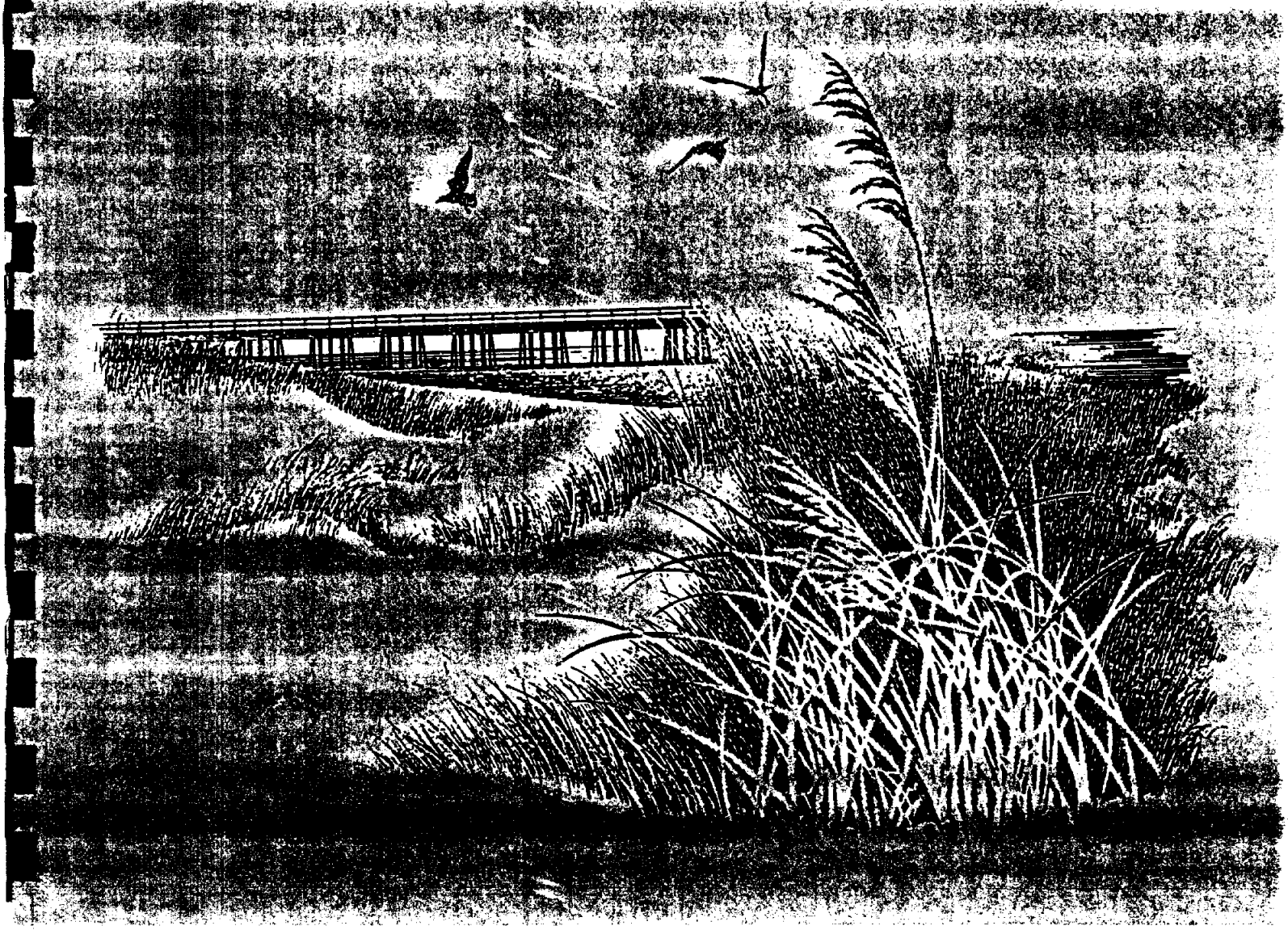
# *The Future of the Texas Gulf Coast*

## *Strategies for Managing Shoreline Erosion and Dune Protection*



# The Future of the Texas Gulf Coast

## Strategies for Managing Shoreline Erosion and Dune Protection

A Report Prepared for the
Texas General Land Office

by

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# PREFACE

In 1989, the 71st Texas Legislature enacted Senate Bill 1571. This bill amended the Texas Natural Resource Code and appointed the Texas General Land Office (GLO) as the lead agency in developing a comprehensive plan for the state's coastal public lands. In response to SB 1571, the GLO appointed a citizens advisory committee, and state and federal agency task forces, to aid in formulating the plan.

Five public meetings were held on the Texas coast. These meetings pinpointed shoreline erosion/dune protection, wetlands, and beach access as the issues of greatest concern to the coastal community.

In the summer of 1990, the GLO employed the Office for Strategic Studies in Resource Policy at Texas A&M University to help develop a Texas coastal management plan. The Office used the Alternative Futures Assessment (AFA) Process, a computer assisted workshop procedure, as a means to incorporate the concerns of the coastal community into the plan. The ultimate goal -- to build a consensus on strategies that will resolve the top three issues affecting the Texas Gulf Coast.

An ideal strategy balances the needs of affected interests and inspires their active support. The strategy should also include practical courses of action to achieve the primary goal as well as actions to anticipate and mitigate unwanted side effects. The workshop participants strived to develop a strategy that comes close to the ideal.

This report documents the work of the participants in the AFA Process who contributed their time and effort to assist in resolving the shoreline erosion/dune protection issue. Their effort succeeded in producing a consensus on a general strategy to resolve the issue for the Texas Gulf Coast.

Companion reports for the wetlands issue and the beach access issue were also completed. This set of reports show that the these two issues, and the shoreline erosion/dune protection issue, are interrelated. Therefore, strategies to resolve the shoreline erosion/dune protection issue will require coordination with strategies adopted to resolve the other issues.

Funding for this project was provided by an interagency contract between the Texas General Land Office and the Texas Water Development Board. Matching support was made by the Office for Strategic Studies in Resource Policy at Texas A&M University. We would like to thank all of our participants for their time and cooperation on this project. We hope that this report will aid in improving the future of the Texas Gulf Coast.

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## Introduction

### *The AFA Process*

- The Alternative Futures Assessment (AFA) Process was used by the Office for Strategic Studies in Resource Policy at Texas A&M University to address the shoreline erosion/dune protection issue.

- The AFA Process is a computer-aided approach for bringing concerned parties together in a workshop setting to formulate strategies to resolve complex issues.

### *The Workshops*

- A series of five workshops were conducted in the AFA Process for this issue. The first three were regional Foundation Workshops. A Strategy Workshop came next followed by a Capstone Workshop.

- The Capstone Workshop produced a consensus among participants on a recommended policy and courses of action to resolve the shoreline erosion/dune protection issue for the Texas Gulf Coast.

## Interest and Concerns

### *Stakeholder Groups*

- People who share a common interest are categorized as a stakeholder group. The interests and concerns of these groups are the driving force in the AFA Process.

- The Texas General Land Office defined 15 stakeholder groups and selected participants to represent the groups.

### *Key Variables*

- The interests and concerns of participants were defined by variables. A variable is the name or description of something that changes, such as the gulf shoreline erosion rate.

- The participants selected 30 key variables, with units of measure, to represent the shoreline erosion/dune protection issue for the Texas Gulf Coast.

- Each stakeholder group had the right to select one variable that best defined their principal interest or concern. This variable is called peremptory because it must be included on the final list.

- There is significant overlap among the key variables for the top three Texas Gulf Coast issues. Therefore, strategies to resolve the shoreline erosion/dune protection issue will require coordination with strategies adopted to address the other issues.

## Trends and Interactions

### *Long-Term Trends*

- Participants estimated the trends in key variables that might occur over the next twenty years under current policies. Most of the variables were expected to increase, including erosion. A few variables were expected to decrease, including dune protection, ecological integrity, river supplied sand, and the sand budget.

- The affects of outside forces were also considered. For instance, the participants decided that 70 percent of the bay shoreline erosion rate and 60 percent of the gulf shoreline erosion rate cannot be controlled by the recommended policy.

### *Interactions*

- The participants defined how the 30 key variables interact with one another. This was accomplished using a cross-impact matrix.

### *Linking Trends and Interactions*

- The trends and interactions were linked using artificial intelligence techniques to form a working computer model of the issue.

- The computer model formalized the participant's mutual understanding of the issue. The participants used the model to compare the possible consequences of new policies with the probable consequences of continuing the old policies.

## Policies and Priorities

### *Defining the Issue*

- The participants selected two variables to define the shoreline erosion/dune protection issue. They were the bay shoreline erosion rate and gulf shoreline erosion rate. These variables are expected to increase over the next twenty years. This increase in the rate of erosion defines the shoreline erosion/dune protection issue for the Texas Gulf Coast.

## *Stakeholder Objectives*

- An objective represents how a stakeholder group would like to see a variable change from the way it is today. For this issue, the time limit for reaching an objective was set at twenty years.

- There were eight objectives from which to choose. A stakeholder group specified an objective for each of the 30 key variables.

- The specified objectives revealed that the stakeholder groups share similar views on a desired future for the Texas Gulf Coast.

## *Recommended Policy*

- The primary policy selected by participants involved increasing federal and state coastal management funds, reducing the human induced erosion rate, increasing planning, increasing the annual sand budget, and increasing interagency coordination.

- The results of simulations showed that the primary policy is likely to reduce bay and gulf shoreline erosion rates below the expected levels in twenty years. However, only the bay shoreline erosion rate was reduced below the current level. The gulf shoreline erosion rate increased a little above the current level, but not as much as would have occurred under the current policy.

- The participants felt that some of the side effects produced by simulating the primary policy were undesirable. To mitigate these unwanted side effects, the participants recommended controlling the growth in use of vehicles on beaches and dunes. They decided to also increase funding for basic research. Finally, they increased river supplied sand by reducing structures that block the flow of sand.

- The recommended policy consists of the original changes in five target variables in the primary policy plus the changes in the four mitigation variables that were added to reduce unwanted side effects.

- The results of simulations showed that the recommended policy is likely to reduce bay shoreline erosion and gulf shoreline erosion rates below current levels.

- The overall or total satisfaction of objectives is generally high for the recommended policy. Satisfaction for individual stakeholder groups ranged between a low of 75 percent for Jefferson County to a high of 100 percent for the Houston/Galveston Subsidence District.

- Levels of dissatisfaction for the recommended policy are relatively low. The highest remaining dissatisfaction is for the Commerce stakeholder group. The variable of concern to the group is setbacks from mean high tide. The Commerce group did not want setbacks to go up but they nearly doubled. Nevertheless, the group is still 80 percent satisfied with the recommended policy.

- The recommended policy is superior to the current policy for three measures of success. For example, the recommended policy produces the lowest level of dissatisfaction for all groups and for any one group. It also provides the most benefits to all groups.

## *Recommended Actions*

- The participants specified actions needed to bring about the recommended change in variables. They specified who should be responsible for taking the action. They also estimated the cost and source of funds. The recommended actions represent a consensus of the participants.

- The total cost of addressing the shoreline erosion/dune protection issue was estimated at about $500 million over the next twenty years. The participants felt that these funds should come from both legislative appropriations and private sources. They also felt that funds should be tailored to the goals of the final coastal management plan.

## *Research Priorities*

- The participants used the cross-impact matrix to decide which interactions between variables were the most important to study. The highest priority means that research funds should be directed toward the interaction because it is not well understood, and it has a strong affect on the issue.

- The highest research priority focused on improving understanding about the affect of the bay shoreline erosion rate on the area of wetlands and the loss of wildlife habitat.

- The second research priority was improving understanding about the contribution of human induced erosion to the gulf shoreline erosion rate. The affects of ship traffic on the bay shoreline erosion rate tied as the second research priority.

- Research on eleven other interactions between variables tied for third priority, including the affects of beach nourishment and dredge spoil reuse on the gulf shoreline erosion rate.

# INTRODUCTION

## The AFA Process

The Alternative Futures Assessment (AFA) Process is a computer-aided approach for bringing concerned parties together in a workshop setting to formulate strategies to resolve complex issues. The AFA Process has successfully addressed a variety of complex resource, environmental and business management issues.

The AFA Process helps participants to pool their knowledge and experience and develop a detailed mutual understanding of the issue under consideration. It also assists them in exploring the potential consequences of alternatives so that they can develop policies. Finally, the AFA Process provides them with an opportunity to recommend funding priorities for research.

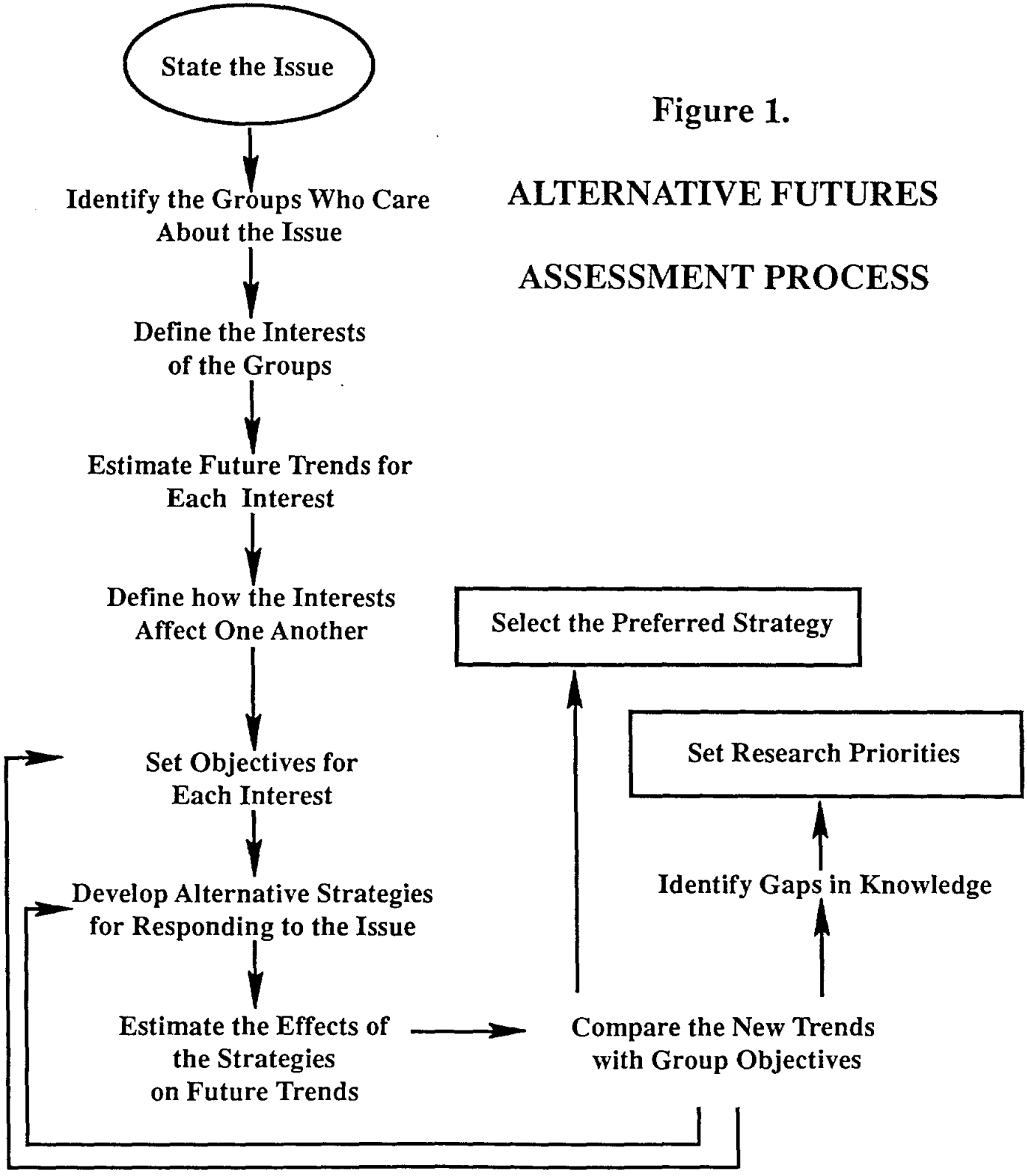
The workshops used in the AFA Process are conducted by a facilitator, a technical assistant, and a recorder. The facilitator mediates discussions among participants and guides them through the AFA Process. The technical assistant operates the computer and distributes the results of each exercise. The recorder helps the technical assistant and takes notes on important points in the discussions.

The AFA Process involves identifying trends that define an issue and evaluating different courses of action to deal with those trends. The AFA Process encourages participants to share their knowledge and experience, and work together as a team to explore solutions. Teamwork is fostered by using the step-by-step procedure shown in Figure 1.

An unavoidable characteristic of the AFA Process is that the participants in a workshop will determine the outcome. In other words, given the same issue, different participants would probably arrive at somewhat different conclusions. This is also true in other group decisionmaking processes, including legislatures, courts, and scientific committees. The AFA Process helps to reduce bias by making assumptions explicit so that others can evaluate the results. The potential problem of bias can be further reduced by involving a broad spectrum of concerned parties.

## The Software

The computer software used in the AFA Process is an expert cross-impact simulation language that shows how variables interact over time. It runs on an IBM compatible personal computer. The software includes artificial intelligence to aid participants in using their knowledge and experience to build a computer model that describes the issue. The model they build formalizes their understanding of the issue. The participants also can quickly and easily make changes in the model as they learn from one another during the workshop. Thus the participants use their model to evaluate courses of action they recommend for resolving the issue.




