A PROPOSAL TO THE NATIONAL PARK SERVICE

VEGETATION MONITORING BEFORE AND AFTER BEACH RENOURISHMENT ON PERDIDO KEY

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Introduction

Beach renourishment associated with the US Navy Gulf Coast Stategic Homeporting is scheduled to deposit 5,000,000 cubic yards of beach quality sand along a 4.5 mile stretch of the eastern end of Perdido Key. The purpose of renourishment is two-fold; the area provides a suitable deposition site for dredge material, and most importantly as far as the goals of the National Park Service are concerned, renourishment is hoped to temporarily arrest beach erosion that is occuring along eastern Perdido Key. One reason for the current high rates of beach erosion is the lack of new sediment being deposited at the eastern end of Perdido Key. It is hoped that the planned beach renourishment will provide sufficient new sediment to alleviate this erosion problem, at least temporarily.

The deposition of such a large amount of dredge material in a 4.5 mile strip, 330 feet wide (approximately 270 feet wide after equilibrium), will have a profound effect on the vegetation of Perdido Key. The old strand line vegetation and fore dunes will become inland by 270 feet and the renourished area will be available for primary colonization. The rate of colonization will depend on the success of pioneer beach species in establishing the open sand. The vegetation types that develop are likely to be similar to those on the rest of the island, but their similarity will depend on colonization rates and seedling success. It is also possible that some of the clonal species such as seaside pennywort (Hydrocotyle bonariensis) can spread from old foredune areas.

Although this general scenario of successional events can be more-or-less predicted, details are impossible given the present knowledge of barrier island vegetation dynamics and Perdido Key in particular. Artificial colonization is expensive and undesirable given the goal of maintaining natural conditions within the Gulf Island National Seashore, although it might prove ultimately necessary if natural colonizataion is too slow to prevent severe erosional losses. It is necessary to carry out an extensive monitoring program over the next five years to document i) the rate and nature of succession on the dredged, deposited material, and ii) the impact of renourishment on the existing vegetation. This will allow predictions to be made on the effects and impacts of possible future renourishment projects, and the feasibility of allowing natural as opposed to managed succession on renourished dredged sand.

Goals and Objectives

It is proposed that the vegetation on Perdido Key, including the renourished area, be monitored using cross-island transects and associated permanent sample plots. In particular, the following questions will be addressed:

i) What is the species composition of the vegetation colonizing the renourished beach area?

ii) How similar is the composition of the vegetation colonizing the renourished beach area to that on the rest of Perdido Key?

iii) What changes in the vegetation occur on the original unnourished area on Perdido Key following beach renourishment?

iv) As the new shoreline equilibrates what is the sequence of vegetation types that become established on the renourished area?

v) Over what time period do any of these postulated changes occur?

In addition, the establishment of sea oats (Uniola paniculata), the dominant dune-stabilizing plant species, from naturally establishing seedlings will be monitored, as well as the development and importance of the dune seed bank.

A real question that has to be considered is, what happens if the renourished material is not stable enough to stay in place? It is expected that the original 330 feet will equilibrate down to approximately 270 feet. But, there remains the problem of drift of renourished material inland onto the rest of the island. This would likely impact the existing vegetation. From both a management and a natural areas view point it is necessary that as much of the renourished material as possible stays in place. As a part of the renourishment process, the National Park Service (NPS) will establish a 2 ft high fence line on the beach face parallel to the Gulf side edge extent of the pre-nourishment vegetation. The purpose of this fence will be to minimize the movement of dredge material onto the rest of the island. A year after renourishment (Autumn 1990), the NPS will assess the success of natural colonization and establishment onto the dredge material. If vegetation is failing to establish and the dredge material is not sufficiently stabilized, plans will be made for possible restoration work, i.e. planting sea oats or other native vegetation, and/or the erection of additional sand fences. The proposed monitoring methods outlined below will not only provide the necessary data for the NPS to make this assessment, but allow for continued data to be collected should artificial restoration prove necessary. The large number of permanent plots and the transects would allow for the success of different restoration options to be evaluated.

