach comprises that area between Mean High Water and the state setback line. Sand in the sub-area is moved by wind and water and stabilized by vegetation forming low dunes.		The Gulf Beach Ridge Zone is the major ridge immediately behind the beach. It is stabilized by dense vegetation. Bland Point—a subarea within the zone—is of very recent formation and susceptible to dramatic change.	The Interior Wetland Basin is the interior bowl which serves as a fresh water reservoir. It is composed of parallel systems of ridges and swales with corresponding bands of vegetation. There are two sub-areas within this area—lowland and upland. The lowland area is composed of low ridges and wide swales and experiences extended periods of flooding each year. The upland consists of higher, broader ridges and narrower swales, and is characterized by less frequent flooding and more upland vegetation types.			The Mid-Island Ridges Zone comprises the major ridges along the trail axis of the island interior and includes some of the highest elevations. In most areas this zone divides the Bay-Mangrove watershed from Interior Wetlands watershed.	The Mangrove Zone includes all areas of red, black and white mangroves, as well as the tidal flats and hardwood hammocks within them. Much of this area, including all areas of red mangroves, is subject to daily tidal flooding. Other areas of the zone are subject to extended periods of flooding every year.			The Bay Beach Zone extends from the city's boundary 200' into the bay to a setback line approximately 50' behind the Mean High Water Line. It is a lower energy beach than the Gulf Beach and includes areas marine grasses on the bay bottom. It includes both sand beach and mud beach.
FUNCTIONS Storm Protection Shoreline Stabilization Maintenance of Marine Life Maintenance of Wildlife		FUNCTIONS Storm Protection Flood Protection Shoreline Stabilization Maintenance of Water Quality Maintenance of Fresh Water System	FUNCTIONS Flood Protection Maintenance of Water Quality Maintenance of Fresh Water System Maintenance of Inland Wildlife			FUNCTIONS Storm Protection Flood Protection Maintenance of Water Quality Maintenance of Fresh Water System	FUNCTIONS Storm Protection Flood Protection Shoreline Stabilization Maintenance of Water Quality Maintenance of Marine Life Maintenance of Wildlife			FUNCTIONS Storm Protection Shoreline Stabilization Maintenance of Marine Life Maintenance of Wildlife
The Gulf Beach Zone is the island's first defense in storm and flood when the impact of storm waves erodes the sand reservoir in the berm. The low dunes of the Back Beach are a reservoir of sand which may be eroded after the berm in a severe storm, thus protecting property further inland on the Beach Ridge. The natural profile of the Gulf Beach Zone is a response to processes of wind, currents, and waves. Undisturbed, it is in a state of balance with natural forces, thus "stabilizing" the shoreline. The Front Beach supports the marine life for which Sanibel is famous, and is an important feeding area for inland wildlife. The low dunes of the Back Beach are an important nesting area for wildlife, the loggerhead turtle being a prime example.		The Gulf Beach Ridge is a delta which buffers flood tides and storm winds, prevents ingressed flooding in the interior (unless overtopped by waves) and contributes to shoreline stabilization. Water quality is maintained by the filtering function of soil and vegetation. Much fresh water runoff enters the ground in the Gulf Beach Ridge Zone, holding seaward intrusion of salt water from the Gulf and thus maintaining the extent of the fresh water lens.	Since the elevation of the Interior Wetland Basin is lower than the adjacent zones, it serves as a storage area for flood waters until they are absorbed into the aquifer. Water quality is protected by the filtering function of soil and vegetation. This zone is crucial to the maintenance of the fresh water lens. It also has the capacity to maintain and improve water quality, and provides food, shelter, water, and nesting areas to wildlife, including the American alligator.			The elevation of the Mid-Island Ridges Zone provides flood protection. This zone helps maintain water quality by the filtering functions of soil and vegetation. Much fresh water runoff enters the ground in the Mid-Island Ridges Zone, holding seaward intrusion of salt water from the Bay and thus maintaining the fresh water lens.	The dense canopy and roots of the mangroves buffer storm winds and tidal surges. The arching prop-roots of the red mangrove and the roots of the black mangrove trap sediments and stabilize and extend the shoreline. Mangroves preserve water quality by filtering suspended material and accumulating dissolved nutrients. Mangroves maintain the highly productive marine ecosystem and provide food, shelter and nesting areas for wildlife.			The Bay Beach zone buffers impact of storm waves. The natural form of the Bay Beach is a response to natural processes of wind, currents, and waves. Undisturbed, it is in a state of balance with natural forms, thus "stabilizing" the shoreline. The Bay Beach is a feeding area for inland wildlife. Beds of marine grasses in submerged portions of the beach are important nursery and feeding areas for marine life.