## Figure 1.

## ALTERNATIVE FUTURES ASSESSMENT PROCESS

## The Workshops

A standard workshop takes 2 1/2 days and can be conducted in a location that is convenient for participants. A standard issue takes about 6 weeks to complete. The time required to complete the AFA Process, and the number and type of workshops, depends on the issue. The three issues addressed for the Texas Gulf Coast took 16 weeks to complete. Thus the AFA Process is a fast, portable, and cost-effective approach for building a consensus on strategies to resolve complex issues.

A series of five workshops were held to address the shoreline erosion/dune protection issue on the Texas Gulf Coast. The first three were Foundation Workshops. A Strategy Workshop came next followed by a Capstone Workshop. Like a pyramid, the AFA Process rested upon a broad base of information generated in the Foundation Workshops and became more focused in subsequent workshops (Figure 2).

### *Foundation Workshops*

The purpose of the Foundation Workshops was to clarify how the issue affects a particular region of the coast. Recommendations to resolve the issue also were considered. Therefore, Foundation Workshops were conducted in three geographic regions: the lower, middle and upper coast. Workshops were conducted in Galveston on June 27, 1990, in Corpus Christi on July 11, 1990, and in Brownsville on July 17, 1990.

Each Foundation Workshop for the Texas Gulf Coast included up to 28 participants who represented a wide array of interests in a particular region. A few individuals representing statewide interests on the coast participated in more than one Foundation Workshop.

The Foundation Workshops were organized to gather as much information as possible from the participants in one day. The most important information provided by the participants was a ranked list of variables defining their interests and concerns. They also identified the top shoreline erosion/dune protection problems affecting their region and they recommended courses of action to resolve those problems (see Appendix C, Appendix D, and Appendix E).

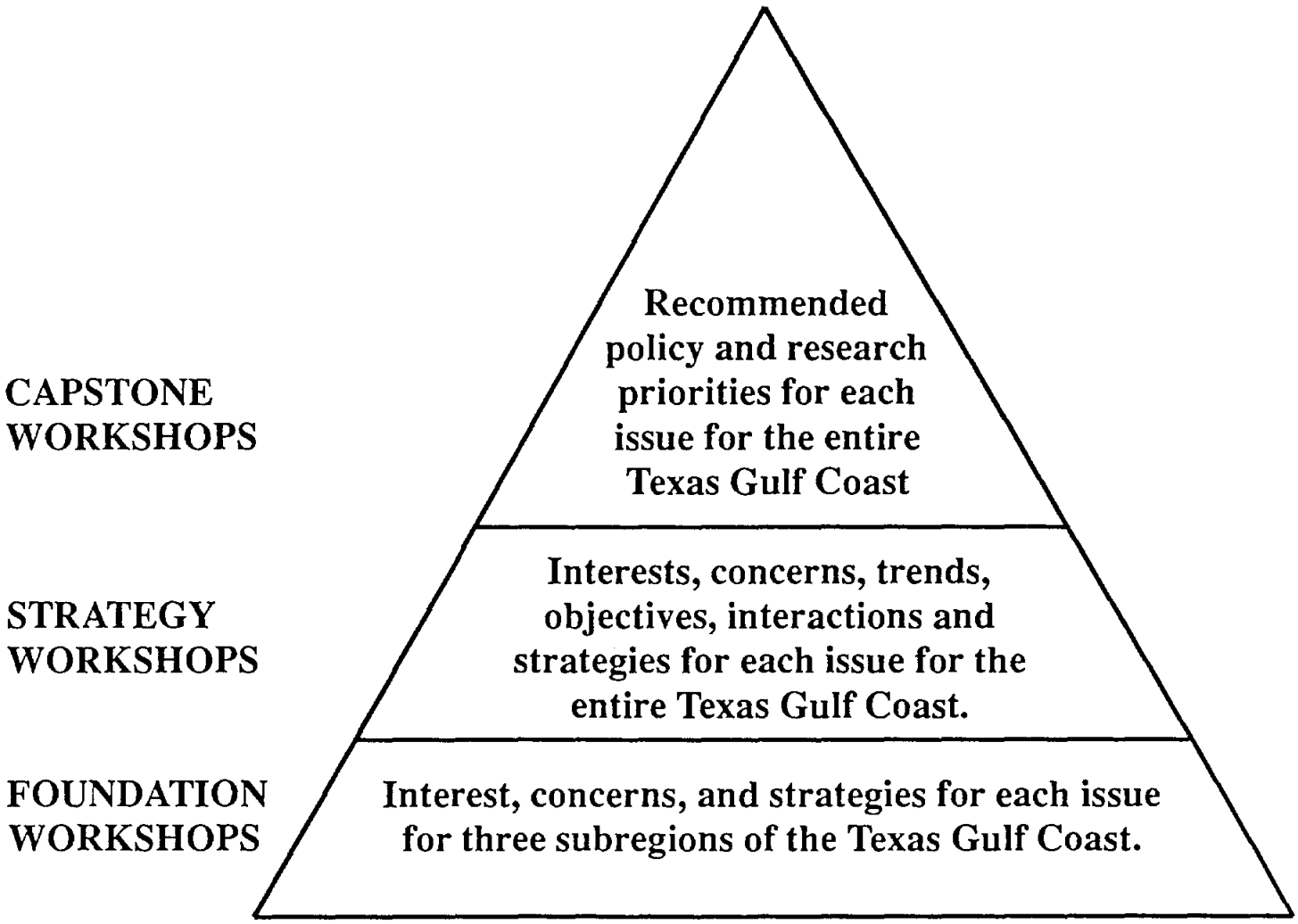
### *Strategy Workshop*

The purpose of the Strategy Workshop was to build a computer model to evaluate the potential consequences of strategies to resolve the issue. Participants also specified their objectives and prepared a preliminary policy. The information and ideas generated in the Foundation Workshops served as the starting point.

The Strategy Workshop for the shoreline erosion/dune protection issue was held on July 24-25, 1990, in Clear Lake, Texas. Like the Foundation Workshops, the Strategy Workshop was structured to use time efficiently.

The Strategy Workshop participants were divided into 15 stakeholder groups. These groups represented the principal interests involved in the issue. Some participants in the Strategy Workshop also took part in the Foundation Workshops.

Figure 2.


CAPSTONE WORKSHOPS
Recommended policy and research priorities for each issue for the entire Texas Gulf Coast
STRATEGY WORKSHOPS
Interests, concerns, trends, objectives, interactions and strategies for each issue for the entire Texas Gulf Coast.
FOUNDATION WORKSHOPS
Interest, concerns, and strategies for each issue for three subregions of the Texas Gulf Coast.

## *Capstone Workshop*

The purpose of the Capstone Workshop was to build a consensus on a realistic strategy to resolve the shoreline erosion/dune protection issue for the Texas Gulf Coast. The workshop also involved identifying gaps in knowledge and recommending priorities for future research. The preliminary policy developed in the Strategy Workshop served as the starting point for the Capstone Workshop.

The Capstone Workshop for the shoreline erosion/dune protection issue was held in Clear Lake, Texas, on September 5, 1990. Most of the participants also took part in the Strategy Workshop for this issue. They were divided into the same 15 stakeholder groups in both workshops. ***The Capstone Workshop produced a consensus among participants on a recommended policy and courses of action to resolve the shoreline erosion/dune protection issue for the Texas Gulf Coast.***

## SHORELINE EROSION/DUNE PROTECTION CAPSTONE WORKSHOP

**SHORELINE EROSION/DUNE PROTECTION CAPSTONE WORKSHOP**

# INTERESTS AND CONCERNS

## Stakeholder Groups

The first and most important step in the AFA Process is determining who cares about the issue and what they care about. People who share a common interest are categorized as a stakeholder group. In short, they have a direct stake in the outcome of decisions that address the issue. ***The interests and concerns of stakeholder groups are the driving force in the AFA Process.***

The computer software used in the AFA Process can accommodate up to 15 stakeholder groups. ***Since there were 34 participants involved in the workshop, those who shared similar interests formed coalitions.*** Each coalition represented a broad stakeholder group. Thus the members of the coalition had to agree on decisions for that stakeholder group. This approach fostered communication among participants who looked at their common interests from different perspectives.

***The Texas General Land Office defined the stakeholder groups and selected participants to represent the groups.*** Table 1 shows the names of the 15 stakeholder groups involved in the Strategy and Capstone Workshops, and the participants that represented each group.

## Key Variables

The interests and concerns of participants were defined by variables. A variable is the name or description of something that changes, such as sleep. To insure that everyone is discussing the same thing a variable must be defined with a unit of measure. For instance, sleep is ambiguous until it is assigned a unit of measure, such as nights of 8 hours sleep per year, or sleepless nights per year. Each unit of measure clarifies the meaning of sleep.

***The participants selected 30 key variables, with units of measure, to represent the shoreline erosion/dune protection issue for the Texas Gulf Coast*** (Table 2). The name of the variable in the table is a seven character abbreviation. The number at the end of the abbreviation is a code that is used in the computer software. The other numbers in the table will be explained in the section on long-term trends.

The procedure for selecting variables began during the Foundation Workshops. A brainstorming session in each Foundation Workshop helped participants to nominate a large number of variables in a short time. This session yielded between 100 and 200 variables in one hour. The participants ranked the list to produce a short list of 30 variables that represented the issue in their region of the coast. The regional lists were combined and sent to the Strategy Workshop.

Participants in the Strategy Workshop clarified and expanded the list of variables they received from the three Foundation Workshops. The list again approached 100 variables. They used the same ranking procedure to reduce this list to the final list of 30 key variables that represented the issue for the entire Texas Gulf Coast (Table 2).

## Table 1.

## TEXAS COASTAL MANAGEMENT PLAN

## SHORELINE EROSION & DUNE PROTECTION PARTICIPANTS

| Stakeholder Group Name | Stakeholder Group Description | Representatives | Organization / Interest |
|---|---|---|---|
| Commerce | Economic Development | Obie O'Brien<br>Pete Pranis | Mitchell Energy & Development<br>Council for South Texas Economic Program |
| SubsDist | Houston/Galveston Subsidence District | Ron Neighbors<br>Karen O'Neal | Houston/Galveston Subsidence District<br>Houston/Galveston Subsidence District |
| Academia | Academia | Mary Thorpe, Ph.D. | Geologist, Del Mar College |
| Environ | Environmental | Sharron Stewart<br>Rex Wahl | Texas Environmental Coalition<br>National Audubon Society |
| GasPipe | Gas Pipeline | Terry Doyle<br>Mike Speed | Enron<br>Oil and Gas Consulting |
| Ports | Ports | Richard Gorini<br>Paul Carangelo | Port of Houston<br>Port of Corpus Christi |
| CityGov | City Government | Robert Pinkerton<br>Robert Lynch | Mayor, South Padre Island<br>Galveston City Council |
| GalvesCo | Galveston County | Pat Hallissey<br>Frank Frankovich<br>Lou Muller | Galveston County Parks Board<br>Dannenbaum Engineering<br>Park Board of Trustees |
| JefferCo | Jefferson County | Richard LeBlanc<br>Robert Stroder<br>Malon Scogin | Jefferson County Judge<br>Jefferson County Engineer<br>Sea Grant Marine Extension Service |
| HarrisCo County | Harrison & Chambers Counties | Bob Naillon | Texas A&M Marine Advisory Service |
| SenatorB | Senator Chet Brooks | Neal Hunt | Senator Chet Brooks |
| SenatorP | Senator Carl Parker | Marty Conway | Senator Carl Parker |
| SenatorT | Senator Carlos Truan | Vick Hines | Senator Carlos Truan |
| StateAgn | State Agencies | Andy Mangan<br>Sally Davenport<br>Kim KcKenna<br>Don Dial<br>C. F. (Dick) Schendel<br>Jeffrey Paine | Texas General Land Office<br>Texas General Land Office<br>Texas General Land Office<br>State Department of Highways & Public Transportation<br>State Soil & Water Conservation Board<br>Bureau of Economic Geology |
| FedAgn | Federal Agencies | Sidney Tanner<br>Jim LeGrotte<br>B.D. King<br>Dana Barbie<br>David Myers | U.S. Army Corps of Engineers<br>Federal Emergency Management Agency<br>U.S. Fish and Wildlife Service<br>U.S. Geological Service<br>U.S. Soil Conservation Service |

# Table 2.

SHORELINE EROSION/DUNE PROTECTION

Variable List and Trends

| No. | Variable Name | Variable Description | Unit of Measure | Maximum Increase (%) | Expected Change (%) | External Impact (% Exp.) |
|---|---|---|---|---|---|---|
| 1 | SCI-DAY1 | Available Data | Sci Days/Yr | 330.0 | 62.0 | 10.0 |
| 2 | RESRCH$2 | Gulf Research Funds | Research $/Yr | 220.0 | 34.0 | 10.0 |
| 3 | BAY-ERO5 | Bay Shore Erosion | Ft Lost/Yr | 180.0 | 31.0 | 70.0 |
| 4 | BAY-VEG9 | Bay Shoreline Veg. | Acs Cov/Shore Mi | 151.0 | 16.0 | 10.0 |
| 5 | BEANOUR3 | Beach Nourishment | Cu Yds Add/Mi/Yr | 181.0 | 18.0 | 10.0 |
| 6 | BEA-RP$2 | Beach Replenishment | Program $/Yr | 167.0 | 17.0 | 10.0 |
| 7 | BLKSEDC5 | Blk. Coast Sediment | Cu Yds Block/Yr | 113.0 | 26.0 | 10.0 |
| 8 | DGREUSE3 | Dredge Spoil Reuse | Cu Yds Reused/Yr | 281.0 | 68.0 | 10.0 |
| 9 | DUNPROT4 | Dunes that Protect | % Protect/Mi/Yr | 101.0 | - 13.0 | 10.0 |
| 10 | DUN-VEG9 | Vegetated Dunes | % Covered by Veg | 115.0 | 0.0 | 10.0 |
| 11 | ECOINTG4 | Ecological Integrity | Acs Undisturb/Mi | 75.0 | - 13.0 | 10.0 |
| 12 | MANAGE$2 | Fed/State Mgmt Funds | Manage $/YR | 170.0 | 17.0 | 10.0 |
| 13 | GULF-ER5 | Gulf Shore Erosion | Ft Lost/Yr | 208.0 | 72.0 | 60.0 |
| 14 | HWYLOSS5 | Highway Losses | Days Closed/Yr | 91.0 | 51.0 | 10.0 |
| 15 | HUMA-ER5 | Hum. Induced Erosion | Ft Lost/Yr | 256.0 | 86.0 | 10.0 |
| 16 | COMRCE$0 | Commerce | $ Generated/Yr | 236.0 | 96.0 | 50.0 |
| 17 | BLKSEDI5 | Blk. Inland Sediment | Cu Yds Block/Yr | 145.0 | 33.0 | 10.0 |
| 18 | PLANING1 | Implementable Plans | # Plans/Yr | 158.0 | 137.0 | 10.0 |
| 19 | PUBEDUC1 | Public Education | Hrs Exposure/Yr | 338.0 | 90.0 | 10.0 |
| 20 | RIV-SND5 | River Supplied Sand | Cu Yds/Yr | 181.0 | - 28.0 | 10.0 |
| 21 | SANDBUD8 | Sand Budget | Cu Yds Avail/Yr | 25.0 | - 22.0 | 10.0 |
| 22 | SETBACK1 | Set Backs | Ft Mn High Tide | 124.0 | 46.0 | 10.0 |
| 23 | SHIPTRF0 | Ship Traffic | #/Yr | 139.0 | 45.0 | 50.0 |
| 24 | STCOORD1 | State InterAg Coord. | Eff Joint Act/Yr | 296.0 | 76.0 | 10.0 |
| 25 | SUBSIDE5 | Subsidence | In/Yr | 149.0 | 22.0 | 10.0 |
| 26 | TOURSM$0 | Tourism Revenue | $ Generated/Yr | 246.0 | 95.0 | 10.0 |
| 27 | TRASH 5 | Trash | Tons/Mi/Yr | 239.0 | 59.0 | 10.0 |
| 28 | VEH-BEA0 | Vehicle Beach Use | # on Beach/Yr | 156.0 | 83.0 | 10.0 |
| 29 | WETLAND4 | Wetlands | Acs/Yr | 169.0 | 46.0 | 10.0 |
| 30 | HABLOSS6 | Wildlife Hab. Lost | Acs Lost/Yr | 326.0 | 78.0 | 10.0 |

Time period is 20 YEARs, beginning 1/ 1991.

In the ranking procedure ***each stakeholder group had the right to select one variable that best defined their interest or concern. This variable is called peremptory because it must be included on the final list.*** In short, a stakeholder group owns the variable they select and no other group can challenge its right to use the variable in the computer model. Similarly, the variable can only be removed from the model with the consent of the stakeholder group. The peremptory variables are presented in Table 3.

The key variables identified by participants for the top three Texas Gulf Coast issues (i.e., shoreline erosion/dune protection, wetlands, and beach access) were compared to determine the degree to which the issues are interrelated. The variables were grouped if they shared a similar description. The results are presented in Table 4.