The renourishment project poses an immediate problem for the NPS. However, it also can be a unique opportunity to gain an understanding of the natural dynamics of succession and colonization of dune systems within a management context. Bearing this in mind, the importance of funding this monitoring program for at least five years cannot be over-emphasised. Ecological responses to events such as beach renourishment may appear to be slow and the direction of successional pathways can be difficult to interpret. In particular, the short-term effects ('transient dynamics' sensu Tilman 1988) might be quite different from the long-term effects; a strong arguement for long-term monitoring programs.

This proposal is for a five year monitoring program starting pre-nourishment in Autumn 1989 and continuing through Summer 1994. If assessment by the NPS a year after renourishment indicates that restoration of the dredged spoil will be necessary then some minor changes in data collection procedures might be required. Similarly it is understood that funding for years 2 through 5 may need renegotiation after year 1.

Methods

The composition of the vegetation on Perdido Key will be sampled by combining a sampling scheme utilizing pre-existing cross-island transects and permanent plots, and a series of newly established plots and transects. These data will provide ground truthing for the recognition of vegetation types that will be visible on aerial photographs to be obtained by the NPS from NASA.

The methodology proposed for vegetation sampling is similar to that used earlier by Cousens (1987) and Shabica & Cousens (1983) and will thus allow a direct comparison of new data with older data from Perdido Key. This type of transect approach has also been used by other workers to study the vegetation dynamics of other dune systems (e.g. Dorp et al., 1984; Roman & Nordstrom 1988). The proposed methods will provide data at several scales; at the population scale the rate of establishment of sea oat seedlings will be determined by density counts in permanent plots. At the community scale, the number, cover and frequency of occurence of species on the renourished and old beach areas will be determined. Finally, at the ecosystem scale, the extent and type of vegetation units will be assessed on both the renourished beach and the island as a whole.

An initial, complete pre-nourishment survey of the transects in Fall 1990 will provide baseline data for the renourishment study and provide a basis for possible additional survey work to be carried out in the event of a hurricane or similar high impact event. Note that the proposed work is more detailed and explicit than that in the proposed interagency agreement, and is also wider and broader in scope.

i) Prexisting study plots

Permanent study plots were established in association with permanent transects by Dr. Michael Cousens (formerly of the University of West Florida) in the early 1980's (Cousens 1987). These plots are currently being resampled by the Principal Investigator (Dr. Gibson) and a research student this summer, 1989. Cousens' transects comprise 3 cross-island transects that are sampled at a resolution of 5 mm (20 7/10 inch) using the line intercept method. A 15 x 25 m (49 x 82 ft) macroplot is associated with each of these transects located in typical examples of scrub, marsh and pioneer beach vegetation types. These macroplots are sampled for cover of all species according to a standard cover abundance scale (Daubenmire 1959) in $0.5m^2$ (0.6 ft sq.) subplots. It is proposed that the monitoring of these transects and permanent plots will be continued on an annual basis throughout the duration of the beach renourishment study. The permanent transects will be extended to the mean high water mark across the new beach material.

Continued monitoring of Cousens' transects and plots will provide a historical context into which future changes in the dune vegetation can be placed. However, data from the plots are insufficient to closely monitor all changes likely to follow beach renourishment. It is therefore proposed that additional transects and permanent plots be established.

ii) New transects and permanent plots

Composition of the vegetation.- Thirteen new cross-island transects will be established in association with even-numbered DNR beach monuments R-40 through R-64 (Fig 1). These encompass the entire 4.5 mile stretch of Perdido Key where renourishment will take place. Each transect will be 120-280m (400-900 ft) in length running the length of the monument line from the mean high water line on the Big Lagoon side across the island to the mean high water mark on the Gulf side. The vegetation along the transects will be sampled in 5 x 1m (16 1/2 x 3 ft) permanent plots placed perpendicular to the line of the transect. Permanent plots will be placed at 12m (40 ft) intervals along the transects on the dredged sand and the first 120m from the Gulf side, and every 24m (80 ft) thereafter. Depending on the width of the island along each transect, this will yield, between 16 and 23 permanent plots per transect; 208 to 299 permanent plots in total. Each permanent plot will be sampled by estimating cover according to the Daubenmire scale (as above in Cousens' plots) in twenty-five 20 x 50 cm (0.1 m^2) (7 7/8 x 18 inch) subplots placed at random to the left or right of a line down the center of the long axis of each permanent plot (Fig 2). To further document the pattern of succession on the renourished and original beach, the line intercept method of sampling at a resolution of 10 cm (3 9/10 inch) will be used on the Gulf side one third of transects R-40, R-45, R-50, R-60, and R-64. These data will allow precise profiles of vegetation succession to be constructed in association with the topographic measurements.

