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# Assessing Man's Impact on Wetlands

By G.E. Galloway







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December 1978

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Document provides background discussions of Federal interest in wetlands and summary of evaluation techniques used in the Government and private sectors to evaluate the impacts of various activities on the wetland environment. The characteristics of an ideal evaluation system are defined and a Wetland Evaluation System (WES) is described. The Wetland Evaluation System is applied in abbreviated case studies to construction in the Yazoo Basin in Mississippi and the Neuse River Estuaries of North Carolina. Typical outputs of the WES are provided.

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ASSESSING MAN'S IMPACT ON WETLANDS

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TABLE OF CONTENTS

## PREFACE

In February, shortly after he became President of the United States, Jimmy Carter launched a massive review of Federal water resource projects with an objective of eliminating those on-going and proposed efforts which were environmentally or economically unsound. A key feature for the Carter team in the assessment of environmental impact was the impact of any construction on the dwindling wetland assets of the Nation.

At that time I was serving as head of a U. S. Army Corps of Engineers field unit and several of the unit's projects were subject to the Carter review. Considerable disagreement among experts was obvious as we quickly responded to Washington-level calls concerning wetland impacts in the central portion of the Lower Mississippi Valley. While we were able to respond, to a degree, to the information needs of the Washington Task Force overseeing the review, I was never satisfied that either we or the Washington group had been able to properly define the relative impacts of our proposed projects on the wetlands of our area. It was as if we were attempting to rope a puffy cloud--we couldn't tie anything down.

This paper represents my look for the methodology I would like to have had in March 1977.

The first section provides a short background on federal interest in wetlands and a discussion of how, when, and where man's impact on wetlands occurs. The next section focuses on impact assessment, first by defining the characteristics of a usable evaluation system and then by briefly surveying current evaluation techniques. The third section proposes the Wetland Evaluation System (WES), my concept of an evaluation system. The fourth section applies this model, for illustrative purposes, to abbreviated case studies of wetland evaluation in the Yazoo Basin of Mississippi and the Neuse River Estuary of North Carolina. The paper concludes with some comments on the utility of the WES and the concepts contained within the WES.

The importance to me of the WES rests in its use as a strawman. WES is not a black box; i.e., plug in information, get out decisions. WES is a way of doing the business of evaluation. Examination and use of the WES and an understanding of the features of the WES should be useful to those in the model development arena. WES is a practitioner's approach to evaluation. It is usable today.

This paper was initiated in October 1977 as part of a University of North Carolina Seminar in Land Use and the Environment and was carried to its present form as part of a Seminar on Coastal Land Use. I am indebted to Professors F. Stuart Chapin and Maynard M. Hufschmidt, Department of City and Regional Planning, for their advice, assistance, and comments during the initial development of the WES. Professor Arthur J. Hawley, Department of Geography, provided invaluable aid and guidance in the follow-on efforts, especially with respect to coastal area problems.

I would also like to express my thanks to Mr. Tom Holland, Mississippi River Commission, Mr. Charles Solomon, U. S. Army Engineer Waterways Experiment Station, Mr. Dick Reppert, U. S. Army Engineer Institute for Water Resources, and Mr. Grady Meehan, Institute for Research in the Social Sciences, UNC, for their assistance.

# I

## WETLANDS

> Wetland is a collective term encompassing . . . areas such as swamps, marshes, and bogs. It shares their hydrologic, vegetative, and soil characteristics . . . . (Hawley, 1977)

Until very recently, to most people in this country, a wetland was a "swamp" and the general attitude was, "Who needs a swamp?" For years we have used our wetlands as dumping grounds, areas to be filled for development or as land banks for future use for development. Tens of thousands of acres of coastal and near coastal wetlands were converted to communities in New Jersey, Maryland, Virginia, North Carolina, Georgia, Florida, and Louisiana. Inland marshes around the country were filled for similar purposes.[1] If one were to believe the glossy advertisements for new developments along the Atlantic and Gulf coasts, the end of construction was not in sight as more and more Americans were seeking second homes or moving to the sunbelt or coast for retirement.[2] Few people saw any real need to protect these areas--those that did were labeled "bird watchers" or "conservation freaks."

In the background, however, voices could be heard. Professor Eugene P. Odum and his brother, Professor H. T. Odum, were talking about something called "ecology" and the ecosystem approach. As early as 1950, E. P. Odum was warning that all species, all forms of life, even those invisible to the naked eye, were critical to the existence of the natural system as a whole--yes, that even swamps were important (Odum, 1971).

And then there was Rachel Carson and Silent Spring. There was a new focus on nature. People began to listen to conservation and wildlife groups as they spoke of guarding the environment. Wetlands became recognized as useful parts of some coastal areas, needed for "flood and water storage, wildlife habitat and fish spawning grounds" (McHarg, 1969). The role of wetlands as nature's living wastewater filter was seen by many. The Federal Sea Grant program pumped funds into a serious look at the ecology of the coastline. Some states even developed management programs for their wetlands.[3] And then it happened--strong federal action.

On 1 January 1970, the President of the United States signed into law the National Environmental Policy Act (NEPA). The Congress recognized ". . . the profound impact of man's activity on the interrelations of all components of the natural environment . . ." and declared it to be the policy of the Federal Government to ". . . use all practicable means and measures . . . to create and maintain conditions under which man and nature can exist in productive harmony . . . ."[4] In addition to simply requiring government agencies to assess the impact of their activities on the environment, NEPA served as a forerunner and catalyst for many bolder ventures towards protecting the environment in general and wetlands in particular.

In the Coastal Zone Management Act of 1972, Congress recognized the wetland problem: "The coastal zone and the fish, shellfish and other living resources and wildlife therein, are ecologically fragile and consequently extremely vulnerable to destruction by man's alterations."[5] The Act put into motion planning and control efforts by state and federal governments designed to ultimately safeguard these critical areas. The federal act was followed closely by many similar state actions.

The same Congress addressed wetlands again in PL 92-500 (The Federal Water Pollution Control Act Amendments of 1972) requiring that the placement of dredged or fill material in wetlands be authorized by a federal permit.[6] The scope of this part of PL 92-500 was broadened in 1975 by a U. S. District Court decision which extended the federal jurisdiction from more traditional "navigable waters" to "waters of the United States."[7] This action placed the responsibility for controlling development in most wetland areas of the United States in the hands of the Army Corps of Engineers. As early as 1973, these Army Engineers had indicated that:

> Unless the public interest requires otherwise, no permit shall be granted for work in wetlands identified as important . . . unless the District Engineer concludes . . . that the benefits of the proposed alteration outweigh the damage to the wetland resource . . . .[8]

The culmination of federal focus on wetlands came on 23 May 1977 in President Carter's first environmental message to Congress.

> The important ecological function of coastal and inland wetlands is well known to natural scientists. The lasting benefits that society derives from these areas often far exceeds the immediate advantages their owners might get from draining or filling them.
>
> . . . We must now protect against the cumulative effect of reducing our total wetland acreage.[9]

This message was followed by Executive Order 11990 which directed federal agencies to insure, in all actions under their jurisdiction, the proper protection of wetlands.

Given a real or even a begrudging acceptance by the nation of the value of wetlands and recognizing that some development will occur in or impinge on wetlands, the problem becomes how to measure these impacts and place a value on them. This paper assumes acceptance of the value of wetlands to society and therefore, in general, treats man's intrusion into these wetlands as a negative factor.

## Man's Impact on Wetlands

Man's first steps into the wetland environment bring change. As man travels, his actions will often change systems, and his impact will be noticed. It will be noticed first at the time of his entry and depending on the nature of his actions, it may be felt again over weeks, months, or years. His actions will have an impact on the varied features of the wetland environment.

Spatial/Temporal Impacts

Obviously, actions within a wetland affect that wetland and often other areas as well. But how far should one go to probe the impact of these wetland activities? There must be some limit. This paper will work in terms of the river basin, the river estuary, or a sector of coastline.

A river basin is defined by the American Collegiate Dictionary as a "hollow or depression in the earth's surface, wholly or partially surrounded by higher land."

Figure 1 illustrates a typical river basin.

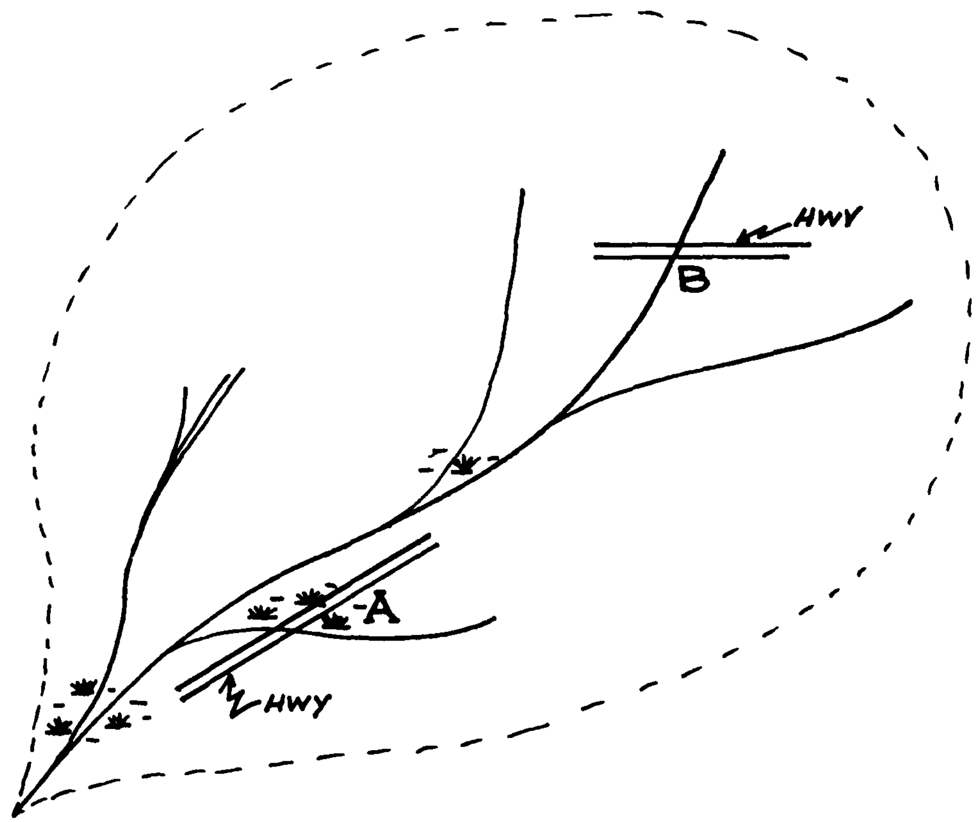



Figure 1. River Basin

The primary focus of the basin is its principal river. Tributaries of various size give it its breadth and sometimes its length. Basins may range in area from a few square miles to the 1.25 million square miles that make up the Mississippi River drainage basin.

Wetlands occur throughout a basin. If a project, say a highway, is to be built at location "A," then it would have direct impact on the wetlands at location "A." Direct impacts are those actions at the project site which cause permanent change in the wetland environment at the project site. Direct impacts include such work as land filling or land drainage and are attributable to the project itself as opposed to those impacts resulting from the presence of the project and which follow the project construction. These follow-on impacts are secondary. The road project (a land fill--direct impact) will probably result in numerous secondary impacts at location "A." Motorists traveling the road may litter the wetlands causing visual or physical pollution. Hunters might use the highway for poaching game resulting in a decrease in wildlife in the wetlands. The magnitude of these secondary impacts may be minor or they may exceed in scope the direct impacts of the project itself.

There will also be impacts on wetland "A" from actions by man (or nature) that are not related to the road project. These "other" impacts might include damming of the river upstream of wetland "A," which would cause a reduction in water quantity at "A," or construction of a road at "B" which would result in water quality changes at "A." "Other" impacts might also include land use changes on the periphery of "A," which would affect any aspect of the wetland at "A."

Lastly, there is a cumulative impact. The degradation of one small area of wetlands might be of only minor consequence. However, considered with similar losses in many other areas, the loss effect would be synergistic with the total loss to the basin being considerably greater now than simply the sum of the individual losses. For example, certain endangered species, like the Florida panther, require considerable "roaming room." Loss of a few acres, in itself, would cause no major problems. The loss of several tracts, especially those that might destroy the contiguity of large wooded areas, could be disastrous. The overall impact of the loss of "linking" woodlands cannot be measured in terms of the loss of the linking woodlands alone.

There are also construction impacts. While actual construction of the road at wetland "A" will cause some impacts in wetland "A" (and in other areas), these construction impacts are normally temporary and will be disregarded in this paper.

The same types of impacts would occur in an estuary (Figure 2) or along a coastline (Figure 3).

Estuaries are defined by Thomas Detwyler (1971, p. 266) as "places of dynamic interaction, where rivers meet the sea and deposit their wastes, where fluvial and oceanic processes interact a complex interface." In the estuary situation one must account for "other" impacts which may come not only from within the estuary but also from outside the estuary. The impacts from outside the estuary are treated simply as impacts which are initiated at the point of entry into the estuary (e.g., location "C").

Coastlines are areas completely under oceanic processes and influences. In the coastline case, the "other" impacts must be treated as impacts which come from a series of spatially distributed locations (e.g., "$D_1$," "$D_2$," etc.). This spatial distribution equates to the broader types of pollution impacts (e.g., oil spills) which affect large sections of coastline.

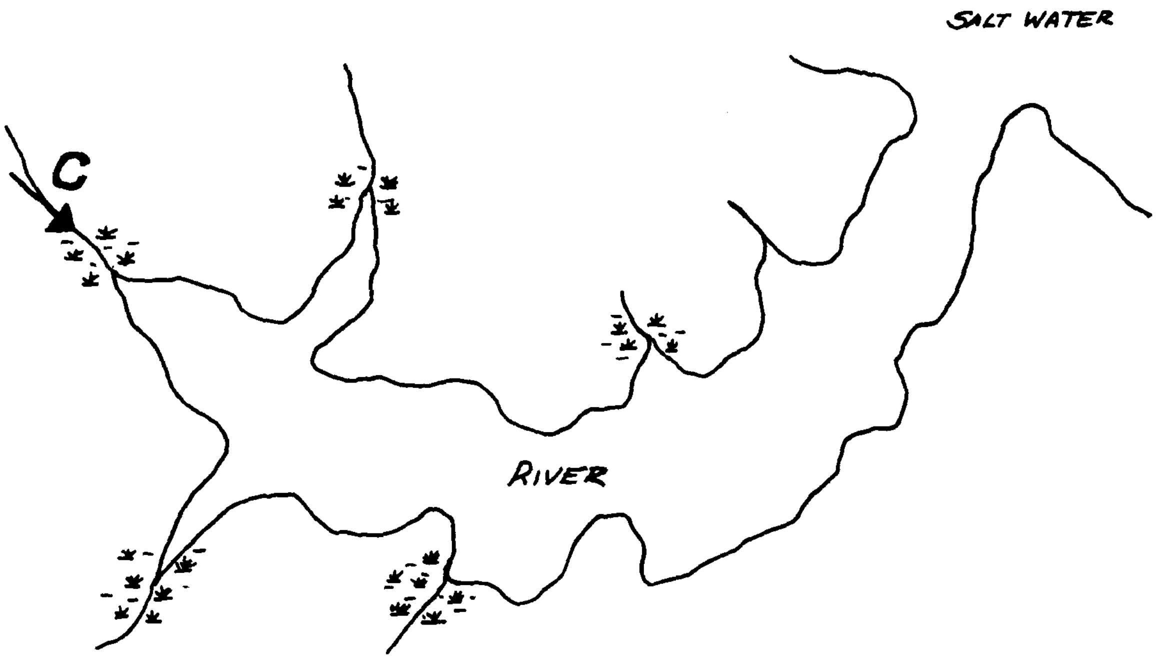



Figure 2. An Estuary

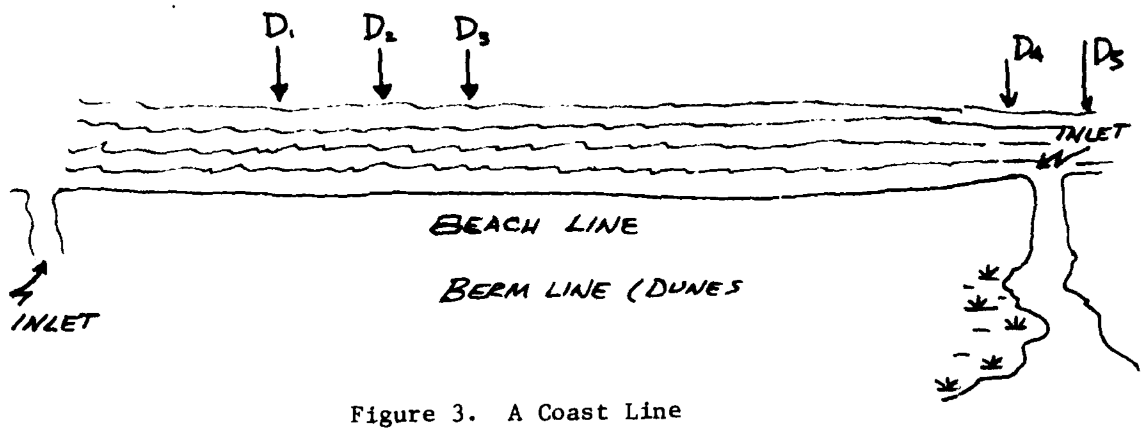



Figure 3. A Coast Line

Features of a Wetland

As mentioned earlier, there are myriad elements that make up the wetland, from the invisible phytoplankton to the thousands of gallons of water that must periodically cover the wetland surface. Man's impact on these wetlands may be felt in three ways: ecologic, human interest, and economic. There is a tremendous interdependence among these categories and within the categories themselves. This interdependence is dynamic and is part of the very fabric of wetlands.

From an ecological standpoint (ecology = "interrelationship between living organisms and their environment," Odum, 1971, p. 3), man, by his actions, destroys many components of the ecological system. Results of his actions can be seen in the actual destruction of fish and wildlife or can be hidden from the naked eye as in the loss of micro-organisms. The results may be evident as in the clearing of bottomland hardwoods, or subtle, as in slow changes in water quality.

In the human category, man derives pleasure from being able to walk or boat in a wetland. He is enthralled by the beauty of a knobby kneed cypress or the solitude of an isolated bayou. He can appreciate the sights and sounds of a relatively unspoiled area. But man can also have an adverse impact on all of these features.

Man's intrustion into the wetlands also can have economic impacts. Filling of a swamp for the purpose of building a new community can bring tremendous profits to the developer. Conversion of "marginal" wetlands to agriculture can bring new money to the farmer and raise the standard of living of his employees. While the largest economic benefits of the use of wetlands relate to changes in the physical structure of the wetlands, use of wetlands for recreational purposes can also generate economic benefits. The local economy is stimulated by hunting and fishing activities through sales of related supplies and services. In addition, wetlands, in many cases, serve as natural wastewater treatment facilities, as air cleaners and as natural reservoirs for storage of flood waters. Each of these uses also generates economic benefits to the community.

## II

## ASSESSING THE IMPACTS

### Evaluation Techniques

As indicated in the preface, there is no approved solution for evaluation of wetlands. EPA notes that:

> There is no universal methodology for evaluating environmental impacts. In all cases, one must ultimately rely on value judgments, which are difficult to quantify and can vary on a case-to-case basis.[10]

From a review of the variety of techniques that have been tried, it is also apparent that there is no consensus as to which approach is the best. This section will discuss the characteristics of a good assessment system and will highlight several approaches that have been used in the assessment of man's impact on the environment in general and on wetlands in particular. Review of all such systems in detail would fill volumes. (General reviews are found in Solomon, et al, 1977, and Warner, et al.)

For years, various agencies of the federal government have used benefit/cost analyses as tools for assessing the relative merits of their water resource projects. This technique depends entirely on the ability to assign economic costs and benefits to all aspects of the project. In the past those items deemed non-quantifiable were simply omitted from the economic analysis. The recent wave of interest in the environment brought with it pressures to place dollar values on recreation, wetland products, and aesthetic features. Efforts have been made to assign dollar values to hunting days, but anyone who has attended a public meeting involving consideration of the value of those hunting days knows of the debate that often rages over the specific figures used. Also, there has been little progress in gaining acceptance for systems which place dollar values on the various features of wetlands.

In an early attempt to price the value of wetlands, Benson and Perry (1965) provided a subjective appraisal of the value of New York marshlands. Noting that the marsh was useful for storage of drinking water, flood water storage, sediment reduction, vegetation production, waterfowl and wildlife habitat, recreation support and education, they found an acre to provide an annual return of nearly $20. This developed a capitalized value of $350/400 per acre. E. P. Odum, Gosselink and Pope, in a 1972 study, developed data indicating that the value of a tidal marsh, in terms of its annual return, was close to $4,150 per acre, with an acre having an income capitalized value of $85,000. These figures were based on assigning values to the fisheries, storm buffer, aquaculture and waste treatment characteristics of the marsh (see also Wharton, 1970). Regional scientist Walter Isard (1972) in a study supported by the U. S. Department of Commerce applied comparative costs and input-output techniques to evaluation of a marina project in Massachusetts. Isard assigned dollar costs (e.g., annual value of an acre of spartina grass--$25) to damages to ecologic systems, and he considered these costs in his final appraisal. T. R. Gupta (1973) developed criteria for evaluation of the dollar value of freshwater wetlands. Gupta's efforts were closely tied to the market value of wetlands in Massachusetts and led to market values of $500 to $60,000 per acre, depending on the quality of the wildlife, aesthetic, water supply and flood control characteristics of the wetland (see also Larson, 1976). York, Dysart and Gahan (1977) developed a complex model for "economic analysis of prospective management schemes" in natural areas. By assigning dollar values to "semi-tangible" benefits and the option value of the natural area (from Kruttila, Cicchetti and Freeman), they were able to compute a figure for the net economic benefit of a project.

Jaworski, McDonald, McDonald and Raphael (1977) and Raphael, Jaworski and McDonald (1978) estimated the gross annual financial return from Michigan coastal wetlands and used this value to develop economic values per wetland acre/year. Their 1978 analysis found that the annual return from an acre was $489.69, with the largest amount coming from sport fishing. Nonconsumptive recreation, waterfowl hunting, trapping and commercial fishing accounted for the remaining amounts.

While economics-oriented systems similar to the above offer some hope for the future, it is difficult to believe that they will gain any real acceptance until there is a better understanding of the relative values of the non-quantifiable environmental factors. Federal courts make awards, in cases involving land values, using the comparable sales principle. Since, at present, there is no market for wetlands at $85,000/acre, there are no $85,000 sales. Even values in the $1,000 to $4,000 range are often difficult to justify when there have been no market experiences at this level.

It is doubtful that the Congress is ready to accept benefit/cost ratios based on the assignment of dollar values to environmental features.

Recent efforts by the U. S. Water Resources Council to develop principles and standards for the assessment of water resource projects have focused on the subjective evaluation of these non-quantifiable features rather than on the assignment of dollar values to these features.[11]

Since, for the present, the ground to be plowed is this assessment of non-quantifiables, this paper will focus on this aspect rather than on economic evaluations. No further attempt will be made to discuss or treat economic evaluations, as important as they may become in the more distant future.

## A "Good" Evaluation System

EPA, in a recent book, Environmental Assessment Perspectives, indicates that the usefulness of an assessment methodology can be judged on the basis of four factors:

- Accuracy--Ability to portray comprehensively and fairly all impacts.

- Replicability--Ability to be used by different investigations of the same subject with equivalent results.

- Economy--Reasonableness of demands upon the analyzer for time and sophisticated computational techniques.

- Understandability--Ability to be understood by persons of different backgrounds.[12]

The above criteria are important and serve to generally outline the requisites of a good evaluation system. Accuracy must include validity and appropriateness as sub-features. The concepts used in the methodology must be theoretically (as well as mathematically) valid. The objectives of the methodology, the output, must be appropriate or clearly related to the input. Replicability is critical in methodologies used by hierarchical organizations where the work of the project analyst will be reviewed at level after level of his organization and possibly even by the courts. It is replicability (the ability to get the same output each time) not repeatability (the ability to get some output each time) that is important. Economy must go beyond savings in the time of the analyst (although that is certainly important). It must also include economies of computation, data collection and display. Dale Keyes (1976, xiv) points out, for example, that "Estimates (of environmental impacts) made by simple inferences will require relatively expensive field surveys (perhaps ten to twenty thousand dollars for a fifty-acre site) if the estimates are to be quantitative." A major endangered species study can cost over $100,000. These kinds of costs must be taken into account in methodology design.

In addition to the four "EPA factors" listed above, a good system also should have flexibility, should consider the area under study as part of some overall system, and should take advantage of the advice of experts and the public.

Recognizing the needs of the planning process, a good methodology should be flexible enough to be as responsive to the planner who needs a 72-hour turn-around time for study results (and has only $500) as it is to the planner who has two years (and say, $50,000) for his study. Obviously, they both would not get the same output. While the shorter study might be more gross, it should be part of an umbrella that would cover the longer, more detailed study. To say that a system cannot be used unless a pre-specified amount of field data is available severely limits the application of the system. If a decision must be made and will be made, then the system should be able to provide results based on the best information available.

System considerations are also important. E. P. Odum notes in Science that there is a need to move to "more holistic approaches wherein interactive, integrative, and emergent properties are also included." As mentioned earlier, a single wetland area is certainly part of a basin, estuary, or coastal regime and that relationship must be examined.

Surveys, investigations, and field counts produce much data--data that can be manipulated, sorted, and displayed. These data are useful. However, equally useful are the advice and opinion of individuals who have personal knowledge of the situation at hand. A wildlife biologist who has spent years in an area has an intuitive feeling as to values of various environmental features. A farmer who has hunted all his life in a wetland is in a position to give advice on the relative importance to him of the various features of that wetland. Neither view is in itself the complete end answer. Both views go to make up the whole and should be considered.

An assessment methodology giving due consideration to these criteria would be well on its way toward being a good methodology.

## Current Assessment Techniques

There are many systems, techniques, and models for assessing the impact of man on the environment. In general, they fall into two categories: macro and micro.