***There is significant overlap among the key variables for the top three Texas Gulf Coast issues.*** For example, Table 4 shows that five variables are important to all three issues. The variables are tourism revenue, interagency coordination, habitat loss, public education, and funding. The shoreline erosion/dune protection issue shares three additional variables with the wetlands issue and six additional variables with the beach access issue. ***Therefore, strategies to resolve the shoreline erosion/dune protection issue will require coordination with strategies adopted to address the other issues.***

## Table 3.

## PEREMPTORY VARIABLES

## Issue: SHORELINE EROSION/DUNE PROTECTION

| Group Name | Variable | Unit of Measure |
|---|---|---|
| Commerce | Commerce | $ Generated/Yr |
| GasPipe | Commerce | $ Generated/Yr |
| Environ | State Interagency Coordination | Effective Joint Actions/Yr |
| StatAgn | State Interagency Coordination | Effective Joint Actions/Yr |
| SubsDist | Subsidence | In/Yr |
| Academia | Sand Budget | Cubic Yds/Yr |
| Ports | Fed/State $ for Management | Management $/Yr |
| CityGov | Vehicle Beach Use | # on Beach/Yr |
| GalvesCo | Public Education | Hrs Exposure/Yr |
| JefferCo | Gulf Shoreline Erosion | Ft Lost/Yr |
| HarrisCo | Bay Shoreline Erosion | Ft Lost/Yr |
| SenatorB | Gulf Coast Research Funding | Research $/Yr |
| SenatorP | Highway Loss | Days Closed/Yr |
| SenatorT | Wildlife Habitat Loss | Acs Lost/Yr |
| FedAgny | Human Induced Erosion | Ft Lost/Yr |

**Table 4.**

## VARIABLES SHARED AMONG TWO OR MORE TEXAS GULF COAST ISSUES

| | Issue | | |
|---|---|---|---|
| Variable | Erosion | Wetlands | Access |
| Tourism Revenue | X | X | X |
| Interagency Coordination | X | X | X |
| Habitat Loss | X | X | X |
| Public Education | X | X | X |
| Funding | X | X | X |
| Ecological Integrity/Biodiversity | X | X | |
| Subsidence | X | X | |
| Wetlands | X | X | |
| Beach Nourishment | X | | X |
| Dune Protection | X | | X |
| Planning | X | | X |
| Setbacks/Easements | X | | X |
| Trash/Litter | X | | X |
| Vehicles on Beach/Dunes | X | | X |
| Enforcement | | X | X |

# TRENDS AND INTERACTIONS

## Long-Term Trends

The next step in the AFA Process involved estimating the trends in variables that might occur over the next twenty years under current policies. ***Most of the key variables were expected to increase, including erosion. A few variables were expected to decrease, including dune protection, ecological integrity, river supplied sand, and the sand budget.*** Stakeholder groups evaluated these trends as either desirable or undesirable. New policies addressed the undesirable trends.

Information was collected about two kinds of trends. The first trend is the possible or "maximum increase" for each variable over the next twenty years (Table 2). The maximum increase defines the upper limit for each variable. The second trend is the probable or "expected change" in each variable over the same period (Table 2). This is the trend that is likely to occur if current policies remain unchanged.

Information on trends was obtained from a questionnaire that was filled in by all participants. The participants were asked for their perceptions of the direction and magnitude of future trends. For example, if they thought a variable would change over the next twenty years, they were asked if it would be higher or lower than it is today. If the variable would be higher, the participants were given the option of saying it would be slightly, a little, moderately, a lot, or immensely higher.

The words in the questionnaire were associated with numbers that formed a geometric progression. For downward trends the progression ranged between 0 and -100 percent, and for upward trends it ranged between 0 and 1000 percent. The numerical values associated with the words selected by the participants were averaged. The averages were displayed, discussed, and modified as necessary. The final trends are illustrated with a bar chart in Figure 3.

The affects of outside forces were also considered. These forces are called external impacts (Table 2). This information is important because it points out how much, or how little, of the change in a variable may be controlled by policy. For instance, ***the participants decided that 70 percent of the bay shoreline erosion rate and 60 percent of the gulf shoreline erosion rate cannot be controlled by the recommended policy.***

## Interactions

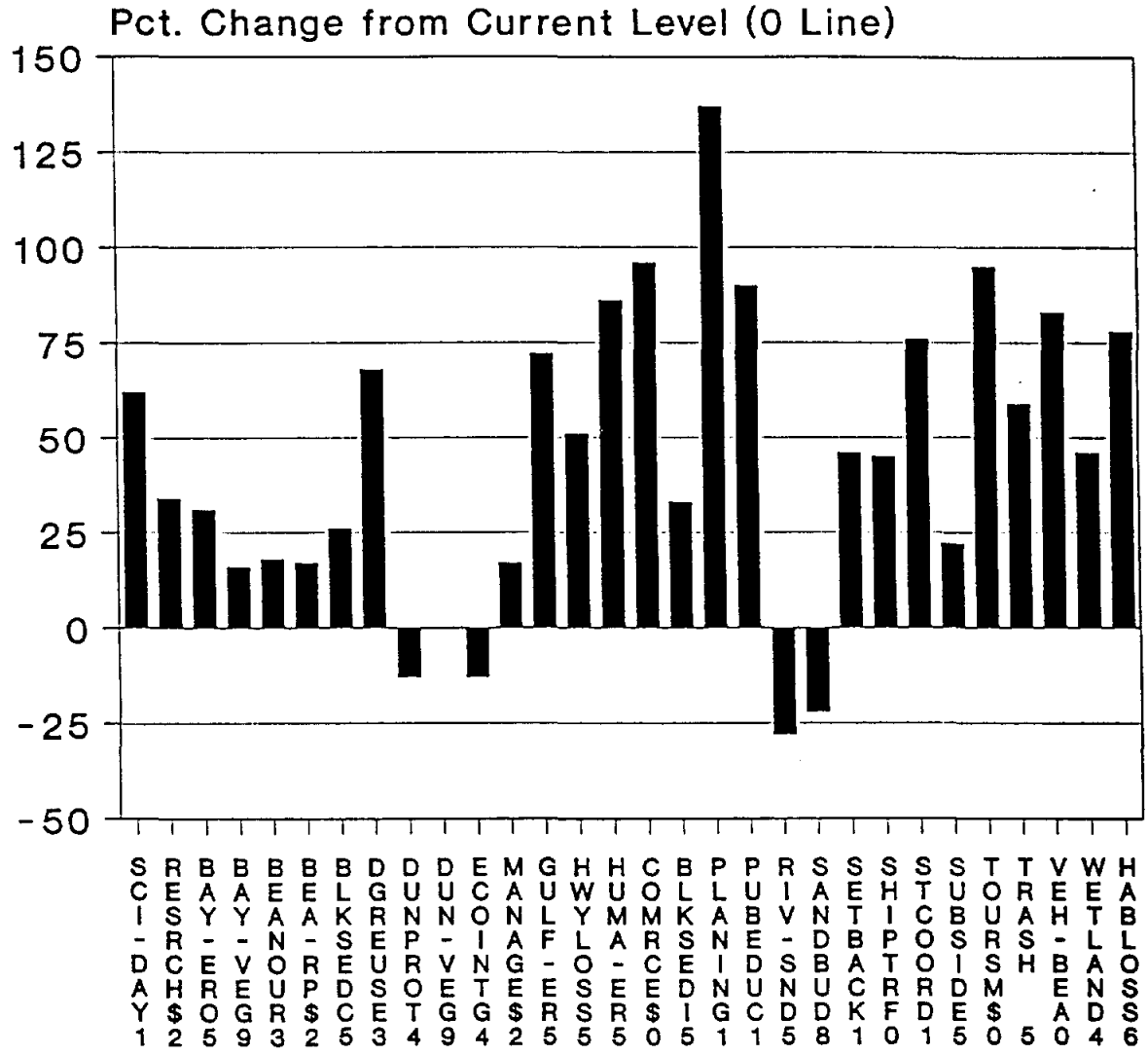
The next step in constructing a computer model is to show how the variables interact with one another to produce the estimated long-term trends. This is accomplished using a cross-impact matrix.

A cross-impact matrix is constructed by listing the key variables across the top of the matrix and then listing them again down the left side of the matrix (Figure 4). In a cross-impact matrix the column variable always impacts or affects the row variable. The number of filled cells in a column shows how many row variables that column variable affects, and in what way. The number of filled cells in a row shows how many column variables affect that row variable, and in what way.

Figure 3.

# Shoreline Erosion/Dune Protection

## Expected Change in Variables Over the Next 20 Years for Current Policy




NOTE: Estimates of expected change in variables were provided by the Erosion Panel.

## Figure 4.

## CROSS-IMPACT MATRIX

## Issue: SHORELINE EROSION/DUNE PROTECTION

| No. | Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SCI-DAY1 | | + | | | | | | | | | | + | | | | | | | | | | | | | | | | | | |
| 2 | RESRCH$2 | + | | + | - | | | | + | | | | | + | | | + | | + | + | | | | | + | | + | + | | - | + |
| 3 | BAY-ERO5 | - | | | - | | | + | - | | - | - | - | | | + | + | + | - | - | - | - | | + | - | + | + | | | - | |
| 4 | BAY-VEG9 | + | | - | + | | | | + | | + | + | + | | | - | - | | + | + | | | + | - | | - | - | | | + | - |
| 5 | BEANOUR3 | | | | | | + | + | + | | | | + | + | | + | | + | + | + | | - | + | | | | | | | | |
| 6 | BEA-RP$2 | + | | | | | | | + | - | - | | + | + | | | | | + | + | | - | | | + | | | | | | + |
| 7 | BLKSEDC5 | - | | | | | | | | | | | - | + | | | + | | - | - | | | - | | - | | + | | | | |
| 8 | DGREUSE3 | + | | | | | + | | | + | | | + | + | | | + | | + | + | + | + | | | + | | | | | + | |
| 9 | DUNPROT4 | + | | | | + | + | - | + | | + | + | + | - | | - | | | + | + | | + | + | | + | | - | | - | | - |
| 10 | DUN-VEG9 | + | | | | | | | | | + | + | + | - | | - | | | + | - | | | + | | + | | - | | - | | - |
| 11 | ECOINTG4 | + | | - | + | + | + | - | | + | + | | + | - | | - | | - | + | + | | + | + | - | + | - | | - | - | + | - |
| 12 | MANAGE$2 | + | | | | | | | | - | | | | | + | + | + | | + | + | | | | | | | + | | | | + |
| 13 | GULF-ER5 | - | | | | - | - | + | - | - | - | - | - | | | + | + | + | - | - | - | - | - | | - | + | + | | + | | |
| 14 | HWYLOSS5 | | | + | | - | - | + | | - | | | - | + | | + | | + | - | | | | - | + | - | + | | | | - | |
| 15 | HUMA-ER5 | - | | | - | | | + | | | | | - | | | | + | + | - | - | - | - | - | - | + | - | + | + | | + | |
| 16 | COMRCE$O | | + | - | | + | + | | + | + | + | | + | - | - | - | | | + | + | | + | + | + | + | - | + | | | + | - |
| 17 | BLKSED15 | - | | | | | | | | | | | - | | | | + | | - | - | | | | | - | | + | | | | |
| 18 | PLANING1 | + | | | | | | | | | | | + | | | | + | | | + | | | | | + | | | | + | - | + |
| 19 | PUBEDUC1 | | + | | | | | | | | | | + | | | | | | + | | | | | | + | | | | | | |
| 20 | RIV-SND5 | | | | | | | | | | | | + | | | | | - | + | | | | | | + | | | | | | |
| 21 | SANDBUD8 | | | - | + | + | | - | | | + | + | + | - | | - | | - | + | + | + | | + | | + | - | | | - | | |
| 22 | SETBACK1 | + | | - | | + | + | | | + | + | + | | - | | - | - | | + | | | | | | | - | | | - | | |
| 23 | SHIPTRFO | + | | - | | | | | + | | | | + | | | | + | | + | + | | | | | + | | + | | | | |
| 24 | STCOORD1 | | | + | | | | | | | | | + | + | + | + | + | + | + | + | | | + | | | | | + | | + | + |
| 25 | SUBSIDE5 | - | | | | | | | | | | | - | | | | | | - | - | - | | | | | | | | | | |
| 26 | TOURSM$O | | | | | | + | | + | + | + | + | + | - | - | - | + | | + | | | | | | + | | | - | + | + | - |
| 27 | TRASH 5 | - | | | | | | | | | | | - | | | | + | | - | - | | | | - | + | | | + | | + | |
| 28 | VEH-BEAO | | | | | + | | | + | | - | + | + | - | | | | | + | - | | | | | + | | + | - | | | |
| 29 | WETLAND4 | + | | - | + | | | | | + | + | + | + | - | | - | | | + | + | | + | + | - | + | - | | | | | - |
| 30 | HABLOSS6 | - | | + | | | | | | | | | - | + | | + | + | | - | - | | - | - | + | - | + | + | + | + | | |

An interaction between two variables in the cross-impact matrix is represented by a plus "+" or a minus "-" sign. The cell is left blank if there is no interaction. A plus sign means that the row variable follows the column variable. In other words, if the column variable goes up the row variable will go up. A minus sign means that the row variable moves in the opposite direction of the column variable. That is, if the column variable goes up the row variable will go down.

All cells in the matrix were considered one at a time to estimate interactions among the 30 key variables. This potentially tedious process of filling in the cells was simplified so that it took only three hours to complete. The workshop participants were assembled into teams, and each team was given up to 5 questionnaires. Each questionnaire focused on how a particular variable affected the other variables in the matrix. The question was stated as "If variable A goes up, then variable B goes up, down, or no impact?". The team then circled one answer for each affected variable. The completed questionnaires were displayed for discussion and revision. This procedure insured that participants agreed on the interactions used to describe the issue.

## Linking Trends and Interactions

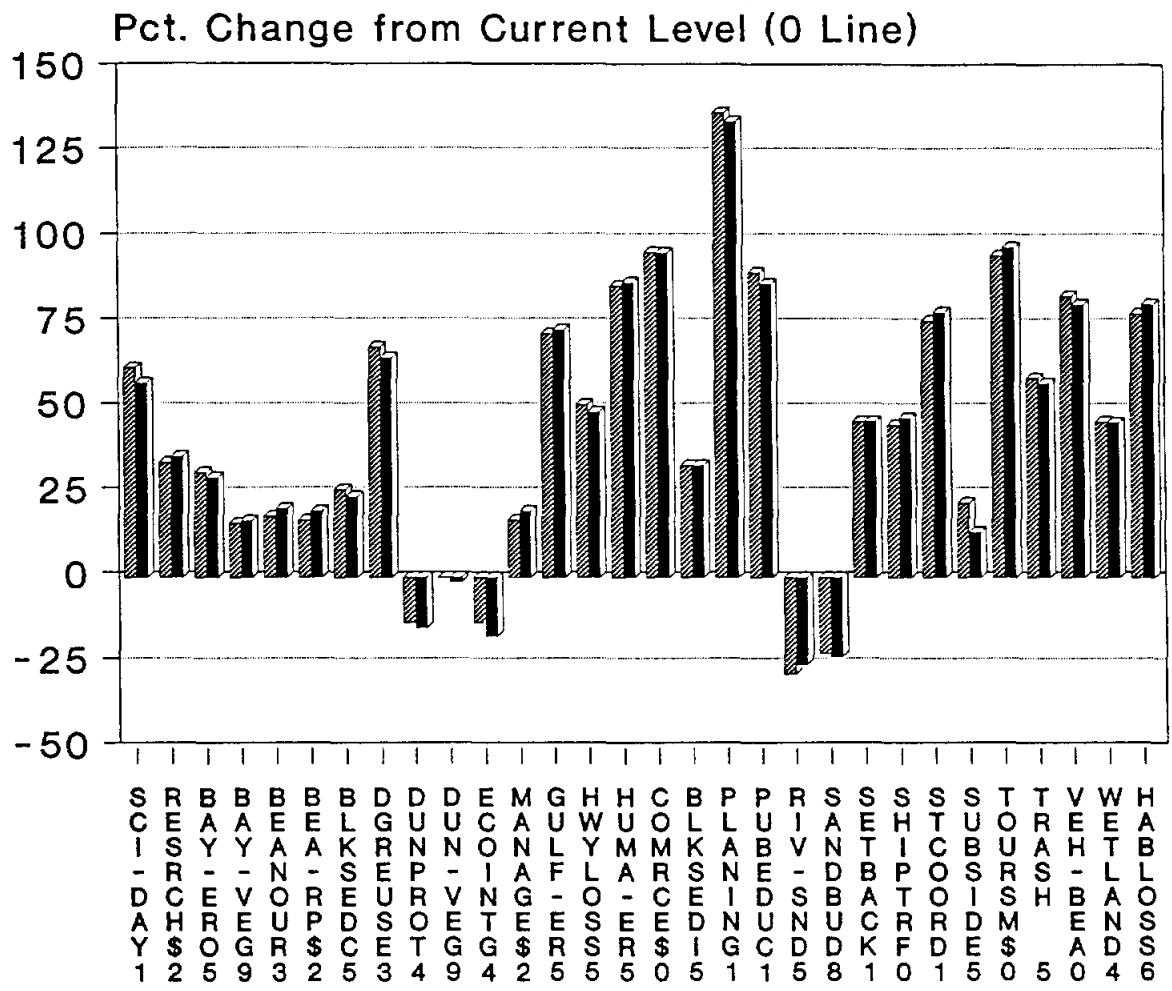
The software for the AFA Process uses artificial intelligence techniques to link the trends and the interactions in the cross-impact matrix to form a working computer model. The computer model is then validated. The closer the simulated trends from the model match the expected trends the better the model. Figure 5 shows that ***the shoreline erosion/dune protection model developed by the participants produces simulated trends that closely match the expected trends.***

The computer model formalized the participant's mutual understanding of the issue. It also provided a baseline for evaluating recommended policies. Thus participants used the model to compare the possible consequences of new policies with the probable consequences of continuing the old policies.

