John K. Bulow. AN ANALYSIS OF THE COMPETITIVE ADVANTAGES OF NORTH CAROLINA PORTS. (Under the direction of Edward P. Leahy) Department of Geography, May 1979.

The purpose of this study is to evaluate the competitive advantages of North Carolina's two state ports, Wilmington and Morehead City, in regard to the transportation networks of the state and in competition with the regional ports of Norfolk, Virginia; Charleston, South Carolina; and Savannah, Georgia. The methodology chosen to accomplish this goal is the subjection of abstracted highway and railroad networks composed of the five port cities and the twenty largest cities of North Carolina to network analysis. By doing so, a value graph matrix is developed for each transport system that will indicate which cities are closest to all others using the parameter distance in miles. This enables us to evaluate the five port cities in terms of highway and railroad mileage to all of the other cities. Also, a composite figure, consisting of all the distances to every city from any one, allows us to rank the port cities in terms of access to the entire system. In this manner the geographic position of the state ports in relation to the largest cities of the state can be analysed in conjunction with that of the competing regional ports of Norfolk, Charleston and Savannah.

All of the above ports transfer a significant portion of the North Carolina import and export commerce and an examination of the distance factor is significant in terms of port selection by those responsible for moving commerce to and from North Carolina's growing economy.

An important area of secondary consideration within this thesis is the documentation of the movement of state commerce through North Carolina's ports. Even though the competing regional ports are much larger than either Morehead City or Wilmington, the state ports transfer a significant portion of the state's ocean going commerce from their wharves. Wilmington is a port where facilities are most concerned with general cargo shipment. Since the containerization of ships cargo is an important technological innovation in this type of trade, an analysis of the containers shipped to and from the state for the year 1977 is made. Morehead City, on the other hand, is oriented more to shipment of bulk cargo and so all tonnages for all types of cargoes for the year 1977 are analysed. This view of the actual cargo shipment demonstrates the ability of the ports to contend for different kinds of cargo within the state.

AN ANALYSIS OF THE COMPETITIVE ADVANTAGES OF NORTH CAROLINA PORTS

A Thesis

Presented to

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In Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Geography

by

John K. Bulow

AN ANALYSIS OF THE COMPETITIVE ADVANTAGES

OF NORTH CAROLINA PORTS

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CHAPTER I

INTRODUCTION

Wilmington and Morehead City, the two deepwater ports of the North Carolina States Ports Authority, function to service the demand for break bulk transfer of the state's foreign commerce. In direct competition with these two ports are the regional ports of Norfolk, Charleston, and Savannah. These larger regional ports account for a significant portion of the movement of North Carolina's foreign trade. In fact, almost fifty percent of the state's imports and exports by volume travel through ports other than Wilmington or Morehead City.[1] Despite the vigorous competition from these ports, state ports are able to contend for the movement of an important if not dominant share of the ocean freight generated by the state's growing economy. These two facilities while small in comparison to the competing ports of Norfolk, Virginia (Hampton Roads complex); Charleston, South Carolina; and Savannah, Georgia are modern seaports with railroad and highway connections.[2]

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[1] Paul F. Mulligan and Raymond L. Collins, Impact of North Carolina Ports on the North Carolina Economy, (Research Triangle Park, North Carolina, 1975), pp. 215-16.

[2] N. C. Ports, Facts and Figures, North Carolina Ports Authority, 1977.

Purpose

Can North Carolina ports survive and flourish in the highly competitive ocean freight trade with its larger counterparts? Support for an affirmative answer to this question can be found in publications which substantiate growth in total tonnage for the two ports from the commencement of the North Carolina State Ports Authority operations in 1952 to the present.[3]

Critics of North Carolina ports who have an understanding of the history and geography of the state will be quick to point out that it is absurd to think that one of North Carolina's ports could someday become the "New York of the South." Because such criticism is valid, many economic planners and government officials have decided that further development is a waste of taxpayers money. Such attitudes do not consider the value of Wilmington and Morehead City to the economy and people of North Carolina. Both ports are significant points of entry and exit for state cargoes. Each facility is in reality a business owned by the people of North Carolina and capable of returning a profit on invested capital. Employment, taxes, and capital investment within the state are positive results of North Carolina cargoes moving through these ports.

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[3]Mulligan and Collins, Impact of N. C. Ports, 2 20-21.

If North Carolina exporters and importers can move cargoes through state owned ports, why is there a problem or need for further research? An understanding of the competitive nature of freight movement will help to answer this question. Freight generally moves from its origin in the state to the port of most economical route and optimum service. Historical business contacts can also be a factor as to how a shipper makes a decision regarding the use of a particular port. While it is possible to move North Carolina cargoes through state owned ports, competing facilities at Norfolk, Charleston, and Savannah are strongly competitive for North Carolina's trade. The latter have traditionally served as break bulk points for North Carolina's ocean freight.[4] The later historical development of North Carolina ports and the relatively recent upgrading of their facilities has hampered the state's ability to compete with cargo inertia developed by older, larger ports.

If North Carolina ports are to attract trade presently using Norfolk, Charleston, and Savannah, they must attempt to be competitive in handling and service costs. It is also important that positive features of the ports, (distances to various cities of the state) be identified and emphasized to those responsible for port selection of North Carolina ocean freight. To capture a larger share of the

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[4]Ibid., pp. 2-16 - 2-21.

total, the state ports must attract trade which has traditionally moved through other ports, but can just as easily or economically go through a North Carolina port.

The future growth of North Carolina's ports is dependent upon the enlargement of their share of the state's cargoes. A position of dominance for Wilmington and Morehead City as the only ports of selection by N. C. customers may be a dreamer's hope, but the establishment of one or both as major points of entry and exit for North Carolina foreign commerce is well within the scope of reality.

It is the intended purpose of this research effort to investigate the transportation network of the ports of Wilmington, Morehead City, and the competing ports of Charleston, Savannah, and Norfolk in relationship to the twenty largest urban centers in North Carolina. Examination of this network will provide insight into the distance relationship between the optimum port or ports of the study region in relation to the state's largest cities. The hypothesis for the study is that North Carolina ports possess advantages in distance and access over the competing port cities to the total transportation network. By testing this hypothesis further information will be produced on the competitive position of North Carolina ports.

Literature

The competitive status of a seaport is the result of many complex variables. Investigation of any portion of such a diverse relationship requires examination and evaluation of various information sources. Understanding the seaport as a point of special function is of importance to this research effort.

Seaports are the subject of a rich and varied scholarly literature. In geographic literature a distinctive type of port study evolved. Articles and books of this type usually deal with the physical description of available facilities and listings of cargoes shipped through a port. A book characteristic of this format is the macro analysis, World Shipping, by Gunnar Alexandersson and Goran Nostrom.[5] Journal articles illustrating a similar vein on a smaller scale are "The Port of Genova" by Allan L. Rogers[6] and "Dar Es Salaam, Port and its Tributary Area" by William A. Hance and Irene S. Van Dogen.[7] Such descriptive articles are still being published in current journals and are still relevant as the port in most cases is not a static entity. but one changing in response to the political and economic fluctuations of the region it serves. Two journal articles

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[5]Gunnar Alexandersson and Goran Nostrom, World Shipping (New York: John Wiley and Sons, 1963).

[6]Allan L. Rogers, "The Port of Genova" Annals of the Association of American Geographers, 48 (1958) : 319-51.

[7]William A. Hance and Irene S. Von Dogen," Dar Es Salaam, The Port and its Tributary Area" Annals of the Association of American Geographers 48 (1958) : 419-35.

which convey this thought are "African Politics and Port Expansion at Dar Es Salaam" by B. S. Hoyle[8] and "Changes in the Port of Amsterdam" by D. G. Mills.[9]

In addition to physical description, the functional definition of a port is a prevalent theme. The often citied book Ports and Harbours by F. W. Morgan[10] and the article "Man's Ports and Channels" by Lester E. Klimm are[11] popular examples. A more recent book, but of the same type is Industrial Port Development by R. E. Takel.[12]

In the early 1960's geographic literature moved toward a quantitative trend thus providing new insights into geographic relationships that were afore unachievable. While port studies continued to be descriptive, other phases of transportation geography subscribed to the quantitative school of thought. Since the inception of this trend, numerous new techniques have been developed to test and analyze geographic problems. Of the various techniques to

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[8] B. S. Hoyle, "African Politics and Port Expansion at Dar Es Salaam" Geographic Review, 68 (1978) : 31-50.

[9] D. G. Mills, "Changes in the Port of Amsterdam" Geography, 63 (1978) : 209-13.

[10] F. W. Morgan, Ports and Harbours (London, Hutchinson House, 1952).

[11] Lester E. Klimm, "Man's ports and Channels" in Man's Role in Changing the Face of the Earth, ed. William L. Thomas, Jr. (Chicago: University of Chicago Press, 1956), pp. 522-41.

[12] R. E. Takel, Industrial Port Development (Bristol, Scientechnica Ltd., 1974).

come from this era, the development of network theory is of particular interest to this research project. This tool is used to evaluate relationships between a group of separated points.

Although numerous studies illustrate the network theory approach as it pertains to various modes of transportation, there has been an absence of research in regards to the seaport as a component of the land transport network. Consequently background information is limited, however, the following works provide a foundation for further inquiry.

A fundamental source of network analysis theory is the Structure of Transportation Networks by K. J. Kansky.[13] This book describes the various measures of network structure, their validity, and interpretation. Another excellent source of that details network theory is The Geography of Movement by Lowe Moryades.[14] A book primarily concerning spatial form that gives special consideration to network theory is Locational Analysis in Human Geography authored by Peter Haggett, Andrew Cliff, and Allan Frey.[15] Transport demand is the

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[13] K. J. Kansky, Structure of Transportation Networks: Relationships between Network Geometry and Regional Characteristics (Chicago: University of Chicago Press, 1963).

[14] Lowe Moryades, The Geography of Movement (Boston: Houghton Mifflin Company, 1975).

[15] Peter Haggett, Andrew D. Cliff, and Allen Frey, Locational Analysis in Human Geography (New York: John Wiley and Sons, 1977).

primary consideration of Allan Hay's Transport for the Space Economy,[16] but graph theory and network analysis figure prominently within the book's framework. An additional source of particular significance is Geography of Transportation by E. J. Taaffe and H. L. Gauthier.[17] Simplification of some of the complex aspects of network theory is a major virtue of this work. Specific procedures discussed by Taaffe and Gauthier are incorporated within the methodology used for testing the hypothesis of this thesis.

The examination of a port's hinterland is not uncommon. However, the study of seaports as a part of a land transportation network is unique. Since specific examples are not available for background study, general types of network analysis are scrutinized. Such samples of the usage of this methodology to test relationships in land transport networks are common.

Network analysis as a technique is flexible in that it allows the researcher to use various parameters in testing network associations. Intercity phone calls are an example of a data source used by John D. Nystuen and Michael Dacey. Their article entitled "A Graph Theory Interpretation of Nodal Regions" used this data source and network analysis to

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[16] Alan Hay, Transport for the Space Economy (Seattle: University of Washington Press, 1973).

[17] E. J. Taaffe and H. L. Gauthier, The Geography of Transportation (Englewoods Cliffs, Prentice-Hall, 1973).

establish a hierachy of cities using the nodal areas of Washington state and the surrounding nodes of Portland, Oregon and Vancouver, British Columbia.[18] Using an economic base to develop a hierarchy of a set of nodes is a prominent method for measuring the association or dominance of a member to the entire set. In addition to the Nystuen and Dacey, an article by William L. Garrison came into prominance in the 1960's. Titled "Connectivity and the Interstate Highway System"[19], it is one of the more frequent works cited by later authors.

Although network analysis became popular in the 1960's. it is still a current technique. William A. Muraco's 1972 article "Intraurban Accessibility" published in Economic Geography[20] is an example. The growth and change in the transport networks of Indianapolis, Indiana and Columbus, Ohio are evaluated using a distance matrix.

Access to seaports from hinterland cities has not been the subject of investigative research. By using techniques developed and tested on other network problems, a contribution

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[18]John D. Nystuen and Michael Dacey, "A Graph Theory Interpretation of Nodal Regions," Papers and Proceedings of the Regional Science Association 7 (1961) : 29-42.

[19]William L. Garrison, "Connectivity and the Interstate Highway System," Papers and Proceedings of the Regional Science Association, 6 (1960) : 121-37.

[20]William A. Muraco, "Intraurban Accessibility" Economic Geography, 48 (1972) : 388-405.

to further understanding the seaport as a special point in the land transport network will be realized.