ECOLOGICAL ZONES: FUNCTIONS

Source: Sanibel Comprehensive Land Use Plan.

Figure A-1. Ecological Zones: Functions



ECOLOGICAL ZONES: FUNCTIONS

Figure A-1 (continued)

GULF BEACH (FRONT BEACH / BACK BEACH)	GULF BEACH RIDGE	INTERIOR WETLAND BASIN (UPLAND / LOWLAND / UPLAND)	MID-ISLAND RIDGES	MANGROVES (MANGROVES / TIDAL FLATS / MANGROVES)	BAY BEACH
The Gulf Beach Zone includes the area between state setback line and the city boundary 300' offshore. There are two subareas within this zone the Front Beach and the Back Beach. The Front Beach extends from the city limit to Mean High Water. Sand in this subarea is in constant motion. Sand migrates between the berm and offshore bars and is transported by longshore currents. The Back Beach comprises that area between Mean High Water and the state setback line. Sand in this subarea is moved by wind and water and stabilized by vegetation, forming low dunes.	The Gulf Beach Ridge Zone is the major ridge immediately behind the beach. It is stabilized by dense vegetation. Blind Pass—a subarea within this zone—is of very recent formation and susceptible to dramatic change.	The Interior Wetland Basin is the interior bowl which serves as a fresh water reservoir. It is composed of parallel systems of ridges and swales with corresponding bands of vegetation. There are two sub-areas within this zone—lowland and upland. The lowland area is composed of low ridges and wide swales and experiences extended periods of flooding each year. The upland consists of higher, broader ridges and narrower swales, and is characterized by less frequent flooding and more upland vegetation types.	The Mid Island Ridges Zone comprises the major ridges along the central axis of the island interior includes some of the highest elevations. In most areas this zone divides the Bay-Mangrove watershed from Interior Wetlands watershed.	The Mangrove Zone includes all areas of red, black and white mangroves, as well as the tidal flats and hardwood hammocks within them. Much of this zone, including all areas of red mangrove, is subject to daily tidal flooding. Other areas of the zone are subject to extended periods of flooding every year.	The Bay Beach Zone extends from the city's boundary 300' into the bay to a setback line approximately 50' behind the Mean High Water Line. It is a lower energy beach than the Gulf Beach, and includes areas of marine grasses on the bay bottom. It includes both sand beach and mud beach
CLIMATE Salt Spray	CLIMATE	CLIMATE	CLIMATE Salt Spray	CLIMATE	CLIMATE
GEOLOGY Oxidized Barrier Sands and Shells	GEOLOGY	GEOLOGY	GEOLOGY	GEOLOGY Oxidized barrier sands and shells	GEOLOGY Muds, Organic Materials, Sands and Shells
SUBSURFACE HYDROLOGY Saline Shallow Aquifer	SUBSURFACE HYRDOLOGY Fresh Water Table Aquifer	SUBSURFACE HYDROLOGY	SUBSURFACE HYDROLOGY Fresh Water Table Aquifer	SUBSURFACE HYDROLOGY	SUBSURFACE HYDROLOGY Saline Shallow Aquifer
SURFACE HYDROLOGY Mean High Water 10 Year Storm Flooding 25 Year Storm Flooding	SURFACE HYDROLOGY 10 Year Storm Flooding	SURFACE HYDROLOGY Seasonal High Water Table at Surface Seasonally Flooded 10 Year Storm Flooding	SURFACE HYDROLOGY Seasonally Flooded 10 Year Storm Flooding	SURFACE HYDROLOGY Mean High Water	SURFACE HYDROLOGY 10 Year Storm Flooding 25 Year Storm Flooding
SOILS Oxidized Barrier Sands and Shells	SOILS Thin Organics	SOILS Organics over Sand Marl	SOILS Thin Organics	SOILS Peat Deposits Salt flats	SOILS Muds, Organic Materials, Sands and Shells
VEGETATION Widely scattered herbaceous vegetation and shrubs. Sea Oats, railroad vine, sea spurges, sea purslane, yucca, salt bush. Invasion of Australian Pine.	VEGETATION Sea grape, yucca, sea oats, wild olive, cabbage palmetto, wax myrtle. Invasion of Australian Pines.	VEGETATION Vegetation varies according to elevation and water levels. Swales: Cordgrass, sawgrass, andropogon, water hyssop, buttonwood, cattails, spatterdock, hydrilla, chara, duckweed, wagongrass. Low ridges: Marsh elder, leather fern, wax myrtle, cabbage palmetto. Invasion of Brazilian pepper and Australian Pine.	VEGETATION West Indian Flora, Cabbage palmetto, saw palmetto, seagrape, gumbo limbo, wild lime, wild coffee, myrsine, wax myrtle, buckthorn, poison ivy, Virginia creeper, century plant. Invasion of Australian Pine and Brazilian pepper.	VEGETATION Mostly mangroves with hardwoods at higher elevations. Vegetation responds to elevation and tidal patterns. Red mangroves predominate to the mean high tide line, black mangroves predominate to slightly higher elevations above the mean high tide line. Red mangrove, black mangrove, white mangrove, buttonwood. Seagrape, sea oxeye and air plants.	VEGETATION Sand beach: Railroad vine, sea spurges, sea purslane, yucca, salt bush, sandspurs. Invasion of Australian Pine. Mud Beach: Red Mangroves Submerged beach: Marine grasses.

