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Economic Development of Areas Contiguous to Multipurpose Reservoirs: The Kentucky-Tennessee Experience

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ECONOMIC DEVELOPMENT OF AREAS CONTIGUOUS TO MULTIPURPOSE RESERVOIRS: THE KENTUCKY-TENNESSEE EXPERIENCE

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ABSTRACT

This study analyzes the effects of multi-purpose reservoir projects on the economic development of areas contiguous to the dam and reservoir. The study concentrates on the development potential in a humid region where the provision of agricultural water is not critical to the economy. Can a reservoir project be a major part of a development program for a local area? How can the favorable effects of the project on the contiguous area be increased? These questions are answered by this study.

The study is divided into three major phases. The first phase is a theoretical analysis of the determinants of the location of economic activity and the effect of multi-purpose reservoirs on the important location factors. This analysis shows that reservoir projects affect only a subset of the total number of factors that determine the desirability of the contiguous area for economic development; therefore, the development promoted in the contiguous area by the project is a function not only of the characteristics of the project but also of the pre-existing characteristics of the area.

The second phase of the study is an empirical investigation of the economic growth in the contiguous areas of twenty existing projects in a study area of Kentucky and Tennessee. The development of these contiguous areas is compared to the development of selected control areas over the period 1940-1960. These comparisons indicate two points. First, that overall projects there is little evidence that the projects have promoted rapid development in the contiguous areas and second, that there is a wide variation in relative development from project to project with some of the projects promoting rapid growth and others seemingly having little effect.

The third phase of the study is a series of individual case studies of the twenty projects to determine the reasons for the wide variations in the

development of the contiguous area. Two of the contiguous areas, one which has experienced rapid development and one which has experienced virtually no development, are studied in detail to better understand the causes of this wide variation among projects in impact on the contiguous areas.

These case studies lead to the conclusion that economic development emerges from a synthesis of the location features of the local area and the factors provided by the reservoir project. If the area is otherwise desirable for industrial location and the reservoir project provides key factors which were previously missing, the area will experience rapid development; however, if the area is deficient in location factors that are not provided by reservoir development, the project will not stimulate the local economy.

The study concludes that multi-purpose reservoirs have the potential to be a major element in development planning, but these projects are rarely sufficient to produce rapid development unless other programs are initiated to remove shortcomings of factors not directly affected by the water project. If reservoir projects are to produce development benefits in the contiguous areas, the planning of these projects must be coordinated with other projects designed to eliminate shortcomings of the local area which would not otherwise be eliminated by the reservoir project.

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CHAPTER I

A DELINEATION OF STUDY OBJECTIVES AND PROCEDURES

The objective of this study is to investigate the effects of multipurpose reservoirs on the economic growth and industrial development of areas contiguous to the project sites. Multipurpose reservoir projects provide a variety of benefits distributed over a large area, but this study will concentrate on a subset of the total affected area, namely the area adjacent to the dam and the reservoir. Rather than attempting to measure total economic benefit as is done for project justification, this study will investigate the effects experienced in the contiguous area.

Project effects in contiguous areas are of special interest for two principle reasons. First, the residents of the contiguous areas are those most likely to suffer psychic, economic, and social disruption as they are forced to sacrifice homes, businesses, and community arrangements for project right-of-way. This prospect often makes these areas centers of hostility and resistance to proposed projects, especially when most of the benefits are realized elsewhere. If the project could be modified to better promote development of the local economy, the required sacrifices might meet with less local resistance. The concept of sacrificing for the benefit of the local community is clearly more appealing to the local residents than a proposal calling for them to give up their homes so that a distant city can have water and power.

The second reason relates to the expressed national goal of regional economic development by bringing the underutilized resources found in depressed sections of the country into fuller utilization. If water resources development is going to be effective in achieving this goal, project effects on the economic development of nearby geographic areas must be better understood.[1]

This study will seek a better understanding of project effects on contiguous areas through the answers to four questions:

(1) Is there reason to believe that multipurpose reservoir projects can be used to enhance economic development in the contiguous areas? If so, what mechanisms produce this effect?

(2) What has been the experience of the areas contiguous to existing multipurpose reservoir projects with respect to economic development? Is there evidence indicating a more rapid development of these areas than what would have been expected were it not for the reservoir?

(3) If there is a diversity among the reservoir projects in the degree of economic development experienced in the contiguous areas, can the reasons for this variation be identified?

(4) Finally, can the planning of multipurpose reservoir projects be modified to increase the positive effects of the projects on the economic development of the contiguous area?

Answers to these questions may help project planners improve the acceptability of the projects to the local communities thus improving the political viability of these projects. In addition, this understanding may improve the ability of regional planning bodies to promote development in underdeveloped areas by increasing the effectiveness of one of the major tools at their disposal.[2]

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[1]Maynard M. Hufschmidt, "Perspectives and Goals for Water Resource Planning." Journal of the Water Pollution Control Federation, XLI (July, 1969), p. 1353.

[2]Roger C. Woodworth and Leroy Rogers, "The Future Agricultural Use of Water - The Southern Humid Region," in Water Resources and Economic Development in the South, edited by the Agricultural Policy Institute of North Carolina State University (Raleigh, N. C.: Agricultural Policy Institute of North Carolina State University, 1965), p. 23.

METHODOLOGY

No single methodology can adaquately answer all four questions raised in this study. In view of this, the study is conducted in three distinct phases, each employing a separate methodology. The results of these separate phases are ultimately combined to produce suggestions for improved project planning.

The first phase of the study is an analysis of the factors that should theoretically determine the location of economic activity and the possible effects of reservoir projects on these factors. This phase attacks the first of the four questions.

The second phase involves measurement of the net effects of existing projects on the economic development of contiguous areas. Linear statistical models are used to isolate differentials between the development of contiguous areas and paired control areas. The null hypothesis of each model is that contiguous and control areas have equal levels and time rates of change in variables that measure economic development. The rejection of the null hypothesis would indicate a significant difference in mean development between the contiguous and the paired control areas. These differences could be either positive (the contiguous areas have greater development) or negative (the contiguous areas have less development). This empirical analysis will answer the second of the four questions.

If the results of the statistical analyses consistently indicate any one conclusion, either a positive, a negative, or a null effect, interest would center on determining the processes that produced these results. If, however, there is great diversity among projects in the relative development with some projects showing positive effects, some negative effects, and some no measurable effects, then the primary interest would center on obtaining explanations for these observed variations.

The third phase of this study uses case studies of the development occurring in areas contiguous to selected projects. The theory developed in phase one is employed to explaining observed differentials in development. By examining the nature of the contiguous areas and the contributions the reservoir projects can make to the factors required for economic development, the observed differentials in development will be explained and suggestions will be formulated to improve the planning of multipurpose reservoir projects with respect to furthering the economic development of the contiguous areas.

SCOPE OF THE STUDY

The investigation into the role of reservoir projects in promoting economic development is cast in the setting of a humid region where there is no physical shortage of water that clearly ties all new activity to the development of supplemental water reserves. Ten states in the Southeastern region of the United States are of particular interest.[3]

The South has long been characterized by underemployed resources, both human and physical; relatively low levels of personal income; and a heavy reliance on primary industries such as agriculture and mineral extraction as sources of export income. Since the rates of growth of agriculture and mining have long been below the growth rates in the industrial sectors of our economy, the South has historically been faced with lagging economic development.[4]

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[3] This includes the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee.

[4] Studies of the history of Southern economic development can be found in Glen E. McLaughlin and Stefan Robock, Why Industry Moves South (Kingsport, Tenn.: National Planning Association, 1949), pp. 9-16; Anthony M. Tang, Economic Development in the Southern Piedmont, 1860-1950 (Chapel Hill, N. C.: University of North Carolina Press, 1958), pp. 22-65; Clarence H. Danhof, "Four Decades of Thought on the South's Economic Problems," in Essays in Southern Economic Development, edited by Melvin L. Greenhut and W. Tate Whitman (Chapel Hill, N. C.: University of North Carolina Press, 1964), pp. 7-68; and Calvin B. Hoover and B. U. Ratchford, Economic Resources and Policies of the South (New York: Macmillan and Co., 1951).

There is an intensifying awareness that a successful attack on the problem of economic underdevelopment in the South requires growth in the industrial sectors.[5] In conjunction with national programs promoting growth in underdeveloped regions, major area redevelopment efforts promoting industry have been instituted throughout the South.[6] In addition, state and local development efforts directed toward industrial growth are widespread. A frequent component of these development efforts are proposals to more fully utilize the water resources of the area.

This interest has not gone unrewarded. The Southern states have only 18 percent of the population but received 27 percent of the expenditures on all U.S. Army Corps of Engineers' (including special river projects not in General Construction Program) from 1946 to 1962.[7] The entire water resources development program of the Tennessee Valley Authority has been located in this same area. Water resources in combination with the other factors necessary for industrial growth are leading to a rapid advance in overall regional industrialization; therefore, the South provides in this period of overall change an ideal setting for an investigation of the role of water resources, in particular multipurpose reservoir projects. It provides a laboratory for observing economic growth in areas contiguous to reservoirs.

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[5]John R. P. Friedmann, The Spatial Structure of Economic Development in the Tennessee Valley (Chicago: University of Chicago Press, 1955), p. 4; Tang, Economic Development..., pp. 210-232; Gilbert Banner, "Toward More Realistic Assumptions in Regional Economic Development," in The Economic Impact of TVA, edited by John R. Moore (Knoxville, Tenn.: Univ. of Tennessee Press, 1967), pp. 122-142; and James M. Stepp, "Some Economic Aspects of Industrial Water Supply in the South," in Water Resources and Economic Development in the South, p. 26.

[6]Marshal R. Colberg, "Area Redevelopment and Related Federal Programs," in Essays in Southern Economic Development, pp. 363-384.

[7]Robert Haveman, "The Postwar Corps of Engineers Program in Ten Southern States: An Evaluation of Economic Efficiency," in Essays in Southern Economic Development, pp. 451-452.

STUDY AREA

In order to reduce the required data gathering into a feasible range, a specific study area inside the South was selected for the empirical analysis. Kentucky and Tennessee were found to be an ideal area because they have a maximum number of individual reservoir projects and a minimum number of extraneous factors causing spatial variation in economic development patterns.

Reservoir Projects in Study Area

Kentucky and Tennessee have received greater shares of the water resource projects of the Corps of Engineers than the remainder of the South.[8] In addition these two states contain nine of the Tennessee Valley Authority's fourteen major dams representing an additional investment of more than $750,000,000.[9] This huge public investment has been accompanied by a substantial private investment to better utilize the output of public water resources development in both states. The total investment has not been too recent to allow development time to occur and has not been so old as to be outside the period relevant to current conditions. In short, these projects provide sufficient replication of the impact of reservoir projects to be the basis for an empirical investigation.

Sources of Exogenous Variation Within the Study Area

It is apparent that each state and each local area poses differences in political climate, cultural characteristics, demography, and geography which affect economic growth and industrialization. These sources of variation in the degree of industrial development occurring in the area contiguous to multipurpose reservoir projects must be considered in an empirical investigation of the effects of water resource projects.

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[8] Ibid, p. 451.

[9] Computed from data on individual projects presented in John H. Kyle, The Building of TVA (Baton Rouge, La.: Louisiana State University Press, 1958).

The choice of the states of Kentucky and Tennessee as the study area minimizes the effect of these exogenous variables. Kentucky and Tennessee share a 341-mile border that passes from the mountainous Appalachian region in the East to the gently rolling area along the Mississippi River in the West.[10] Although there is a great deal of heterogeneity between the various subsections of each state, Kentucky and Tennessee as a whole share a common geographical, cultural, and political environment that will aid in minimizing the exogenous variation in the empirical analysis. The high degree of homogeneity between Kentucky and Tennessee is reflected in that they are classified as being in the same region of the United States by the Regional Economics Division, U.S. Department of Commerce, and U. S. Bureau of the Census.[11]

The similarity of the geographic characteristics of Kentucky and Tennessee can be seen by comparing the patterns of their physiographic regions shown in Figure 1. The eastern sections of both states are in the Appalachian Plateau, the middle sections are in the Interior Low Plateau, and the western sections are in the Coastal Plain. Since extreme eastern Tennessee is in the Valleys and Ridges and Blue Ridge Mountain regions, the physiographic division of the two states is not identical; however, the overall homogeneity of the physiographic context of the economic systems in the two-state area is quite evident.[12]

The similarity between the two states is also seen in the indices of employment patterns presented in Table 1. Definitions of the Index of Regional Homogeneity (IRH) and of the Index of Economic Differentiation (IED)

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[10] Approximated by measurement from U. S. Department of Interior, Geological Survey, Map of the State of Kentucky (Washington, D. C.: U. S. Geological Survey, 1958).

[11] Hugh O. Nourse, Regional Economics (New York: McGraw-Hill Book Co., 1968), pp. 135-136.

[12] Physiographic regions taken from Charles B. Hunt, Physiography of the United States (San Francisco: W. H. Freeman & Co., 1967), p. 88.

FIG. I MAP OF STUDY AREA SHOWING PHYSIOGRAPHIC REGIONS

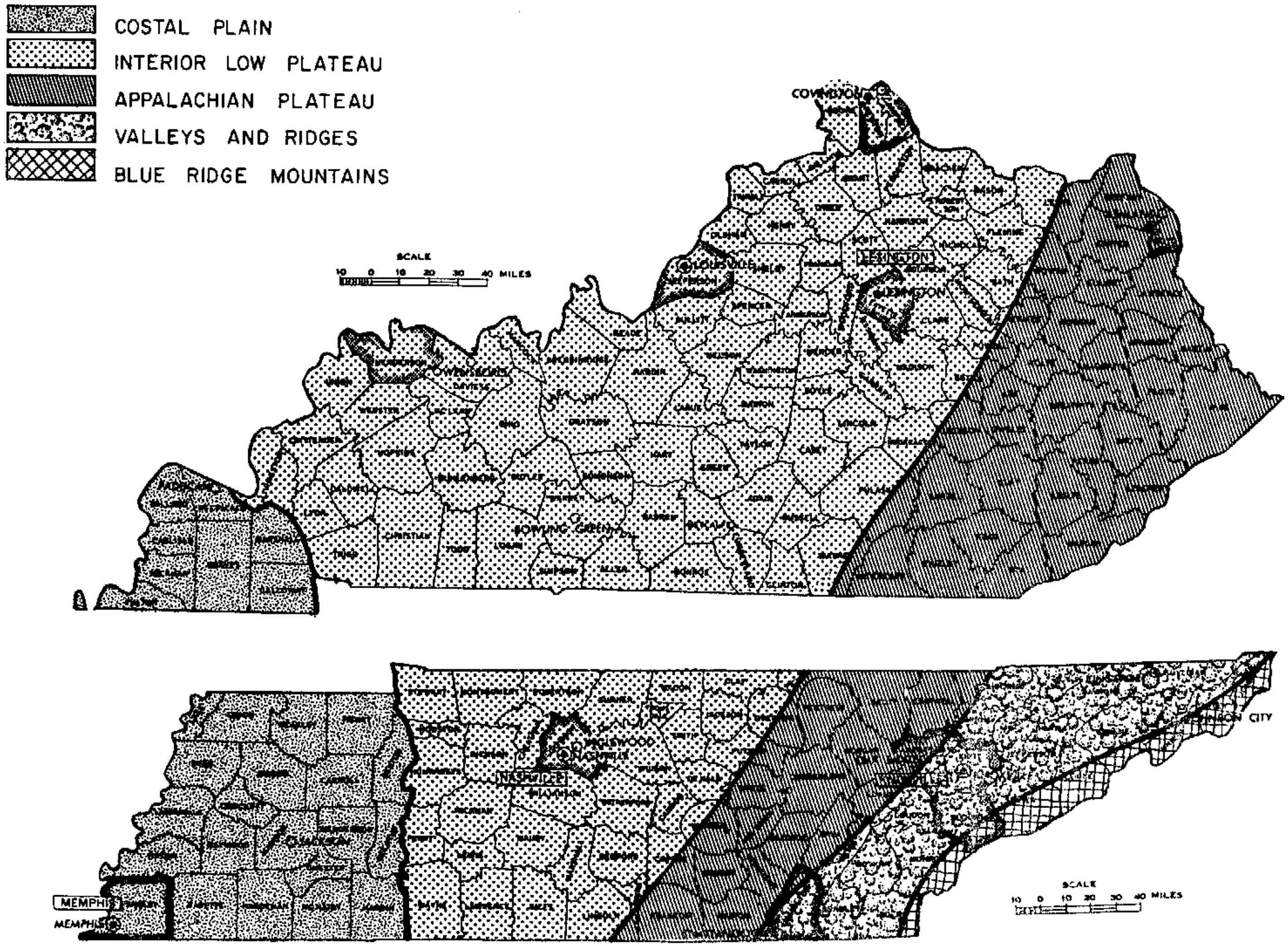

TABLE 1

INDICES OF EMPLOYMENT CHARACTERISTICS OF SELECTED REGIONS

EMPLOYMENT INDEX	Year		
	1940	1950	1960
IRH Between Kentucky - Tenessee	0.8711	0.8233	0.8247
IRH Between Kentucky - Study Area[a]	0.9345	0.9079	0.9027
IRH Between Tennessee - Study Area[a]	0.9366	0.9154	0.9220
IRH Between Study Area[a] - Southeast[b]	0.9321	0.9005	0.8778
IRH Between Southeast[b] - United States	0.7313	0.7198	0.7916
Mean IRH Between Regions of United States (other than Southeast) - U.S.	0.7308	0.7530	0.8104
IED - Kentucky	0.8686	0.9331	0.9690
IED - Tennessee	0.8933	0.9493	0.9747
IED - Southeast[b]	0.8829	0.9478	0.9753
IED - United States	0.9613	0.9754	0.9768
IRH Between County - State (both states)			
Maximum	0.8943	0.8613	0.8547
Minimum	0.1909	0.2356	0.2331
Mean	0.7558	0.6794	0.6094
IED County (both states)			
Maximum	0.9783	0.9823	0.9943
Minimum	0.2896	0.3805	0.6234
Mean	0.6868	0.8028	0.9242

[a] Kentucky and Tennessee

[b] Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi North Carolina, South Carolina, and Tennessee.

[c]Regions - New England, Mideast, Great Lakes, Southeast, Southwest, Plains, Rocky Mountains, and Far West, as defined by Office of Business Economics, U.S. Department of Commerce.

Source: U.S. Department of Commerce. Office of Business Economics, Growth Patterns in Employment by County, 1940-1950, 1950-1960, Vol. V., Southeast, (Washington, D.C.: Government Printing Office, 1965).

are presented in Chapter 3. For the present, it will suffice to interpret an IRH near one as indicating that two regions are quite similar in the proportion of the total work force employed in various employment categories. An IED near one indicates that the work force in a region is distributed nearly equally among the employment categories.