Scope, Study Area, and Hypothesis

A total appraisal of all elements contributing to the success or failure of a port is beyond the scope of this investigation. The substance of this paper is confined to the establishment of a representative hinterland for the North Carolina ports of Wilmington and Morehead City, and an analysis of the highway and rail networks between the twenty largest cities in North Carolina and the five port cities mentioned initially.

Establishing a hinterland for a port can be a complex undertaking. Ports may specialize in a few commodities or handle a multitude of different cargoes. Documentation of cargoes moving through North Carolina ports does not facilitate an in-depth study of cargo movement. Information is available, however, that is used to develop a hinterland for each port. Morehead City is a port that specializes in bulk shipments. North Carolina State Ports Authority personnel are able to identify origin and destination of cargoes crossing these wharves. By using 1977 tonnage totals and this identification process, a hinterland of reasonable accuracy is produced.

Wilmington, on the other hand, is more involved with general cargo shipment. As stated earlier, information on the exact movement of cargo is difficult to obtain. General cargo is of high value and is increasingly being containerized to enable faster and easier shipment. Wilmington has entered into the containerized cargo trade in the last year and information in regard to its origin and destination is available. "It is now believed that, on some major transoceanic routes, nearly all of the traffic which is physically capable of being containerized is actually transported in containers."[21] In light of this development, a container hinterland is relevant in respect to future general cargo movement.

The main purpose of this project is to evaluate the hypothesis that North Carolina ports are more accessible in terms of distance to the twenty largest urban centers of the state than the competing ports of Norfolk, Charleston, and Savannah. The technique selected to evaluate the hypothesis is network analysis. Highway and railroad networks between the chosen cities are developed into a matrix for each system and represented as a value graph. This graph is multiplied by itself a successive number of times until a minimum distance for each entry to every other entry is known. The total sum of distance from each node to every other is compiled and ranked. Ranking of the nodes allows

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[21] Harold M. Mayer, "Some Geographical Aspects of Technological Change in Maritime Transportation," Economic Geography 49 (April, 1973): 149.

the composition of a hierarchy of cities to the entire network. From this hierarchy the evaluation of the port cities is accomplished.[22]

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[22] Taaffe and Gauthier, The Geography of Transportation, 138-158.

CHAPTER II

PORT DESCRIPTION

The development of Wilmington and Morehead City has been restricted by the existance of the larger ports of Norfolk, Charleston, and Savannah. These out-of-state ports developed during the early period of colonialization and became the dominant ports within the region.

Historical Background of North Carolina Ports

Several factors contributed to the slow growth of North Carolina ports. Physical features of the coast did not encourage early development during the colonial period. The shape, currents, shoals, stormy weather, barrier beaches, shallow inlets and sounds made access to the colonial ports dangerous.[23] The number of ports, itself, was a hinderance in that with five small river ports operating during this period, no single port could establish itself in a position of dominance. These ports remained small due to interport competition and a trade area restricted to the coastal plain by the fall line of North Carolina's rivers. The coastal plain was not an area of major settlement during early development of the state. Although the climate and soils of the region were conducive to agriculture of crops in demand

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[23]B. E. Logan, "A Historical Geographic Study of North Carolina Ports" (Ph. D. dissertation, University of North Carolina, 1956), p. 2.

at this time, the fear of malaria limited early immigration into the area.[24]

Pioneers moving south from the already established northern colonies settled in the Piedmont, forming a central core for early development of the state. The ports selected to market the commerce of this region were those of Virginia and South Carolina, which were already established and provided good marketing facilities. The road network connected the interior of the state to these ports, whereas, access to North Carolina ports was virtually nonexistant.[25]

The only North Carolina port able to compete for the movement of the piedmont's commerce during this time was Wilmington. The Cape Fear River was navigable for a considerable distance toward Fayetteville and a road was built from the head of navigation to this city. A plank road completed the link to the city of Salem in the Piedmont thus enabling the port to contend for the ocean transit freight generated by the area.[26]

Railroad construction was undertaken in North Carolina between 1830-1860. Nine hundred miles of track were laid during these years with Wilmington being the only port with

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[24]Ibid., pp. 18-21.

[25]Ibid., p. 43.

[26]Ibid., p. 43.

regular service. The Piedmont's commerce was still predominantly moving through out of state ports, even though Wilmington did have access to this region.

As a result of being able to attract some of the commerce, from the interior of the state, Wilmington was the only port of the colonial era to survive. The major period of growth for the port was in the 1860's. As a Confederate haven for blockade runners during the civil war, the port began to grow. More important was the postwar demand for naval stores brought to the port by rail and the movement of coastal plain agricultural products to world markets. Cotton was the dominant crop and remained so until the 1930's. By 1905 the port was fourth in cotton exports in the United States. Further growth was enhanced by the consolidation of the Atlantic Coast Line and the Seaboard Air Line in the early 1900's. This merger improved service to Wilmington and decreased shipping rates within the state.[27]

Growth continued until the 1930's when the United States' tariff policy on cotton encourage foreign markets to buy from other nations. Tobacco then became the most important cargo in terms of value to the port. In the 1950's petroleum came on the scene to become the most valuable cargo moved through the port.[28]

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[27]Ibid., p. 83.

[28]Ibid., pp. 96, 111, 117.

Port Facilities

The port facilities of Wilmington are one-half the physical size of its smallest out-of-state competitor, Charleston. The physical features of the port are of two parts, the private docks not controlled by the state and the public docks under the direct supervision of the North Carolina Ports Authority. The private wharves are almost totally involved with the movement of bulk commodities such as petroleum products, iron ore, and cement (see Figures 1 and 2). Bulk items crossing the public wharves are metal scrap, chemicals, tobacco, lumber, pulp, phosphate, iron and steel (see Figures 3 and 4). General cargo, a major area of emphasis at the public facility, grew significantly in volume during the 1960's. The quantity of shipments of this high value cargo grew from 24,000 tons in 1961 to 100,000 tons by 1972.[29] It is this type of cargo that is conducive to containerized shipment and Wilmington provides this service to its' customers. At present the port owns one container crane and additional adapters to conventional cranes to move this form of cargo (see Figures 5, 6, 7, 8, and 9). While this small amount of equipment does limit efficiency to some degree, projected expenditures include

[29] Paul F. Mulligan and Raymond L. Collins, "Impact of North Carolina Ports on the North Carolina Economy" (Raleigh: North Carolina Deport of Transportation and Highway Safety, 1975), pp. 3-1, 3-31.

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Figure 1: Petroleum unloading facility at the Wilmington port (T-head pier, private facility). All photographs within the text were taken by Everett T. Wall.

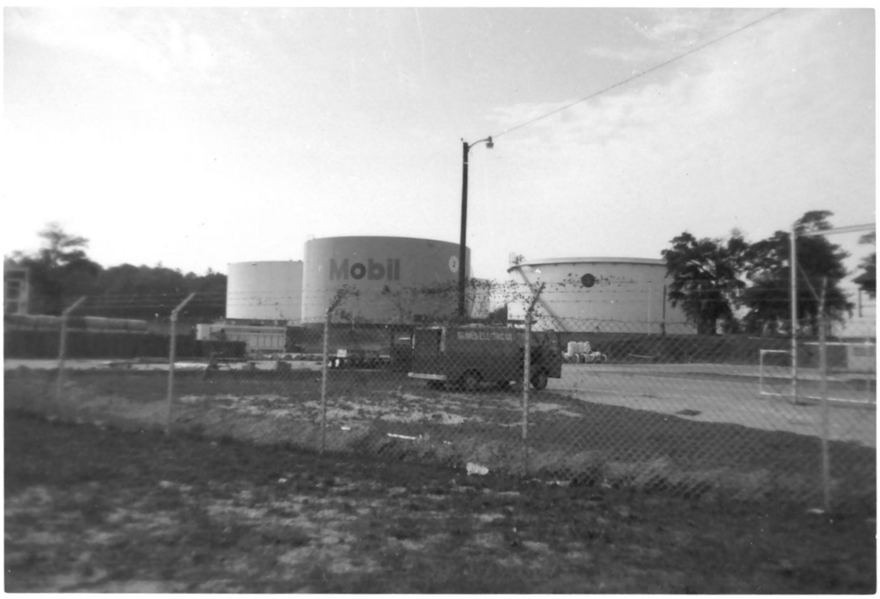

Figure 2: Private Petroleum storage facilities at the Wilmington port.

Figure 3: Loading of tobacco hogsheads at the Wilmington port.

Figure 4: Tobacco fumigation facility at the Wilmington port.

Figure 5: Simultaneous unloading of a container ship at the Wilmington port by a container crane and a gantry crane with an adapter for container handling.

Figure 6: Container crane unloading the middle section of a container ship at the Wilmington port.

Figure 7: Gantry crane unloading the fore section of a container ship at Wilmington port.

Figure 8: Special adapter that enables gantry cranes to load and unload containerized cargo.

Figure 9: Specialized piece of equipment utilized for stacking containers in storage areas.

procuring of additional container cranes and related support equipment.[30]

Morehead City, the second port of the North Carolina State Ports Authority (S.P.A.), does not have the historical heritage of its' counterpart Wilmington. It first entered the ocean freight trade in 1935. It became part of the S.P.A. in 1945 and became operational in 1952.[31] Private facilities at this port are small in size. They are presently limited to moving jet fuel for Cherry Point Marine Air Station and kerosene and pulp for commercial usage.[32] The public docks are oriented to the movement of bulk cargo. A significant commodity of the port is phosphate which accounts for over 50% of the total tonnage at the port. Lumber (construction grade), liquid sulfur, fishmeal, and tobacco are examples of principle cargoes imported to Morehead. Tobacco is of special importance because of its' high value and the revenue it provides due to special services rendered at the port. Containerization of tobacco exports in the future is viewed with interest by the port management. This process would diminish traffic peaks and also diminish seasonal variation in demand for labor. Few insurance claims as a result of less handling by port personnel would be a benefit as well as the ability to ship tobacco in smaller lots at

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[30] North Carolina States Ports Authority, unpublished report, Raleigh, 1977.

[31] Logan, "History of N.C. Ports," pp. 128-9.

[32] Mulligan and Collins, "Impact of N.C. Ports," pp. 2-10.

any time of the year. At present one container crane is operational at the port; but materialization of this anticipated change in tobacco handling has been slow (see Figure 10).[33] Limited use of the container crane at the Morehead City port has resulted in a decision to move this piece of specialized equipment to the Wilmington port by the governing board of the North Carolin State Ports Authority. Local opposition to the anticipated move by those people interested in the development of the Morehead City port may stop the intended move. At this point in time (May 1979) the conflict is unresolved.

General cargo at Morehead City has been negligible in the last decade despite attempts to attract this trade.[34] The port, at present, seems destined to handle only bulk cargoes.

The regional ports that compete for North Carolina's ocean commerce are Norfolk, Charleston, and Savannah. It is true that other Atlantic coast ports, such as New York, ship cargoes to and from the state, but this study is limited to North Carolina ports and the surrounding regional ports.

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[33] Mulligan and Collins, "Impact of N. C. Ports," pp. 3-6, 3-29.

[34] Mulligan and Collins, "Impact of N. C. Ports," p. 3-31.

Figure 10: Container crane at the Morehead City port.

Norfolk, the headquarters of the Virginia Ports Authority (V.P.A.) is the largest of the regional ports. This developmental and promotional Authority owns the terminals and equipment of its' states ports as do all the ports within this study. V.P.A. differs from the other state port authorities in that it leases all its terminals to private operators. These facilities include Norfolk International Terminal, Lambert's Point Docks, Portsmouth Marine Terminals, Sewell's Point Facility and Newport News Terminals. All of these encompass an area called Hampton Roads and provide berths for 42 ships. Container services at this complex are expedited by the utilization of eight container cranes, backed up by ample support equipment and storage space.[35]

Charleston, South Carolina has been developed as the primary port of the South Carolina Ports Authority. Three terminals are operated by this orgnaization. They are Columbus Street Terminal, North Charleston facilities, and Union Pier. This combination of terminals provides berths for 22 ships at any one time. A new facility on the Wando River is expected to be completed by 1980 and will enable even more ships to be in port at any one time.

All types of cargo are transported through this port, including grain, which moves through a modern elevator

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[35]North Carolina States Ports Authority, unpublished report, Raleigh, 1977.

and dispensing system. Containerized cargo is an important aspect of the port's general cargo trade. This operation is equipped with five container cranes on location, with four more planned for expansion of this service.[36]

The state of Georgia's largest port, Savannah, also handles North Carolina trade. The ports authority of this state operates three terminals: Garden City Terminal, Ocean Terminal, and Container Central. Twenty-seven berths are included within these facilities. Again, all types of cargo are unloaded in this port and two container cranes, with a projected increase of two additional cranes, service the container trade.[37]

Identification of Trade Areas of North Carolina Ports

The five regional ports of this study consider North Carolina as part of their hinterlands. "A hinterland can be described as an organized and developed land space which is connected with a port by means of transportation lines, and which receives or ships through that port."[38] This simple definition of a hinterland leaves out a great deal to be considered. It is probably more accurate to state that a port's hinterland is, in reality, a series of hinterlands, one each for every commodity that enters into

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[36]Ibid.