Dynamics of seaoats.- The density of seedlings and vegetative and flowering tillers (shoots) of sea oats (Uniola paniculata), the dominant dune building species, will be counted in all permanent plots on each sample date.

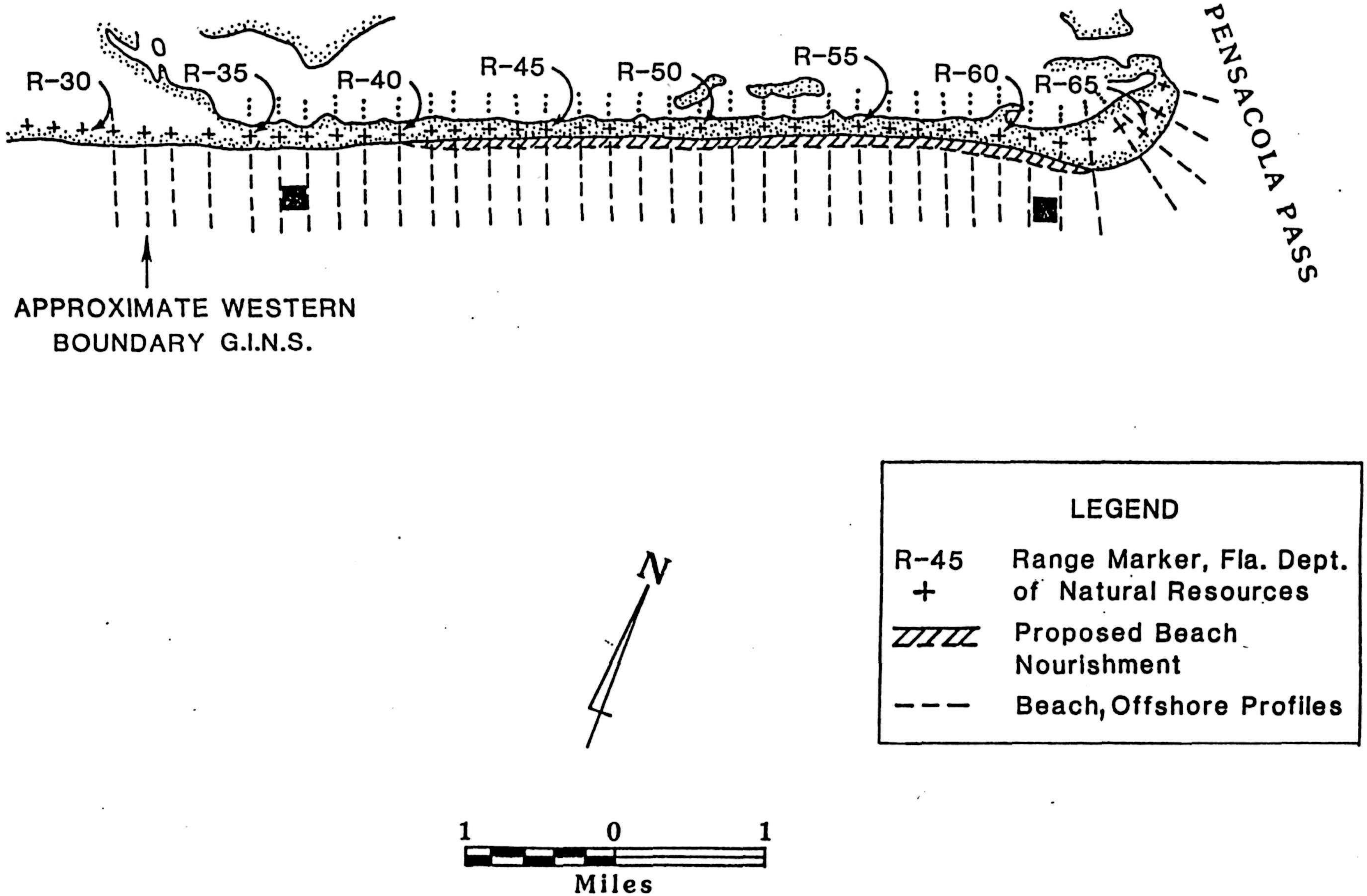
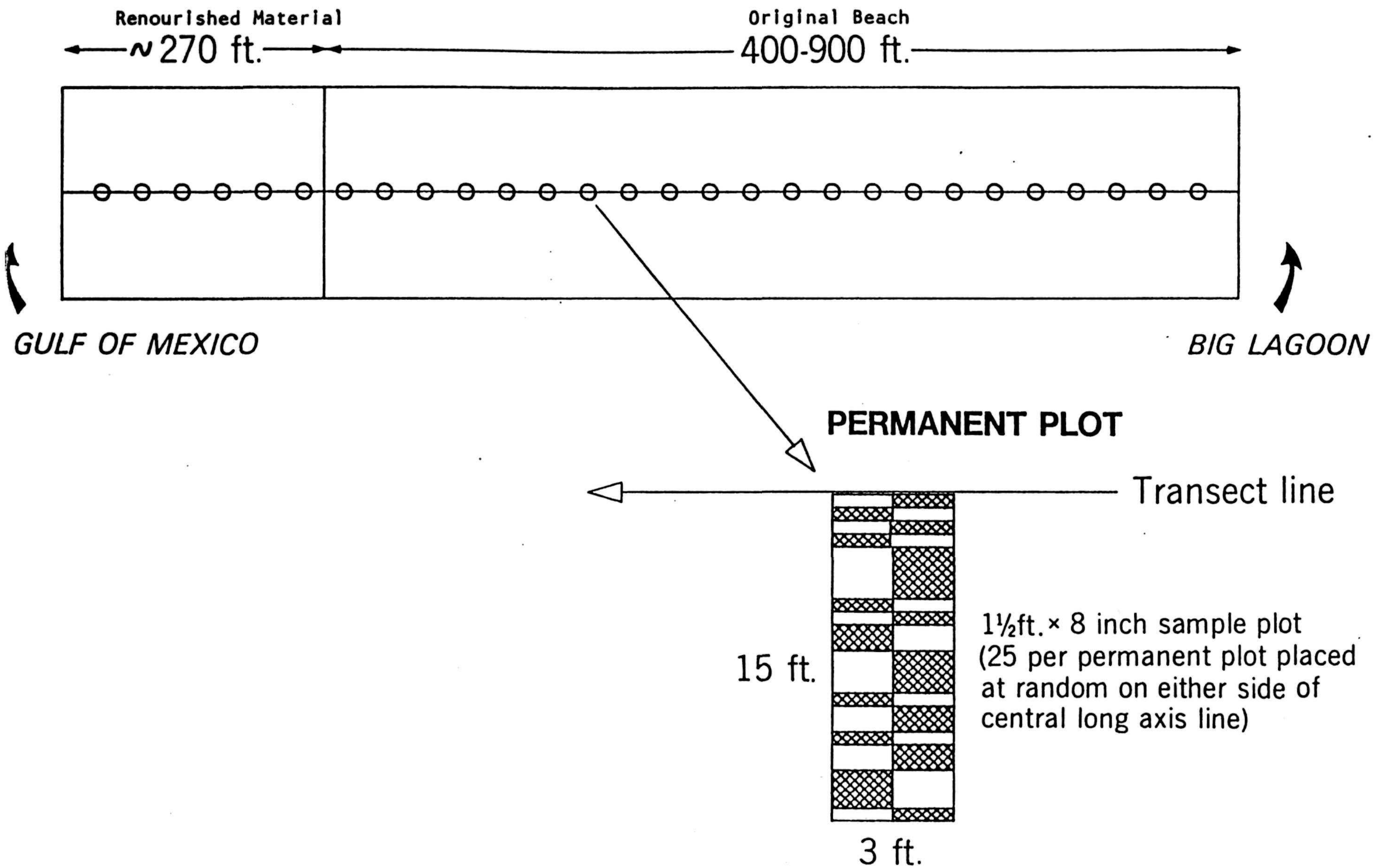


Figure 1 - Location of cross-island profiles. Vegetation data will be collected in association with even-numbered profiles R-40 through R-64.