The high values for the IRH indices comparing Kentucky to Tennessee and each state to the combined area demonstrate the homogeneity of the two states in terms of economic activities. The high value of the IRH comparing the study area of Kentucky and Tennessee to the Southeast Region and the relatively lower IRH of the Southeast compared to the United States as a whole suggests that this study area may be in some ways representative of the economic activities of the Southeast and to a lesser degree of the country.

In summary, Kentucky and Tennessee meet the requirements of a desirable study area. Overall, they are sufficiently homogeneous to minimize exogeneous variations. The extensive investment in multipurpose reservoir projects in the two states provides a large number of individual projects for analysis. All this activity is in the context of the struggle of the South to achieve economic development through increased industrialization. The conjunction of these conditions makes this area, Kentucky and Tennessee, an ideal study area for an empirical analysis of the role of multipurpose reservoir projects in promoting economic development in the area contiguous to the projects.

TIME PERIOD FOR STUDY

The selection of a time period for the study must balance the desirability of a long study period against the shortage of available data. These guidelines lead to the selection of the period 1940 to 1960 as the time period for analysis.

A long study period is desirable because development is more often evolutionary than revolutionary. The number of firms relocating or locating new plants at any point in time is small in comparison to the total number of firms; therefore, the expected development pattern is a slow inflow of firms whose needs are well-matched to the economic features of an area and a slow outflow of firms that are ill-matched. A long study period is required to allow evolutionary development of this nature to be detected by statistical models.

The length of the study period is limited by the availability of suitable data measuring the income, population, and employment by industrial catagory on a county by county basis. This data can be obtained in comparable time series only for the census years 1940, 1950, and 1960.[13] The lack of suitable older data require a 1940 to 1960 study period for the statistical analysis.

Data for case studies can be obtained from more recent investigations by the Kentucky Department of Commerce, personal investigations, and a variety of published sources. This permits the case studies to extend past 1960 allowing any recent developments and trends that escaped detection in the empirical analysis to be included.

BRIEF SUMMARY OF RESULTS

This study indicates that multipurpose reservoirs have the potential to be an important tool in regional planning for economic development, but the current practice is not oriented toward maximizing development in the contiguous areas. If the advancement of underdeveloped regions is a major goal, then project formulation must be modified to concentrate more on the

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[13] Population data can be obtained from the U. S. Department, Bureau of the Census, County and City Data Book (Washington, D. C.: Government Printing Office, 1949, 1953, and 1963 editions). Per capita income by county is available from unpublished sources provided by the U. S. Department of Commerce, Office of Business Economics. Employment by county by industrial category is available in the U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, Vol. V, Southeast (Washington, D. C.: Government Printing Office, 1965.)

location of the project induced development rather than the aggregate benefits without regard to their geographic distribution.

The theoretical phase of this study examines the linkages between the requirements of industrial and economic growth and the factors provided and influenced by multipurpose reservoirs. These linkages derive from both the physical features of the projects and the psychological effects of the projects on the communities, the state development agencies, and the location decision makers inside the individual firms. Location theory also establishes limits on the ability of reservoirs to promote development. Many vital factors affecting the location decision making process are unaffected or at most marginally affected by reservoir development; therefore, reservoir projects can not remove all barriers to economic development.

The empirical investigations reveal a great diversity in the relative economic development in the contiguous areas of existing reservoir projects. Only a minority of the projects examined show significant indications of net positive development benefit in the contiguous areas. Great variation is experienced among projects in the relative levels and rate of change of development in the contiguous areas, and this variation is not due to variations in the physical characteristics or geographic locations of the reservoir projects, but is due to the varied interrelationships between the characteristics of the reservoir projects, the characteristics of the contiguous areas, and the requirements of various types of economic activities.

The case studies emphasize the necessity of a favorable interaction between factors provided by reservoir projects and other factors outside their direct influence before the barriers to economic development can be removed so that rapid development of the contiguous areas can be accomplished. Projects are most effective where a shortage of the output they provide to contiguous areas was previously a bottleneck to local economic growth. The areas where rapid development has occurred are shown to be areas where a fortuitous combination of reservoir related factors with other factors already existing in the area have combined to promote rapid development. Areas which have failed to develop are shown to be areas where deficiences in factors outside the direct influence of the projects continue to retard development. The reservoir projects have increased the availability of factors which are already in relatively excess supply.

This combination of evidence indicates that reservoir planning as currently practiced has not consistently promoted rapid development in the areas contiguous to the site. This failure is due to two major shortcomings. First, the development of the contiguous area has not been an important goal of project planning. The justification of the project is based on total aggregate benefits without any restriction on the geographic distribution of these benefits. Second, the administrative agencies charged with responsibility for water resource development have limited capabilities to act to improve the availability of non-reservoir related factors. If an agency is to plan for economic development, it must have a much wider spectrum of factors under its control than is the current practice.

Reservoir projects may be a necessary precondition for the development of many areas, but they are not generally sufficient to insure the desired development. Reservoir projects must be viewed as an element in a development program, and their planning should be supervised by an agency with authority over a broad range of economic factors before development benefits to limited geographic areas can be maximized.

STUDY ORGANIZATION

The study is divided into six remaining chapters. Chapter II develops the location theory relevant to the analysis. Chapters III, IV, and V present the analyses of the development occurring near the existing reservoir projects. Chapter VI is a case study of two areas of special interest. Chapter VII, the final chapter, summarizes the results of the study and suggests improvements in project planning policies and administration. Five appendices follow Chapter VII.

CHAPTER II

A THEORETICAL ANALYSIS OF THE ROLE OF RESERVOIR PROJECTS IN THE ECONOMIC DEVELOPMENT OF CONTIGUOUS AREAS

An attempt to analyze the role of multipurpose reservoir projects in promoting the economic growth of contiguous areas is confronted with three questions. First, is there reason to believe that reservoir projects can effect the development of contiguous areas? Unless this question can be answered in the affirmative, there is no justification for further analysis. Given an affirmative answer to this question two additional questions become germane. Through what processes do reservoir projects enhance economic development? What limits the ability of projects to influence development, and how are these limits established? Answers to these questions would provide a theoretical basis for an empirical analysis of the experiences of existing projects; therefore, this chapter is devototed to the answering of these questions.

The appropriate methodology for investigation of these questions is a theoretical study of the determinants of the spatial distribution of economic activity. By examining relationships between the factors that determine the spatial patterns of economic activity and the factors that are affected by reservoir projects, answers to these questions can be established.

The theoretical analysis is directed toward understanding the spatial distribution of industry. The focus on industry as the measure of economic development stems from numerous studies on the economic development of the South which indicate that significant economic progress is unlikely without substantial increases in industrial activity.[1] This emphasis should not,

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[1] Friedman, Spatial Structure of Economic Development. ., pp. 1-21; Tang, Economic Development. . ., pp. 210-232; Banner, in Economic Impact of TVA, pp. 122-242; Dale E. Hathaway, "Migration from Agriculture: The Historical Record and Its Meaning," American Economic Review, L (May 1960), 379-391; and James M. Stepp, Water Resource Management and Industrial Development Under Southeastern Condition, South Carolina Agricultural Experiment Station Report AE203 (Clemson, S. C.: South Carolina Agricultural Experiment Station, 1961), pp. 12-14.

however, be construed as an indication that industrial activity is the only source of development.

This analysis is divided into three sections. First, the factors which determine the location of economic activity are isolated; second, the possible effects of reservoir projects on these vital location factors are surveyed; and third, the probable effects of projects on the economic development of contiguous areas are predicted from a synthesis of the previous results.

A LOCATION MODEL FOR ECONOMIC ACTIVITY

In a capitalistic society, economic development occurs through the aggregation of the location decisions of many individual firms, each trying to maximize its own economic welfare. Therefore, the assessment of the role of reservoir projects in the economic development of contiguous areas requires an understanding of the factors which determine the optimal location of individual firms and the effect of multipurpose reservoir projects on these factors in areas contiguous to the projects.

A Location Model For Individual Firms

"Businesses do not locate where costs are least, or receipts greatest, but where the positive difference, profits is greatest."[2] Thus, the location decision, where the firm will produce, is made with the same basic goal in mind as are the decisions on the product to produce, the production methods to employ, and the quantity to produce. The search is for a location maximizing profits, where profits are a function of both revenue (demand) and cost (supply).[3]

The revenue producing and cost incurring factors of production may potentially vary with the location of the firm. Therefore, a general model for

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[2] Nourse, Regional Economics, p. 2.

[3] Melvin L. Greenhut, Plant Location in Theory and in Practice (Chapel Hill, N.C.: University of North Carolina Press, 1956), p. 291.

the location decision by the firm can be stated as follows: maximize the profits of the firm P where

$$P = R - C \tag{1}$$

where the revenue realized by the firm (R) and the costs to the firm (C) are

$$R = g(r_i , i = 1, m) \tag{2}$$

$$C = h(c_j , j = 1, n) \tag{3}$$

The m revenue producing factors r_i are defined by

$$r_i = M_i (L, q_i, \ldots) , i = 1, m \tag{4}$$

The n cost producing factors c_j are defined by

$$c_j = N_j (L, q_j, \ldots) , j = 1, n \tag{5}$$

where q_i, q_j = quantities of the i^{th} of j^{th} factor used

L = the location of the firm

g, h = the transformation functions converting factors into revenue and costs, respectively

M_i, N_j = the transformation functions converting location and other relevant variables into revenue factors and cost factors respectively. The ellipises in the functions indicate that these transformations are influenced by such variables as quality and price that are not explicitly mentioned.

The economics of location decision making says to select the location of the firm (L) so that profits (P) will be maximized.[4] Although functional relationships g, h, M_i N_j are not yet specified, several properties of the model need to be considered.

Implications of the Model to the Location Decisions by Firms

The location model as proposed has several implications to the location decisions by individual firms. The first point is the one stated earlier that the

[4]This model is based on the model presented in Greenhut, Plant Location. . . , Chapter XII, pp. 273-291.

maximum profit position is not where revenue (R) is maximum or where costs (C) are a minimum, but where the profit (R-C) is a maximum. The second point that can be observed is that the revenue (R) and costs (C) of the firm depend on a combination of individual factors, (r_i) and (c_j), each of which may be a function of the location (L); therefore, the maximum profit location of the firm may not be at a location where any single revenue factor (r_i) is maximized or any single cost factor (c_j) is minimized. The third point that can be made is that if the revenue and cost functions (M_i, N_j) were of such a nature that all the r_i and c_j, the revenue and cost factors, were independent of the location of the firm (L); then, the firm would be free to choose its location on the basis on non-economic factors. Conversely, if any one of the r_i or c_j is not an ubiquitous factor, then the profit function cannot be maximized without consideration of the location of the firm. Since ubiquitous materials are so few, it is hard to conceive of a firm whose cost or revenue function is totally independent of location.

A fourth point can be made after a brief consideration of the revenue and cost functions. The relative contribution of each factor to cost or revenue may vary over a wide range from industry to industry. Thus, a factor which is a major contributor to cost in one industry may be of little or no consequence in another. For example, coal is a major factor in the steel industry, while it is unimportant in the manufacture of ladies' garments.

THE INDUSTRIAL COMPOSITION MODEL

Since the availability of factors varies from region to region and the importance of each factor varies from industry to industry, the industrial composition of a region depends on how the management of many individual firms view regional factor availability as matching their production and sales requirements. A model for the industrial composition of a given region can be formulated in the following manner:

$$IC_k = \sum_{i=1}^{x} \sum_{f=1}^{y_i} LD_{i,f} \qquad (6)$$

IC_k = the industrial composition of a given region (k)

LD = the location decision of individual firms

i = a subscript indicating a particular industry where the industries run from Industry (1) to Industry (x)

f = a subscript indicating a particular firm inside a given industry, where the firms run from Firm (1) to Firm (y_i)

y_i = the number of firms in the $(i)^{th}$ industry.

x = the number of industries.

Since the location decisions of the individual firms (LD) are determined by the nature of the functions g and h which vary from industry to industry and the level of the factors (r_i; c_j) which vary from location to location, the industrial composition (IC) will vary from region to region. The way in which reservoir projects can affect the industrial composition of contiguous regions is by changing the levels of either revenue or cost factors (r_i; c_j) or by changing the transformations of (r_i; c_j) into revenue and costs (g, h) associated with locations inside the region, or by some combination of these effects; therefore, to gain an understanding of the manner in which multipurpose reservoirs can influence the industrialization of contiguous regions, it is necessary to investigate the individual factors (r_i, c_j), the functions (M_i, N_j) which relate location to the level of factor, and the transformation functions (g, h).

THE IMPORTANT LOCATION FACTORS

A logical starting point for an analysis of the individual factors associated with the revenues and costs of a firm is an enumeration of normally significant factors. The cost factors associated with production are material costs, processing costs, and capital costs. If all factors were perfectly mobile (had zero cost of transport), there would be no variation in the cost factors from location to location.

Similarly, the revenue factors are linked to the market area of the firm. The market area of the firm is determined by the ability of a firm to take advantage of its proximity to spatially distributed buyers and to use this ability to deliver the product at a lower total price than more distant competitors and thereby exert a degree of monopoly power over a certain segment of the market.[5] The shorter time required for delivery and the increased personal contact in the selling process also give the local producer an advantage.[6] If there were no time and cost elements associated with the transfer of goods and goodwill from point to point, there would be no variation in the revenue potential of the individual firm from location to location. Thus, the variation in costs and revenues of an individual firm from location to location are due to the cost of transport of both input and output, and the immobilities of labor, capital, and the goodwill of the firm.

The Cost Factors

Materials: Spatial variation in costs of acquiring materials for production is important because the quantity and quality of nonubiquitous materials varies from location to location. The cost of materials at any point is cost of obtaining the materials plus the cost of transporting the material to the point of utilization.[7]

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[5]Melvin L. Greenhut, "The Size and Shape of the Market Area of the Firm." Southern Economic Journal, XIX (April 1952), pp. 37-50; Edgar M. Hoover, The Location of Economic Activity (New York: McGraw-Hill Book Co., 1948), pp. 48-53; and August Losch, The Economics of Location (New Haven, Conn.: Yale University Press, 1954), pp. 105-120.

[6]Greenhut, Plant Location. . ., pp. 174-175.

[7]The cost of obtaining the resources is a function of the cost of production and the market structure in the resource market.

The proper unit of distance for locational analyses is a cost unit.[8] The cost of transport for a given material is determined by the weight of the material; the distance the material is to be transported; and the rate (dollars per ton-mile) charged for the transport. This rate-ton-mile measure gives the economic measure of distance.

Several characteristics of the effect of transport costs on the location decision can be seen at this point. If the production process results in a loss of weight and bulk or a reduction in the unit cost of transport, the industry tends to be attracted to the material sources. Conversely, if a small amount of transported material is to be combined with an ubiquitous material or the final product is bulky and is transported at only a high cost, the productive process tends to be attracted to the market.[9] The use of inputs or the production of outputs that are fragile or perishable and thus have a high unit cost of transport will also affect the orientation of the industry. In all cases, the basic goal is to assemble the materials and transport the product to market at a minimum cost.[10]

Labor: Another major cost factor is labor. If workers could migrate at zero cost, i.e., if individuals were influenced only by income in choosing where to live, there would be no economic reason for variation of labor costs from region

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[8] Walter Isard, Location and the Space Economy (Cambridge, Mass.: Massachusetts Institute of Technology Press, 1956), pp. 36-37.

[9] An early statement of this concept of material or market orientation can be found in Alfred Weber, Theory of the Location of Industry, translated by Carl J. Friedrich (Chicago: University of Chicago Press, 1929), pp. 41-75. A revised analysis can be found in Hoover, Location of Economic Acticity, pp. 28-40; Greenhut, Plant Location..., pp. 113-119; and Nourse, Regional Economics, pp. 74-85.

[10] Edgar M. Hoover, Location Theory and the Shoe and Leather Industries, (Cambridge, Mass.: Harvard University Press, 1937), p. 36.

to region, but, in fact, the migration of people occurs only at a positive social and economic cost.[11] Thus, differentials in labor costs are observed from region to region.[12] It is important to remember that total labor costs are determined by wage rates, productivity, turnover and attitudes of workers, recruitment costs, and laws or union practice dealing with compensation requirements and restrictions on the utilization of the labor force.[13]

Land: Costs are also influenced by the prices of land and plant buildings. Of these two, the price of land shows the greater spatial variation.[14]

Taxes: An additional factor is the tax structure of the region. Although the level of taxes generally relate to the level of government services offered, significant variation in the costs of production from location to location can occur due to differences in the fraction of local tax revenue needs supplied by local industry.[15] Also, the need for various types of public services varies from industry to industry and within a given industry by the scale of plant.

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[11] Nourse, Regional Economics, p. 108.

[12] George Borts, "Returns Equilization and Regional Growth," American Economic Review, L (June 1960), pp. 319-347; Hathaway, "Migration from Agriculture...", pp. 370-391; and Larry A. Sjastad, "The Costs and Returns of Human Migration," Journal of Political Economy, Vol. V, Part 2 (October, 1962), pp. 80-93.

[13] Greenhut, Plant Location..., pp. 129-135.

[14] Nourse, Regional Economics, pp. 124-125; and James H. Thompson, Methods of Plant Site Selection Available to Small Manufacturing Firms (Morgantown, W. Va.: Bureau of Business Research of the University of West Virginia, 1961), pp. 48-49.

[15] Some studies of the effect of tax differentials on location decisions are: John F. Due, "Studies of State-Local Tax Influences of Location of Industry," National Tax Journal, XIV (June, 1961), pp. 163-173; James Martin and Glenn Morrow, Taxation of Manufacturing in the South (Tuscaloosa, Ala.: Bureau of Public Administration of the University of Alabama, 1948); and James Martin, Effects of Taxation on Industrial and Commercial Development with Special Reference to the South (Lexington, Ky.: Bureau of Business Research of the University of Kentucky, 1940). A review of the literature in this area can be found in Greenhut, Plant Location..., pp. 137-139.

Capital: The availability and cost of capital is also spatially variable. The variability of capital costs from region to region tends to be a function of the size of the firm.[16] A large corporation can obtain funds in the local area in which it has established goodwill and is therefore limited to considering only that region for location. The impact on location decision making of municipal industrial bonds, a popular form of industrial promotion, is shown to be significant in recent studies. It acts both to aid financing and lower corporate taxes.[17]

These individual cost factors combine to produce the total costs of the firm. The relative importance of each cost favor varies widely from industry to industry; thus, the attractiveness of a given region for a given industry depends on the relative importance to the industry of the factors of production which are available at a cost advantage in the region. If the industry cost consists primarily of transport costs, then a location which lowers the cost of bringing materials to the site or the costof transporting the product to the consumer may prove to be optimal. If the costs of transport are minimal and the processing costs are a major proportion of the total costs, a location offering low labor costs may prove optimal.[18]

The Revenue Factors

Market Area: The preceding discussion has covered only the effect of variation in cost factors from region to region in the location decision of the firm. As the model of equation 1 indicates, the revenue of the firm also varies with its spatial relationship to the market area served. The boundaries

[16] Greenhut, Plant Location. . ., pp. 135-137; and Thompson, Methods of Plant Site Selection. . ., p. 49.