[37]Ibid.

[38]Weigand, "Port Geography," pp. 192-3.

the port's trade. The boundaries of each are not static, but variable and dependent upon political and economic conditions of the port.[39] From these statements one can surmise that determination of a port's hinterland is a complex undertaking. This complexity is further complicated by the lack of raw data in a form conducive to the orderly composition of accurate trade areas. In 1963 Donald C. Darton wrote a journal article titled "We Can Have Hinterland Data." This essay highlights the deficiencies within various governmental agencies regarding collection of data pertinent to movement of cargo through United States ports. Darton's recommendations have not been adopted and accurate information regarding cargo movement through ports is still almost impossible to obtain. Often it is possible to establish a representative hinterland or series of such using data not generally available to the public. Such is the case with studies cited by Darton in his article. The information used to ascertain trade areas for North Carolina ports is of such an origin.

Although exact data regarding the movement of import and export cargoes within the state is not available, information furnished by the North Carolina States Ports Authority (S.P.A.) is used to construct sample hinterlands for both ports. The relatively small number of bulk items moving through Morehead City enables the S.P.A. to determine

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[39] Morgan, Ports and Harbours, p. 111.

origins and destinations for these few commodities with a reasonable degree of accuracy. Wilmington on the other hand is a much more diversified port with many types of cargo crossing its' wharves. Much of the trade of this port is of the general freight type. Considered the cream of the crop in regards to cargo, this classification type produces higher revenues per ton than other types.[40] Also it is conducive to containerization, a packaging process that has become important to the shipping industry in recent years.

Due to the importance of the impact of this technological innovation upon shipping and the desire of the S.P.A. to increase its' share of North Carolina container trade, data has been collected regarding the movement of containers in and out of the state for the year 1977. This information identifies the counties within the state receiving or sending containerized shipments and the port through which the cargoes passed. Such information enables the determination of Wilmington's containerized cargo hinterland. This type of cargo is of consequence now at Wilmington, and promises to be increasingly important in the future. An examination of containerized general cargo will demonstrate the range of service from Wilmington and competing ports. The

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[40]Donald J. Patton, "General Cargo Hinterlands of New York, Philadelphia, Baltimore, and New Orleans," Association of American Geographers 48 (1958): 436.

relevancy of this effort is outstanding, since the amount of general liner cargo estimated to be containerized by 1980 is 61%.[41]

"The essence of containerization is the application of mass production techniques to freight shipment. It requires the handling of a box of standard dimensions in a controlled system which embraces as much of the ultimate objective (door-to-door transfer) as possible."[42] The process, itself, is a capital intensive operation, requiring special ships, port equipment, and the containers, of standard design. An advantage of the system is the savings in handling of the cargo. The labor force for loading and unloading is of smaller size and constant number. This facilitates the employment of contract labor rather than the day-to-day longshoremen used in conventional loading crew. Benefits of this type of employment are less union problems and a consistant work force of experienced labor.[43] Other positive features of the process are the fast speed (25 to 28 knots) and shallow draft (33 to 35 feet) of the ships designed specifically for this trade. The containers can

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[41]Organization for Economic Co-Operation and Development, Developments and Problems of Seaborne Container Transport 1970, Maritime Transport Committee, 1971.

[42]Iain Wallace, "Containerization at Canadian Ports," Association of American Geographers 65 (1975): 434.

[43]Ibid. 434-443.

Figure 11: Container crane unloading containers onto truck bodies for transshipment.

Figure 12: Containers secured on special railroad cars awaiting transshipment.

be carried overland by railroad or truck allowing ease of transfer to and from inland cities (see Figures 11 and 12).[44]

With containerized cargo constituting such an important technological advance, it is natural that the industries of North Carolina have adopted this system. In 1977, 35,749 containers, moving through the five regional ports, were generated by businesses within the state. Thirty-six counties of the state were the origin or destination for these shipments. Other containers moved through the state by way of ports not examined in this survey. Also additional containers moved to and from areas outside North Carolina through state ports. The analysis of container traffic within the state, through state ports indicated, is the focal point of the hinterland study and the data on container movement is limited to such.

Wilmington's 1977 share of the state trade in containerized general cargo was 31%. Imports and exports were almost evenly divided with exports representing 15.9% of total and imports composing the remaining 15%. The largest competitor for the state's trade was Norfolk with 45.3% of the total. Charleston was next with 18.5% and Savannah followed with 4%. Morehead City is included within the total with 1.9% but its' share of this market is negliable.

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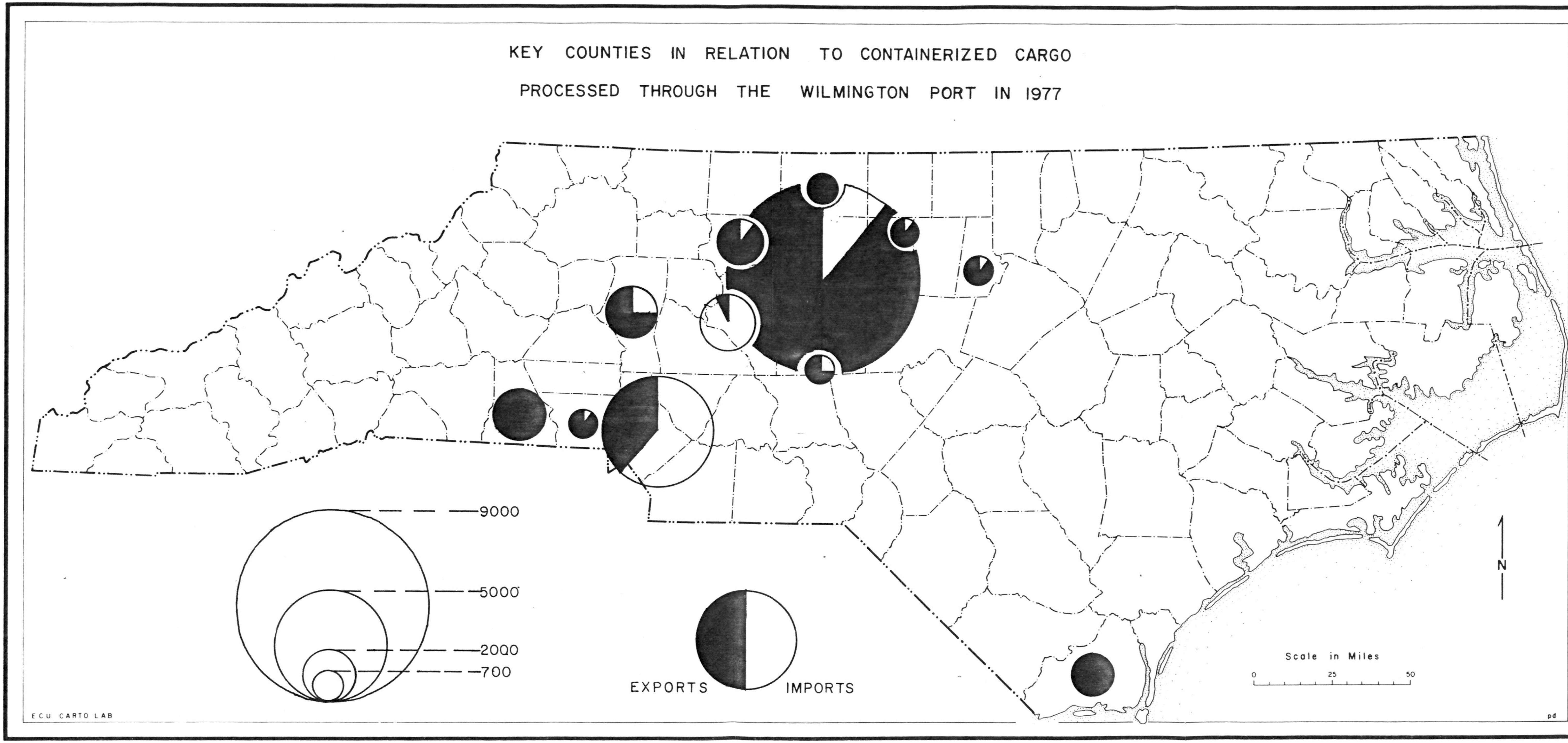
[44]Harold M. Mayer, "Some Geographic Aspects of Technological Change in Maritime Transportation," Economic Geography 49 (1973): 146-155.

In the trade area represented by the origins and destinations of the containers, twelve counties account for 77% of the total volume. These dominant counties include Guilford, Mecklenburg, Davidson, Iredell, Forsyth, Cleveland, Gaston, Randolph, Durham, Alamance, and Rockingham. Of the twelve, eleven counties are within the Piedmont region of the state. The only county not located in this area is Brunswick County of the coastal plain. The percentage of container trade of this key region moving through Wilmington is relatively constant with statewide container movement through the port at 29%.

This band of counties, excepting Brunswick, crossing the state along the Piedmont is an area of industrialization. Competition for trade is keen as evidenced by the division of business between the regional ports. Wilmington competes for a significant portion of this key trade area but is strongly challenged by Norfolk and Charleston. It is notable that Wilmington does transfer some containers from every county of the region as does Norfolk (see Figure 13). Charleston's competitive advances are more restricted to the southern counties of Mecklenburg, Gaston, and Cleveland. By controlling a meaningful portion of the container traffic in this industrial region, Wilmington has demonstrated its ability to contend with Norfolk and Charleston.

Fig. 13


KEY COUNTIES IN RELATION TO CONTAINERIZED CARGO
PROCESSED THROUGH THE WILMINGTON PORT IN 1977
9000
5000
2000
700
EXPORTS
IMPORTS
N
Scale in Miles
0
25
50
ECU CARTO LAB
pd

Morehead City is primarily a bulk cargo port. As such, the number of different commodities moving through the port is small. Using data supplied by the S.P.A. for the year 1977, it is possible to identify both the origins and destinations of cargo moving through the public sector. Examination of this information reveals that most of the counties using this port are located in the coastal plain region near the port itself (see Figure 14). The only counties outside the coastal plain shipping cargo through the port are Catawba county, which imports lumber, and Forsyth which imports tobacco. A large percentage of the port's business is concentrated in three counties, Craven, Carteret, and Beaufort. These counties are located close to the port and a few local activities dominant the port's trade. These include the phosphate mines in Beaufort county and lumber and paper industry within Craven County (see Figures 15, 16, 17, and 18). Also important in terms of revenue is the tobacco exported from Wilson, Pitt, Edgecombe, and Nash counties. Some tobacco originates in Danville, Virginia and exits through the port.

The number of imports is very small with petroleum products dominating the total tonnage. Individual products include asphalt and bunker C oil which are both used locally.