Figure 5.

# Validation of Erosion Computer Model

Estimated Changes for Current Policy vs.
Simulated Changes from Computer Model




NOTE: A valid computer model can approximate the expected changes in variables estimated by the Erosion Panel.

# POLICIES AND PRIORITIES

## Defining the Issue

The participants selected two variables to define the shoreline erosion/dune protection issue. They were bay shoreline erosion and gulf shoreline erosion. Both variables were measured in ft. lost/yr. ***The rate of erosion is expected to increase over the next twenty years if current policies are not changed.*** This increase in the rate of erosion defines the shoreline erosion/dune protection issue for the Texas Gulf Coast.

## Stakeholder Objectives

An objective represents how a stakeholder group would like to see a variable change from the way it is today. For this issue, the time limit for reaching an objective was set at twenty years.

There were eight objectives from which to choose (Table 5). They included No Change, Not Up, Not Down, Up %, Down %, Up Max., Down Max., and Don't Care. The definitions of the objectives are presented in Table 5. Since the objectives were stated simply, the stakeholder groups specified their objectives for the 30 key variables in less than one-half hour. They were also given an opportunity to change their objectives. Most of the participants took advantage of this opportunity on more than one occasion.

The computer software converts the objectives into a form that can be used to evaluate policies. The simulated trends in variables for a policy are compared with these objectives to determine the level of satisfaction achieved by a stakeholder group. The closer a variable comes to the objective the higher the stakeholder group's satisfaction. Thus satisfaction does not express a group's happiness, it defines the degree to which an objective is met.

Table 6 summarizes the objectives specified by the 15 stakeholder groups for the 30 key variables used to describe the shoreline erosion/dune protection issue. The Up Max., Up %, and Not Down objectives were grouped to illustrate a preference for an increase in the variable. Similarly, the Down Max., Down %, and Not Up objectives were grouped to illustrate a preference for a decrease in the variable. Table 6 reveals that ***the stakeholder groups share similar views on a desired future for the Texas Gulf Coast.*** Appendix A shows the objectives for all stakeholder groups for all 30 variables.

## Table 5.

## DEFINITIONS OF OBJECTIVES

| Objective | Definition |
|---|---|
| NO CHANGE | You do not want the variable to go higher or lower than its current level. |
| NOT UP | You do not want the variable to go higher than its current level, but you do not care if it goes lower. |
| NOT DOWN | You do not want the variable to go lower than its current level, but you do not care if it goes higher. |
| UP % | You want the variable to go up to or above a certain percent of its current level. |
| DOWN % | You want the variable to go down to or below a certain percent of its current level. |
| UP MAX. | You want the variable to go up as high as possible from its current level. |
| DOWN MAX. | You want the variable to go to zero. |
| DON'T CARE | You do not care about the variable. |

## TABLE 6.

## SUMMARY OF GROUP OBJECTIVES

## Issue: SHORELINE EROSION/DUNE PROTECTION

| Variable No. | Variable | No Change | Preference for Increase* | Preference for Decrease** | Don't Care |
|---|---|---|---|---|---|
| 1 | Available Data for Coast | 0 | 15 | 0 | 0 |
| 2 | Gulf Coast Research Funds | 0 | 14 | 0 | 1 |
| 3 | Bay Shoreline Erosion Rate | 0 | 0 | 15 | 0 |
| 4 | Bay Shoreline Covered by Vegetation | 0 | 14 | 0 | 1 |
| 5 | Beach Nourishment Rate | 0 | 10 | 3 | 2 |
| 6 | Beach Replenishment Funds | 0 | 10 | 3 | 2 |
| 7 | Blockage Rate of Coastal Sediment | 0 | 0 | 14 | 1 |
| 8 | Dredge Spoil Reuse Rate | 1 | 11 | 2 | 1 |
| 9 | Proportion of Coast Protected by Dunes | 0 | 14 | 0 | 1 |
| 10 | Proportion of Dunes Covered by Vegetation | 0 | 14 | 0 | 1 |
| 11 | Area of Coast Undisturbed | 0 | 14 | 0 | 1 |
| 12 | Federal/State Coastal Management Funds | 0 | 14 | 0 | 1 |
| 13 | Gulf Shoreline Erosion Rate | 0 | 0 | 15 | 0 |
| 14 | Highway Closures Due to Erosion | 0 | 0 | 10 | 5 |
| 15 | Human Induced Erosion | 0 | 0 | 15 | 0 |
| 16 | Dollars Generated by Coastal Commerce | 0 | 11 | 0 | 4 |
| 17 | Blockage Rate of River Sediment | 0 | 0 | 14 | 1 |
| 18 | Planning | 0 | 14 | 0 | 1 |
| 19 | Public Education About Issue | 0 | 15 | 0 | 0 |
| 20 | Flow Rate of River Supplied Sand | 0 | 14 | 0 | 1 |
| 21 | Annual Sand Budget | 0 | 14 | 0 | 1 |
| 22 | Setback from Mean High Tide | 0 | 14 | 1 | 0 |
| 23 | Annual Ship Traffic | 0 | 10 | 0 | 5 |
| 24 | Interagency Coordination | 0 | 14 | 0 | 1 |
| 25 | Subsidence Rate | 0 | 0 | 15 | 0 |
| 26 | Annual Tourism Revenue | 0 | 13 | 0 | 2 |
| 27 | Annual Volume of Litter/Trash | 0 | 0 | 14 | 1 |
| 28 | Vehicles on Beaches/Dunes | 2 | 0 | 12 | 1 |
| 29 | Area of Wetlands | 0 | 12 | 0 | 3 |
| 30 | Wildlife Habitat Loss Rate | 1 | 0 | 13 | 1 |

*The Up Max., Up %, or Not Down objectives were combined.
**The Down Max., Down %, or Not Up objectives were combined.

## Recommended Policy

### *Primary Policy*

The participants followed a step-by-step procedure do develop a recommended policy. They began by selecting up to 5 target variables that could reduce the bay and gulf shoreline erosion rates. ***The participants chose federal and state coastal management funds, human induced erosion, planning, the annual sand budget, and interagency coordination as the five variables to include in their primary policy.*** They made this selection because the interactions in the cross-impact matrix showed that the five target variables directly affect the two problem variables (Figure 4).

The primary policy is created by deciding the direction, magnitude, and rate of change needed to produce a new trend in each target variable. The assumption is that new trends in the target variables will cause favorable changes in the problem variables.

Computer simulations were performed by forcing the five target variables to follow the new trends specified in the primary policy. These new trends in the target variables then interacted through the cross-impact matrix to change the trends in the problem variables. The trends in other variables also changed because they are connected to one another in the matrix.

The results produced by simulating policies should be interpreted qualitatively since the data used in building the computer model also was qualitative. Thus a percentage change in a variable caused by a policy is best interpreted with words. For example, 100 percent above the current level might be stated as substantially higher, while 20 percent below the current level might be stated as slightly lower.

***The simulation showed that the primary policy is likely to reduce bay and gulf shoreline erosion rates below the expected levels in twenty years. However, only the bay shoreline erosion rate was reduced below the current level. The gulf shoreline erosion rate increased a little above the current level, but not as much as would have occurred under the current policy.***

### *Mitigation Policies*

The participants felt that some of the side effects produced by simulating the primary policy were undesirable. The use of vehicles on beaches and dunes went a little higher than was expected for the current policy. This potential increase in vehicles was attributed to a similar increase in tourism caused by the primary policy. Table 6 shows that most of the stakeholder groups want fewer vehicles on beaches and dunes. Therefore, ***the participants decided to control the growth in use of vehicles on beaches and dunes by allowing them to increase 50 percent over the next twenty years instead of the 83 percent that was expected.*** Thus they added a mitigation variable to their primary policy to form a policy portfolio (Policy 2) that was again simulated to test for new side effects.

This second policy produced another unwanted side effect. Funding for basic research on the coast could decline because many of the problems are resolved and management funding emphasizes applied research. Therefore ***the participants decided to increase basic research funding by 25 percent over the next twenty years.*** This was still below the 34 percent increase expected under the current policy. They added this mitigation variable to their policy portfolio (Policy 3) and conducted another simulation to test for new side effects.

Although the policy portfolio continued to improve with each additional mitigation variable, it still produced another unwanted side effect. This time river supplied sand declined further than expected (i.e., river supplied sand dropped 44 percent below the current level and the expected drop was 28 percent). This sand is essential to help increase the sand budget and reduce erosion. The potential loss of sand was caused by increased development on the coast due to the beneficial affects of the primary policy. Such development increases dams and other structures that block the flow of river sand. As a result, the participants added two more mitigation variables to their policy portfolio (Policy 4). ***The participants increased river supplied sand by 10 percent over the next twenty years and they reduced structures that block the flow of sand from rivers by 10 percent.*** The new policy was simulated to check for more unwanted side effects. The results of the simulation were acceptable so this became the recommended policy (Table 7).

## *Final Recommendation*

***The recommended policy consists of the original five target variables in the primary policy plus the four mitigation variables that were added to reduce unwanted side effects.*** The recommended policy selected by participants includes 1) increasing federal and state coastal management funds by 3 times, 2) reducing the human induced erosion rate by half, 3) increasing planning by 3 times, 4) increasing the annual sand budget by 5 percent, 5) increasing interagency coordination by 4 times, 6) increasing Gulf Coast research funds by one quarter, 7) reducing the blockage rate of river supplied sand by 10 percent, 8) increasing the flow rate of river supplied sand by 10 percent, and 9) slowing the growth in use of vehicles on beaches and dunes to a 50 percent increase (Table 7).

A bar chart comparing the affects of the current policy and the recommended policy is presented in Figure 6. The chart is constructed with the zero line representing the current level of the variable. A bar above the line means that, over the next twenty years, the variable is likely to move higher than it is today. A bar below the line means that the variable is likely to move lower than it is today. The bars are shown in pairs. One bar is the expected change in a variable estimated by workshop participants for the current policy. The other bar is the simulated change produced for the recommended policy.

As Figure 6 shows, ***the recommended policy is likely to reduce bay shoreline erosion and gulf shoreline erosion rates below current levels.*** Under the current policy they are expected to go up over the next twenty years. Increasing river supplied sand as a mitigation variable improved the primary policy by potentially reversing the increase in the gulf shoreline erosion rate.

## Table 7.

## CHANGES SPECIFIED FOR THE RECOMMENDED POLICY

## Issue: SHORELINE EROSION/DUNE PROTECTION

### TARGET VARIABLES (Primary Policy)

| Variable No. | Variable | Policy | % | Rate of Desired Change |
|---|---|---|---|---|
| 12 | Federal/State Coastal Management Funds | Up Max | 170 | Gradually |
| 15 | Human Induced Erosion | Down | 50 | Gradually |
| 18 | Planning | Up Max | 158 | Rapidly |
| 21 | Annual Sand Budget | Up | 5 | Gradually |
| 24 | Interagency Coordination | Up Max | 296 | Rapidly |

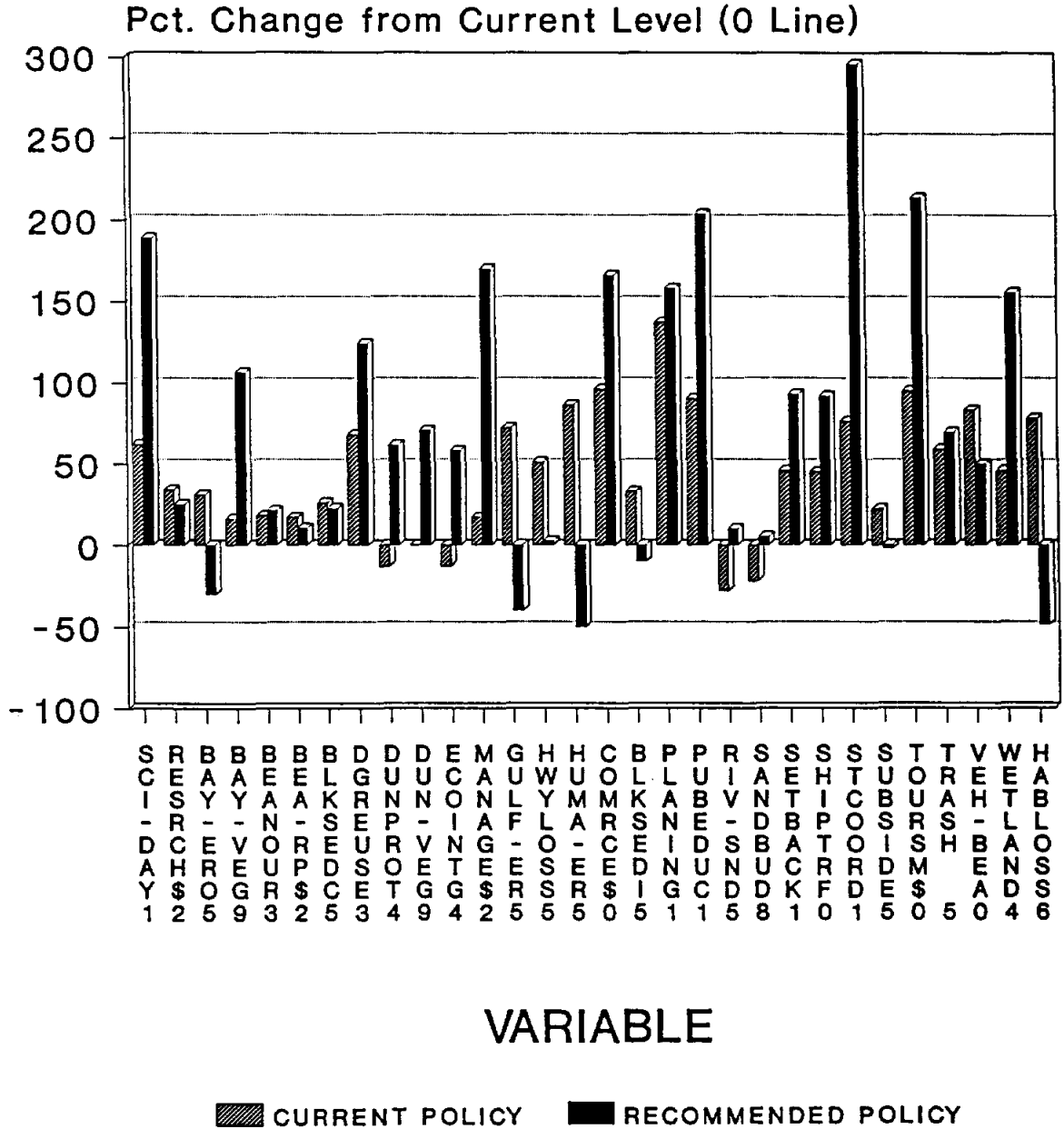
### MITIGATION VARIABLES (Added to Primary Policy)

| Variable No. | Variable | Policy | % | Rate of Desired Change |
|---|---|---|---|---|
| 2 | Gulf Coast Research Funds | Up | 25 | Gradually |
| 17 | Blockage Rate of River Sediment | Down | 10 | Gradually |
| 20 | Flow Rate of River Supplied Sand | Up | 10 | Gradually |
| 28 | Vehicles on Beaches/Dunes | Up | 50 | Gradually |

Figure 6.

# Shoreline Erosion/Dune Protection

## Percentage Change in Variables for Current and Recommended Policies




VARIABLE

CURRENT POLICY  RECOMMENDED POLICY

NOTE: The percentage shown is the total change that may occur over 20 years.

The line graphs presented in Appendix B show the simulated trends in variables over the next twenty years for the current policy and the recommended policy. The graphs are arranged in pairs with the same seven variables in each graph. The top graph shows the expected change in variables over time if current policies continue into the future. The lower graph shows the change that might occur in the same variables if the recommended policy is adopted.

## *Satisfaction of Objectives*

Table 8 shows the satisfaction levels achieved by each stakeholder group for the recommended policy (Policy 4). The first column shows the names of the groups. The second column shows the total level of satisfaction achieved by each group. A 100 for a group would mean that all of their objectives were met or exceeded by the policy.

The third column in Table 8 shows the highest level of dissatisfaction experienced by a stakeholder group for any variable. In this case, a 100 for a group would mean that they are completely dissatisfied. That is, the group's objective for the variable was not even partially met. The last three columns show the name of the variable that caused the dissatisfaction, how much it changed as a result of the policy, and how the group wanted the variable to change.

***The overall or total satisfaction of objectives is generally high for the recommended policy (Policy 4).*** Satisfaction for individual stakeholder groups ranged between a low of 75 percent for Jefferson County to a high of 100 percent for the Houston/Galveston Subsidence District. On the other hand, ***levels of dissatisfaction are relatively low for the recommended policy.*** The highest remaining dissatisfaction for the recommended policy is for the Commerce stakeholder group. The variable of concern to the group was setbacks from mean high tide. The Commerce group did not want setbacks to go up but they nearly doubled. Nevertheless, the group is still 80 percent satisfied with the recommended policy (Table 8).

Table 9 compares the current policy (Expected) and the recommended policy (Policy 4). The table is constructed in three columns and the index of success used in each column is scaled between zero and 100 percent. In columns one and two the larger the percent the better the policy. In column three the smaller the percent the better the policy.