[17] William J. Stober and Laurence H. Falk, "The Effect of Financial Inducements on the Location of Firms," Southern Economic Journal, XXXVI (July 1969), 25-35.

[18] Nourse, Regional Economics, pp. 74-85.

of the market area are determined by the actions of individual buyers who are spatially distributed. If a product is homogeneous and the buyers are economically rational, they purchase from the supplier who can deliver the product at the lowest price. Since the delivered price is the at-plant price plus the transport cost to the consumer, the producer nearest to the buyer has a price advantage. In addition, the local firm is in a better position to provide service, maintenance, and advice. The location which provides the greatest competitive advantage over the greatest volume of potential sales will be the choice which will maximize the revenue of the firm.[19]

Goodwill: In addition to the delivered price advantage given by a contiguous location, the personal contacts that are so important to sales and maintenance, the speed of the delivery of the product, and the feedback of information about product acceptability are all increased by locating production near the buyer.[20] A lower transport cost on the finished good will tend to increase the market area of the firm, particularly if this transport advantage accrues only to the firm in the given location.[21]

Agglomeration Economies as Location Factors

The analysis to this point has proceeded without explicit recognition of the dependence of the location decision of any one firm on the location of other firms. However, such interaction is implicit in the analysis since the market

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[19] Greenhut, Plant Location. . ., p. 140.

[20] Ibid, pp. 170-175.

[21] The relationship between the transport cost and the size of the plant constructed and the market area served for England shows a lower transport cost to processing cost ratio tends to promote large plants serving large markets as seen in Phillip Sargant Florence, Investment, Location and Size of Plant, National Institute of Economic and Social Research, Economic and Social Studies, Vol. VII (Cambridge: Cambridge University Press, 1962), pp. 28-31.

area of a firm locating at any given point will obviously be determined by the location of rival firms. Voluminous literature on the selection of the optimum location for the firm and the shape of the market area under a wide variety of assumptions as to the nature of the interactions among the spatial competitors is readily available.[22]

Less obvious is the fact that the cost function of the individual firm locating at a given point is a function of the location of other firms in the vicinity.[23] These "agglomeration" economies (diseconomies) are derived from several sources.[24] One is transfer economies. If several plants, each using some output of the others in its production, are located close to one another, the transport cost of input materials for all producers tends to be reduced below the level that would exist if the plants were spatially separated. Economies of scale external to an individual firm but internal to the industry can occur when several firms in the industry locate in the same area. As examples, a large pool of trained labor may be created which reduces the recruitment and training problems of each firm or specialized subcontractors

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[22] See Greenhut, Plant Location. . ., pp. 140-162; Greenhut, Southern Economic Journal (April 1952), 37-50; Harold Hotelling, "Stability in Competition," Economic Journal, XLIX (March 1929), 41-57; Abba P. Lerner and H. W. Singer, "Some Notes on Duopoly and Spatial Competition," Journal of Political Economy, XIV (April 1939), 145-186; Morris A. Copeland, "Competing Products and Monopolistic Competition," Quarterly Journal of Economics, LV (November 1940), 1-35; Arthur F. Smithies, "Optimum Location in Spatial Competition," Journal of Political Economy, XLIX (June 1941), 423-439; Edgar M. Hoover, "Sparial Price Discrimination," Review of Economic Studies, IV (June 1937), 278-288; and W. P. Hyson, "The Economic Law of Market Areas," Quarterly Journal of Economics, LXIV (May 1950), pp. 319-327.

[23] The first recognition of this effect was Weber, Location of Industries, pp. 124-172.

[24] Nourse, Regional Economics, pp. 85-92.

may locate in the area and offer components to the prime contractors at a saving to all.[25] External economies of scale may accrue to firms in different industries through economies in the provision of commonly required factors such as utilities, transportation services, and repair services.[26] Agglomeration diseconomies occur when mutual location clogs transportation arteries, causes competition for labor and industrial sites, and causes pollution of normally ubiquitous inputs such as air and water.

LIMITATIONS OF THE ECONOMIC MODEL

This model of the determinants of industrial location contains two idealized assumptions which may not be entirely realistic when applied to actual firms such as those investigated in the empirical phase of this study.[27] First, the profit motive of the firm includes both psychological and cultural elements.[28] Second, the location decision maker does not have total information about the characteristics of alternative locations. A concept of

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[25] An interesting study of the limits on the degree of economies of specialization resulting from limits on the size of the firm results from the optimum size of market served by a single plant can be found in George J. Stigler, "The Division of Labor is Limited by the Extent of the Market," Journal of Political Economy, LIX (June 1959), 185-193.

[26] Hoover, Location Theory. . . , pp. 108-110; Isard, Location and the Space Economy, pp. 182-188; and Greenhut, Plant Location. . . , pp. 168-170.

[27] Greenhut, Plant Location. . . , pp. 276-279; and Allan Pred, Behavior and Location, Department of Geography Land Studies in Geography Series B, No. 27 (Lund, Sweden: Royal University of Lund, 1967), p. 6.

[28] Psychic income is treated in Greenhut, Plant Location. . . , p. 175; George Katona and James N. Morgan, "The Quantitative Study of Factors Determining Business Decisions" Quarterly Journal of Economics, LXVI (February 1952), 67-90. Location decisions which are reported to have been made on the basis of personal preferences may actually be economically determined, is the conclusion of Charles M. Tiebout, "Location Theory, Empirical Evidence, and Economic Evolution," Papers and Proceedings of the Regional Science Association, III (1963), 74-88.

partial information is certainly more realistic in view of observed location decisions, especially since anticipation of future conditions is what is required.[29]

Information and Perception

The need to modify the model to reflect real rather than idealized conditions requires conceptualizing the location decision not as a determination of the optimal location by a decision maker motivated entirely by profit and possessing omniscient powers of prediction, perception, and reasoning, but as a problem in decision making under uncertainty where the information and perception of the decision maker is limited and the perceived benefits of any given location are determined in part by the psychological and cultural characteristics of the individual decision maker.[30] The economic location decision model needs to be modified to recognize that the motivation of the decision maker is directed in part toward objectives other than profit and influenced predominately by the information at his disposal.[31]

Cultural Factors

The cultural background of a given community or region, especially as evidenced in the attitude toward industry, is a major factor in determining the desirability of any specific location as a plant site.[32] The evidence indicates

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[29] Pred, Behavior and Location, pp. 32-52; Julian Wolpert, "The Decision Process in Spatial Context," Annals of the Association of American Geographers, LIV (December, 1964) 537-558; and Thorsten Hagerstrand, "Aspects of the Spatial Structure of Social Communication on the Diffusion of Information," Papers and Proceedings of the Regional Science Association, XVI (1966), 27-42.

[30] A behavioral model of location decision making is presented in Pred, Behavior and Location, pp. 21-64.

[31] The role of information in changing perceived risk is analyzed in Melvin L. Greenhut, Microeconomics and the Space Economy (Chicago: Scott, Foresman, & Co., 1963); and Melvin L. Greenhut, "The Decision Process and Entrepreseural Returns," Manchester School of Social and Economic Studies, XXXIV (September, 1966), 247-267.

[32] The importance of a favorable attitude toward industry is a reoccurring theme in empirical investigations of location decisions. See McLaughlin and Robock, Why Industry Moves South, p. 83, pp. 105-106, and pp. 120-121; Thompson, Methods of Plant Site Selection. . ., pp. 46-47; and Randell T. Klemme, "Community Development as a Forerunner of Industrial Development," Appraisal Journal, XXVIII (October, 1960), 444-448.

that positive community attitudes and actions have played an important role in attracting industry to the industrially developing sections of the South.[33]

Areas which have a positive attitude toward industrial development often disseminate promotional literature, plan industrial parks, establish tax incentives, and engage in other activities in an attempt to attract industry. If location decisions were made under conditions of perfect knowledge, these promotional activities (other than the provision of tax subsidies) would be of little value; however, in the existing case of decision making under uncertainty, community efforts directed toward giving the decision maker information at a low cost may well make the area more likely to be selected.

Steps in the Location Decision Process

The location decision process is, characteristically, a series of decision steps. The degree of variation of factors from one area to another tends to depend on the size of the area. Some factors, such as land prices, flood risks, and access to water vary widely inside a small area while other factors such as the market area, the climate, and the labor supply and skill levels tend to be variable only over a wider area.[34] A study of industries locating in the South shows that growth in the South as a market has tended to attract plants to the region to serve this new market.[35] The exact location of the plant inside the region is then determined by the availability of other factors, such as labor, utilities, taxes, sites, and water.

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[33] That prevailing agrarian culture in other parts of the South has retarded industrial development is the view of William Nichols, Southern Tradition and Regional Progress (Chapel Hill, N. C.: University of North Carolina Press, 1960), p. 15.

[34] Robert A. Will, "Finding the Best Plant Location," Chemical Engineering, LXXII (March 1, 1965), 87-92.

[35] McLaughlin and Robock, Why Industry Moves South, pp. 31-34.

An Over-view of the Model

In summary, the industrial composition of any region is the result of the location decisions of many individual firms. Each location decision is made with the goal of choosing a location so that profits (broadly defined to include both economic and other factors) are maximized. The relevant profits are the profits anticipated by the decision maker operating with limited information to result in the future from location at a given point.

THE EFFECTS OF MULTIPURPOSE RESERVOIRS ON THE DETERMINANTS OF THE SPATIAL DISTRIBUTION OF ECONOMIC ACTIVITY

By what mechanisms can the presence of a multipurpose reservoir influence economic development? The theoretical model indicates that the spatial pattern of economic development is the aggregate of location decisions by many individual economic units, each motivated to maximize its own profit. The profit potential of any given site is a function of many factors. Reservoirs affect the development of contiguous areas through modification of the area's preexisting configuration of location factors.

What factors are modified by reservoir projects? What net effect from reservoir induced changes can be anticipated on the economic development of contiguous areas? The answers are best attained by considering the changes in each of the factors likely to result from reservoir development.

Flow Stabilization

The expressed primary objective of most reservoir construction has been to benefit downstream areas through flow regulation to reduce high and increase low flows. The resulting flow regulation affects three major factors influencing location decisions: flood hazard, water supply, and water quality.

Reservoir storage for flood control shifts the availability of land suited for industrial development from upstream to downstream sites. The reservoir pool removes acreage from its former productive use, often farming, range, or forest uses, and improves the industrial potential of downstream flood plain land by reducing flood hazard, firming up the dependability of the water supply, and improving water quality by dilution.[36] These downstream effects are likely to be more extensive along larger streams where flows and flat areas are usually more in line with industrial needs. They are also likely to be more extensive in such mountainous regions as Eastern Kentucky and Tennessee where most land level enough for industrial development is in a flood plain where the flood hazard is high under natural conditions.[37]

One aspect of this change needs to be especially emphasized for this study. The loss of land from productive use lies entirely within the contiguous area as defined for this study. The gains begin at the damsite and extend downstream in gradually diminishing degree for tens and even hundreds of miles. Only the first few miles and hence only a small portion of the benefit is likely to be in the contiguous area. The implication is that the impact of a project on industrial development in the contiguous area through the flow stabilization effect will be greatest for projects where non-reservoir related factors favor industrial locations immediately downstream from the dam site and flow stabilization effects remove a critical bottleneck.

Where high quality water is of limited supply either by time of year or by location within the contiguous area, reservoir water may be used for cooling, processing, or waste dilution.[38] Most of the benefit is again likely to be down-

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[36] Aubrey J. Wagner, "The Future of TVA," in Moore, Economic Impact of TVA, pp. 151-154.

[37] Mary J. Bowman and W. Warren Haynes, Resources and People in East Kentucky (Baltimore, Md.: Johns Hopkins Press, 1963), p. 12.

[38] The country does not face a general water shortage if reservoir development is continued as stated in Alternatives to Water Management; A Report by the National Research Council, Committee on Water (Washington, D. C.: National Academy of Sciences-National Research Council, 1966), p. 1., but industry is sensitive to the availability of high quality water since in time of shortage industry users are the first to be restricted says Leonard C. Yaseen, Plant Location (New York: Institute for Business Planning, Inc., 1955), p. 97. The study area of Kentucky and Tennessee are particularly safe from a general water shortage.

stream from the project through low flow mitigation in the natural stream, but water distribution systems fed from the reservoir can be used to supply sites throughout the contiguous area. Special care must be exercised in controlling industrial waste discharged directly into the reservoir.

Electric Power

Reservoir projects may affect the availability and cost of electric power in two ways. First, the project may provide for the generation of hydro-electric power; and second, it may provide coolant for thermal power generation. Electric power is becoming increasingly important for the industrial processes.[39] The continued expansion of thermo-nuclear power plants which create high levels of waste heat may increase the importance of this effect. Because electric power can be inexpensively transmitted over long distances, project effects are neither confined to the contiguous area nor as downstream oriented as flow stabilization effects.

Navigable Waterways

Another physical factor that may be provided by reservoir projects is navigable waterways. Water transport can produce major revisions in the economic haul distances, particularly for heavy and/or bulky commodities because these are transported at much lower cost by barge than by other means of transportation.[40] The primary benefit to the contiguous area comes as locks for vessel by-pass and the dam permits the lake to be connected to a large waterway system. In the Kentucky-Tennessee area, many reservoirs are connected into the interconnected navigation system on the Mississippi, Ohio, and Tennessee Rivers and, where they are, a lakeside location can have a major transportation advantage.

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[39] The role of electric power in development is analyzed in Bruce C. Netschent, "Electric Power and Economic Development," in Moore, Economic Impact of TVA, pp. 2-23.

[40] Shipment by water characteristically requires a higher terminal cost in proportion to the cost per mile than does truck or rail transportation, as discussed in Hoover, Location Theory..., p. 56; thus, water transport is particularly important on long, high tonnage hauls as illustrated in Nourse, Regional Economics, pp. 70-71.

Labor

A reservoir project has an indirect effect on the labor force through two major sources: first, the skills learned by local workers while working on the project construction may affect the supply of skilled labor, and second, the reservoir right-of-way by removing existing sources of employment increases the pool of available workers.

Esthetic Factors

A reservoir project often provides fish and wildlife augmentation and can serve as a site of water-based recreation activities such as boating, swimming, and fishing. This recreation potential may provide a local market for service industries such as restaurants and lodging.[41] These esthetic factors also serve as a "fringe benefit" to workers residing in the local area and may entice new workers or people looking for a retirement location. Another potential linkage is that the restaurant and lodging facilities attracted to the area by the tourist business may also serve the needs of businessmen with respect to banquet facilities, accommodations for visiting business associates, and other common business entertaining requirements.

Community Attitudes

There is a psychological linkage between the reservoir and economic development because a multipurpose reservoir is an innovation which can act to change the culture of the contiguous region.[42] Through the process of meeting the local community obligations with respect to reservoir construction the community may become more willing to promote industry in the area. For example, in an area with little industrial development, the prevailing attitude toward industry might be negative due to a widespread feeling that meaningful

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[41] Yang Ch'eng Shih, American Water Resources Administration, Vol. I (New York: Bookman Associates, Inc., 1956), pp. 36-38.

[42] The role of innovation in the process of cultural development is analyzed in Homer Barnett, Innovation: The Reason for Cultural Change (New York: McGraw-Hill Book Co., 1953).

industrial growth would disturb the status quo and produce undesirable side effects. The construction of a multipurpose reservoir project may disrupt the established patterns enough to allow a reevaluation of community goals. Consequently, community leaders may find the climate more favorable for engaging in industrial promotion activities and for the revision of physical and cultural features of the area in view of the needs of industry.

RESERVOIR PROJECTS AND THE ECONOMIC DEVELOPMENT OF CONTIGUOUS AREAS

Among the factors that influence the location of economic activity, are there any that are affected by reservoir projects in such a manner as to promote economic development in the contiguous areas? The answer is a qualified yes.

The contiguous area is the prime beneficiary of the recreational, esthetic, and cultural effects of reservoir development. If these factors affect economic development, the area contiguous to the reservoir project is the most likely site of this development.

Some factors affect the contiguous area and the non-contiguous areas to the same degree. For example, electric power benefits accrue to a wide area due to the relatively low transmission cost. The areas of benefit are determined more by the authorized market areas of the agencies or companies that distribute the power than by economic limits on the distribution of electric power.

Many of the benefits of reservoir projects accrue primarily to locations downstream from the project site. This is particularly true of flow stabilization and, unless locks are provided, of navigation. Water quality control with respect to both thermal and physical waste dilution is more easily accomplished in a flowing water environment below the dam than in the still water of the reservoir pool.

PREDICTIONS OF THEORY

Reservoir projects can change the relative availability of both cost and revenue producing factors in the contiguous areas and thereby provide economic incentives for location of new industry. Reservoirs also improve the economic environment by providing non-economic incentives for industrial location. In addition, the project may begin a process of cultural innovation leading to increased efforts by both local and state groups to promote industry in areas contiguous to projects.

On the other hand, many factors known to be vital in industrial location decision making are not affected by the development of a reservoir project. For example, a reservoir project does not correct an inadequate land transportation system or an unsatisfactory educational system. Since the project does not affect all factors entering into the location decision, the project alone can not remove all limits to economic development. Whether or not development occurs depends on the relative importance of the favorably affected factors to the location decision makers.[43]

If this analysis is correct, what pattern of development of the contiguous areas would be expected? The most likely prediction is that the individual projects would show a great deal of diversity in the degree of development in the contiguous areas. This diversity would derive from the inability of reservoir projects to affect all the relevant location factors and the heterogeneity in the availability of these factors among reservoir locations. If the project happens to remove a serious limitation to the economic attractiveness of the area, the area may experience rapid development. If, however, the area has a serious deficiency in a factor that is not affected by project

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[43] Statements on the need for water resource planning to incorporate controls over socio-economic variables in planning area can be found in Stefan H. Robock, "A Socio-Economic Evaluation of the TVA Experiment," in Moore, Economic Impact of TVA, pp. 110-113.

development, this continued deficiency may prevent development. It is also possible for a project to remove a desirable feature of the area and thus retard future development.

The model of this chapter would predict varied degrees of development in the contiguous areas of the individual projects, with the source of this divarication, a variation in the ability of the projects to remove deficiencies in the industry attracting features of the areas. Since both positive and negative effects are theoretically possible, the net effect of reservoir projects on the economic development of contiguous areas differ. Just how much they differ can only be ascertained by investigating the actual experiences of areas contiguous to existing projects.