Micro systems look to the assessment of specific impacts of man's actions on small, sub-systems of the environment. Typical of these would be the whole family of water quality assessment models, various fish and other aquatic life evaluation tools. By dealing with a few very select elements of the environment, to the exclusion of the remainder, these models are able to provide reasonable and accurate predictions of the results of specific actions on specific sub-systems of the environment. CLEANER, a complex ecosystem model, is typical (Russell, 1975, p. 50). It deals with macrophytes, phytoplankton and other biologic elements and requires 29 coupled differential equations to determine the relative quality of these smaller elements of the food chain. EPA's (1974) Ecosystem Analysis of the Big Cypress Swamp and Estuaries provided a similar heavy focus on the sub-systems of the area.

Macro models, on the other hand, focus on the complete picture, the "big picture." They are management oriented. Through selection of only those factors or elements of the environment deemed critical, macro models attempt to provide a holistic approach. E. P. Odum (1977) agrees that, ". . . there is much to be said for a procedure that combines a few selected systems-level properties that monitor the performance of the whole, with selected 'red flag' components, such as game species, or a toxic substance, that, in themselves, have direct importance to the general public . . . ."

Clifford Russell (1975, p. 354), speaking at the conclusion of a Resources for the Future Symposium on ecological modeling, indicated:

> I now have a strong feeling that the models are considered pretty good up to phytoplankton and not much beyond that. I have asked questions about the management context and I have the impression that this is where we really need to do a lot more work together.

Recognizing that the emphasis now needs to be on the macro, this paper will focus on the macro evaluation system or model.

Macro models can be classified as graphic, computer assisted graphic, quantitative and matrix. Each type, in reality, contains elements of the other and each model type develops its input from the same general sources as the others. Some models will use, as base information, data obtained by the gestalt method wherein an observer makes a generalized subjective assessment of the whole without attempting to sum its parts. Other models will be based on painstakingly procured counts of specific ecosystem components, which are added to other similar data to derive various indices. Most will fall in between these extremes.

## Graphic Models

Perhaps the grandfather of all graphic modeling is Ian McHarg. His models stand as the best examples of this class. In Design With Nature (pp. 36-41), he described the assessment of a variety of environmental impacts with a series of overlays, which taken together portrayed areas where a given project would encounter the least and highest social costs. As illustrated in Figure 4, degrees of shading depict the differential impacts. In this case, the darker the shading, the greater the impact of man's intrusion.


Figure 4. Typical Visual-Macro Display (from Design With Nature)

By combining these overlays, each of which might be prepared by an expert in the feature described, an assessment of the total impact of a project can be made (Figure 5).

The McHarg system, in its basic form, provides equal weighting (or value) to each overlay. By varying the shading intensity among the overlays, a limited weighting system can be used. In either case, the product is in a display form that is understandable to the decision maker, He, as well as the public, can see the impacts that are being modeled.

Figure 5. Combination of Overlays
(from Design With Nature)

Computer Assisted Graphics

Recognizing the shortcomings of equally weighted overlays and the problems in physical recognition of a spectrum of shaded weightings, McHarg and others turned to the computer to develop systems that would allow more flexibility. Over the last ten years, a number of impressive strides have been made.

Harvard University's Graduate School of Design, the center of much of this activity, developed GRID, a computer graphic display system.[14] GRID divides the study area into square cells (of various sizes) and permits the analyst to assign values to the cell for each feature being considered. A computer printed (not plotted) map is easily prepared for the study area for each feature (Figure 6). Then, if desired, the values of each cell may be weighted and summed to provide an overall value for the cell. This provides, in a manner similar to McHarg's, the areas of most and least environmental, social, and/or even economic cost. (See also Clout, 1972, Chapter 9.)

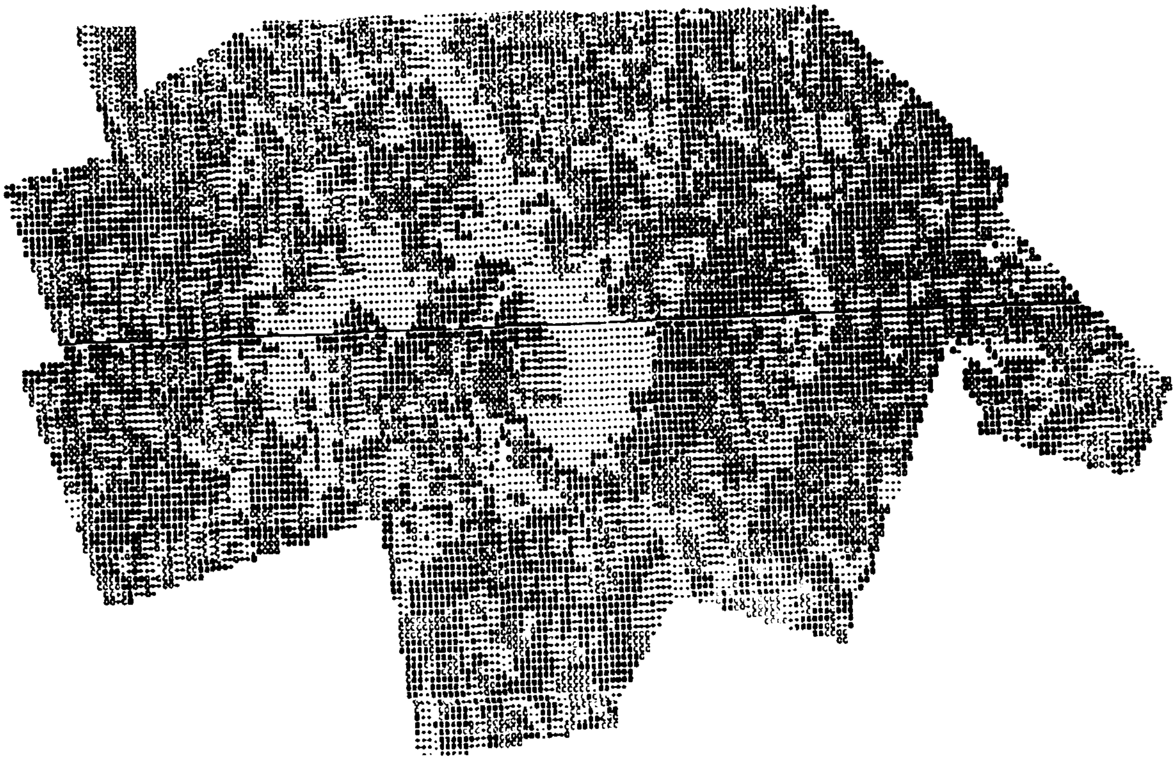


Figure 6. The GRID System

Harvard's Steinitz, in a 1969 study for the Army Corps of Engineers, applied the GRID technique to 16 different non-display methodologies and found that the utility of each was generally enhanced by the graphic display.

Since 1969 numerous improvements have been made in the state of the art. GRID has been supplemented by systems such as SYMAP (Figure 7) which permit contour-proximal as well as choropleth mapping and CALFORM, a plotter program (Figure 8).

Steinitz and the Corps of Engineers worked together in the Santa Ana basin in California to add more sophisticated input systems to a basic GRID effort. The Santa Ana and a similar study in the Oconee Basin in Georgia have shown the versatility of this type of program.[15] Systems such as Harvard's SYMVU which produces "3-D" plots are useful for highlighting what has been pointed out in other efforts (Figure 9).

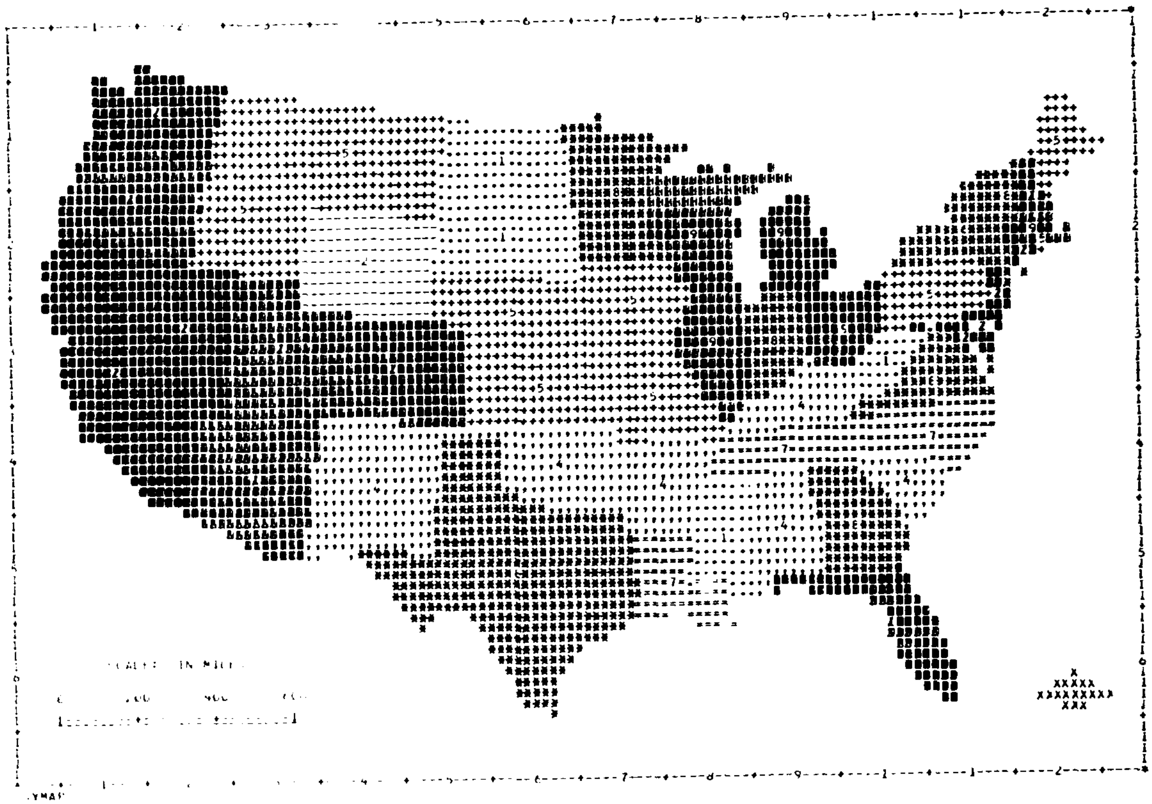


Figure 7. SYMAP

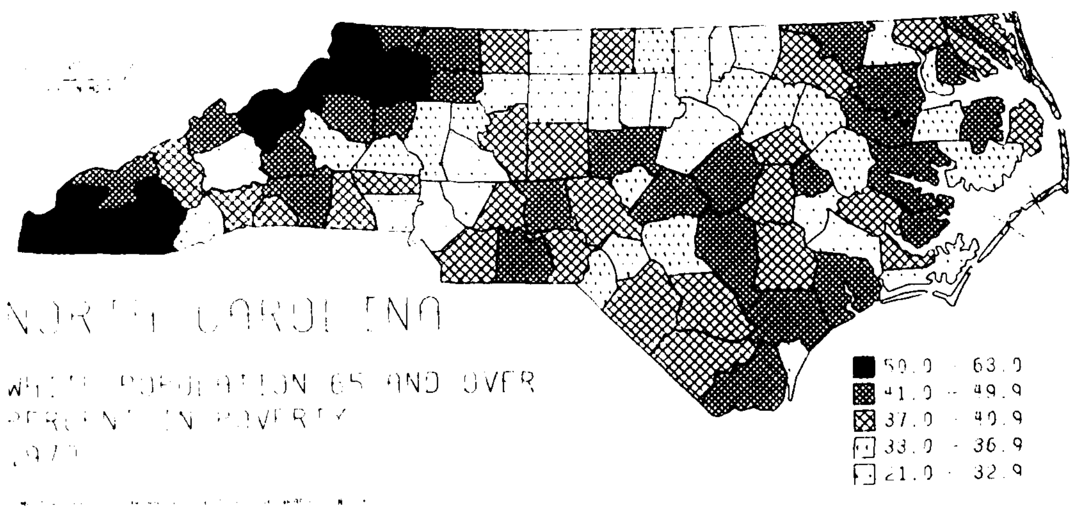



Figure 8. CALFORM

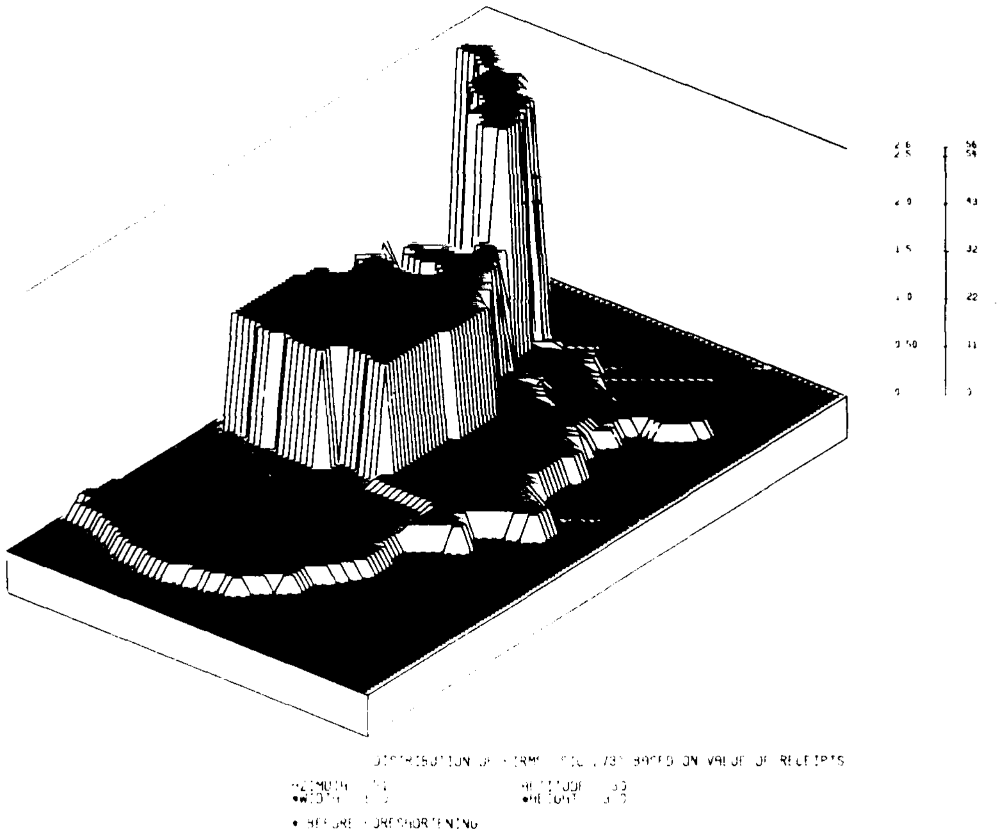


Figure 9. SYMVU
United States from the Southwest

While each computer graphic system is useful as a means of efficiently storing and displaying data, these systems rely on sub-systems or independent systems for preparation of the data from which the graphics are taken.

The principal value of the graphic is its recognizability. As with the McHarg product, the decision maker can generally understand the results and relate to them. The principal drawback of graphics rests with the difficulty of assigning values to a visual display. Given several different displays (e.g., alternative projects), the decision maker is often hard pressed to differentiate between the displays and seeks some form of relative standing--preferably, a numerical value.

*Quantitative Evaluation*

Countless systems have been developed to produce a numerical value as the end product. These systems also provide input for several computer graphic systems as well as operating as independent evaluation techniques.

Typical of early attempts to quantify the relative value of a variety of parameters was an effort by the Bureau of Outdoor Recreation (BOR) (1968, p. 15) to rate two alternative routes for Interstate 70 in Colorado (Figure 10).

TABLE NO. 2
RATING OF ALTERNATE ROUTES FOR INTERSTATE 70
BETWEEN BOOTH CREEK AND DILLON, COLORADO

| Factors | | Reference* | Rating of Alternates | | Weight Factor | Weighted Ratings | |
|---|---|---|---|---|---|---|---|
| | | | Vail Pass | Red Buffalo | | Vail Pass | Red Buffalo |
| ENVIRONMENTAL AND RECREATIONAL FACTORS | Wilderness Loss | A.1. | -1 | -3 | 5 | -5 | -15 |
| | Driving for Pleasure | A.2. | +7 | +6 | 1 | +7 | +6 |
| | Fish and Wildlife Damage | A.3. | -1 | -4 | 2 | -2 | -8 |
| | Other Recreation | A.4. | +2 | +1 | 2 | +4 | +2 |
| IMPACT ON ECONOMICS | Local | B.1. | +3 | +2 | 3 | +9 | +6 |
| | State | B.2. | +3 | +3 | 4 | +12 | +12 |
| | National | B.3. | +2 | +1 | 5 | +10 | +5 |
| HIGHWAY EFFICIENCY FACTORS | Annual Direct Cost | C.1. | +1 | +1 | 5 | +5 | +5 |
| | Traffic-Carrying Ability | C.2. | +2 | +1 | 1 | +2 | +1 |
| | Safety | C.3. | +4 | +4 | 4 | +16 | +16 |
| TOTALS | | | | | | +58 | +30 |

*EXPLANATION OF RATINGS AND WEIGHT FACTORS follows.

Figure 10. BOR System

Each factor was rated by BOR personnel using all available information sources (to include conferences with local officials and representatives). The same team then assigned relative weights to each parameter. The sum of these weighted ratings was then used as a guide for determining the best route.

An attempt to develop a more comprehensive quantitative system was made by Norbert Dee, et al, in a 1972 Battelle study. They developed, at the request of the Bureau of Reclamation (BuRec), a system in which 1000 possible environmental quality points were distributed among ecology, environmental pollution, aesthetic and human interest parameters (Figure 11).

The assignment of relative values to these parameters--i.e., their share of the 1000 points--was made by the Battelle team of experts. The assignment of values within each parameter was to be made by field personnel of BuRec based primarily on a series of charts (Figure 12) depicting

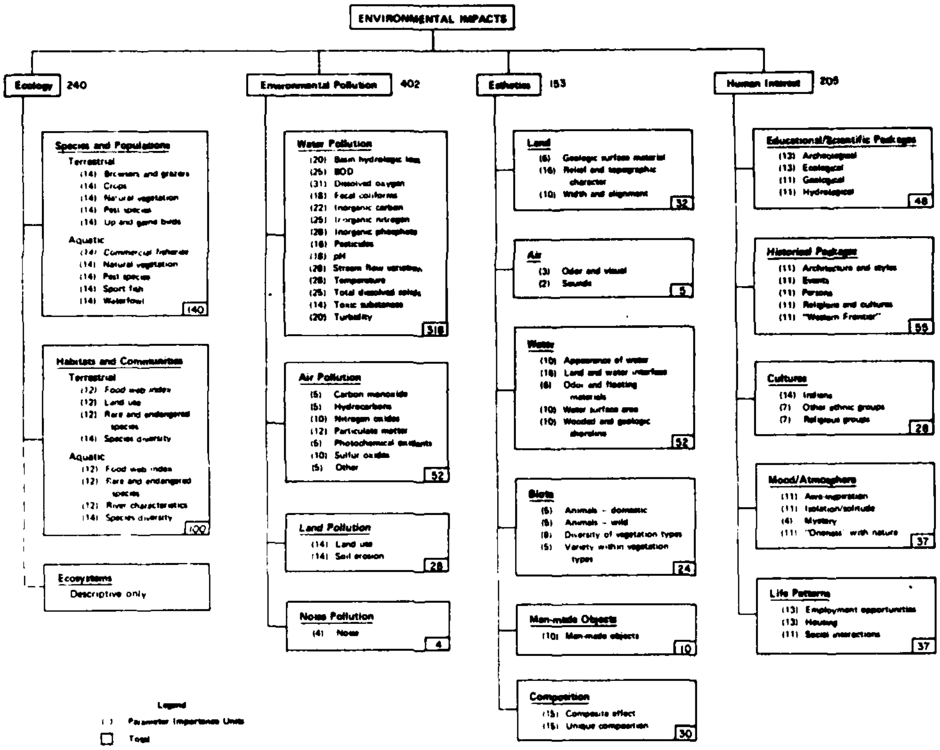
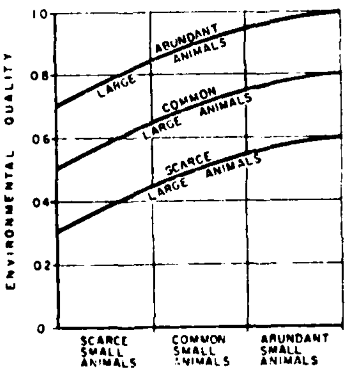
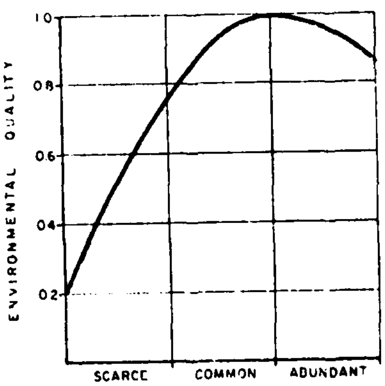


Figure 11. The Battelle System



Animals - Wild



Animals - Domestic

Figure 12. Typical Battelle Curves

Field personnel would use these curves to determine the quality level, in their area, of a given parameter.

functional relationships between environmental elements and levels of environmental quality. This system aimed to provide consistency of evaluation throughout BuRec. With the Battelle system, theoretically all BuRec projects could be ranked according to their impact on the environment. In reality, the system floundered on disagreements over the relative values of the parameters and on the lack of local input to the basic rating process.

A recent effort to develop a more flexible quantitative system is found in the Army Engineers Waterways Experiment Station's Water Resources Assessment Methodology (WRAM), which was developed by the Army in an effort to support the Water Resources Council's principles and standards. WRAM (Solomon, et al, 1977), which resulted from a survey of most available assessment techniques, combines many aspects of the Battelle model with the use of a semi-sophisticated weighting system and an interdisciplinary team approach to assignment of parameter values. The weighting system is based on Dean and Nishry's (1965) relative importance coefficient (RIC) (Figure 13).

| Variable | Assignment of Importance Values | | | | | | | | | | | | | | | | | | | | | Sum | RIC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| V1 | 0 | 1 | 1 | 0 | [illegible] | 1 | | | | | | | | | | | | | | | | [illegible] | [illegible] |
| V2 | 1 | | | | | | 1 | 0.5 | 0.5 | 1 | 1 | | | | | | | | | | | [illegible] | [illegible] |
| V3 | | 0 | | | | | 0 | | | | | 0.5 | [illegible] | 0.5 | 1 | | | | | | | [illegible] | [illegible] |
| V4 | | | 0 | | | | | 0.5 | | | | 0.5 | | | | 0.5 | 0 | 1 | | | | [illegible] | [illegible] |
| V5 | | | | 1 | | | | | 0.5 | | | | 1 | | | 0.5 | | | 1 | 1 | | 5.0 | 0.24 |
| V6 | | | | | 1 | | | | | 0 | | | | 0.5 | | | 1 | | 0 | | 1 | 3.5 | [illegible] |
| V7 (Dummy) | | | | | | 0 | | | | | 0 | | | | 0 | | | 0 | | 0 | 0 | 0.0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | Total | 21.0* | 1.00** |

*Check: N(N − 1)/2 = [illegible] = 21

**Must sum to unity

Figure 13. Relative Importance Coefficient (RIC)

Each variable ($V_n$) is compared individually to every other variable to determine which of the two being compared is most important in the study area. The more important variable is assigned a value of one, while the other receives a zero. If they are equal, both receive 0.5. The RIC then reflects the overall relative weight of the variable.

A similar scheme is followed to assess the relative impact (benefit) of given alternatives on the study area, with alternatives replacing variables in the matrix to produce alternative choice coefficients (ACC). ACC are combined with the RIC to produce a final coefficient matrix (Figure 14). This matrix indicates the most beneficial alternative to be "A."

Actual choices between alternatives in developing the ACC may be based on subjective evaluations or on detailed analyses.

| Variable | RIC | ACC of Alternative | | | | Final Coefficient Matrix RIC × ACC | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | A | B | C | D |
| V1 | 0.20 | 0.25 | 0.25 | 0.40 | 0.10 | 0.05 | 0.05 | 0.08 | 0.02 |
| V2 | 0.40 | 0.33 | 0.00 | 0.17 | 0.50 | 0.13 | 0.00 | 0.07 | 0.20 |
| V3 | 0.10 | 0.30 | 0.30 | 0.20 | 0.20 | 0.03 | 0.03 | 0.02 | 0.02 |
| V4 | 0.20 | 0.30 | 0.30 | 0.30 | 0.10 | 0.06 | 0.06 | 0.06 | 0.02 |
| V5 | 0.10 | 0.50 | 0.17 | 0.33 | 0.00 | 0.05 | 0.02 | 0.03 | 0.00 |
| | | | | | Total | 0.32 | 0.16 | 0.26 | 0.26 |

Figure 14. WRAM Coefficient Matrix

The Corps of Engineers Lower Mississippi Valley Division's Habitat Evaluation System (1976) as well as the U. S. Department of the Interior's Fish and Wildlife Service Habitat Evaluation Procedure (1976) both focus on developing quantitative data concerning wildlife habitat. The Corps of Engineers' program relies heavily on the use of Battelle-type curves for placing values on habitat. The curves, however, are developed by an interdisciplinary team in the local area rather than at the national level. The Fish and Wildlife Service's model places heavy reliance for habitat evaluation on the subjective views of a team of experts who visit the area being evaluated. Dr. Albert Radford (1977) has developed a model to measure and inventory species, community, and habitat diversity in natural areas. Involving classification at the system, sub-system, class, subclass, generitype and type levels, the focus is on gaining maximum knowledge about all levels of the biology, climate, soils, geology, hydrology, hydrography, topography and physiography of the area. Following classification of the area (and concurrent development of knowledge about the area by the classifiers), seven systems are rated by the classifiers (Figure 15). The sum of these ratings provides the natural area evaluation.

The Army Corps of Engineers Institute for Water Resources (IWR) is currently working a dual track methodology for developing quantitative evaluations. In a 1977 draft of Wetland Values, IWR proposes two approaches. When adequate time for a detailed evaluation is not available, a desk-top deductive assessment of critical wetland values would be performed. When more time is available, an in-depth analysis would be carried out. This analysis would involve the evaluation and weighting of some fifteen parameters, resulting in a total score for each wetland being evaluated. Wetland Values underwent field testing in late 1977 and is now in final review prior to publication.