***The recommended policy is superior to the current policy for three measures of success.*** For example, the first column in Table 9 shows that the recommended policy maximizes the minimum level of satisfaction for all groups (i.e., ***it produces a lower level of dissatisfaction for all groups than the current policy***). The second column shows that the recommended policy maximizes total satisfaction for all groups (i.e., ***it provides more benefits to all groups than the current policy***). The third column shows that the recommended policy minimizes total dissatisfaction for any one group (i.e., ***it produces a lower level of dissatisfaction for any one group than the current policy***).

# Table 8.

SHORELINE EROSION/DUNE PROTECTION

EXPERIMENT: POLICY4

Satisfaction of Group Objectives *

| Group | Total Satisfaction (% of Max.)** | Highest Dissatisfaction (%) | Variables | Dif. From Initial Value (%) | Objective |
|---|---|---|---|---|---|
| Commerce | 80.0 | 74.9 | SETBACK1 | 92.9 | Not Up |
| SubsDist | 100.0 | 0.0 | SCI-DAY1 | 188.7 | Up 25% |
| | | | RESRCH$2 | 25.0 | Up 25% |
| | | | BAY-ERO5 | - 30.0 | Not Up |
| | | | MANAGES2 | 170.0 | Up 50% |
| | | | GULF-ER5 | - 40.0 | Not Up |
| | | | HUMA-ER5 | - 50.0 | Not Up |
| | | | PLANING1 | 158.0 | Up 50% |
| | | | PUBEDUC1 | 203.6 | Up 100% |
| | | | SETBACK1 | 92.9 | Up 50% |
| | | | STCOORD1 | 296.0 | Up 100% |
| | | | SUBSIDE5 | - 2.3 | Not Up |
| Academia | 84.3 | 53.1 | BLKSEDC5 | 22.5 | Down 80% |
| Environ | 86.3 | 50.0 | TRASH 5 | 69.3 | Down 100% |
| GasPipe | 85.6 | 50.0 | TRASH 5 | 69.3 | Down 100% |
| Ports | 87.6 | 58.6 | VEH-BEA0 | 50.0 | Down 100% |
| CityGov | 81.0 | 58.6 | BEA-RP$2 | 10.6 | Up Max. 167% |
| GalvesCo | 81.3 | 58.6 | BEA-RP$2 | 10.6 | Up Max. 167% |
| JefferCo | 75.3 | 58.6 | BEA-RP$2 | 10.6 | Up Max. 167% |
| | | | VEH-BEA0 | 50.0 | Down 100% |
| HarrisCo | 78.5 | 58.6 | VEH-BEA0 | 50.0 | Down 100% |
| SenatorB | 86.1 | 50.0 | TRASH 5 | 69.3 | Down 100% |
| SenatorP | 77.1 | 60.9 | RIV-SNO5 | 10.0 | Up Max. 181% |
| SenatorT | 84.2 | 53.1 | BLKSEDC5 | 22.5 | Down 80% |
| StateAgn | 92.1 | 41.3 | DGREUSE3 | 124.1 | Up Max. 281% |
| | | | TRASH 5 | 69.3 | Down 50% |
| FedAgn | 87.4 | 58.6 | BEA-RP$2 | 10.6 | Up Max. 167% |

* Computed using normalized (% of Max.) units.

** Maximum excludes variables assigned 'Don't Care'.

# Table 9.

SHORELINE EROSION/DUNE PROTECTION

Satisfaction of Objectives by Policy Experiment

| Experiment | Total Min. Sat. All Groups (% of Max.) | Total Weighted Sat. All Groups (% of Max.) | Highest Total Dissat. Any One Group (% of Max.) |
|---|---|---|---|
| EXPECTED | 49.2 | 66.1 | 45.4 |
| POLICY4 | [ 68.9]* | [ 83.8]** | [ 24.7]*** |

* MAXIMIN Solution: Policy maximizes total minimum satisfaction (i.e., policy is least hurtful to all groups).

** MAXIMAX Solution: Policy maximizes total weighted satisfaction (i.e., policy provides the most benefits to all groups).

*** MINIMAX Solution: Policy minimizes total dissatisfaction for any one group (i.e., policy is least hurtful to any one group).

## Recommended Actions

The recommended policy is composed of nine variables. The participants specified how these variables should change over the next twenty years to resolve the shoreline erosion/dune protection issue. Their recommendation was based on the assumption that the changes in variables were optimistic but realistic.

The participants worked in multi-stakeholder teams to formulate workable actions to bring about the desired changes in variables. Each team was given up to two target and/or mitigation variables to review. The team filled in a questionnaire for each variable that requested information on the specific actions needed to bring about the recommended change. They specified who should be responsible for taking the action. They also estimated the cost and source of funds.

The proposed actions from the teams were displayed for discussion and revision by all participants. As a result, ***the recommended actions represent a consensus of the participants.*** These actions are listed below. (The recommendation to increase river supplied sand includes reducing the blockage of river sediments.)

### *Increase Coastal Management Funding*

*ACTION*: Legislative appropriations consistent with the priorities and problems identified in the planning effort (i.e., all plans as adopted by the identified jurisdictions); agency surveillance and enforcement of state plans and regulations; coordination of state/local planning and implementation efforts, including establishment of regional mitigation banks; coordinate with the private sector in the planning and implementation process; inter-agency coordination on management practices.

*RESPONSIBLE PARTY*: State agencies; local governments; special districts, including Conservation Districts; private sector.

*ESTIMATED COST*: Year 1-5: $150 million; Year 6-10: $150 million; Year 11-15: $100 million; Year 16-20: $100 million.

*SOURCE OF FUNDS*: Taxes; private sector.

### *Reduce Human Induced Erosion*

*ACTION*: Public education/policy; minimize impacts of development and other activities; minimize vehicle impacts; bay/gulf vegetation; prevent subsidence; applied research; planning; appropriate funds to carry out actions.

*RESPONSIBLE PARTY*: Public; private; public-private organizations; specific public-private partnerships to work on specific and focused topics and problems.

*ESTIMATED COST*: No cost estimated.

*SOURCE OF FUNDS*: No source of funds specified.

### *Increase Planning*

*ACTION*: Legislative adoption of bay/coastal planning policies and procedures: a) Identify areas of statewide significance, b) establish standards for planning, plan adoption, and implementation, c) identify planning jurisdictions, d) allocate funds for "a" and "b", e) establish a planning grant program for the jurisdictions.

*RESPONSIBLE PARTY*: Legislative designation of a state agency or coordinating board to carry out the legislative program.

*ESTIMATED COST*: Year 1-5: $6 million; Year 6-10: $3 million; Year 11-15: $3 million; Year 16-20: $3 million.

*SOURCE OF FUNDS*: Taxes.

### *Increase the Sand Budget*

*ACTION*: Research feasibility of increasing sand budget both upstream and along the coast; implement policy decisions arrived at through research.

*RESPONSIBLE PARTY*: Joint state/federal research coordinated by GLO and COE as leads; create a private sector/local government organization to involve interests and open the door to direct financial involvement in the research phase.

*ESTIMATED COST*: Year 1-5: $5 - 10 million.

*SOURCE OF FUNDS*: State and federal general revenue supplemented with private and local funds.

### *Increase Interagency Coordination*

*ACTION*: Obtain consensus from state and federal agencies on cooperative action plans, formalizing responsibilities through legislation.

*RESPONSIBLE PARTY*: GLO as lead agency, networking with appropriate agencies.

*ESTIMATED COST*: Year 1-5: $750,000; Year 6-10: $750,000; Year 11-15: $750,000; Year 16-20: $750,000.

*SOURCE OF FUNDS*: State general revenue.

### *Increase Funding for Basic Research*

*ACTION*: Increase in appropriations for basic research by state and federal legislatures.

*RESPONSIBLE PARTY*: The State Legislature; Congress.

*ESTIMATED COST*: Year 1-5: $5 million; Year 6-10: $5 million; Year 11-15: $5 million; Year 16-20: $5 million.

*SOURCE OF FUNDS*: Taxes, bond sales, self-sustaining investments, general revenue.

### *Increase River Supplied Sand*

*ACTION*: Dredge each reservoir at the point nearest the coast; retrofit existing dams, groins and other structures to allow by-pass of sand; require new structures to be constructed with by-pass systems; management of dredge placement; require improved management of water flow and dredged materials; conduct a demonstration project to prove feasibility.

*RESPONSIBLE PARTY*: Corps of Engineers; river authorities; Texas Water Development Board; U.S. Congress; State Legislature; port authorities.

*ESTIMATED COST*: Year 1-5: $20 million; Year 6-10: $60 million; Year 11-15: $35 million; Year 16-20: $35 million.

*SOURCE OF FUNDS*: Federal; river authorities; state; local; user fees to a limited extent.

***Control Vehicles on Beaches and Dunes***

*ACTION*: Amend Dune Protection Act to apply to all Texas Coastal Counties; give coastal counties regulatory authority to manage beaches in unincorporated areas.

*RESPONSIBLE PARTY*: The Legislature - for legislation; county governments - implementing beach management.

*ESTIMATED COST*: Year 1-5: $5 million; Year 6-10: $5 million; Year 11-15: $5 million; Year 16-20: $5 million.

*SOURCE OF FUNDS*: Taxes; U.S. Corps of Engineers; Cigarette Tax.

## Research Priorities

The cross-impact matrix was used to identify which interactions between variables are important to study. The participants were asked to rate up to 10 percent of the interactions in the matrix as unimportant and up to 10 percent as extremely important. The remaining 80 percent of the interactions were automatically rated as moderately important.

An unimportant rating means that research funds would be wasted on the interaction because it is either well understood or it has little affect on the issue. An extremely important rating means that research funds should be directed toward the interaction because it is not well understood, and it has a strong affect on the issue.

The ratings from the participants were processed with a statistical procedure that produces an importance index that varies between 0 and 100. The higher the index the more research effort should be focused on the interaction. An index of 100 would mean that all of the participants identified the interaction as extremely important. Thus research funding should start with interactions that have the highest importance index and work downward toward those with the lowest importance index.

The recommended priorities for future research on the shoreline erosion/dune protection issue are presented in Table 10. ***The highest research priority focused on improving understanding about the affect of the bay shoreline erosion rate on the area of wetlands and the loss of wildlife habitat. The second research priority was improving understanding about the contribution of human induced erosion to the gulf shoreline erosion rate. The affects of ship traffic on the bay shoreline erosion rate tied as the second research priority. Research on eleven other interactions between variables tied for third priority, including the affects of beach nourishment and dredge spoil reuse on the gulf shoreline erosion rate.***

**Table 10.**

**RECOMMENDED RESEARCH FUNDING PRIORITIES**

**Issue: SHORELINE EROSION/DUNE PROTECTION**

| Rank | Importance Index | | Interaction |
|---|---|---|---|
| 1 | 64% | **AFFECT OF** | the Bay Shoreline Erosion Rate |
| | | **ON** | the Area of Wetlands |
| | 64% | **AFFECT OF** | the Bay Shoreline Erosion Rate |
| | | **ON** | the Wildlife Habitat Loss Rate |
| 2 | 56% | **AFFECT OF** | Human Induced Erosion |
| | | **ON** | the Gulf Shoreline Erosion Rate |
| | 56% | **AFFECT OF** | Annual Ship Traffic |
| | | **ON** | the Bay Shoreline Erosion Rate |
| 3 | 49% | **AFFECT OF** | the Bay Shoreline Erosion Rate |
| | | **ON** | Bay Shoreline Covered by Vegetation |
| | 49% | **AFFECT OF** | the Beach Nourishment Rate |
| | | **ON** | the Gulf Shoreline Erosion Rate |
| | 49% | **AFFECT OF** | the Dredge Spoil Reuse Rate |
| | | **ON** | the Gulf Shoreline Erosion Rate |
| | 49% | **AFFECT OF** | the Gulf Shoreline Erosion Rate |
| | | **ON** | the Area of Wetlands |
| | 49% | **AFFECT OF** | Human Induced Erosion |
| | | **ON** | Bay Shoreline Covered by Vegetation |
| | 49% | **AFFECT OF** | Human Induced Erosion |
| | | **ON** | Annual Tourism Revenue |
| | 49% | **AFFECT OF** | Human Induced Erosion |
| | | **ON** | the Area of Wetlands |
| | 49% | **AFFECT OF** | Human Induced Erosion |
| | | **ON** | the Wildlife Habitat Loss Rate |
| | 49% | **AFFECT OF** | the Flow Rate of River Supplied Sand |
| | | **ON** | the Annual Sand Budget |
| | 49% | **AFFECT OF** | Annual Ship Traffic |
| | | **ON** | the Area of Wetlands |
| | 49% | **AFFECT OF** | the Subsidence Rate |
| | | **ON** | the Wildlife Habitat Loss Rate |

# APPENDIX A
# Stakeholder Objectives

Objective Specified for Each Variable by Each Group

| | | GROUP | | | | |
|---|---|---|---|---|---|---|
| No. | Variable | Commerce | SubsDist | Academia | Environ | GasPipe |
| 1 | SCI-DAY1 | Up Max. | Up 25% | Up 50% | Up 50% | Up Max. |
| 2 | RESRCH$2 | Don't Care | Up 25% | Up 50% | Up 50% | Up 100% |
| 3 | BAY-ERO5 | Not Up | Not Up | Down Max. | Down Max. | Down Max. |
| 4 | BAY-VEG9 | Up Max. | Don't Care | Up Max. | Up 100% | Up Max. |
| 5 | BEANOUR3 | Not Down | Don't Care | Not Up | Don't Care | Not Up |
| 6 | BEA-RP$2 | Up Max. | Don't Care | Not Up | Don't Care | Not Up |
| 7 | BLKSEDC5 | Not Up | Don't Care | Down 80% | Not Up | Not Up |
| 8 | DGREUSE3 | Up Max. | Don't Care | Not Up | Not Down | Not Up |
| 9 | DUNPROT4 | Up Max. | Don't Care | Up Max. | Up 100% | Up Max. |
| 10 | DUN-VEG9 | Up Max. | Don't Care | Up Max. | Up 100% | Up Max. |
| 11 | ECOINTG4 | Not Down | Don't Care | Up Max. | Up Max. | Not Down |
| 12 | MANAGE$2 | Don't Care | Up 50% | Up 20% | Up 100% | Up 20% |
| 13 | GULF-ER5 | Not Up | Not Up | Down Max. | Not Up | Not Up |
| 14 | HWYLOSS5 | Down Max. | Don't Care | Don't Care | Don't Care | Not Up |
| 15 | HUMA-ER5 | Not Up | Not Up | Down 80% | Down Max. | Down 50% |
| 16 | COMRCE$0 | Up Max. | Don't Care | Up 15% | Don't Care | Up 50% |
| 17 | BLKSEDI5 | Not Up | Don't Care | Down 80% | Down Max. | Not Up |
| 18 | PLANING1 | Don't Care | Up 50% | Up 20% | Not Down | Up 10% |
| 19 | PUBEDUC1 | Up Max. | Up 100% | Up 50% | Up Max. | Up 10% |
| 20 | RIV-SND5 | Not Down | Don't Care | Up 80% | Up 50% | Up 80% |
| 21 | SANDBUD8 | Not Down | Don't Care | Up Max. | Up 100% | Up Max. |
| 22 | SETBACK1 | Not Up | Up 50% | Up 100% | Up Max. | Not Down |
| 23 | SHIPTRF0 | Don't Care | Don't Care | Up 20% | Don't Care | Up 50% |
| 24 | STCOORD1 | Don't Care | Up 100% | Up 20% | Up Max. | Up 20% |
| 25 | SUBSIDE5 | Down Max. | Not Up | Not Up | Not Up | Down Max. |
| 26 | TOURSM$0 | Up Max. | Don't Care | Up 30% | Up 50% | Up 50% |
| 27 | TRASH 5 | Not Up | Don't Care | Down 80% | Down Max. | Down Max. |
| 28 | VEH-BEA0 | No Change | Don't Care | Down 50% | Not Up | Down 50% |
| 29 | WETLAND4 | Up 50% | Don't Care | Up Max. | Up Max. | Up 50% |
| 30 | HABLOSS6 | Not Up | Don't Care | Down Max. | Down Max. | Down 50% |