CHAPTER III

DEFINITIONS AND MEASUREMENTS FOR THE EMPIRICAL ANALYSIS

The preceding chapter used a theoretical model to describe the mechanisms whereby projects may have either a positive or a negative influence on individual industrial location decisions and how the individual decisions interact to determine the economic development of the area. The net effect of a project on its contiguous area was shown to depend on interactions among positively and negatively affected factors and how the location decision makers perceive the outcome as affecting the desirability of the site from their point of view. The extent of this effect can only be evaluated by investigating the empirical evidence.

GOAL OF THE EMPIRICAL STUDY

The goal of this phase of the study is to evaluate empirical evidence contrasting the economic development of areas contiguous to existing projects with the development occurring in otherwise similar areas which have not experienced the construction of a large reservoir in the immediate vicinity. By relating the actual experiences of these areas to the theoretical model, more evidence is accumulated on the effectiveness of reservoir affected factors in influencing the location decision process.

Several points must be clarified before the desired comparisons can be made. First, specific yardsticks for measuring economic development must be established. Second, the projects must be selected and the contiguous areas of these projects must be geographically defined. Third, a criteria for the selection of control areas must be chosen and used to select a control area for each contiguous area. This chapter is devoted to the definition of measures of economic development, the selection of projects for study, the definition of the contiguous and control areas for each project, and evaluation of the validity of the criteria employed in selecting the control areas. The outcome will be the background necessary for statictical analysis of the relative economic development of the contiguous as opposed to control areas in the next chapter.

MEASURES OF THE RELATIVE ECONOMIC DEVELOPMENT OF TWO AREAS

The problem in comparing the level of economic development of two regions originates in the multi-dimensional nature of development; the more diverse the regions, the more difficult the comparison. Fortunately, the areas under consideration in this study have similar economies and common monetary units. The problems of differing economic structures and monetary standards that are encountered in international comparisons are not present.

To the degree that it can be assumed that the purpose of an economy is to provide economic substance, per capita income of the residents is a good measure of the economic development of an area; therefore, per capita income will be employed as one measure of economic development.[1] Rapid development often produces an in-migration of people; therefore, population will be used as another index of economic development.

A third characteristic of economically developing areas is change in the types of economic activities that employ the labor force. In the Southeastern region of the United States, the dominant employment activity during the early 1900's was agriculture, a low-income industry. Development has been marked by a shift to a diversified economy from a concentration of employment in agriculture or, in the case of certain mountainous sections.

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[1] Richard S. Thorn, "Per Capita Income as a Measure of Economic Development", Zietschrift Fur Nationalokonomic, XXVIII (October, 1968), pp. 206-16, maintains that per capita income is as good a measure as has been developed to present. Suggests it performs better than any composite index developed to date.

in mining; therefore, a third measure of economic development will be employment pattern trends.

The impact of a exogenous factor, such as a reservoir, on the economic development of an area, has two dimensions. First, the level of development may differ; second, the time rate of change of development may be affected. The measurement of the levels and rates of change of per capita income and total employment presents no problem; however the characterization of the level or rate of change of an employment pattern requires the development of a suitable index statistic.

Measurement of Employment Patterns

The Level of Economic Diversification: The first problem is to develop an index which will provide a measure of the degree to which employment is diversified over many as contrasted with being concentrated in a few job categories. Amemiya[2] defined an Index of Economic Differentiation (IED) by the formula

$$IED = \sum_{i=1}^{N} \left[\frac{N}{N-1} \left(P_i - \frac{1}{N} \right)^2 \right] \tag{7}$$

where P_i = the fraction of total employment found in the i^{th} employment category;

N = the number of employment catagories.

In order to provide an Index of Economic Differentiation that ranges from zero when employment is concentrated in one category to one when employment is equally spread over all employment catagories, this index has been modified for this study by using the formula:

$$IED = 1 - \sum_{i=1}^{N} \left[\frac{N}{N-1} \left(P_i - \frac{1}{N} \right)^2 \right] \tag{8}$$

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[2] Eiji C. Amemiya, "Measurement of Economic Differentiation," Journal of Regional Science, Vol. V, No. 1 (1963), pp. 85-87.

Thus, increasing values of the IED indicate increasing diversification of the labor force. Since a diversification of employment is associated with more highly developed economies, the IED is an employment pattern measure of the level of economic development.

The Similarity of Employment in Two Regions: The next problem is to develop a measure of the similarity of the employment patterns of two regions. The Index of Regional Homogeneity (IRH) devised by Sherr will be adopted.[3] The IRH is computed from the formula

$$IRH = 1 - \frac{1}{90°} \cos^{-1}\left[\frac{(A \cdot B')}{(|A| \cdot |B|}\right] \tag{9}$$

where A = an N element row vector with the i^{th} coordinate of the vector the number of employees in the i^{th} employment catagory in the first region.

B = an N element row vector for the second region.

B' = the column vector that is the transpose of B

|A|, |B| = the moduli of the vectors A and B

N = the number of employment catagories.

The index degree of similarity of employment patterns between two regions varies from zero if the two regions are completely orthogonal in their employment patterns to unity if they have identical employment proportions in all catagories.

The Rate of Change of Employment: To provide a measure of the change in employment patterns in a given region over time, the Index of Intraregional Change (IIC) will be used. This adaptation of the IRH is computed from

$$IIC = 1 - \frac{1}{90°} \cos^{-1}\left[\frac{(\gamma \cdot \beta')}{(|\gamma| \cdot |\beta|}\right] \tag{10}$$

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[3]Lawrence A. Sherr, "A Note on the Measurement of Regional Homogeneity", Journal of Regional Science, Vol. VI, No. 2, (1966), pp. 49-52.

where γ = a row vector of employment by catagory in a given region in time period t.

β = a row vector of employment by catagory in the same region in time period t-1.

Therefore, the IIC would be unity if no change in the employment pattern occurred over time and zero if a totally new employment pattern existed in period t than had existed in period t-1.

A Summary of the Indices

The level and rate of change of economic development for comparing contiguous with control areas will be measured in several alternative ways in order to develop a better understanding of the relevant relationships. The more conventional measures of per capita income and population are supplemented with three employment pattern indices. The IED is a measure of the level of diversification of employment in a region at a point in time, the IRH is a measure of the similarity of two regions at a point in time, and the IIC is a measure of the change in a region between two points in time. All measurement data are taken from published U. S. census data. The published data use 32 employment catagories. *

The correlation among the values of these alternative measures for all the counties in Kentucky and Tennessee can be seen in Table 2, which shows the degree of correlation among the measures of the level of economic development (income, IED, and population). The bottom of the table shows correlation among measures of the rates of change in development (percent change in income, percent change in population, and IIC). The results show positive significant correlation among all three measures of development. The decreasing correlation of IED with population over time reflects the increasing diversification of the less populated counties.

*These catagories are described in Appendix E.

TABLE 2

SIMPLE CORRELATION COEFFICIENTS AMONG ECONOMIC DEVELOPMENT PARAMETERS FOR ALL KENTUCKY AND TENNESSEE COUNTIES

Measures of Level of Economic Development

	1940	1950	1960
Per Capita Income with IED	0.592	0.574	0.449
Per Capita Income with Population	0.495	0.492	0.451
IED with Population	0.693	0.512	0.282

Measures of Rate of Economic Development

	1940 - 1960
Percent Change in Per Capita Income with IIC	-0.157
Percent Change in Per Capita Income with Percent Change in Population	-0.164
IIC with Percent Change in Population	-0.233

Source: Computed from data presented in U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, 1940 - 1950, 1950 - 1960, (Washington, D. C.: Government Printing Office, 1965), Vol. V, Southeast.

The negative correlation between IIC and population and income changes is expected since high income and population changes represent rapid economic development, while low values of IIC represent rapid change in employment patterns. The negative coefficient between percentage change in income and percentage change in population is unexpected; however, it is probably due to the rapid percentage income rises from a relatively low base in the rural sections of the study area. These areas almost reverted to barter and self-sufficient economies during the depression of the 1930's and since have experienced rapid increases in income while remaining below the income levels of the more populated areas. These rural areas have not increased in population as fast as the urban areas; in fact, the population of most of them has decreased.

SELECTION OF RESERVOIRS FOR EMPIRICAL STUDY

All large reservoirs (those exceeding 50,000 acre-feet of useful storage) in the states of Kentucky and Tennessee are included in the empirical study if they were operational during the period 1940-1955. Projects completed after 1955 are excluded because industrial development occurs too slowly for a data base ending in 1960 to provide significant information. Time pressures for completing the study precluded waiting for 1970 census data even though a review of recent developments around the periphery of many of these reservoirs[4] and a cursory examination of reservoir recreation statistics suggest that 1960-1970 was the decade of greatest change yet. A followup study should be worthwhile. The selection rule also assumes that all large reservoirs are inherently multipurpose in character even though they were originally conceived for some single purpose such as power generation. All large reservoirs have

[4] Billy R. Prebble, "Patterns of Land Use Change Around a Large Reservoir," Lexington, Kentucky, University of Kentucky Water Resources Institute, Research Report No. 22, 1969.

downstream flow stabilization, recreation, and esthetic change as by-products even though multipurpose operation can improve efficiency in providing these services.

The twenty projects selected are listed in Table 3. The majority were completed in the 1930-1955 period. Economic development occurring before 1940 around the older reservoirs was minimal due to the agrarian culture of the South and the severe depression of the 1930's that slowed economic development, particularly industrial development; therefore, the period 1940-1960 contains most of the reservoir induced development.

DEFINITION OF STUDY AREAS FOR RESERVOIR PROJECTS

The Contiguous Area

Given that the goal of this study is to analyze the role large reservoirs have in the economic development of areas contiguous to the projects, the ideal boundaries of the study area would be a band around each of the projects, or perhaps to evaluate degrees of effect, a series of concentric bands with the reservoir at the center. Such a design can only be approximated without resorting to the collection of original data, a task beyond the scope of this study. The county is the smallest geographic area for which data on socio-economic variables have been collected over a sufficient time span to allow the tracing of development. Some data on smaller geographic divisions, such as census tracts, are obtainable; but the small amount of information available, the short time span covered by these data and the variation in tract boundaries from one census to the next preclude their use.

In view of this limitation on available data, the contiguous area of a reservoir project is defined as the counties along the reservoir shore line excluding upstream areas where the lake is small and use of the storage is irregular. The twenty contiguous areas for the twenty projects are presented in Appendix A, and maps of these areas are presented in Appendix B.

TABLE 3

PHYSICAL CHARACTERISTICS OF THE SELECTED RESERVOIRS

No.	Name	Year Completed	Reservoir Capacity (acre - feet)	Power Capacity (kw/hour)
1	Kentucky Lake	1944	6,002,600	160,000
2	Old Hickory Lake	1955	445,000	100,000
3	Pickwick Lake	1938	1,091,400	216,000
4	Elk River Lake	1952	68,570	a
5	Guntersville[b] &	1939	1,018,700	97,200
	Hales Bar Lakes[b]	1913	147,660	99,700
6	Chickagauga Lake	1940	705,300	108,000
7	Parkersville Lake	1912	91,300	18,000
8	Watts Bar Lake	1942	1,132,000	150,000
9	Fort Loudon Lake	1943	386,500	128,000
10	Douglas Lake	1943	1,514,100	112,000
11	Cherokee Lake	1942	1,565,400	120,000
12	Boone Lake	1953	196,700	75,000
13	South Holston Lake	1951	744,000	35,000
14	Watauga Lake	1949	778,800	50,000
15	Norris Lake	1936	2,567,000	100,800
16	Dewey Reservoir	1951	93,300	a
17	Herrington Lake	1924	300,000	28,500
18	Cumberland Lake	1952	6,089,000	270,000
19	Dale Hollow Lake	1953	1,706,000	54,000
20	Center Hill Lake	1951	2,092,000	135,000

[a]no power plant

[b]considered as a single project because of their close proximity

Source: T. W. Mermal (ed.), Register of Dams in the United States, (New York: McGraw-Hill Book Company, Inc., 1958), Table I, pp. 5-229.

A Disclaimer

This definition of a contiguous area does not include the entire area that receives benefits from a reservoir project. A plant may locate many miles downstream from a reservoir and receive flood control, low-flow augmentation, navigation, and perhaps power benefits from the project. Economic development throughout the entire Tennessee and lower Mississippi Valleys has been influenced by the aggregate effects of the water resource projects of the Tennessee Valley Authority and the U. S. Army Corps of Engineers. The contiguous area as defined is too small to include all the benefits realized from the project; in fact, the area as defined is more likely to include only a small faction of the total benefits.

Benefits accruing outside the contiguous area are immaterial to deciding whether or not a reservoir project promotes development in the contiguous area or how projects can be better planned to increase the benefit to the local area. No inference that the contiguous area receives all of the benefits of any water project is intended.

Control Areas

If the changes in economic levels and patterns that have resulted from the effect of a reservoir project on its contiguous area are to be separated from the movements over time that have occurred due to changes in the characteristics of the national and regional economy, a time-variant standard for comparison must be provided. The selected approach is to select a control area and compare the behavior of the control area to the behavior of the contiguous area over time.

Criteria for Control Areas: Ideally, the control area should have exactly the same levels of all indigenous factors as the contiguous area and be free from the effects of any factors exogeneous to the study. Since the factors that affect industrial location are numerous and diverse, no control area can be selected that completely satisfies this criterion.

Control areas are commonly selected to be contiguous to the study area or in the same political or physiographic region as the study area. Others have used large areas for comparison, such as an entire state or nation in an attempt to average out the effects of exogenous variables. The basic problem is to find a method of selection which leads to an area with similar levels of location factors and is free from the effects of factors exogenous to the study.

The levels of the location factors in an area are reflected in the types of economic activities conducted in the area. The economic activities of the area determine the employment patterns of the residents; therefore, two areas with similar levels of location factors should have similar employment patterns. Similarity in employment patterns can be measured with the Index of Regional Homogeneity (IRH); therefore, the counties in the study area of Kentucky and Tennessee with the highest IRH when compared to the contiguous area of a reservoir in the beginning of the study period (1940) should be counties with similar patterns of location factors. Counties contiguous to another reservoir or known to have been affected by the impact of another major exogenous variable should be excluded from the control area because of the introduction of the exogenous variable since that time.

<u>Definition of Control Areas:</u> The ten counties in Kentucky and Tennessee with the highest IRH in 1940 when compared to the area as a whole contiguous to a reservoir are used as its control area. Counties contiguous to other reservoirs, counties where a major military base was activated during the study period, and counties which are centers of state governments have been excluded. Ten counties are included to moderate the effect of other exogenous factors in a single county on the behavior of the control area as a whole.

The counties in the control area for each contiguous area are listed in Appendix A, and the maps in Appendix B show the location of the control counties in relation to the contiguous areas. Table 4 shows the relatively high degree of homogeneity among the contiguous areas and the control areas in contrast with the differences when the contiguous area is compared to all the counties in Kentucky and Tennessee.

TABLE 4

THE CONTRAST BETWEEN THE HOMOGENIETY OF THE CONTIGUOUS AREA WITH THE CONTROL AREA AND ITS HOMOGENIETY WITH THE STATES AS A WHOLE, 1940

Reservoir Project	IRH between Contiguous and Control Areas, Each taken as a whole	Mean IRH between the contiguous area Taken as a Whole and counties in its Control Area	Mean IRH between the contiguous area Taken as a whole and all counties in Kentucky & Tenn.
Kentucky Lake	0.9539	0.9464	0.8111
Old Hickory Lake	.9628	.9434	.8064
Pickwick Lake	.9437	.9167	.7727
Elk River Lake	.9379	.9061	.7789
Guntersville & Hales Bar Lakes	.7939	.7510	.4982
Chickamauga Lake	.6889	.5104	.2950
Parkersville Lake	.8491	.8124	.6663
Watts Bar Lake	.7922	.7823	.6565
Fort Loudon Lake	.7212	.5628	.3931
Douglas Lake	.9590	.9477	.8153
Cherokee Lake	.9669	.9578	.8167
Boone Lake	.6711	.6250	.5115
South Holston Lake	.5516	.5183	.4147
Watauga Lake	.5583	.5509	.4881
Norris Lake	.9349	.8844	.6650
Dewey Reservoir	.9139	.8210	.3850
Herrington Lake	.9806	.9662	.8127
Cumberland Lake	.9750	.9664	.8138
Dale Hollow Lake	.9858	.9795	.8069
Center Hill Lake	.9891	.9815	.8045

Source: Indices computed from data presented in U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), Vol. V., Southeast, pp. 61-132.

THE VALIDITY OF THE CRITERIA FOR THE SELECTION OF CONTROL AREAS

The control areas were determined by selecting the ten counties in the study area having the employment patterns most similar to that of the contiguous area at the beginning of the study period. This selection procedure was justified a priori by asserting that similar areas would have similar levels of locating determining factors that would attract similar types of economic activity resulting in homogeneous employment patterns. If this logic is valid, the areas selected should be similar with respect to variables other than employment patterns. Before attempting a statistical analysis of reservoir effects, the validity of the criteria employed in the selection of the control areas should be evaluated by investigating the overall similarity of the contiguous and control areas in 1940.

Table 5 contrasts the levels of population, per capita income, and IED, a measure of employment differentiation, between the contiguous and control areas of the twenty reservoir projects. For all three variables, the relative homogeneity between the contiguous areas and their control areas as compared to the variation among the areas of the different projects is apparent. A coefficient of correlation between contiguous and control areas was computed for each of the three variables. For population, the correlation coefficient is 0.798, for per capita income it is 0.781, and for IED it is 0.966. Since the control areas are selected on the basis of similar employment patterns, the high correlation in IED is expected, but the high correlations in per capita income and population lend support to the selection criteria.