ECOLOGICAL ZONES: INVENTORY

Figure A-2. Ecological Zones: Inventory

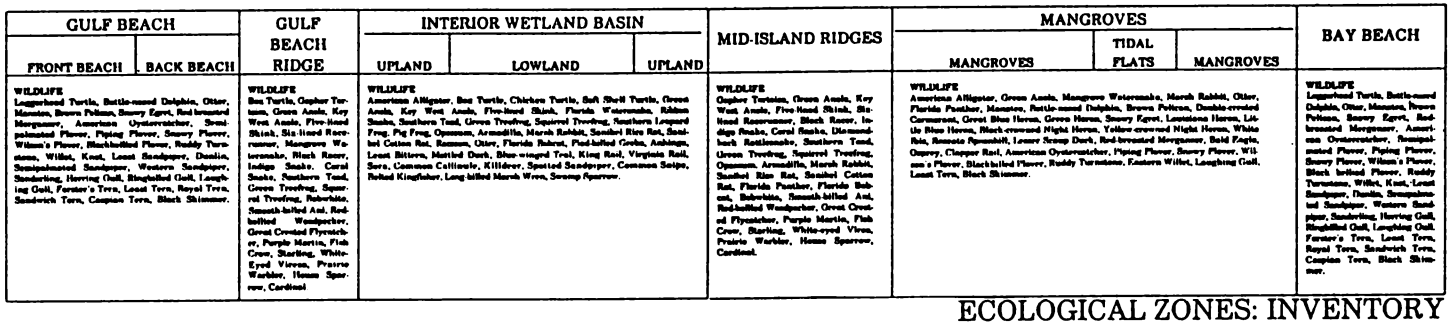
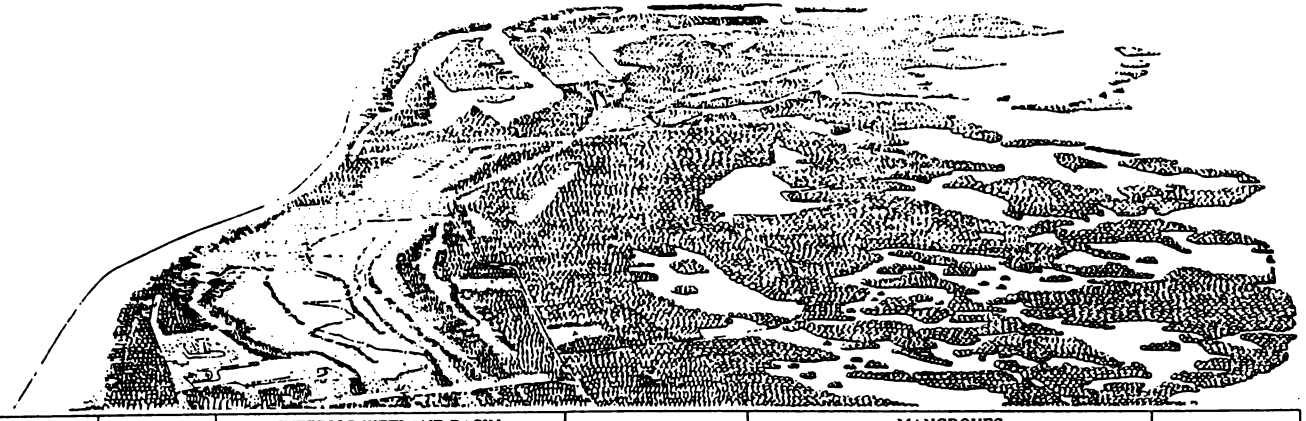