## B. NATURAL AREA EVALUATION CLASSIFICATION SYSTEM SUGGESTIONS

| INFORMATION SYSTEM I | INFORMATION SOURCES I | DOCUMENTATION I |
|---|---|---|
| A. ENDANGERED & THREATENED SPECIES (total: ____) | | |
| Endangered Endemic 10 | International Lists | |
| Endangered Throughout 9 | Smithsonian List | |
| Endangered Disjunct 8 | State Lists | |
| Threatened Endemic 7 | Field observation, determination | |
| Threatened Throughout 6 | and authentication | |
| Threatened Disjunct 5 | | |
| Endangered Peripheral 4 | | |
| Threatened Peripheral 3 | | |
| Infrequent Endemic 2 | | |
| Infrequent Peripheral 1 | | |
| B. BIOTIC AND ABIOTIC DIVERSITY (total Biotic: _____; total Abiotic: _____) | | |
| Biotic Systems - Pedologic - | Vegetation maps, studies and reports | |
| Cover Classes - Geologic - | Pedologic maps, studies and reports | |
| Cover Types - Hydrologic - | Hydrologic maps, studies and reports | |
| Species - Topographic - | Topographic maps, studies and reports | |
| Hydrographic - | Field observation, determination and | |
| Excellent, 5; Good, 4; Average, 3; | authentication | |
| Mediocre, 2; Poor, 1. | | |
| C. NATURAL FEATURES CONDITION (total: _____) | | |
| Communities - Hydrology - | Pertinent reports and studies | |
| Pedology - Topography - | Field observation and determination | |
| Geology - Hydrography - | | |
| Virgin or excellent, 5: Good, 4; | | |
| Average, 3; Mediocre, 2; Poor, 1. | | |
| D. NATURAL FEATURES DISTRIBUTION (total: _____) | | |
| Community - Hydrology - | Vegetation maps, studies and reports | |
| Pedology - Topography - | Pedologic maps, studies and reports | |
| Geology - Hydrography - | Geologic maps, studies and reports | |
| | Hydrologic maps, studies and reports | |
| Endemic, 5; Unique, 4; | Topographic maps, studies and reports | |
| Infrequent, 3; Common, 2; | Hydrographic maps, studies and reports | |
| Very Common, 1. | Field observation and determination | |
| E. HUMANISTIC FEATURES (total: _____) | | |
| Aesthetic Value - | Field experience and reports | |
| Scenic Value - | Scientific reports | |
| Scientific Value- | Historical reports | |
| Historical Value- | Land Use reports | |
| Excellent, 5; Good, 4; Average, 3; | | |
| Mediocre, 2; Poor, 1. | | |
| F. PRODUCTIVITY etc. (total: _____) | Wildlife reports | |
| Biomass - | Economic reports | |
| Cover - | | |
| Food - | | |
| Breeding territory - | NATURAL AREA EVALUATION | |
| | Total: ________ | |
| Excellent, 5; Good, 4; Average, 3; | | |
| Mediocre, 2; Poor, 1. | | |

Figure 15. Natural Area Evaluation
(A.E. Radford)

While the above systems, as well as other similar systems, provide quantitative results, considerable effort is required to develop the results, and none of the systems, in themselves, provide an adequate visual display of the results.

## INSTRUCTIONS

1- Identify all actions (located across the top of the matrix) that are part of the proposed project.
2- Under each of the proposed actions, place a slash at the intersection with each item on the side of the matrix if an impact is possible.
3- Having completed the matrix, in the upper left-hand corner of each box with a slash, place a number from 1 to 10 which indicates the MAGNITUDE of the possible impact; 10 represents the greatest magnitude of impact and 1, the least (no zeroes). Before each number place + if the impact would be beneficial. In the lower right hand corner of the box place a number from 1 to 10 which indicates the IMPORTANCE of the possible impact (e.g. regional vs. local); 10 represents the greatest importance and 1, the least (no zeroes).
4- The text which accompanies the matrix should be a discussion of the significant impacts, those columns and rows with large numbers of boxes marked and individual boxes with the larger numbers.

SAMPLE MATRIX

**PROPOSED ACTIONS**

A. MODIFICATION OF REGIME

a. Exotic flora or fauna introduction
b. Biological controls
c. Modification of habitat
d. Alteration of ground cover
e. Alteration of ground water hydrology
f. Alteration of drainage
g. River control and flow modification
h. Canalization
i. Irrigation
j. Weather modification
k. Burning
l. Surface or paving
m. Noise and vibration

B. LAND TRANSFORMATION AND CONSTRUCTION

a. Urbanization
b. Industrial sites and buildings
c. Airports
d. Highways and bridges
e. Roads and trails
f. Railroads
g. Cables and lifts
h. Transmission lines, pipelines and corridors
i. Barriers including fencing
j. Channel dredging and straightening
k. Channel revetments
l. Canals
m. Dams and impoundments
n. Piers, seawalls, marinas, and sea terminals
o. Offshore structures
p. Recreational structures
q. Blasting and drilling
r. Cut and fill
s. Tunnels and underground structures
a. Blasting and drilling

1. EARTH
a. Mineral resources
b. Construction material
c. Soils
d. Land form
e. Force fields and background radiation
f. Unique physical features

2. WATER
a. Surface
b. Ocean
c. Underground
d. Quality
e. Temperature
f. Recharge
g. Snow, ice, and permafrost

3. ATMOSPHERE
a. Quality (gases, particulates)
b. Climate (micro, macro)
c. Temperature

**Figure 16.**
**Extract from USGS Matrix**

## Matrix Analyses

Matrix models portray for the decision maker the relative importance of project impacts on specified features of the environment. He must then assess the relative weights of the factors involved and make his decision.

Typical matrix analyses are the USGS Circular 645 effort and a program developed for the Army by Battelle.

In the USGS effort (Leopold, 1971), an 80 x 100 matrix was developed (Figure 16). Values were assigned at each intersection of project action and earth/water process for the magnitude of the impact and the importance of the impact. By reviewing the row or columns, the decision maker could rapidly determine the relative impact of a specific action or the relative impact on a specific natural process by all of the proposed actions.

The Battelle (1974) effort, which focused on the impacts of dredging, proposed the use of a series of matrix displays which characterize the impacts of actions on processes with a scale of ++ to --. Again, the utility of the system rests with the ability of the decision maker to assess the relative weights of the various interfaces (Figure 17). A similar matrix approach is also found in Clark (1977).

TABLE C-3. SUMMARY OF AESTHETIC IMPACT ANALYSIS FOR REACH 1, CHOCOLATE BAYOU

| | Present | Without Project | | Alternative-A | | Alternative-B | |
|---|---|---|---|---|---|---|---|
| | | 2-3 yrs | 3-50 yrs | 2-3 yrs | 3-50 yrs | 2-3 yrs | 3-50 yrs |
| Land | | | | | | | |
| Surface Configuration | 0 | 0 | 0 | + | + | + | + |
| Geological Surface Material | 0 | 0 | 0 | -- | 0 | - | 0 |
| Water | | | | | | | |
| Flow | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clarity | 0 | 0 | 0 | - | 0 | - | 0 |
| Land-Water Interface | + | + | + | + | + | + | + |
| Air | | | | | | | |
| Odor | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Clarity | 0 | 0 | 0 | - | 0 | - | 0 |
| Sounds | 0 | - | - | -- | - | -- | - |
| Biota | | | | | | | |
| Shoreline Vegetation | 0 | 0 | 0 | 0 | 0 | - | 0 |
| Upland Vegetation | - | - | - | -- | - | - | - |
| Terrestrial Animals | - | - | - | -- | - | - | - |
| Aquatic Animals | + | + | + | - | - | -- | - |
| Man-Made Structures | | | | | | | |
| Compatibility | - | - | - | -- | -- | -- | -- |
| Planting and Site Design | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Composition | | | | | | | |
| Prospect | + | + | + | + | 0 | + | 0 |
| Composite Effect | 0 | - | - | - | -- | - | -- |

KEY: ++ Uniquely attractive for region, not more than one comparable example exists
+ Unusually attractive for region, two or more comparable examples exist
0 Comparable to regional norm
- Unusually unattractive for region, two or more comparable examples exist
-- Uniquely unattractive for region, not more than one comparable example exists
* Conditions highly uncertain, see text

Figure 17. Battelle Matrix

## Other Systems

The above categories obviously do not exhaust the types of environmental impact models available. They do, however, provide an overview of the principal types in use. Several other systems have been used, and two are worthy of comment because of the lack of parallel systems.

Following up earlier work by Leopold (1971), the Kentucky Water Resources Institute (Dearinger, 1971) has developed a model which focuses on the uniqueness of a given environmental resource; in short, focusing on those areas that have extremely unique features, be they bad or good. An area with no super qualities or no poor qualities might receive the higher rating. If uniqueness is a virtue, this system is most effective.

The State of New York (Black, 1974, p. 50) has developed a vulnerability model with the purpose of determining those natural areas most susceptible to development. The system, which surveys features of wetlands attractive to developers, provides an early warning to the potential of land development and gives the state the opportunity to purchase the land, if appropriate.

## III

## THE WETLAND EVALUATION SYSTEM

The purpose of this section is to present another model--the Wetland Evaluation System (WES) model. But why another model?

The basic reason for development of the WES is the need to fill a void. The techniques discussed in the previous section provide partial solutions to the evaluation problem. WES is an attempt to draw the best features of these techniques into a method that is usable today. WES provides the systems approach to evaluation that is missing in the other techniques.

Another reason for development of the WES, and probably a more important reason, is to provide a vehicle for discussing the several features which I believe should be included in any model.

In addition to satisfying the basic criteria for a "good" model outlined in Section II, the WES is designed to:

a. Provide a quantifiable output: information that will enable the decision maker to compare the relative merits of several alternative plans.

b. Take advantage of the computer's capability to store and manipulate a large amount of data.

c. Provide, for the decision maker and the analyst, graphic displays of the impacts of the various actions being considered.

The model is designed to be as useful to the planner who is making a behind-the-desk survey of wetland impacts as it is to the planner who is in the last stages of planning and who has had the benefit of extensive visits to the project area and is thoroughly familiar with the area. To insure its understandability, its output displays all of the input information used to develop the quantitative output.

The purpose of WES as a model is to produce information concerning the change in value of the environmental quality of a wetland area (or areas) as a result of the intrusion of man into the area(s).

### The Structure of WES

Since there is no one measure of environmental quality, the model assesses the change in value of certain environmental quality indicators from a (today's) base value under "with project" and "without project" conditions. These indicators represent the principal features of a wetland and the weighted sum of their values provides a measure of the quality of a designated wetland. For a given wetland area, the basic model is:

(1) $C = V_B - V_C$

where $C$ = Change in value of wetland area

$V_B$ = Base value of area

$V_C$ = Value of area under "change from base" conditions

If the value of the area increases, C will be a negative number. This reflects an improvement in the area's condition.

(2) $V_B = W_1I_1A_1 + W_2I_2A_2 + W_3I_3A_3 \dots + W_nI_nA_n$

where $W_n$ = Relative weight of Indicator n

$I_n$ = Indicator n

$W_1 + W_2 + W_3 + \dots W_n = 1.00$

$A_n$ = Surface area of wetland n

(3) $V_C = W_1C_1I_1A_1 + W_2C_2I_2A_2 + \dots W_nC_nI_nA_n$

where $C_n$ = Percentage change in Indicator n under "change from base" conditions

To provide for consideration of the probabilities involved, appropriate factors may be introduced in equation (3) to produce:

(4) $V_C = W_1C_1P_1I_1A_1 + W_2C_2P_2I_2A_2 + \dots W_nC_nP_nI_nA_n$

where $P_n$ = Probability of occurrence of event causing change n

Since a wetland area is normally part of some larger system, the change in value of this system is determined by:

(5) $C_B = \sum_{j=1}^{n} (V_{B_j} - V_{C_j})$

where $C_B$ = Change within the parent system (basin, estuary, reach)

n = Number of areas

## Features of the WES

What distinguishes WES from any other model? While WES is a model, it is also a system, a way of doing things. It is a system that can be seen best through the features that go to make up the system. These features or sub-sets of the system are outlined below.

### Environmental Quality Indicators

WES is designed to work with basic indicators of wetland quality. It is obvious that there are numerous indicators of wetland quality; however, in order to make the model understandable and the system truly capable of being modeled at the macro level, the myriad features need to be reduced to a manageable level. From a statistical standpoint, factor analysis of data concerning many wetlands could produce some sense of the dominant features or indicators of quality in these wetlands. A similar result can be obtained by a subjective "factor analysis." Perhaps fifteen or twenty would provide representation; however, as the number of indicators increase, so will the interdependence among these indicators and the confusion among the evaluators. WES assumes that there are nine critical indicators of a given wetland's quality. While the nine may not fully represent 100 percent of the wetland's quality, they do represent a most substantial amount. These nine indicators are:

1. Endangered Species (ENDANG). The quality of critical habitat in the area for those species listed as endangered by the U.S. Fish and Wildlife Service (USFWS). Critical habitat is normally defined (and physically located) by the USFWS as part of endangered species classification actions. This indicator would include both fish and wildlife even though they are logically part of the other indicators listed below. Doing this provides both visibility for endangered species, something mandated by law, and the opportunity for those in the local area, through the weighting process, to express their views on the relative importance of the endangered species to the overall ecology of the area.

2. Fish and Other Aquatic Ecosystems (FISH). The extent, size, and quality of the aquatic ecosystem as a whole. This indicator reflects not only the vitality and diversity of aquatic organisms, but also the vegetative and other systems necessary to support the fishery resources, as well as the water quality necessary to ensure their existence. If the endangered species indicator (ENDANG) is used, and involves aquatic systems, the FISH indicator is assumed to be aquatic ecosystems minus the endangered species.

3. Wildlife and Other Terrestrial Ecosystems (WLDLF). The extent, size, and quality of the terrestrial ecosystem as a whole, minus waterfowl. This indicator includes all vegetation necessary to sustain these ecosystems. It includes consideration of species diversity as well as the periodic innundation necessary to maintain these biotic species. The indicator includes all birds except waterfowl. If the endangered species indicator (ENDANG) is used and involves a terrestrial system, the WLDLF indicator is assumed to be minus those endangered species. Waterfowl are excluded from the WLDLF indicator and placed in a separate category because of the intense national interest in waterfowl and because of the obvious close interrelationship between waterfowl survival and the existence of adequate wetlands.

4. Waterfowl (FOWL). The extent, size, and quality of the waterfowl population in or known to frequent the area. It includes those vegetative and water features necessary to provide water-

fowl habitat. As with FISH and WLDLF, if any waterfowl are listed in the endangered species category, those species are not considered under this category.

5. Uniqueness (UNIQUE). The relative degree of uniqueness of any features of the area. The presence of the last remaining large cypress in the region or the largest pine tree in the county or the deepest bayou in the region, for example, would all be considered as unique features.

6. Appearance (APPEAR). The visual quality of the aquatic and terrestrial features of the area. Included in this indicator are aesthetic qualities of the area such as the solitude of a remote wetland or a moss-draped bayou as well as the visual quality of the air and water in the area. The presence or absence of uncontaminated water would be reflected both in this indicator from the visual/nasal standpoint and in the indicators such as FISH or WLDLF as the presence or absence of high quality air or water impacted on those features.

7. Natural Protection (PROTEK). The capability (capacity) of the area to hold significant amounts of flood waters as natural valley storage or the capability of coastal wetlands to serve as buffers to storm wave action. From a flood reduction standpoint, a high value would reflect flood coverage of the area for short periods. This latter, short-period coverage derives its utility from its "safety valve" function, which permits peak flows to be stored until natural or man-made floodways below the wetland area can handle the stored water. From a coastal standpoint, a high value would indicate that the wetland provided substantial wave energy action dissipation.

8. Life-Cycle Support (LIFE). The capability of the area to serve as a living filter for tertiary treatment of passing wastewaters and to serve as an oxygen recharge source for the region.

9. Historical-Cultural (CULTURE). The number and significance of historical, cultural, and archaeological features of the wetland area. Presence of a site on the National Register of Historical Landmarks would give an area the highest CULTURE value.

Focus

To provide for a degree of focus, the WES operates with only six of the nine indicators listed above. Prior to putting the model into operation, evaluators determine which six indicators (of the nine) best represent the wetland area under study. Some attributes may be found in only a few areas; others throughout the basin. Six indicators must be selected for each area (see below), but the same indicators need not be used for all areas in the basin. Reduction in numbers of indicators used permits the WES to avoid evaluating wetland qualities that may not exist or may exist only to a limited degree in the wetland under study.

Areas

To permit the wetland to be evaluated with some degree of specificity, the total wetland is divided into areas (see Figures 18, 19, and 20).

Areas are selected by those familiar with the basin so that the wetlands contained within each area are of a relatively homogeneous nature. The model restricts the size of an area to no more than 9,999 acres, although normally an area would involve considerably less acreage. Areas are then grouped by topography or other suitable criteria into sub-basins, estuaries or sectors, and it is the sum of these sub-sets that represents the basin, estuary, or sector as a whole. Where topography dictates, an area may also be a sub-basin, estuary, or sector.

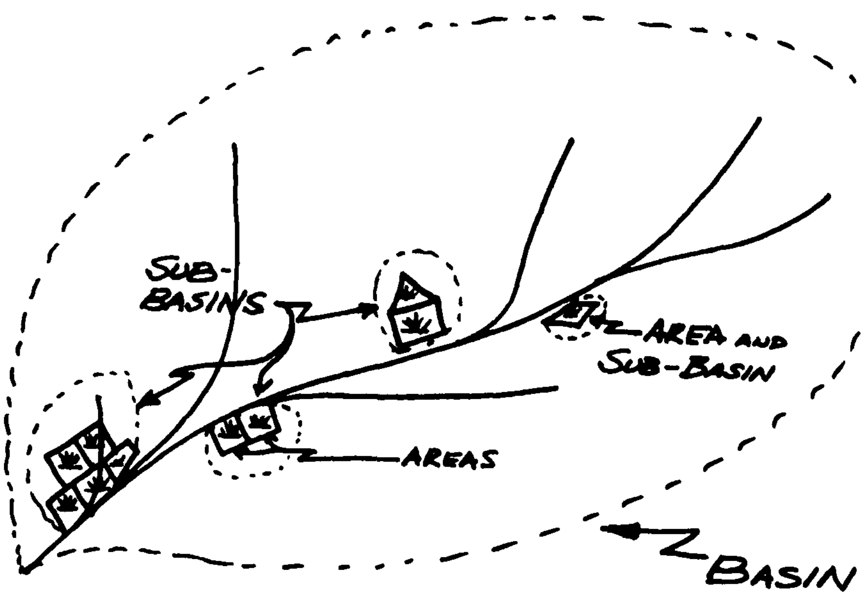



Figure 18. Typical Areas

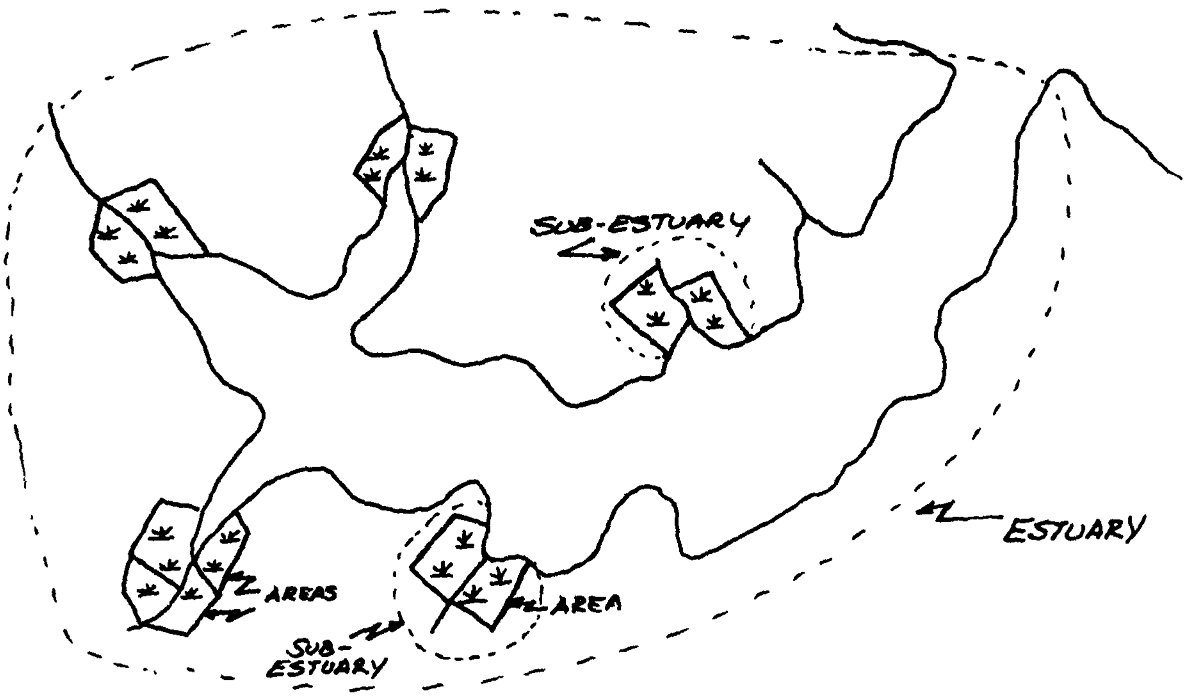



Figure 19. Typical Areas - Estuary

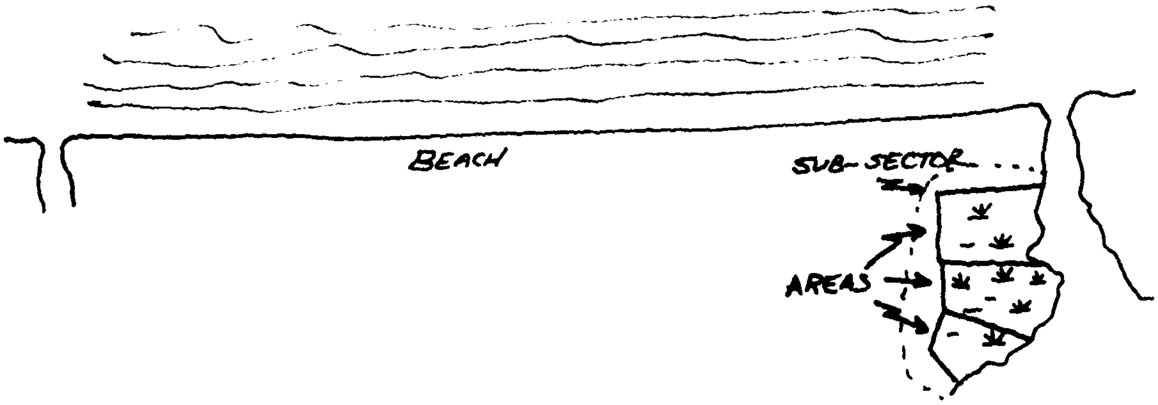



Figure 20. Typical Areas - Coastal

## Local Citizen and Expert Participation

There is a natural tendency on the part of many decision makers to look outside their own area for advice and assistance. At the same time, they may place less stock in the advice of individuals within their own organization or area, feeling that their views may be biased towards the "establishment." While there is truly something to be said for both sides, in the case of evaluation of local wetlands, the expertise of the local or regional expert must be given great weight. The local has seen the area under a variety of climatic circumstances. Probably, he has walked the area under these varied conditions and can better picture the strong and weak features of the area. Because he has witnessed a variety of events which have occurred in the wetland, he is also better able to visualize the impact of man's actions on the wetland. The local's expertise is something that cannot be passed over lightly.

Similarly, local officials provide a great insight into the public's desires--the vox populi. While it is admitted that these local officials do not always speak for the national or regional best interest, they do speak for the local interest. Determination of the relative value to the public of the various wetland indicators under consideration is, to a great degree, a local matter. Often, in the decision-making process of the federal government, efforts are made to insure public participation. What way short of a referendum would do more to involve the public than the participation of their elected representatives in the wetland evaluation process?

WES provides for the participation of highly trained local experts in the determination of the value of the wetlands under study and in the assessment of the impacts of man's intrusion into a wetland area. These experts are drawn from the organization conducting the evaluation, the U.S. Fish and Wildlife Service, state game and fish agency representatives (preferably, at the local level) and local institutions of higher learning.

Similarly, WES provides for the participation of local elected officials in the indicator weighting process (described below). Where possible, the elected officials participating in the program would be drawn from not only the county or parish in which the wetlands were located but also from the list of elected officials whose representation is more regional (e.g., State Representatives or Levee Board Members).

## Evaluation

The WES provides three types of evaluation: the determination of the relative value of a wetland indicator, assessment of the percentage change in this base value that will occur under various conditions and determination of the relative weight or importance of each indicator being used.

Basic Area Values. In the first type of evaluation, a team of local experts, representing a cross section of the social and natural sciences, reviews, by area, each indicator present in that area.

A value must be assigned to each indicator on a cardinal scale of one to ten. Ten represents the highest environmental quality or quantity of the indicator being assessed; one the lowest quality or quantity. In the case of appearance, for example, an untouched backwood swamp with great diversity of trees and vegetation might be rated as a ten. An area about half as beautiful in the eyes of the evaluators might be assigned a five. Since it is assumed that the indicators of the wetland quality selected were selected because of the presence of these qualities, there is no zero value on the indicator rating scale (see Figure 21).

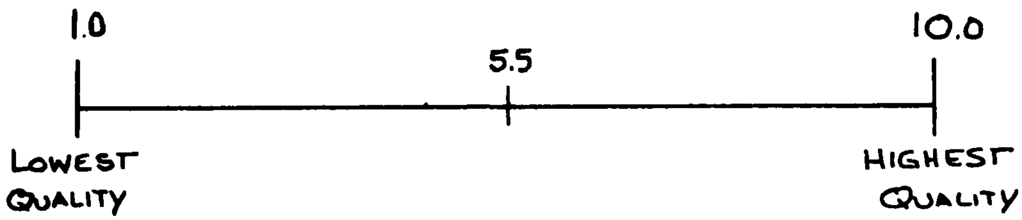



Figure 21. Value Scaling - Indicators

The evaluation is a judgment call,but a call by individuals who are familiar with the diversity and value of wetland features throughout the area and who know that some of the wetlands are of high value and others of only marginal value.

The values assigned to a given wetland area can be based on existing detailed studies of the area. Possibly, a detailed analysis of various aspects of the area had been conducted by one of the agencies represented at the evaluation session. Normally, "hard" information like this would have a higher credibility in the determination of values than "pure" opinion.