Objective Specified for Each Variable by Each Group

| | | GROUP | | | | |
|---|---|---|---|---|---|---|
| No. | Variable | Ports | CityGov | GalvesCo | JefferCo | HarrisCo |
| 1 | SCI-DAY1 | Up 25% | Up Max. | Up Max. | Up Max. | Up 100% |
| 2 | RESRCH$2 | Up 25% | Up 80% | Up 100% | Up 100% | Up 50% |
| 3 | BAY-ERO5 | Down 25% | Down Max. | Down 50% | Down Max. | Down Max. |
| 4 | BAY-VEG9 | Up 25% | Up Max. | Up Max. | Up Max. | Up 100% |
| 5 | BEANOUR3 | Up 25% | Up Max. | Up 50% | Up Max. | Up 100% |
| 6 | BEA-RP$2 | Up 25% | Up Max. | Up Max. | Up Max. | Up 100% |
| 7 | BLKSEDC5 | Down 25% | Down 60% | Down 25% | Down 20% | Down 50% |
| 8 | DGREUSE3 | Up Max. | Up 80% | Up 100% | Up Max. | Up Max. |
| 9 | DUNPROT4 | Up 25% | Up 20% | Up Max. | Up Max. | Up 100% |
| 10 | DUN-VEG9 | Up 25% | Up 75% | Up Max. | Up Max. | Up 100% |
| 11 | ECOINTG4 | Not Down | Up Max. | Up Max. | Up Max. | Not Down |
| 12 | MANAGE$2 | Up 25% | Up Max. | Up Max. | Up Max. | Up 100% |
| 13 | GULF-ER5 | Not Up | Down Max. | Down 50% | Down Max. | Not Up |
| 14 | HWYLOSS5 | Down Max. | Down Max. | Down 75% | Down Max. | Down Max. |
| 15 | HUMA-ER5 | Down Max. | Down 50% | Down Max. | Down Max. | Down Max. |
| 16 | COMRCE$0 | Up 100% | Up Max. | Up 25% | Up Max. | Up Max. |
| 17 | BLKSEDI5 | Down 25% | Down 10% | Down 50% | Down 50% | Down Max. |
| 18 | PLANING1 | Up 100% | Up 80% | Up 50% | Not Down | Up Max. |
| 19 | PUBEDUC1 | Up 100% | Up 80% | Up Max. | Up Max. | Up Max. |
| 20 | RIV-SND5 | Up 25% | Not Down | Up 25% | Up 50% | Up 100% |
| 21 | SANDBUD8 | Up Max. | Up 80% | Up 10% | Up Max. | Up 50% |
| 22 | SETBACK1 | Up 100% | Not Down | Up Max. | Up Max. | Up 100% |
| 23 | SHIPTRF0 | Up 100% | Not Down | Up 5% | Not Down | Up 100% |
| 24 | STCOORD1 | Up 100% | Up 50% | Not Down | Up 30% | Up 100% |
| 25 | SUBSIDE5 | Down Max. | Down Max. | Down Max. | Down Max. | Down Max. |
| 26 | TOURSM$0 | Up Max. | Up Max. | Up 100% | Up Max. | Up Max. |
| 27 | TRASH 5 | Down Max. | Down Max. | Down Max. | Down Max. | Down Max. |
| 28 | VEH-BEA0 | Down Max. | Down 50% | Down 75% | Down Max. | Down Max. |
| 29 | WETLAND4 | Up 50% | Don't Care | Not Down | Up Max. | Up Max. |
| 30 | HABLOSS6 | Down Max. | Down Max. | Down Max. | Down Max. | Down Max. |

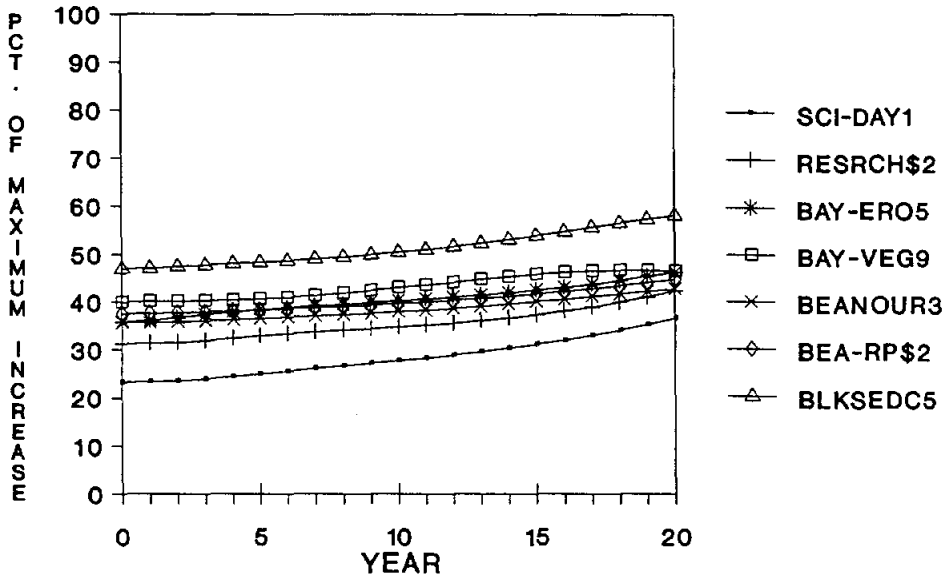
Objective Specified for Each Variable by Each Group

| No. | Variable | GROUP SenatorB | SenatorP | SenatorT | StateAgn | FedAgn |
|---|---|---|---|---|---|---|
| 1 | SCI-DAY1 | Up Max. | Up 50% | Up 15% | Up 50% | Up 25% |
| 2 | RESRCH$2 | Up 100% | Up 50% | Up 15% | Up 50% | Up 10% |
| 3 | BAY-ERO5 | Not Up | Down Max. | Down Max. | Not Up | Down 50% |
| 4 | BAY-VEG9 | Up 30% | Up Max. | Up Max. | Up 30% | Up 15% |
| 5 | BEANOUR3 | Up 25% | Up Max. | Not Up | Up 25% | Up Max. |
| 6 | BEA-RP$2 | Up 25% | Up Max. | Not Up | Up 25% | Up Max. |
| 7 | BLKSEDC5 | Not Up | Not Up | Down 80% | Not Up | Down 15% |
| 8 | DGREUSE3 | Up Max. | Up Max. | No Change | Up Max. | Up Max. |
| 9 | DUNPROT4 | Up Max. | Up Max. | Up Max. | Up Max. | Up 20% |
| 10 | DUN-VEG9 | Up Max. | Up 75% | Up Max. | Up 50% | Up 15% |
| 11 | ECOINTG4 | Up Max. | Up Max. | Up Max. | Not Down | Not Down |
| 12 | MANAGE$2 | Up Max. | Up Max. | Up 25% | Up Max. | Up Max. |
| 13 | GULF-ER5 | Not Up | Down 25% | Down Max. | Not Up | Down 50% |
| 14 | HWYLOSS5 | Not Up | Down Max. | Don't Care | Not Up | Don't Care |
| 15 | HUMA-ER5 | Down 20% | Down 25% | Down Max. | Down 20% | Down 20% |
| 16 | COMRCE$0 | Up Max. | Up Max. | Don't Care | Not Down | Don't Care |
| 17 | BLKSEDI5 | Down 40% | Not Up | Down 80% | Not Up | Down 15% |
| 18 | PLANING1 | Up Max. | Up Max. | Up 20% | Up 50% | Up Max. |
| 19 | PUBEDUC1 | Up Max. | Up Max. | Up 50% | Up Max. | Up 150% |
| 20 | RIV-SND5 | Up 50% | Up Max. | Up 80% | Not Down | Up 15% |
| 21 | SANDBUD8 | Up 10% | Up 50% | Up Max. | Up 10% | Up Max. |
| 22 | SETBACK1 | Up Max. | Up Max. | Up 100% | Up Max. | Up 50% |
| 23 | SHIPTRF0 | Not Down | Up Max. | Don't Care | Not Down | Don't Care |
| 24 | STCOORD1 | Up 20% | Up Max. | Up 20% | Up Max. | Up Max. |
| 25 | SUBSIDE5 | Down 25% | Down Max. | Not Up | Not Up | Down 50% |
| 26 | TOURSM$0 | Up Max. | Up Max. | Up 20% | Not Down | Don't Care |
| 27 | TRASH 5 | Down Max. | Down Max. | Down 80% | Down 50% | Down 50% |
| 28 | VEH-BEA0 | Not Up | No Change | Not Up | Not Up | Down 20% |
| 29 | WETLAND4 | Up 50% | Don't Care | Up Max. | Not Down | Not Down |
| 30 | HABLOSS6 | Down 50% | No Change | Down Max. | Not Up | Not Up |