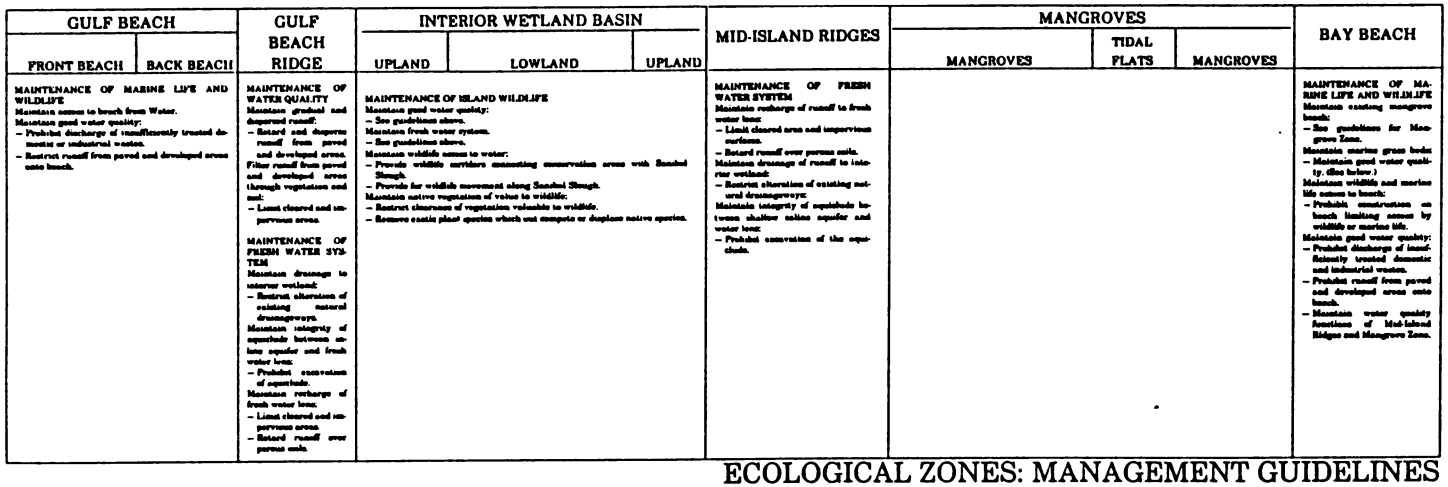
Figure A-2 (continued)