Exports are also limited in scope with the already mentioned phosphate, lumber, pulp, and tobacco composing

Fig. 14

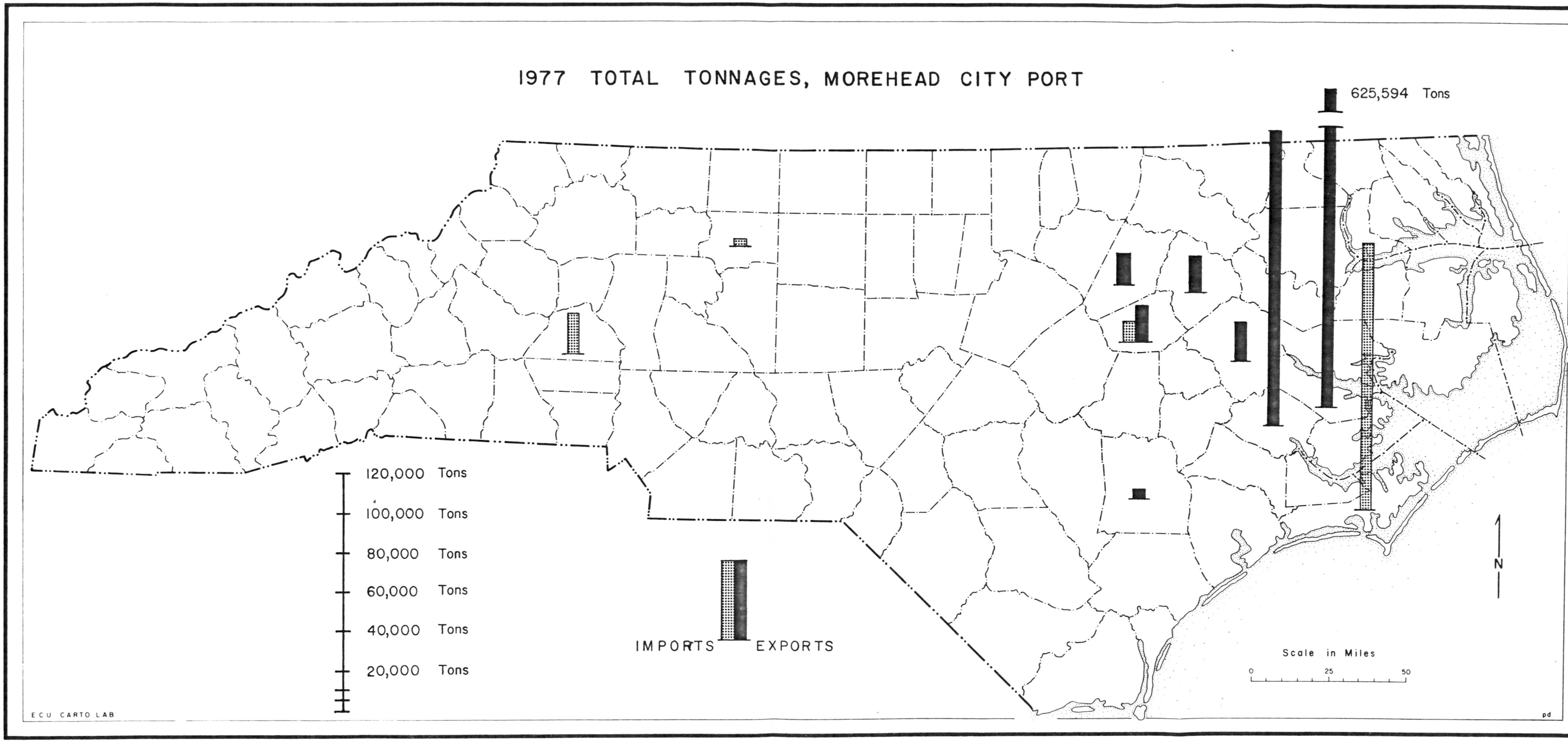

1977 TOTAL TONNAGES, MOREHEAD CITY PORT
625,594 Tons
120,000 Tons
100,000 Tons
80,000 Tons
60,000 Tons
40,000 Tons
20,000 Tons
IMPORTS
EXPORTS
Scale in Miles
0
25
50
N
ECU CARTO LAB
pd

Figure 15: Dockside phosphate conveyor at the Morehead City port.

Figure 16: Phosphate storage facility at the Morehead City port.

Figure 17: Phosphate barge from local mine waiting to unload into the storage facility at the Morehead City port.

Figure 18: Imported lumber at the Morehead City dock.

most of the total. Only peanut meal and strapping steel are not associated with or are a derivative of the aforementioned exports.

CHAPTER III

CONSTRUCTION OF THE ABSTRACTED TRANSPORTATION MODEL

A port is the point of modal transfer of cargoes between land and ocean transit. Serving this function entails providing facilities and services to both modes. Movement of cargo results in economic opportunities for the port city and surrounding region; thus, it is natural for a port city to attract as much traffic as possible. Often this leads to competition between neighboring ports.[45] Relative accessibility of North Carolina's inland cities to seaports is a factor influencing the competitive position of ports seeking the state's trade. Granted this is only one factor contributing to the economic position of a particular port, but it is one that is significant. The ability to transport manufactured products or bulk commodities from a city within the state to a port or vice versa is vital to the state's economy. Determination of the optimum seaport in terms of distance from the twenty largest cities of North Carolina to the Atlantic coast ports of Wilmington, Morehead City, Norfolk, Charleston and Savannah is the goal of this research effort. This goal is accomplished by subjecting the highway and railroad system connecting the involved cities to

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[45] Guido G. Weigand, "Some Elements in the Study of Port Geography," Geographic Review, 48 (1958): 185.

network analysis. Obviously, it is an advantage for any port to have the shortest and most direct route to the cities of the contested hinterland. Common sense substantiates this statement while "studies dealing with spatial effects of social interaction have shown that distance between individuals (or cities) is important. As physical and social distance increase between participants, interaction is likely to decline."[46]

Origin of Data

Both the railroad and highway networks used in this study are derived from actual maps of the two systems. Each includes the twenty largest urban centers within the state as defined by level of population based on 1976 estimate by the North Carolina Department of Administration, Division of State Budget and Management.[47] One of the port cities, Wilmington, is contained within this group. Additionally, the remaining port cities complete the set.

In the initial composition of the model networks, the direct linkages between the cities are of major importance. It is from these linkages that all others are derived. The existance of a link (defined as a route with

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[46]Fredrick P. Staz, "Distance and Network Effects on Urban Social Travel Fields," Economic Geography, 49 (April, 1973): 134.

[47]North Carolina, North Carolina Municipal Population, (1977), Table 2.

no intervening nodes between the two points of origin) is determined by examination of a highway map in the case of the road system. Naturally there are many more cities in North Carolina than those selected and a multitude of possible connections between them. Thus the network analyzed is an abstraction of the real highway network (see Figure 19). Direct linkages are obtained for the abstracted network by viewing a 1977 North Carolina state highway map to ascertain if a plausible route between the two cities in question exists. To qualify as a direct route, the route between two cities or nodes must not be intersected by another member of the set and the highway, itself, must be considered a primary route, primary meaning the most likely access route for actual transport. Examples of such are multilane highways, primary two-lane trunk roads, and important secondary roads that connect a significant portion or area of the state. Secondary roads with a maze of connections and intersections are not considered direct routes.

The railroad network constructed for this study is also an abstraction of reality (see Figure 20). Using the same cities as the highway network, direct routes between cities or nodes are determined in a similar manner. The shortest direct routes between member cities are established if they exist. Judgement was used in the definition of these routes. It is true that railroad tracks within the state are the private property of individual railroad companies and not

Figure 19

SCHEMATIC HIGHWAY NETWORK

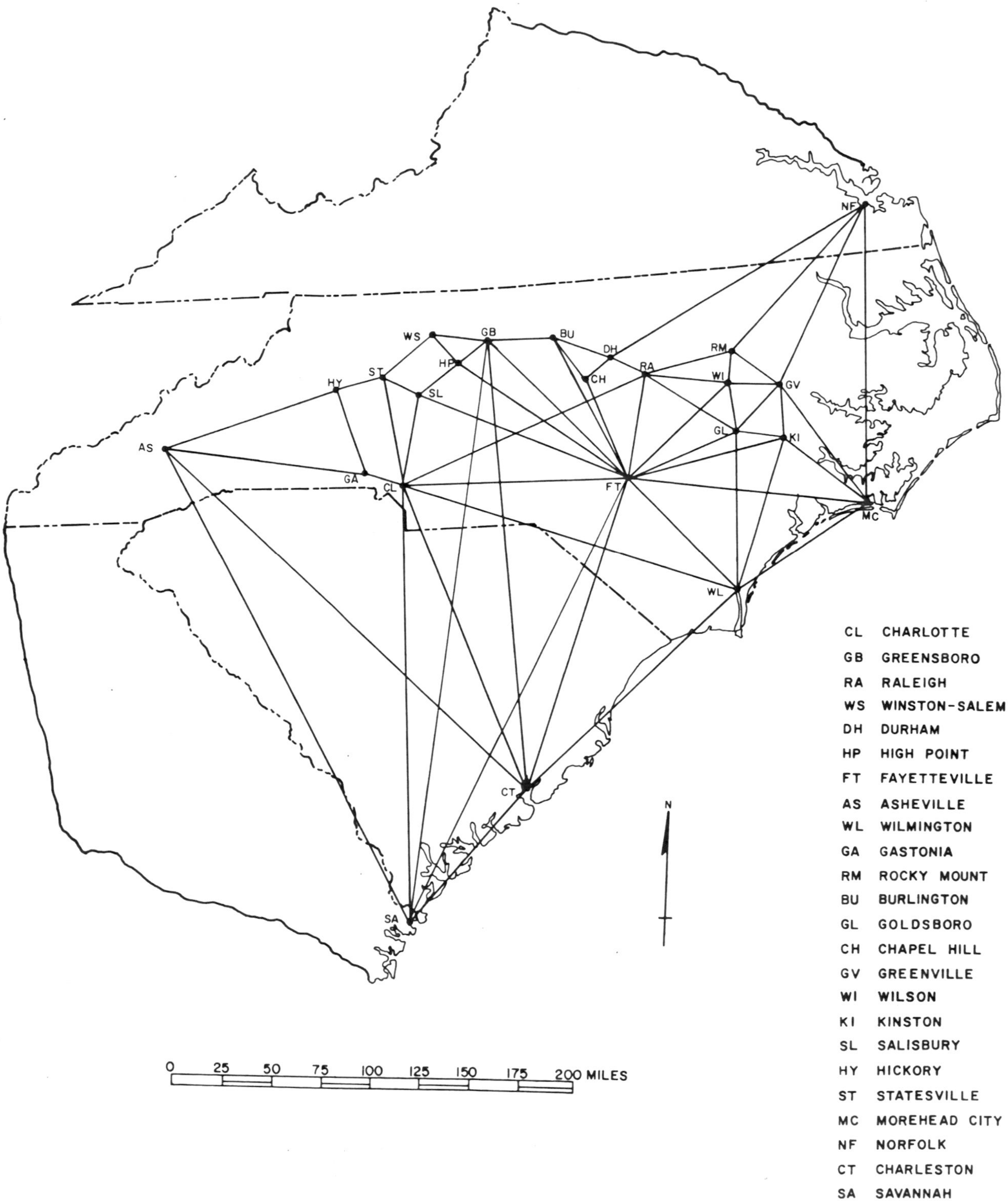
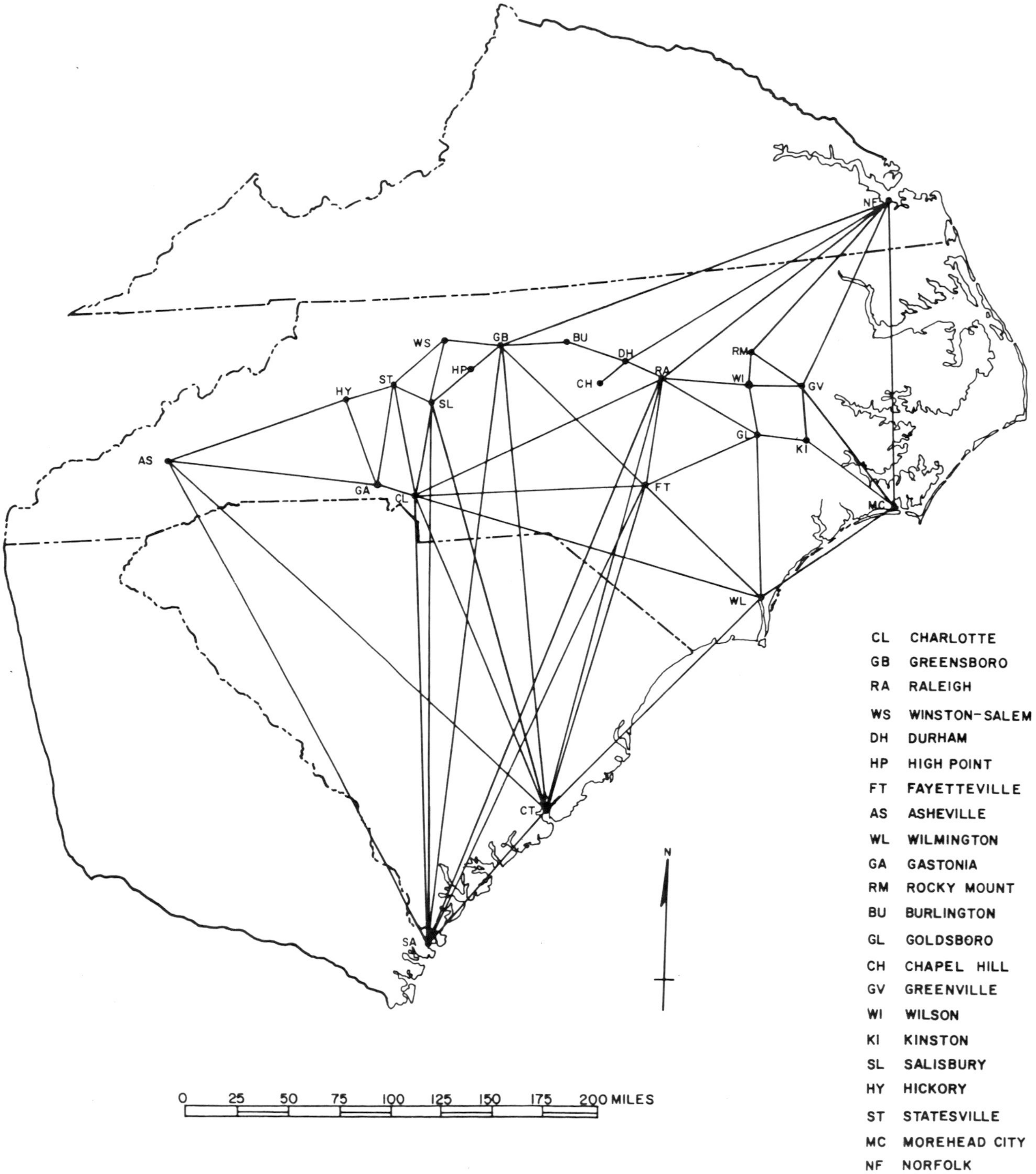


