Report No. 25

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ECONOMIC EVALUATION OF ZONING ALTERNATIVES IN THE MANAGEMENT OF ESTUARINE RESOURCES IN SOUTH CAROLINA

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ECONOMIC EVALUATION OF ZONING ALTERNATIVES IN THE MANAGEMENT OF ESTUARINE RESOURCES IN SOUTH CAROLINA

by

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Other Publications Resulting From This Project

W. W. Hall, Jr. and J. C. Hite, "The Use of Central Place Theory and Gravity-Flow Analysis to Delineate Economic Areas," Southern Journal of Agricultural Economics, 2 (December 1970), pp. 147-153.

James C. Hite and Eugene A. Laurent, The Structure of the Charleston Area Economy: An Input-Output Study, South Carolina Agricultural Experiment Station in cooperation with Water Resources Research Institute, Clemson University, Clemson, South Carolina, AE 342, March 1971.

Eugene A. Laurent and James C. Hite, Economic-Ecologic Analysis in the Charleston Metropolitan Area: An Input-Output Study, Water Resources Research Institute, Clemson University, Clemson, South Carolina, Report No. 19, April 1971.

James C. Hite and Eugene A. Laurent, "Empirical Study of Economic-Ecologic Linkages in a Coastal Area," Water Resources Research, 7 (October 1971).

James C. Hite and Eugene A. Laurent, "Economic and Environmental Repercussions of Area Development," American Journal of Agricultural Economics, 53 (December 1971).

Chapter I

INTRODUCTION

The Coastal Zone Management Problem in South Carolina

South Carolina's numerous estuaries and inlets create a coastal environment along 2,879 miles of tidal shoreline. Behind that shoreline lie approximately 425,000 acres of salt marsh. Although, in most cases, legal title to the salt marshes and estuaries is held by the State, these areas have been traditionally utilized as a common property resource. The traditional users -- the commercial fishermen, sportsmen, shipping interests -- have known minor and sporadic conflicts, but until relatively recently the competition for the use of estuarine resources lacked the intensity needed to generate major conflicts. The growth of population and industry in coastal areas, however, has spawned a whole set of potential uses for the estuarine areas -- waste disposal, residential development, intensive recreation. In conjunction with these new uses has come a wave of controversy over legal title to estuarine property and very intense pressure for state government to commit the public estuarine areas to long-range (and often irreversible) uses. If the coastal areas of South Carolina are to be healthy economically, as well as ecologically, the productive services of these natural resources must be understood and managed in a comprehensive manner so as to maximize the benefits received from their resources.

Within recent years, very real examples of conflicts over coastal resources have surfaced in South Carolina. At Pawley's Island, a controversy has boiled over digging of a channel in the marsh and filling of marsh area for construction. Charleston harbor, perhaps the most valuable single natural resource in the State, continues to shoal and require regular dredging activity. The marsh around Charleston harbor is being filled not only with the spoil from this dredging, but also with the solid waste generated by economic activity in the area. The BASF controversy in Beaufort County has stirred national interest over possible environmental damage due to industrial development on Port Royal Sound. It is likely that similar conflicts will develop in the future at an ever accelerating rate, and some system for adjudicating these conflicts is badly needed.

Recognition of the need for a coastal zone management system is apparent at both the Federal and State levels. Legislation aimed at development of a national coastal zone policy has been introduced in The Congress [1, pp. 22-28]. State government in South Carolina has also taken cognizance of growing coastal resource problems, and in 1968, Governor Robert McNair directed the establishment of a multi-agency taskforce to suggest alternative management policies for the estuarine and tidal areas of the State [18]. (The taskforce submitted its report in January 1970 [21]). Both the 1970 and 1971 sessions of the South Carolina General Assembly saw the introduction of legislation aimed at settling some of the problems associated with legal title to the old rice-growing areas in the tidal marshes and the establishment of a permit system for control of activities in the tidal zone. The exact nature of the legislation which will eventually be passed cannot be fully anticipated, but that some management system will eventually be established is almost certain.

Basically, there are three ways in which land-use and economic activity in the coastal zone can be controlled, and the three are not mutually exclusive. The simplest system might be based on permits. Any person or firm desiring to use or change the form of estuarine resources would be required to secure a permit before initiating action. To some extent, such a permit system is already in effect due to the requirements of the U. S. Army Corps of Engineers. State government is currently asked to review permit applications and provide comments to the Corps before action is taken on these applications, and a system for handling this review is currently in operation in South Carolina [19, pp. 4-6]. But a permit system, alone, is essentially an ad-hoc process. Unless there is a comprehensive coastal zone management plan, each permit application must be examined on its own merits individually and without regard to the pattern of uses for which the coastal zone is suited. A second tool for coastal zone management involves use of the taxing powers of government. Since most coastal resources are common property they are owned by all the people. It is legitimate, therefore, for government, as representatives of the people, to place user charges in the form of taxes on all who wish to use these resources. The taxes on users of coastal resources would vary in such a way as to approximate the damages which society is likely to suffer from allowing each of the particular uses which might be undertaken [14, pp. 88-90]. A third approach is the use of zoning regulations based on a comprehensive management plan for the coastal area. Zoning would establish which activities are to be allowed and where in the coastal zone. Since zoning pre-empts certain activities from particular areas, however, there are opportunity costs associated with alternative zoning schemes; and these costs may be quite significant, especially when viewed against the economic needs of small, coastal communities. Rational use of any, or all, of these tools requires careful economic analysis to determine both the benefits and costs associated with various types of coastal developments.

Objectives of the Study

Although there is no certainty that zoning will be used as a coastal zone management tool in South Carolina, it appears that some form of land-use restrictions are likely to be applied to coastal areas. Accordingly, this study was designed to achieve four objectives:

(1) To examine the role of estuarine resources in the economic development of the South Carolina Coastal Plain.

(2) To delineate suitable economic planning units for comprehensive estuarine management on the basis of present concentrations of economic activities.

(3) To develop a generalized model as a method of analysis of the local and regional economic impact, relative to given public goals of resource development, of alternative zoning plans in estuarine areas.

(4) To develop economic data for inclusion in the model to evaluate the effect of alternative zoning patterns in a specific estuarine area.

The project was undertaken in four phases:

Phase I : Identification and delineation of principal estuarine areas of South Carolina, classification of users of estuarine resources, and delineation of suitable management units or zones.

Phase II : Development of a computer model, based on input-output procedures, for evaluation of various patterns of coastal area economic activity.

Phase III: Application of the model to the critical areas in the coastal zone of South Carolina.

Phase IV : Refinement of the model and evaluation of some specific economic alternatives.

Plan of the Study

This report presents the results of activities in each of the four phases of research outlined previously. The discussion in Chapter II will focus on results of Phase I, including examination of the historical significance of estuarine resources in the South Carolina economy and current land-use patterns. Alternative delineations of planning area units in the South Carolina coastal zone will also be discussed in Chapter II, and the areas where major conflicts seem most likely will be noted. In Chapter III, the basic planning model developed in this study will be presented and discussed. Implementation of the model using data from the Charleston and Beaufort areas will be achieved in Chapter IV and the economic impacts of alternative uses of coastal resources will be discussed.

Chapter II

USES OF ESTUARINE RESOURCES IN SOUTH CAROLINA

Historical Background

The resources of the coastal zone have been critical to the economy of South Carolina since colonial times. Soon after founding of the Colony, the planters learned how to use the rise and fall of tidewater streams to flood and drain fields which could be planted in rice. Carolina rice achieved an international reputation for quality, and, although there were lean years, the rice culture made South Carolina one of the most prosperous colonies in the old British empire /̅3, p. 46_7. The black, mucky landward of the line of salt water intrusion became prime agricultural lands. A description of South Carolina printed in London in 1761 noted that the coastal swamps and marshes were "... the source of infinite wealth," and were commonly called the "Golden mines of Carolina" /̅4, p. 268_7. In Georgetown County, alone, as many as 46,000 acres of tidelands were diked and used in the cultivation of rice /̅22, p. 168_7.

Cultivation of the Piedmont after the invention of the cotton gin in 1793, increased the silt loadings of coastal rivers and damaged the rice culture /̅19_7. The ravages of the War Between the States further damaged rice agriculture, and by 1885, many of the old rice fields had fallen into disuse. In Georgetown County, the acreage of tidelands in rice culture dropped to 10,000 and the average price of an acre of fresh-water marsh in 1885 was reported at $2 to $5 /̅4, p. 168_7. The sale marshes were considered of no value and many owners were reported to have allowed the State to confiscate them for taxes. Article I of the Amendments to the State Constitution of South Carolina, written in 1895, requires the General Assembly to take measures for condemnation of all lands necessary to drain the swamps and low lands in the State [6, p. 11] and in the Drainage District Act of 1911, the General Assembly declared that, as a matter of policy, "... the reclamation of tidal marshes shall be considered a public benefit ...." [6, p. 52].

The marshes were not the only coastal resource important in the economic history of South Carolina. The ports of Charleston, Beaufort and Georgetown have also played a vital role in South Carolina development since colonial times. In the 1730's, an average of more than 45,000 barrels of rice were exported annually through Charlestion and more than 1,700 barrels annually through the ports of Georgetown and Beaufort [24, p. 768]. By the early 1770's, the volume of rice exports averaged annually almost 113,000 barrels at Charleston and more than 5,000 barrels at Beaufort and Georgetown [24, p. 767]. But rice was not the only commodity moving through South Carolina ports in colonial times. Indigo, furs, tobacco, pitch, tar and turpentine also were exported,and slaves, iron and manufactured goods were imported. In 1774, immediately prior to the Revolution, more than 400 vessels called at Charleston, importing 29,933 tons and exporting 31,548 tons of cargo [24, p. 760]. By 1875, cargo through the port of Charleston had increased to imports of more than 484,000 tons and exports of more than 447,000 tons. In 1969, exports at Charleston exceeded 1,000,000 tons [26].

A third use of coastal resources from colonial times has been a habitat for commercial fish and shellfish. Lunz quotes the records of

Mark Catesby, dating from 1722 to 1726, relative to the abundant harvest of oysters by inhabitants of the South Carolina coast [17, p. 9]. In the years after the War Between the States, the fisheries of Charleston were considered the most important on the Atlantic Coast between Sandy Hook and Key West. But the quantity of the fisheries landing in South Carolina have been rather constant in the last one hundred years and South Carolina has not kept pace with the expanding fisheries industry in neighboring states [17, p. 10]. The fisheries industry, therefore, has been a residual user of coastal resources in South Carolina, and quantitatively, of little significance to the State's total economy [10, Chapter 11].

Generalized Current Land Use Patterns

A survey of current resource use in the coastal zone of South Carolina was undertaken in the summer of 1969. The most recent sets of aerial photographs available in the Soil Conservation Service office of each coastal county were used as the basic source of information for this survey. Supplementary information was obtained from data in the local planning commission offices and from interviews with community leaders. Finally, the land-use patterns in critical areas were updated and verified by field inspection. The generalized land-use patterns are presented in the maps shown on Plates I-IV in the text of this report and in Plates VII-XVIII in the Appendix.

Plates I-VI show land-use patterns along the entire coastal zone of South Carolina from the North Carolina border on the right-hand side of the map to the Georgia border on the left-hand side of the map. More detailed versions of these maps are shown in Plates VII and XVIII in the

Plate I Base Map, South Carolina Costal Zone, 1969 (Color Key: Green-Marshland)

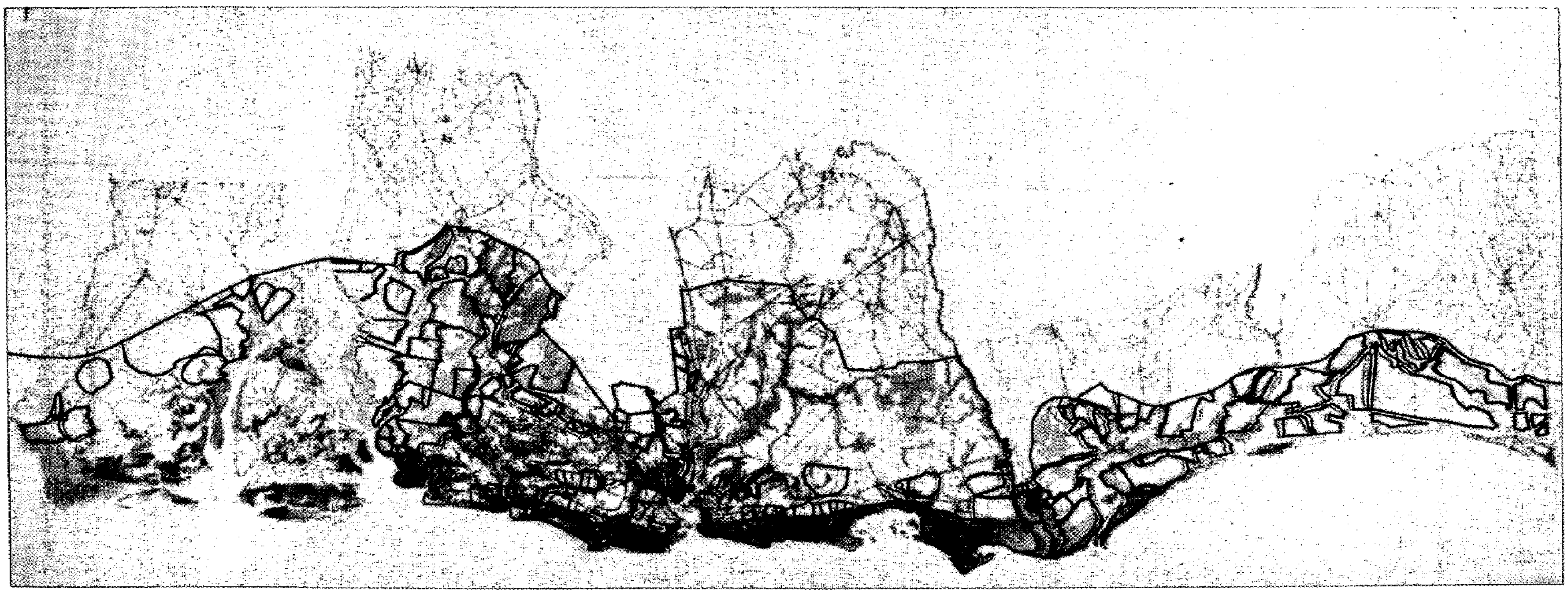

Plate II Oyster Leases and Large Land Holdings, South Carolina Coastal Zone, 1969
(Color Key: Green-Marshland; Blue-Oyster Leases; Black Polygons-Landholdings of 1000 acres or more).

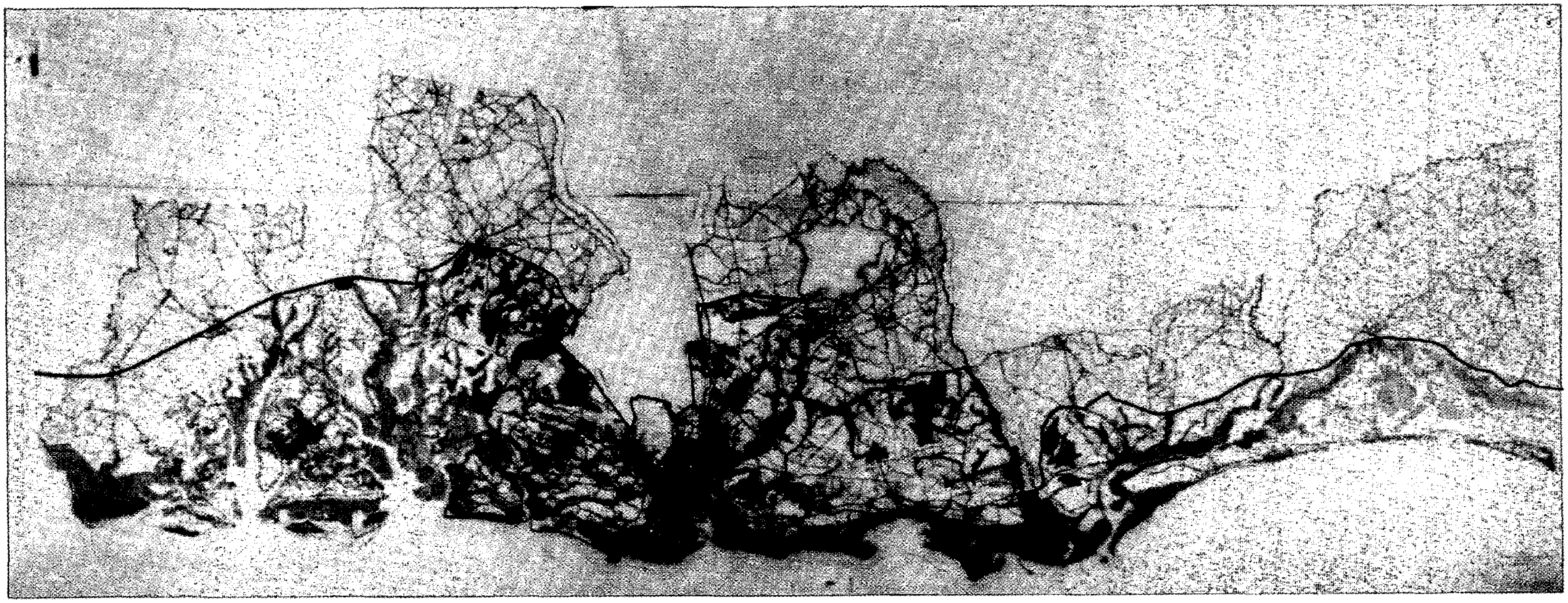

Plate III Residential and Industrial Areas, South Carolina Coastal Zone, 1969
(Color Key: Green-Marshland; Red-Residential Areas; Yellow-Industrial Areas).