Decisions of the evaluation group reflect a majority vote. If felt necessary, initial voting can be followed by discussion and another vote, in a manner similar to the Delphi System described later in this paper.

While it would be more satisfying to be able to rate a given wetland feature against an ideal or nation's best wetland, this concept is unworkable. Wetlands in California are far different than those in Louisiana or North Carolina. The characteristics of a wetland even differ from north to south Louisiana with the Felsenthal bottoms having a different makeup than lower Atchafalaya bayou areas. So by comparing wetlands to other wetlands in the area, not only is the effort workable but it also permits the decision maker to consider that wetlands in one area, even though not as valuable as wetlands in some other area of the country, being the best in the region, are worthy of special value.

The net result of this first evaluation effort is the assignment of a numerical base value to the six indicators in each area; i.e., in a 12-area basin, 6 x 12 = 72 values would have been assigned.

Changes in Base Value from Project Actions. In the second phase of the evaluation, the same team of experts assesses the damage done by the action under consideration. The group, based on briefings by project engineers, assigns percentage changes in the base value of each indicator in each area. These changes are attributable to the particular impact under study. Normally, this would involve: (1) assessment of the change attributable to the direct impact of the project under consideration; (2) the determination of the incremental change attributable to secondary impacts that would follow project completion; and (3) an assessment of the percentage change in base values that would occur from "other" actions in a "without project" condition.

Most assessments will result in reductions in the base values as most projects have some negative impact on the area. However, there will be times when wetland enhancement programs that are considered under the "other" impact category will result in an improvement in the area and a resultant increase in the base value. Assessed changes, therefore, may vary from zero to minus 100 percent or zero to plus whatever percent will raise the base value to its maximum value of 10.

If time permits, visits to the project site could be made by the team. If not, the team must again rely on the knowledge of its members to determine the impacts of the actions being considered.

Weighting. In order to determine the overall value of an area under base "with project" or "without project" conditions, the base or modified values must be combined. This combining action is the weighting process of WES.

As noted earlier, the weighting process is a most sensitive but often disguised portion of an evaluation system. In many systems, the weighting is done by default; that is, the area of composite value represents either the average of the indicator values or the sum of these values. This technique would be acceptable if each indicator was equally important. Seldom, however, is this the case. Therefore, some method must be used to assign relative weights to each indicator.

In WES, the assignment of these weights is accomplished by the team of local representatives described earlier. This group is briefed by representatives of the interdisciplinary team on the reasons why the six indicators being used were selected. Following this briefing, the local representatives assign relative weights to each indicator. In this case, the scale runs from zero, representing a "no importance" assessment by the rater, to ten, representing the highest degree of importance (see Figure 22).

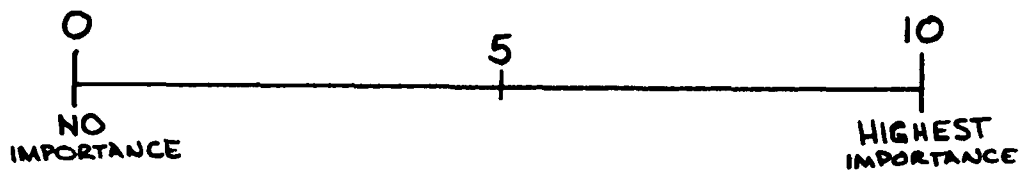



Figure 22. Value Scaling - Weighting

Use of a zero value permits the rater to "eliminate" from the model an indicator if the rater believes that the indicator is of no importance to the people that he or she represents. It is unlikely, however, that any indicator would receive zeros from all raters and thus be dropped from the evaluation. Weights assigned to each indicator are assigned considering each indicator individually in terms of its importance to the regions adjacent to and containing the wetland under study.

To insure that all views are heard and considered in the weighting process, a modified Delphi technique is used in the WES.[16] After the initial briefing, the team of local representatives individually assign weights to the various indicators. Administrative personnel then calculate and display the average weight assigned to each indicator by the group. Using these average weights as talking points, the group then discusses the factors involved in the assignment of the weights. No individual member discloses his "vote" from the previous tally; however, each member is able to see and understand through the discussion why he or she is below or above or with the group consensus.

Another vote is then taken; and if deemed appropriate by the administrative personnel, based on their analysis of the vote, another round of discussion is held. If the group has arrived at a consensus or if it is obvious that there is full understanding of the issues and that the differences in voting will not be modified further by discussion, the last vote is taken as the final vote.

The result of this action is the assignment of a weight to each indicator for each sub-basin, estuary, or sector.[17]

Probability

Recognizing that not all possible events relating to wetlands have an equal chance of occurrence, the WES provides for consideration of probability. Probabilities are assigned to the occurrence of project impacts (direct impacts), secondary impacts and "other" impacts. Probabilities assignment is accomplished by a combination of the interdisciplinary team and the project engineers. Participation of the project engineers is important because in many cases they are more aware of those local events and actions that might cause "other" impacts or exacerbate secondary impacts.

Probability of occurrence scores are assigned on a sub-basin/estuary/sector basis to each indicator being used and for each impact being considered in the evaluation. Normally, direct impacts would have a 100 percent probability of occurrence and secondary and "other" impacts a somewhat lower probability.

Assignment of probability scores permits WES to bring the overall ratings in closer touch with reality. While one can assume that certain secondary impacts will occur as a result of the project--e.g., oil pollution of adjacent waters resulting from construction of a boat marina--it is more realistic to indicate that based on the best judgment of the combined groups, there is a 70 percent probability that such secondary impacts will occur.

"With" and "Without" Project Evaluations

WES provides for display of the evaluation of the value of the wetlands under "with project" and "without project" conditions, as well as under base or present conditions. Often, discussions of proposed projects are limited to consideration of "What is going to happen if we build this project?" when in reality the discussion should involve "What is the difference between the way it will be if we build the project and the way it will be if forecast non-project actions in the area take place?"

The difference between "with project" and "without project" values is a much better measure of project impact than the difference between "with project" and "base" values. In addition, display of the "without project" values/changes often serves as an alert to the true negative impact of some proposed "other" actions.

Cumulative Impacts

The WES provides for consideration of cumulative impacts both over time and over space.

From a spatial standpoint, the WES requires the evaluators to initially assess percentage changes in indicator values on an area basis. Then, after appropriate displays have been prepared, the evaluators are required to assess the cumulative impact of the area changes taking into account the interdependence of adjacent or contiguous areas. As discussed earlier, the utility of certain areas may be strongly affected by changes in the values of these adjacent areas. This cumulative spatial analysis is accomplished twice. The analysis is first made after assignment of value changes to the areas. This analysis would result in further changes to sub-basin or area values. Following this, another display is prepared, and the basin is analyzed on a sub-basin basis. If appropriate, further changes in indicator values are made, again based on the cumulative effect.

The same procedure can be used to assess cumulative impacts over time. A series of displays are prepared showing changes in indicator value that have occurred (or are forecast to occur) since a base date.

Display

The output of WES includes both computer printouts and computer generated maps. These documents enable those involved in the project review process at all levels to have access to the same hard copy information as the decision maker and, more importantly, for the decision maker to be able to understand the general basis of the evaluation. In addition, during the evaluation process, the displays provide the vehicle for the interdisciplinary team to assess the cumulative impact of the reduction in value of key wetland indicators. The displays also provide a useful record of wetland status.

Computer Printout

A section of a typical printout is shown in Figure 23.

```
EVALUATION OF NEUSE RIVER ESTUARY
BACK AREA SUB-ESTUARY
INCREASED FISHING ACTIVITY (A)


ENVIRONMENTAL FEATURE               ENDANG     FISH      FOWL     UNIQUE    APPEAR    WILDLF

WEIGHT                (B)            10.00     10.00      2.00      2.00      4.00      2.00

                                                     AREA   9   (C)
                                                 ACREAGE  400
VALUE                                 3.00      3.00      3.00      4.00      8.00      8.00
BASE VAL-EQ POINTS    (D)          1200.00   1200.00   1200.00   1600.00   3200.00   1200.00

NON PROJ IMPACT (%CHANGE)           -15.00    -15.00    -15.00    -15.00    -10.00    -15.00
PROB OF OCCURRENCE                   20.00     20.00     20.00     20.00     20.00     20.00
BASE VALUE W/O PROJ                1236.00   1236.00   1236.00   1648.00   3264.00   1236.00
PERCENTAGE CHANGE     (E)            -3.00     -3.00     -3.00     -3.00     -2.00     -3.00
                                          AREA BASE VALUE   1493.33
                                          W/O PROJ VALUE   1452.80  (F)
                                          PERCENT CHANGE     -2.71


PROJECT IMPACT(%CHANGE)             -10.00    -10.00    -20.00    -20.00     -5.00    -10.00
PROB OF OCCURRENCE                  100.00    100.00    100.00    100.00    100.00    100.00
SECOND IMPACT(%CHANGE)              -10.00    -10.00    -10.00    -10.00    -10.00    -10.00
PROB OF OCCURRENCE                   30.00     30.00     30.00     30.00     30.00     30.00
BASE VALUE W/ PROJ    (G)          1359.60   1359.60   1483.20   1977.60   3460.80   1359.60
PERCENTAGE CHANGE                   -13.30    -13.30    -23.60    -23.60     -8.15    -13.30
                                          AREA BASE VALUE   1493.33
                                          W/ PROJECT VALUE   1297.47  (H)
                                          PERCENT CHANGE    -13.12
```

Figure 23. Typical Computer Printout

The first two rows (A) list the title of the basin, estuary, or sector and the name of the project being evaluated. The third and fourth rows (B) identify the six indicators being used in the evaluation and the weights assigned to these indicators by the local representatives. At (C) is listed the area number and the acreage of area. The seventh and eighth rows (D) contain a list of the values assigned to each indicator by the interdisciplinary team as well as a display of the base EQ (environmental quality) points computed for each indicator. The next four rows (E) address by indicator the "without project" case, listing the assessed percentage change for the "other" impacts, the estimated probability that the impact will occur, the "without" project EQ points and the percentage change from base value that has resulted from the "without" project impact.

Section (F) lists the base (present) value of the area in EQ points, the area's "without" project value (EQ points), and the percentage change in the area resulting from the "without" project actions. Sections (G) and (H) parallel sections (E) and (F) except that they deal with "with" project direct and secondary impacts.

Following a listing of all areas in the sub-basin/estuary/sector, a listing similar to (H) is provided for the entire sub-basin/estuary/sector. At the end of the printout, a summary for the entire basin/estuary/sector is provided in a format similar to (H).

### Computer Graphic Display

WES uses either SYMAP or CALFORM as its display technique. (Any computer graphic system could be used.) Figure 24 illustrates a typical CALFORM output.

As indicated in the title information (A), this output reflects the percentage change from the base (present) value under "without" project conditions of the waterfowl indicator. The shaded polygons (B) indicate both the location of the areas under evaluation and the percentage change in wetland value occurring in that area.

It should be emphasized that it is not the "brand" of display that is important; rather, it is the use of display that is important. The decision maker and the reviewers must be given the opportunity to see and understand the spatial status of wetland values and man's impact on these values.

## Assumptions

A model is a simplified portrayal of a real world situation. To be useful, the model must not be overly complex. To prevent important results of model operation from being lost in an excessive amount of unimportant information, certain assumptions are made in model development. The assumptions related to WES, assumptions which are designed to help separate the "wheat from the chaff," are highlighted below.

### Independence of Indicators

The nine indicators are assumed to be independent of each other. There is no overlap between these indicators. Assignment of values to an indicator in an area is an operation independent of the assignment of values to each other indicator for that area. In reality, there is some interdependence;

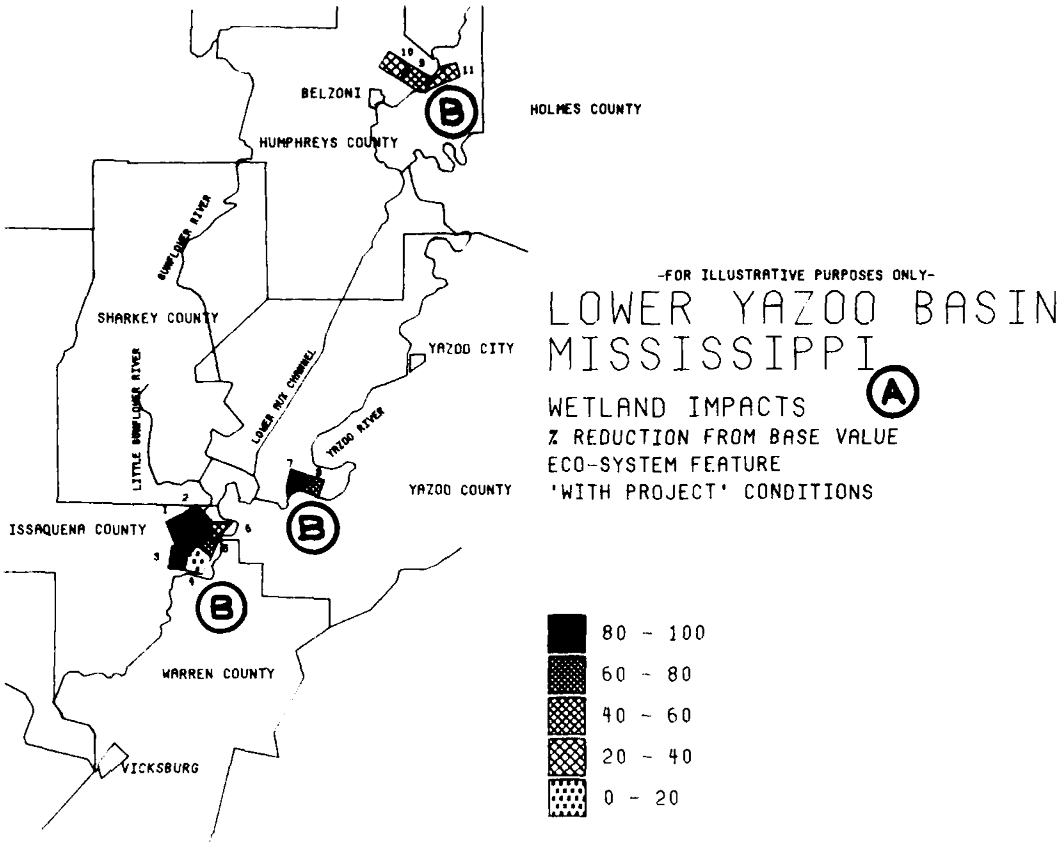



Figure 24. CALFORM Display

however, through judicious selection of indicators, most of this interdependence can be reduced to a point where it is not significant in the overall context of the evaluation.

Human Focus

The nine indicators are assumed to represent human interest in the wetland and value assignments are made based on this human focus. The indicators represent factors which are "pleasing" to man or which he recognizes to be needed by him for his existence in the earth ecosystem.

Independence of Values and Weights

The assignment of values to indicators and the assignment of relative weights to the indicators are assumed to be independent operations. While independence is provided for in WES through use of different groups for assignment of values and weights, the possibility exists that under some circumstances the two evaluation groups could mentally be picturing the same evaluation process and some redundancy could be created. This is assumed not to occur.

Independence of Areas

For the initial evaluation of areas, WES assumed that the areas are independent of each other. This assumption permits a detailed examination of each indicator on an area basis without concern for the relationships among areas. The assessment of the impacts of interdependence of areas is accomplished in the sub-basin and basin level appraisals.

More is Better

The WES assumes that larger wetland areas are more valuable than smaller ones. Since all indicators except uniqueness and historical-cultural are basically areally related, this assumption is valid in these cases. If aquatic ecosystems have an equally high value in two adjacent areas, the larger of the two areas is more valuable in the aquatic ecosystem judgment. In the case of uniqueness and historical-cultural where a single object--e.g., a tree--may be the reason for the designation, size of the area is not as important; however, since these two indicators represent only two of the six indicators being used and since size of the area is important to these indicators, size can be assumed to be a valid overall measure (or multiplier) of relative importance.

## Operation of the WES

Figure 25 illustrates the basic Wetland Evaluation System.

The model first assigns values to each indicator of wetland quality in each area. These indicators are weighted, and the impact of the action in question is assessed in terms of a change in value. After summing these impacts across the entire area, information on the base value and changed value of each area is displayed. A separate analysis is conducted for each impact (primary, secondary, and other) expected to occur in the area. After initial area value changes have been calculated and summed across the sub-basin, the analyst is given the opportunity to go back and modify the change in value assessed in the first step to account for the impact of concurrent occurrence of changes across the entire sub-basin. The same steps then take place as changes are summed across the entire basin. The output is a display of the change in value of wetlands throughout the basin under present "without project" and "with project" conditions. The display is both quantitative and graphic.

In the first step of the model, the interdisciplinary team divides the basin's wetlands into areas, determining the homogeneity from a map survey, records, prior knowledge or field surveys, depending on the time available.

In step two (Figure 26), the base value of each area is determined. The interdisciplinary team first selects from the nine indicators the six that are most representative of the sub-basin being evaluated. Assuming that each area has at least six of the indicators, the team selects the six indicators that are most important to this sub-basin. (It is assumed that this screening would apply across a sub-basin; if it would be more appropriate to provide a screening for each area, it could be done.)

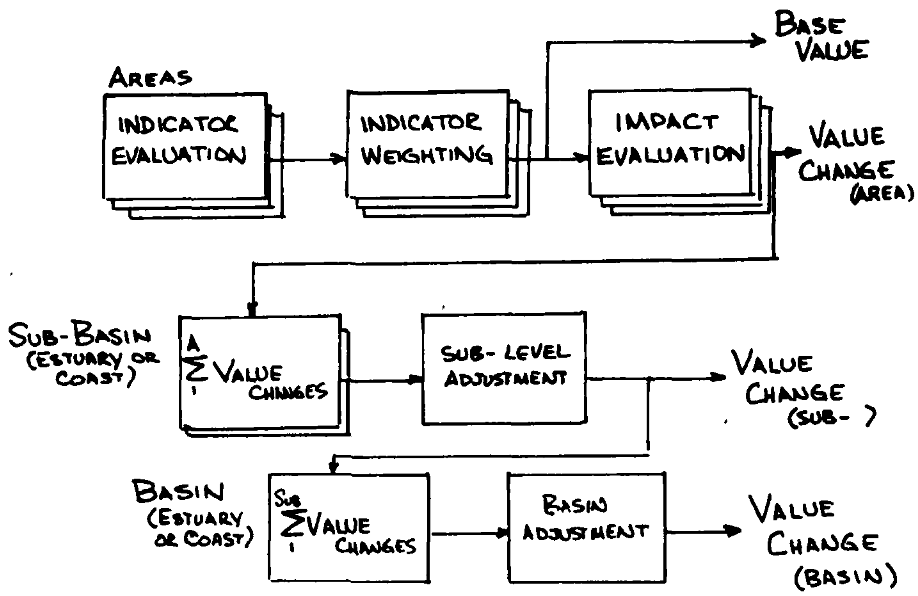



Figure 25. Wetland Evaluation System

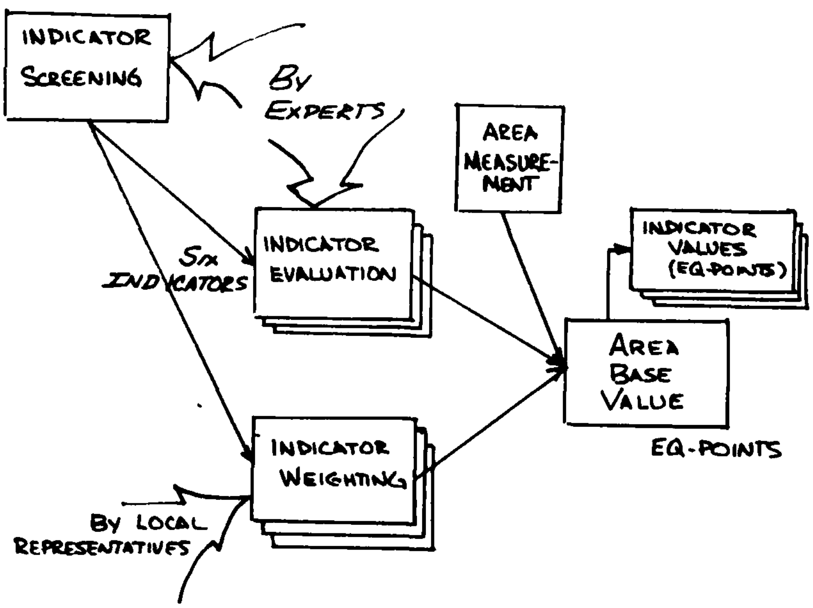



Figure 26. Step Two - Base Value Computation

Once the six indicators are selected, the interdisciplinary team assigns values to each of the indicators by area. Concurrently, another group, representing the citizens of the local area, assigns weights to the indicators.

All of these values are used together with the acreage of the area to compute the base value of the area in environmental quality (EQ) points. In the third step (Figure 27), the impacts of the various actions are assessed.

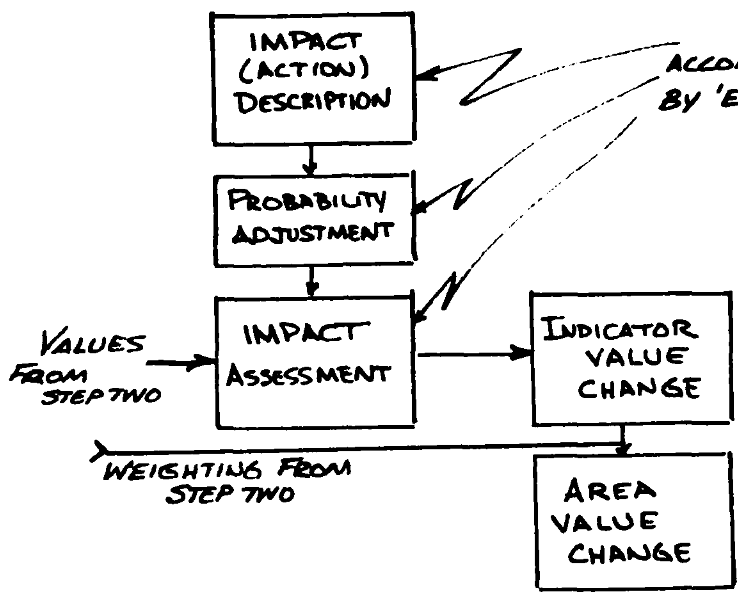



Figure 27. Impact Assessment

In each case the nature of the action causing the impact being assessed is described by someone familiar with the action; normally, the project engineer. The interdisciplinary team and the project engineers assign a probability of occurrence to the action in question. Probability values are assigned to direct and secondary impacts and to impacts that result from actions not connected with the basic project.

Following the probability assignment, the interdisciplinary team then assesses the impact of the specified action on each indicator, developing a percentage change in value for each feature. These changes are then combined with the probabilities, base values and the previously assigned weights to develop an expected value change.

Step three is repeated for each impact (direct, secondary, and "other") as well as for each alternative plan being evaluated.

In step four, a series of values are computed and displayed. The base value for each feature is calculated and printed by the computer. Then, the expected "without project" value is computed and printed along with the percentage change from the base represented by this value. The "without project" value equals the base minus or plus the changes attributed to "other" conditions; that is, attributed to those impacts that will occur whether or not the project under study is carried out. Following this, the "with project" value is computed and printed. The "with project" value represents the base value minus or plus the changes attributable to primary and secondary impacts. Concurrently, graphic displays of the percentage change in feature values attributable to each condition are produced by either the plotter or the printer.

In step five (Figure 28) a sub-basin/estuary/sector evaluation is conducted. The interdisciplinary team reviews the output of step four to assess the cumulative spatial impact of changes across the areas of the sub-basin/estuary/sector. If the cumulative effect is significant (e.g., the loss of value in certain contiguous areas isolated other areas and thereby reduced their value), the team may assign additional reductions to each feature. Steps three and four are then repeated and displays (graphic and numerical) similar to step four are produced for the sub-basin/estuary/sector level.

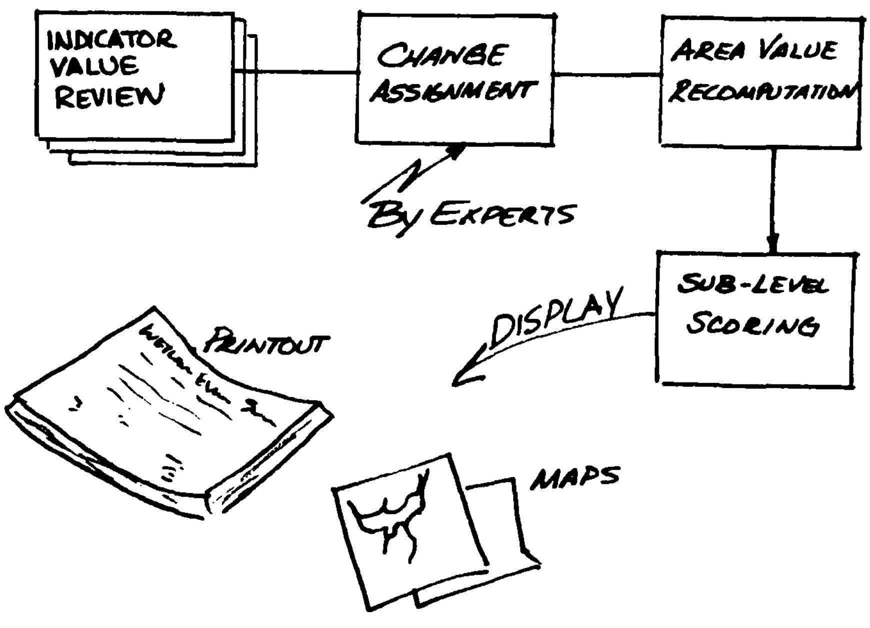



Figure 28. Sub Level Evaluation

Step six (Figure 29) is essentially a repeat of step five with the assessment now being conducted at the basin/estuary/sector level. The displays in this step represent the final output of the WES.

The combination of the computer printouts and graphic display should provide ample information for the decision maker.