Figure 20

SCHEMATIC RAILROAD NETWORK



CL CHARLOTTE
GB GREENSBORO
RA RALEIGH
WS WINSTON-SALEM
DH DURHAM
HP HIGH POINT
FT FAYETTEVILLE
AS ASHEVILLE
WL WILMINGTON
GA GASTONIA
RM ROCKY MOUNT
BU BURLINGTON
GL GOLDSBORO
CH CHAPEL HILL
GV GREENVILLE
WI WILSON
KI KINSTON
SL SALISBURY
HY HICKORY
ST STATESVILLE
MC MOREHEAD CITY
NF NORFOLK
CT CHARLESTON
SA SAVANNAH

subject to unrestrained access. However, it is possible to move cargo between various locations by transfer of cargo between several railroad lines. Therefore, it is assumed, for the purpose of this study, that the cooperation between companies constitutes the same thing as freedom of movement between rail systems.

Since the gradient of North Carolina roadways generally allows maximum speed by vehicles, the parameter mileage is used as a data source. Highway mileage for direct connections is compiled from the 1977 North Carolina State Highway Map and highway maps of the states of Virginia, South Carolina, and Georgia. Railroad mileage is procured from the 1977 map of North Carolina Railroads prepared by the North Carolina Utilities Commission. Distances to the out-of-state ports are computed from the maps of the 1978 Commercial Atlas and Marketing Guide.[48]

Road quality can be a significant factor in the choice of routes or in the selection of destinations by those responsible for decisions on highway movement of port bound cargoes. In respect to this factor two matrices for the highway network are compiled. The first is based on mileage obtained directly from a map with no regard to road quality, whereas, the second is weighted to determine the impact of interstate and four lane highways upon the

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[48] 1978 Commercial Atlas and Marketing Guide (Chicago: Rand McNally and Company, 1978), pp. 477-78 and 530-31.

abstracted system.

In the weighted highway matrix the distances between cities and adjusted, dependant upon the amount of interstate and four lane highway on each route. Mileage is calculated using the formula one map mile = one mile on two lane road, one map mile = .88 mile on four lane roads, and one map mile = .76 mile on interstate highway. These numbers are derived from the average truck speeds for the terrain of North Carolina used by Curtis C. Harris, Jr. in his book Regional Economic Effects of Alternate Highway Systems.[49]

Methodology

The networks constructed and the information concerning the shortest direct connections between nodes are abstracted as a graph and represented as a matrix. In this initial stage the matrix, twenty-four cells by twenty-four, contains only direct route connections. All other positions within the matrix are incomplete. A direct shortest path between each member of the set and all other members is an impossibility. Therefore, it is the next step to identify the shortest two stage links where they exist within the system. This step is accomplished by computation.

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[49]Curtis C. Harris, Jr., Regional Economic Effects Of Alternative Highway Systems (Cambridge, Mass., Ballinger Publishing Company, 1974), p. 118.

The process entails the element by element addition of each member of a row by a member of the column side of the matrix. From this series of additions the minimum two-link value is established and inserted in the appropriate position within the second matrix. For example in Figure 21 to determine if a two-stage link is present between Raleigh and Wilmington, each element of the row WL and column RA is added. The resulting combinations are 203 + 143 = 347, 0 + 0 = Ø (Ø meaning no connection) 0+0=Ø, 0+0=Ø, 23+0=Ø, 0+0=Ø, 59+92=151, 0+0=Ø, 0+0=Ø, 0+0=Ø, 53+0=Ø, 0+0=Ø, 50+89=139, 0+28=Ø, 0+0=Ø, 0+47=Ø, 89+0=Ø, 0+0=Ø, 0+0=Ø, 0+0=Ø, 87+0=Ø, 0+0=Ø, 165+0=Ø, 0+0=Ø. The minimum value in this case is 139 miles. This indicates that there is a two-stage link of 139 miles between the two cities.[50]

The two-stage links derived in this manner are added to one-stage links of the original matrix to form a new matrix consisting of the shortest paths of both stages of linkage. Successive powers of the matrices are calculated until the distance from each node to every other node is computed. In the final matrix all cells are filled with the exception of those which concern a node's linkage to itself. The formula used to derive the two stage linkages is:

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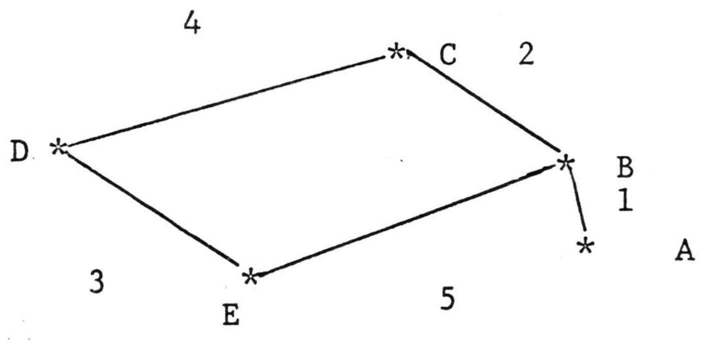
[50] Taaffe and Gauthier, Geography of Transportation, pp. 138-48.

$$\sum_{k=1}^{N} l_{ik} \cdot l_{jk} = \min (l_{ik} + l_{jk})$$

Simplified this formula means that the cell ij value is the minimum value of the sums of possible two stage links from origin ik and the destination ij. Further stages of linkage are identified by using the formula until all shortest paths between each node and every other is known. Upon completion of the matrix, each row is summed to determine a figure that represents the total number of miles from each node to the entire system. This figure is the basis for the establishment of a hierarchy of accessibility from the members of the entire set. Evaluation of the port cities positions to the total network is accomplished through this index.[51]

A simplified example of the preceeding methodology may clarify any questions resulting from the discussion of this process. In the example it will be assumed that a network of five separated cities exist. These cities are connected by roads in the manner illustrated below and are named City A,B,C,D, and E. In addition the distance in miles connecting the various cities is labeled.



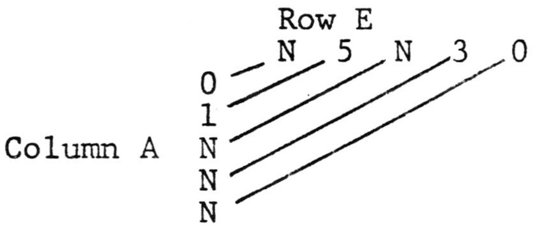
[51]Ibid.

The initial matrix for this network would be as follows:

	A	B	C	D	E
A	0	1	N	N	N
B	1	0	2	N	5
C	N	2	0	4	N
D	N	N	4	0	3
E	N	5	N	3	0

N represents no connection

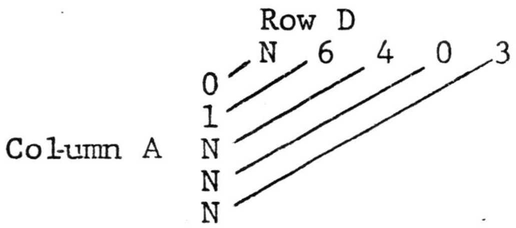
To determine the shortest two-stage path between the cities E and A, the column A and the row E are added together in pairs to ascertain if a route exist. The following pairings would exist.



These pairs will produce the following combinations: 0 + N = N (N = no connection), 1 + 5 = 6, N + N = N, N + 3 = N, N + N = N. Thus the two stage connection between cities A and E is 6 miles. If all of the positions of the initial matrix that are incomplete are subjected to this form of computation the following matrix representing the connection of one and two stage links would result:

	A	B	C	D	E
A	0	1	3	N	6
B	1	0	2	6	5
C	3	2	0	4	7
D	N	6	4	0	3
E	6	5	7	3	0

To demonstrate the progression of linkages a three-stage link for the example network is calculated. In this step the second stage matrix is paired with the original one-stage matrix to produce the three-stage matrix. The calculation of the position DA, which is the connection between the cities D and A, illustrates this process. To accomplish this row D from the second-stage matrix and column A from the initial matrix are paired and inspected to determine if this incomplete position DB can be completed in the third level matrix. The following pairs result;



The combinations produced by these pairings are 0 + N = N, 1 + 6 = 7, N + 4 = N, N + 0 = N, and N + 3 = N. In this particular instance the progression to the third-stage linkage completes the matrix. In a more complete network it can take many stages to completion.

Once the matrix is complete, as in the example, a composite number or index can be calculated to identify the optimum city of the network in terms of distance to all the other cities. A hierarchy of cities for the network can be determined from this calculation. The completed example network below illustrates this concept. In this final matrix the shortest distances from all points to every other point has been compiled. These figures are summed for every city to provide a total figure which represents the total mileage from this city to all others in the network.

	A	B	C	D	E	
A	0	1	3	7	7	18
B	1	0	2	6	5	14
C	3	2	0	4	7	16
D	7	6	4	0	3	20
E	6	5	7	3	0	21

In the example network city B is the most accessible in terms of distance.

Matrices of the Transportation Networks

The following pages contain the matrices of the highway, weighted highway, and railroad networks. For each type of network, an intial matrix composed of direct links and a completed matrix composed of the initial matrix and the successive multiple connections calculated by the methodology previously discussed are shown. A computer program was used to accomplish the calculation of the final matrix in order to speed up the mathematical process and to minimize human error. This program was based on the procedures discussed by T. C. Hu in his article "Revised Matrix Alogrithms for Shortest Paths."[52]

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[52] T. C. Hu, "Revised Matrix Algorithms for Shortest Paths," Siam Journal of Applied Mathematics 15 (January 1967): 207-18.

Figure 21

Initial Highway Matrix

	CL	GB	RA	WS	DH	HP	FT	AS	WL	GA	RM	BU	GL	CH	GV	WI	KI	SL	HY	ST	MC	NF	CT	SA	TOTAL
CHARLOTTE (CL)	0		143				141		203	20								42		43			215	235	
GREENSBORO (GB)		0		19		17	91					21											250	320	
RALEIGH (RA)	143		0		23		59				53		50	28		47									
WINSTON-SALEM (WS)		19		0		19														48					
DURHAM (DH)			23		0						67	34		12								175			
HIGH POINT (HP)		17		19		0	100											35							
FAYETTEVILLE (FT)	141	91	59			100	0		92			82	59	67		76	78	128			144		185	280	
ASHEVILLE (AS)								0	95										74				275	300	
WILMINGTON (WL)	203						92		0				89				89				87		165		
GASTONIA (GA)	20							95		0									44						
ROCKY MOUNT (RM)			53		67						0				41	18						115			
BURLINGTON (BU)		21			34		82					0		26											
GOLDSBORO (GL)			50				59		89				0		49	26	27								
CHAPEL HILL (CH)			28		12		67					26		0											
GREENVILLE (GV)											41		49		0	38	28				79	140			
WILSON (WI)			47				76				18		26		38	0									
KINSTON (KI)							78		89				27		28		0				70				
SALISBURY (SL)	42					35	128											0		26					
HICKORY (HY)								74		44									0	28					
STATESVILLE (ST)	43			48														26	28	0					
MOREHEAD CITY (MC)							144		87						79		70				0	195			
NORFOLK (NF)					175						115				140						195	0			
CHARLESTON (CT)	215	250					185	275	165														0	105	
SAVANNAH (SA)	235	320					280	300															105	0	