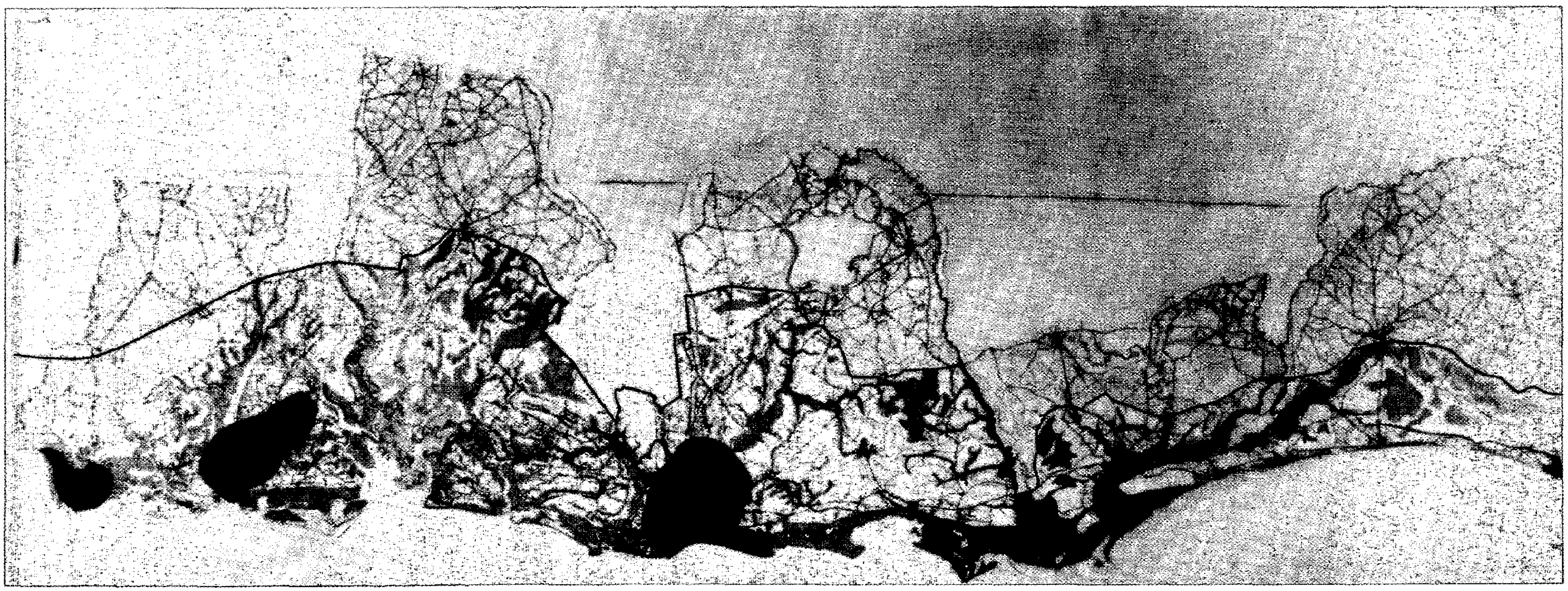

Plate IV Areas of Gross Pollution and Spoil Disposal, South Carolina Coastal Zone, 1969 (Color Key: Green-Marshland; Purple-Areas of Gross Pollution; Orange-Spoil Areas).

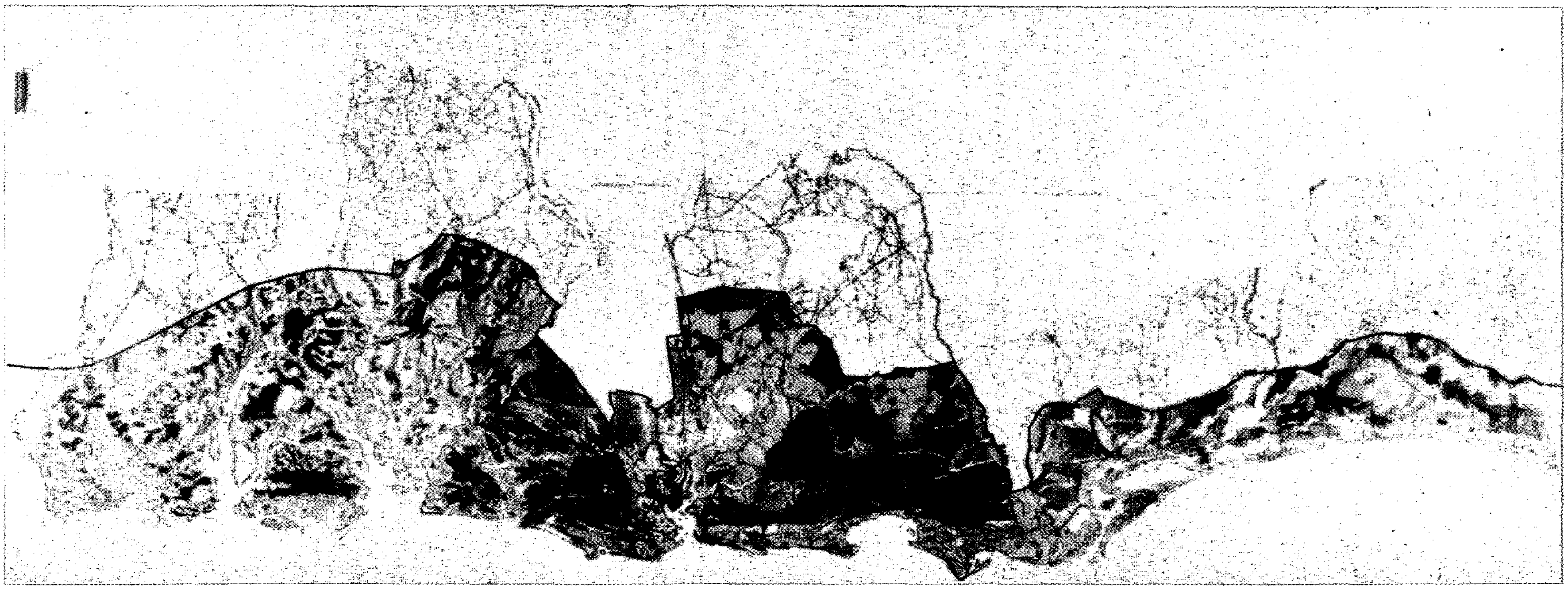

Plate V Agricultural and Timber Lands, South Carolina Coastal Zone, 1969
(Color Key: Green-Marshland; Light Brown-Timberland; Dark Brown-Cultivated Lands).

Plate VI Game Management and Recreation Areas, South Carolina Coastal Zone, 1969
(Color Key: Green-Marshland; Pink-Game Management Areas; Red-Recreation Areas; Blue-Boat Ramps and Marinas).

Appendix. Although the maps do not show fine detail, the Charleston harbor complex is recognizable slightly to the left of the center of the maps. The long, relatively unbroken coast on the right of the maps is the Grand Strand area centered on Myrtle Beach and anchored on the south by Georgetown and Winyah Bay. South of Winyah Bay lie the Santee River delta and Cape Romain. On the left-hand side of the maps, south of Charleston, the coastline is broken by numerous sea islands and the two major inlets of St. Helena Sound and Port Royal Sound. The landward side of the coastal zone in these maps is defined somewhat arbitrarily by a heavy black line which follows either major highways or county lines.

Plate II shows oyster leases and land holdings of 1,000 acres or more. Color reproduction on this plate is especially poor, but it is clear that the oyster areas are largely concentrated south of the mouth of the Santee River, with particularly intense use of the coastal resources for oysters in the Cape Romain area and in the areas on either side of the mouth of Charleston harbor and in Beaufort County. Large land holdings tend to be concentrated in the northern third and southern third of the South Carolina coastal zone and there is a noticeable absence of large land holdings in Berkeley County.* Many of these large landholdings are owned by pulp and paper companies and used for growing pulpwood, others are owned by wealthy sportsmen who manage them for wildlife.

Plate III shows residential and industrial areas in the coastal zone of South Carolina. Although there are scattered residents throughout

*Much of Berkeley County is in the Francis Marion National Forest.

the coastal zone, the most striking feature of Plate III is the heavy concentration of population in the vicinity of Charleston harbor. To an important extent, the red markings at Charleston overlay a significant industrial complex also located in the area. Other major industrial (or potential)* industrial sites are found in the Georgetown and Beaufort areas, but these sites are small.

Plate IV shows areas of gross pollution and spoil disposal sites. There are five major areas of pollution in the South Carolina Coastal Zone: 1) Winyah Bay, at Georgetown is polluted by industrial and domestic waste; 2) the Santee delta is polluted by industrial wastes; 3) the Charleston harbor area is polluted by industrial and domestic wastes; 4) the Beaufort River and parts of Port Royal Sound is polluted by domestic waste from the city of Beaufort; and 5) the mouth of the Savannah River is polluted by industrial and domestic wastes from the city of Savannah. Spoil from dredging operations at the ports of Charleston, Georgetown, and Port Royal and along the Atlantic Intracoastal Waterway has much the same effect on the marshlands as pollution from industry and homes. Both tend to interfere with natural estuarine processes. Spoil areas, in orange, can be seen on Plate IV underneath the pollution zone around Charleston harbor and along much of the Intracoastal Waterway for the full length of the Coast.

Agricultural and Timber Lands are shown on Plate V. The cultivated agricultural lands are most heavily concentrated near the center of the coast in Berkeley and Charleston Counties. (The reproduction process has distorted color somewhat and only the darkest brown areas are cultivated

*At the time of the land-use survey, the Colleton River site in Beaufort County was considered a potential industrial site.

lands.) Most of the non-marshland of the South Carolina Coastal Zone is in timber, primarily pine; and the cultivated plots are primarily small truck farming operations.

Plate VI shows game management (both public and private) areas and recreational areas in the South Carolina Coastal Zone. Intense recreational uses of South Carolina's coastal resources are concentrated in the extreme northern stretch of the coast, north of Pawley's Island along the Grand Strand, and in the extreme southern portion on Hunting, Fripp and Hilton Head Islands in Beaufort County. There are numerous boat ramps and marinas scattered throughout the coastal zone, but, by far, the heaviest concentration of these are concentrated south of St. Helena Sound. There are three rather large areas under management for game in the South Carolina Coastal Zone: 1) a conglomerate of public and private lands stretching from south of Cape Romain through the Santee Delta and to Pawley's Island, north of Winyah Bay and up the Waccamaw River; 2) the Cooper River swamps northwest of Charleston in Berkeley County; and 3) much of the area south and west of Port Royal Sound in Jasper and Beaufort Counties.

Major Estuarine Areas

One of the major problems in developing a scientific management program is determining the size of suitable management and planning units.

In terms of current land-use patterns in the South Carolina coastal zone, the coastline can be divided into four major parts. From Little River on the North Carolina border to Pawley's Island, the Grand Strand area is already heavily developed as beachfront resorts. South of Pawley's Island to the northern end of the Isle of Palms, the coastline is relatively undeveloped and in largely a natural state, with the primary resource use being timber, oyster and wildlife operations. Charleston harbor and its environs, stretching roughly from the Isle of Palms on the north to the northern end of Edisto Island on the south, constitutes a third use area. The Charleston area is a relatively low-density urbanized area, with considerable truck farming and oyster operations in the coastal areas. Although there are remaining natural, unpolluted estuarine areas in the vicinity of Charleston harbor, these areas tend to be either small or on the northern and southern peripheries. The fifth major resource use area in the South Carolina coastal zone lies from Edisto Island on the north to the Savannah River on the south and includes St. Helena and Port Royal Sounds and the vast marshland complexes of Colleton, Beaufort, and Jasper Counties. The principal uses of estuarine resources in this area are oystering, truck farming, timber production and recreational-residential complexes (e.g., Hilton Head and Fripp Island). Like the areas lying between Pawley's Island and the Isle of Palms, the St. Helena-Port Royal area is essentially in a natural state, although pollution does interfere with shellfish harvesting in some parts of the area.

The natural resource use areas in the South Carolina coastal zone do not correspond exactly to political boundaries, and thus it may not be practical to delineate management areas on the basis of resource use alone. In March 1969, the Governor of South Carolina issued an executive order establishing ten planning and development areas in the state, three of which include coastal counties. In the north, the Waccamaw Planning and Development District is composed of Horry, Georgetown and Williamsburg Counties, and thus has jurisdiction over that stretch of the coastal zone extending from the North Carolina state line to the mouth of the Santee River, including all of the Grand Strand and a part of the wildlife area south of Pawley's Island. The Trident District, composed of Charleston, Berkeley and Dorchester Counties, contains all of Charleston harbor and its periphery, plus the oyster and wildlife area in the vicinity of Cape Romain. The Lowlands Planning and Development District, in the south, consists of Colleton, Beaufort, Jasper and Hampton Counties, and thus is coincident with most of the St. Helena-Port Royal estuarine use region south of Edisto Island to the Savannah River.

For planning and management purposes, therefore, it is probably most practical to think of the South Carolina coastal zone in three areas: 1) the Waccamaw area; 2) the Charleston metropolitan area; and 3) the St. Helena-Port Royal area.* The Waccamaw area is already heavily committed to a tourist-oriented recreational use of its coastal resources and it is probably impractical to consider major alterations in resource use in that area. Likewise, it is unlikely that urbanization can be reversed in the Charleston area, although there are still options as to the type and level of use of estuarine resources in the Charleston vicinity. The St. Helena-Port Royal area, on the south, has open a wide range of options on resource use and can be managed as either a natural estuarine area or developed for intensive economic operations. Since the options for large-scale planning and management seem most viable in the Charleston and St.

*As part of this project, an effort was made to delineate geographic management units in the coastal zone using commuter patterns. At its lowest level of aggregation, this attempt grouped Georgetown and Horry Counties into one area and Charleston, Berkeley, Colleton, Beaufort and Jasper Counties into another. Since the analysis did not consider the attraction of Savannah, Georgia on the southern coastal counties, it failed to separate the St. Helena-Port Royal area as a separate unit. See Hall and Hite [8, p. 151].

Helena-Port Royal area, the analysis of the economic and environmental aspects of alternative resource uses reported in this study will concentrate in these latter two areas.

Chapter III

THE PLANNING MODEL

Background of Economic-Ecologic Models

Scientists have been attempting the construction of mathematical models of both physical and social phenomena for many years. But it was the advent of the computer that made large-scale models practical as tools for rational planning and policy analysis. Perhaps the first attempt at modeling the interface between an ecologic and an economic system was the pioneering work sponsored by the Federal Water Quality Administration for the Delaware Estuary [For details, see 20]. The Delaware model uses the Streeter-Phelps oxygen balance equations along with a linear programming format to find minimum costs of a range of different water quality targets.

Since the late 1960's the literature of economics began to be enriched by several articles describing conceptual approaches to a broader type of economic-ecologic planning model than that represented by the Delaware Model. Notable among these were papers by Cumberland [5], Isard [12], Ayres and Kneese [2] and Leontief [16]. All of these approaches envision essentially linear systems. Perhaps the most comprehensive of the conceptual models is the one suggested by Isard which has been empirically implemented on small scale in a study of Plymouth Bay,

In general form, the Isard model may be represented visually by the diagram in Figure 1. Materials are removed from the natural environment and processed by industries and households, then discharged back into the environment where they are again used in ecologic processes. In some cases, these residuals constitute enrichment for the natural environment, stimulating growth and reproduction; in other cases, the residuals constitute pollution, destroying or impeding ecologic processes.