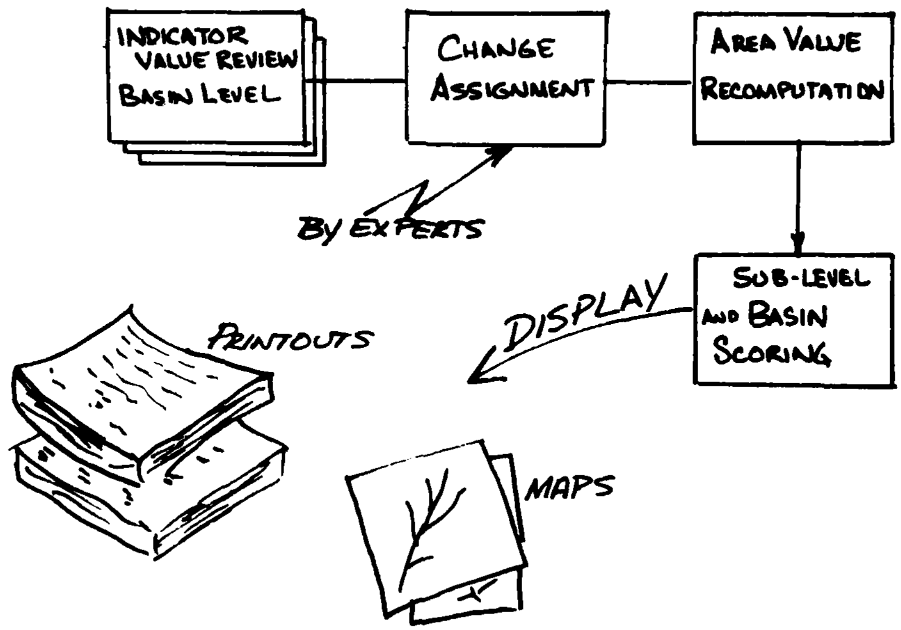



Figure 29. Basin, Estuary or Coastal Evaluation

# IV

# WES IN ACTION

To provide examples of how WES might work in an actual situation, hypothetical situations were developed for wetlands in the Yazoo Basin, Mississippi, and the Neuse River Estuary, North Carolina. In each example one sub-basin/estuary is treated in detail, while information on the other sub-basins/estuaries is provided without explanation, for illustrative purposes.

## Yazoo Basin

In this example it is assumed that various types of development are taking place in the wetlands of the basin. In the backwater sub-basin (Figures 30 and 31), local residents are considering the installation of a pumping station along an already existing levee. At the present time, the waters of the Little Sunflower River empty into the Yazoo through a small drainage structure. When the Yazoo is at high stages, the drainage structure must be closed and the waters of the Sunflower are then trapped causing interior (behind the levee) flooding. The pumping station would permit these trapped waters to be evacuated from the Sunflower basin into the Yazoo River during the high stages on the Yazoo.

An interdisciplinary team selects the fish and aquatic ecosystems, wildlife and terrestrial ecosystems, waterfowl, appearance, historical and cultural, and water storage indicators to be most representative of the wetlands in the area and based on studies previously conducted in the area, assigns values to each of these indicators. Since the areas closest to the levee (4, 5, 6) are lower and are more frequently flooded, they receive generally higher values than areas 1, 2, and 3. (Specific values used in this example are found in Appendix A and in Figure 32.)

Concurrently, members of the Board of Supervisors for Sharkey County along with representatives of the Board of Mississippi Levee Commissioners gather to assign relative weights to the indicators. Because of their great interest in fish, wildlife, and waterfowl, they assign higher weights to these features than to the other features.

Following these actions, the responsible planners and engineers brief the interdisciplinary team on the nature of the proposed construction. They also point out to the groups that land clearing is occurring at a fast pace just above wetland areas 1, 2, and 3 and that this clearing is the forecast principal "other" impact on the project area. They also note that the only secondary impact that might occur from project construction would be diesel spills connected with the operation of the pumping station.

The combined groups then assign probability values to the forecast actions. The pumping station is given a 100 percent probability of occurrence while the secondary impact of diesel spill is assigned a five percent probability of occurrence. Because all feel quite certain that land clearing will likely continue from the north, the group assigns a 70 percent probability to the potential intrusion of agriculture into areas 1, 2, and 3.

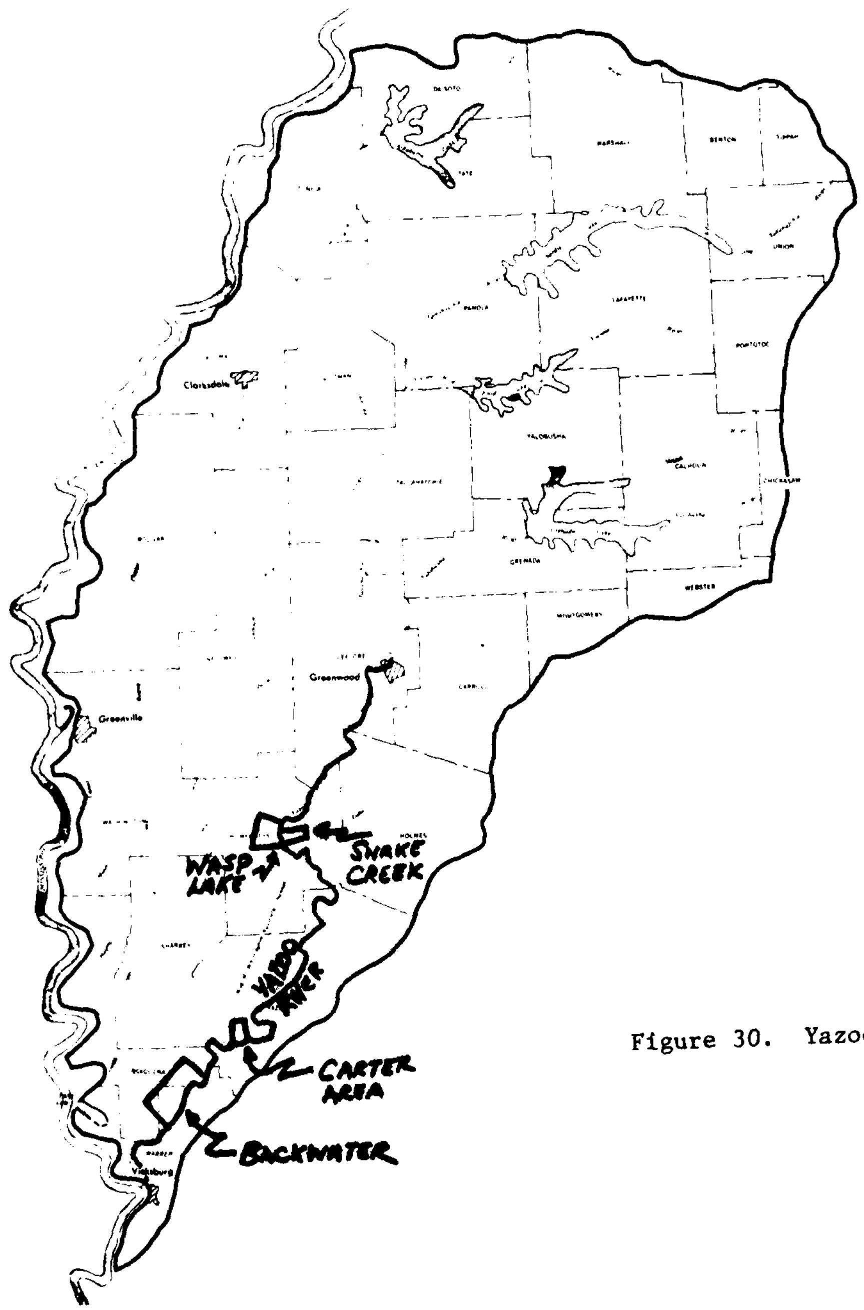



Figure 30. Yazoo Basin

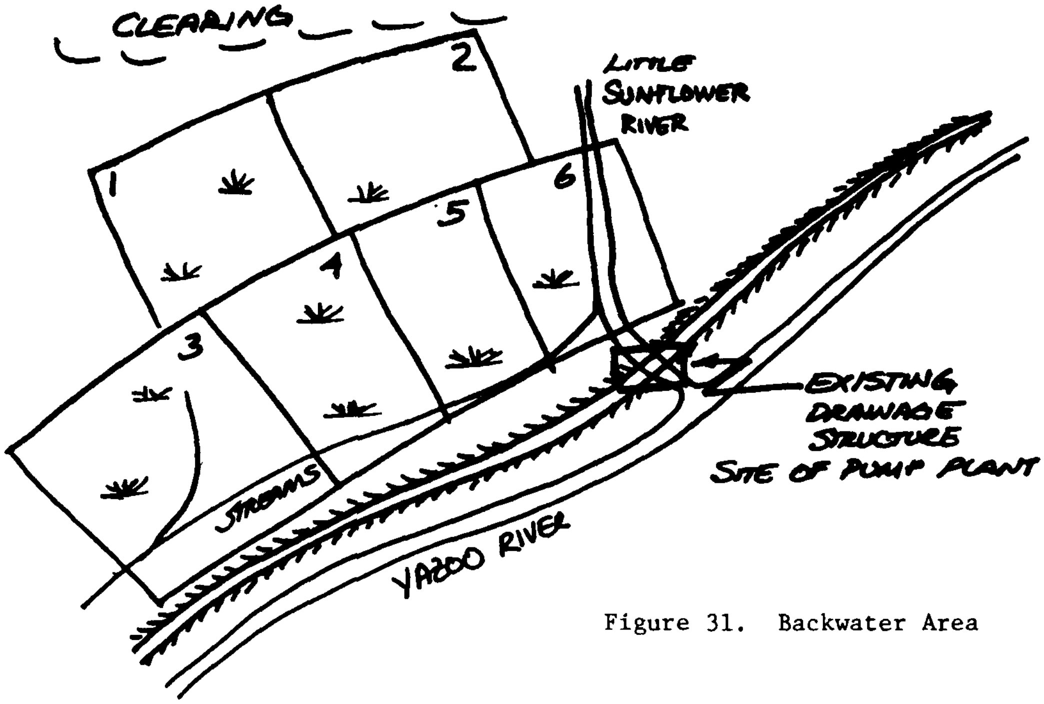



Figure 31. Backwater Area

EVALUATION OF YAZOO BASIN
BACKWATER SUB-BASIN
PUMP PLANT PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |
| | | | AREA 1 | | | |
| | | | ACREAGE 350 | | | |
| VALUE | 2.00 | 7.00 | 6.00 | 7.00 | 5.00 | 3.00 |
| BASE VAL-EQ POINTS | 700.00 | 2450.00 | 2100.00 | 2450.00 | 1750.00 | 1050.00 |
| NON PROJ IMPACT (%CHANGE) | -65.00 | -70.00 | -75.00 | -70.00 | -72.00 | -76.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 358.75 | 1163.75 | 918.75 | 1163.75 | 805.00 | 451.50 |
| PERCENTAGE CHANGE | -48.75 | -52.50 | -56.25 | -52.50 | -54.00 | -57.00 |
| | | AREA BASE VALUE 1656.67 | | | | |
| | | W/O PROJ VALUE 783.77 | | | | |
| | | PERCENT CHANGE -52.69 | | | | |
| PROJECT IMPACT (%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 244.39 | 855.36 | 733.16 | 1588.52 | 1728.17 | 837.90 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |
| | | AREA BASE VALUE 1656.67 | | | | |
| | | W/ PROJECT VALUE 807.64 | | | | |
| | | PERCENT CHANGE -51.25 | | | | |

Figure 32. Printout Extract

The interdisciplinary team then gathers to assess the specific impacts of the above action on a feature-by-feature basis. In each case, they review the indicator values by area and assess a percentage change in value as a result of each action. All of this information is then fed to the computation center personnel who produce the output found at Appendix A and in Figures 33 through 39.

The printout indicates that at this first stage of evaluation (step four of the process) a noticeable reduction in value of Areas 1-6 would result from the project. The output also indicates, however, that the magnitude of the "without project" losses (i.e., the losses that will occur whether or not the project is constructed) are also quite high in Areas 1-3.

At this point the interdisciplinary team would regather to review the data and the displays to determine if additional losses should be assigned as a result of the cumulative impact factor.

Review of the spatial patterns of the wetland losses for each indicator indicates that under "without project" conditions, Areas 1-3 will experience heavy losses in the wildlife and waterfowl categories. The impact on wildlife and waterfowl of these "other" actions (projected clearing for agriculture) will be more severe than initially evaluated at the area level since heavy losses of forested land in three adjacent areas will severely curtail the movements of wildlife and cover for waterfowl.

As a result of this relook, the interdisciplinary team assigns an additional fifteen percent reduction to the wildlife and waterfowl indicator values for Areas 1-3.

The entire computation process is repeated and new printouts and graphic displays prepared (Figures 40 through 42).

Review of these displays highlights the severe impact on Areas 1-3 of the "without project" actions. Assessment of the additional negative change in the last step also increased the "without project" conditions at the sub-basin and basin level.

The review does not indicate that any additional cumulative impact changes need be assessed at the basin level. Had major losses in adjacent sub-basins been noted, additional negative changes could have been assessed and the above process repeated to obtain the final basin scores

In this case, since no major impacts were noted in adjacent basins, the WES assessment is complete.

Presented with the final displays (of "with" and "without" conditions), the decision maker is in a position to judge the relative impact of the proposed actions on the wetland resources of the area. His final decision as to approval of the proposed actions most probably would be based on the economic, social, and environmental costs and benefits of the actions. While WES has not addressed the first two of these issues, it has provided a tool for judgment in the third.

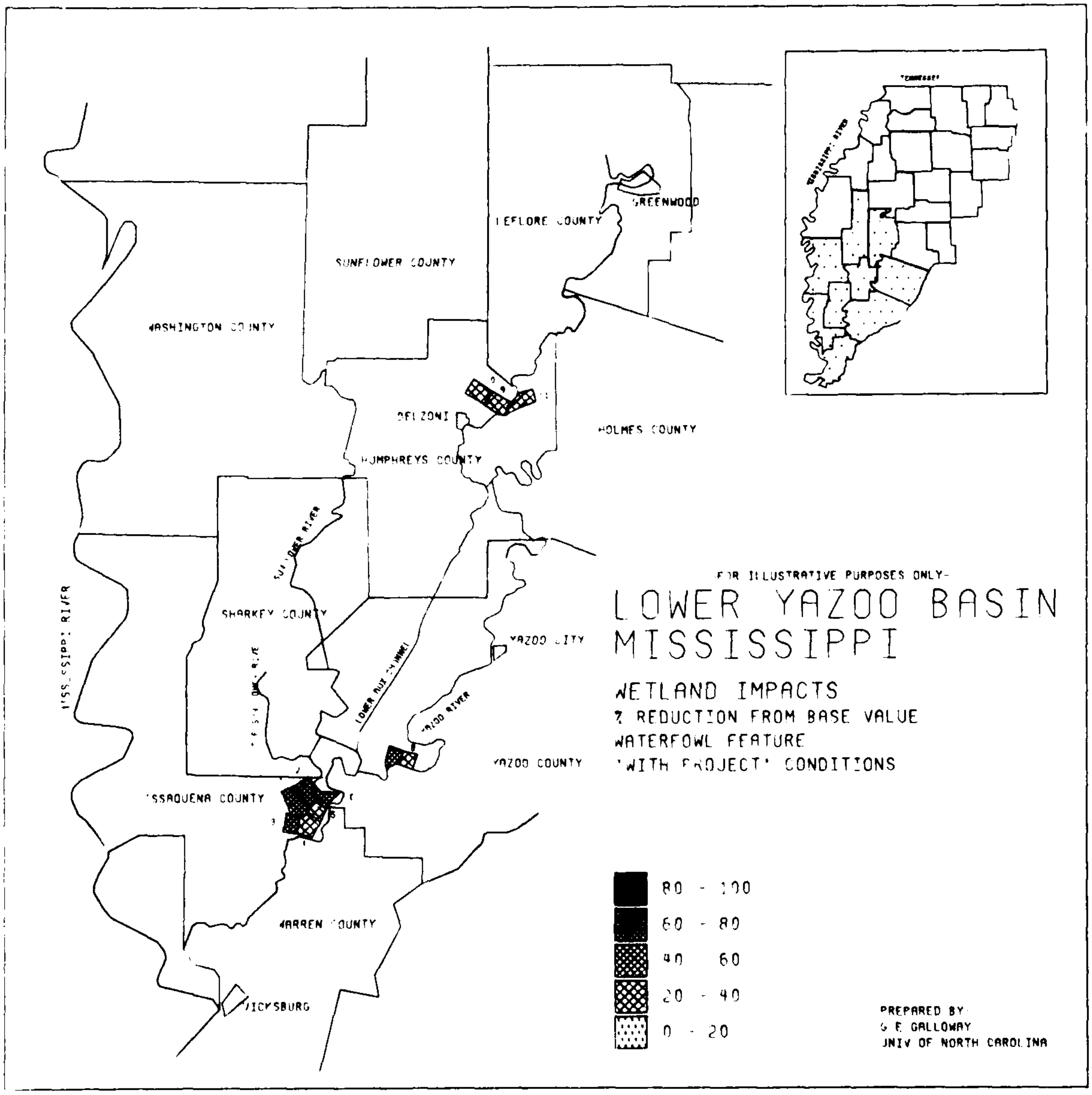
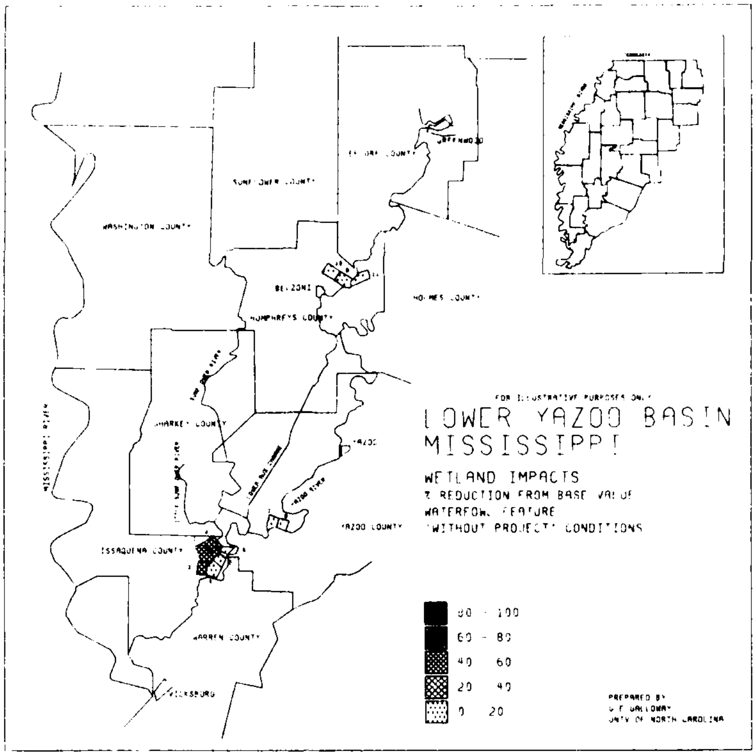



Figure 33. Graphic Display



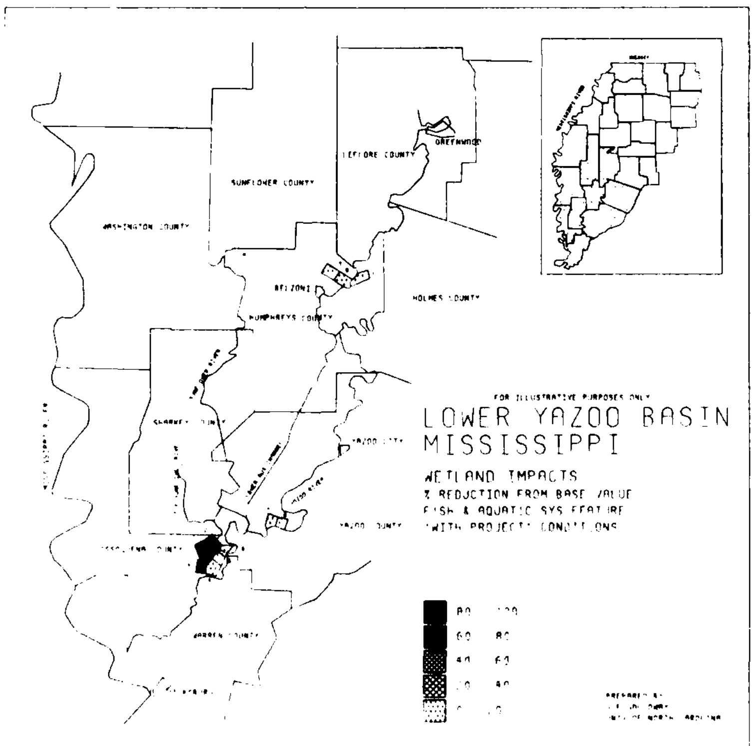
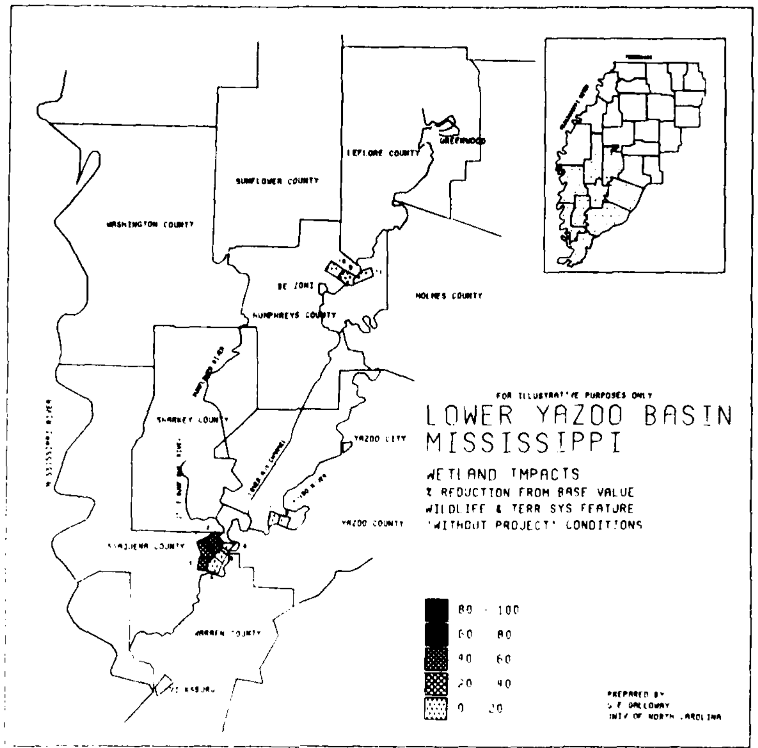
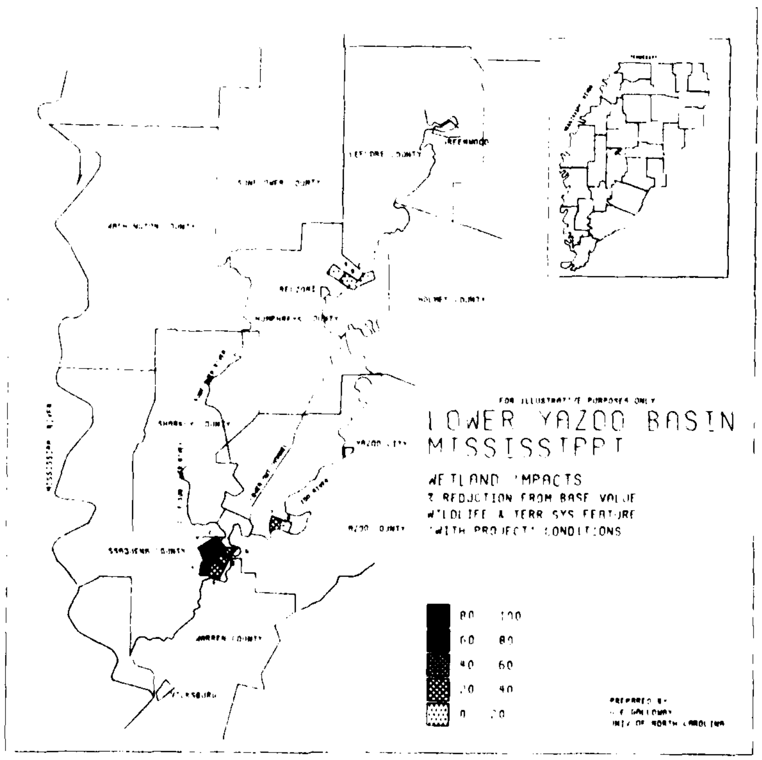
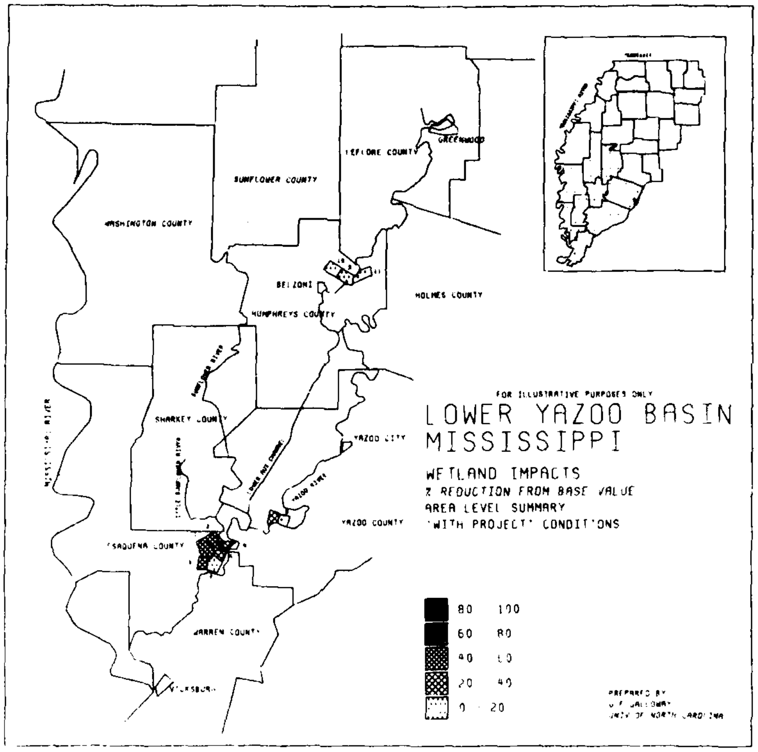