Table 6 shows the movements of these variables over the period 1940-1960 in the contiguous and control areas. Once again the similarity between contiguous and control areas is apparent. The correlation coefficients between value pairs are 0.799 for the percent change in population, 0.622 for the percent change in per capita income, and 0.492 for IIC, a measure of

TABLE 5

COMPARISON OF POPULATION PER COUNTY, ANNUAL PER CAPITA INCOME, AND INDEX OF ECONOMIC DIFFERENTIATION FOR PAIRS OF CONTIGUOUS AND CONTROL AREAS, 1940

	Contiguous Area			Control Area		
Reservoir Project	Population	Income	IED	Population	Income	IED
Kentucky Lake	13688	$208	.6749	14168	$ 234	.6039
Old Hickory Lake	21366	495	.7062	26248	238	.6525
Pickwick Lake	17806	168	.7014	11475	191	.7017
Elk River Lake	23892	222	.7819	24975	267	.7308
Guntersville & Hales Bar Lake	19140	225	.9017	31378	242	.8162
Chickamauga Lake	67741	475	.9665	81424	558	.9748
Parkersville Lake	15473	239	.8669	17477	173	.7749
Watts Bar Lake	16847	180	.8676	22320	245	.7928
Fort Loudon Lake	79807	441	.9644	81424	558	.9748
Douglas Lake	21998	170	.6629	22592	206	.6179
Cherokee Lake	20500	195	.6101	15292	203	.5599
Boone Lake	60358	368	.9544	29906	352	.8954
South Holston Lake	69085	424	.9543	29906	352	.8340
Watauga Lake	19062	333	.8340	29070	294	.7678
Norris Lake	21606	196	.7705	25852	188	.7952
Dewey Reservoir	52986	226	.7320	34471	226	.8173
Herrington Lake	13269	260	.6502	19741	237	.6228
Cumberland Lake	20240	144	.5328	14238	175	.4950
Dale Hollow Lake	9829	132	.3970	14183	166	.3723
Center Hill Lake	14588	165	.4203	19019	174	.3878

Sources:

Population Data: Computed from population data in U. S. Department of Commerce Bureau of the Census, United States of Population; 1940, Vol. II, Characteristics of the Population, Parts 3 and 6, Kentucky and Tennessee (Washington, D. C.: Government Printing Office, 1943).

Income Data: Computed from unpublished data provided by U. S. Department of Commerce, Office of Business Economics.

Employment Data: Computed from U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, Vol. V, Southeast, pp. 61-132 (Washington, D. C.: Government Printing Office, 1965).

TABLE 6

COMPARISON OF RATES OF CHANGE IN POPULATION PER COUNTY, ANNUAL PER CAPITA INCOME, AND EMPLOYMENT PATTERNS FOR PAIRS OF CONTIGUOUS AND CONTROL AREAS, 1940-1960

Reservoir Project	Contiguous Area			Control Area		
	Population[a]	Income[a]	IIC	Population[a]	Income[a]	IIC
Kentucky Lake	-14.80	512.18	0.5676	- 5.43	395.16	0.7552
Old Hickory Lake	7.33	294.18	.6047	- 2.28	395.38	.7431
Pickwick Lake	- 2.29	409.52	.4939	- 4.06	406.18	.6015
Elk River Lake	6.84	350.00	.5507	11.21	416.40	.6306
Guntersville & Hales Bar Lake	9.90	316.00	.5430	- 2.84	370.73	.5311
Chickamauga Lake	27.53	297.53	.7128	44.37	278.86	.7108
Parkersville Lake	-21.41	361.09	.5342	-16.57	333.16	.5565
Watts Bar Lake	19.02	461.75	.4742	13.91	407.57	.6095
Fort Loudon Lake	38.52	308.99	.6251	44.37	278.86	.7107
Douglas Lake	4.75	458.01	.6180	- 5.30	437.25	.6995
Cherokee Lake	4.82	412.44	.6790	-10.65	375.91	.7562
Boone Lake	48.25	396.57	.6276	16.26	341.54	.6153
South Holston Lake	65.21	386.32	.6266	16.26	341.54	.6153
Watauga Lake	37.29	221.27	.6622	7.86	358.77	.6289
Norris Lake	-14.37	279.08	.6428	-16.41	328.00	.5508
Dewey Reservoir	-21.40	299.56	.6652	-14.66	347.95	.6508
Herrington Lake	- 8.27	429.28	.7812	- 7.04	404.23	.7528
Cumberland Lake	-14.69	462.69	.7788	-17.34	400.18	.7788
Dale Hollow Lake	-27.66	404.91	.7647	-22.51	431.06	.8193
Center Hill Lake	-26.14	496.36	.5074	-18.83	417.37	.8581

[a] percentage increase over 20-year period

Sources:

Population Data: Computed from population data in U.S. Bureau of the Census, U.S. Census of Population, 1940, Vol. II, Parts 3 & 6 (Washington, D.C., U.S. Government Printing Office, 1943); U.S. Bureau of the Census, U.S. Census of Population, 1950, Vol. II, Parts 17 & 42 (Washington, D.C.; Government Printing Office, 1952); and U.S. Bureau of the Census, U.S. Census of Population, 1960, Vol. I, parts 17 & 44 (Washington, D.C.; Government Printing Office, 1963).

Income Data: Computed from unpublished data compiled by the Office of Business Economics, U.S. Department of Commerce.

Employment Data: Computed from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment, by County, Vol. V, Southeast, pp. 61-132 (Washington: U.S. Government Printing Office).

change in employment patterns. These correlations suggest that whatever the differences between the economic development in contiguous as contrasted with control areas may be, the forces causing them do not act so rapidly that initial conditions do not continue to have an important influence even after twenty years. The lower coefficients for income and IIC suggest the possibility of divergence over time. More explicit analysis of divergence is the goal of the next section of the empirical phase of the study.

Overall these correlations indicate that the criteria has led to the selection of control areas that were quite similar to the contiguous areas at the beginning of the study period, and that this similarity persists even though it has decreased over the entire study period. The above results support the validity of the selection criteria, and indicate that the control areas thus selected provide desirable standards against which the preformance of the contiguous areas can be measured.

SUMMARY

This section of the empirical study has created a data base for analysis of the influence of large reservoirs on the economic development of contiguous areas by establishing the areas to be studied, the measures of economic development to be employed, and control areas as a standard of comparison. The study can now proceed to compare historical patterns of economic development between paired contiguous and control areas.

CHAPTER IV

EXPERIENCE OF AREAS CONTIGUOUS TO EXISTING RESERVOIR PROJECTS

The goal of the empirical phase of this study is to contrast the economic development of areas contiguous to existing reservoir projects with that in otherwise similar areas which do not have a large reservoir in the immediate vicinity. The preceding chapter established appropriate measures of economic development, the reservoir projects for study, their contiguous and control areas, and discussed the validity of the selected control areas. This chapter is devoted to the investigation of the relative economic development of the contiguous and control areas. The methodology tries to detect differences between economic development occurring in contiguous and control areas by comparing the two on a paired basis. The technique examines the variation in the measures of economic development among counties, the smallest subareas for which data are available.

THE STATISTICAL MODELS

The statistical models employed in this study are linear models of the general form

$$Y = M + \phi_1 + \phi_2 + \dots + \phi_p + \epsilon \qquad (11)$$

where Y = an observed value of a measure of economic development in a particular county.

M = the mean level of Y over all counties.

ϕ_N = the mean effect of factor N on the observed value. ($N = 1, \dots, p$.)

ϵ = a residual, random error effect.

The linear model is used to partition the total variation in the observed values of Y into components of variations due to each of the factors in the model. The null hypothesis, H_o: $\phi_n = 0$, is tested against the alternative hypothesis, H_a: $\phi_n \neq 0$, by comparing the variance attributed to the factor to the residual variance remaining after all factors are taken into account. If H_o is accepted, there is no measurable effect attributed to the n^{th} factor while if H_a is accepted, the factor is concluded to have a significant effect.[1]

<u>The Factors in the Linear Models</u>

The exact linear model employed in any given analysis is determined by the particular factors that are being considered as affecting the observed values of the dependent variable. The set of factors, ϕ_n, of which a subset may be used for a particular model, include the following:

Γ_i; the mean effect of the treatment of being in the control area (i = 1) or the contiguous area (i = 2).

t_j; the mean effect of the observation being taken at a point in time. In this study, the observations are taken at three points in time, 1940 (j=1), 1950 (j=2), and 1960 (j=3).

δ_{ij}; the mean interaction between the effects of time and the effects of treatment. A significant interaction effect would indicate a different movement over time between the contiguous and control areas.

β_k; the mean effect of the observed value being associated with

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[1] For a discussion of linear models of the type see Franklin A. Graybill, An Introduction to Linear Statistical Models (New York: McGraw-Hill Book Company, Inc., 1961), pp. 93-145.

the k^{th} block of reservoir projects.[2] Table 7 identifies the individual reservoir projects used in each block.

The Hypotheses of Interest

The prime factor of interest in this study is the mean effect of reservoir projects on the measured values of variables that indicate either the level or the rate of change of economic development in the contiguous counties. The presence of a significant difference between contiguous and control areas is detected by testing the null hypothesis, $\Gamma_i = 0$ against the alternative hypothesis, $\Gamma_i \neq 0$. The acceptance of the alternative hypothesis indicates a significant difference between contiguous and control areas. A positive Γ_2 indicates a higher mean for the variable in the contiguous area implying a positive effect from the reservoir project; and a negative Γ_2 indicates a lower mean in the contiguous area, implying a negative effect. In addition to tests of $\Gamma_i = 0$, the tests of the null hypothesis, $\delta_{ij} = 0$, against the alternative hypothesis, $\delta_{ij} \neq 0$, are performed in those models which include a time effect in the model. This detects non-parallel movements over time in the dependent variables between the contiguous and control areas.

[2] The β_k terms in the model have been added to compensate for the variation in the mean of the dependent variable among reservoir projects. Ideally each of the twenty projects would constitute a separate block, and each county would fall uniquely in a single block. Unfortunately, this design cannot be achieved in this study since many counties fall in more than one control area and therefore are included in more than one block. A more serious problem was the need to include more than one observation in each cell of the model. The contiguous areas with only one county would violate this restriction. The reservoir projects with only one county in the contiguous area are grouped together in a common block. In addition, two reservoir projects having the same control area are analyzed as one block. The resulting thirteen blocks are identified in Table 7. The counties can be determined by inspecting Appendix A.

TABLE 7

DEFINITION OF BLOCKS USED IN STATISTICAL MODELS BY RESERVOIR AREAS

Block Number	Reservoir Name(s)
1	Kentucky Lake
2	Old Hickory Lake
3	Chickamanga Lake, Fort Loudon Reservoir
4	Watts Bar Lake
5	Douglas Lake
6	Cherokee Lake
7	Boone Lake, South Holston Lake
8	Watauga Lake
9	Norris Lake
10	Herrington Lake
11	Cumberland Lake
12	Dale Hollow Lake
13	Pickwick, Elk River, Guntersville and Hales Bar, Parkersville, Dewey, and Center Hill Reservoirs

Decision Criteria for Hypothesis Tests

The decision between accepting the null hypothesis (no difference) or accepting the alternative hypothesis (effect of factor) is made by comparing the sum of squared deviations due to the specific factor to that attributed to random sources. This is accomplished by a statistic of the form

$$F = \frac{MS_f}{MS_r} \tag{12}$$

where

MS_f = the mean squared deviation due to the factor

and

MS_r = the mean squared deviation due to some random error.

The decision is made on the basis of the critical value on the appropriate F distribution.

Assumptions of Statistical Model

Several assumptions must be made in the analysis of variance model before the statistic of equation 12 can be considered to follow the F distribution.[3] The behavior of the data at hand should be compared to the requirements of the model. The first assumption is constant error variance over all cells. This appears to be reasonably satisfied by the data. A second assumption is independence between the error terms associated with any two observations. With three observations being made on the same country over three points in time, a condition exists which may cause a violation of this assumption. The residuals of the model were examined and no obvious pattern in the residuals was detected; however, since there are only three points in time, no test for autocorrelation was performed. A third assumption is that the errors are normally distributed. This would not seem to be a major

[3] Graybill, Introduction to Linear Statistical Models, pp. 106-110.

problem when population or per capita income are the dependent variables. When the IED or IIC are used as dependent variables, the normality of the error terms is achieved by the use of a transformation described in Appendix D. On the whole it would appear that the data conforms to the requirements of the model.

Limitations of the Statistical Models

Before attempting to analyze the results of the specific models, two limitations of these models should be considered and the implications of these limitations to the findings of this study investigated.

First, if a statistical model does not indicate that the null hypothesis is to be rejected, this is not equivalent to proving the null hypothesis (no effect) is true. What is indicated is that the component of variation attributed to the factor is small in comparison to the random component of variation from county to county. If this residual component of variation is large, then substantial variation due to the factor may escape detection. The residual variation can be reduced by entering as many relevant factors into the statistical model as possible, allowing the total variation from county to county to be separated into a number of identifiable components, thus leaving little variation to be attributed to random, unexplained sources. This approach may not be entirely successful in this study due to the complexity of the economic development process.

Location theory has indicated two factors that tend to produce an uneven pattern of development among counties with essentially the same development potential. The first factor is agglomeration economies. The second factor is the tendency toward risk aversion in decision making in the face of uncertainty. Both of these factors tend to cause new industries to locate near existing plants. Over time this promotes a dichotomous development pattern with those counties that experienced earlier development experiencing rapid development while those counties that were not extensively developed earlier are falling further behind in development.

These effects lead to a large component of variation among counties that can not be attributed to any measurable characteristic of the county before industry entered. This creates an environment in which the power of a statistical model to isolate a significant impact of a factor on development in the contiguous counties is limited.

A second problem is created by the fact that census data is measured by county of residence, while industrial location decisions are more directly associated with the county of employment. This discrepancy has two effects on the statistical analysis. First, commuting workers who work in but reside outside the contiguous area are not attributed by the data to the contiguous area. This effect is offset to some extent by residents of the contiguous area who commute to jobs outside the area.

A second effect is created by commuting among counties within the contiguous area. If development occurs in one county inside the contiguous area and workers from other counties inside the contiguous area commute to these jobs, this tends to attribute part of the employment created at one point in the contiguous area to each of the counties. This tends to smooth the dichotomous pattern of development among counties that leads to large components of variation.

The net impact of these problems on the statistical model is hard to estimate. The bias produced by commuting workers may be important in some pairs because of the relatively large numbers of commuting workers. The results of the analyses should be interpreted with an awareness of these possible biases.

LEVEL OF ECONOMIC DEVELOPMENT: MEAN FOR ALL PROJECTS

In this section the three measures of the level of economic development; Index of Economic Differentiation (IED), Per Capita Income, and Population; are investigated for significant differences between the mean of the measures for counties contiguous to reservoir projects and the mean for counties in the control area of the projects using the data from all reservoir projects.

The Statistical Model

The basic model used is a linear model of the form

$$Y_{ijk\ell} = \mu + \Gamma_i + \tau_j + \delta_{ij} + \beta_k + \epsilon_{ijk\ell} \tag{13}$$

where

Y	=	a measure of the level of economic development
μ	=	the overall mean of the population
Γ_i	=	the effect of being in the i^{th} treatment group
τ_j	=	the effect of being in the j^{th} time period
δ_{ij}	=	the interaction effect of the i^{th} treatment with the j^{th} time period
β_k	=	the effect of the k^{th} reservoir block
ϵ	=	a random error term
i	=	a subscript indicating whether an observation is from a control county ($i = 1$) or contiguous county ($i = 2$)
j	=	a subscript indicating whether an observation is from 1940 ($j = 1$), 1950 ($j = 2$), or 1960 ($j = 3$).
k	=	a subscript indicating the reservoir block ($K = 1, \ldots, 13$)
ℓ	=	a subscript indicating a particular observation ($\ell = 1$ to n where n is the number of observations).

The model is subject to the restrictions

$$\sum_{i=1}^{2} \Gamma_i = 0 \tag{14}$$

$$\sum_{j=1}^{3} \tau_j = 0 \tag{15}$$

$$\sum_{i=1}^{2} \delta_{ij} = \sum_{j=1}^{3} \delta_{ij} = 0 \qquad (16)$$

$$\sum_{k=1}^{13} \beta_k = 0 \qquad (17)$$

The hypotheses of interest are each $\Gamma_i = 0$, or there is no difference between contiguous and control counties, and each $\delta_{ij} = 0$, or there is no difference between contiguous and control counties in terms of time-treatment interaction. The rejection of these hypotheses would indicate a significant impact of reservoir projects on the level of economic development in the contiguous areas.

A Summary of Findings

Table 8 reports the results of the model applied to data from all the reservoir study areas with IED, Per Capita Income, and Population as the dependent variables.[4] The F ratios with IED indicate that there is a significant component of variation attributable to differences between contiguous and control areas; however, there is no evidence of a significant interaction between treatment and time. The results with per capita income show the same thing. The results with population indicate no significant difference between contiguous and control areas and no significant interaction effect.

For the cases in which a significant difference is revealed, the question is which area, contiguous or control, has the higher mean level of the dependent variable. This can be answered by inspecting the sign of Γ_2 estimated using the model. When IED is the dependent variable, Γ_2 came out positive indicating a greater diversity of employment in the contiguous areas.

[4] Computations done by BMDO2R as described in W. J. Dixon, Biomedical Computer Programs (Berkeley, Cal.: University of California Press, 1968), pp. 218-232. Coding as indicated in N. R. Draper and H. Smith, Applied Regression Analysis (New York: John Wiley & Sons, 1966), pp. 257-258.

TABLE 8

RESULTS WITH THE MODEL OF EQUATION 13

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Block (β_k)	77.938	12	6.495	25.57*
Time (τ_j)	55.950	2	26.475	104.23*
Time-Treatment Interaction (δ_{ij})	0.168	2	0.084	0.33
Treatment (Γ_i)	1.168	1	1.168	4.60*
Residual ($\epsilon_{ijk\ell}$)	105.227	414	0.254	
Per Capita Income as the Dependent Variable				
Block (β_k)	13,666,200	12	1,138,850	17.82*
Time (τ_j)	55,549,900	2	27,974,950	435.85*
Time-Treatment Interaction (δ_{ij})	27,420	2	13,710	0.21
Treatment (Γ_i)	321,408	1	321,468	5.03*
Residual ($\epsilon_{ijk\ell}$)	26,450,998	414	63,891	
County Population in Thousands as the Dependent Variable				
Block (β_k)	276,775	12	23,014	12.50*
Time (τ_j)	32	2	16	0.086
Time-Treatment Interaction (δ_{ij})	20	2	10	0.054
Treatment (Γ_i)	1,234	1	1,234	0.67
Residual ($\epsilon_{ijk\ell}$)	762,346	414	1,841	

* Significant at $\alpha = 0.05$

The sign of Γ_2 is negative when per capita income is the dependent variable indicating a lower mean income in the contiguous areas.

RATE OF ECONOMIC DEVELOPMENT: MEAN FOR ALL PROJECTS

Three measures of the time rate of change of economic development; Index of Intraregional Change (IIC), percent change in per capita income, and percent change in population; are examined for significant differences between the mean of these variables in counties contiguous to reservoir projects and the mean in counties in the control areas. The analysis is performed using data from all the reservoir projects.

The Statistical Model

The model employed is a linear model of the form

$$Z_{ik\ell} = \mu + \Gamma_i + \beta_k + \epsilon_{ik\ell} \tag{18}$$

where Z is an observed value of a measure of the rate of change of economic development $(Y_{i3k\ell} - Y_{i1k\ell})$ and the other variables are as defined in equation 13. The model is subject to the restrictions of equations 14 and 17. The particular hypothesis of interest is that each $\Gamma_i = 0$, or there is no difference in the mean value of the dependent variable between counties in the contiguous and control areas. The rejection of this hypothesis would indicate a significant impact of reservoir projects on the rate of change of economic development in the contiguous counties.