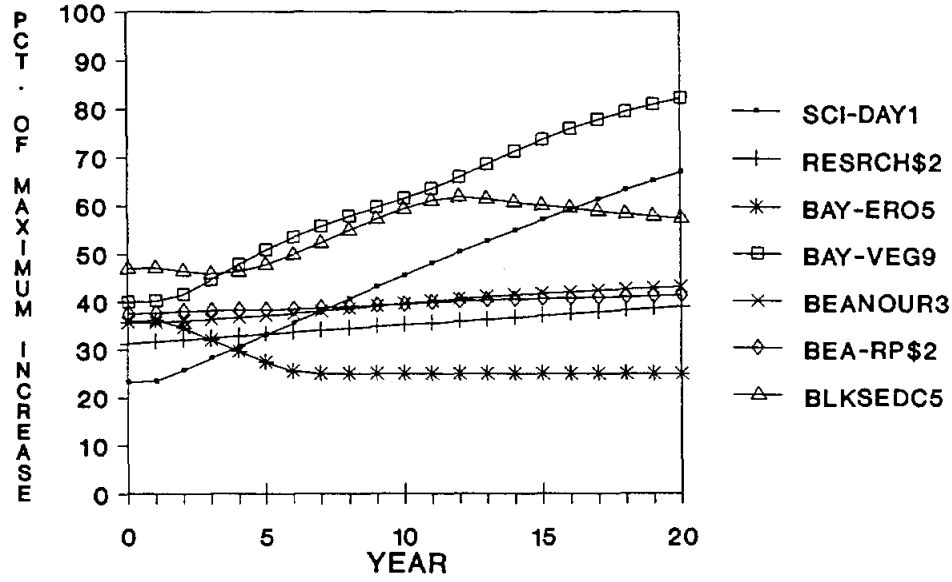
# APPENDIX B
# Simulated Trends

# Shoreline Erosion/Dune Protection

## Simulated Trends for Current Policy

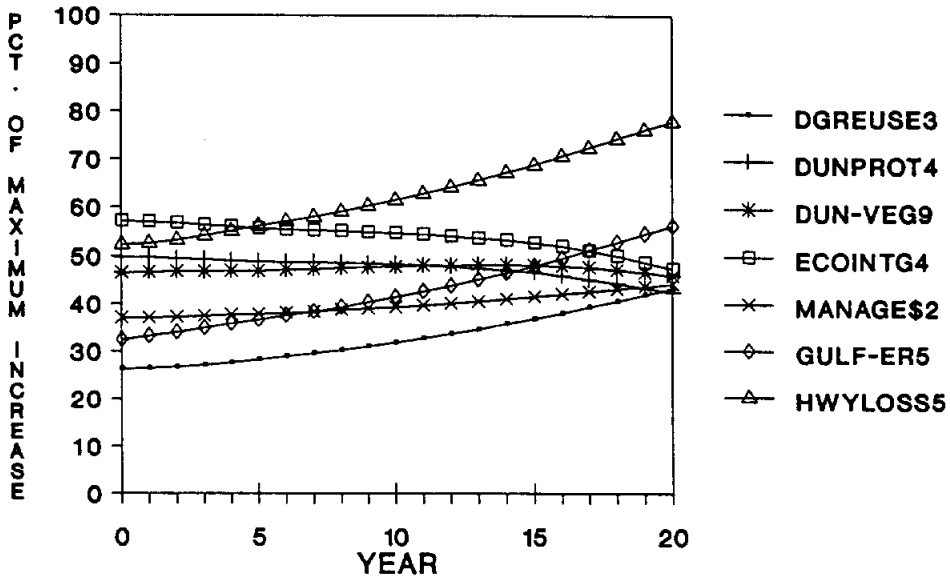



## Simulated Trends for Recommended Policy

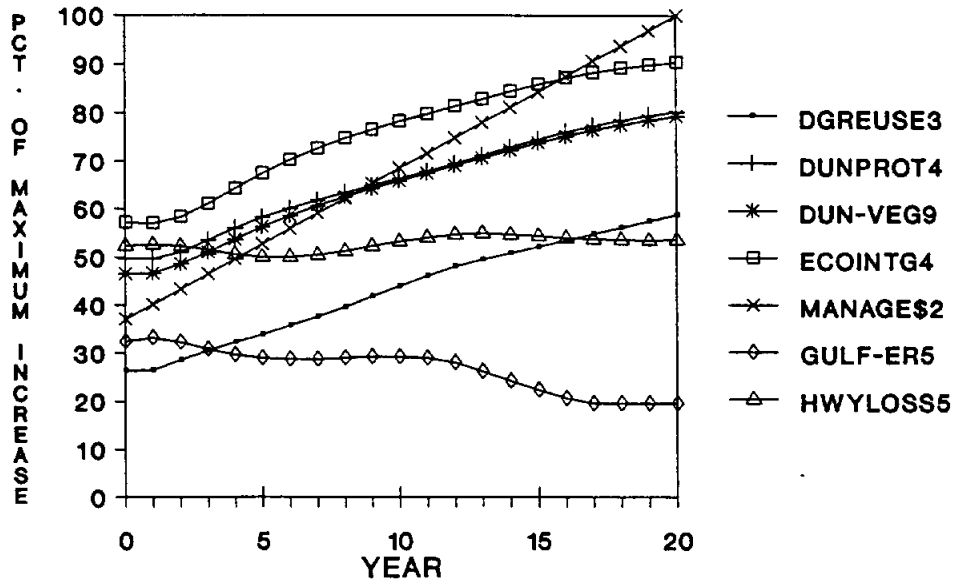


# Shoreline Erosion/Dune Protection

## Simulated Trends for Current Policy

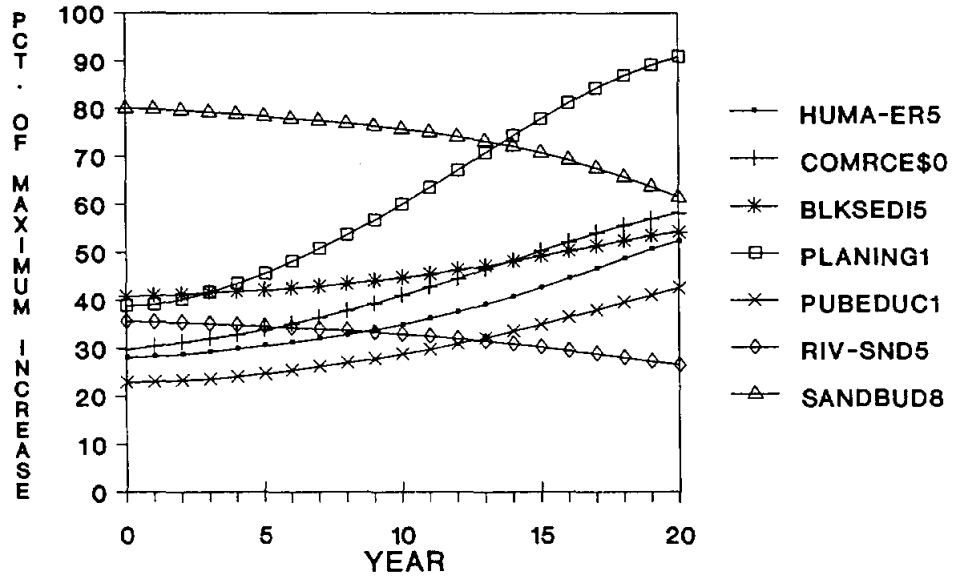



## Simulated Trends for Recommended Policy

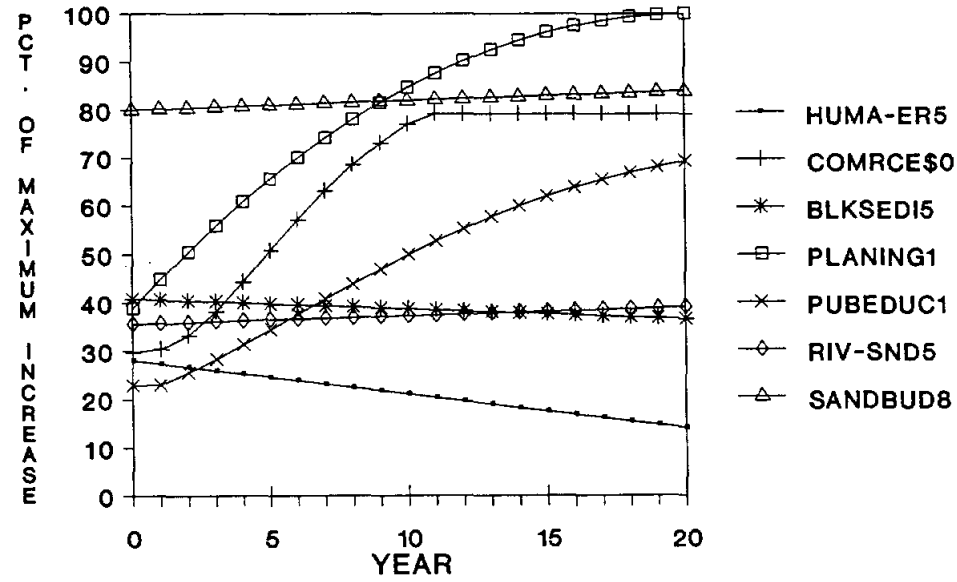


# Shoreline Erosion/Dune Protection

## Simulated Trends for Current Policy

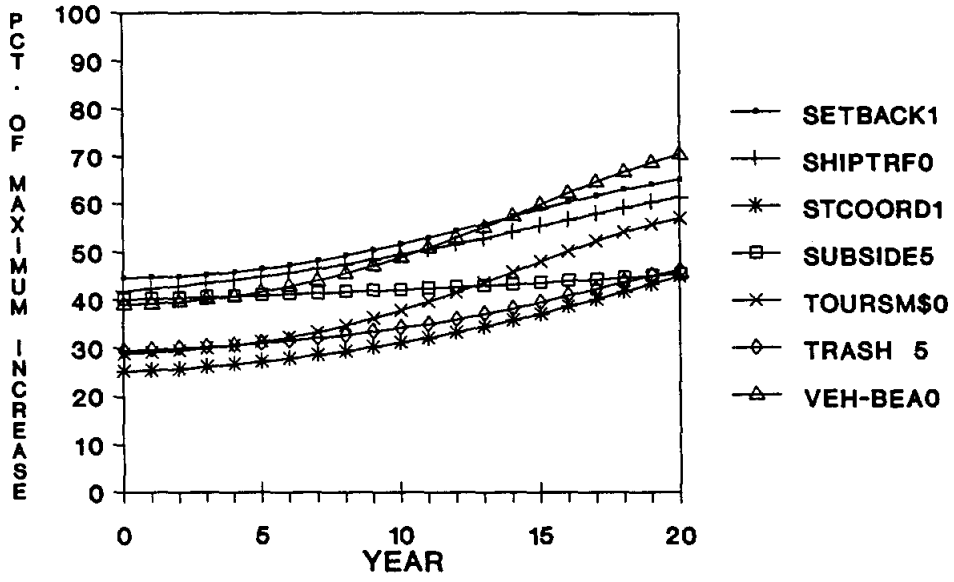



## Simulated Trends for Recommended Policy

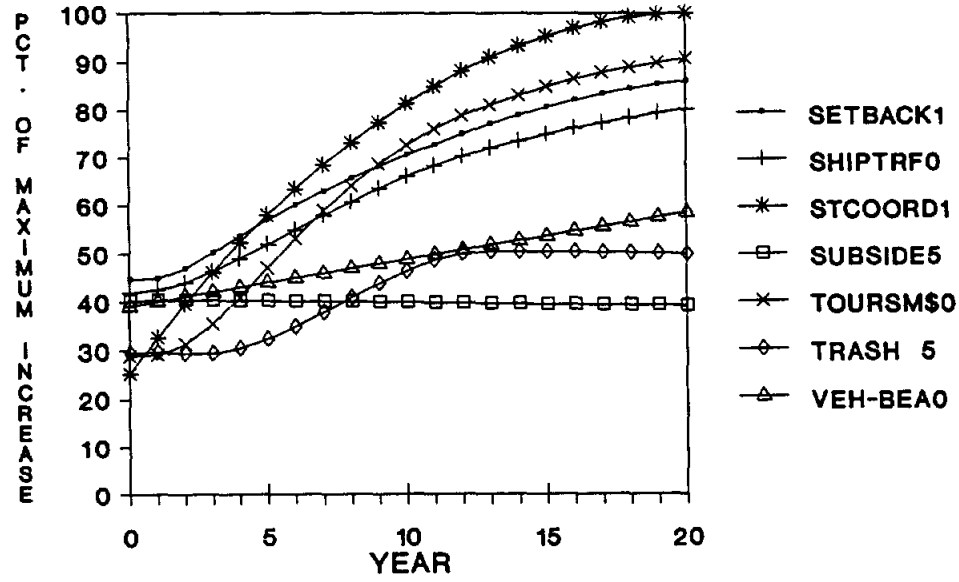


# Shoreline Erosion/Dune Protection

## Simulated Trends for Current Policy

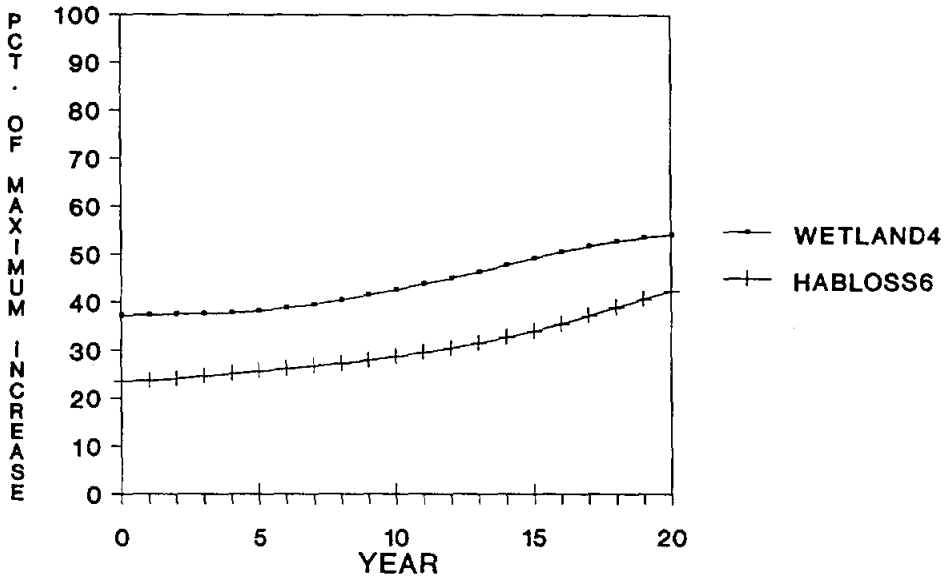



## Simulated Trends for Recommended Policy

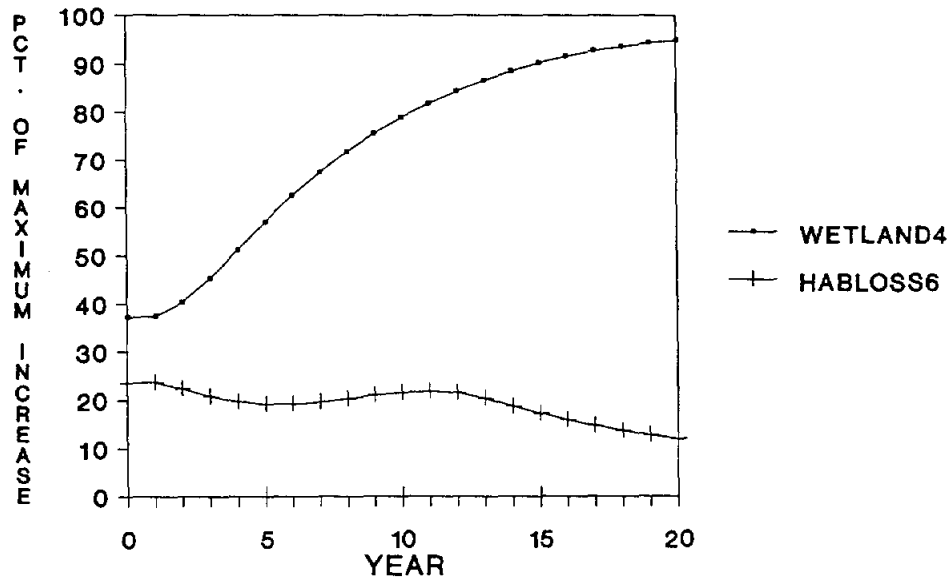


# Shoreline Erosion/Dune Protection

## Simulated Trends for Current Policy




## Simulated Trends for Recommended Policy



# APPENDIX C
# Region I Foundation Workshop

## REGION I

## PARTICIPANT LIST

John Arrington, *Galveston resident*
Peter Bowman, *University of Houston - Clear Lake*
Patsy Clapper, *Representative Mark Stiles*
Marty Conway, *Senator Carl Parker*
Dale Durr, *Chevron Chemical Co.*
John Eberling, *Gulf Coast Rod, Reel & Gun Club*
Russell E. Eitel, *Galveston Beach Environmental Committee*
Frank Frankovich, *Dannenbaum Engineering*
Richard Gorini, *Port of Houston*
Pat Halliseey, *Galveston County Parks Board*
Wilson Hillman, *Standley (commercial fishing)*
Neal Hunt, *Senator Chet Brooks*
James D. McNicholas, *Jefferson County Drainage District Committee*
Karen O'Neal, *Houston/Galveston Subsidence District*
A.R. "Babe" Schwartz, *lobbyist/attorney*
Eddie Seidensticker, *U.S. Soil Conservation Service*
Linda Shead, *Galveston Bay Foundation*
Gwen Smith, *Texas League of Women Voters*
Sam O. Smith, *Jefferson County Drainage District Committee*
Sharron Stewart, *Texas Environmental Coalition*
Robert Stroder, *Jefferson Co. Engineer*
Mary Ellen Summerlin, *Mayor, Port Arthur*
Steve Valerius, *Hollywood Marine, Inc.*
John Watson, *Mitchell Energy and Development*
Kerry Whelan, *Houston Power and Light*

**REGION I**
**RANKED VARIABLE LIST**

**Issue: SHORELINE EROSION/DUNE PROTECTION**

| RANK | VARIABLE | DEFINITION |
|---|---|---|
| 1 | Gulf Shore Erosion | Area Lost/Yr |
| 2 | Public Education | Time/Yr |
| 3 | Inland Struct. that Impede Sed. | Area Blocked/Yr |
| 4 | Planning | # Plans/Yr |
| 5 | State Interagency Coordination | MOUs/Yr |
| 6 | Dune Erosion | Ft Lost/Yr |
| 7 | Bay Shoreline Erosion | Area Lost/Yr |
| 8 | Highway Losses | Miles Lost/Yr |
| 9 | Inland Waterway Loss | # Breaks Through Barrier Island |
| 10 | Setback Lines | Ft |
| 11 | Bay Shoreline Vegetation | Area Covered |
| 12 | Beach Nourishment | Cubic Yds/Yr |
| 13 | Pop. Density on Coastline | #/Sq Mile |
| 14 | Gen. Fed/State Approp. to Mgmt. | $/Yr |
| 15 | Boundary Disputes | #/Yr |
| 16 | Storm Events | #/Yr |
| 17 | Dune Vegetation | Area Covered |
| 18 | Coast. Struct. Impd. Sediment | Area Blocked/Yr |
| 19 | Dune Protection | $ Allocated/Yr |
| 20 | Subsidence | In/Yr |
| 21 | Dune Access | # People/Yr |
| 22 | Mechanical Beach Cleaning | Area Cleaned Mechanical/Yr |
| 23 | Regulations | Miles Affected/Yr |
| 24 | Vehicular Beach Access | # Vehicles/Yr |
| 25 | Sea Level Rise | In/Yr |
| 26 | Shoreline Boundary | Mean High Tide |
| 27 | Dredged Spoil (Material) Reused | Vol/Yr |
| 28 | Vehicular Dune Access | # Vehicles/Yr |
| 29 | Compliance | Notices of Violation/Yr |
| 30 | Property Loss | $/Yr |

# 1 Problem for Region I

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 1<br>Gulf Shoreline Erosion<br>(Area Lost/Yr) | - Destroys ecology<br>- Deny access<br>- Destroys property<br>- Destroys tax base<br>- Destroys dunes<br>- Increases insurance rates<br>- Loss of habitat<br>- Impacts on the economy<br>- Permanent loss of shoreline<br>- Loss of wetlands<br>- Loss of highway structures<br>- Loss of sand budget<br>- Erosion is inevitable<br>- Threatens wildlife<br>- Threatens safety<br>- Threatens recreation<br>- Loss of land value<br>- Social loss<br>- Loss of income<br>- Permanent loss of beach<br>- Reduction in tourism revenue<br>- Highest impact on coastal residents | - Beneficial use of dredge material<br>- Better management<br>- Mitigation<br>- Dune management<br>- Local tax districts<br>- Public education<br>- Funding of R & D to impede erosion and help shoreline recovery<br>- Citizen and industry cooperation<br>- Formulate a plan<br>- Establish guidelines to implement plan<br>- Provide funding for plan<br>- Inspect projects<br>- Limit types of beach cleaning<br>- Limit vehicle use<br>- Only clean man-made objects off beach<br>- Construct groins<br>- Construct seawalls<br>- Control access<br>- Enforce pollution laws<br>- Protect wetlands<br>- Protect nature conservation districts<br>- Erosion prevention plan<br>- Beach nourishment<br>- Dune replacement<br>- Vegetation planting |
| # 7<br>Bay Shoreline Erosion<br>(Area Lost/Yr) | - Loss of bay productivity<br>- Loss of biotic diversity<br>- Loss of land<br>- Sediment in estuaries<br>- Loss of tax revenue<br>- Loss of wetland habitat<br>- Decline in water quality | - Beneficial use of dredge material<br>- Use of vegetation<br>- Use of structures<br>- Cost sharing<br>- Tax incentives<br>- Education |
| # 2<br>Public Education<br>(Time/Yr) | | - Increase education programs |
| # 3<br>Inland Structures that Impede Sediment<br>(Areas Blocked/Yr) | - Dams sediment and reduces sediment budget<br>- Beaches are not replenished naturally | - Stop building dams and reservoirs |
| # 5<br>State Interagency Coordination<br>(MOUs/Yr) | | - Create interagency resource policy board composed of agency heads |

# 1 Problem for Region I

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 8<br>Highway Losses<br>(Miles Lost/Yr) | - Expensive to reconstruct<br>- Loss of wetlands by saltwater intrusion | - Relocate landward<br>- Establish intervening dunes to protect from storm damage |
| # 9<br>Inland Waterway Loss<br>(Barrier Island Breakthroughs) | - Destroys beaches for tourism<br>- Interrupt navigation<br>- Erode wetlands<br>- Destroy protected salt marshes | - Dune enhancement<br>- Bulkheading where dune is gone |
| # 10<br>Setback Lines<br>(Feet) | - Conflicts caused by "rolling vegetation" line | - Establish a bureau of beach erosion in GLO<br>- Work with universities and technical consultants |
| # 11<br>Bay Shoreline Vegetation<br>(Area Covered) | - Lack of vegeation causes erosion to progress | - Reduce nutrient and toxic inflows into bays<br>- Support planting programs<br>- Regulate and control boat and ship wake controls<br>- Maintain salinity regimes in bays by regulating freshwater inflows and channel dredging<br>- Reduce shrimp trawling in bays because it increases turbidity |
| # 13<br>Population Density<br>(#/Sq Mile) | - All environmental problems caused by population increase | - Research on new birth control methods<br>- Educate public in effective methods |
| # 18<br>Coastal Structures that Impede Sediment<br>(Areas Blocked/Yr) | - 60 - 80% of all erosion is due to man-made inlets | - Inlet sand bypass systems for all new inlets and existing inlets |
| # 30<br>Property Loss<br>($/Yr) | - Public and private sector losses<br>- Habitat Loss<br>- Loss of biological productivity ($)<br>- Loss of tourism ($) | - Natural controls (vegetation cover)<br>- Structural controls (wave dissipation)<br>- Zoning to reduce private sector impacts<br>- Facilitate property owners ability to protect property<br>- Increased planning<br>- Research<br>- Streamlined licensing |

# APPENDIX D
# Region II Foundation Workshop

## REGION II

## PARTICIPANT LIST

Anthony Amos, *University of Texas Marine Science Institute*
J.C. Barr, *Port Aransas City Government*
Hugo Berlaga, *Texas House of Representatives*
Paul Carangelo, *Port of Corpus Christi*
George Deshotels, *Matagorda County, Precinct 2*
Carl Duncan, *Commissioner, Precinct 2*
Sharon Weaver, *Representative Robert Early*
Alex Hernandez, *Calhoun County Judge*
Henry Hildebrand, *Environmental and fisheries*
William H. Holmes, Jr., *Boating Trades Association of Texas*
Todd Hunter, *Texas House of Representatives*
Ray Allen, *Central Power and Light*
Robert Jones, *University of Texas Marine Science Institute*
Ted Jones, *Environmental*
Kenneth Lester, *Mayor, Port Lavaca*
J.P. Luby, *Nueces County Commissioner*
David McKee, *Corpus Christi State University*
Joe Moseley, *Shiner, Moseley and Associates, Inc.*
Bob Mullen, *Builder*
Erma Patton, *Patton Sea Foods*
George Fred Rhodes, *Port Lavaca resident*
Harrison Stafford, II, *County government*
Charles Stone, *County government*
Mary Thorpe, *Del Mar College*
Vic Hines, *Senator Carlos Truan*
Ro Wauer, *National Audubon Society*
Willie Younger, *Texas A&M Marine Advisory Service*

**REGION II**
**RANKED VARIABLE LIST**

**Issue: SHORELINE EROSION/DUNE PROTECTION**

| RANK | VARIABLE | DEFINITION |
|---|---|---|
| 1 | Sand Budget | Vol Sand Available |
| 2 | Hurricanes | Ft Lost/Event |
| 3 | Sea Level Rise | In/Yr |
| 4 | Bay Shoreline Loss | Ft/Yr |
| 5 | Institutional Fragmentation | # Entities Responsible |
| 6 | Vehicular Traffic | # Vehicles on Beach/Day |
| 7 | Biological Diversity | Index Level |
| 8 | Ship Traffic | Frequency by Size |
| 9 | Impact on Commerce | $ |
| 10 | Tourism | $ Generated |
| 11 | Offshore Sediment FLow | Vol |
| 12 | Hurricanes | Frequency |
| 13 | Riparian Rights | Area Lost to Private Landowners |
| 14 | Endangered Species | # |
| 15 | Recreational Fisheries | Fishing Success |
| 16 | Barrier Island Passes | Design & Maintenance |
| 17 | Sand Beach Width | Ft from Water |
| 18 | Beach Front Structures | Ft Beach Impacted |
| 19 | Ecological Integrity | Area Undisturbed |
| 20 | Loss of Storm Protection | Area Affected |
| 21 | Vegetation | % Area Dune Covered |
| 22 | Wetlands | Area/Yr |
| 23 | Erosion Control Structures | #/Mi |
| 24 | Jettys | # |
| 25 | Recreation Use | #/Area |
| 26 | Riverine Supplied Sand | Vol |
| 27 | Beach Cleaning | Sand Removed from Beach |
| 28 | Dune Dimensions | Vol Sand Stored |
| 29 | Scientific Uncertainty | # Conflicting Witnesses |
| 30 | Available Data | Useful Information |