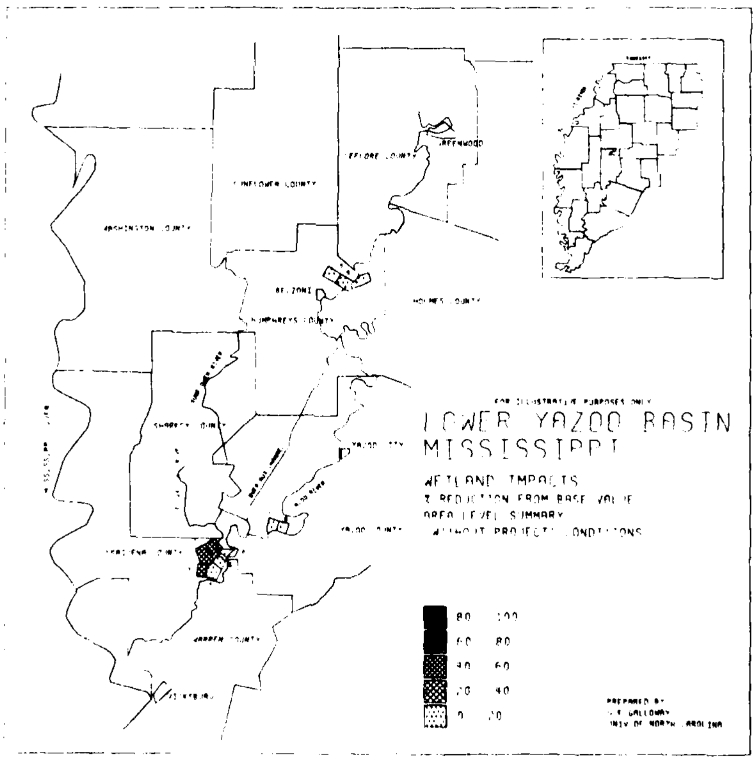

Figure 34-35. Graphic Displays




Figures 36-37. Graphic Displays



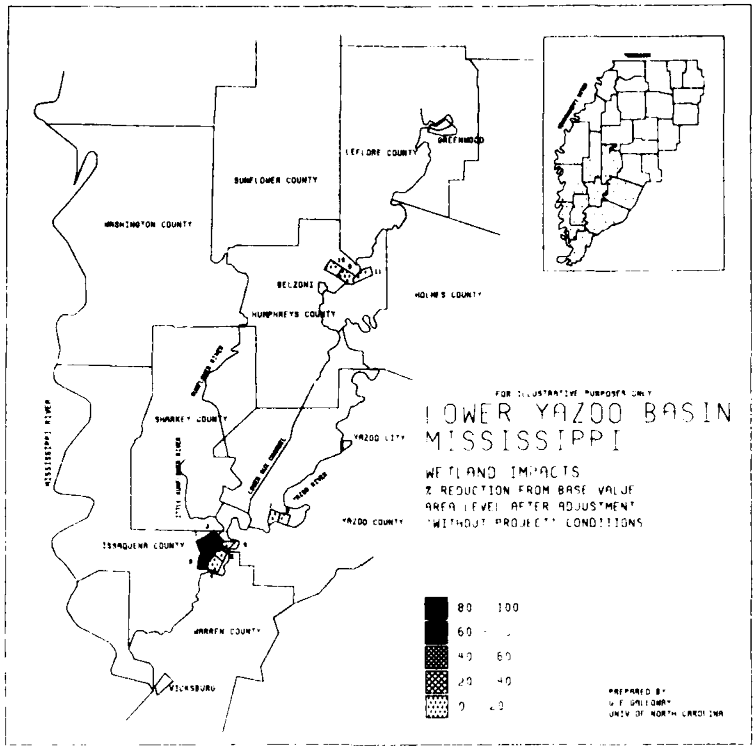



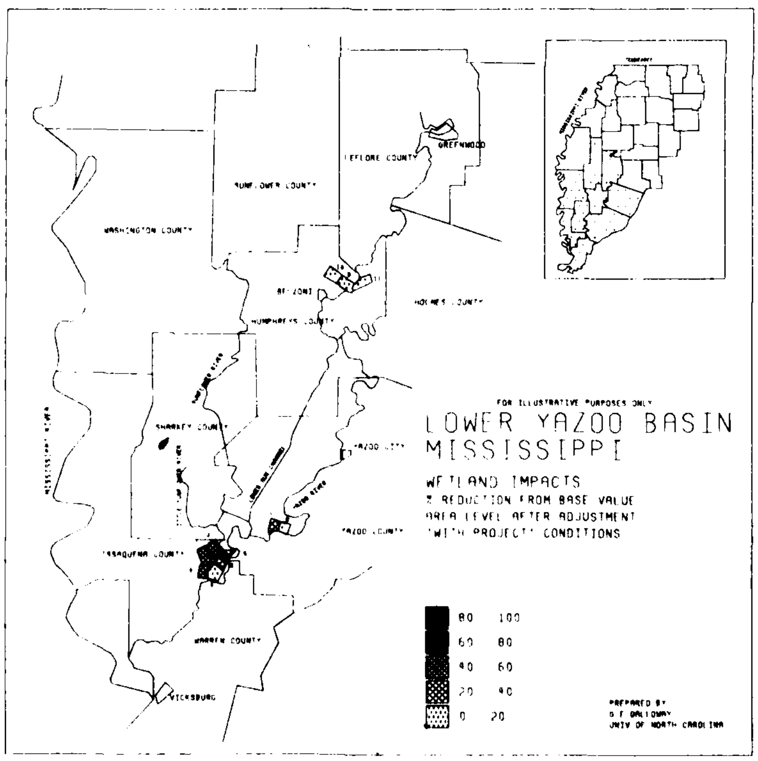

**Figures 38-39. Graphic Displays**

EVALUATION OF YAZOO BASIN
BACKWATER SUB-BASIN
PUMP PLANT PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDLF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |
| | | | AREA 1 | | | |
| | | | ACREAGE 350 | | | |
| VALUE | 2.00 | 7.00 | 6.00 | 7.00 | 5.00 | 3.00 |
| BASE VAL-EQ POINTS | 700.00 | 2450.00 | 2100.00 | 2450.00 | 1750.00 | 1050.00 |
| NON PROJ IMPACT (%CHANGE) | -80.00 | -85.00 | -90.00 | -70.00 | -72.00 | -76.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 280.00 | 888.13 | 682.50 | 1163.75 | 805.00 | 451.50 |
| PERCENTAGE CHANGE | -60.00 | -63.75 | -67.50 | -52.50 | -54.00 | -57.00 |
| | | AREA BASE VALUE 1656.67 | | | | |
| | | W/O PROJ VALUE 649.89 | | | | |
| | | PERCENT CHANGE -60.77 | | | | |
| PROJECT IMPACT (%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 244.39 | 855.36 | 733.16 | 1588.52 | 1728.17 | 837.90 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |
| | | AREA BASE VALUE 1656.67 | | | | |
| | | W/ PROJECT VALUE 807.64 | | | | |
| | | PERCENT CHANGE -51.25 | | | | |
| | | | AREA 2 | | | |
| | | | ACREAGE 300 | | | |
| VALUE | 2.00 | 7.00 | 6.00 | 7.00 | 5.00 | 3.00 |
| BASE VAL-EQ POINTS | 600.00 | 2100.00 | 1800.00 | 2100.00 | 1500.00 | 900.00 |
| NON PROJ IMPACT (%CHANGE) | -80.00 | -85.00 | -90.00 | -70.00 | -75.00 | -76.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 240.00 | 761.25 | 585.00 | 997.50 | 656.25 | 387.00 |
| PERCENTAGE CHANGE | -60.00 | -63.75 | -67.50 | -52.50 | -56.25 | -57.00 |
| | | AREA BASE VALUE 1420.00 | | | | |
| | | W/O PROJ VALUE 552.55 | | | | |
| | | PERCENT CHANGE -61.09 | | | | |
| PROJECT IMPACT (%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 209.48 | 733.16 | 628.43 | 1361.59 | 1481.29 | 718.20 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |
| | | AREA BASE VALUE 1420.00 | | | | |
| | | W/ PROJECT VALUE 692.27 | | | | |
| | | PERCENT CHANGE -51.25 | | | | |

Figure 40. Adjusted Impacts - 'Non-Project'




Figures 41-42. Graphic Displays

Neuse River Estuary

This example portrays the WES as a tool for evaluating differences among alternative plans ("with project") and the "without project" conditions.

Development is taking place in several areas throughout the estuary (Figure 43). Of prime concern is the proposed expansion of Marine facilities at Cherry Point. Two alternatives are available for the expansion (Figures 44 and 45) and WES is used to assist in portraying the environmental differences between the impacts of the two alternatives on the estuary as a whole.

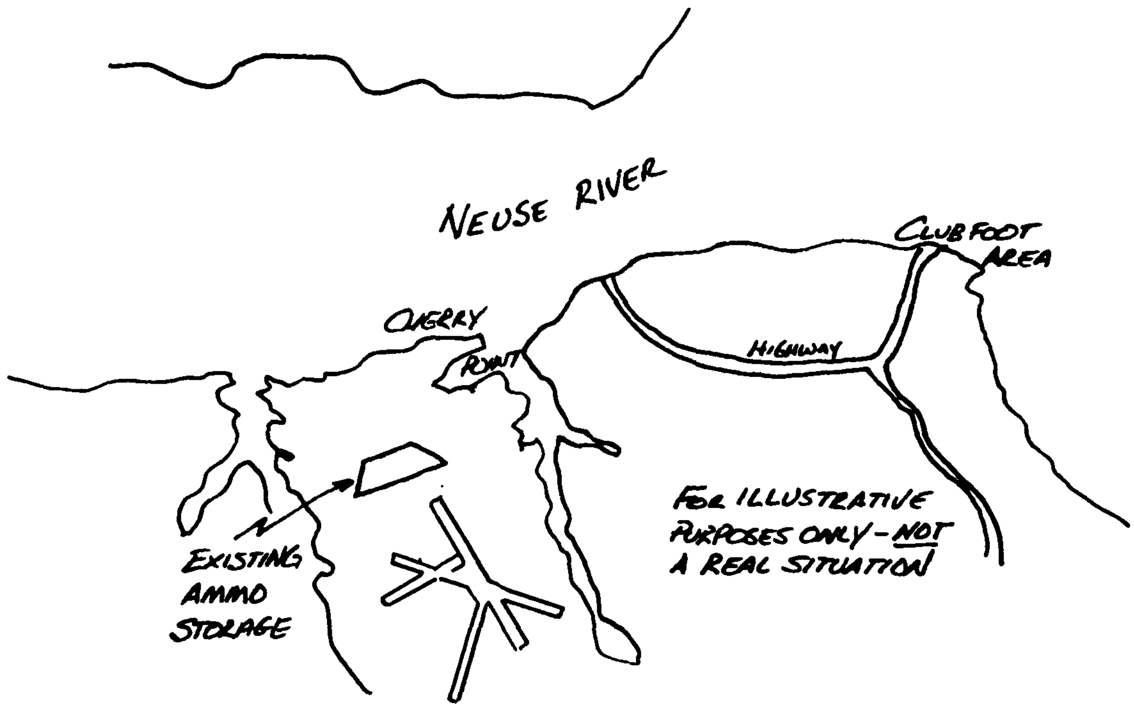



Figure 43. Cherry Point

As in the previous example, an interdisciplinary team representing federal, state, and local natural resource and wildlife agencies, selects the six indicators best representing the Cherry Point wetland area. (The team also selects indicators representative of the other areas of the estuary.)

Local elected representatives (County Commissioners) are asked to meet with representatives of the Marine Air Station to discuss the various indicators and to assign relative weights to these indicators. After several rounds of voting, a consensus is reached and is recorded.

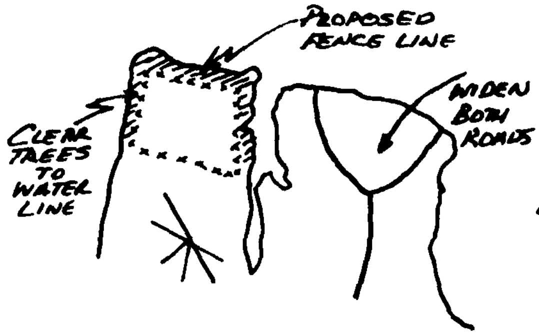



Figure 44. Plan A

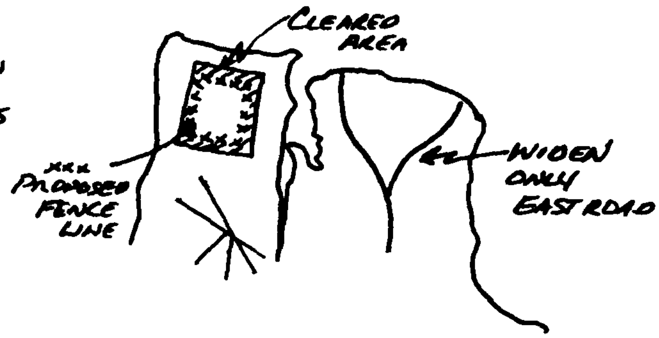



Figure 45. Plan B

Concurrently, the interdisciplinary team has been briefed by the Station staff on the extent of the two alternative projects. Plan A (Figure 44) involves considerably more land clearing than Plan B (Figure 45) and also involves two access roads to the shoreline. As a result, the team generally assesses larger negative changes in indicator values to Plan A than to Plan B. Since both Plan A and Plan B are the direct impacts they are each assigned 100 percent probability. The secondary impacts of both alternatives are related to pollution resulting from human habitation of the shoreline. The group assigns equal negative changes in indicator values to both alternatives and assesses a 30 percent probability of occurrence to the secondary impacts.

Principal "other" impacts result from upstream discharge of pollutants into the estuary. The team assigns losses in indicator values to each area in the estuary as well as a 20 percent probability of occurrence.

All value assignments are turned over to the administrative staff for submission to the computer. Figure 46 indicates the data used in and the results of an evaluation of Plan A and Figure 47 indicates the evaluation of Plan B. Figures 48 and 49 provide graphic illustration of the summary results at the area level.

Examination of the results of this first iteration indicates that:

1. Plan A causes more impact locally and estuary-wide than Plan B, and

2. Because of a concentration of losses in Areas 1-3, an additional iteration involving assessment of cumulative losses needs to be made.

EVALUATION OF NEUSE RIVER ESTUARY
CHERRY POINT SUB-ESTUARY
AMMO STORAGE EXTENSION-PLAN A

| ENVIRONMENTAL FEATURE | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 1
ACREAGE 640

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 6.00 | 9.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 3840.00 | 5760.00 | 4480.00 | 3200.00 | 3840.00 | 5120.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 3955.20 | 5932.80 | 4614.40 | 3296.00 | 3916.80 | 5273.60 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 4565.33
W/O PROJ VALUE 4433.49
PERCENT CHANGE -2.89

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -83.00 | -67.00 | -82.00 | -90.00 | -80.00 | -90.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 7238.02 | 9907.78 | 8398.21 | 6262.40 | 7119.36 | 10019.84 |
| PERCENTAGE CHANGE | -88.49 | -72.01 | -87.46 | -95.70 | -85.40 | -95.70 |

AREA BASE VALUE 4565.33
W/ PROJECT VALUE 820.79
PERCENT CHANGE -82.02

AREA 2
ACREAGE 800

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 8.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 5600.00 | 6400.00 | 5600.00 | 4000.00 | 4800.00 | 6400.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 5768.00 | 6592.00 | 5768.00 | 4120.00 | 4896.00 | 6592.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 5706.67
W/O PROJ VALUE 5541.87
PERCENT CHANGE -2.89

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -89.00 | -80.00 | -82.00 | -82.00 | -44.00 | -93.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 10901.52 | 11865.60 | 10497.76 | 7498.40 | 7119.36 | 12722.56 |
| PERCENTAGE CHANGE | -94.67 | -85.40 | -87.46 | -87.46 | -48.32 | -98.79 |

AREA BASE VALUE 5706.67
W/ PROJECT VALUE 827.13
PERCENT CHANGE -85.51

Figure 46. Plan A

EVALUATION OF NEUSE RIVER ESTUARY
CHERRY POINT SUB-ESTUARY
AMMC STORAGE EXTENSION-PLAN B

| ENVIRONMENTAL FEATURE | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 1
ACREAGE 640

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| VALUE | 6.00 | 9.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 3840.00 | 5760.00 | 4480.00 | 3200.00 | 3840.00 | 5120.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 3955.20 | 5932.80 | 4614.40 | 3296.00 | 3916.80 | 5273.60 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 4565.33
W/O PROJ VALUE 4433.49
PERCENT CHANGE -2.89

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -45.00 | -70.00 | -30.00 | -50.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 6526.08 | 9789.12 | 6690.88 | 5603.20 | 5141.76 | 7910.40 |
| PERCENTAGE CHANGE | -69.95 | -69.95 | -49.35 | -75.10 | -33.90 | -54.50 |

AREA BASE VALUE 4565.33
W/ PROJECT VALUE 1659.73
PERCENT CHANGE -63.64

AREA 2
ACREAGE 800

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 8.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 5600.00 | 6400.00 | 5600.00 | 4000.00 | 4800.00 | 6400.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 5768.00 | 6592.00 | 5768.00 | 4120.00 | 4896.00 | 6592.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 5706.67
W/O PROJ VALUE 5541.87
PERCENT CHANGE -2.89

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -45.00 | -73.00 | -45.00 | -63.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 9517.20 | 10876.80 | 8363.60 | 7127.60 | 7168.80 | 10744.96 |
| PERCENTAGE CHANGE | -69.95 | -69.95 | -49.35 | -78.19 | -49.35 | -67.89 |

AREA BASE VALUE 5706.67
W/ PROJECT VALUE 1910.42
PERCENT CHANGE -66.52

Figure 47. Plan B

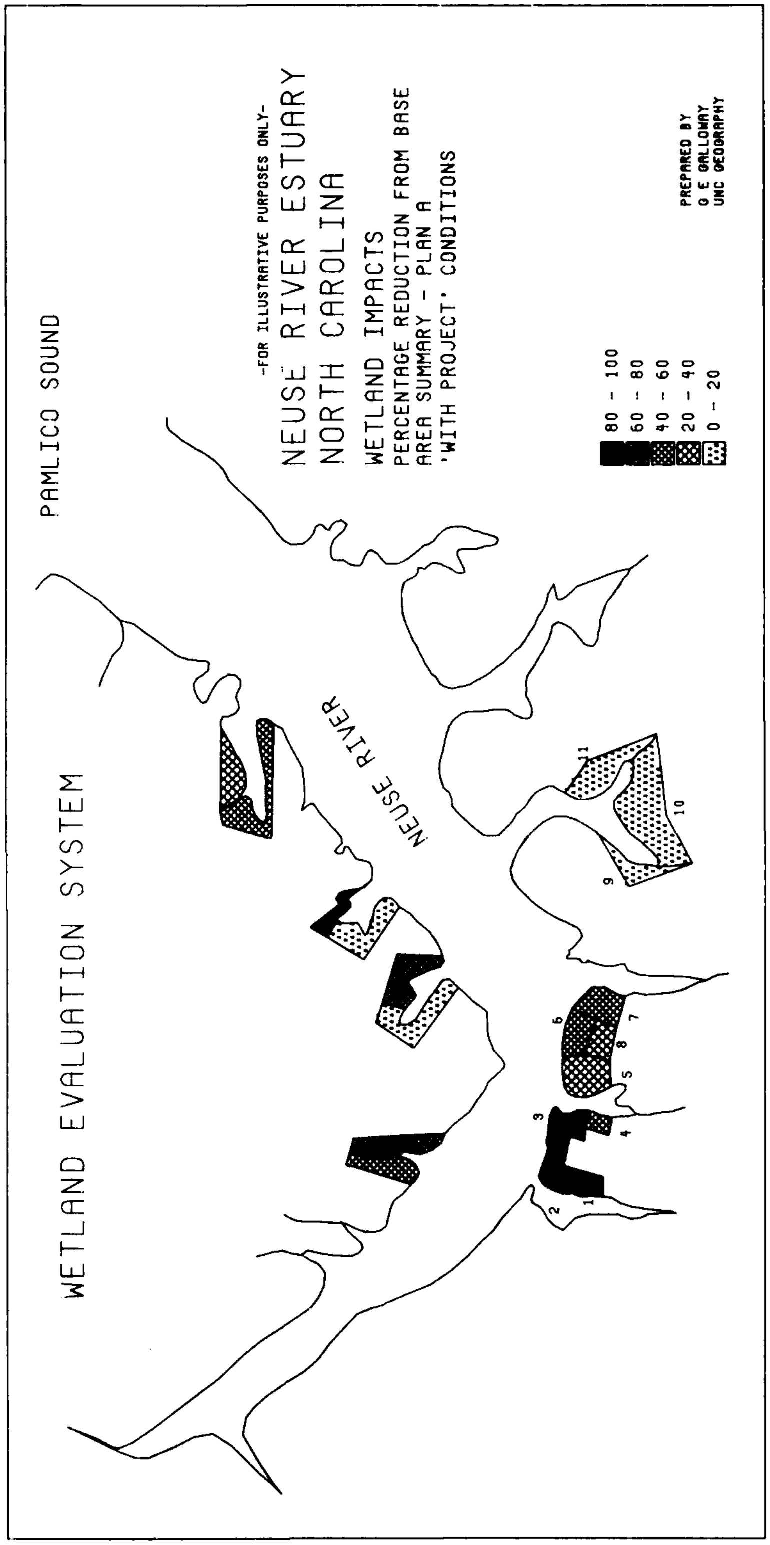



Figure 48. Plan A

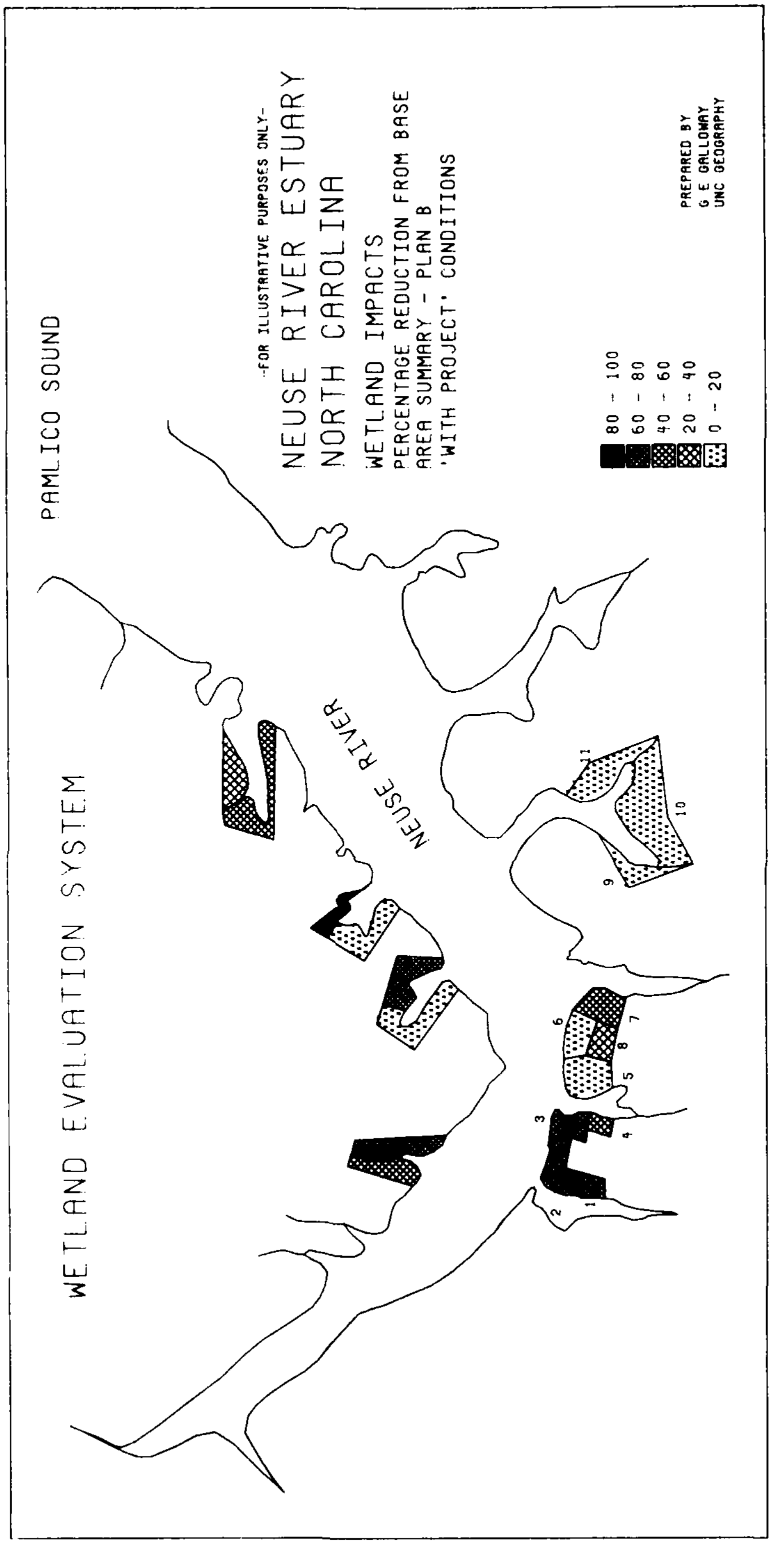



Figure 49. Plan B

These additional runs (omitted in this example) would then be conducted, and the final results presented to the decision maker to aid in his overall decision.

The WES again has produced displays that will assist the reviewers and analysts at all levels in their handling of the project. Dated information concerning these wetland areas has been gathered and stored for future use. The views of local citizens have been heard and taken into account. A decision has not been made solely on the basis of the WES output; however, the output has significantly aided the decision maker.

## Computer Programming

The printouts used in the examples represent the output of a PL/C program written by the author. The graphic displays are CALFORM and SYMAP outputs based on inputs by the author. Details concerning the relative cost of these outputs as well as the basic cartographic programs are found at Appendix C.

## V

## CONCLUSIONS AND COMMENTS

The purpose of this paper was to propose a structure for the evaluation of man's impact on wetlands. The WES is a structure. Whether or not it is the structure remains to be seen.

The WES is not one equation or one program. It is the blending of a number of concepts, concepts which, I believe, give it considerable strength. While there can be considerable discussion as to the specific subsystems used to obtain the numbers for area value, project impacts and probabilities, there should be little disagreement that any successful system must have the principal features that define the WES.