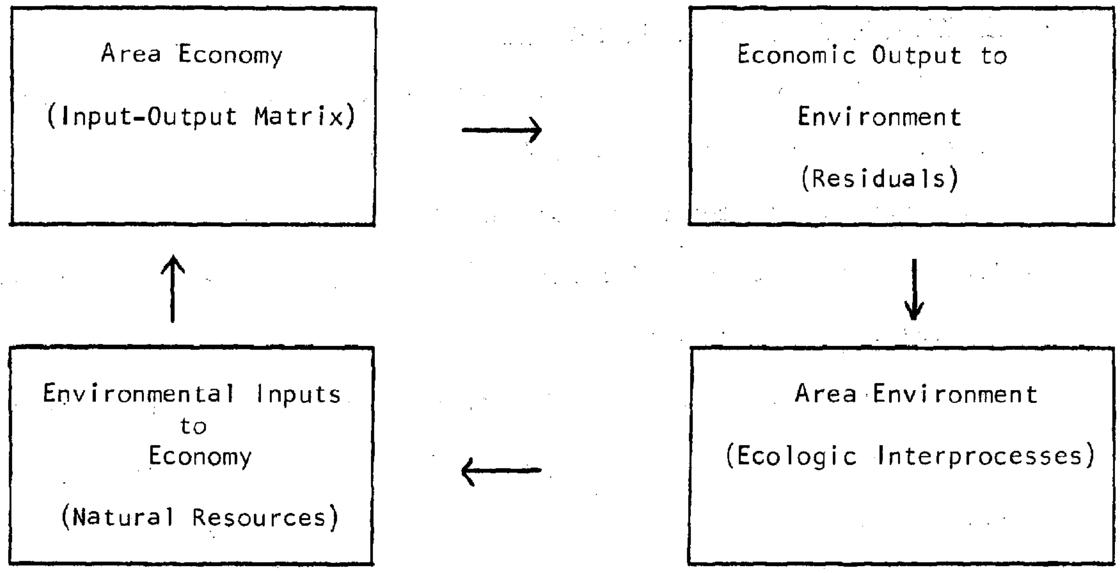

Figure 1. Generalized Economic Linkages Model

The Isard model has two fundamental limitations as a practical planning tool. (1) It requires a matrix completely describing all of the interrelated processes that take place within the eco-system under consideration. This requirement necessitates an extreme disaggregation of environmental resources. For example, in the Plymouth Bay study, Isard found it necessary to attempt to quantify the various components of the food chain for winter flounder in order to develop inputs for commercial fisheries sector. The broad nature of the model makes this extreme disaggregation difficult to avoid. Though the disaggregation of environmental resources may be conceptually desirable, the Isard model requires enormous amounts of quantitative environmental data which are difficult, if not impossible, to obtain. (2) As with all input-output models, the Isard model is a linear system. Unfortunately, there are ecologic relationships that do not exhibit linearity. In an attempt to minimize this problem, Isard considered these non-linear processes separately in the Plymouth Bay study /‾13_7; but the necessity to consider the non-linear relationships outside the model restricts the model's capabilities as a planning tool.

A Modified Model

Many of the problems of the Isard model appear to stem from its all-encompassing nature. Although ecologic inputs into any economic system can be examined at many levels of aggregation (e.g., land, hard marsh, soft marsh), many planning problems do not require such detailed identification. The only ecologic processes of interest in economic analysis are those that have specific linkages to the economic system. Hence, the Isard model can be modified to provide a simple, more practical planning tool by concentration only on those processes of particular interest or for which data are available.

Figure 2 represents a simplified version of a modified Isard model. Like the more comprehensive Isard model, it assumes a linear system and constant coefficients, but the ecologic interprocesses portion of the Isard model has been deleted. Matrix A, in the upper left-hand corner, is an area interindustry, or input-output matrix. Matrix E, in the upper right-hand corner, is the ecologic exports matrix containing data on selected residuals outputs of the various sectors of the area economy. In the lower right-hand corner, Matrix F shows the imports of selected natural resources by the area economy. Operationally, the modified model allows greater flexibility in specifying the number and type of residuals and natural resource imports which will be analyzed, and, thus, the data problems are greatly reduced.*

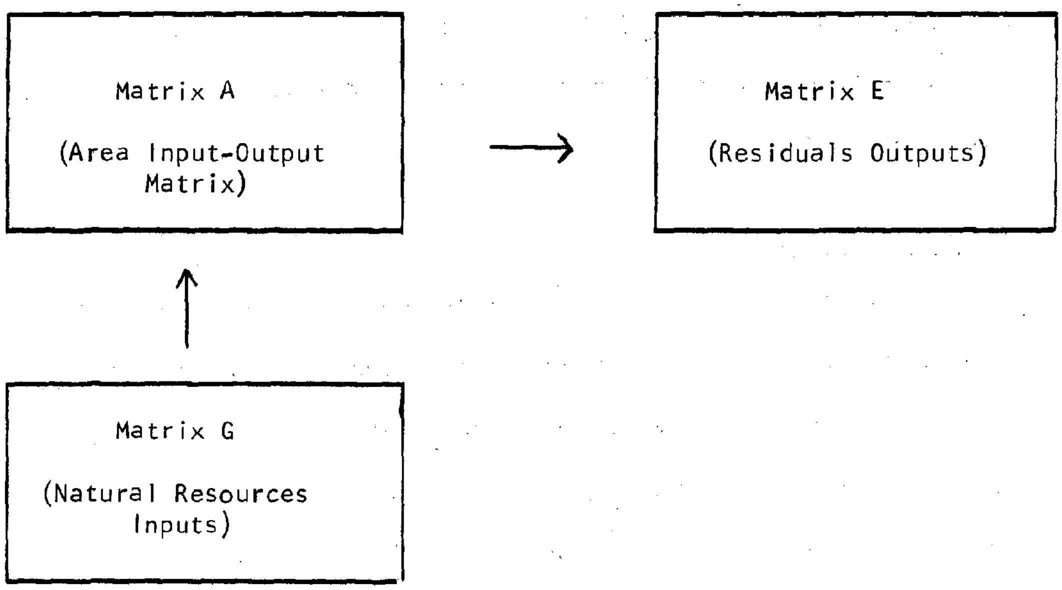

Figure 2. A Modified Economic-Ecologic Linkages Model

For purposes of simplifying mathematical manipulation of the model, a further modification can be made. Matrix E, the residuals matrix, can be incorporated into Matrix G, and the residuals can be conceived as negative imports. That is, the elements of the Matrix G are given negative signs and included in Matrix E. This modification causes no loss in the information that can be derived from the model and greatly facilitates the matrix algebra necessary to obtain useful results from the model.

With these modifications, the model used in this study contains two essential elements: (1) the Leontief inverse of an input-output matrix of the area economy, and (2) a matrix showing the natural resource inflow from the environment and the residuals outflow to the environment

*For a more complete treatment of the model, see [15, pp. 14-21].

associated with one dollar of gross output of each sector in the input-output matrix. Inflows from the environment are given a positive sign and residuals outflows are given a negative sign. The basic mathematical operation involves post-multiplying the environmental linkages matrix by the Leontief inverse:

$$(E)\ (I-A)^{-1} = (R)$$

where

E is a matrix of order m x n, showing inflows to and outflows from the economy to the environment,

$(I-A)^{-1}$ is the Leontief inverse of an area input-output matrix of order n x n, and

R is a matrix of the direct and indirect environmental impact per dollar of deliveries to final demand of each economic sector.

Although, by ignoring the ecologic interprocesses where an assumption in linearity may be especially troublesome, the model described above avoids some of the pitfalls of the Isard model, it does not avoid the prevailing assumption of linearity. All coefficients are constant and are based on averages. Consequently, the model requires an assumption that the same quantities of inputs and outputs are required to the one-millionth dollar of output as are required to produce the first dollar of output. Such a general assumption is patently unrealistic, and estimates based on this assumption cannot be interpreted as highly accurate. Care in detailed design of the empirical versions of such a model can do much to minimize the imprecision of estimates, but the results must be estimates containing some indefinable degree of error.

The Model and Export Base Theory

A model such as that described requires that some purchasing sector (or sectors) of the economy be designated as representative of final demand, the ultimate user and autonomous force in activitating the economy. In some forms of the model, households and governments are designated as final demand sectors. In the Laurent-Hite model used in the study, area exports (i.e., sales by area firms to customers located outside the area) are considered the final demand. The model, therefore, is based essentially on the export base theory of regional economic growth and development.

Export base theory holds that a region's growth is a function of the level of its sales to customers outside the region. Sales to customers inside the region are induced by the income occurring to the region from its export sales and, thus, are dependent upon these export sales. For a region to grow, therefore, it must increase its regional exports. Export base theory is not entirely satisfactory in explaining regional economic growth. The world, as a whole, does not export, yet it has experienced economic growth over time.

The level of exports cannot be considered highly important in stimulating economic growth in the United States at large. On the opposite extreme, however, the level of income derived from the outside sale of labor by a household is extremely important to the economic well-being of that household. In general, the smaller the region, in terms of either geographic boundaries or diversity of economic activities, the greater the applicability of export base theory. Most of the coastal zone consists of economic areas which are relatively small and more or less specialized, therefore a model based on export base theory should not be inappropriate.

Chapter IV

EVALUATION OF DEVELOPMENT ALTERNATIVES

Study Areas

The discussion in Chapter II noted that the major future conflicts over coastal zone resource uses were likely to be centered in the Charleston metropolitan and the St. Helena-Port Royal Sound (particularly Beaufort County) areas. Consequently, the analysis of development alternatives undertaken in this project was confined to those two areas.

Both the Charleston and Beaufort County areas have special economic and environmental problems. Both areas are currently heavily dependent upon military activities as an economic base. In 1968, 54.0 percent of the gross sales in the Charleston area was, directly or indirectly, due to military activities in the area [11, p. 18] to account, directly or indirectly, for 56 percent of the gross sales in Beaufort County in 1969 [9, p. 13]. As a consequence of this dependence on military activities, which are inherently unstable and politically sensitive, the economy of both areas is potentially subject to major shocks resulting from changes in the level of the defense budget or the location of military bases. In the Beaufort area, particularly, the heavy dependence on Impacted Area Funds, accruing to the school budget as a result of the military presence, makes local educational services highly vulnerable to changes in the level of local military activities. In both the Charleston and Beaufort areas, per capita income is less than 70 percent of the national average. Each of these areas, therefore, needs to diversify and strengthen its economic base in order to expand job opportunities and increase its tax base. The question facing local planners and public administrators, however, is how can such development be achieved with minimal damage to the environment.

Note on Quality of Data

Two efforts at empirical implementation of the model discussed in Chapter III have been attempted. A 28 sector input-output matrix was developed from survey data for the three-county Charleston metropolitan area and used in conjunction with an environmental matrix containing 16 types of inflows and outflows [16]. The data for the environmental matrix was also primarily obtained from a survey of area business and industrial firms, but supplemented by data collected earlier by Stepp [25] and by air pollution data compiled by Duprey [7]. A 20 sector input-output matrix for Beaufort County was also constructed using survey data. The resulting matrix was then mated with a modified version of the same environmental matrix developed for the Charleston area [9].

One important problem arising from the data used in evaluating development alternatives is associated with the classification of the various types of economic activity. Much of the data used in developing the input-output matrices for Charleston and Beaufort were obtained by survey of business and industrial firms. Each firm was promised that data would be reported in such a way as to avoid identification of particular firms. If one large firm dominated some sector of the economy, it was necessary to combine sectors to avoid disclosure of information from an individual firm. The activity, lumber and wood products manufacturing, for example is defined to include pulp and paper operations. In most cases, the definition of a sector will be rather obvious, but the reader who desires a precise definition should consult Laurent and Hite [15, pp. 27-28].

Secondly, the data in the environmental matrix used in this analysis must be considered. As part of the survey of business and industrial firms in the Charleston area, questions were asked concerning water usage, five-day BOD output, and solid waste resulting from each firm's operations. These data constitute the basic core of information used to calculate the coefficients necessary for the environmental matrix. As noted above, these survey data were supplemented where necessary by resort to secondary sources. The environmental matrices used in implementation of the model in both the Charleston and Beaufort areas were identical except for certain reductions in the size of the Beaufort matrix required by the reduced number of sectors in the Beaufort input-output matrix. These data in the environmental matrix must be considered as somewhat imprecise estimates representative of the existing level of waste treatment in the area. In many cases, there was little or no treatment of waste in the Charleston area. Concern over environmental pollution and the advent of higher standards for waste treatment will almost certainly have the effect of reducing the levels of pollution associated with particular levels of economic output at Charleston or Beaufort. Consequently, the estimates reported in the analysis which follows are probably high if applied to new industrial facilities. The inverse of the input-output matrices and the environmental matrix are presented in Appendix Tables 1-3.

Basic Empirical Results

Examples of the basic results obtained from the two empirical case studies are shown in Table 1. This table shows examples of both the direct emissions and the total (direct and indirect) emissions resulting from the delivery of the dollar of output to final demand for some selected sectors in Charleston and Beaufort. One of the most notable features of

Table 1. Selected Direct and Total (Direct and Indirect) Residuals Emissions per Dollar of Deliveries to Final Demand. Selected Sectors, Charleston and Beaufort Areas, South Carolina, 1968-69

	Particulates (lbs/yr)			5-Day BOD (lbs/yr)		
		Total			Total	
Sector	Direct	Charleston Area	Beaufort Area	Direct	Charleston Area	Beaufort Area
Food & Kindred Products	0	.0261	.0040	.3264	.3413	.4559
Textiles & Apparel	0	.0231	.0060	.3834	.4148	.6012
Lumber & Wood Products	1.2887	1.2887	1.2808	1.3501	1.3566	1.4324
Chemicals	0	.0191	.0336	.1062	.1322	.2206
Tourism	.0134	.0390	.0176	0	.0364	.1202

this table is that even those sectors which do not show direct emissions into the environment are indirectly responsible for rather significant emissions. Food and kindred products manufacturing for example, accounts for no significant direct emissions of particulates into the atmosphere, yet, because of that sector's supply linkages with other types of economic activities which do account for particulate emissions, expansion of the sales of food and kindred products to final demand will indirectly increase the atmospheric particulates in both the Charleston and Beaufort areas. If, however, the food and kindred products industry purchased all its inputs from firms outside the Charleston or Beaufort areas, the indirect particulate pollution would be exported and the local area would not experience increased emissions of this residual. Hence, since the Beaufort area is much smaller geographically and less diverse economically, a larger proportion of the inputs for most sectors are purchased outside the area and the total emissions resulting from one dollar expansion in sales to final demand is less than for the Charleston area. In the case of BOD residuals, however, the total (direct plus indirect) emissions are greater at Beaufort than at Charleston for the five sectors being analyzed. Local purchasing patterns, therefore, can affect the level of these total emissions, and industrial development in a small geographic area may produce more total emissions than the same type of development in a larger area when there are relatively large local supply linkages to "dirty" industries in the smaller area. Local interindustry linkages and the unique structure of each local economy is extremely important in determining the total impact on the environment of specified types of economic development.

An Expanded Model

The basic model discussed above can be expanded with relatively little effort to produce additional impact estimates which may be useful to development groups and planners. One approach is to expand the E matrix to include coefficients on personal income, number of jobs, and tax revenues per dollar of gross sales for each sector in the input-output matrix. Tables 2 and 3 illustrate the results produced by such an expanded model applied to comparable sectors in the Charleston and Beaufort areas. Following export base theory, sales to customers located outside each of the areas are considered autonomous and designated as deliveries to final demand. The estimates presented in Tables 2 and 3, therefore, are premised on an expansion of selected sectors by 100 workers, all of whom are assumed to produce surplus goods (or services, in the case of tourism) for sale to non-local customers.