GULF BEACH		GULF BEACH RIDGE	INTERIOR WETLAND BASIN			MID-ISLAND RIDGES	MANGROVES			BAY BEACH
FRONT BEACH	BACK BEACH		UPLAND	LOWLAND	UPLAND		MANGROVES	TIDAL FLATS	MANGROVES	
MANAGEMENT GUIDELINES STORM PROTECTION AND SHORELINE STABILIZATION Maintain natural profile of beach here, berm and dunes: – Prohibit removal of sediments from beach. – Prohibit construction of any sort on Front Beach. – Prohibit construction on Back Beach except to provide beach access. – Restrict public beach access to elevated walkways over the Back Beach. Maintain sand reservoir in here, berm, and dunes: – Prohibit removal of sediments from beach. Maintain natural patterns of gradual and dispersed runoff from land: – Restrict runoff from paved and developed areas onto beach. Allow for longshore sand movement: – Prohibit construction of groins or any other structures which inhibit or prevent sand movement. Maintain hardy dune vegetation: – Restrict public beach access to elevated walkways over the Back Beach. – Prohibit clearance of hardy native vegetation. – Replace Australian Pines on Back Beach with hardy native dune vegetation.		MANAGEMENT GUIDELINES STORM AND FLOOD PROTECTION AND SHORELINE STABILIZATION Maintain natural profile and elevation of ridge: – Prohibit development which would lower existing elevation. Maintain hardy native vegetation: – Restrict clearance of existing native vegetation. – Establish hardy native vegetation in areas where are not well vegetated. – Replace Australian Pines with hardy native vegetation wherever possible. Maintain storm protection and shoreline stabilization functions of Gulf Beach: – Restrict runoff from paved or developed areas from draining onto the Gulf Beach Zone.	MANAGEMENT GUIDELINES FLOOD PROTECTION Maintain water storage capacity of the Interior Wetland Basin: – Prohibit development activities which would result in a reduction of freshwater storage capacity. Maintain natural free-flowing patterns of water circulation: – Do not impede or impound water flow. – Improve the Banshee River system to provide for a continuous free flowing system. MAINTENANCE OF WATER QUALITY Maintain natural free-flowing patterns of water circulation: – See guidelines above. Maintain natural patterns of gradual and dispersed runoff: – Retard and disperse runoff from paved and developed areas. Filter runoff from paved and developed areas through vegetation and soil: – Limit cleared area and impervious surfaces. Regulate quality of domestic and industrial wastes discharged into Interior Wetland Basin: – Provide that all released effluent be of water quality equal to that achieved by advanced treatment. MAINTENANCE OF FRESH WATER SYSTEM Maintain recharge of runoff to freshwater lens: – Limit cleared area and impervious surfaces. – Retard runoff over porous soils. Maintain sufficient water levels to prevent salt water intrusion. Maintain integrity of impermeable bed between shallow saline aquifer and freshwater lens. – Prohibit excavation of the aquaclude. Maintain natural free flowing patterns of water circulation: – See guidelines above.	MANAGEMENT GUIDELINES FLOOD PROTECTION Maintain existing elevation of ridge: – Prohibit development activities would result in lowering elevation of ridge. MAINTENANCE OF WATER QUALITY Maintain gradual and dispersed runoff: – Retard and disperse runoff from paved and developed areas. Filter runoff from paved and developed areas through vegetation and soil: – Limit amount of cleared area and impervious surfaces. – Retard runoff over porous soils.	MANAGEMENT GUIDELINES STORM PROTECTION, SHORELINE STABILIZATION, LAND BUILDING Maintain healthy mangroves: – Protect mangroves. – Restrict excavation or filling. – Maintain good water quality. MAINTAIN WATER QUALITY Maintain healthy mangroves: – See guidelines above. Regulate quality of domestic and industrial wastes discharged into Mangrove Zone: – Provide that all water or other effluent which is released be of water quality equal to that achieved by advanced treatment prior to its release. Maintain natural patterns of water circulation: – Elevate roads and pathways on an not to impound or impede water flow. – Maintain existing natural patterns of fresh water runoff from interior. Maintain water quality function of Mid-Island Ridges Zone: – Refer to guidelines for Mid-Island Ridges Zone. MAINTENANCE OF MARINE LIFE AND WILDLIFE Maintain healthy mangroves: – See guidelines above. Maintain water quality: – See guidelines above.		MANAGEMENT GUIDELINES STORM PROTECTION AND SHORELINE STABILIZATION Maintain natural profile of beach: – Prohibit removal of sediments from beach. – Prohibit construction on beach which would result in change of the natural beach profile. – Restrict public access over vegetated areas of beach to elevated walkways. Maintain natural patterns of gradual and dispersed runoff from land: – Restrict runoff to beach from developed areas. Allow for longshore sand movement: – Prohibit construction of groins or any other structures which inhibit sand movement. Maintain hardy beach vegetation: – Restrict public access over vegetated areas of beach to elevated walkways. – Prohibit clearance of native beach vegetation. – Replace Australian Pines on the beach with hardy native vegetation.

ECOLOGICAL ZONES: MANAGEMENT GUIDELINES

Figure A-3. Ecological Zones: Management Guidelines



ECOLOGICAL ZONES: MANAGEMENT GUIDELINES

Figure A-3 (continued)

VITA

Lynn B. Thomas Jr. was born in Cambridge, Maryland on March 21, 1963. He attended elementary schools in Eldorado and Hurlock, Maryland and graduated from North Dorchester High School in June 1981. The following September he entered Salisbury State College in Salisbury, Maryland, and in May 1985 he received a Bachelor of Science degree in Geography and Regional Planning. In the fall of that same year he entered the University of Tennessee, Knoxville and began study toward a Master of Science in Planning degree. In August of 1987 this degree was awarded.