Figure 22

Completed Highway Matrix

		CL	GB	RA	WS	DH	HP	FT	AS	WL	GA	RM	BU	GL	CH	GV	WI	KI	SL	HY	ST	MC	NF	CT	SA	TOTAL
CHARLOTTE	(CL)	0	94	143	91	149	77	141	115	203	20	196	115	193	141	228	190	219	42	64	43	285	311	215	235	3510
GREENSBORO	(GB)	94	0	75	19	55	17	91	169	183	114	122	21	125	47	160	122	152	52	95	67	222	230	250	320	2802
RALEIGH	(RA)	143	75	0	94	23	92	59	244	139	163	53	54	50	28	85	47	77	127	170	142	147	168	244	349	2763
WINSTON-SALEM	(WS)	91	19	94	0	74	19	110	150	202	111	141	40	144	66	179	141	171	54	76	48	241	249	269	326	3015
DURHAM	(DH)	149	55	23	74	0	72	79	224	162	169	67	34	73	12	108	70	100	107	150	122	170	175	264	359	2818
HIGH POINT	(HP)	77	17	92	19	72	0	100	163	192	97	139	38	142	64	177	139	169	35	89	61	239	247	267	312	2947
FAYETTEVILLE	(FT)	141	91	59	110	79	100	0	256	92	161	94	82	59	67	106	76	78	128	182	154	144	209	185	280	2933
ASHEVILLE	(AS)	115	169	244	150	224	163	256	0	318	95	291	190	294	216	329	291	321	128	74	102	391	399	275	300	5335
WILMINGTON	(WL)	203	183	139	202	162	192	92	318	0	223	133	174	89	159	117	115	89	220	267	246	87	248	165	270	4093
GASTONIA	(GA)	20	114	163	111	169	97	161	95	223	0	216	135	213	161	248	210	239	62	44	63	305	331	235	255	3870
ROCKY MOUNT	(RM)	196	122	53	141	67	139	94	291	133	216	0	101	44	79	41	18	69	174	217	189	120	115	279	374	3272
BURLINGTON	(BU)	115	21	54	40	34	38	82	190	174	135	101	0	104	26	139	101	131	73	116	88	201	209	267	341	2780
GOLDSBORO	(GL)	193	125	50	144	73	142	59	294	89	213	44	104	0	78	49	26	27	177	220	192	97	159	244	339	3138
CHAPEL HILL	(CH)	141	47	28	66	12	64	67	216	159	161	79	26	78	0	113	75	105	99	142	114	175	187	252	347	2753
GREENVILLE	(GV)	228	160	85	179	108	177	106	329	117	248	41	139	49	113	0	38	28	212	255	227	79	140	282	386	2726
WILSON	(WI)	190	122	47	141	70	139	76	291	115	210	18	101	26	75	38	0	53	174	217	189	117	133	261	356	3159
KINSTON	(KI)	219	152	77	171	100	169	78	321	89	239	69	131	27	105	28	53	0	204	247	219	70	168	254	358	3549
SALISBURY	(SL)	42	52	127	54	107	35	128	128	220	62	174	73	177	99	212	174	204	0	54	26	272	282	257	277	3236
HICKORY	(HY)	64	95	170	76	150	89	182	74	267	44	217	116	220	142	255	217	247	54	0	28	317	325	279	299	3927
STATESVILLE	(ST)	43	67	142	48	122	61	154	102	246	63	189	88	192	114	227	189	219	26	28	0	289	297	258	278	3442
MOREHEAD CITY	(MC)	285	222	147	241	170	239	144	391	87	305	120	201	97	175	79	117	70	272	317	289	0	195	252	257	4772
NORFOLK	(NF)	311	230	168	249	175	247	209	399	248	331	115	209	159	187	140	133	168	282	325	297	195	0	394	489	5660
CHARLESTON	(CT)	215	250	244	269	264	267	185	275	165	235	279	267	244	252	282	261	254	257	279	258	252	394	0	105	5753
SAVANNAH	(SA)	235	320	339	326	359	312	280	300	270	255	374	341	339	347	386	356	358	277	299	278	357	489	105	0	7302

Figure 23

Initial Weighted Highway Matrix

		CL	GB	RA	WS	DH	HP	FT	AS	WL	GA	RM	BU	GL	CH	GV	WI	KI	SL	HY	ST	MC	NF	CT	SA	TOTAL
CHARLOTTE	(CL)	0		143				131		188	15								32		33			178	195	
GREENSBORO	(GB)		0		14		13	85					16											200	253	
RALEIGH	(RA)	143		0		18		48				46		45	25		44									
WINSTON-SALEM	(WS)		14		0		19														36					
DURHAM	(DH)			18		0						65	26		11								152			
HIGH POINT	(HP)		13		19		0	100											27							
FAYETTEVILLE	(FT)	141	85	48			100	0		83			82	48	67		61	78	128			143		141	206	
ASHEVILLE	(AS)								0		87									58				209	229	
WILMINGTON	(WL)	188						83		0				89				89				87		156		
GASTONIA	(GA)	15							87		0									44						
ROCKY MOUNT	(RM)			46		65						0				41	14						115			
BURLINGTON	(BU)		16			26		82					0		26											
GOLDSBORO	(GL)			45				48		89				0		49	26	23								
CHAPEL HILL	(CH)			25		11		67					26		0											
GREENVILLE	(GV)											41		49		0	38	25				75	140			
WILSON	(WI)			47				61				14		26		38	0									
KINSTON	(KI)							78		89				23		25		0				64				
SALISBURY	(SL)	32					27	128											0		26					
HICKORY	(HY)								58		44									0	21					
STATESVILLE	(ST)	33			36														26	21	0					
MOREHEAD CITY	(MC)							143		87						75		64				0	188			
NORFOLK	(NF)					152						115				140						188	0			
CHARLESTON	(CT)	178	200					141	209	156														0	99	
SAVANNAH	(SA)	195	253					206	228															99	0	

Figure 24

Completed Weighted Highway Matrix

		CL	GB	RA	WS	DH	HP	FT	AS	WL	GA	RM	BU	GL	CH	GV	WI	KI	SL	HY	ST	MC	NF	CT	SA	TOTAL
CHARLOTTE	(CL)	0	72	132	69	114	59	131	102	188	15	178	88	177	114	214	176	200	32	54	33	264	266	178	195	3051
GREENSBORO	(GB)	72	0	60	14	42	13	85	129	168	87	106	16	105	42	142	104	128	40	71	50	192	194	200	253	2313
RALEIGH	(RA)	132	60	0	74	18	73	48	189	131	147	46	44	45	25	82	44	68	100	131	110	132	161	189	254	2303
WINSTON-SALEM	(WS)	69	14	74	0	56	19	99	115	182	84	120	30	119	56	156	118	142	46	57	36	206	208	214	264	2484
DURHAM	(DH)	114	42	18	56	0	55	66	171	149	129	64	26	63	11	100	62	86	82	113	92	150	152	207	272	2280
HIGH POINT	(HP)	59	13	73	19	55	0	98	132	181	74	119	29	118	55	155	117	141	27	74	53	205	207	213	254	2471
FAYETTEVILLE	(FT)	131	85	48	99	66	98	0	214	83	146	75	82	48	67	96	61	71	125	156	135	135	190	141	206	2558
ASHEVILLE	(AS)	102	129	189	115	171	132	214	0	290	87	235	145	234	171	271	233	257	105	58	79	321	323	209	229	4299
WILMINGTON	(WL)	188	168	131	182	149	181	83	290	0	203	129	165	89	150	114	115	89	208	239	218	87	244	156	255	3833
GASTONIA	(GA)	15	87	147	84	129	74	146	87	203	0	193	103	192	129	229	191	215	47	44	48	279	281	193	210	3326
ROCKY MOUNT	(RM)	178	106	46	120	64	119	75	235	129	193	0	90	40	71	41	14	63	146	177	156	116	115	216	281	2791
BURLINGTON	(BU)	88	16	44	30	26	29	82	145	165	103	90	0	89	26	126	88	112	56	87	66	176	178	216	269	2307
GOLDSBORO	(GL)	177	105	45	119	63	118	48	234	89	192	40	89	0	70	48	26	23	145	176	155	87	155	189	254	2647
CHAPEL HILL	(CH)	114	42	25	56	11	55	67	171	150	129	71	26	70	0	107	69	93	82	113	92	157	163	208	273	2344
GREENVILLE	(GV)	214	142	82	156	100	155	96	271	114	229	41	126	48	107	0	38	25	182	213	192	75	140	237	302	3285
WILSON	(WI)	176	104	44	118	62	117	61	233	115	191	14	88	26	69	38	0	49	144	175	154	113	129	202	267	2689
KINSTON	(KI)	200	128	68	142	86	141	71	257	89	215	63	112	23	93	25	49	0	168	199	178	64	165	212	277	3025
SALISBURY	(SL)	32	40	100	46	82	27	125	105	208	47	146	56	145	82	182	144	168	0	47	26	232	234	210	227	2711
HICKORY	(HY)	54	71	131	57	113	74	156	58	239	44	177	87	176	113	213	175	199	47	0	21	263	265	232	249	3214
STATESVILLE	(ST)	33	50	110	36	92	53	135	79	218	48	156	66	155	92	192	154	178	26	21	0	242	244	211	228	2819
MOREHEAD CITY	(MC)	264	192	132	206	150	205	135	321	87	279	116	176	87	157	75	113	64	232	263	242	0	188	243	341	4268
NORFOLK	(NF)	266	194	161	208	152	207	190	323	244	281	115	178	155	163	140	129	165	234	265	244	188	0	331	396	3929
CHARLESTON	(CT)	178	200	189	214	207	213	141	209	156	193	216	216	189	208	237	202	212	210	232	211	243	331	0	99	4706
SAVANNAH	(SA)	195	253	254	264	272	254	206	229	255	210	281	269	254	273	302	267	277	227	249	228	341	396	99	0	5855

Figure 25

Initial Railroad Matrix

		CL	GB	RA	WS	DH	HP	FT	AS	WL	GA	RM	BU	GL	CH	GV	WI	KI	SL	HY	ST	MC	NF	CT	SA	TOTAL
CHARLOTTE	(CL)	0		147				143		190	23								44		45			210	238	
GREENSBORO	(GB)		0		28		15						21										228	287	365	
RALEIGH	(RA)	147		0		26		62						48			49						168	250	328	
WINSTON-SALEM	(WS)		28		0														37		553					
DURHAM	(DH)			26		0							34		19								167			
HIGH POINT	(HP)		15				0												34							
FAYETTEVILLE	(FT)	143	138	62				0		113				69										172	296	
ASHEVILLE	(AS)								0		129									82				286	286	
WILMINGTON	(WL)	190						113		0				83								102		193		
GASTONIA	(GA)	23							129		0									46	58					
ROCKY MOUNT	(RM)											0				43	16						108			
BURLINGTON	(BU)		21			34							0													
GOLDSBORO	(GL)			48				69		83				0			25	26								
CHAPEL HILL	(CH)					19									0											
GREENVILLE	(GV)											43				0	35	28				82	113			
WILSON	(WI)			49								16		25		35	0									
KINSTON	(KI)													26		28		0				67				
SALISBURY	(SL)	44			37		34												0		25			220	307	
HICKORY	(HY)								82		46									0	22					
STATESVILLE	(ST)	45			53						58								25	22	0					
MOREHEAD CITY	(MC)									102						82		67				0	191			
NORFOLK	(NF)		228	168		167						108				113						191	0			
CHARLESTON	(CT)	210	287	250				172	286	193									220					0	113	
SAVANNAH	(SA)	238	365	328				296	286										307					113	0	