A Summary of Findings

Table 9 reports the results of this model applied to data from all twenty reservoir project study areas using IIC, Percent Change in Per Capita Income, and Percent Change in Population, respectively, as the dependent variables. The computed F ratios indicate a significant difference in the mean IIC between contiguous and control areas. The sign of Γ_2 is positive indicating a more rapid change in employment patterns in the contiguous areas. The F

TABLE 9

RESULTS WITH THE MODEL OF EQUATION 18

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IIC as the Dependent Variable				
Block (β_k)	2.256	12	0.188	3.18*
Treatment (Γ_i)	0.331	1	0.331	5.16*
Residual ($\epsilon_{ik\ell}$)	7.730	130	0.059	
Percent Change in Per Capita Income as the Dependent Variable				
Block (β_k)	301,544	12	25,128	2.49*
Treatment (Γ_i)	3,022	1	3,022	0.30
Residual ($\epsilon_{ik\ell}$)	1,313,442	130	10,103	
Percent Change in County Population as the Dependent Variable				
Block (β_k)	40,674	12	3,389	3.44*
Treatment (Γ_i)	739	1	739	0.75
Residual ($\epsilon_{ik\ell}$)	128,050	130	985	

* Significant at α = 0.05.

ratios for change in income and change in population indicate that the null hypothesis of no difference between the contiguous and control areas should be accepted.

LEVEL OF ECONOMIC DEVELOPMENT: EACH RESERVOIR BLOCK

The preceding analyses have considered the mean effect over all projects in the study area. In three cases there is and in the other three cases there is no indication of a difference between contiguous and control areas. This does not indicate necessarily that individual projects have no effect. The possibility exists that some of the projects had a net positive influence on their contiguous areas while other projects exerted a net negative effect and offsetting effects resulted in no significant mean effect over all projects. More likely, no effect for many projects may have masked a significant effect for a few projects when the two were lumped together.

To investigate this possibility, a model to determine the mean performance of counties in the contiguous and control areas of each project is needed. Once again, the problem of projects with only one county in the contiguous area makes this impossible; however, a separate analysis of each reservoir block has been completed.

The Statistical Model

The basic model used for each block is of the form

$$Y_{ij\ell} = \mu + \Gamma_i + \tau_j + \delta_{ij} + \epsilon_{ij\ell} \qquad (19)$$

where all variables are as defined for equation 13. The model is subject to the restrictions of equations 14, 15, and 16. Once again the null hypotheses are each $\Gamma_i = 0$, or no difference between contiguous and control areas, and each $\delta_{ij} = 0$, or no difference in movement over time between contiguous and control areas. A rejection of these hypotheses would indicate a significant difference in the mean levels of economic development between counties in the contiguous and control areas of a particular reservoir block.

Results of Analyses

The results of the analyses of the individual blocks are reported in Appendix C. Table 10 presents a summary of these results which shows ten of the thirteen blocks have higher mean values of the Index of Economic Differentiation in their contiguous areas, five significantly so. Three contiguous areas have less diverse employment patterns; only one significantly so.

The results of the analyses using per capita income as the dependent variable indicate a near mirror image of the analyses of employment differentiation. Only three contiguous areas are revealed to have higher income levels, only one significantly so. Ten control areas show higher incomes with four significant differences.

The population analyses show a mixed pattern with five contiguous and eight control areas showing higher levels of population. Of these, two contiguous and two control areas are revealed to be significantly different.

The F ratios for testing the hypothesis, $\delta_{ij} = 0$, there is no difference in the movement over time between contiguous and control areas, are also reported in Appendix C. In all cases, the computed values indicate no significant differences in the movements over time.

These results indicate a great diversity among projects in the relative development of contiguous areas. In addition there is a discrepancy in the behavior of the three dependent variables for a given reservoir block. In most cases the results of the individual analyses are congruent with the results of the preceding analyses over all projects. There is some evidence to indicate a positive effect of reservoirs in promoting more diverse employment patterns, but the evidence with respect to income is predominantly negative; however, the numbers of projects showing a significant difference are less. The evidence with respect to population is mixed, some positive, some negative, and only four projects show a significant difference in either direction.

TABLE 10

SUMMARY OF RESULTS WITH THE MODEL OF EQUATION 19

Reservoir Block	Dependent Variable					
	IED		Per Capita Income		Population	
	F Ratio	Sign of Γ_2	F Ratio	Sign of Γ_2	F Ratio	Sign of Γ_2
1	20.11*	+	0.332	-	0.827	-
2	3.93	+	15.35*	+	0.835	-
3	0.23	+	4.72*	-	0.09	-
4	4.79*	+	7.03	-	2.157	-
5	8.32*	+	1.77	-	0.0007	+
6	3.92	+	0.534	-	3.077	+
7	14.06*	+	1.64	+	33.99*	+
8	1.45	-	0.417	-	0.947	-
9	9.47*	-	0.421	-	0.657	-
10	0.19	-	1.189	+	5.595*	-
11	0.15	+	8.304*	-	5.712*	+
12	1.13	+	6.193*	-	14.99 *	-
13	5.60*	+	0.320	-	0.081	+

* Significant at $\alpha = 0.05$

RATE OF ECONOMIC DEVELOPMENT: EACH RESERVOIR BLOCK

In addition to the preceding evidence on the relative level of economic development between contiguous and control areas, information on the relative time rates of change of these measures over the study period 1940 to 1960 can be obtained by measuring the relative levels of the Index of Intraregional Change, the percent change in per capita income, and percent change in population.

The Statistical Model

The model for these analyses are linear models of the form

$$Z_{i\ell} = \mu + \Gamma_i + \epsilon_{i\ell} \tag{20}$$

where the variables are as defined for equation 18 and the model is subject to the restriction of equation 14. The application of this model to the three measures of the rate of change of economic development allows the detection of significant difference between the mean behavior of counties in the contiguous areas and counties in the control areas by testing the null hypothesis, $\Gamma_2 = 0$, against the alternative $\Gamma_2 \neq 0$.

Results of Analyses

The results of this model applied to data from each of the thirteen reservoir blocks is reported in Appendix C and summarized in Table 11. Of the thirteen reservoir blocks, eight had more rapid changes in employment patterns of the contiguous areas while five appear to have had negative effects in the contiguous areas when compared to the control areas. Two positive and one negative difference is shown to be significant.

When percent change in per capita income is used as the dependent variable, eight contiguous areas show a positive effect and five show a negative effect; however, two of the negative differences are significant while only one of the positive differences is significant. The analyses on percent change in population reveals five contiguous areas with positive differences and eight with negative differences with only one positive difference as significant.

TABLE 11

SUMMARY OF RESULTS WITH THE MODEL OF EQUATION 20

Reservoir Block	Dependent Variable					
	IIC		Percent Change in Per Capita Income		Percent Change in Population	
	F Ratio	Sign of Γ_2	F Ratio	Sign of Γ_2	F Ratio	Sign of Γ_2
1	6.320*	+	1.694	+	4.093	-
2	3.283	+	12.63 *	-	0.101	-
3	1.369	+	0.513	+	1.018	+
4	0.794	+	0.117	+	0.136	-
5	0.626	+	0.227	+	1.42	+
6	0.213	+	1.162	+	3.675	+
7	0.049	-	0.335	+	2.16	+
8	5.77 *	-	13.68 *	-	8.26 *	+
9	2.104	-	0.272	-	0.007	-
10	0.333	-	0.357	+	0.154	-
11	0.673	-	6.793*	+	0.306	+
12	1.206	+	0.393	-	0.683	-
13	5.802*	+	0.005	-	0.054	-

* Significant at $\alpha = 0.05$

The results of these analyses of the individual reservoir blocks are congruent with the results of the overall analyses presented in Table 9. The employment patterns have tended to change more rapidly overall in the contiguous areas and eight of the thirteen reservoir blocks are shown to have experienced more rapid employment pattern change in their contiguous areas. The individual analyses reveal mixed patterns of income growth and population change and this is reflected in the failure of the analysis over all projects to detect a significant change.

AN ANALYSIS OF THE RESULTS OF THE STATISTICAL MODELS

Data measuring the levels and rates of change of three variables that indicate the economic development of the counties in the contiguous and control areas of twenty reservoirs projects have been processed by appropriate linear statistical models, and the results of each of these models is presented. The implications of the results to the determination of the ability of multipurpose reservoir projects to affect economic development in the contiguous areas need to be analyzed.

The analyses of the level and rate of change of employment patterns indicate that reservoirs tend to stimulate changes among employment catagories and to produce a more diversified pattern of employment in the contiguous areas. In other words, reservoirs tend to attract new types of employment to an area and/or reduce old types of employment. These results are congruent with the predictions of location theory in that reservoir induced changes in location factors in the contiguous areas should lead to changes in the relative attractiveness of these areas for various types of economic activity.

Are these changes in employment movements into more remunitive types of employment? The applications of the statistical models do not give strong support to the hypothesis that these shifts are into higher paying employment catagories. The analyses show the contiguous areas have a statistically insignificant higher rate of income growth and statistically significant lower levels of income. The net effect is an indication of a pre-existing differential in income levels between contiguous and control areas which appears to be remaining relatively constant with time in the majority of cases.

Rapid inflows of population into the contiguous areas would not be expected unless the development of the contiguous areas lead to positive income differentials. The results of the models analyzing population change indicate no overall significant population differentials between contiguous and control areas of the projects. These results are consistent with the observed failure of the reservoirs to create positive income differentials. In fact, the failure of the negative income differentials to promote population outflows may be due in part to psychic income received by the local residents from the esthetic features of the reservoir projects.

SUMMARY

The major finding of the statistical analyses is that the magnitude and direction of the effects of the reservoir projects on the economic development of the contiguous area is shown to vary greatly from project to project. Why have some of the contiguous areas developed at an accelerated rate while others have developed at a relatively slow pace as compared to their control areas? Can this variation be explained by features of the individual areas?

These results are consistent with the predictions of location theory as developed previously in this study. The theory indicated that reservoir projects affect only a subset of the factors that enter into the location decisions of the individual firm whose aggregate behavior determines the economic development of an area. The observed development in the contiguous area would be expected to vary from project to project depending on the relative success with which reservoir provided factors remedy locational shortcomings of the contiguous areas. The results of the statistical analyses are consistent with the hypothesis that reservoir projects contribute to the development potential of the contiguous area, but the projects are not sufficient to insure rapid development.

If this hypothesis is correct, then the development that has occurred in the contiguous areas of the reservoir projects is related to the characteristics of each of the contiguous areas. Additional support for this hypothesis can be obtained by inspecting the development occurring in the areas contiguous to each of the reservoir blocks to see if the relative development of the area can be logically explained by advantages and disadvantages of the area with respect to the factors indicated by theory to influence location decisions.

CHAPTER V

SURVEY OF DEVELOPMENT IN CONTIGUOUS AREAS OF RESERVOIR BLOCKS

The statistical analyses indicated that the areas contiguous to some of the reservoir projects have developed more rapidly than their control areas while others have developed less rapidly. Location theory suggests reasons for this variation, and these reasons may become more apparent if the development of each block of reservoir projects is examined individually.

This chapter briefly surveys the development occurring in the contiguous and control areas of each of the thirteen blocks of reservoir projects observing the employment patterns, per capita income changes, and population shifts. By examining the development that has occurred, noting any unique features of the development in the contiguous area, and relating this development to the features of the reservoir and the contiguous area, these studies present additional evidence that the variation in development from project to project is due to differences among project contiguous areas in the levels of factors important to the location decision-making process and variations in the degree to which factors provided by the reservoir remove limiting deficiencies in the features of the local area.

The analysis of each reservoir block involves four sections. First, a brief discussion of the geographic environment of the reservoir project or projects in the block; second, a survey of the 1940 and 1960 levels of employment, per capita income, and population and the changes from 1940 to 1960, third, a comparison of these data with the outcomes of the statistical analyses presented in Chapter IV; and fourth, a summary of the unique features of the development in the contiguous area and an analysis of the role of the reservoir project in this development. These analyses provide the background necessary for a meaningful intrepretation of the outcomes of the statistical analyses. These studies show that most of the variation revealed by the statistical analyses can be explained by the presence or absence of important location factors in the contiguous areas and variations in the abilities of reservoir provided factors to compensate for shortcomings of the local area.

SURVEYS OF RESERVOIR BLOCKS

Reservoir Block One

The first reservoir block is the Kentucky Lake project on the lower Tennessee River in western Kentucky and western Tennessee. The contiguous area includes Calloway, Livingston, Lyon, Marshall, and Trigg counties in Kentucky and Benton, Henry, Houston, Humphreys, and Stewart counties in Tennessee.[1] Lying in a gently rolling agricultural area with no major population centers, the contiguous area has an adequate transportation system with several rail lines and major highways passing through the area. The educational levels and skills of the labor force are characteristic of this type of rural area. The reservoir project, the largest in the Tennessee Valley Authority's system of projects, provides navigation, recreation, flood control, and electric power.

Table 12 summarizes the development occurring in the contiguous and control areas of the project over the period 1940-1960. The statistical analyses indicate significantly more rapid changes in employment in the contiguous area (Appendix C, Table C-1). The data in Table 12 indicate that the contiguous area has experienced a more rapid decrease in agricultural employment and a more rapid increase in service employment. Manufacturing has grown rapidly in both the contiguous and control areas. The most rapidly increasing catagories of manufacturing employment were chemicals, machinery, and apparel.

[1] For the listing of the counties in the control area see Appendix A, Table A-1. Appendix B, Plate-1 is a map showing the contiguous and control areas.

TABLE 12

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 1

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	60.35	19.53	-68.90	65.98	33.59	-47.25
Mining	1.29	1.16	-13.94	0.61	0.52	71.25
Construction	7.23	9.40	24.91	4.13	7.35	85.00
Manufacturing	6.38	23.69	256.88	3.41	19.38	490.47
Transportation & Utilities	3.70	7.38	97.85	3.38	5.04	54.94
Trade Services	18.37	17.27	98.50	9.22	15.03	69.41
Financial Ser.	0.68	1.78	153.26	0.92	2.07	123.23
Services	12.01	19.78	58.30	12.60	17.11	41.12
Total Employed	39,518	37,974	-3.91	44,441	46,178	3.91
Per Capita Income	$208	$1275	512.18	$ 234	$1159	395.06
Population	136,876	116,624	-14.80	141,680	133,979	-5.44

[a]Employment Categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, County and City Data Book, (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

The statistical analyses show no significant differences in per capita income between the contiguous and control areas. The chemical industry is a high wage industry while services and apparel manufacturing are relatively low wage industries. The failure of the shifts in employment to produce rapid income growth may be due to the balancing of the positive effects of the chemical industry by the negative effects of shifts into apparel manufacturing and services.

The population movements in both areas were negative reflecting the strong decline in agriculture during the period 1940-1960. The decline in agriculture has been more severe in the contiguous area and has promoted a more rapid outflow of population from the contiguous area than the control group.

The major developments in the contiguous area occurred at Calvert City, Kentucky, and Johnsonville, Tennessee. Outside these two locations, the development in the contiguous area was quite similar to the development in the control area. Calvert City and Johnsonville have been extensively developed by the chemical industry due to a fortunate conjunction of location features at these sites. Chapter VI presents a detailed analysis of the Calvert City area and shows that the reservoir project provides vital factors to the chemical plants at Calvert City and the plants could not be located there without the project; however, this analysis also reveals that the plants require additional factors that are not provided by the project, and that the fortunate availability of these factors in the Calvert City area has produced the development. The reservoir is a necessary but not sufficient condition for this development.

Reservoir Block Two

The second reservoir block is the Old Hickory Lake project of the U. S. Army Corps of Engineers. Lying on the Cumberland River just northeast of Nashville, the contiguous area includes Sumner, Trousdale, and Wilson counties in Tennessee.[2] The proximity to Nashville has led to substantial

[2] For the listing of the counties in the control area see Appendix A, Table A-2. Appendix B, Plate B-2 is a map showing the contiguous and control areas.

recreational and residential use of the contiguous area by people employed outside the area.

Table 13 shows the development in the contiguous and control areas over the period 1940-1960. The statistical analyses reveal that in the contiguous area, the economy is more diversified and the employment pattern has changed more rapidly over time than in the control area. The trends are similar with decreasing agricultural employment and increasing manufacturing, trade, and services.

The income level of the contiguous area is higher, but its growth has been slower than in the control area. In the contiguous area, the unusually high 1940 per capita income levels and employment pattern changes are due in part to the employment of local residents in Nashville. This effect has been multiplied by the movement of individuals into the contiguous area who would have chosen a residence nearer to their jobs if the reservoir project had not increased the esthetic appeal of the local area.

The major contribution of the project to the economic development of the contiguous area is in attracting into the area higher income residents who earn their income outside. The project has contributed to the industrial potential of the Nashville metropolitan area through benefits from water supply, flood control, navigation, and waste dilution. The project has indirectly effected the development of the contiguous area by contributing to the growth of the Nashville area and directly affected it by attracting individuals employed in the Nashville area to reside in the contiguous area.

Reservoir Block Three

Reservoir block three includes two reservoir projects, Chickamauga Lake and Fort Loudon Lake, both on the Tennessee River in eastern Tennessee. The contiguous area of Chickamauga Lake includes Hamilton, Meigs, and Rhea counties and the contiguous area of Fort Loudon Lake contains Blount, Knox,

TABLE 13

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 2

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	56.60	20.48	-57.22	61.51	29.93	-48.68
Mining	0.18	0.24	62.15	0.50	0.51	7.99
Construction	3.59	7.87	159.39	2.91	6.40	132.19
Manufacturing	12.16	28.08	172.99	8.00	21.00	176.80
Transportation & Utilities	2.51	6.61	210.65	2.49	4.17	76.65
Trade Services	8.96	16.04	111.65	9.38	16.73	88.11
Financial Ser.	0.97	2.54	208.38	1.05	2.28	128.72
Services	15.03	18.14	42.72	14.16	18.98	41.41
Total Employed	21,730	25,690	18.22	86,084	90,797	5.47
Per Capita Income	$495	$1949	294.18	$238	$1179	395.38
Population	64,099	68,799	7.33	262,475	256,490	-2.28

[a]Employment categories defined in Appendix E.

Source: Employment data from U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U. S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U. S. Bureau of Census, County and City Data Book, (Washington: U. S. Government Printing Office) 1949, 1953, and 1962 Editions.

and Loudon counties.[3] Each contiguous areas contains a metropolitan area, Chattanooga in Hamilton county and Knoxville in Knox county. The metropolitan communities dominate the economies of the contiguous areas and cause the selection of identical control areas of other urban counties around both states. This made necessary the grouping of the two projects into one block for statistical analysis.