The use of 100 workers as the unit of analysis presented some problems in connection with the export base theory embodied in the Hite-Laurent model, however. In the Beaufort area, almost all of the output of workers in manufacturing activities will be sold to customers outside the county since there are no large urban areas in the county and consequently no major local markets for this output. Some manufacturing activities at Charleston, however, currently serve as primarily residential, or local service, industries, and produce primarily for the local market. For example, in 1968, the food and kindred products manufacturers at Charleston sold 63 percent of their output back to other Charleston area customers, and textile and apparel manufacturers sold almost 42 percent of their output locally [11, p. 6]. Consequently, a large portion of the output of 100 workers in many Charleston activities will be sold locally

Table 2. Projected Effects of 100 "Export" Jobs in Five Types of Economic Activities on the Charleston (S.C.) Metropolitan Area Economy, 1968

Type of Impact	Given 100 "Export" Workers in:				
	Food & Kindred Products	Textiles and Apparel	Lumber and Wood Products	Chemicals	Tourism
Total Sales ($)	2,088,400	2,694,600	2,433,100	3,001,000	2,984,100
Total Personal Income ($)	1,123,400	1,642,200	1,262,900	1,797,500	1,943,400
Total Number of Jobs	125	136	124	143	149
Local & County Taxes ($)	12,900	77,100	15,300	35,000	22,000
State Taxes ($)	92,500	138,100	154,500	120,100	175,500
Particulates (lbs/yr)	19,200	18,100	1,561,700	21,600	42,500
SO_2 (lbs/yr)	6,200	6,000	4,500	5,600	16,000
5-Day BOD (lbs/yr)	250,900	324,400	1,644,100	149,300	39,800
Solid Waste (cu yds/yr)	900	2,200	153,000	2,500	4,000

SOURCE: Computed using the Hite-Laurent model and output levels reported in Appendix Table IV.

Table 3. Projected Effects of 100 "Export" Jobs in Five Types of Economic Activities on the Beaufort County (S.C.) Economy, 1969

Type of Impact	Given 100 "Export" Workers in:				
	Food & Kindred Products	Textiles and Apparel	Lumber and Wood Products	Chemicals	Tourism
Total Sales ($)	1,030,800	1,895,900	2,003,100	2,157,700	2,309,500
Total Personal Income ($)	679,400	1,147,200	982,800	1,288,600	1,493,600
Total Number of Jobs	111	119	114	118	126
Local & County Taxes ($)	5,100	71,200	11,800	27,000	12,500
State Taxes ($)	65,900	113,800	138,400	94,800	151,400
Particulates (lbs/yr)	2,900	4,700	1,552,200	4,100	19,200
SO_2 (lbs/yr)	4,600	3,500	3,500	3,900	17,300
5-Day BOD (lbs/yr)	335,100	470,200	1,736,000	249,300	131,100
Solid Waste (cu yds/yr)	3,500	6,900	156,300	5,400	7,600

SOURCE: Computed using the Hite-Laurent model and output levels reported in Appendix Table IV.

and cannot be considered autonomous. In this analysis, concern is focused on development alternatives which expand the economic base, i.e., export sales. Application of the fixed coefficients from the 1968 input-output matrix to a situation which postulates considerable expansion of output for export to other areas, especially in the cases of sectors that were selling in 1968 a large part of their output locally, will cause gross increases in the size of the local multipliers. To adjust the model in order to make it consistent with the assumption that the output of these 100 new workers would all be exported, the model was implemented sequentially with a different row in the input-output technical coefficients matrix reduced to zeroes in each implementation. Such an adjustment had the effect of assuming that the sector represented by the row reduced to zeroes was selling none of its output locally. Since the columns in the input-output technical coefficients matrix were not changed (except in the cases where the columns intersected the particular row being reduced to zeroes), the operation had the further effect of assuming that buying patterns did not change as particular industries expanded their export sales.

Results of the Analysis

The results of implementation of the expanded model, adjusted as noted above, are shown in Tables 2 and 3. In general, since the Charleston area is more self-contained and has fewer economic linkages than the Beaufort area, one would expect the local impact of expanding most economic sectors by 100 "export" workers would be greater at Charleston than at Beaufort. The nature of the industry and local conditions are very important, however, in determining the relative size of the local impact. Comparison of Tables 2 and 3 reveals, for example, that in every case, the economic impacts (as estimated in the first five rows of each table) of expansion of five basic industries by 100 new export workers will likely be greater in the Charleston area than in the Beaufort area. For example, if one excludes the initial 100 workers which are assumed to be directly employed by the expansion of any particular industry, one will note that the induced employment (number of jobs over 100) averages about 50 percent greater at Charleston than at Beaufort.

Comparison of environmental impacts at Charleston and Beaufort, as shown in Tables 2 and 3, reveals a somewhat mixed picture. In general, as might be expected, the environmental impacts at Beaufort are lower than at Charleston. There are three exceptions to that generality, however: (1) sulfur dioxide emissions from tourism are about 8 percent higher at Beaufort than at Charleston (largely as a result of greater usage of automobiles in Beaufort tourism); (2) BOD emissions for all five sectors are higher at Beaufort than at Charleston; and (3) solid waste emissions for all five sectors are higher at Beaufort than at Charleston. Again, these latter two cases are explained by local buying patterns at Beaufort which result in more local purchases from relatively "dirty" industries per dollar of output than occur at Charleston.

Adaptation of a Linear Programming Model

Model Formulation

Although the information reported in Tables 2 and 3 might be used in its raw form as an input into planning decisions, this information might also lend itself to use in a linear programming model. Linear programming is essentially a mathematical technique for maximizing or minimizing some variable, given a set of constraints which must be met [23].

Thus, linear programming might be used to determine the optimum mix of industries in the coastal zone of South Carolina, given that the goal was to minimize pollution, subject to a set of economic constraints relative to minimum allowable levels of income, jobs, tax revenues, etc. The information reported in Tables 2 and 3 could be used to obtain the coefficients necessary for writing such a linear programming model.

Suppose, for example, it was decided that the planning goal for the South Carolina coastal zone was to minimize the 5-day BOD emissions. We could write an objective function to be minimized based on information in line eight of Tables 2 and 3. Obviously, the easiest way to minimize the BOD residuals in the coastal zone would be to declare the whole area off limits to all types of economic activity. But such an easy course of action begs the question because the coastal zone of South Carolina is populated and that population must earn a livelihood. Consequently, we will probably want to minimize BOD residuals subject to some constraints. If we desire to place a floor under personal income in the coastal zone, we can use information from line two in Tables 2 and 3, if we desire to assure full employment, we can obtain information from line three, and if we desire to hold tax revenues to some minimum level, we can use information from lines four and five. Thus, Tables 2 and 3 give us the information we need to write a linear programming model for obtaining an optimum mix of industries in the Charleston and Beaufort areas.

One practical linear programming model for the coastal zone might be to minimize total BOD residuals, subject to:

(1) generation of enough jobs to fully employ the labor force in both the Charleston and Beaufort areas,

(2) generation of enough personal income to bring per-capita income in the two areas up to the national average,*

(3) generation of enough local and county tax revenue to adequately support local services, and

(4) assurance that no existing industry would be shut-down or forced to cut back its employment.

With only a few pieces of additional data on population, per-capita incomes, etc., there is enough information in Tables 2 and 3 to write such a linear programming problem.

But the actual writing of equations for constraints 2 and 3 poses some problems. These constraints must be dynamic. In constraint 2, for example, the total personal income must be great enough to yield the national average per-capita income when divided by the local population. If the total number of jobs created exceed the local labor supply, one would assume in-migration which will raise the local population. Thus, as the population increases, the total amount of personal income must also increase if per-capita income in the area is to be at least equal to the national average. Given that we know that about one person out of every 3.874 in the local population in the Charleston and Beaufort areas is a member of the labor force, and that the national per-capita income in 1969 was $3,676, constraint 2, written as inequalities (one each for Charleston and Beaufort areas) then become:

$$1{,}123{,}400X_1 + 1{,}642{,}200X_3 + 1{,}262{,}900X_5 + 1{,}797{,}500X_7 + 1{,}943{,}400X_9 \geq 3{,}676\left[3.874(125X_1 + 136X_3 + 125X_5 + 143X_7 + 149X_9)\right]$$

and

$$179{,}400X_2 + 1{,}147{,}200X_4 + 982{,}800X_9 + 1{,}288{,}600X_8 + 1{,}493{,}600X_{10} \geq 3{,}676\left[3.874(111X_2 + 119X_4 + 114X_6 + 118X_8 + 126X_{10})\right],$$

*This is the Coastal Plains Regional Commission's goal for the eastern portion of the two Carolinas and Georgia.

where:

X_1 = Hundreds of workers employed in food and kindred products at Charleston,

X_2 = hundreds of workers employed in food and kindred products at Beaufort,

X_3 = hundreds of workers employed in textiles and apparel at Charleston,

X_4 = hundreds of workers employed in textiles and apparel at Beaufort,

X_5 = hundreds of workers employed in lumber and wood products (including pulp and paper) at Charleston

X_6 = hundreds of workers employed in lumber and wood products (including pulp and paper at Beaufort,

X_7 = hundreds of workers employed in chemicals at Charleston,

X_8 = hundreds of workers employed in chemicals at Beaufort,

X_9 = hundreds of workers employed in tourism at Charleston, and

X_{10} = hundreds of workers employed in tourism at Beaufort.

Then, simplifying these inequalities, we get:

$$-656{,}887X_1 - 294{,}684X_3 - 503{,}050X_5 - 239{,}004X_7 - 178{,}387X_9 \geq 0$$

and

$$-901{,}280X_2 - 547{,}436X_4 - 641{,}992X_6 - 391{,}331X_8 - 300{,}288X_{10} \geq 0$$

Upon examination of these inequalities, the reader familiar with only basic mathematics will realize that it is impossible for the sum of a series of negative numbers to be equal to or greater than, zero. Consequently, we must conclude that the income constraint which we wish to impose is not realistic. The five basic industries being examined in this study cannot bring per-capita income in the Charleston and Beaufort areas to the national average, regardless of how large their activities are allowed to become. As a group, these industries use relatively large amounts of labor (thus requiring a relatively large population to supply labor) and relatively low amounts of income. A similar mathematical exercise concerning constraint 4 will yield the same conclusion.*

Although it is not feasible to include constraints on income and tax revenues in the linear programming model suggested above, there are no special difficulties associated with constraints 1 and 4. It may be useful to continue development of the model with these constraints. Accordingly, a linear programming problem was formulated so that we:

Minimize: $\emptyset = 250{,}900X_1 + 335{,}100X_2 + 324{,}400X_3 + 470{,}200X_4 + 1{,}644{,}100X_5 + 1{,}736{,}000X_6 + 149{,}300X_7 + 249{,}300X_8 + 39{,}800X_9 + 131{,}100X_{10}$

Subject to:

(1) $125X_1 + 136X_3 + 124X_5 + 143X_7 + 149X_9 \geq 58{,}763$
(2) $111X_2 + 119X_4 + 114X_6 + 118X_8 + 126X_{10} \geq 13{,}200$
(3) $X_1 \geq 16.00$
(4) $X_2 \geq 3.50$
(5) $X_3 \geq 33.64$
(6) $X_4 \geq 2.50$
(7) $X_5 \geq 43.36$
(8) $X_6 \geq 1.00$
(9) $X_8 \geq 1.00$
(10) $X_{10} \geq 6.92$

where:

$\emptyset$ = Total 5-day BOD emissions in both the Charleston and Beaufort areas and all other notation is as previously defined.

The first two inequalities in this problem require that the total number of jobs created in the Charleston and Beaufort areas be at least

*Constraint 4 was formulated to assure that one-half of annual local tax revenues would be great enough to allow local governments to spend the South Carolina state average on per-pupil school expenditures.

equal to the labor forces in the two areas, respectively. The last eight inequalities require that no current activity in the two areas, except Charleston area chemicals and tourism at Beaufort, be reduced to lower than current level of employment. Charleston area chemicals were omitted from these constraints because most of the existing facilities at Charleston are old and somewhat antiquated, so that these facilities could be gradually closed without sacrifice of significant fixed assets. Tourism at Beaufort was omitted because it produces relatively low amounts of BOD per worker and was considered likely to be included in an optimum solution at a level of about current employment.

The solution to this linear programming problem is shown in Table 4. Tourism emerges as the major employer in both areas in this optimum solution; 31,417 persons would be employed in tourism in the Charleston area and 9,748 in the Beaufort area. Such a solution is to be expected if one observes in Tables 2 and 3 that tourism produces the least BOD per hundred workers inducing the greatest number of outside jobs of any of the five alternatives. All the other activities are shown in Table 4 at the levels required by inequalities 3-10 in the mathematical formulation of the problem.

Evaluation of Results

Table 5 shows the economic and environmental ramifications of the optimum solution presented in Table 4. Line 3 in Table 4 shows that per-capita income in both areas is below the national average, but perhaps the most striking feature of Table 4 is that per-capita income in Beaufort County is about one-third greater than at Charleston in the optimum solution. Since the military activities were not considered as alternatives in the linear programming problem, per-capita income at Charleston

Table 4. Optimum Employment to Minimize BOD Subject to Full Employment and Existing Size of Industry Constraints for Five Selected Basic Activities, Charleston and Beaufort Areas, South Carolina, 1968-1969

Activity	Employment at: Charleston (3 County Area)	Employment at: Beaufort County
	- Workers -	
Food & Kindred Products	1,600	350
Textiles & Apparel	3,364	250
Lumber & Wood Products	4,336	100
Chemicals	-	100
Tourism	31,417	9,748

SOURCE: Computed by linear programming.

Table 5. Economic and Environmental Ramifications of Linear Programming Solution of Optimum Industry Mix, Charleston and Beaufort Areas, South Carolina, 1968-1969

Type of Impact	Charleston Area	Beaufort County
Total Sales ($)	1,167,074,700	211,318,800
Total Personal Income ($)	738,535,300	153,113,400
Per Capita Income ($)	2,000	3,000
Total Number of Jobs	58,763	13,200
Local & County Taxes ($)	10,375,200	1,453,200
State Taxes ($)	67,958,300	15,506,800
Particulates (lbs/yr)	81,983,600	3,449,800
SO_2 (lbs/yr)	5,522,900	1,718,700
5-Day BOD (lbs/yr)	98,719,400	17,113,300
Solid Waste (cu yds/yr)	7,979,200	932,000

SOURCE: Computed by use of data in Tables 2-4.

in the optimum solution is actually about $300 less per year than the per-capita income prevailing at Charleston in 1968 [11, p. 24]. Total sales at Charleston is also lower in the optimum solution than the 1968 level; the 1968 level was $2,232,000,000, the optimum solution level is $1,167,074,000. Per-capita income in the Beaufort area is about $450 per year greater in the optimum solution than the 1969 per-capita income in that county [9, p. 12], although even at Beaufort, total sales are reduced by the optimum solution from the estimated 1969 level of $245,972,000 [9, p. 13]. It is apparent, therefore, that any policy designed to minimize BOD residuals, constrained only by a requirement that the labor force be fully employed, will require a considerable reduction in the level of economic activity at Charleston and a slight reduction in the level of economic activity at Beaufort. Moreoever, it is also apparent that such a policy will reduce per-capita income in the Charleston area.

School expenditures normally take up to as much as one-half of local tax revenues in South Carolina. The statewide average expenditure per pupil in South Carolina in 1969-1970 was $214 [9, p. 8]. If we allocate one-half of line 4 in Table 4 (Local and County Tax Revenue) for schools and divide by the number of public school pupils in each of the two areas, we will see that the optimum solution determined from our linear programming problem produces only about $70 per year per pupil. Of course, local governments could spend more than one-half of their tax revenues on schools, but to do so they would be forced to cutback on other services. Even if all of the local and county tax revenues in these two areas were spent on schools, however, the linear programming solution would provide only about $140 per pupil per year, a figure far short of the statewide average. Thus, it appears that a policy aimed at minimizing

BOD residuals consistent with full-employment will force drastic cutbacks in local expenditures for education in the Charleston and Beaufort areas.

The burden of the analysis in the two paragraphs above is that policy regulating discharge of emissions into the coastal zone of South Carolina must consider a wide range of economic constraints. Full employment is a legitimate goal, but other economic criteria must also be considered. The existing economic base is not strong enough to raise per-capita incomes to the national average, or to raise per-pupil school expenditures to the statewide average, even when no environmental factors are considered. In the long-run, that economic base can be broadened and strengthened. But in the short-run, policy aimed at minimizing BOD emissions (and probably other types of residuals) will necessitate considerable economic sacrifice.

Chapter V

SUMMARY AND CONCLUSIONS

Summary of the Research

This report presents the result of an effort to develop procedures for the economic evaluation of alternative uses of the resources of the coastal zone of South Carolina. The research embodied in tnis report was divided into four phases: (1) an attempt was made to identify and delineate suitable planning units in the coastal zone; (2) a modified input-output model was developed to examine the economic and environmental repercussions of various types of economic activity; (3) the input-output model was applied to the Charleston and Beaufort areas of the South Carolina coastal zone; and (4) the input-output model was extended, using linear programming, to examine the implications of one particular policy alternative.

This project has produced two distinct kinds of results. It has shed new light on the technical problems associated with evaluating the economic and environmental impacts of various types of economic development. It has also given us some additional insight into the kinds of policy alternatives available for the management of estuarine resources in South Carolina and some of the limitations on such policy. The former type of results are largely technical in nature and are of primary interest to other researchers. They have been summarized and reported in other places (see the listing on page ii) and will not be further discussed here. Rather, we will discuss the implications of the results of this project for estuarine management policy and planning.