Realistic evaluation requires that impacts be determined and compared for "with" and "without" project conditions. The advice of local experts and the voice of the elected representative should be heard. For assessment at the macro-level, the myriad parameters that make up the wetland must be "factored" into only a few representative traits. Whether six, four, eight, or twenty are enough "factors" is irrelevant as is the makeup of the factors. Within reason it is dealer's choice. To be understandable, the results of any evaluation must be available for display and review. Base line data must be recorded and maintained. While the WES addresses the above items, there is still much room for improvement and new initiatives.

The most dangerous aspect of the WES is its susceptibility to misuse. The WES is designed to serve as a tool to aid the decision maker in his judgments. It provides relative values, and these values are subject to wide interpretation. In the hands of pure "number crunchers," the WES might produce results far from reality. Properly used, it can be invaluable.

The state of the macro-modeling art is far from satisfactory. Hopefully, the WES will provide grist for the discussion mill and a point of departure for other efforts in the same vein.

FOOTNOTES

[1]See Bosselman and Callies for review of efforts to control this development in coastal areas. Goodwin and Niering discuss critical Inland Areas. See also Phyllis Pyers for problems with Florida Wetlands.

[2]Subdividing Rural America, ASPO, provides an overview of relation between the second home push and the impact on natural resources (see p. 45).

[3]Massachusetts has had a Wetland Act since 1963. Wisconsin has had legislation regarding shorelines since 1966.

[4]National Environmental Policy Act, Section 101 (83 Stat. 852).

[5]Coastal Zone Management Act, Section 302c (86 Stat. 1280).

[6]Federal Water Pollution Control Act Amendments, Section 404 (86 Stat. 884).

[7]NRDC v. Callaway (7ERC1784).

[8]U. S. Army, Corps of Engineers Regulation 1145-2-303 (8c).

[9]President Carter's Environmental Message to Congress, 23 May 77.

[10]EPA, Environmental Assessment Perspective, p. 87.

[11]U. S. Water Resources Council, "Water and Related Land Resources; Establishment of Principles and Standards for Planning," Federal Register, Vol. 32, No. 174.

[12]EPA, op. cit., pp. 87-88.

[13]See Lewis Hopkins, "Methods for Generating Land Suitability Maps: A Comparative Evaluation," AIP Journal, October 1977, p. 387.

[14]GRID has been followed by a better version, IMGRID.

[15]See Oconee Basin Pilot Study, Savannah District Corps of Engineers for Test of Automap and An Example of the Use of Computer Graphics in Regional Plan Evaluation, Los Angeles District for updated Steinitz effort.

[16]See Dalkey, et al., Studies on Quality of Life, Delphi and Decision Making, pp. 13-55.

[17]Weights could be assigned to each area if desired.

[18]Only selected plots are provided. A plot would normally be produced for each indicator for "with" and "without" conditions.

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APPENDIX A

PRINTOUTS - YAZOO RIVER BASIN

WETLAND EVALUATION SYSTEM (WES)

TECHNICAL ANALYSTS: EXAMPLE ONLY-WALTON,HOBGOOD,FLANAGAN,PARKS,SMITH

PUBLIC REPRESENTATIVES: EXAMPLE ONLY-SHARKEY BD OF SUPV,ED OF MS LVEE COMM

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********************************
*           NOTE:              *
*   CUMULATIVE EFFECT HAS      *
*           NOT                *
*   BEEN TAKEN INTO ACCOUNT    *
*        IN THIS RUN           *
********************************
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EVALUATION OF YAZOO BASIN
BACKWATER SUB-BASIN
PUMP PLANT PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 1
ACREAGE 350

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 2.00 | 7.00 | 6.00 | 7.00 | 5.00 | 3.00 |
| BASE VAL-EQ POINTS | 700.00 | 2450.00 | 2100.00 | 2450.00 | 1750.00 | 1050.00 |
| NON PROJ IMPACT (%CHANGE) | -65.00 | -70.00 | -75.00 | -70.00 | -72.00 | -76.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 358.75 | 1163.75 | 918.75 | 1163.75 | 805.00 | 451.50 |
| PERCENTAGE CHANGE | -48.75 | -52.50 | -56.25 | -52.50 | -54.00 | -57.00 |

AREA BASE VALUE 1656.67
W/O PROJ VALUE 783.77
PERCENT CHANGE -52.69

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 244.39 | 855.36 | 733.16 | 1588.52 | 1728.17 | 837.90 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |

AREA BASE VALUE 1656.67
W/ PROJECT VALUE 807.64
PERCENT CHANGE -51.25

AREA 2
ACREAGE 300

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 2.00 | 7.00 | 6.00 | 7.00 | 5.00 | 3.00 |
| BASE VAL-EQ POINTS | 600.00 | 2100.00 | 1800.00 | 2100.00 | 1500.00 | 900.00 |
| NON PROJ IMPACT (%CHANGE) | -65.00 | -70.00 | -75.00 | -70.00 | -75.00 | -70.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 307.50 | 997.50 | 787.50 | 997.50 | 656.25 | 427.50 |
| PERCENTAGE CHANGE | -48.75 | -52.50 | -56.25 | -52.50 | -56.25 | -52.50 |

AREA BASE VALUE 1420.00
W/O PROJ VALUE 670.00
PERCENT CHANGE -52.82

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 209.48 | 733.16 | 628.43 | 1361.59 | 1481.29 | 718.20 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |

AREA BASE VALUE 1420.00
W/ PROJECT VALUE 692.27
PERCENT CHANGE -51.25

AREA 3
ACREAGE 300

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 2.00 | 7.00 | 6.00 | 3.00 | 4.00 | 3.00 |
| BASE VAL-EQ POINTS | 600.00 | 2100.00 | 1800.00 | 900.00 | 1200.00 | 900.00 |
| NON PROJ IMPACT (%CHANGE) | -65.00 | -70.00 | -75.00 | -70.00 | -75.00 | -70.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 307.50 | 997.50 | 787.50 | 427.50 | 525.00 | 427.50 |
| PERCENTAGE CHANGE | -48.75 | -52.50 | -56.25 | -52.50 | -56.25 | -52.50 |

AREA BASE VALUE 1300.00
W/O PROJ VALUE 614.50
PERCENT CHANGE -52.73

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 209.48 | 733.16 | 628.43 | 583.54 | 1185.03 | 718.20 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |

AREA BASE VALUE 1300.00
W/ PROJECT VALUE 600.89
PERCENT CHANGE -53.78

AREA 4
ACREAGE 450

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 9.00 | 9.00 | 7.00 | 7.00 | 4.00 |
| BASE VAL-EQ POINTS | 1350.00 | 4050.00 | 4050.00 | 3150.00 | 3150.00 | 1800.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -6.00 | -10.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1299.38 | 3867.75 | 3746.25 | 3031.88 | 3031.88 | 1732.50 |
| PERCENTAGE CHANGE | -3.75 | -4.50 | -7.50 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 2820.00
W/O PROJ VALUE 2694.00
PERCENT CHANGE -4.47

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -20.00 | -20.00 | -20.00 | -5.00 | -30.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1199.81 | 3199.50 | 3199.50 | 2488.50 | 2955.09 | 1244.25 |
| PERCENTAGE CHANGE | -11.13 | -21.00 | -21.00 | -21.00 | -6.19 | -30.87 |

AREA BASE VALUE 2820.00
W/ PROJECT VALUE 2322.60
PERCENT CHANGE -17.64

AREA 5
ACREAGE 500

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 5.00 | 9.00 | 9.00 | 7.00 | 6.00 | 5.00 |
| BASE VAL-EQ POINTS | 2500.00 | 4500.00 | 4500.00 | 3500.00 | 3000.00 | 2500.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -7.00 | -6.00 | -8.00 | -8.00 | -9.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 2406.25 | 4263.75 | 4297.50 | 3290.00 | 2820.00 | 2331.25 |
| PERCENTAGE CHANGE | -3.75 | -5.25 | -4.50 | -6.00 | -6.00 | -6.75 |

AREA BASE VALUE 3433.33
W/O PROJ VALUE 3260.58
PERCENT CHANGE -5.03

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -40.00 | -40.00 | -40.00 | -5.00 | -40.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 2221.88 | 2666.25 | 2666.25 | 2073.75 | 2814.38 | 1481.25 |
| PERCENTAGE CHANGE | -11.12 | -40.75 | -40.75 | -40.75 | -6.19 | -40.75 |

AREA BASE VALUE 3433.33
W/ PROJECT VALUE 2419.38
PERCENT CHANGE -29.53

AREA 6
ACREAGE 500

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 9.00 | 9.00 | 8.00 | 9.00 | 7.00 | 7.00 |
| BASE VAL-EQ POINTS | 4500.00 | 4500.00 | 4000.00 | 4500.00 | 3500.00 | 3500.00 |
| NON PROJ IMPACT (%CHANGE) | -9.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 4196.25 | 4331.25 | 3850.00 | 4331.25 | 3368.75 | 3368.75 |
| PERCENTAGE CHANGE | -6.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 4266.67
W/O PROJ VALUE 4061.67
PERCENT CHANGE -4.80

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -20.00 | -70.00 | -80.00 | -20.00 | -40.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 3999.38 | 3555.00 | 1185.00 | 888.75 | 2765.00 | 2073.75 |
| PERCENTAGE CHANGE | -11.12 | -21.00 | -70.37 | -80.25 | -21.00 | -40.75 |

AREA BASE VALUE 4266.67
W/ PROJECT VALUE 3163.29
PERCENT CHANGE -25.86

BACKWATER SUB-BASIN
BASE VALUE(ACRE POINTS) 14897
W/O PROJECT VALUE 12085
PERCENT CHANGE -18.88
W/ PROJECT VALUE 10006
PERCENT CHANGE -32.83

EVALUATION OF YAZOO BASIN
CARTER AREA SUB-BASIN
LEVEE PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDLF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 7
ACREAGE 600

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 3.00 | 4.00 | 8.00 | 6.00 |
| BASE VAL-EQ POINTS | 1800.00 | 6000.00 | 1800.00 | 2400.00 | 4800.00 | 3600.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1732.50 | 5775.00 | 1732.50 | 2310.00 | 4620.00 | 3465.00 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 3760.00
W/O PROJ VALUE 3619.00
PERCENT CHANGE -3.75

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -20.00 | -70.00 | -80.00 | -20.00 | -40.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1599.75 | 4740.00 | 533.25 | 474.00 | 3792.00 | 2133.00 |
| PERCENTAGE CHANGE | -11.13 | -21.00 | -70.37 | -80.25 | -21.00 | -40.75 |

AREA BASE VALUE 3760.00
W/ PROJECT VALUE 2828.20
PERCENT CHANGE -24.78

AREA 8
ACREAGE 400

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 3.00 | 4.00 | 8.00 | 6.00 |
| BASE VAL-EQ POINTS | 1200.00 | 4000.00 | 1200.00 | 1600.00 | 3200.00 | 2400.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1155.00 | 3850.00 | 1155.00 | 1540.00 | 3080.00 | 2310.00 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 2506.67
W/O PROJ VALUE 2412.67
PERCENT CHANGE -3.75

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1066.50 | 3555.00 | 948.00 | 1264.00 | 3002.00 | 2133.00 |
| PERCENTAGE CHANGE | -11.13 | -11.12 | -21.00 | -21.00 | -6.19 | -11.12 |

AREA BASE VALUE 2506.67
W/ PROJECT VALUE 2230.43
PERCENT CHANGE -11.02

CARTER AREA SUB-BASIN

| | |
|---|---|
| BASE VALUE(ACRE POINTS) | 6267 |
| W/O PROJECT VALUE | 6032 |
| PERCENT CHANGE | -3.75 |
| W/ PROJECT VALUE | 5059 |
| PERCENT CHANGE | -19.28 |

EVALUATION OF YAZOO BASIN
WASP LAKE SUB-BASIN
LEVEE PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 9
ACREAGE 400

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 3.00 | 3.00 | 4.00 | 8.00 | 3.00 |
| BASE VAL-EQ POINTS | 1200.00 | 1200.00 | 1200.00 | 1600.00 | 3200.00 | 1200.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1155.00 | 1155.00 | 1155.00 | 1540.00 | 3080.00 | 1155.00 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 1493.33
W/O PROJ VALUE 1437.33
PERCENT CHANGE -3.75

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1066.50 | 1066.50 | 948.00 | 1264.00 | 3002.00 | 1066.50 |
| PERCENTAGE CHANGE | -11.13 | -11.13 | -21.00 | -21.00 | -6.19 | -11.13 |

AREA BASE VALUE 1493.33
W/ PROJECT VALUE 1329.83
PERCENT CHANGE -10.95

AREA 10
ACREAGE 450

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 3.00 | 3.00 | 4.00 | 8.00 | 3.00 |
| BASE VAL-EQ POINTS | 1350.00 | 1350.00 | 1350.00 | 1800.00 | 3600.00 | 1350.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1299.38 | 1299.38 | 1299.38 | 1732.50 | 3465.00 | 1299.38 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 1680.00
W/O PROJ VALUE 1617.00
PERCENT CHANGE -3.75

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1199.81 | 1199.81 | 1066.50 | 1422.00 | 3377.25 | 1199.81 |
| PERCENTAGE CHANGE | -11.13 | -11.13 | -21.00 | -21.00 | -6.19 | -11.13 |

AREA BASE VALUE 1680.00
W/ PROJECT VALUE 1496.06
PERCENT CHANGE -10.95

WASP LAKE SUB-BASIN

| | |
|---|---|
| BASE VALUE(ACRE POINTS) | 3173 |
| W/O PROJECT VALUE | 3054 |
| PERCENT CHANGE | -3.75 |
| W/ PROJECT VALUE | 2826 |
| PERCENT CHANGE | -10.95 |

EVALUATION OF YAZOO BASIN
SNAKE CREEK SUB-BASIN
LEVEE PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 11
ACREAGE 500

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 5.00 | 5.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1500.00 | 5000.00 | 2500.00 | 2500.00 | 4000.00 | 4000.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1443.75 | 4812.50 | 2406.25 | 2406.25 | 3850.00 | 3850.00 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 3300.00
W/O PROJ VALUE 3176.25
PERCENT CHANGE -3.75

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | 5.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1333.13 | 4443.75 | 1975.00 | 1975.00 | 3752.50 | 4147.50 |
| PERCENTAGE CHANGE | -11.13 | -11.13 | -21.00 | -21.00 | -6.19 | 3.69 |

AREA BASE VALUE 3300.00
W/ PROJECT VALUE 2965.79
PERCENT CHANGE -10.13

SNAKE CREEK SUB-BASIN
BASE VALUE(ACRE POINTS) 3300
W/O PROJECT VALUE 3176
PERCENT CHANGE -3.75
W/ PROJECT VALUE 2966
PERCENT CHANGE -10.13

YAZOO BASIN
BASE VALUE(ACRE POINTS) 27637
W/O PROJECT VALUE 24347
PERCENT CHANGE -11.90
W/ PROJECT VALUE 20856
PERCENT CHANGE -24.53

WETLAND EVALUATICN SYSTEM (WES)

TECHNICAL ANALYSTS: EXAMPLE ONLY-WALTCN,HOBGOOD,FLANAGAN,PARKS,SMITH

PUELIC REPRESENTATIVES: EXAMPLE CNLY-SHARKEY BD OF SUPV,BD OF MS LVEE COMM

```
*******************************
*          NOTE:              *
*   CUMULATIVE EFFECT HAS     *
*                             *
*   BEEN TAKEN INTO ACCOUNT   *
*        IN THIS RUN          *
*******************************
```

EVALUATION OF YAZOO BASIN
BACKWATER SUB-BASIN
PUMP PLANT PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDLF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 1
ACREAGE 350

| | FISH | WLDLF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| VALUE | 2.00 | 7.00 | 6.00 | 7.00 | 5.00 | 3.00 |
| BASE VAL-EQ POINTS | 700.00 | 2450.00 | 2100.00 | 2450.00 | 1750.00 | 1050.00 |
| NON PROJ IMPACT (%CHANGE) | -80.00 | -85.00 | -90.00 | -70.00 | -72.00 | -76.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 280.00 | 888.13 | 682.50 | 1163.75 | 805.00 | 451.50 |
| PERCENTAGE CHANGE | -60.00 | -63.75 | -67.50 | -52.50 | -54.00 | -57.00 |

AREA BASE VALUE 1656.67
W/O PROJ VALUE 649.89
PERCENT CHANGE -60.77

| | FISH | WLDLF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 244.39 | 855.36 | 733.16 | 1588.52 | 1728.17 | 837.90 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |

AREA BASE VALUE 1656.67
W/ PROJECT VALUE 807.64
PERCENT CHANGE -51.25

AREA 2
ACREAGE 300

| | FISH | WLDLF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| VALUE | 2.00 | 7.00 | 6.00 | 7.00 | 5.00 | 3.00 |
| BASE VAL-EQ POINTS | 600.00 | 2100.00 | 1800.00 | 2100.00 | 1500.00 | 900.00 |
| NON PROJ IMPACT (%CHANGE) | -80.00 | -85.00 | -90.00 | -70.00 | -75.00 | -76.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 240.00 | 761.25 | 585.00 | 997.50 | 656.25 | 387.00 |
| PERCENTAGE CHANGE | -60.00 | -63.75 | -67.50 | -52.50 | -56.25 | -57.00 |

AREA BASE VALUE 1420.00
W/O PROJ VALUE 552.55
PERCENT CHANGE -61.09

| | FISH | WLDLF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 209.48 | 733.16 | 628.43 | 1361.59 | 1481.29 | 718.20 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |

AREA BASE VALUE 1420.00
W/ PROJECT VALUE 692.27
PERCENT CHANGE -51.25

AREA 3

ACREAGE 300

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 2.00 | 7.00 | 6.00 | 3.00 | 4.00 | 3.00 |
| BASE VAL-EQ POINTS | 600.00 | 2100.00 | 1800.00 | 900.00 | 1200.00 | 900.00 |
| NON PROJ IMPACT (%CHANGE) | -80.00 | -85.00 | -90.00 | -70.00 | -75.00 | -70.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 240.00 | 761.25 | 585.00 | 427.50 | 525.00 | 427.50 |
| PERCENTAGE CHANGE | -60.00 | -63.75 | -67.50 | -52.50 | -56.25 | -52.50 |

AREA BASE VALUE 1300.00
W/O PROJ VALUE 499.75
PERCENT CHANGE -61.56

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -65.00 | -65.00 | -65.00 | -35.00 | -1.00 | -20.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 209.48 | 733.16 | 628.43 | 583.54 | 1185.03 | 718.20 |
| PERCENTAGE CHANGE | -65.09 | -65.09 | -65.09 | -35.16 | -1.25 | -20.20 |

AREA BASE VALUE 1300.00
W/ PROJECT VALUE 600.89
PERCENT CHANGE -53.78

AREA 4

ACREAGE 450

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 9.00 | 9.00 | 7.00 | 7.00 | 4.00 |
| BASE VAL-EQ POINTS | 1350.00 | 4050.00 | 4050.00 | 3150.00 | 3150.00 | 1800.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -6.00 | -10.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1299.38 | 3867.75 | 3746.25 | 3031.88 | 3031.88 | 1732.50 |
| PERCENTAGE CHANGE | -3.75 | -4.50 | -7.50 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 2820.00
W/O PROJ VALUE 2694.00
PERCENT CHANGE -4.47

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -10.00 | -20.00 | -20.00 | -20.00 | -5.00 | -30.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1199.81 | 3199.50 | 3199.50 | 2488.50 | 2955.09 | 1244.25 |
| PERCENTAGE CHANGE | -11.13 | -21.00 | -21.00 | -21.00 | -6.19 | -30.87 |

AREA BASE VALUE 2820.00
W/ PROJECT VALUE 2322.60
PERCENT CHANGE -17.64

AREA 5

ACREAGE 500

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 5.00 | 9.00 | 9.00 | 7.00 | 6.00 | 5.00 |
| BASE VAL-EQ POINTS | 2500.00 | 4500.00 | 4500.00 | 3500.00 | 3000.00 | 2500.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -7.00 | -6.00 | -8.00 | -8.00 | -9.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 2406.25 | 4263.75 | 4297.50 | 3290.00 | 2820.00 | 2331.25 |
| PERCENTAGE CHANGE | -3.75 | -5.25 | -4.50 | -6.00 | -6.00 | -6.75 |

AREA BASE VALUE 3433.33
W/O PROJ VALUE 3260.58
PERCENT CHANGE -5.03

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -40.00 | -40.00 | -40.00 | -5.00 | -40.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 2221.88 | 2666.25 | 2666.25 | 2073.75 | 2814.38 | 1481.25 |
| PERCENTAGE CHANGE | -11.12 | -40.75 | -40.75 | -40.75 | -6.19 | -40.75 |

AREA BASE VALUE 3433.33
W/ PROJECT VALUE 2419.38
PERCENT CHANGE -29.53

AREA 6
ACREAGE 500

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 9.00 | 9.00 | 8.00 | 9.00 | 7.00 | 7.00 |
| BASE VAL-EQ POINTS | 4500.00 | 4500.00 | 4000.00 | 4500.00 | 3500.00 | 3500.00 |
| NON PROJ IMPACT (%CHANGE) | -9.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 4196.25 | 4331.25 | 3850.00 | 4331.25 | 3368.75 | 3368.75 |
| PERCENTAGE CHANGE | -6.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 4266.67
W/O PROJ VALUE 4061.67
PERCENT CHANGE -4.80

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -20.00 | -70.00 | -80.00 | -20.00 | -40.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 3999.38 | 3555.00 | 1185.00 | 888.75 | 2765.00 | 2073.75 |
| PERCENTAGE CHANGE | -11.12 | -21.00 | -70.37 | -80.25 | -21.00 | -40.75 |

AREA BASE VALUE 4266.67
W/ PROJECT VALUE 3163.29
PERCENT CHANGE -25.86

BACKWATER SUB-BASIN
BASE VALUE(ACRE POINTS) 14897
W/O PROJECT VALUE 11718
PERCENT CHANGE -21.34
W/ PROJECT VALUE 10006
PERCENT CHANGE -32.83

EVALUATION OF YAZOO BASIN
CARTER AREA SUB-BASIN
LEVEE PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 7
ACREAGE 600

| | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 3.00 | 4.00 | 8.00 | 6.00 |
| BASE VAL-EQ POINTS | 1800.00 | 6000.00 | 1800.00 | 2400.00 | 4800.00 | 3600.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1732.50 | 5775.00 | 1732.50 | 2310.00 | 4620.00 | 3465.00 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 3760.00
W/O PROJ VALUE 3619.00
PERCENT CHANGE -3.75

| | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -20.00 | -70.00 | -80.00 | -20.00 | -40.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1599.75 | 4740.00 | 533.25 | 474.00 | 3792.00 | 2133.00 |
| PERCENTAGE CHANGE | -11.13 | -21.00 | -70.37 | -80.25 | -21.00 | -40.75 |

AREA BASE VALUE 3760.00
W/ PROJECT VALUE 2828.20
PERCENT CHANGE -24.78

AREA 8
ACREAGE 400

| | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 3.00 | 4.00 | 8.00 | 6.00 |
| BASE VAL-EQ POINTS | 1200.00 | 4000.00 | 1200.00 | 1600.00 | 3200.00 | 2400.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1155.00 | 3850.00 | 1155.00 | 1540.00 | 3080.00 | 2310.00 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 2506.67
W/O PROJ VALUE 2412.67
PERCENT CHANGE -3.75

| | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1066.50 | 3555.00 | 948.00 | 1264.00 | 3002.00 | 2133.00 |
| PERCENTAGE CHANGE | -11.13 | -11.12 | -21.00 | -21.00 | -6.19 | -11.12 |

AREA BASE VALUE 2506.67
W/ PROJECT VALUE 2230.43
PERCENT CHANGE -11.02

CARTER AREA SUB-BASIN

| | |
|---|---|
| BASE VALUE(ACRE POINTS) | 6267 |
| W/C PROJECT VALUE | 6032 |
| PERCENT CHANGE | -3.75 |
| W/ PROJECT VALUE | 5059 |
| PERCENT CHANGE | -19.28 |

EVALUATION OF YAZOO BASIN
WASP LAKE SUB-BASIN
LEVEE PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 9
ACREAGE 400

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 3.00 | 3.00 | 4.00 | 8.00 | 3.00 |
| BASE VAL-EQ POINTS | 1200.00 | 1200.00 | 1200.00 | 1600.00 | 3200.00 | 1200.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1155.00 | 1155.00 | 1155.00 | 1540.00 | 3080.00 | 1155.00 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 1493.33
W/O PROJ VALUE 1437.33
PERCENT CHANGE -3.75

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1066.50 | 1066.50 | 948.00 | 1264.00 | 3002.00 | 1066.50 |
| PERCENTAGE CHANGE | -11.13 | -11.13 | -21.00 | -21.00 | -6.19 | -11.13 |

AREA BASE VALUE 1493.33
W/ PROJECT VALUE 1329.83
PERCENT CHANGE -10.95

AREA 10
ACREAGE 450

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 3.00 | 3.00 | 4.00 | 8.00 | 3.00 |
| BASE VAL-EQ POINTS | 1350.00 | 1350.00 | 1350.00 | 1800.00 | 3600.00 | 1350.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1299.38 | 1299.38 | 1299.38 | 1732.50 | 3465.00 | 1299.38 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 1680.00
W/O PROJ VALUE 1617.00
PERCENT CHANGE -3.75

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1199.81 | 1199.81 | 1066.50 | 1422.00 | 3377.25 | 1199.81 |
| PERCENTAGE CHANGE | -11.13 | -11.13 | -21.00 | -21.00 | -6.19 | -11.13 |

AREA BASE VALUE 1680.00
W/ PROJECT VALUE 1496.06
PERCENT CHANGE -10.95

WASP LAKE SUB-BASIN

| | |
|---|---|
| BASE VALUE(ACRE POINTS) | 3173 |
| W/O PROJECT VALUE | 3054 |
| PERCENT CHANGE | -3.75 |
| W/ PROJECT VALUE | 2826 |
| PERCENT CHANGE | -10.95 |

EVALUATION OF YAZOO BASIN
SNAKE CREEK SUB-BASIN
LEVEE PROJECT

| ENVIRONMENTAL FEATURE | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 11
ACREAGE 500

| | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 5.00 | 5.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1500.00 | 5000.00 | 2500.00 | 2500.00 | 4000.00 | 4000.00 |
| NON PROJ IMPACT (%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 | 75.00 |
| BASE VALUE W/O PROJ | 1443.75 | 4812.50 | 2406.25 | 2406.25 | 3850.00 | 3850.00 |
| PERCENTAGE CHANGE | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 | -3.75 |