Table 14 shows the development in the contiguous and control areas of the projects over the period 1940-1960. The presence of the large cities is reflected in the diversified employment patterns in the contiguous areas. The development in these areas contrasts with the development patterns in the agricultural areas previously examined. Rather than experiencing a rapid movement from agriculture to manufacturing, this area has experienced a mild decrease in concentration in manufacturing and an increase in the service industries. This pattern is typical of the development of urban areas over the period 1940-1960. The statistical analyses show only one significant difference between the contiguous and control areas--lower levels of income in the contiguous area. This may be due to the fact that Knoxville and Chattanooga are southern cities while the control area includes Louisville, the Kentucky suburbs of Cincinnati, Ohio, and other more northern urban areas. The observed differential in per capita income may be due to North-South wage differentials rather than differences in the experienced development.

The statistical analyses do not support the contention that the contiguous areas have experienced more rapid development than the control areas. This interpretation ignores the contribution to the growth of Chattanooga and Knoxville made by the flood control, navigation, and power benefits of the Tennessee Valley Authority's system of reservoir projects. Both contiguous and control areas have experienced rapid development over the period 1940-

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[3] For the listing of the counties in the control area see Appendix A, Tables A-6 and A-9. Appendix B, Plates B-6 and B-9 are the maps showing the contiguous and control areas.

TABLE 14

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 3

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	9.87	3.04	-57.54	10.11	3.73	-46.12
Mining	1.18	0.59	-30.37	0.55	0.36	- 6.42
Construction	6.44	6.86	46.85	6.16	6.57	55.98
Manufacturing	33.16	32.48	35.06	24.59	30.79	83.00
Transportation & Utilities	7.08	7.49	45.75	11.45	9.61	- 2.67
Trade Services	17.80	20.62	59.70	20.55	21.00	49.34
Financial Ser.	2.78	4.37	116.79	3.70	4.66	84.43
Services	21.69	24.54	56.02	22.88	23.28	48.66
Total Employed	152,173	209,808	37.87	573,974	838,818	46.14
Per Capita Income	$457	$1842	303.18	$558	$2113	278.86
Population	442,646	590,733	33.45	1,628,484	2,351,178	44.38

[a]Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, County and City Data Book, (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

1960 and both currently have high levels of development. It is unlikely that the contiguous areas could have developed at an equal rate without the benefits provided by the reservoir projects.

Reservoir Block Four

The fourth block is the Watts Bar project on the upper Tennessee River between Chattanooga and Knoxville. The contiguous area includes Meigs, Rhea, and Roane counties[4], and is similar to the rural sections of the contiguous area in the preceding block. The area is traversed by the main rail lines connecting Chattanooga with the Northeast, but the highway system has been marginal. This stiuation is currently being improved as interstate highway I-40 is being built through the area and I-75 passes nearby.

Table 15 shows the development occurring in the contiguous and control areas over the period 1940-1960. The contiguous area is marginal for agriculture, and there has been a dramatic decrease in agricultural employment. The manufacturing, trade, and service sectors of the local economy have grown. The manufacturing growth has been primarily in textiles, apparel, chemicals, and machinery manufacturing.

The statistical analyses reveal only one significant difference between the contiguous and control areas; the contiguous area has a more diverse employment pattern. This is apparent upon inspection of the data on employment by catagory in 1940. The unusually high employment in construction in thecontiguous area in 1940 was due to employment in project construction, and this should be considered in the intrepretation of the statistical results.

The income figures indicate that the contiguous area was not prosperous in 1940 and remains a relatively low income area. Major development may occur in the future as the improvements in the highway system increase the attractiveness of an area between two larger cities.

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[4] For the listing of the counties in the control area see Appendix A, Table 8. Appendix B, Plate B-8 is a map showing the contiguous and control areas.

TABLE 15

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 4

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	35.65	8.01	-70.24	47.86	17.70	-53.50
Mining	2.45	1.29	-30.32	0.70	0.91	63.62
Construction	10.38	7.83	- 0.11	4.27	7.48	120.52
Manufacturing	24.40	38.59	109.45	15.70	28.26	126.36
Transportation & Utilities	3.88	8.96	206.20	3.81	4.88	61.19
Trade Services	9.44	16.37	129.64	11.05	18.00	104.86
Financial Ser.	0.66	1.72	244.77	1.07	2.56	200.12
Services	13.13	17.22	73.68	15.54	20.21	63.61
Total Employed	14,541	19,257	32.43	69,980	88,016	25.77
Per Capita Income	$ 180	$ 1011	461.75	$ 245	$ 1241	407.57
Population	50,541	60,156	10,02	223.200	254,066	13.83

[a]Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, County and City Data Book, (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

Reservoir Block Five

The fifth block is the Douglas Lake project on the French Broad River in Eastern Tennessee. The contiguous area includes Cocke, Jefferson, Sevier counties.[5] The area is served by two U. S. highways, and the transportation situation is improving as I-40 and I-81 will intersect in the contiguous area.

Table 16 shows the levels and rates of change of development in the contiguous and control areas over the period 1940-1960. The general pattern of development is quite similar to that of block four. The statistical analyses indicate only one significant difference - the contiguous area has a more diverse employment pattern. The familiar decrease in agricultural employment and increase in manufacturing, trade, and services is found in both the contiguous and control areas. The growth in manufacturing in the contiguous area has been primarily in chemicals; lumber, wood products, and furniture; and machinery. The control area has experienced greater growth in apparel manufacturing and less growth in the chemical industry.

The contiguous area was a highly agricultural area before project development, and since project construction there has been a major increase in industrial activity. The income levels remain low despite the rapid growth. The improvements in the highway system may combine with the factors provided by the reservoir to promote accelerated growth in the future.

Reservoir Block Six

The sixth block is the Cherokee Lake project on the Holston River between Knoxville and Kingsport in northeastern Tennessee. The contiguous area includes Grainger, Hawkins, and Jefferson counties.[6] The area is in the

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[5] For the listing of the counties in the control area see Appendix A, Table A-10. Appendix B, Plate B-10 is a map showing the contiguous and control areas.

[6] For the listing of the counties in the control area see Appendix A, Table A-11. Appendix B, Plate B-11 is a map showing the contiguous and control areas.

TABLE 16

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 5

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	60.88	21.93	-55.49	64.58	28.44	-53.45
Mining	2.15	2.38	36.76	0.69	0.70	7.60
Construction	3.96	9.00	180.41	2.90	6.87	150.14
Manufacturing	11.45	28.66	209.39	6.91	24.60	276.39
Transportation & Utilities	2.11	3.68	115.83	2.60	4.35	76.86
Trade Services	7.39	16.48	175.61	8.92	15.37	88.15
Financial Ser.	0.41	1.12	240.90	0.77	1.95	168.66
Services	11.66	16.76	77.69	12.63	17.22	44.11
Total Employed	18,241	22,541	23.57	69,656	73,641	5.72
Per Capita Income	$ 170	$ 947	458.01	$ 206	$1105	437.25
Population	65,995	69,134	4.76	225,916	213,933	- 5.30

[a]Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, County and City Data Book, (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

Great Valley physiographic region of rolling and hilly farm land and is well-served by both highway and rail transportation.

Table 17 shows the development occurring in the contiguous and control areas over the period 1940–1960. As in the cases of the other projects built in highly agricultural areas, the contiguous area has experienced a shift from agricultural employment to employment in manufacturing, trade, and services. The manufacturing growth in the contiguous areas has been primarily in lumber, wood products, furniture, and chemicals. The control area has experienced growth primarily in apparel and machinery manufacturing. The statistical analyses indicate positive effects of the project on development in the contiguous area, but the differences are not significant at the 95% level of confidence.

The failure of the statistical models to detect a significant difference may be due to high variation among the counties within both the contiguous and control groups. The summary data presented in Table 17 suggest positive effects of the project on employment shifts, income growth, and population growth.

Reservoir Block Seven

The seventh block includes the Boone Dam and Ft. Patrick Henry Lake project on the Watauga River and the South Holston project on the Holston River, both in northeastern Tennessee. Sullivan county is contiguous to both projects and Washington county is contiguous to the Boone Dam project.[7] Since the contiguous areas of the projects have counties in common and both projects have the same control areas, the projects have been blocked together for analyses.

Table 18 shows the development in the contiguous and control areas of the projects. The contiguous area includes the industrial centers of Kingsport and Johnson City, Tennessee, and this is reflected in the employment patterns.

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[7] For the listing of the counties in the control area see Appendix A, Tables A-12 and A-13. Appendix B, Plates B-12 and B-13 are the maps showing the contiguous and control areas.

TABLE 17

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 6

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	65.22	26.74	-52.21	69.37	33.69	-51.60
Mining	2.27	2.77	42.51	0.46	0.63	36.22
Construction	3.47	7.72	159.07	3.50	7.84	123.33
Manufacturing	9.85	27.67	227.39	4.56	22.43	390.52
Transportation & Utilities	2.28	5.26	169.25	2.57	3.83	48.39
Trade Services	6.42	13.04	136.59	7.88	14.16	79.14
Financial Ser.	0.39	1.12	229.83	0.69	1.60	132.70
Services	10.09	15.69	81.31	10.98	15.82	43.60
Total Employed	17,688	20,619	16.57	45,542	45,387	- 0.34
Per Capita Income	$ 195	$ 1000	412.44	$ 203	$ 966	375.51
Population	61,500	64,467	4.82	152,919	136,626	-10.65

[a]Employment categories defined in Appendix E.

Source: Employment data from U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U. S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U. S. Bureau of the Census, County and City Data Book, (Washington: U. S. Government Printing Office) 1949, 1953, and 1962 Editions.

TABLE 18

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 7

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	17.37	5.97	-41.43	33.73	13.49	-50.27
Mining	0.47	0.44	59.11	1.21	0.97	- 0.50
Construction	4.68	7.65	178.53	5.08	6.84	67.20
Manufacturing	37.56	38.24	73.59	16.03	25.85	100.51
Transportation & Utilities	6.04	6.48	83.05	8.16	7.93	20.88
Trade Services	14.50	18.58	118.60	14.54	20.03	71.27
Financial Ser.	1.51	2.94	232.12	1.67	3.20	138.01
Services	17.87	19.72	88.18	19.58	21.69	37.74
Total Employed	59,715	101,831	70.53	199,414	247,906	24.32
Per Capita Income	$ 388	$1917	394.04	$ 352	$1555	341.54
Population	189,801	293,110	54.43	598,118	695,392	16.26

[a]Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, _Growth Patterns in Employment by County,_ (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, _County and City Data Book,_ (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

The statistical analyses show the contiguous area as significantly more diversified and more heavily populated. The statistical anlayses reveal no other significant differences between the development of the contiguous and control areas, but the data presented in Table 18 shows that both areas have developed rapidly.

A recent study of the development in the Kingsport-Johnson City area concluded that water supply and flood control from the reservoir projects play a major role in promoting the industrial growth of the area.[8] The principal industrial activity in the contiguous area is the manufacturing of chemical products, an activity with very high water and power requirements. The development of this industry to its present level in the contiguous area would not have been possible without the factors provided by the reservoir projects.

Reservoir Block Eight

The eighth block is the Watauga Lake project on Roan Creek and the Watauga River in northeastern Tennessee. The contiguous area includes Carter and Johnson counties.[9] The contiguous area is relatively isolated in the Blue Ridge Mountain region of east Tennessee and the reservoir site is removed from major transportation routes.

Table 19 shows the development in the contiguous and control areas of the project over the period 1940-1960. The statistical analyses show significantly less rapid employment change and income growth in the contiguous area, but more rapid population growth. The major industrial employer in the contiguous area is the chemical industry, but much of this employment is in plants located in the Johnson City area rather than in plants located in the contiguous area. The results of the statistical analyses are thus affected by

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[8] Leo T. Surla, Jr., Lawrence K. Lynch, and William E. Moyer, Estimation, Evaluation, and Allocation of Multipurpose Benefits: A Case Study and Methodology, (Cincinnati, Ohio: U.S. Army, Corps of Engineers, Office of Appalachian Studies, 1967), pp. 117-23.

[9] For the listing of the counties in the control area see Appendix A, Table A-14. Appendix B, Plate B-14 is a map showing the contiguous and control areas.

TABLE 19

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 8

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	32.01	13.58	-47.67	50.78	19.53	-54.01
Mining	0.81	0.37	-42.70	1.54	1.16	2.98
Construction	3.87	7.91	152.13	3.57	7.41	144.63
Manufacturing	38.86	37.51	19.12	13.05	25.95	137.82
Transportation & Utilities	3.24	4.22	60.42	3.13	4.72	80.38
Trade Services	8.18	15.89	139.64	10.96	17.82	94.52
Financial Ser.	0.74	2.04	237.35	1.09	2.76	202.42
Services	12.28	18.48	85.69	16.07	20.75	54.40
Total Employed	12,172	15,020	23.40	92,557	110,694	19.60
Per Capita Income	$ 333	$ 1070	221.27	$ 294	$ 1351	358.77
Population	38,125	52,343	37.29	290,700	313,564	7.87

[a] Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U. S. Bureau of the Census, County and City Data Book, (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

commuting. The area near the project site has received little development due to the poor transportation system. The contradictory results of a population growth with a lower per capita income is due to an increase in the retired residents in the local area. This choice of the area as a site for retirement can be attributed to the low cost of living and possibly the esthetic features of the reservoir and the mountains.

Reservoir Block Nine

The ninth block is the Norris Lake project on the Cinch River approximately thirty miles north of Knoxville, Tennessee. The contiguous area includes Campbell, Claiborne, and Union Counties.[10] The contiguous area is a hilly region with one major highway and adaquate rail service.

Table 20 shows the development of the contiguous and control areas over the period 1940-1960. The statistical analyses indicate that the contiguous area is significantly less diverse in its employment patterns which is an indication of a lower level of economic development, but in this case the contiguous area has a substantially greater employment in the key manufacturing sector. The primary manufacturing activities are apparel manufacturing and lumber, wood products, and furniture. These industries are low wage industries, and the per capita income figures reflect this.

The economy of the area contiguous to Norris Lake was a coal mining and marginal agricultural area in 1940, and it has attracted low wage industries by the availability of labor as the primary employers have declined over the period 1940-1960. The reservoir has played only a minor role in this development.

Reservoir Block Ten

The tenth block is the Herrington Lake project on the Dix River in Central Kentucky. The contiguous area includes Garrard and Mercer

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[10] For the listing of the counties in the control area see Appendix A, Table 15. Appendix B, Plate B-15 is a map showing the contiguous and control areas.

TABLE 20

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 9

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	44.87	25.00	-47.00	43.92	13.22	-76.12
Mining	24.08	5.87	-76.81	22.81	21.76	-24.35
Construction	2.57	7.12	163.67	2.57	6.25	92.77
Manufacturing	8.03	23.11	173.89	3.83	11.36	135.13
Transportation & Utilities	3.06	4.24	31.79	5.54	7.73	10.69
Trade Services	7.21	15.96	110.65	8.96	18.18	60.99
Financial Ser.	0.39	1.48	256.45	0.61	1.60	107.56
Services	9.80	17.22	67.23	11.76	19.00	34.19
Total Employed	16,048	15,266	- 4.87	60,452	47,950	-20.68
Per Capita Income	$ 196	$ 742	279.08	$ 188	$ 804	328.00
Population	64,818	55,501	-14.37	258,521	216,081	-16.42

[a]Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, County and City Data Book, (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

counties.[11] One unique feature of this project is that is is a private development whose primary purpose is electric power generation.

Table 21 shows the development in the contiguous and control areas of the project over the period 1940-1960. The statistical analyses show the only significant difference between the contiguous and control areas to be less population in the contiguous area. This can be explained by the relatively small county areas. The pattern of employment change is typical of the agricultural areas; the area has experienced a decrease in agriculture and an increase in manufacturing, trade, and services. The principle manufacturing growth has been in apparel, machinery, and miscellaneous light manufacturing. Industry of this nature is attracted more by low wage labor than by factors provided by the reservoir project.

Reservoir Block Eleven

The eleventh block is the Wolf Creek Dam and Lake Cumberland Reservoir on the Cumberland River in southern Kentucky. The project has the largest reservoir included in the study, and the contiguous area includes Clinton, Pulaski, Russell, and Wayne counties.[12] The area is isolated from major population centers and the highway system is inadequate except for near Somerset at the eastern end of the reservoir. Rail service is also available only in the Somerset area.

Table 22 shows the development in the contiguous and control area of the project over the time period 1940-1960. The extreme concentration of the economy of the contiguous area in agriculture is evident. The usual pattern of movement out of agriculture into manufacturing, trade, and services has occurred, but the area continues to have high agricultural employment.

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[11] For the listing of the counties in the control area see Appendix A, Table A-17. Appendix B, Plate B-17 is a map showing the contiguous and Control areas.

[12] For the listing of the counties in the control area see Appendix A, Table A-18. Appendix B, Plate B-18 is a map showing the contiguous and control areas.

TABLE 21

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 10

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	61.75	35.20	-38.74	64.11	32.60	-47.79
Mining	0.26	0.68	183.59	0.46	0.62	39.65
Construction	3.83	6.40	79.88	3.31	6.25	93.59
Manufacturing	4.19	18.56	375.89	4.43	19.72	357.03
Transportation & Utilities	3.04	4.40	55.34	3.29	4.52	40.99
Trade Services	10.14	13.63	44.45	9.66	15.97	69.81
Financial Ser.	1.25	1.99	71.05	1.03	1.94	93.09
Services	15.56	19.13	32.15	13.70	18.38	37.82
Total Employed	8,427	9,056	7.46	63,422	65,135	2.70
Per Capita Income	$ 260	$ 1376	429.28	$ 237	$ 1195	404.23
Population	26,539	24,343	- 8.27	197,408	183,513	- 7.04

[a] Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, County and City Data Book, (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

TABLE 22

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 11

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	70.67	37.61	-51.02	73.87	38.06	-52.97
Mining	1.61	1.93	10.09	0.57	1.04	66.52
Construction	2.38	6.60	154.75	2.56	7.83	178.66
Manufacturing	3.77	15.97	289.28	3.31	18.86	420.83
Transportation & Utilities	4.75	5.26	2.02	2.43	4.10	53.82
Trade Services	7.31	15.41	93.93	7.12	13.84	77.33
Financial Ser.	0.54	1.35	129.47	0.59	1.39	114.14
Services	8.97	15.87	62.81	9.54	14.89	42.49
Total Employed	21,336	19,633	- 7.98	40,238	36,736	- 8.70
Per Capita Income	$ 144	$ 808	462.69	$ 175	$ 874	400.18
Population	80,961	69,065	-14.69	142,379	117,689	-17.34

[a]Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, County and City Data Book, (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

The statistical analyses indicate significantly lower income in the contiguous area, but significantly greater population. The data in Table 22 indicate that these differentials are due to preexisting differences between the contiguous area and the control area before project construction. The statistical analyses also indicate a more rapid income growth in the contiguous area which is an indication of rapid development, but in this case the result may be attributed to the low income in the contiguous area in 1940 which established a very low base for the calculation of the percent change in income for the period 1940-1960. The differential in dollars between the contiguous and control areas has widened over the period 1940-1960.