Conclusions

Perhaps the most important point documented by this research is the conflict between area economic well-being, as measured by per-capita income, number of jobs, and tax revenues, and environmental quality, as measured by outputs of residuals into the eco-system. Although all the analysis in this report is based on waste treatment technology which may be antiquated, it is clear that economic activity will produce waste and that waste must eventually find its way back into the environment. The only way to have a "natural" estuarine system in the coastal zone of South Carolina is to exclude economic activity from that zone. Since there are people living in the coastal zone of South Carolina, and since those people must have a source of livelihood, excluding economic activity from the estuarine areas will require moving the current population to the interior. Such a drastic remedy is not realistic. Therefore, coastal zone resource management must be based on allowance of some tolerable levels of waste emissions into estuarine eco-systems. The real question is: What kinds of economic activities will give us the minimum level of environmental damage while providing necessary economic support for the residents of the coastal areas and the people of the State? This research has not answered that question, but it has made a start toward an answer.

Although economic activity cannot be realistically excluded from all of the coastal zone, it does not follow that it cannot be excluded from any area along the coast. This report has shown that there are areas on the South Carolina coast which are sparsely populated and which are still in something approaching a natural state. A zoning policy which serves to set some of these areas aside would appear to be feasible and desirable. But zoning is an "either or" proposition; it does not provide any means for regulating the mix and size of activities within a particular use zone. We have shown, for example, that food processing industries produce smaller quantities of environmental residuals per dollar of income, or per job, than do wood, pulp and paper industries. Yet, if zoning is the sole management tool, it may not be possible to exclude the relatively "dirty" industries from industrial zones. A permit system, used in conjunction with a zoning system, however, could provide the added control needed to regulate the mix and size of the various types of economic activities to be allowed in selected coastal areas such as Charleston and Beaufort.

Under a zoning and permit system, certain areas would be declared off-limits to further economic development. Other areas would be zoned for residential developments, for tourist and recreational developments, for agriculture and for manufacturing. The tools developed in this research project could be used to assess how much of each type of use area was needed to meet economic objectives. Persons seeking to make use of these areas for the purposes to which they were set aside would apply for a permit. In the application, they would spell out the details of their proposal, including the type of activity being proposed and its approximate size. This application would then be evaluated relative to the overall plan of development for the coastal area.

Suggestions for Further Research

Before such a management system can be implemented, we will need to know more than we know now about what additional types of economic activities should be allowed to develop in the coastal areas of South

Carolina. We have shown in this research that if the military is excluded from the economic base, the current mix of activities cannot provide local tax revenue needed to support the public schools at a level consistent with the statewide average per pupil expenditure of local governments. Neither can these activities be used to bring per-capita incomes in the coastal areas in line with the national average. New types of activities are needed, but further research must be undertaken to determine which activities will produce the greatest economic returns with the least environmental costs. Once determined, these activities must be evaluated to determine if the coastal areas of South Carolina have locational advantages for attracting them.

REFERENCES CITED

1. Adams, David A., "Management Systems Under Consideration at the Federal-State Level," in J. C. Hite and J. M. Stepp, editors, Coastal Zone Resource Management, New York, Praeger Publishers, 1971.

2. Ayres, Robert V. and Allen V. Kneese, "Production, Consumption and Externalities," American Economic Review, 59 (July 1969), pp. 284-285.

3. Bridenbaugh, Carl, Cities in Revolt, Urban Life in America, 1743-1776, New York, Alfred A. Knopf, 1955.

4. Carroll, B. R., editor, Historical Collection of South Carolina, Volume I, New York City, Harper and Brothers, 1836.

5. Cumberland, John H., "A Regional Interindustry Model for Analysis of Development Objectives," The Regional Science Association Papers, 17 (1966), pp. 65-94.

6. Dukes, Gene W., and James M. Stepp, South Carolina Laws, Policies, and Programs Pertaining to Water and Related Land Resources, Water Resources Research Institute in cooperation with South Carolina Agricultural Experiment Station, Clemson University, Clemson, South Carolina, 1968.

7. Duprey, R. L., Compilation of Air Pollutant Emission Factors, U. S. Department of Health, Education, and Welfare, National Air Pollution Control Administration, Durham, North Carolina, Public Health Service Publication No. 999-Ap-42, 1968.

8. Hall, W. W., Jr., and J. C. Hite, "The Use of Central Place Theory and Gravity-Flow Analysis to Delineate Economic Areas," Southern Journal of Agricultural Economics, 2 (December 1970), pp. 147-153.

9. Hite, J. C., W. W. Hall, Jr., J. M. Stepp and others, Economic and Environmental Evaluation of Development Alternatives for Beaufort County, South Carolina, Water Resources Research Institute, Clemson University, Clemson, South Carolina, Special Report, June 1971.

10. Hite, J. C., and J. M. Stepp, Economic Analysis of the Development Potential of the Commercial Fisheries of the Coastal Plains Region, South Carolina Agricultural Experiment Station in cooperation with the Coastal Plains Regional Commission, Clemson University, Clemson, South Carolina, AE 319, January 1969.

11. Hite, James C. and Eugene A. Laurent, The Structure of the Charleston Area Economy: An Input-Output Study, South Carolina Agricultural Experiment Station in cooperation with Water Resources Research Institute, Clemson University, Clemson, South Carolina, AE 342, March 1971.

12. Isard, Walter, "Some Notes on the Linkage of the Ecologic and Economic Systems," The Regional Science Association Papers, 22 (1969), pp. 86-87.

13. Isard, Walter, and others, "On the Linkage of Socio-Economic and Ecologic Systems," The Regional Science Association Papers, 21 (1967), pp. 79-99.

14. Knetsch, Jack L., "Economics and Management of Coastal Zone Resources," in J. C. Hite and J. M. Stepp, editors, Coastal Zone Resource Management, New York, Praeger Publishers, 1971.

15. Laurent, E. A., and J. C. Hite, Economic-Ecologic Analysis in the Charleston Metropolitan Region: An Input-Output Study, Water Resources Research Institute, Clemson University, Clemson, South Carolina, Report No. 19, April 1971.

16. Leontief, Wassily, "Environmental Repercussions and the Economic Structure: An Input-Output Approach," The Review of Economics and Statistics (August 1970), pp. 262-271.

17. Lunz, G. Robert, Jr., Special Study of the Marine Fishery Resources of South Carolina, South Carolina State Planning Board, Columbia, Bulletin No. 14, May 1944.

18. Minutes of the Task Force to Plan for Future Development and Improvement of Tidelands and Coastal Waters in South Carolina, South Carolina Water Resources Committee, Columbia, March 1968.

19. Proceedings of the Twenty-Seventh Meeting of the South Carolina Water Resources Commission, Columbia, September 14, 1970.

20. Sobel, M. J., "Water Quality Improvement Programming Problems," Water Resources Research, 1 (Fourth Quarter 1965), pp. 477-487.

21. South Carolina Tidelands Report, South Carolina Water Resources Commission, Columbia, January 1970.

22. Sparkman, Dr. James R., in D. M. Nesbit, editor, Tide Marshes of the United States, U. S. Department of Agriculture, Washington, D. C., U. S. Government Printing Office, Miscellaneous Special Report No. 7, 1885.

23. Spivey, W. Allan, Linear Programming: An Introduction, New York, The MacMillan Company, 1963.

24. The Statistical History of the United States from Colonial Times to the Present, Stamford, Connecticut, Fairfield Publishers, 1965.

25. Stepp, James M., Water Use, Water Treatment, Water Pollution and Related Economic Data on South Carolina Manufacturing Plants, Water Resources Research Institute, Clemson University, Clemson, South Carolina, Report No. 8, August 1968.

26. Waterborne Commerce of the United States, Part I, Waterways and Harbors, Atlantic Coast, Department of the Army, Corps of Engineers, Vicksburg, Mississippi, 1968.

A P P E N D I X

Appendix Table 1. Inverse of Charleston Area, South Carolina, Input-Output Matrix, 1968

	Agriculture, Forestry & Fisheries (1)	Food & Kindred Products (2)	Construction and Mining (3)	Textile and Apparel (4)	Lumber & Wood Products (5)	Furniture and Fixtures (6)	Printers and Publishers (7)
1. Ag. Forestry, & Fisheries	1.1573	.2712	.0177	.0331	.0694	.0411	.0260
2. Food & Kindred Products	.0190	1.1476	.0150	.0169	.0067	.0117	.0161
3. Construction & Mining	.0765	.0627	2.1490	.0977	.0638	.0766	.0912
4. Textiles & Apparel Mfg	.0015	.0034	.0012	1.0133	.0005	.0008	.0016
5. Lumber, Pulp & Paper Prods	.0070	.0063	.0554	.0081	1.0255	.5180	.0079
6. Furniture & Fixtures Mfg	.0015	.0009	.0012	.0012	.0005	1.0008	.0010
7. Printers & Publishers	.0135	.0125	.0107	.0207	.0043	.0074	1.1670
8. Chemical Manufacturing	.0035	.0074	.0175	.0047	.0189	.0118	.0220
9. Petroleum & Coal Mfg	.0003	.0008	.0002	.0002	.0006	.0004	.0002
10. Rubber, Plastic & Related Products	.0035	.0050	.0133	.0048	.0030	.0032	.0052
11. Stone, Clay & Glass Prods	.0026	.0022	.0087	.0028	.0012	.0021	.0028
12. Machinery & Metal Shops	.0156	.0074	.0042	.0058	.0029	.0079	.0057
13. Miscellaneous Manufacturing	.0011	.0015	.0059	.0017	.0010	.0023	.0046
14. Transportation	.0165	.0090	.0168	.0129	.0267	.0181	.0097
15. Communications	.0031	.0036	.0032	.0048	.0014	.0026	.0083
16. Utilities	.0183	.0234	.0126	.0175	.0088	.0843	.0165
17. Eating and Drinking Places	.0102	.0090	.0086	.0152	.0043	.0077	.0135
18. Hotel & Lodging Places	.0002	.0002	.0002	.0013	.0002	.0002	.0003
19. Gasoline Service Stations	.0372	.0230	.0150	.0204	.0093	.0159	.0204
20. Other Wholesale & Retail Trade	.7980	.4693	.5879	.5214	.2351	.3864	.5008
21. Finance & Insurance	.0709	.0479	.0487	.0454	.0190	.0430	.0754
22. Real Estate	.0305	.0255	.0311	.0424	.0116	.0213	.0394
23. Other Business & Professional Services	.1385	.0846	.0981	.2739	.0347	.0511	.2049
24. Local & State Gov't	.0150	.0156	.0119	.0191	.0050	.0086	.0256
25. Defense-Related Gov't	0	0	0	0	0	0	0
26. Other Federal Gov't	0	0	0	0	0	0	0
27. Households	.6991	.6911	.6412	.8687	.3420	.6604	.8707
28. Unallocated	.0232	.0167	.0169	.0443	.0063	.0097	.0344
29. Total Direct	3.1636	2.9478	3.7922	3.0983	1.9027	2.9934	3.1712

Continued

Appendix Table 1. Continued

	Chemical Manufacturer (8)	Petroleum & Coal Products (9)	Rubber, Plastic and Related Products (10)	Stone, Clay and Glass Products (11)	Machinery, Repairs & Metal Shops (12)	Miscellaneous Manufacturing (13)	Transportation (14)	Communication (15)
1.	.0238	.0121	.0157	.0163	.0117	.0100	.0134	.0077
2.	.0101	.0145	.0131	.0182	.0141	.0131	.0180	.0101
3.	.0682	.0597	.0648	.2627	.4332	.0456	.1359	.0846
4.	.0021	.0010	.0012	.0011	.0012	.0038	.0010	.0006
5.	.0086	.0108	.0071	.0129	.0154	.0128	.0097	.0058
6.	.0070	.0014	.0008	.0011	.0009	.0014	.0012	.0007
7.	.0144	.0090	.0142	.0275	.0090	.0090	.0107	.0101
8.	1.0848	.0553	.2414	.0293	.0055	.0098	.0030	.0019
9.	.0001	1.0001	.0001	.0002	.0016	.0001	.0002	.0002
10.	.0054	.0025	1.0307	.0074	.0046	.0265	.0028	.0016
11.	.0016	.0023	.0023	1.0038	.0036	.0017	.0033	.0019
12.	.0033	.0047	.0046	.0064	1.0340	.0042	.0063	.0040
13.	.0014	.0010	.0067	.0036	.0081	1.0704	.0014	.0008
14.	.0225	.0092	.0109	.0109	.0094	.0056	1.0496	.0059
15.	.0073	.0280	.0088	.0039	.0144	.0024	.0063	1.0099
16.	.0109	.0121	.0121	.0158	.0459	.0250	.0170	.0170
17.	.0101	.0090	.0010	.0125	.0091	.0067	.0115	.0068
18.	.0002	.0002	.0002	.0003	.0003	.0002	.0003	.0002
19.	.0126	.0175	.0173	.0240	.0181	.0128	.0299	.0155
20.	.3064	.4768	.4008	.5672	.4698	.2960	.6052	.3312
21.	.0319	.0406	.0418	.0483	.0407	.0342	.0477	.0269
22.	.0306	.0250	.0278	.0338	.0259	.0184	.0321	.0364
23.	.2027	.0688	.1113	.0966	.0625	.0537	.0702	.0413
24.	.0085	.0096	.0084	.0114	.0106	.0066	.0114	.0113
25.	0	0	0	0	0	0	0	0
26.	0	0	0	0	0	0	0	0
27.	.4767	.7558	.7335	1.0397	.7828	.5533	1.0060	.5817
28.	.0325	.0148	.0195	.0177	.0128	.0098	.0138	.0924
29.	2.3837	2.6418	2.7961	3.3726	3.0452	2.2331	3.1079	2.3065

Continued

Appendix Table 1. Continued

	Utilities (16)	Eating & Drinking (17)	Hotels & Lodging Places (18)	Gasoline Service Stations (19)	Other Wholesale and Retail Trade (20)	Finance & Insurance (21)	Real Estate (22)	Other Bus & Professional Services (23)
1.	.0089	.0419	.0203	.0094	.0096	.0152	.0239	.1224
2.	.0119	.1608	.0582	.0161	.0202	.0126	.0150	.0217
3.	.1515	.0522	.0754	.0442	.0262	.2026	1.7372	.2164
4.	.0007	.0010	.0012	.0026	.0012	.0023	.0019	.0066
5.	.0073	.0045	.0068	.0045	.0038	.0102	.0461	.0094
6.	.0011	.0010	.0015	.0015	.0021	.0008	.0012	.0014
7.	.0067	.0063	.0089	.0065	.0062	.0281	.0155	.0669
8.	.0030	.0026	.0045	.0025	.0026	.0043	.0167	.0141
9.	.0002	.0003	.0012	.0038	.0002	.0001	.0002	.0003
10.	.0023	.0022	.0026	.0024	.0029	.0053	.0125	.0140
11.	.0019	.0014	.0022	.0012	.0007	.0025	.0073	.0023
12.	.0517	.0056	.0056	.0031	.0017	.0046	.0042	.0056
13.	.0018	.0007	.0009	.0007	.0004	.0022	.0052	.0014
14.	.0088	.0091	.0121	.0145	.0190	.0080	.0154	.0149
15.	.0030	.0023	.0042	.0024	.0013	.0136	.0050	.0047
16.	1.0151	.0603	.0397	.0102	.0109	.0115	.0136	.0333
17.	.0062	1.0052	.0077	.0048	.0030	.0091	.0101	.0341
18.	.0002	.0095	1.0018	.0001	.0001	.0002	.0002	.0004
19.	.0120	.0108	.0154	1.0103	.0051	.0155	.0147	.0147
20.	.4767	.5247	.6990	.8202	1.1665	.4198	.5689	.6523
21.	.0280	.0260	.0425	.0293	.0268	1.2883	.0827	.0619
22.	.0174	.0150	.0218	.0143	.0103	.1073	1.0542	.1004
23.	.0487	.0444	.0549	.0468	.0409	.1058	.1660	1.1693
24.	.0238	.0394	.0278	.0202	.0188	.0088	.0150	.0213
25.	0	0	0	0	0	0	0	0
26.	0	0	0	0	0	0	0	0
27.	.5085	.4224	.6536	.3758	.2094	.6659	.6199	.5381
28.	.0095	.0091	.0110	.0088	.0074	.0189	.0274	.1778
29.	2.4069	1.5540	2.7808	2.4865	1.5973	2.9635	4.4798	3.3003