Fig. 2 Schematic showing placement of permanent plots for monitoring vegetation change along choss-island transects.



Surface sediment samples (50 g) will be collected in the autumn adjacent to the permanent plots; these will be taken back to the UWF greenhouse (Appendix 1) to determine the germinable soil seed bank. To do this the sand will be spread out in trays, and kept moist. All seedlings that emerge will be recorded and identified. Particular attention will be paid to the emergence of seacats seedlings from the dredged material as this will indicate the beginnings of 'normal' soil dynamics in this material.

iii) Frequency of sampling

The new cross-island transects associated with the monuments will be first sampled in the Fall of 1989. After beach renourishment has been completed in Spring 1990, a regular sampling schedule will be followed for the next five years. The permanent plots on the southernmost one third (i.e. Gulf side) of each transect will be sampled in the Spring and Summer of every year. The entire length of all the transects will be sampled in the Fall of each year. The older plots and transects of Cousens will be sampled in the summer of every year to provide continuity of this data set.

iv) Correspondence with aerial photographs

Color-infrared (1:68000) and black-and-white aerial (1:30000) photographs taken in Fall 1989 by NASA will be used in conjunction with the vegetation transect data to delineate vegetation types and construct a detailed vegetation map of Perdido Key.

Additional photographic data are required for the autumn of years three and five at the same scales. The aquisition of NASA images by the NPS is a necessity for this part of the project. Photointerpretation will allow changes in the vegetation establishing on and adjacent to the renourished beach area to be monitored. In particular, this map will allow documentation of the encroachment and succession of new vegetation types onto the renourished beach area.

v) Methods of data analysis

Data analysis methods will proceed to address the goals and objectives outlined above. Raw tables of vegetation data will be initially prepared as a basis for intrepretation and as a permanent record. Species diversity indices (i.e. Shannon's H', Hills numbers) and equitability measures will be used to provide quantitative measures of plant community structure. Delineation of vegetation types will be aided using cluster analysis classification procedures, e.g. TWINSPAN (Hill 1979). Patterns of change (succession) in the vegetation through time, and the relationship between sites (transects and/or permenent plots) will be analysed using ordination procedures, e.g. DECORANA (Hill & Gauch 1980), based on between-site similarity coefficients (e.g. Jaccards and Sorensons coefficients). These methods seek to display graphically the relationship between sites. Barbour et al (1987) provide an example of this approach from dune vegetation in the Gulf of Mexico. Comparison of the vegetation between transects will allow succession to be monitored in accordance with beach profiles; again ordination methods provide a useful tool for addressing this type of question (e.g. Roman & Nordstrom 1988).

Resampling permanent plots through time allows the use of mathematical models for predicting various management options. In particular, Markov chain models allow measurements of the pathways of succession given data of this type (e.g. Usher 1979, Van Hecke et al 1984). By calculating the probability that a particular vegetation type will change over a given time period to another type (e.g. pioneer beach to mature dune), predictions can be made as to the course of succession and the longevity of vegetation types on the landscape.

The Principal Investigator has the hardware and software computer facilities to undertake these types of analysis (Appendix 1). Previous experience with long-term data sets (e.g. Gibson & Hulbert 1987), including dune vegetation (Gibson 1988a,b) and recolonizatin studies (Gibson et al 1985) has involved extensive use of these types of analysis.

Summary of Products

Data collected according to the methods and budget proposed here will allow the Principal Investigator to furnish the National Park Service with the following products in the form of reports:

i) List of plant species, and plant species abundances on Perdido Key bewteen DNR beach monuments R-40 and R-64 before beach renourishment (Autumn 1989) and at intervals afterwards (Spring, Summer and Autumn of 1990, 1991, 1992, 1993, 1994).

ii) Vegetation maps of pre-and post-nourishment conditions of Perdido Key (temporal sequence depends on availability of NASA photographs).

iii) Quantitative (statistical) evaluation of inter-relationships of vegetation types and species abundances on Perdido Key over a five year period.

iv) List of proposed recommendations regarding future renourishment projects for Perdido Key or similar barrier islands.

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