# 1 Problem for Region II

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 1<br>Sand Budget<br>(Vol. of Sand Available) | - Changes in the width and shape of beaches<br>- Dams and other stream control measures are curtailing the delivery of sand to beaches and bay marshes<br>- Most critical variable to shoreline erosion<br>- Lack of sand places beaches, dunes and ecosystem in jeopardy<br>- Impact extends beyond the coastal zone | - Control structures that block the movement of sand<br>- Unblock sand behind dams<br>- Increase knowledge about the movement of sand along the coast<br>- Dredge the Brazos River delta and pump sediments to nearby beaches (e.g., Sargent Beach)<br>- Find methods to allow sediment to bypass dams<br>- Increase stream velocity<br>- Halt the loss of sediment carried by the Mississippi River (e.g., channelization)<br>- Increase use of dredge material for beach nourishment<br>- Curtail development of new reservoirs that serve as sediment traps<br>- Pass/channel construction to reduce interruptions of longshore currents<br>- Reduce erosion control structures<br>- Prevent vehicle traffic on beaches<br>- Prevent pedestrian traffic in fore dunes<br>- Reduce cuts through dune ridge<br>- Reduce permanent development on barrier islands<br>- Define bay beaches<br>- Collect data<br>- Reduce wind erosion<br>- Increase public awareness<br>- Control bay up current and down current impact of shoreline construction<br>- Measure and monitor available sand<br>- Protect and enhance available sand<br>- Consider recreational and economic needs of the people of Texas<br>- Dune stabilization using vegetation<br>- Prohibiting actions which remove sand from ecosystem |

# 1 Problem for Region II

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 4<br>Bay Shoreline Loss<br>(Ft/Yr) | - Loss of valuable structures<br>- Shallowing of bays and channels<br>- Damage to wetlands<br>- Damage to oyster beds<br>- Silting of estuaries<br>- Loss of property<br>- Recreation is diminished | - Simplify permitting procedures for approved erosion control structures<br>- Develop low cost method of shoreline erosion control<br>- Plant vegetation<br>- Install protection measures where feasible<br>- Develop a program to control sand and silt<br>- Study local segments of coast<br>- Attack problem on each segment<br>- Set back provisions for new construction<br>- Determine how to help nature build dunes<br>- Help nature build dunes |
| # 5<br>Institutional Fragmentation<br>(# of Entities Responsible) | - Too many different opinions on the resolution of problems<br>- Too many agencies with overlapping responsibilities<br>- Confusion and frustration in the private sector<br>- Delays in solving problems and setting policy | - More state and federal funding needed<br>- Educate public about problems<br>- Need more data<br>- Extend the width of beaches from the water<br>- Limit ordinance powers of counties on beach front structures<br>- Form one agency or give existing agency overall regulatory authority |
| # 7<br>Biological Diversity<br>(Index Level) | - Threatened by shoreline erosion<br>- Wetlands<br>- Bay bottom vegetation<br>- Commercial fisheries<br>- Recreational fisheries<br>- Endangered species<br>- Tourism<br>- Sand Budget<br>- Dunes<br>- Littoral equilibrium<br>- Beach width<br>- Storm protection<br>- Riparian rights<br>- Beach front structures<br>- Bay side erosion<br>- Ecological integrity | - Maximize wetlands<br>- Maximize dune protection<br>- Enforce the Endangered Species Act<br>- Reduce herbicide use and pollution<br>- Public education program on value of biodiversity and sustainable development<br>- Inventory of natural systems<br>- Identify areas<br>- Complete protection for top area<br>- Lesser protection for lower priority areas<br>- Restoration programs for top areas<br>- Long-term monitoring to insure continuation<br>- Write guidelines on managing |

# 1 Problem for Region II

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 7 (continued)<br>Biological Diversity<br>(Index Level) | - Biological diversity has declined drastically<br>- Need biological diversity for sustainable development<br>- Biological diversity supports long-term ecosystem productivity | various level areas<br>- Incorporate system into CZM program for further management techniques |
| # 18<br>Beach Front Structures<br>(Ft of Beach Impacted) | - Cannot prevent erosion<br>- Cannot prevent sea level rise<br>- Structures behind beach will become beach front structures<br>- Impair public access<br>- Accelerate erosion<br>- Raise "call" for expensive protective measures<br>- Some property owners only have access from the beach | - Require all future buildings to be set back a distance equal to at least 100 years of present/historical erosion<br>- Designate lead agency<br>- Establish penalties<br>- Provide enforcement<br>- Use existing erosion data<br>- Amend Dune Protection Act to make setbacks mandatory for all counties<br>- Aggressively enforce existing laws<br>- Require inlet management plan for beach structures<br>- No development without access from some source other than the beach |
| # 30<br>Available Data<br>(Useful Information) | - Lack of cause/effect understanding<br>- Lack of scientific input to management<br>- Lack of measured rates of change<br>- Lack of integrated system and validated model<br>- Large body of information exists on causes and effects of gulf and bay shoreline erosion<br>- Cause of erosion is loss of riverine input and man induced restrictions<br>- Many persons and institutions with no experience are compiling and disseminating useless information<br>- Misuse of available and useful data | - Model Texas coastal zone sediment budget (origin, deposition, forces)<br>- Conduct research on impact of vehicular traffic on beaches<br>- Numerous other questions need research<br>- Prime need is research funding<br>- Expert review of state or federal agency programs<br>- Creat an office of Coastal Restoration and Management<br>- Define societal goals<br>- Direct resources toward achieving societal goals |
| # 6<br>Vehicular Traffic<br>(# Vehicles on Beach/Day) | - Too many vehicles on beach<br>- Significant impact on ecosystem<br>- Causes shoreline erosion<br>- Impact on beach vegetation<br>- Damage to dunes, reducing their ability to buffer hurricanes | - Limit vehicular beach access to specific areas<br>- Provide pedestrian walkways over dunes<br>- Provide parking behind dunes<br>- Use barricades in front of dunes to limit vehicular traffic<br>- Develop a series of protected "pocket" beaches where wildlife and vegetation are protected from vehicular traffic |

# 1 Problem for Region II

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 11<br>Offshore Sediment Flow<br>(Vol) | - Most beach erosion is due to the lack of sand in longitudinal currents caused by:<br>- Flood control dams<br>- Jettys<br>- River deltas | - Replenish sand in currents<br>- Look at each beach; identify cause of erosion; identify responsible party; hold responsible party accountable |
| # 15<br>Recreational Fisheries<br>(Fishing Success) | - Private industry and the state are highly dependent on revenue from sport fishing | - Increase freshwater inflow<br>- Preserve wetlands<br>- Preserve biological diversity<br>- Increase water flow through inlets<br>- Increase water flow through natural passes |
| # 16<br>Barrier Island Passes<br>(Design and Maint) | - Passes are very expensive<br>- Dredging and maintenance of passes is constant and costs "mega-bucks"<br>- Who will pay? | - Limit/prohibit control of offshore sediment flow<br>- Hurricane reporting<br>- Better available data<br>- Education |

# APPENDIX E
# Region III Foundation Workshop

## REGION III

## PARTICIPANT LIST

Gary Becher, *City Manager's Office, SPI*
Sid Beckman, *Brownsville Navigation District*
Deyaun Boudreaux, *Texas Environmental Coalition*
Sudie Blakcburn, *Keep Brownsville Beautiful*
Calvin Byrd, *Mayor, Port Isabel*
Jack Campbell, *Brownsville Economic Development Council*
Mary Lou Campbell, *Sierra Club*
Ken Conway, *Cameron County Parks*
Ed Cooper, *Valley Sportsman Club*
Merriwood Ferguson, *Frontera Audubon Society*
J.A. Garcia, Jr., *Kenedy County Judge*
Joe Garcia, *Representative Eddie Lucio*
Antonio O. Garza, Jr., *Cameron County Judge*
Eustolio Gonzalez, *Senator Carlos Truan*
Wayne Halbert, *Harlingen Irrigation District*
Vic Hines, *Senator Carlos Truan*
Don Hockaday, *Coastal Studies Lab, University of Texas - Pan Am*
Herb Houston, *Alderman, SPI*
Darlene Caines, *SPI National Seashore*
Harris Lasseigne, Jr., *Texas Shrimp Association*
Robert Lerma, *Attorney*
Eddie B. Long, *Texas Pipe Trades Association*
Richard McInnis, *Gulf Coast Conservation Association*
Diana Munoz, *Representative Larry Warner*
Pete Pranis, *COSTEP*
Sonny Ramirez, *Businessman*
Mike Reuwsaat, *Kleberg County Park System, King Ranch*
Laurel Devaney, *Laguna Atascosa National Wildlife Refuge*
Rob Youker, *Lower RGV Boating Trades Assocation*

**REGION III**
**RANKED VARIABLE LIST**

**Issue: SHORELINE EROSION/DUNE PROTECTION**

| RANK | VARIABLE | DEFINITION |
|---|---|---|
| 1 | Wildlife Habitat Loss | Area Lost |
| 2 | Sand Supply | Volume |
| 3 | Vegetation Density | Biomass |
| 4 | Dune Protection Regulations | # |
| 5 | Vehicles on Beach | #/Day |
| 6 | Endangered Species | # |
| 7 | Human Induced Erosion | Ft/Yr |
| 8 | Dune Area | Acres |
| 9 | Beach Replenishment Programs | $/Yr |
| 10 | Character of Dune Line | Frequency of Breaks |
| 11 | Tides | Aver Dist of Fluctuation |
| 12 | Onshore Structures | Dist from Mean High Tide |
| 13 | Vegetation Line | Dist from Mean High Tide |
| 14 | Beach Erosion | Ft/Yr |
| 15 | Beach Accessibility | Acs/Mi of Easily Access Beach |
| 16 | Storm Surge Intensity | Intensity |
| 17 | Setbacks | Ft from Mean Low Tide |
| 18 | Storm Surge Frequency | Frequency |
| 19 | People on Beach | #/Mi |
| 20 | Beach Use | #/Mi |
| 21 | Ownership (Private/Dev) | % |
| 22 | Trash | Tons/Mi |
| 23 | Dune Ht | Ft Above Sea Level |
| 24 | Vehicle Density | #/Linear Mile |
| 25 | Recreational Boat Traffic | #/Yr |
| 26 | Hard Surface Road Behind Dune | Mi Affected |
| 27 | Ownership (Private) | % |
| 28 | Ownership (Public) | % |
| 29 | Dune Stability | % Covered by Vegetation |
| 30 | Littoral Drift | Cu Yds Mi/Yr |
| 31 | Island Migration | Ft Movement/Yr |

# 1 Problem for Region III

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| Problem Variable | Problem Explanation | Proposed Action |
| # 2<br>Sand Supply<br>(Vol) | - Needed for dune and barrier islands so they can provide storm surge protection<br>- Needed for natural beach recovery after storms<br>- Needed to define boundaries of bay and estuarine systems<br>- Cause of nearly all beach erosion isues<br>- Precipitated dune protection efforts<br>- Loss of beaches due to the trapping of sediment behind dams<br>- Loss of dune sand due to development<br>- Loss of sand to beaches on barrier islands because dams reduce the natural supply of sand<br>- Islands will eventually disappear<br>- Wind erosion is moving sand across islands and into bays<br>- Loss of sand due to beach cleaning<br>- Loss of dunes because sand is used for fill for buildings on beaches<br>- Sea walls stop interchange of sand with wave action<br>- No sand reservoir<br>- Littoral drift impaired by jetties | - Use cost-effective means to artificially replenish sand on some beaches<br>- Keep existing sand from blowing off the beaches and into the bays<br>- Increase dune protection<br>- Make local dune protection programs mandatory<br>- Decrease destruction of back-dune vegetation<br>- Extend Dune Protection Act to Barrier Island Protection Act<br>- Ban grazing on islands<br>- Reduce developments that reduce equilibrium on islands<br>- Strengthen 404 process pursuant to GAO Audit<br>- Use RTC process to convert non-performing foreclosed real estate<br>- Reduce littoral sand drift caused by jetties and breakwaters<br>- Minimize lake construction<br>- Prevent seawall construction<br>- Prevent seawall construction<br>- Consider lake dredging with sand returned to river<br>- Beach nourishment using beach quality sand from intercoastal canal dredge spoil<br>- Use mechanical means to transport sand from accumulation zones (feeder beaches) to erosion zones (fund with special tax assessments of landowners)<br>- Make dune protection act mandatory<br>- Allow more sediment flow from dams<br>- Ban or minimize hard structures that interrupt sand transport<br>- Use set backs based on local erosion rate |

# 1 Problem for Region III

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 2 (continued)<br>Sand Supply<br>(Vol) | | - Create sediment bypasses in dammed rivers<br>- Forbid removal of sand from barrier islands<br>- Plan for care and replacement of dune vegetation<br>- Enforce current set backs<br>- Limit height of structures adjacent to beach<br>- Discourage 4-wheel vehicles from "dune wrecking" by forbidding use in all jurisdictions<br>- Extend Dune Protection Act to Cameron and Willis Co.<br>- County Dune Protection Committee<br>- Establish set back lines for buildings<br>- Ban hard structures from beach<br>- Enter Federal Coastal Zone Management Plan |
| # 7<br>Human Induced Erosion<br>(Ft/Yr) | - Dune vegetation loss<br>- Wildlife habitat loss<br>- Sand supply<br>- Neglect of the environment is very costly<br>- As the population expands, more damage will be done unless action is taken to regulate how the beaches are used<br>- Inadequate information is provided to the public and decisionmakers<br>- Conflicting information<br>- Failure to consider all consequences of actions<br>- Failure to consider all possible alternatives<br>- Lack of communication to promote discovery of the best possible solution<br>- All parties should win<br>- Severely impacts endangered species<br>- Harms water quality<br>- Impacts estuary productivity<br>- Increases storm damage to natural and man-made systems | - Proper controls<br>- Regulations<br>- Education<br>- Formulate a coastal zone management program<br>- Give authority to local government to make rules to implement policy<br>- Establish user fees to offset program costs<br>- Establish ordinances to regulate user actions<br>- Develop data base on human impacts on beaches<br>- Objectively evaluate the level of impacts<br>- Cost/benefit analysis of impacts<br>- Develop alternatives to impact types<br>- Establish policies to prevent dune destruction<br>- Establish local steering committees to review proposals for development or use<br>- Prevent development of structures that will cause more erosion |

# 1 Problem for Region III

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 7 (continued)<br>Human Induced<br>Erosion<br>(Ft/Yr) | - Major factor affecting the health and survival of the entire coastal system<br>- Increasing population living on the shoreline or dunes have an adverse affect on the ecosystem<br>- Loss of critical habitat for both endangered and non-endangered species<br>- Vegetation which stabilizes dunes is destroyed by structures and foot and vehicle traffic<br>- Repairing ecosystem costs money and time | - Land zoning against hard structures<br>- Eliminate or alter existing structures that cause erosion<br>- Public acquisition and land use zoning to preserve coast areas in native state<br>- no federal flood insurance<br>- Don't try to control natural erosion<br>- Don't put valuable structures in unstable areas<br>- Limit human use to certain areas (e.g., board walks)<br>- Limit development on fragile dunes<br>- Close certain areas to public use during nesting seasons of endangered species<br>- Revegetation/stabilization program to stabilize eroding areas<br>- Establish carrying capacity for shoreline<br>- Environmental education<br>- Designate the gulf as a closed body of water under MARPOL |
| # 29<br>Dune Stability<br>(% Covered by Vegetation) | - Dune stability will solve most other erosion related problems<br>- Without vegetation dunes are nothing but a pile of powder<br>- Vegetation provides habitat and anchors sand | - Remove all vehicles from dune areas<br>- Keep vehicles on parking lots<br>- Use fences & Christmas trees to stabilize dunes<br>- Allow only permanent hard surfaced roads to beach or parking lots<br>- Add park areas for public use<br>- Plant salt resistant plants to stabilize dunes<br>- Plant a mix of species to broaden genetic base<br>- Plant mangrove trees<br>- No property tax increases on projects by private owners<br>- Subsidize planting<br>- Use prisoners and addicts as workers |
| # 1<br>Wildlife Habitat Loss<br>(Area Lost) | - Decline in wildlife populations<br>- It is difficult to artificially replace habitat<br>- Loss of habitat in one place can accelerate habitat loss in other places | - Education<br>- Enhance regulation of pesticides |

# 1 Problem for Region III

Issue: SHORELINE EROSION/DUNE PROTECTION

| Problem Variable | Problem Explanation | Proposed Action |
|---|---|---|
| # 3<br>Vegetation Density<br>(Biomass) | - Reduces erosion<br>- Protects dunes | - Encourage vegetation growth as much as possible |
| # 5<br>Vehicles on Beach<br>(#/Day) | - Dangerous<br>- Destroys natural habitat<br>- Destroys dunes<br>- Kills vegetation on dunes | - Laws<br>- Enforcement<br>- Stiff fines |
| # 14<br>Beach Erosion<br>(Ft/Yr) | - Less beach for public use<br>- Eat into the dune line<br>- Reduce wildlife habitat<br>- Reduce vegetation<br>- Reduce storm protection afforded by dunes | - Develop feasible beach replenishment programs, funding, and maintenance of completed projects<br>- Reduce motor vehicles on the beach<br>- Reduce all-terrain vehicles on the dunes<br>- Reduce development close to the water |