Continued

Appendix Table 1. Continued

	Local & State Gov't (24)	Defense Related Gov't (25)	Other Federal Gov't (26)	Households (27)	Unallocated (28)
1.	.0170	.0139	.0144	.0148	.0048
2.	.0202	.0185	.0171	.0199	.0032
3.	.1997	.1756	.2633	.0855	.3245
4.	.0014	.0010	.0011	.0011	.0006
5.	.0122	.0110	.0128	.0096	.0095
6.	.0017	.0012	.0011	.0012	.0012
7.	.0139	.0110	.0195	.0119	.0030
8.	.0054	.0036	.0054	.0028	.0033
9.	.0031	.0003	.0009	.0002	.0009
10.	.0034	.0030	.0036	.0026	.0025
11.	.0041	.0036	.0037	.0037	.0015
12.	.0083	.0067	.0098	.0073	.0008
13.	.0018	.0015	.0040	.0014	.0010
14.	.0137	.0106	.0105	.0108	.0034
15.	.0050	.0035	.0057	.0038	.0010
16.	.0215	.0182	.0262	.0172	.0031
17.	.0131	.0122	.0116	.0136	.0037
18.	.0006	.0003	.0016	.0003	.0001
19.	.0275	.0247	.0229	.0277	.0029
20.	.6100	.5917	.5410	.6214	.1098
21.	.0531	.0480	.1057	.0522	.0158
22.	.0484	.0324	.0361	.0356	.1938
23.	.0987	.0721	.0808	.0769	.0330
24.	1.0292	.0109	.0114	.0114	.0036
25.	0	1.0000	0	0	0
26.	0	0	1.0000	0	0
27.	1.0803	1.0764	.9849	1.2054	.1201
28.	.0503	.0140	.0202	.0151	1.0754
29.	3.3436	3.1659	3.2153	2.2534	1.9225

Appendix Table 2. Inverse of Beaufort County, South Carolina, Input-Output Matrix, 1969

	Ag, Forestry and Fisheries (1)	Food and Kindred Products (2)	Construction (3)	Textiles and Apparel (4)	Lumber and Wood Prods. (5)
1. Ag, Forestry and Fisheries	1.0416	0.0134	0.0055	0.0046	0.0599
2. Food and Kindred Products	0.0102	1.0047	0.0049	0.0080	0.0033
3. Construction	0.0278	0.0171	1.6452	0.0273	0.0380
4. Textiles and Apparel	0.0003	0.0001	0.0002	1.0002	0.0001
5. Lumber and Wood Products	0.0035	0.0024	0.0138	0.0040	1.0234
6. Chemicals	0.0005	0.0002	0.0003	0.0002	0.0001
7. Manufacturing	0.0004	0.0003	0.0003	0.0005	0.0002
8. Transportation	0.0086	0.0030	0.0034	0.0050	0.0044
9. Communications	0.0018	0.0021	0.0015	0.0022	0.0008
10. Utilities	0.0158	0.0167	0.0076	0.0117	0.0079
11. Eating and Drinking Places	0.0068	0.0044	0.0047	0.0072	0.0029
12. Hotels and Lodging Places	0.0001	0.0001	0.0001	0.0001	0.0000
13. Gasoline Ser. Stations	0.0299	0.0096	0.0090	0.0154	0.0071
14. Other Wholesale and Retail Trade	0.6145	0.2030	0.2299	0.3582	0.1539
15. Financial Services	0.0356	0.0196	0.0212	0.0234	0.0103
16. Real Estate	0.0159	0.0102	0.0156	0.0173	0.0066
17. Other Business and Professional Ser.	0.0922	0.0326	0.0564	0.0449	0.0196
18. Local and State Government	0.0465	0.0172	0.0155	0.0249	0.0112
19. Federal Government	0.0000	0.0000	0.0000	0.0000	0.0000
20. Households	0.7028	0.5256	0.4982	0.8697	0.3445
Local Multiplier	2.6548	1.8823	2.7787	2.4248	1.6942

Continued

Continued

	Chemicals (6)	Other Manufacturing (7)	Transportation (8)	Communi-cations (9)	Utilities (10)	Eating and Drinking Places (11)	Hotels and Lodging places (12)	Gasoline Ser. Sta. (13)
1.	0.0129	0.0035	0.0056	0.0031	0.0036	0.0227	0.0419	0.0035
2.	0.0047	0.0049	0.0103	0.0057	0.0068	0.0165	0.0203	0.0133
3.	0.0221	0.0172	0.0813	0.0234	0.0893	0.0162	0.0387	0.0165
4.	0.0007	0.0002	0.0002	0.0001	0.0002	0.0001	0.0002	0.0002
5.	0.0022	0.0025	0.0055	0.0029	0.0031	0.0016	0.0037	0.0023
6.	1.0008	0.0002	0.0003	0.0002	0.0002	0.0001	0.0002	0.0002
7.	0.0003	1.0003	0.0007	0.0004	0.0003	0.0002	0.0004	0.0003
8.	0.0034	0.0030	1.0393	0.0035	0.0054	0.0025	0.0063	0.0099
9.	0.0013	0.0013	0.0054	1.0014	0.0019	0.0009	0.0032	0.0018
10.	0.0091	0.0089	0.0170	0.0167	1.0127	0.0548	0.0377	0.0293
11.	0.0066	0.0047	0.0092	0.0052	0.0046	1.0027	0.0058	0.0036
12.	0.0000	0.0001	0.0001	0.0001	0.0001	0.0009	1.0001	0.0000
13.	0.0083	0.0098	0.0258	0.0133	0.0096	0.0063	0.0133	1.0085
14.	0.2040	0.2075	0.4545	0.2473	0.3922	0.1671	0.4439	0.6743
15.	0.0147	0.0149	0.0320	0.0169	0.0177	0.0098	0.0258	0.0195
16.	0.0138	0.0106	0.0220	0.0130	0.0107	0.0065	0.0136	0.0087
17.	0.1714	0.0368	0.0528	0.0283	0.0362	0.0177	0.0378	0.0353
18.	0.0156	0.0158	0.0320	0.0227	0.0328	0.0395	0.0383	0.0263
19.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
20.	0.4547	0.5514	1.1359	0.6431	0.5264	0.3328	0.7023	0.4029
Local ıltiplier	1.9466	1.8936	2.9299	2.0473	2.1538	1.6989	2.4335	2.2564

Continued

Continued

	Other Wholesale and Retail Trade (14)	Financial Services (15)	Real Estate (16)	Other Business and Professional Ser. (17)	Local and State Government (18)	Federal Government (19)	Households (20)
1.	0.0032	0.0050	0.0081	0.0792	0.0071	0.0038	0.0066
2.	0.0134	0.0072	0.0042	0.0087	0.0117	0.0069	0.0122
3.	0.0110	0.0477	0.9899	0.0730	0.0974	0.0249	0.0413
4.	0.0001	0.0010	0.0004	0.0042	0.0004	0.0001	0.0003
5.	0.0019	0.0036	0.0091	0.0027	0.0060	0.0035	0.0063
6.	0.0002	0.0003	0.0011	0.0051	0.0013	0.0002	0.0003
7.	0.0001	0.0008	0.0004	0.0003	0.0008	0.0005	0.0009
8.	0.0149	0.0053	0.0030	0.0079	0.0085	0.0040	0.0072
9.	0.0009	0.0074	0.0025	0.0025	0.0035	0.0016	0.0029
10.	0.0103	0.0110	0.0083	0.0290	0.0198	0.0100	0.0180
11.	0.0022	0.0054	0.0047	0.0244	0.0101	0.0086	0.0112
12.	0.0000	0.0001	0.0000	0.0001	0.0003	0.0001	0.0002
13.	0.0042	0.0302	0.0078	0.0096	0.0232	0.0135	0.0246
14.	1.1195	0.3843	0.1961	0.4190	0.4719	0.2899	0.5156
15.	0.0136	1.0627	0.0458	0.0318	0.0343	0.0199	0.0362
16.	0.0059	0.0365	1.0313	0.0473	0.0289	0.0140	0.0256
17.	0.0334	0.0548	0.0988	1.1024	0.0713	0.0331	0.0601
18.	0.0224	0.0259	0.0160	0.0262	1.0467	0.0210	0.0380
19.	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000
20.	0.2163	0.6084	0.3950	0.4443	1.2012	0.7614	1.3929
Local :ltiplier	1.4797	2.2976	1.8265	2.3177	3.6444	2.2170	2.2004

Appendix Table III. Selected Environmental and Economic Impacts per Dollar of Gross Output for Selected Economic Activities, Charleston and Beaufort Areas, South Carolina, 1968-1969

	Agriculture, Forestry & Fisheries (1)	Food & Kindred Products (2)	Construction and Mining (3)	Textiles and Apparel (4)	Lumber & Wood Products (5)	Furniture and Fixtures (6)	Printers and Publishers (7)
1. Particulates (lbs)	0.0240	0.0000	0.0000	0.0000	1.2790	0.0000	0.0000
2. SO_2 (lbs)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3. 5-Day BOD (lbs)	0.0000	0.3264	0.0000	0.3834	1.3501	0.0000	0.0000
4. Solid Waste (lbs)	0.0000	0.0000	0.0011	0.0009	0.1260	0.0000	0.0000
5. Income/$ Output	0.4126	0.2655	0.4130	0.3804	0.3430	0.4315	0.4700
6. Jobs/$ Output	0.0000	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001
7. Local Taxes/$ Output	0.0237	0.0017	0.0002	0.0832	0.0053	0.0009	0.0097
8. State Taxes/$ Output	0.0506	0.0602	0.0324	0.0982	0.0911	0.0912	0.0142
9. Sales/$ Output	0.5273	1.0896	0.4202	1.8088	1.6864	1.6314	0.0034

Continued

Appendix Table III. Continued

	Chemical Manufacturer (8)	Petroleum & Coal Products (9)	Rubber, Plastic and Related Products (10)	Stone, Clay and Glass Products (11)	Machinery, Repairs & Metal Shops (12)	Miscellaneous Manufacturing (13)	Transportation (14)	Communication (15)
1.	0.0000	6.5000	0.0000	0.9200	0.5396	0.0000	0.0213	0.0000
2.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3.	0.1062	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.	0.0006	0.0007	0.0000	0.0000	0.0006	0.0000	0.0000	0.0006
5.	0.4680	0.2505	0.4454	0.4902	0.4181	0.4029	0.6071	0.5141
6.	0.0001	0.0001	0.0000	0.0001	0.0001	0.0003	0.0000	0.0001
7.	0.0192	0.0489	0.0142	0.0654	0.0004	0.0393	0.0074	0.2076
8.	0.0544	0.0462	0.0496	0.0666	0.1253	0.0125	0.1022	0.0157
9.	0.8428	0.8079	0.7575	1.0820	2.3510	0.0115	1.7516	0.0071

Continued

Appendix Table III. Continued

	Utilities (16)	Eating & Drinking (17)	Hotels & Lodging Places (18)	Gasoline Service Stations (19)	Other Wholesale and Retail Trade (20)	Finance & Insurance (21)	Real Estate (22)	Other Bus & Professional Services (23)
1.	0.0119	0.0000	0.0000	0.0340	0.0000	0.0000	0.0000	0.0000
2.	0.3743	0.0000	0.0000	0.0030	0.0000	0.0000	0.0000	0.0000
3.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4.	0.0043	0.0038	0.0045	0.0002	0.0000	0.0000	0.0000	0.0000
5.	0.5606	0.6175	0.6745	0.4680	0.7245	0.5602	0.7223	0.5120
6.	0.0000	0.0001	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
7.	0.0203	0.0008	0.0169	0.0004	0.0025	0.0001	0.0054	0.0003
8.	0.0706	0.0698	0.1488	0.0839	0.0356	0.0168	0.0218	0.0155
9.	1.0865	1.0698	2.6799	1.4578	0.2915	0.0003	0.0048	0.0051

Continued

Appendix Table III. Continued

	Local & State Gov't (24)	Defense Related Gov't (25)	Other Federal Gov't (26)	Households (27)	Unallocated (28)
1.	0.0000	0.0000	0.0000	0.0000	0.0000
2.	0.0000	0.0000	0.0000	0.0000	0.0000
3.	0.0000	0.0000	0.0000	0.2413	0.0000
4.	0.0000	0.0002	0.0005	0.0085	0.0000
5.	0.0000	0.0000	0.0000	0.8500	0.4001
6.	0.0000	0.0002	0.0000	0.0000	0.0000
7.	0.0000	0.0000	0.0000	0.0068	0.0215
8.	0.1261	0.1519	0.1543	0.0286	0.0194
9.	2.6278	3.1659	3.2153	0.0659	0.1560

Appendix Table IV. Annual Output per 100 Workers Used to Compute Economic and Environmental Impacts, Charleston Metropolitan Area and Beaufort County, South Carolina, 1968-1969

Sector	Annual Output per 100 Workers
Food & Kindred Products	$ 735,000
Textiles & Apparel	782,000
Lumber & Wood Products	1,211,900
Chemicals	1,129,900
Tourism	1,090,900

SOURCE: Computed from Table 1, Laurent and Hite, Economic-Ecologic Analysis in the Charleston Metropolitan Region: An Input-Output Study, Water Resources Research Institute Report No. 19, Clemson University, Clemson, South Carolina, April 1971.

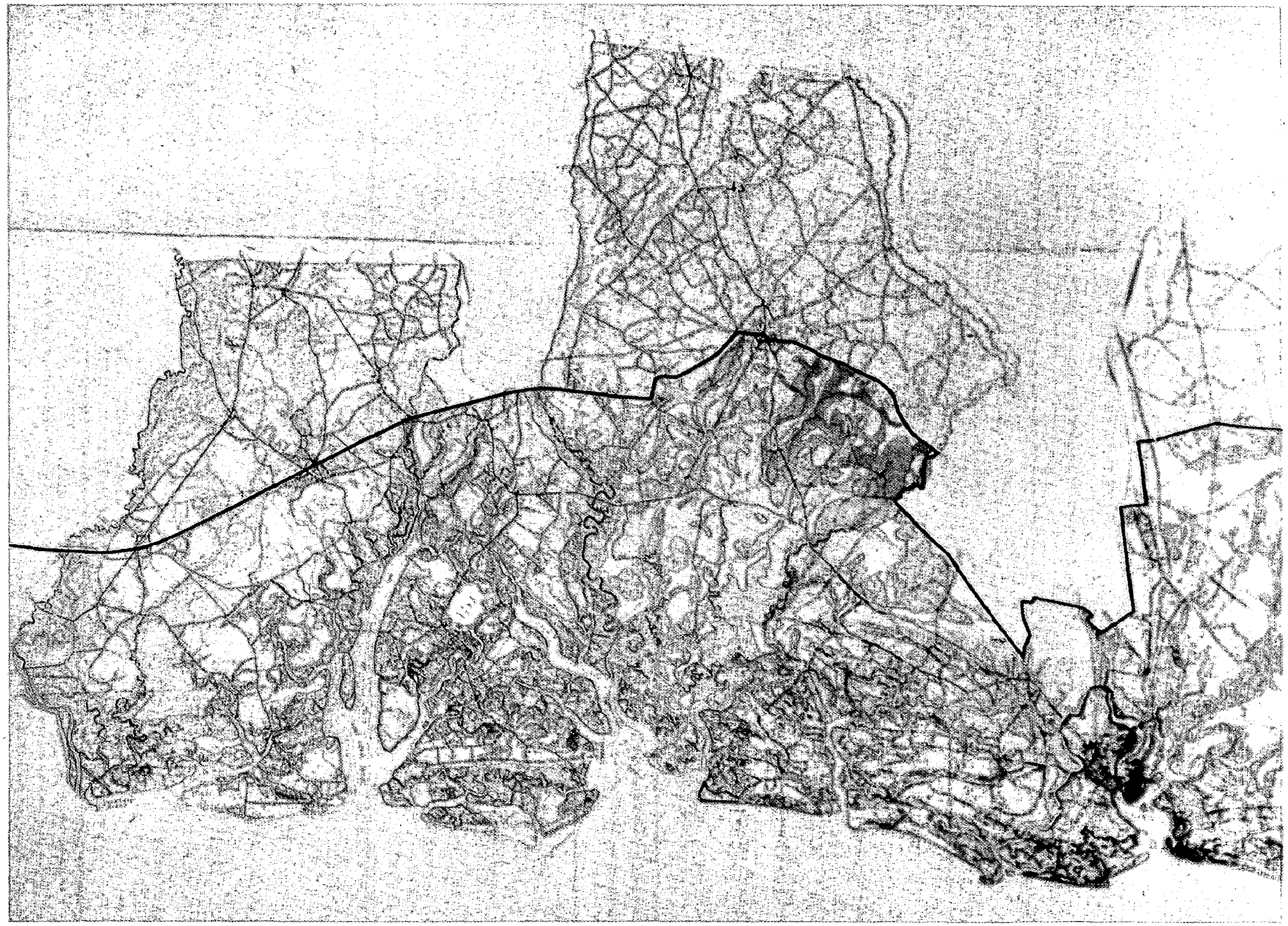

Plate VII Base Map, Southern Region, South Carolina Coastal Zone, 1969 (Color Key: Green-Marshland).