AREA BASE VALUE 3300.00
W/O PROJ VALUE 3176.25
PERCENT CHANGE -3.75

| | FISH | WLDIF | FOWL | APPEAR | STORE | CULTURE |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | 5.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 |
| BASE VALUE W/ PROJ | 1333.13 | 4443.75 | 1975.00 | 1975.00 | 3752.50 | 4147.50 |
| PERCENTAGE CHANGE | -11.13 | -11.13 | -21.00 | -21.00 | -6.19 | 3.69 |

AREA BASE VALUE 3300.00
W/ PROJECT VALUE 2965.79
PERCENT CHANGE -10.13

SNAKE CREEK SUB-BASIN
BASE VALUE(ACRE POINTS) 3300
W/O PROJECT VALUE 3176
PERCENT CHANGE -3.75
W/ PROJECT VALUE 2966
PERCENT CHANGE -10.13

YAZOO BASIN
BASE VALUE(ACRE POINTS) 27637
W/O PROJECT VALUE 23981
PERCENT CHANGE -13.23
W/ PROJECT VALUE 20856
PERCENT CHANGE -24.53

APPENDIX B

PRINTOUTS - NEUSE RIVER ESTUARY

WETLAND EVALUATION SYSTEM (WES)

TECHNICAL ANALYSTS: EXAMPLE ONLY-ADAMS(USMC),AIKENS(USFWS),HAWLEY(UNC)

PUBLIC REPRESENTATIVES: EXAMPLE ONLY-USMC-MAS STAFF,CRAVEN CTY COMMISSIONERS

```
******************************
*          NOTE:             *
*   CUMULATIVE EFFECT HAS    *
*          NOT               *
*   BEEN TAKEN INTO ACCOUNT  *
*        IN THIS RUN         *
******************************
```

EVALUATION OF NEUSE RIVER ESTUARY
CHERRY POINT SUB-ESTUARY
AMMO STORAGE EXTENSION-PLAN A

| ENVIRONMENTAL FEATURE | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 1
ACREAGE 640

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| VALUE | 6.00 | 9.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 3840.00 | 5760.00 | 4480.00 | 3200.00 | 3840.00 | 5120.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 3955.20 | 5932.80 | 4614.40 | 3296.00 | 3916.80 | 5273.60 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 4565.33
W/O PROJ VALUE 4433.49
PERCENT CHANGE -2.89

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -83.00 | -67.00 | -82.00 | -90.00 | -80.00 | -90.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 7238.02 | 9907.78 | 8398.21 | 6262.40 | 7119.36 | 10019.84 |
| PERCENTAGE CHANGE | -88.49 | -72.01 | -87.46 | -95.70 | -85.40 | -95.70 |

AREA BASE VALUE 4565.33
W/ PROJECT VALUE 820.79
PERCENT CHANGE -82.02

AREA 2
ACREAGE 800

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 8.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 5600.00 | 6400.00 | 5600.00 | 4000.00 | 4800.00 | 6400.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 5768.00 | 6592.00 | 5768.00 | 4120.00 | 4896.00 | 6592.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 5706.67
W/O PROJ VALUE 5541.87
PERCENT CHANGE -2.89

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -89.00 | -80.00 | -82.00 | -82.00 | -44.00 | -93.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 10901.52 | 11865.60 | 10497.76 | 7498.40 | 7119.36 | 12722.56 |
| PERCENTAGE CHANGE | -94.67 | -85.40 | -87.46 | -87.46 | -48.32 | -98.79 |

AREA BASE VALUE 5706.67
W/ PROJECT VALUE 827.13
PERCENT CHANGE -85.51

AD-A094 652 ARMY MILITARY PERSONNEL CENTER ALEXANDRIA VA F/G 8/6
ASSESSING MAN'S IMPACT ON WETLANDS,(U)
DEC 80 G E GALLOWAY

UNCLASSIFIED NL

2 OF 2
AD-
A094652

END
DATE
FILMED
3 81
DTIC

AREA 3
ACREAGE 1000

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 6.00 | 5.00 | 4.00 | 5.00 | 5.00 |
| BASE VAL-EQ POINTS | 7000.00 | 6000.00 | 5000.00 | 4000.00 | 5000.00 | 9000.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 7210.00 | 6180.00 | 5150.00 | 4120.00 | 5100.00 | 9270.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 6200.00
W/O PROJ VALUE 6020.67
PERCENT CHANGE -2.89

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -87.00 | -83.00 | -81.00 | -83.00 | -65.00 | -92.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 13482.70 | 11309.40 | 9321.50 | 7539.60 | 8497.50 | 17798.40 |
| PERCENTAGE CHANGE | -92.61 | -88.49 | -86.43 | -88.49 | -69.95 | -97.76 |

AREA BASE VALUE 6200.00
W/ PROJECT VALUE 692.33
PERCENT CHANGE -88.83

AREA 4
ACREAGE 800

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 8.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 5600.00 | 6400.00 | 5600.00 | 4000.00 | 4800.00 | 6400.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 5768.00 | 6592.00 | 5768.00 | 4120.00 | 4896.00 | 6592.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 5706.67
W/O PROJ VALUE 5541.87
PERCENT CHANGE -2.89

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -45.00 | -65.00 | -35.00 | -47.00 | -45.00 | -32.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 8363.60 | 10876.80 | 7786.80 | 6056.40 | 7168.80 | 8701.44 |
| PERCENTAGE CHANGE | -49.35 | -69.95 | -39.05 | -51.41 | -49.35 | -35.96 |

AREA BASE VALUE 5706.67
W/ PROJECT VALUE 2541.05
PERCENT CHANGE -55.47

CHERRY POINT SUB-ESTUARY
BASE VALUE(ACRE POINTS) 22179

W/O PROJECT VALUE 21538
PERCENT CHANGE -2.89
W/ PROJECT VALUE 4881
PERCENT CHANGE -77.99

EVALUATION OF NEUSE RIVER ESTUARY
CLUBFOOT AREA SUB-ESTUARY
ACCESS ROAD-PLAN A

| ENVIRONMENTAL FEATURE | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 5
ACREAGE 950

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 8.00 | 6.00 | 5.00 | 7.00 | 7.00 |
| BASE VAL-EQ POINTS | 6650.00 | 7600.00 | 5700.00 | 4750.00 | 6650.00 | 7600.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 6849.50 | 7828.00 | 5871.00 | 4892.50 | 6783.00 | 7828.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 6840.00
W/O PROJ VALUE 6643.67
PERCENT CHANGE -2.87

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -40.00 | -40.00 | -40.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 7534.45 | 10959.20 | 8219.40 | 6849.50 | 7191.97 | 8610.80 |
| PERCENTAGE CHANGE | -13.30 | -44.20 | -44.20 | -44.20 | -8.15 | -13.30 |

AREA BASE VALUE 6840.00
W/ PROJECT VALUE 4977.87
PERCENT CHANGE -27.22

AREA 6
ACREAGE 1100

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 6.00 | 5.00 | 5.00 | 4.00 | 4.00 | 4.00 |
| BASE VAL-EQ POINTS | 6600.00 | 5500.00 | 5500.00 | 4400.00 | 4400.00 | 8800.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 6798.00 | 5665.00 | 5665.00 | 4532.00 | 4488.00 | 9064.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 5866.67
W/O PROJ VALUE 5696.53
PERCENT CHANGE -2.90

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -40.00 | -40.00 | -70.00 | -80.00 | -20.00 | -40.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 9517.20 | 7931.00 | 9630.50 | 8157.60 | 5438.40 | 12689.60 |
| PERCENTAGE CHANGE | -44.20 | -44.20 | -75.10 | -85.40 | -23.60 | -44.20 |

AREA BASE VALUE 5866.67
W/ PROJECT VALUE 3160.30
PERCENT CHANGE -46.13

AREA 7
ACREAGE 600

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 3.00 | 4.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1800.00 | 6000.00 | 1800.00 | 2400.00 | 4800.00 | 3600.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1854.00 | 6180.00 | 1854.00 | 2472.00 | 4896.00 | 3708.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 3760.00
W/O PROJ VALUE 3653.60
PERCENT CHANGE -2.83

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -80.00 | -50.00 | -70.00 | -80.00 | -20.00 | -40.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 3337.20 | 9270.00 | 3151.80 | 4449.60 | 5932.80 | 5191.20 |
| PERCENTAGE CHANGE | -85.40 | -54.50 | -75.10 | -85.40 | -23.60 | -44.20 |

AREA BASE VALUE 3760.00
W/ PROJECT VALUE 1673.72
PERCENT CHANGE -55.49

AREA 8
ACREAGE 400

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 3.00 | 4.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1200.00 | 4000.00 | 1200.00 | 1600.00 | 3200.00 | 2400.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1236.00 | 4120.00 | 1236.00 | 1648.00 | 3264.00 | 2472.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 2506.67
W/O PROJ VALUE 2435.73
PERCENT CHANGE -2.83

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -30.00 | -20.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 1606.80 | 4944.00 | 1483.20 | 1977.60 | 3460.80 | 2719.20 |
| PERCENTAGE CHANGE | -33.90 | -23.60 | -23.60 | -23.60 | -8.15 | -13.30 |

AREA BASE VALUE 2506.67
W/ PROJECT VALUE 1956.29
PERCENT CHANGE -21.96

CLUBFOOT AREA SUB-ESTUARY
BASE VALUE(ACRE POINTS) 18973

| | |
|---|---|
| W/O PROJECT VALUE | 18430 |
| PERCENT CHANGE | -2.87 |
| W/ PROJECT VALUE | 11768 |
| PERCENT CHANGE | -37.98 |

EVALUATION OF NEUSE RIVER ESTUARY
BACK AREA SUB-ESTUARY
INCREASED FISHING ACTIVITY

| ENVIRONMENTAL FEATURE | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 9
ACREAGE 400

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 3.00 | 3.00 | 4.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1200.00 | 1200.00 | 1200.00 | 1600.00 | 3200.00 | 1200.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1236.00 | 1236.00 | 1236.00 | 1648.00 | 3264.00 | 1236.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 1493.33
W/O PROJ VALUE 1452.80
PERCENT CHANGE -2.71

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 1359.60 | 1359.60 | 1483.20 | 1977.60 | 3460.80 | 1359.60 |
| PERCENTAGE CHANGE | -13.30 | -13.30 | -23.60 | -23.60 | -8.15 | -13.30 |

AREA BASE VALUE 1493.33
W/ PROJECT VALUE 1297.47
PERCENT CHANGE -13.12

AREA 10
ACREAGE 450

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 3.00 | 3.00 | 4.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1350.00 | 1350.00 | 1350.00 | 1800.00 | 3600.00 | 1350.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1390.50 | 1390.50 | 1390.50 | 1854.00 | 3672.00 | 1390.50 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 1680.00
W/O PROJ VALUE 1634.40
PERCENT CHANGE -2.71

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT (%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT (%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 1529.55 | 1529.55 | 1668.60 | 2224.80 | 3893.40 | 1529.55 |
| PERCENTAGE CHANGE | -13.30 | -13.30 | -23.60 | -23.60 | -8.15 | -13.30 |

AREA BASE VALUE 1680.00
W/ PROJECT VALUE 1459.65
PERCENT CHANGE -13.12

AREA 11
ACREAGE 500

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 5.00 | 5.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1500.00 | 5000.00 | 2500.00 | 2500.00 | 4000.00 | 4000.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1545.00 | 5150.00 | 2575.00 | 2575.00 | 4080.00 | 4120.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 3300.00
W/O PROJ VALUE 3206.33
PERCENT CHANGE -2.84

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -20.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 1699.50 | 5665.00 | 2832.50 | 3090.00 | 4326.00 | 4326.00 |
| PERCENTAGE CHANGE | -13.30 | -13.30 | -13.30 | -23.60 | -8.15 | -8.15 |

AREA BASE VALUE 3300.00
W/ PROJECT VALUE 2885.13
PERCENT CHANGE -12.57

BACK AREA SUB-ESTUARY
BASE VALUE(ACRE POINTS) 6473
W/O PROJECT VALUE 6294
PERCENT CHANGE -2.78
W/ PROJECT VALUE 5642
PERCENT CHANGE -12.84

NEUSE RIVER ESTUARY
BASE VALUE(ACRE POINTS) 47625
W/O PROJECT VALUE 46261
PERCENT CHANGE -2.86
W/ PROJECT VALUE 22292
PERCENT CHANGE -53.19

WETLAND EVALUATION SYSTEM (WES)

TECHNICAL ANALYSTS: EXAMPLE ONLY-ADAMS (USMC),AIKENS (USFWS),HAWLEY (UNC)

PUBLIC REPRESENTATIVES: EXAMPLE ONLY-USMC-MAS STAFF,CRAVEN CTY COMMISSIONERS

```
******************************
*          NOTE:             *
*   CUMULATIVE EFFECT HAS    *
*          NOT               *
*   BEEN TAKEN INTO ACCOUNT  *
*        IN THIS RUN         *
******************************
```

EVALUATION OF NEUSE RIVER ESTUARY
CHERRY POINT SUB-ESTUARY
AMMC STORAGE EXTENSION-PLAN B

| ENVIRONMENTAL FEATURE | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 1
ACREAGE 640

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 6.00 | 9.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 3840.00 | 5760.00 | 4480.00 | 3200.00 | 3840.00 | 5120.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 3955.20 | 5932.80 | 4614.40 | 3296.00 | 3916.80 | 5273.60 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 4565.33
W/O PROJ VALUE 4433.49
PERCENT CHANGE -2.89

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -45.00 | -70.00 | -30.00 | -50.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 6526.08 | 9789.12 | 6690.88 | 5603.20 | 5141.76 | 7910.40 |
| PERCENTAGE CHANGE | -69.95 | -69.95 | -49.35 | -75.10 | -33.90 | -54.50 |

AREA BASE VALUE 4565.33
W/ PROJECT VALUE 1659.73
PERCENT CHANGE -63.64

AREA 2
ACREAGE 800

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 8.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 5600.00 | 6400.00 | 5600.00 | 4000.00 | 4800.00 | 6400.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 5768.00 | 6592.00 | 5768.00 | 4120.00 | 4896.00 | 6592.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 5706.67
W/O PROJ VALUE 5541.87
PERCENT CHANGE -2.89

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -65.00 | -65.00 | -45.00 | -73.00 | -45.00 | -63.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 9517.20 | 10876.80 | 8363.60 | 7127.60 | 7168.80 | 10744.96 |
| PERCENTAGE CHANGE | -69.95 | -69.95 | -49.35 | -78.19 | -49.35 | -67.89 |

AREA BASE VALUE 5706.67
W/ PROJECT VALUE 1910.42
PERCENT CHANGE -66.52

AREA 3
ACREAGE 1000

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 6.00 | 5.00 | 4.00 | 5.00 | 5.00 |
| BASE VAL-EQ POINTS | 7000.00 | 6000.00 | 5000.00 | 4000.00 | 5000.00 | 9000.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 7210.00 | 6180.00 | 5150.00 | 4120.00 | 5100.00 | 9270.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 6200.00
W/O PROJ VALUE 6020.67
PERCENT CHANGE -2.89

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -69.00 | -67.00 | -52.00 | -70.00 | -25.00 | -45.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 12184.90 | 10320.60 | 7828.00 | 7004.00 | 6437.50 | 13441.50 |
| PERCENTAGE CHANGE | -74.07 | -72.01 | -56.56 | -75.10 | -28.75 | -49.35 |

AREA BASE VALUE 6200.00
W/ PROJECT VALUE 2154.93
PERCENT CHANGE -65.24

AREA 4
ACREAGE 800

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 8.00 | 7.00 | 5.00 | 6.00 | 6.00 |
| BASE VAL-EQ POINTS | 5600.00 | 6400.00 | 5600.00 | 4000.00 | 4800.00 | 6400.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 5768.00 | 6592.00 | 5768.00 | 4120.00 | 4896.00 | 6592.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 5706.67
W/O PROJ VALUE 5541.87
PERCENT CHANGE -2.89

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -45.00 | -47.00 | -65.00 | -72.00 | -35.00 | -50.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 8363.60 | 9690.24 | 9517.20 | 7086.40 | 6674.40 | 9888.00 |
| PERCENTAGE CHANGE | -49.35 | -51.41 | -69.95 | -77.16 | -39.05 | -54.50 |

AREA BASE VALUE 5706.67
W/ PROJECT VALUE 2739.36
PERCENT CHANGE -52.00

CHERRY POINT SUB-ESTUARY
BASE VALUE(ACRE POINTS) 22179

| | |
|---|---|
| W/O PROJECT VALUE | 21538 |
| PERCENT CHANGE | -2.89 |
| W/ PROJECT VALUE | 8464 |
| PERCENT CHANGE | -61.84 |

EVALUATION OF NEUSE RIVER ESTUARY
CLUBFOOT AREA SUB-ESTUARY
ACCESS ROAD-PLAN B

| ENVIRONMENTAL FEATURE | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 5
ACREAGE 950

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| VALUE | 7.00 | 8.00 | 6.00 | 5.00 | 7.00 | 7.00 |
| BASE VAL-EQ POINTS | 6650.00 | 7600.00 | 5700.00 | 4750.00 | 6650.00 | 7600.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 6849.50 | 7828.00 | 5871.00 | 4892.50 | 6783.00 | 7828.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 6840.00
W/O PROJ VALUE 6643.67
PERCENT CHANGE -2.87

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 7191.97 | 8219.40 | 6164.55 | 5137.12 | 7191.97 | 8219.40 |
| PERCENTAGE CHANGE | -8.15 | -8.15 | -8.15 | -8.15 | -8.15 | -8.15 |

AREA BASE VALUE 6840.00
W/ PROJECT VALUE 6282.54
PERCENT CHANGE -8.15

AREA 6
ACREAGE 1100

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| VALUE | 6.00 | 5.00 | 5.00 | 4.00 | 4.00 | 4.00 |
| BASE VAL-EQ POINTS | 6600.00 | 5500.00 | 5500.00 | 4400.00 | 4400.00 | 8800.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 6798.00 | 5665.00 | 5665.00 | 4532.00 | 4488.00 | 9064.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 5866.67
W/O PROJ VALUE 5696.53
PERCENT CHANGE -2.90

| | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -15.00 | -15.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 7817.70 | 6514.75 | 6514.75 | 5211.80 | 5211.80 | 10423.60 |
| PERCENTAGE CHANGE | -18.45 | -18.45 | -18.45 | -18.45 | -18.45 | -18.45 |

AREA BASE VALUE 5866.67
W/ PROJECT VALUE 4784.27
PERCENT CHANGE -18.45

AREA 7
ACREAGE 60C

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.C0 | 3.0C | 4.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1800.00 | 6000.00 | 1800.0C | 2400.00 | 4800.00 | 3600.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.0C | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.C0 | 20.00 | 20.0C | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1854.00 | 6180.C0 | 1854.0C | 2472.00 | 4856.00 | 3708.0C |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.0C | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 3760.00
W/O PROJ VALUE 3653.6C
PERCENT CHANGE -2.83

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -80.00 | -50.00 | -70.00 | -80.00 | -20.00 | -40.00 |
| PROB OF OCCURRENCE | 1C0.00 | 100.00 | 100.0C | 100.00 | 1C0.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.0C | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 3C.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 3337.20 | 9270.00 | 3151.80 | 4449.60 | 5932.80 | 5191.20 |
| PERCENTAGE CHANGE | -85.40 | -54.50 | -75.1C | -85.40 | -23.60 | -44.20 |

AREA BASE VALUE 3760.00
W/ PROJECT VALUE 1673.72
PERCENT CHANGE -55.49

AREA 8
ACREAGE 40C

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 3.0C | 4.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1200.00 | 4000.00 | 1200.00 | 1600.00 | 3200.00 | 2400.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.0C | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.0C | 20.C0 | 20.0C | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1236.00 | 4120.00 | 1236.0C | 1648.0C | 3264.00 | 2472.C0 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 2506.67
W/O PROJ VALUE 2435.73
PERCENT CHANGE -2.83

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -30.00 | -20.C0 | -20.0C | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.C0 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.0C | 30.0C | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 1606.80 | 4944.00 | 1483.2C | 1977.60 | 3460.80 | 2719.20 |
| PERCENTAGE CHANGE | -33.90 | -23.60 | -23.6C | -23.60 | -8.15 | -13.30 |

AREA BASE VALUE 2506.67
W/ PROJECT VALUE 1956.29
PERCENT CHANGE -21.96

CLUBFOOT AREA SUB-ESTUARY
BASE VALUE(ACRE POINTS) 18973

| | |
|---|---|
| W/C PROJECT VALUE | 18430 |
| PERCENT CHANGE | -2.87 |
| W/ PROJECT VALUE | 14697 |
| PERCENT CHANGE | -22.54 |

EVALUATION OF NEUSE RIVER ESTUARY
BACK AREA SUB-ESTUARY
INCREASED FISHING ACTIVITY

| ENVIRONMENTAL FEATURE | ENDANG | FISH | FOWL | UNIQUE | APPEAR | WILDLF |
|---|---|---|---|---|---|---|
| WEIGHT | 10.00 | 10.00 | 2.00 | 2.00 | 4.00 | 2.00 |

AREA 9
ACREAGE 400

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 3.00 | 3.00 | 4.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1200.00 | 1200.00 | 1200.00 | 1600.00 | 3200.00 | 1200.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1236.00 | 1236.00 | 1236.00 | 1648.00 | 3264.00 | 1236.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 1493.33
W/O PROJ VALUE 1452.80
PERCENT CHANGE -2.71

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 1359.60 | 1359.60 | 1483.20 | 1977.60 | 3460.80 | 1359.60 |
| PERCENTAGE CHANGE | -13.30 | -13.30 | -23.60 | -23.60 | -8.15 | -13.30 |

AREA BASE VALUE 1493.33
W/ PROJECT VALUE 1297.47
PERCENT CHANGE -13.12

AREA 10
ACREAGE 450

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 3.00 | 3.00 | 4.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 1350.00 | 1350.00 | 1350.00 | 1800.00 | 3600.00 | 1350.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1390.50 | 1390.50 | 1390.50 | 1854.00 | 3672.00 | 1390.50 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 1680.00
W/O PROJ VALUE 1634.40
PERCENT CHANGE -2.71

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -20.00 | -20.00 | -5.00 | -10.00 |
| PROB OF OCCURRENCE | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 1529.55 | 1529.55 | 1668.60 | 2224.80 | 3893.40 | 1529.55 |
| PERCENTAGE CHANGE | -13.30 | -13.30 | -23.60 | -23.60 | -8.15 | -13.30 |

AREA BASE VALUE 1680.00
W/ PROJECT VALUE 1459.65
PERCENT CHANGE -13.12

AREA 11
ACREAGE 50C

| | | | | | | |
|---|---|---|---|---|---|---|
| VALUE | 3.00 | 10.00 | 5.00 | 5.00 | 8.00 | 8.00 |
| BASE VAL-EQ POINTS | 150C.00 | 5000.00 | 2500.00 | 2500.00 | 4000.00 | 4000.00 |
| NON PROJ IMPACT (%CHANGE) | -15.00 | -15.00 | -15.00 | -15.00 | -10.00 | -15.00 |
| PROB OF OCCURRENCE | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| BASE VALUE W/O PROJ | 1545.00 | 5150.00 | 2575.00 | 2575.00 | 4080.00 | 4120.00 |
| PERCENTAGE CHANGE | -3.00 | -3.00 | -3.00 | -3.00 | -2.00 | -3.00 |

AREA BASE VALUE 3300.00
W/O PROJ VALUE 3206.33
PERCENT CHANGE -2.84

| | | | | | | |
|---|---|---|---|---|---|---|
| PROJECT IMPACT(%CHANGE) | -10.00 | -10.00 | -10.00 | -20.00 | -5.00 | -5.00 |
| PROB OF OCCURRENCE | 10C.00 | 100.00 | 100.0C | 100.00 | 100.00 | 100.00 |
| SECOND IMPACT(%CHANGE) | -1C.00 | -10.00 | -10.0C | -10.00 | -10.00 | -10.00 |
| PROB OF OCCURRENCE | 3C.00 | 30.00 | 30.00 | 30.00 | 30.00 | 30.00 |
| BASE VALUE W/ PROJ | 1699.50 | 5665.00 | 2832.50 | 3090.00 | 4326.00 | 4326.00 |
| PERCENTAGE CHANGE | -13.30 | -13.30 | -13.3C | -23.60 | -8.15 | -8.15 |

AREA BASE VALUE 3300.00
W/ PROJECT VALUE 2885.13
PERCENT CHANGE -12.57

BACK AREA SUB-ESTUARY
BASE VALUE(ACRE POINTS) 6473
W/O PROJECT VALUE 6294
PERCENT CHANGE -2.78
W/ PROJECT VALUE 5642
PERCENT CHANGE -12.84

NEUSE RIVER ESTUARY
BASE VALUE(ACRE POINTS) 47625
W/O PROJECT VALUE 46261
PERCENT CHANGE -2.86
W/ PROJECT VALUE 28804
PERCENT CHANGE -39.52

# APPENDIX C

# COMPUTER TECHNIQUES

## APPENDIX C

## COMPUTER TECHNIQUES

The computer is a most effective assistant in the processing and display of masses of information. Computer support for this project came from the UNC Computation Center and the University's Department of Geography Computer Graphics Laboratory.

The data processing and computation for the WES were accomplished using a PL/C program written by the author. One run of the WES requires .03 seconds of Central Processing Unit (CPU) time at an estimated cost of $0.98. Data for revisions are inputted interactively through remote terminals.

The map displays used in the example were prepared using CALFORM. The Yazoo Basin map required .05 seconds of CPU time and 2296 plots on a Calcomp plotter. The estimated cost of one map is $5.00. The Neuse River map required .06 CPU seconds, 1950 plots and cost approximately $2.50.

The maps were essentially prepared from data digitized by the author, although the inset map of the Yazoo was developed from the output of the U. S. Census Bureau county DIME files.

Information on CALFORM, SYMAP and SYMU can be obtained from Harvard University, Laboratory for Computer Graphics and Spatial Analysis, Cambridge, Massachusetts 02138. Programs and manuals are available to educational institutions and government agencies at a nominal cost.

Assistance within North Carolina is available from the Computer Graphics Laboratory, Department of Geography, University of North Carolina, Chapel Hill, North Carolina 27514.

DATE
FILMED

- 8