Figure 26

Completed Railroad Matrix

		CL	GB	RA	WS	DH	HP	FT	AS	WL	GA	RM	BU	GL	CH	GV	WI	KI	SL	HY	ST	MC	NF	CT	SA	TOTAL
CHARLOTTE	(CL)	0	93	147	81	148	78	143	149	190	23	212	114	195	167	231	196	221	44	67	45	288	315	210	238	3595
GREENSBORO	(GB)	93	0	81	28	55	15	138	178	212	116	146	21	129	74	165	130	155	49	96	74	222	222	269	331	2999
RALEIGH	(RA)	147	81	0	109	26	96	62	259	131	170	65	60	48	45	84	449	74	130	177	155	141	168	234	328	2839
WINSTON-SALEM	(WS)	81	28	109	0	83	43	166	157	240	104	174	49	157	102	193	158	183	37	75	53	250	250	257	319	3268
DURHAM	(DH)	148	55	26	83	0	70	88	233	157	171	91	34	74	19	110	75	100	104	151	129	167	167	260	354	2866
HIGH POINT	(HP)	78	15	96	43	70	0	153	163	227	101	161	36	144	89	180	145	170	34	81	59	237	237	254	316	3089
FAYETTEVILLE	(FT)	143	138	62	166	88	153	0	292	113	166	110	122	69	107	123	94	95	187	210	188	162	218	172	285	3463
ASHEVILLE	(AS)	149	178	259	157	233	163	292	0	339	128	324	199	307	252	343	308	333	129	82	104	400	400	286	286	5651
WILMINGTON	(WL)	190	212	131	240	157	227	113	339	0	213	124	191	83	176	137	108	109	234	257	235	102	232	193	306	4309
GASTONIA	(GA)	23	116	170	104	171	101	166	128	213	0	235	137	218	190	254	219	244	67	46	58	311	338	233	261	4003
ROCKY MOUNT	(RM)	212	146	65	174	91	161	110	324	124	235	0	125	41	110	43	16	67	195	242	220	125	108	282	393	3609
BURLINGTON	(BU)	114	21	60	49	34	36	122	199	191	137	125	0	108	53	144	109	134	70	117	95	201	201	290	352	2962
GOLDSBORO	(GL)	195	129	48	157	74	144	69	307	83	218	41	108	0	93	54	25	26	178	225	203	93	149	241	354	3214
CHAPEL HILL	(CH)	167	74	45	102	19	89	107	252	176	190	110	53	93	0	129	94	119	123	170	148	186	186	279	373	3284
GREENVILLE	(GV)	231	165	84	193	110	180	123	343	137	254	43	144	54	129	0	35	28	214	261	239	82	113	295	408	3865
WILSON	(WI)	196	130	49	158	75	145	94	308	108	219	16	109	25	94	35	0	51	179	226	204	117	124	266	377	3305
KINSTON	(KI)	221	155	74	183	100	170	95	333	109	244	67	134	26	119	28	51	0	204	251	229	67	141	267	380	3648
SALISBURY	(SL)	44	49	130	37	104	34	187	129	234	67	195	70	178	123	214	179	204	0	47	25	271	271	220	282	3294
HICKORY	(HY)	67	96	177	75	151	81	210	82	257	46	242	117	225	170	261	226	251	47	0	22	318	318	267	305	4011
STATESVILLE	(ST)	45	74	155	53	129	59	188	104	235	58	220	95	203	148	239	204	229	25	22	0	296	296	245	283	3605
MOREHEAD CITY	(MC)	288	222	141	250	167	237	162	400	102	311	125	201	93	186	82	117	67	271	318	296	0	191	295	408	4930
NORFOLK	(NF)	315	222	168	250	167	237	218	400	232	338	108	201	149	186	113	124	141	271	318	296	191	0	390	496	5531
CHARLESTON	(CT)	210	269	234	257	260	254	172	286	193	233	282	290	241	279	295	266	267	220	267	245	295	390	0	113	5818
SAVANNAH	(SA)	238	331	328	319	354	316	285	286	306	261	393	352	354	373	408	377	380	282	305	283	408	496	113	0	7548

CHAPTER IV

EVALUATION OF ABSTRACTED TRANSPORT NETWORKS

In the previous chapter, the highway and railroad systems, constructed to test the hypothesis of this thesis, are developed into a matrix or value graph by network analysis. This data is evaluated to provide insight regarding the ability of North Carolina's ports to effectively compete for the ocean freight trade of the state.

Highway Network

Highways linking a port city to a trade area are essential to the survival of the port as an outlet to ocean commerce in the United States. Trucking companies serving maritime interest must have fast and efficient access from ports to interior cities to remain competitive. When several ports contend for the trade of one area, or as in this case, a state, distance from major cities to ports is an important factor regarding port selection by those businesses importing or exporting commerce from foreign nations. "Since motor rates are not usually equalized and tend to bear a more direct relation to distance than rail, their impact is to favor the closest viable port."[53] North Carolina's ports do have a freight rate advantage

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[53]James B. Keyon, "Elements in Inter-Port Competition in the United States," Economic Geography 46 (1970) : 17.

over the other regional ports in a large portion of the state in both truck and rail rates. Wilmington has a preferential rate over the other ports in most of the Piedmont and southern Coastal Plains counties. The major area of contention, in terms of rate advantage, for this port is the area of Mecklenburg and surrounding counties, which have an equal rate per mile to the port of Charleston. Morehead City has a very limited area of freight rate advantage. This area includes Greene, Beaufort, Lenoir, Jones, Pamlico, Carteret, and parts of Wayne, Pitt, Johnston, Wake, Durham, and Orange Counties. Norfolk's close proximity to the northern border of the state affords it a rate advantage over Morehead City in most of the northeastern counties.[54] As freight charges are determinant upon the rate times the distance traveled per unit, distance can figure prominently in port selection. It is this distance component that is evaluated in the matrices of highway and railroad connections.

The actual evaluation of the distance component for the five port cities in the completed highway matrix is very simple. The composite totals for each of the port cities reveals that Wilmington is the top port city in terms of network distance with 4,093 miles. Morehead City is second with 4,772 miles and the out of state ports

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[54] Mulligan, "Impact of N. C. Ports," pp. 5 6-5 11.

follow with Norfolk at 5,660 miles, closely trailed by Charleston with 5,753 miles. Savannah is last with 7,302 miles. (See Table 1).

The second highway matrix, designed to account for the increased highway speeds of interstate and multilane highways, is similar to the unadjusted original network. Wilmington is, again, the most accessible in terms of distance with 3,833 miles. Morehead City is second with a composite total of 4,268 miles. Norfolk and Charleston, while still close in total mileage (4,929 to 4,706 respectively), switch positions in the port rankings. Savannah once more, is last with a total of 5,855 miles (see Table 1). It is significant to note that while the rankings of the cities do not change to a large degree, the port cities most affected by the weighted matrix are the out-of-state ports. This indicates a larger amount of interstate and multilane highway on the routes from these ports to the twenty North Carolina cities selected as important transportation centers.

Both of the matrices evaluating the highway network between the twenty-four cities of the abstracted network support the hypothesis that North Carolina ports have a distance advantage over the competing ports of Norfolk, Charleston, and Savannah in terms of distance to the twenty largest cities of the state.

Table 1

Highway Matrices Composite Mileage Totals

	Highway Matrix	Weighted Highway Matrix
Charlotte	3510	3051
Greensboro	2802	2313
Raleigh	2763	2303
Winston-Salem	3015	2484
Durham	2818	2280
High Point	2947	2471
Fayetteville	2933	2558
Asheville	5335	4299
Wilmington	4093	3833
Gastonia	3870	3326
Rocky Mount	3272	2791
Burlington	2780	2307
Goldsboro	3138	2647
Chapel Hill	2753	2344
Greenville	3726	3285
Wilson	3159	2689
Kinston	3548	3025
Salisbury	3236	2711
Hickory	3927	3214
Statesville	3442	2819
Morehead City	4772	4268
Norfolk	5660	4929
Charleston	5753	4706
Savannah	7302	5855

Note: The first twenty cities of the table are ranked in descending order of population size. The last four cities are those of the additional port cities.

Railroad Network

The evaluation of the railroad matrix compiled in Chapter Three is also relevant to the investigation of the transportation network between the twenty-four cities. Railroads at present (1970) are major carriers of maritime freight, especially in distances exceeding 200 miles. Bulk items which do not necessitate immediate delivery are the dominant cargo shipped by this type carrier.[55] The existance of rail connection from the interior cities of the state to the various ports is, in itself, a solicitor for the ports. Often railroad company promotion is well organized, spread out over the trade area, and very effective.[56]

North Carolina's rail system includes 44,330 miles of track operated by twenty three companies. Of this total, three companies, the Seaboard Coast Line, Southern, and the Norfolk Southern control 80% of the railbeds.[57] Wilmington is serviced by three lines of the Seaboard Coast Line and Morehead City is connected to the main lines of other companies by the Atlantic and East Carolina Railroad.[58]

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[55] Keyon, "Inter-Port Competition," p. 19.

[56] Patton, "General Cargo," p. 436.

[57] Barton-Asham, "Statewide Transportation Plan," p. 59.

[58] 1978 Commercial Atlas and Marketing Guide, pp. 394-5.

The composite indexes, from the completed railroad matrix in the previous chapter, are similar to that of the highway model. The port of Wilmington, with 4,309 miles, is the top ranking port of the five port set. Morehead City is second in the rankings with 4,930 miles. The three out-of-state ports follow the leaders with Norfolk and Charleston closely grouped together at 5,531 and 5,818 miles respectively. Savannah is a distant last with 7,548 miles. (See Table 2).

The above totals support the hypothesis that Wilmington and Morehead City are superior to the out-of-state competing ports in terms of rail distance for the cities of the abstracted network.

Table 2

Railroad Matrix Composite Mileage Totals

Charlotte	3595
Greensboro	2999
Raleigh	2839
Winston-Salem	3268
Durham	2866
High Point	3089
Fayetteville	3463
Asheville	5651
Wilmington	4309
Gastonia	4003
Rocky Mount	3609
Burlington	2962
Goldsboro	3214
Chapel Hill	3284
Greenville	3865
Wilson	3305
Kinston	3648
Salisbury	3294
Hickory	4011
Statesville	3605
Morehead City	4930
Norfolk	5531
Charleston	5818
Savannah	7548

CHAPTER V

SUMMARY AND CONCLUSION

The optimum seaport identified in the highway network discussed in Chapter 4 is Wilmington. Morehead City also compared favorably in this composite ranking of ports. Just how much of a distance advantage do these ports have and is it significant? By breaking-down the information contained within the matrix, it is possible to further appraise the advantageous position of North Carolina ports to some degree.

North Carolina Ports and Their Distance Relationships to The Twenty Largest North Carolina Cities

In Table 3, the dominant urban centers of the state are portrayed in relation to their distances from the five ports of this study. The distances from the N. C. port cities to the nineteen urban centers (Wilmington is also a member of the twenty top urban centers, increasing the total to twenty) are shorter than the out-of-state ports to seventeen of the nineteen cities. Wilmington's distances to fifteen of these cities are shorter, whereas, Morehead City is nearer to only two. The average distance advantage of Wilmington to the seventeen cities is thirty-four miles compared to eighty miles, for Morehead City. Norfolk and Charleston are each the optimum port in terms of distance

Table 3

Highway Distances to Ports From N. C. Urban Centers

	WL	MC	NF	CT	SA
Charlotte	203	285	311	215	235
Greensboro	183	222	230	250	320
Raleigh	139	147	168	244	339
Winston-Salem	202	241	249	269	326
Durham	162	170	175	264	359
High Point	192	239	247	267	312
Fayetteville	92	144	209	185	280
Asheville	318	391	399	275	300
Gastonia	223	305	331	235	255
Rocky Mount	133	120	115	279	374
Burlington	174	201	209	267	341
Goldsboro	89	97	159	244	339
Chapel Hill	159	175	187	252	347
Greenville	117	79	140	282	386
Wilson	115	117	133	261	356
Kinston	89	70	168	254	358
Salisbury	220	272	282	257	277
Hickory	267	317	325	279	299
Statesville	246	289	297	258	278

WL - Wilmington
MC - Morehead City
NF - Norfolk
CT - Charleston
SA - Savannah

for one of the cities of the set. Norfolk is closest to Rocky Mount, whereas, Charleston is the port with the shortest distance to Asheville. Further limiting the totals to just the industrialized Piedmont cities results in a reduction of the average advantage to twenty-nine miles for Wilmington and zero for Morehead City. In fact the port of preference in terms or distance for all of the cities within the Piedmont group is Wilmington. These cities include Charlotte, Greensboro, Raleigh, Winston-Salem, Durham, High Point, Gastonia, Burlington, Chapel Hill, Salisbury, and Statesville.

The weighted highway distances from the five ports to the urban centers are displayed in Table 4. Of the total, thirteen cities are closer to North Carolina ports than those of the competing states. Wilmington's distances are minimal to nine of the nineteen cities with an average advantage of twenty-one miles. Morehead City has the shortest routes to four cities with an average advantage of sixty-three miles. Charleston is the closest port to three of the total nineteen cities. These include Charlotte, Asheville, and Gastonia. Norfolk remains the port with the shortest distance to Rocky Mount. Limiting the scope to the Piedmont cities results in the reduction of Wilmington's advantage to an average of fifteen miles. Morehead City is no longer the optimum port in regard to any of the cities

Table 4

Weighted Highway Distances to Ports from N. C. Urban Centers

	WL	MC	NF	CT	SA
Charlotte	188	264	266	178	195
Greensboro	168	192	194	200	253
Raleigh	131	132	161	189	254
Winston-Salem	182	206	208	214	264
Durham	149	150	152	207	272
High Point	181	205	207	213	254
Fayetteville	83	135	190	141	206
Asheville	290	321	323	209	229
Gastonia	203	279	281	193	210
Rocky Mount	129	116	115	216	281
Burlington	165	176	178	216	269
Goldsboro	89	87	155	189	254
Chapel Hill	150	157	163	208	273
Greenville	114	75	140	237	302
Wilson	115	113	129	202	267
Kinston	89	64	165	212	277
Salisbury	208	232	234	210	227
Hickory	239	263	265	232	249
Statesville	218	242	244	211	228

WL - Wilmington
MC - Morehead City
NF - Norfolk
CT - Charleston
SA - Savannah

of this reduced set. The three cities with the shortest routes to Charleston are members of this Piedmont crescent group and posses an average distance advantage of ten miles over the nearest competing port city.