Plate VIII Base Map, Northern Region, South Carolina Coastal Zone, 1969 (Color Key: Green-Marshland).

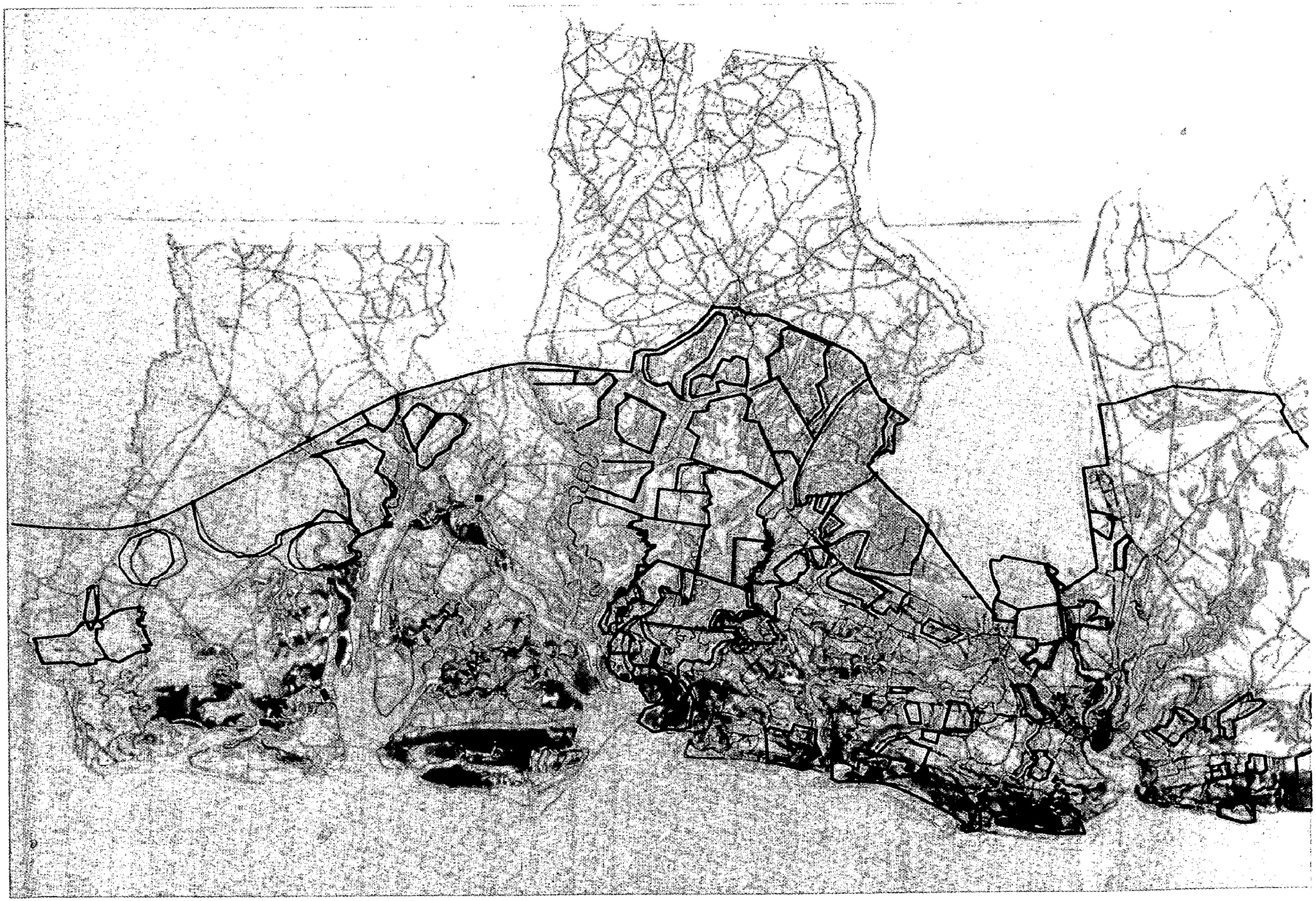

Plate IX Oyster Leases and Large Land Holdings, Southern Region, South Carolina Coastal Zone, 1969
(Color Key: Green-Marshland; Blue-Oyster Leases; Black Polygons-Landholdings of 1000 acres or more).

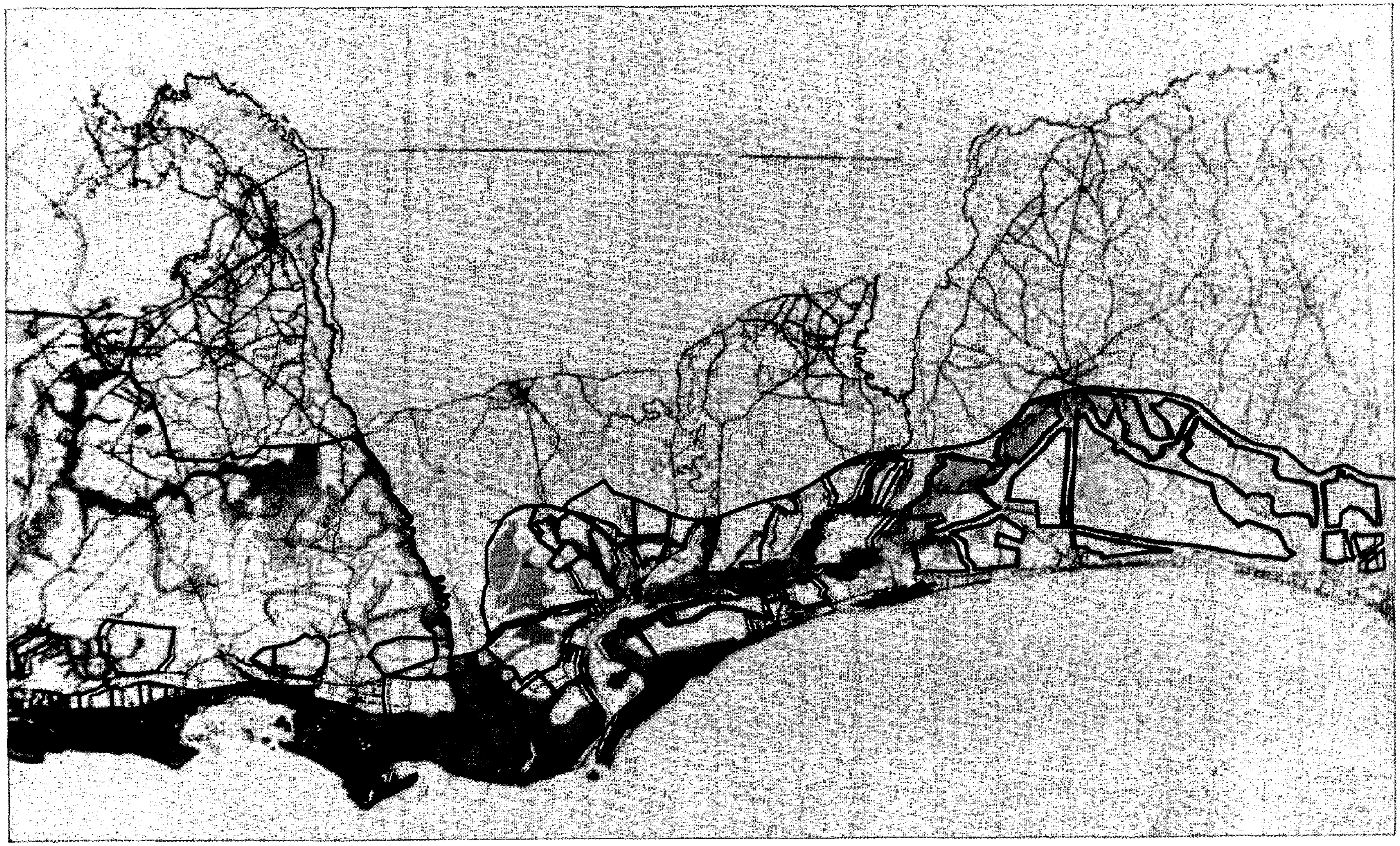

Plate X Oyster Leases and Large Land Holdings, Northern Region, South Carolina Coastal Zone, 1969
(Color Key: Green-Marshland; Blue-Oyster Leases; Black Polygons-Landholdings of 1000 acres or more).

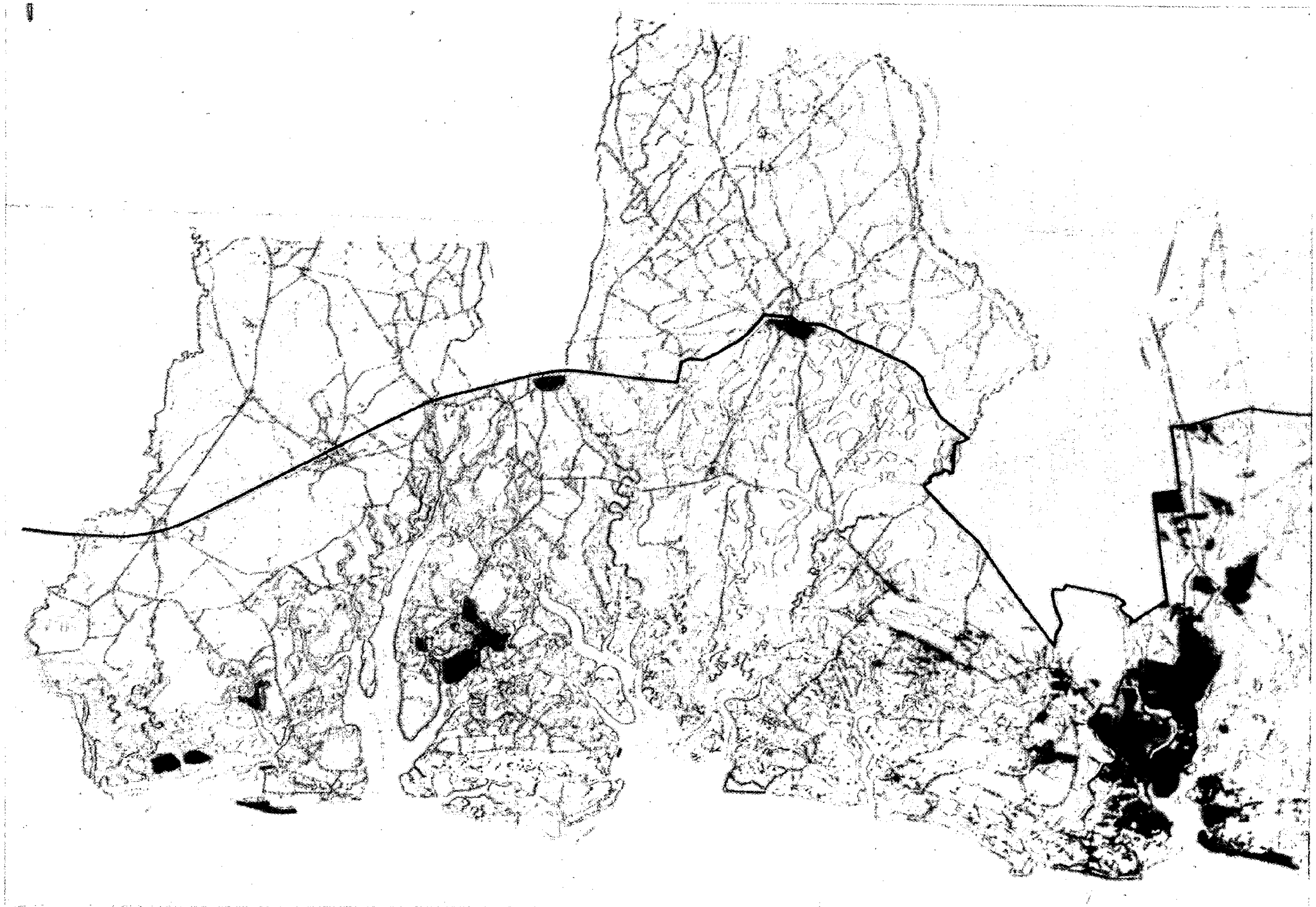

Plate XI Industrial and Residential Areas, Southern Region, South Carolina Coastal Zone, 1969 (Color Key: Green-Marshland; Red-Residential Areas; Yellow-Industrial Areas).

Plate XII Industrial and Residential Areas, Northern Region, South Carolina Coastal Zone, 1969 (Color Key: Green-Marshland; Red-Residential Areas; Yellow-Industrial Areas).

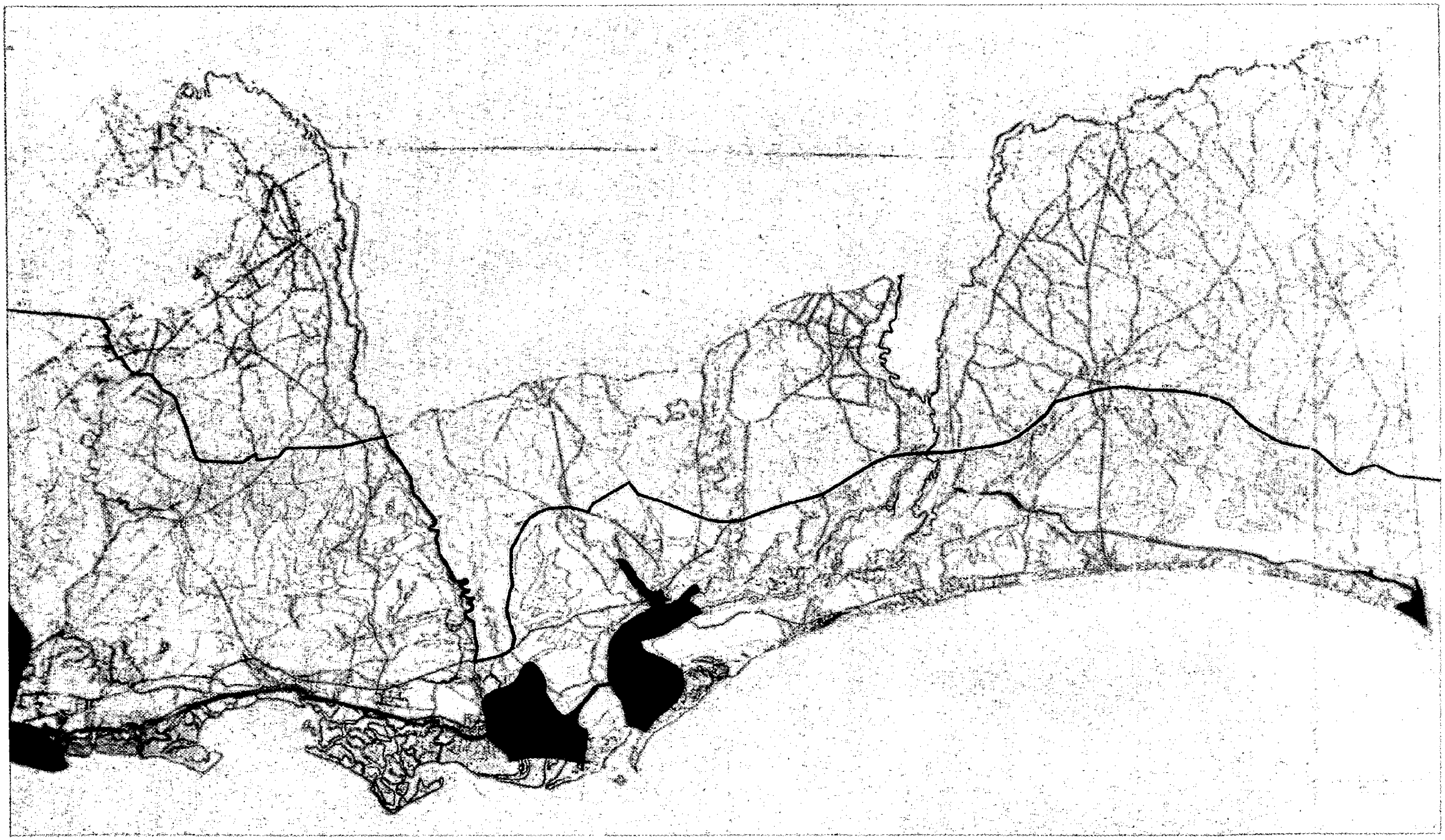

Plate XIII Areas of Gross Pollution and Spoil Disposal, Southern Region, South Carolina Costal Zone, 1969 (Color Key: Green-Marshland; Purple-Areas of Gross Pollution; Orange-Spoil Areas).

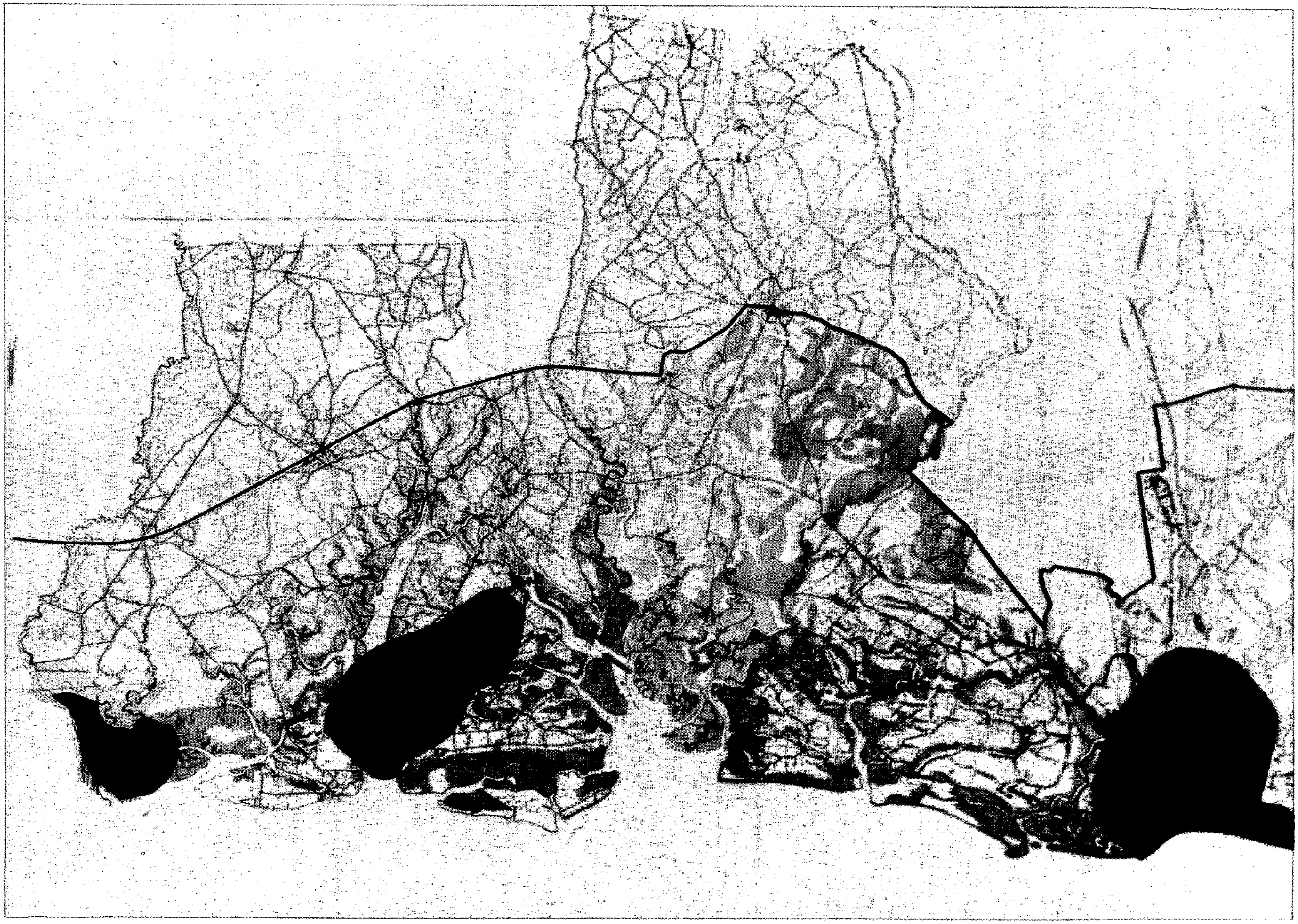

Plate XIV Areas of Gross Pollution and Spoil Disposal, Northern Region, South Carolina Coastal Zone, 1969 (Color Key: Green-Marshland; Purple-Areas of Gross Pollution; Orange-Spoil Areas).

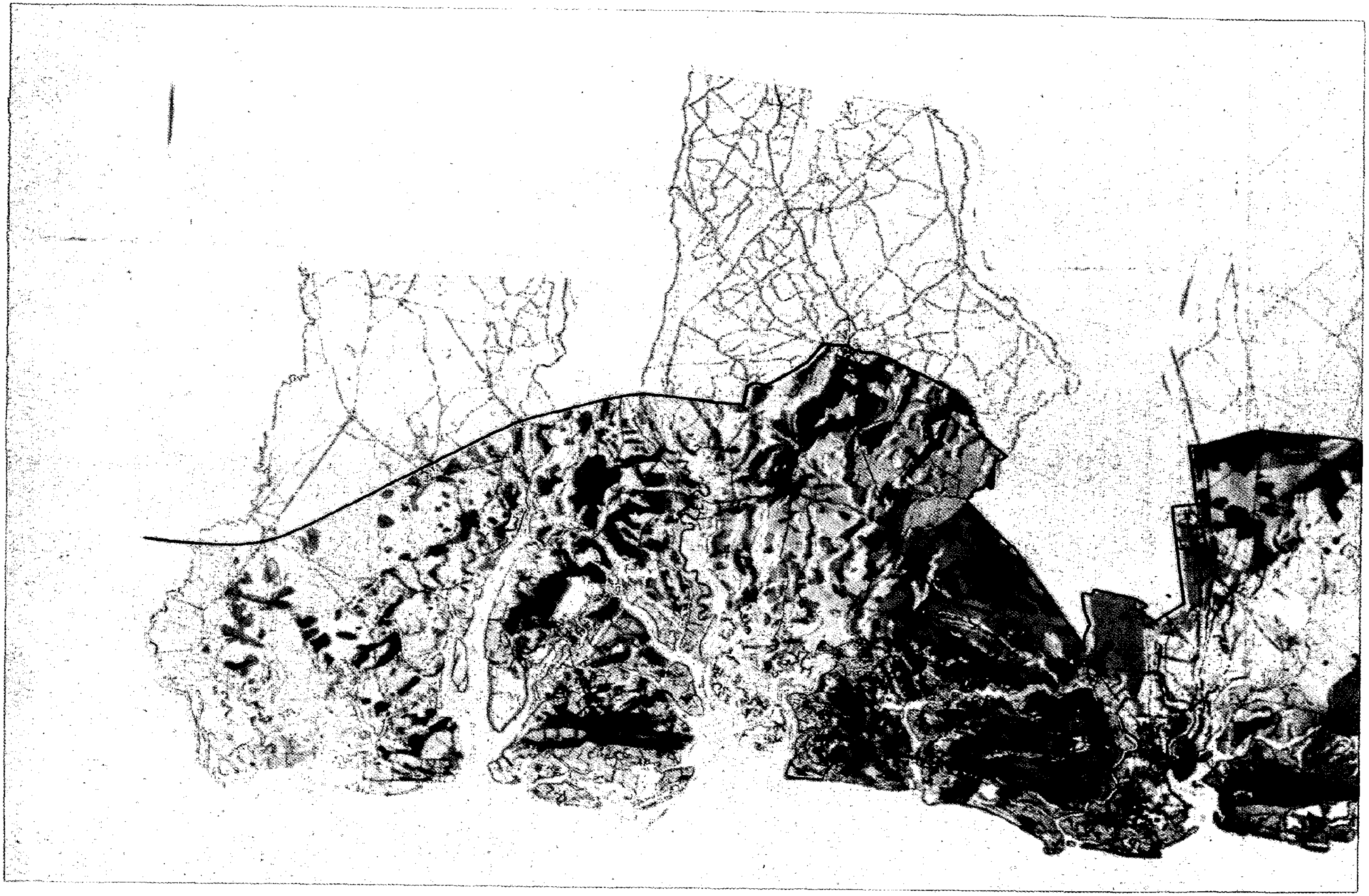

Plate XV Agricultural and Timber Lands, Southern Region, South Carolina Coastal Zone, 1969
(Color Key: Green-Marshland; Light Brown-Timberland; Dark Brown-Cultivated Lands).

Plate XVI Agricultural and Timber Lands, Northern Region, South Carolina Coastal Zone, 1969 (Color Key: Green-Marshland; Light Brown-Timberland; Dark Brown-Cultivated Lands).

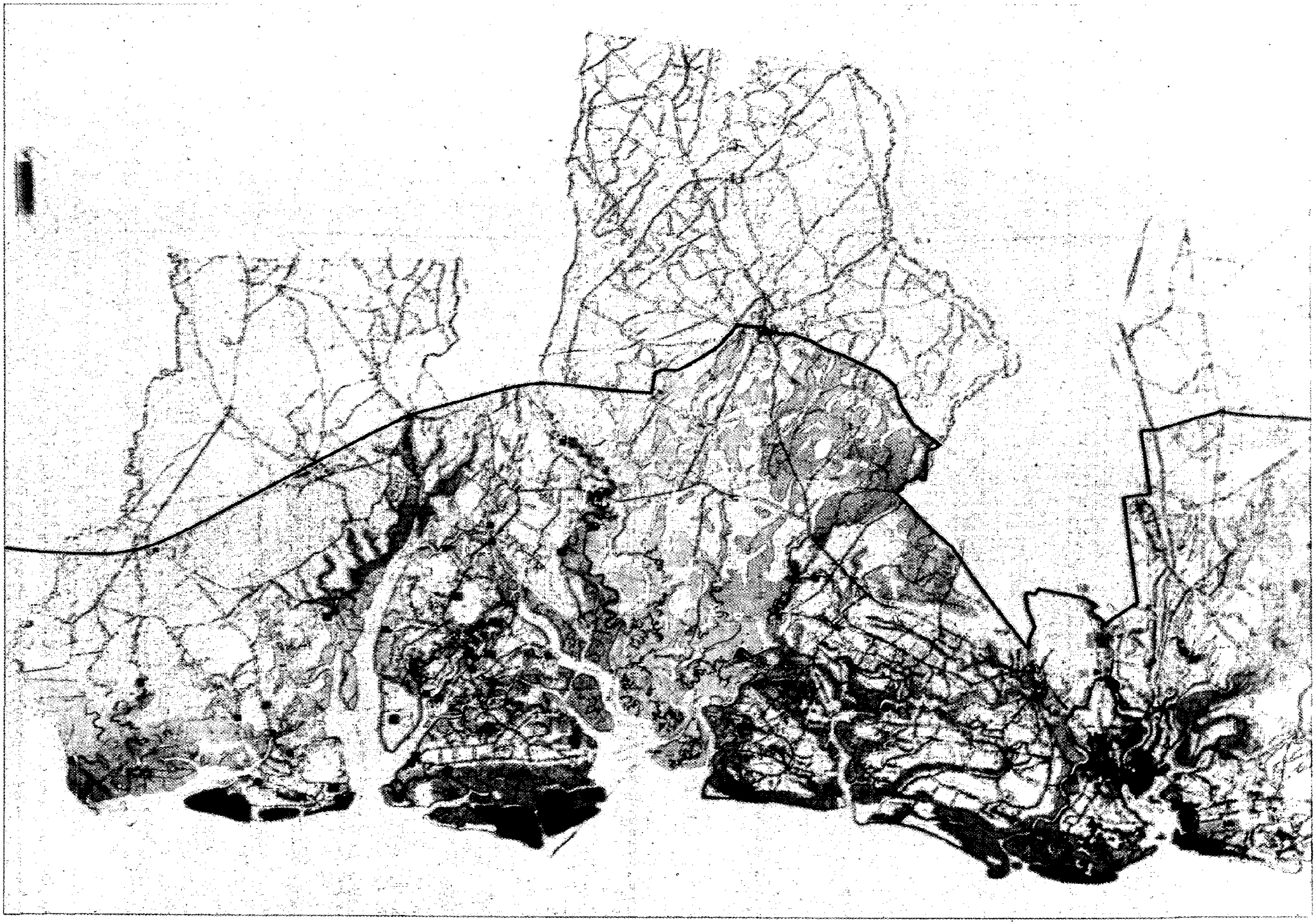

Plate XVII Game Management and Recreation Areas, Southern Region, South Carolina Coastal Zone, 1969
(Color Key: Pink-Game Management Areas; Red-Recreation Areas; Blue-Boat Ramps and Marinas).

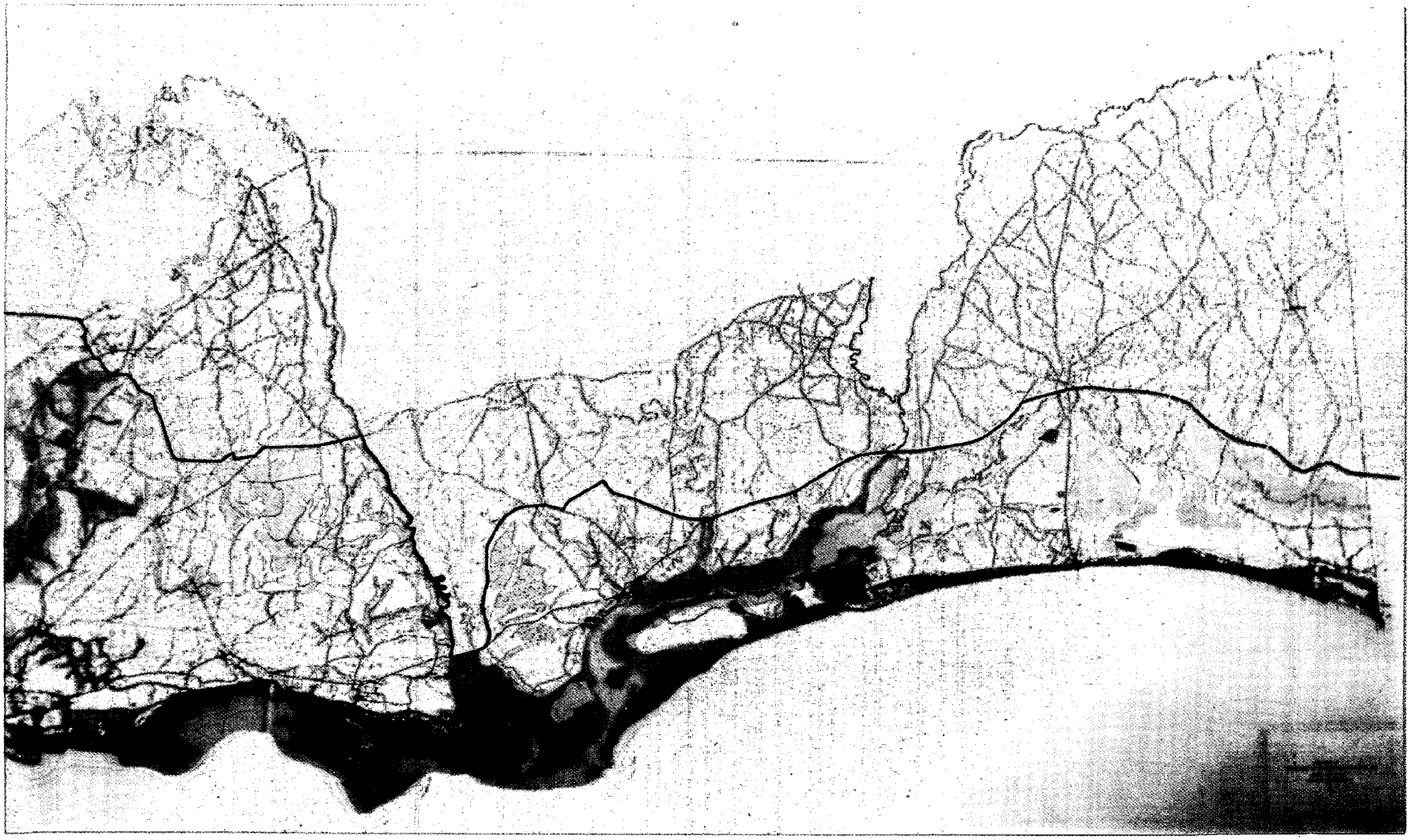

Plate XVIII Game Management and Recreation Areas, Northern Region, South Carolina Coastal Zone, 1969
(Color Key: Pink-Game Management Areas; Red-Recreation Areas; Blue-Boat Ramps and Marinas).