In the total assessment of the highway situation the acceptance of the hypothesis that North Carolina ports are located favorably in terms of distance to the twenty top urban centers of the state must be done so with some reservation. Connection within the highway system does not seem to constitute any problem, but the relatively small margin of advantage the ports possess is not of major significance. A port selection decision would not be made on this amount of distance in most cases.

A final evaluation of the North Carolina ports relationship with the urban centers in terms of highway distance is that while the state ports have a distance advantage, it is miniscule.

The evaluation of the state's rail networks in relation to the port cities is similar to that of the highway network. Again Wilmington and Morehead City are favored in the composite scoring of the distance totals of the inspection matrix. Norfolk, Charleston, and Savannah follow in respective order. Reducing the data to that pertinent to the question at hand in Table 6 results in insights regarding the actual advantages of the North Carolina ports.

Table 5

Railroad Distances to Ports from N. C. Urban Centers

	WL	MC	NF	CT	SA
Charlotte	190	288	315	210	238
Greensboro	212	222	222	269	331
Raleigh	131	141	168	234	328
Winston-Salem	240	250	250	257	319
Durham	157	167	167	260	354
High Point	227	237	237	254	316
Fayetteville	113	162	218	172	285
Asheville	339	400	400	286	286
Gastonia	213	311	338	233	261
Rocky Mount	124	125	108	282	393
Burlington	191	201	201	290	352
Goldsboro	83	93	149	241	354
Chapel Hill	176	186	186	279	373
Greenville	137	82	113	295	408
Wilson	108	117	124	266	377
Kinston	109	67	141	267	380
Salisbury	234	271	271	220	282
Hickory	257	318	318	267	305
Statesville	235	296	296	245	283

WL - Wilmington
MC - Morehead City
NF - Norfolk
CT - Charleston
SA - Savannah

Wilmington and Morehead are closer to sixteen of the nineteen cities in the rail network. Wilmington accounts for most of those connections with Morehead only closer to two of the urban centers. The average advantage of Wilmington is twenty-two miles with Morehead City averaging 53 for its two cities. The remaining three cities are evenly distributed as to their closest port with the out-of-state ports. Charleston is the port of choice for Salisbury in terms of railroad distance and Asheville is tied between Charleston and Savannah as to its closest port. Norfolk continues to be the port of choice for Rocky Mount in regards to distance. Limiting the set to the Piedmont cities reduces Wilmington's average to sixteen miles while Morehead City is not closest to any of these cities. (See Table 5). Of the eleven Piedmont cities, the North Carolina port of Wilmington dominates the group with shorter routes to ten of the cities. Charleston has a distance advantage to one city of this group (Salisbury). It is questionable whether the limited mileage advantage enjoyed by the ports of Wilmington and Morehead, particularly in respect to Norfolk and Charleston, would be important enough to influence a port selection decision. Again the initial hypothesis is accepted, but with the knowledge that the effect of the distance advantage is probably not a major consideration in this particular instance.

Conclusion

In the examination of the highway and railroad networks abstracted between the port cities and urban nodes the distance component has been determined to be of less significance than originally conceived. It is true that the ports of Wilmington and Morehead City are closer to the urban cities of the state than those of Norfolk, Charleston, and Savannah, but to a degree which is not critical enough to alone influence port selection.

Does the lack of a large distance advantage for North Carolina ports mean that the state ports cannot effectively compete for the foreign trade generated by the state's economy? The answer to this question is no. Wilmington, although not in a geographic position of great dominance in terms of distance, is still the closest port to most cities. The ability of the port to capture a significant portion of the container trade of the industrialized Piedmont demonstrates the value of its existance. While connection to the interior trade area is no problem, the quality of such could be improved with the construction of limited access four lane highways from this city to the Piedmont crescent.

Such a highway, Interstate 40, is scheduled for completion in the early 1990's. This limited access highway will provide Wilmington with direct connections to Raleigh and to other cities of the Piedmont. The accomplishment of this improvement over existing roadway will most definitely be an asset to the development of the Wilmington state port.[59] Port services could be improved to make the port more attractive to prospective customers. By prudent capital investment, equipment necessary to expedite loading and unloading could induce further business. Additional service in regards to sailing schedules and liner service could prove beneficial to the port.

In summary, Wilmington, while not in a position of great advantage, is neither in a position of disadvantage. The slight distance advantage for the port means that the real keys to the potential growth of the port and capture of contested trade are port facilities and service. Also additionally four lane access to the interior would further enhance the competitive position of the port.

The future of Morehead City seems to be somewhat limited in that it has not exhibited any ability to process any meaningful volume of cargo from the industrialized interior of the state. The distance advantage itself is limited to only a few cities of the Coastal Plain. The area is predominately rural in character providing little business to the port excepting bulk commodities. At this time the port is performing service in the form of local

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[59]Charles Atkins, Interview (telephone), Department of Transportation, North Carolina State Government, Raleigh, North Carolina, April 1979.

trade without much hope of developing a large general cargo trade. Even if the facilities and service were available it is doubtful that this type of shipment would move through this port. The actual demand necessary for the successful establishment of general cargo service does not exist in the limited trade area favored by preferential freight rates or distance to Morehead City.

The examination of the two North Carolina ports in this study concerns the transportation and economic situations as they exist today (1979). While this is certainly pertinent, one must realize that North Carolina is a state in transition and that the economic character of the state is changing. This change will have an impact on future port development. Once a predominantly rural society, the state's non-farm employment has risen from 879,600 in 1949 to 2,128,300 in 1977. Correspondingly, farm employment has dropped from 676,000 in 1940 to 164,000 in 1977.[60] This shift in employment is continuing as farms become larger and more mechanized and people look to non-farm employment for sustenance.

Eastern North Carolina, long considered the agricultural heartland of the state, is also a part of this change in economic emphasis. While agriculture is still

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[60]Mary Stewart, Interview (telephone), North Carolina Division of State Budget and Management, Raleigh, North Carolina, April 1979.

very important to the region, the number of manufacturing and non-farm establishments is increasing in the area. As the change occurs, the coastal plain will become more important to the two ports in terms of cargo potential. In the examination of the transportation system, one might erroneously perceive that this study concedes that all significant economic activity occurs in cities. Obviously this is not so, especially in North Carolina where the population has not chosen to congregate in large urban centers, but in smaller, moderately spaced towns or in rural areas. The transportation system in this study is an abstraction which allows us to simplify the actual system to a point where an evaluation of the economic situation is possible. Again, it must be acknowledged that the transportation of the state, especially the highway segment, is not a static entity. The system is constantly being upgraded and refined and these processes will have an impact on future port development.

Finally, political considerations are an important factor that will affect the future of North Carolina ports. People from the local areas of the two state ports realize that the economy of the state is growing and each group seeks to develop it's port by acquiring the largest amount of development capital possible from the state legislature. The political strength of these port boosters can have a significant affect upon the future of the indivitual ports.

As of today, Wilmington seems to hold the edge as it has demonstrated it can compete for the ocean transit trade of the state. Morehead City, serving a limited hinterland, seems less likely to be able to compete for the general cargo of the state and will most probably remain oriented to handling of bulk cargoes for some time. The development potential of the eastern portion of the state will most likely be sought by both ports and may influence the future development of each facility.

APPENDIX A

North Carolina Container Imports - Exports for 1977

1977 Container Exports to Northern Europe

County	WL	MC	NF	CT	SA
Alamance	245		285		
Buncombe			120		
Caldwell			132	60	
Carteret	120		120		
Catawba	96		169		
Chatham	250				
Cleveland	45		180	45	
Craven	300	300			
Cumberland	36				
Davidson	45		72	45	
Davie	300				
Durham			373		
Forsyth			1,620		
Gaston	343		252	175	
Guilford	382		560	13	
Halifax			75		
Lee			80		
Mecklenburg	384		222	120	
Pitt			10		
Randolph	115		222	123	
Rockingham	85		163		
Rowan			156	60	
Rutherford				12	
Stanly	195				
Transylvania			130		
Union	54		48		
Vance	18		18		
Wake			25		
Washington	300	300			
Wilkes			120		

Container Exports to the Middle East

County	WL	MC	NF	CT	SA
Durham		75	75		
Guilford	100				
Iredell			50	50	
Mecklenburg	100		100		
Rockingham			500		

1977 Exports to Japan, Hong Kong, and Taiwan

County	WL	MC	NF	CT	SA
Brunswick	1,550				
Cleveland				760	
Durham			175		
Forsyth			140		
Gaston				70	70
Guilford			805	330	240
Iredell				400	
Mecklenburg	105				
Rowan			200		
Transylvania			150		150

1977 Container Imports from Northern Europe

County	WL	MC	NF	CT	SA
Alamance	90		10		
Catawba	20		12		
Cleveland	75				
Davidson	996		466		
Durham	25		25		
Edgecombe	150		150		
Forsyth	50		10		
Guilford	333		279	12	15
Iredell	12				
Lincoln				36	
Mecklenburg	656		256	250	15
Orange			20		
Pitt	120				
Randolph	60				
Rockingham	49				
Rowan			18		
Vance			30		
Wake	102				
Wayne	12				
Wilson	140		130		

1977 Container Imports from the Mediterranean

County	WL	MC	NF	CT	SA
Catawba			6	6	
Davidson			262		
Durham			50		
Forsyth			34		
Guilford	125		43		
Lee			30		
Mecklenburg	45		27	15	
Randolph			60		
Wake	230		60		
Wayne			12		
Wilson			40		

1977 Container Imports from

Japan, Hong Kong, and Taiwan

County	WL	MC	NF	CT	SA
Brunswick	55				55
Craven				250	
Cumberland			19		164
Davidson	201			62	
Edgecombe			18	350	19
Gaston	72				
Granville			140		
Guilford	140		134	50	60
Henderson	40				
Iredell	246		147	147	
Lee			8		
Mecklenburg	783		71	756	135
Montgomery	40				40
Randolph	75				
Union	48				
Vance	205		230		
Wake	50				
Wilkes	48				

1977 Container Exports to the Mediterranean

County	WL	MC	NF	CT	SA
Alamance	50		50		
Brunswick	360				
Buncombe				90	90
Davidson	12			12	
Gaston				100	
Guilford			5,200	700	
Halifax			75	75	
Iredell			520	520	
Mecklenburg	24			810	30
Orange			10		
Randolph			35	51	36
Union	24				

APPENDIX B

Total Import - Export Trade of Morehead City in 1977

1977 Import Export Trade Processed by Morehead City

IMPORTS

Product	Tonnage	Origin	Destination
Asphalt	62,070	Venezuela	Carteret County
Bunker C Oil	52,774	Venezuela	Carteret County
Lumber	22,568	Canada	Catawba County
		Brazil	Catawba County
Meal Bone	6,485	Panama	Wilson County
		Chile	Wilson County
Urea	14,270	Holland	Carteret County
Tobacco	1,200	Turkey	Forsyth County
Total Import Tonnage	159,367		

EXPORTS

Product	Tonnage	Origin	Destination
Peanut Meal	4,110	Duplin County	Holland
Logs	5,607	Craven County	Brazil Germany
Lumber	25,366	Craven County	Holland Belgium Italy Germany
Milk Carton Stock	11, 374	Craven County	Germany Iran
Paper Scrap	5,310	Craven County	Italy
Strapping Steel	4,180	Pitt County	South Africa
Tobacco	83,455	Wilson, Pitt, Edgecombe Nash Counties; Danville, Va.	Japan Germany Thailand
Woodchips	44,387	Craven County	Finland
Phosphoric Acid	26,798	Beaufort County	Brazil
Phosphate	598,796	Beaufort County	Belgium France Chile Nicarauga Brazil United Kingdom Germany Singapore Rumania Holland
Woodpulp	57,372	Craven County	Canada Argentina Colombia Ecuador Peru Venezuela Belgium France Germany Rumania Scotland Japan Egypt Greece Italy Portugal
Total Export Tonnage	886,935		

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