The industry in the contiguous area is primarily apparel manufacturing and lumber, wood products, and furniture. These industries are attracted more by low wage levels and the availability of hardwoods than by features provided by the reservoir project.

Why has the project failed to attract more industry to the area? There are three principle reasons. First, there is the lack of adaquate land transportation in the contiguous area; second, the contiguous area is isolated from major market areas; and third, the physiography of the region causes shoreline sites to be hilly and undesirable for industrial location.

Reservoir Block Twelve

The twelth block is the Dale Hollow Lake project on a tributary of the Cumberland River on the Kentucky-Tennessee border approximately twenty miles southwest of Lake Cumberland. The contiguous area includes Clinton and Cumberland counties in Kentucky and Clay and Pickett counties in Tennessee.[13] The area is similar to the area around Lake Cumberland, but it is even more isolated and inaccessible.

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[13] For the listing of the counties in the control area see Appendix A, Table A-19. Appendix B, Plate B-19 is a map showing the contiguous and control areas.

TABLE 23

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 12

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	79.76	42.47	-54.46	81.27	46.68	-51.14
Mining	0.57	2.66	298.60	0.18	1.74	699.68
Construction	2.23	5.87	124.84	1.86	6.05	176.38
Manufacturing	4.21	20.35	313.72	3.19	16.35	336.52
Transportation & Utilities	1.27	2.18	46.95	1.20	2.65	88.34
Trade Services	4.93	12.38	114.86	4.99	12.08	105.79
Financial Ser.	0.22	0.64	145.51	0.36	1.04	148.03
Services	6.81	13.46	68.97	6.95	13.41	69.04
Total Employed	10,513	8,991	-14.48	41,701	35,701	-14.94
Per Capita Income	$ 132	$ 668	404.91	$ 166	$ 884	431.06
Population	39,319	28,441	-27.67	141,834	109,896	-22.52

[a]Employment categories defined in Appendix E.

Source: Employment data from U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U.S. Bureau of the Census, County and City Data Book (Washington: U.S. Government Printing Office) 1949, 1953, and 1962 Editions.

Table 23 shows the development in the contiguous and control areas of the project over the period 1940-1960. The economic situation is similar to that around Lake Cumberland, a predominance of agriculture which is declining over time with an accompanying slow rise in manufacturing, trade, and services. The statistical analyses indicate significantly lower per capita income and population in the contiguous area. The result is the lowest level of development in any contiguous area in this study. The growth in the manufacturing has been almost entirely in apparel manufacturing, an industry attracted by low wage labor rather than by factors provided by the reservoir project.

The reasons for the failure of the contiguous area to develop are the same as those discussed in connection with the neighboring Lake Cumberland area; no rail transportation, very poor highway transportation, poor waterfront sites, and isolation from major markets.

Reservoir Block Thirteen

This reservoir block contains the reservoir projects that have only one county in their contiguous area. These projects are Pickwick and Guntersville-Hales Bar projects on the Tennessee River, Elk River Reservoir and Center Hill Lake in central Tennessee, Parkersville Reservoir in east Tennessee, and Dewey Reservoir in the mountains of eastern Kentucky.[14] Since this block is composed of several projects, it is difficult to generalize about the locational factors in the areas contiguous to the project except to note that none of the projects has a major population center in the contiguous area. The development of this block may be considered typical of smaller projects constructed in rural areas.

Table 24 shows the development occurring in the contiguous and control areas of the projects over the period 1940-1960. The statistical analyses show significantly more diversified employment and more rapid changes in the

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[14] For the listing of the contiguous and control areas see Appendix A, Tables A-3, A-4, A-5, A-7, A-16, and A-20. Appendix B, Plates B-3, B-4, B-5, B-7, B-16, and B-20 are the maps showing the contiguous and control areas.

TABLE 24

ECONOMIC CHARACTERISTICS OF THE CONTIGUOUS AND CONTROL AREAS OF RESERVOIR BLOCK 13

VARIABLE	Contiguous Area			Control Area		
	1940	1960	Change 1940-1960	1940	1960	Change 1940-1960
Employment Category[a]	Percent of Employment	Percent of Employment	Percent Change	Percent of Employment	Percent of Employment	Percent Change
Agriculture	42.28	13.25	-68.33	47.06	17.77	-62.59
Mining	19.66	13.41	-31.08	17.17	11.69	-32.53
Construction	3.36	8.24	147.81	2.90	6.97	138.26
Manufacturing	9.14	33.75	162.53	7.31	19.11	159.01
Transportation & Utilities	4.18	6.11	47.54	3.59	5.85	61.61
Trade Services	8.17	15.56	92.32	8.98	16.73	84.71
Financial Ser.	0.51	1.45	185.19	0.71	2.00	179.68
Services	12.69	18.22	45.00	12.28	19.88	60.37
Total Employed	35,440	35,804	1.03	352,127	384,924	- 0.91
Per Capita Income	$ 213	$ 947	343.97	$ 221	$1082	389.08
Population	143,885	128,537	-10.67	1,357,976	1,262,683	- 7.02

[a]Employment categories defined in Appendix E.

Source: Employment data from U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U. S. Government Printing Office, 1965), income from unpublished data provided by the Office of Business Economics, and population data from U. S. Bureau of the Census, County and City Data Book, (Washington: U. S. Government Printing Office) 1949, 1953, and 1962 Editions.

employment patterns in the contiguous areas. The general pattern of development is the typical decrease in agriculture and growth in manufacturing, trade, and services. The principle difference between the contiguous and control areas is the growth in the manufacturing employment. The manufacturing growth has occurred primarily in the apparel; lumber, wood products, and furniture; and miscellaneous manufacturing. The direct ties of this manufacturing growth to physical factors of the projects is not evident; however, psychological ties may exist. The empirical evidence supports a contention of positive effect of these small projects on manufacturing growth in the contiguous area.

IMPLICATIONS OF RESULTS OF SURVEYS TO ROLE OF RESERVOIRS IN DEVELOPMENT

The brief surveys of the development occurring in each of the blocks of reservoir projects reveal several aspects of the development of the contiguous areas that were not apparent from the results of the statistical analyses. An appreciation of the implications of these results enhances a meaningful intrepretation of the empirical evidence concerning the ability of reservoir projects to influence the economic development of the contiguous areas.

The first point is that all the contiguous areas have experienced development over the period 1940-1960. All the areas have experienced growth in per capita income and have increased in the number of workers employed in manufacturing activities. In several of the blocks, the observed growth in the manufacturing sector would have been impossible without the water supply, flood control, and power provided by the reservoir projects.

The second point is that there is a wide variation in the degree of development among contiguous areas. This variation is predictable from differences in the levels of location factors among the areas. Areas contiguous to projects which are isolated from population centers, with poor land transportation systems, or in terrain that is unsuitable for plant sites have experienced far less development than have contiguous areas with more favorable combinations of location factors.

The third point is that the control areas selected for the statistical study do not provide a constant standard of comparison for all projects. Those projects located in areas with high development potential are matched with control areas with high development potential, likewise low potential contiguous areas are matched with low potential control. This kind of matching was of course done purposely to study the effect of introducing a reservoir as an exogenous variable, and the failure of the statistical analysis to detect a significant difference means no more than that both areas have developed at a similar rate. It is incorrect to intrepret this as equivalent to saying that no development has occurred. It is also unwise to intrepret a finding of no significant difference as proof that the reservoir project has not affected the contiguous area. In several cases, the type of development which has occurred in the contiguous area would not have been possible without the reservoir project.

A fourth point is that the most frequently observed positive effect of reservoirs on the development in their contiguous areas is a far more rapid growth of the chemical industry in the contiguous areas than in the control areas. The location decisions of firms in the chemical industry are influenced by the availability of factors such as cooling water, waste diluting water, electric power, and shoreline sites with low flood hazard, that may be directly provided by reservoir projects. All of the contiguous areas that have experienced rapid growth have had their principle manufacturing growth in the chemical industry.

The picture of development revealed by these surveys of development in the contiguous and control areas is quite logical in view of the predictions of location theory. There has been a wide variation in the degree of development around the reservoir projects, and the source of this variation is variation in the overall attractiveness of the contiguous area to industry as determined by the levels of other location factors and the degree to which the reservoir provided factors necessary to improve the attractiveness of the areas.

The empirical evidence supports the contention that water resource development may be a necessary condition for the economic development of many areas, but water resources alone are seldom, if ever, sufficient to produce development. A still better understanding of this relationship can be gained by a detailed inspection of selected contiguous areas which have had differing experiences with respect to development and by showing that these variations in development can be explained by variations in the location factors in the areas and variations in the factors provided by the projects.

CHAPTER VI

CASE STUDIES OF SELECTED CONTIGUOUS AREAS OF RESERVOIR PROJECTS

The statistical analyses presented in Chapter IV and the brief surveys presented in Chapter V have established that some development has occurred in the contiguous areas of all the existing projects, but the absolute amount of the development, the nature of the development, and the degree of development relative to that occurring in the control area varies widely from project to project. Economic location theory suggests and the empirical evidence supports the hypothesis that this variation is due to differences in the levels of location factors among the local areas and differences in the ability of reservoir-provided factors to compensate for shortcomings in other factors.

This section of the study is devoted to detailed inspection of the development that has occurred in the areas contiguous to two projects. By selecting two projects, one whose contiguous area has developed rapidly and one whose has not, and contrasting the locational features and the interaction of the reservoir projects with the features of the local areas, additional support for the hypothesis is obtained and the need for development planning on a multi-program basis is demonstrated.

THE CASE STUDY AREAS

Criteria for Selection of Areas

If the case studies are to provide a maximum understanding of the role of reservoir projects in the economic development of contiguous areas, the projects to be analyzed should be selected to bring out points of interest and a minimum of extraneous features. The physical features of the areas contiguous to the two projects should be as alike as possible to minimize this source of extraneous variation. The economies of the contiguous areas should be at the beginning of the study period both similar to each other and to the economies of the majority of the contiguous areas of the reservoir projects. The projects should be constructed at approximately the same time, preferably early in the study period, to allow the development to have reached equivalent new equilibrium levels. The areas should be within one state to minimize the problems of data comparability and acquisition. Finally, the selection of one project whose contiguous area has experienced considerable development by the chemical industry, the major type of industrial development in the rapidly developing contiguous areas, and one project whose contiguous area has experienced little development would ensure that the sources of variation in development would be present in the areas case studied.

The Case Study Areas

Two areas contiguous to multipurpose reservoir projects were selected by following the above criteria. The first is the area contiguous to Lake Cumberland Reservoir formed by Wolf Creek Dam. The second is the area contiguous to Kentucky Lake inside the state of Kentucky.

The area contiguous to Lake Cumberland includes Clinton, Pulaski, Russell, and Wayne counties. The location of this area can be seen from Plate B-18 of Appendix B. The Kentucky Lake area includes Calloway, Livingston, Lyon, Marshall, and Trigg counties. The five contiguous counties in Tennessee are excluded due to problems encountered with data comparability between states. The location of the contiguous area can be seen from Plate B-1 of Appendix B.

A comparison of the features of these two areas with the selection criteria indicates that these areas are suitable for case study. Both projects are large multipurpose reservoirs providing a variety of benefits to the contiguous area. Lake Cumberland is the largest project in the study area, and Kentucky Lake is the second largest.

Tables 25 and 26 show the employment and per capita income in the contiguous areas of Lake Cumberland and Kentucky Lake. In 1940, the economies of both areas were highly oriented toward agriculture; in this way, they are similar to the majority of the projects in the study. The Kentucky Lake project was completed in 1944 and Lake Cumberland in 1950 allowing sufficient time for development to occur in response to the effect of the projects in the contiguous areas.

DEVELOPMENT IN CONTIGUOUS AREAS 1940-1960

Employment and Income Change

Tables 25 and 26 show the employment in the contiguous areas in 1940 and in 1960. These data reveal that both contiguous areas have experienced growth in manufacturing over the period 1940-1960, but the Kentucky Lake area has had more rapid growth. The area contiguous to Kentucky Lake has experienced more growth in the manufacturing sector, and the growth has been primarily in industries whose location is related to factors provided by the reservoir project. The area contiguous to Lake Cumberland has experienced less growth in the manufacturing sector, and the growth that has been experienced is not directly related to factors provided by the reservoir project.

Of all the counties in the case study areas, the county with the most rapid manufacturing growth is Marshall County in the Kentucky Lake area. Inspecting the relationship between the concentration in manufacturing and the per capita income indicates a positive correlation between the variables. The relatively highly industrialized Marshall County has the highest per capita income by a clear margin.

Change in Manufacturing Employment

Tables 27 and 28 show manufacturing employment by industry. Table 27 indicates that the most dramatic change in industrial employment in the Lake Cumberland area has been the growth of a large apparel industry. Lumber, wood products, and furniture industry remains a major employer; and food products manufacturing has also grown. Table 28 reveals that the

TABLE 25

EMPLOYMENT AND INCOME FOR COUNTIES
CONTIGUOUS TO LAKE CUMBERLAND

	County				
	Clinton	Pulaski	Russell	Wayne	All Four
1940					
Percentage Employed in					
Agriculture	82.46	61.18	84.38	73.96	70.67
Mining	1.20	1.89	0.03	2.49	1.61
Construction	2.08	3.27	1.26	1.46	2.38
Manufacturing	2.08	4.55	2.13	4.37	3.77
Trans. & Utility	0.98	8.36	0.84	2.00	4.75
Trade Service	4.67	9.51	4.21	6.44	7.31
Financial Ser.	0.22	0.76	0.42	0.34	0.54
Services	6.31	10.49	6.73	8.95	8.97
Total Employed	2,792	10,327	3,647	4,570	21,336
Per Capita Income	$ 107	$ 166	$ 125	$ 128	$ 144
1960					
Percentage Employed in					
Agriculture	43.46	32.41	43.85	43.06	37.60
Mining	6.01	1.03	1.07	2.35	1.92
Construction	5.62	6.39	9.01	5.91	6.60
Manufacturing	14.33	17.14	9.79	18.72	15.97
Trans. & Utility	2.75	7.03	3.50	3.48	5.27
Trade Services	12.70	17.87	14.26	11.39	15.42
Financial Ser.	0.69	1.61	1.14	1.24	1.35
Services	14.46	16.52	17.37	13.85	15.88
Total Employed	2,508	10,358	2,984	3,783	19,633
Per Capita Income	$ 596	$ 933	$ 767	$ 673	$ 808

Source: Employment computed from Growth Patterns in Employment by County (Washington, D. C.: U. S. Government Printing Office, 1965), pp. 61-132.

Income from unpublished data provided by Office of Business Economics, U. S. Department of Commerce.

TABLE 26

EMPLOYMENT AND INCOME FOR COUNTIES CONTIGUOUS TO KENTUCKY LAKE

	County					
	Calloway	Livingston	Lyon	Marshall	Trigg	All Five
1940						
Percentage Employed in						
Agriculture	62.4	62.51	57.16	49.30	73.55	58.48
Mining	0.07	9.37	0.53	0.04	1.01	1.43
Construction	4.56	7.47	7.16	28.40	1.63	10.37
Manufacturing	5.49	2.49	9.82	3.30	3.80	4.56
Trans. & Utility	2.11	2.53	5.03	2.90	2.40	2.65
Trade Ser.	10.59	6.55	8.12	7.79	6.35	8.03
Financial Ser.	1.05	0.50	0.63	0.53	0.33	0.65
Services	13.66	8.59	11.56	7.74	10.94	10.41
Total Employment	6,276	2,509	2,215	4,855	3,452	19,307
Per Capita Income	$ 210	$ 142	$ 210	$ 187	$ 203	$ 194
1960						
Percentage Employed in						
Agriculture	17.93	28.82	29.27	9.74	40.20	21.00
Mining	0.11	3.21	0.68	0.35	0.31	0.58
Construction	6.83	12.02	17.41	13.28	7.26	10.07
Manufacturing	19.67	18.33	14.43	34.43	13.58	22.22
Trans. & Utilities	4.31	8.97	5.83	7.06	4.29	5.67
Trade Ser.	21.39	13.97	15.24	16.79	14.95	17.92
Financial Ser.	2.21	1.47	2.85	1.58	1.05	1.85
Services	27.54	13.21	14.30	16.77	18.35	20.69
Total Employment	7,371	2.033	1,602	5,079	2,827	18,912
Per Capita Income	$1,287	$ 854	$ 895	$2,229	$ 902	$1,404

Source: Employment computed from <u>Growth Patterns in Employment by County</u> (Washington, D.C.; U.S. Government Printing Office, 1965), pp. 61-132.

Income from unpublished data provided by Office of Business Economics, U.S. Department of Commerce.

TABLE 27

MANUFACTURING EMPLOYMENT BY INDUSTRY FOR COUNTIES CONTIGUOUS TO LAKE CUMBERLAND

Industry	County				
	Clinton	Pulaski	Russell	Wayne	All Counties
1940					
Food and Kindred Products Man.	10	62	8	9	89
Textile Mill Products Man.	0	3	0	1	4
Apparel Man.	0	5	2	0	7
Lumber, Wood Products, Furniture	36	314	50	170	570
Printing and Publishing	3	21	6	8	38
Chemical Man.	1	4	1	0	6
Electrical and Other Machinery	2	8	2	2	14
Motor Vehicles and Equipment	2	5	1	0	8
Other Transportation Equipment	0	1	0	1	2
Miscellaneous Man.	3	36	6	4	49
Total Manufacturing Employment (1940)	57	459	76	195	787

TABLE 27 (Continued)

Industry	County				
	Clinton	Pulaski	Russell	Wayne	All Counties
1960					
Food and Kindred Products Man.	47	263	53	36	399
Textile Mill Products Man.	0	0	0	0	0
Apparel Man.	168	565	80	198	1,011
Lumber, Wood Products Furniture	77	419	97	370	963
Printing and Publishing	12	34	4	11	61
Chemical Manu.	0	135	0	4	139
Electrical and Other Machinery	0	88	8	25	121
Motor Vehicles and Equipment	0	12	17	8	37
Other Transportation Equipment	4	0	0	0	4
Miscellaneous Man.	26	149	15	10	200
Total Manufacturing Employment (1960)	334	1,665	274	662	2,935

Source: U.S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U.S. Government Printing Office), V, Southeast, pp. 61-132.

TABLE 28

MANUFACTURING EMPLOYMENT BY INDUSTRY FOR COUNTIES CONTIGUOUS TO KENTUCKY LAKE

Industry	County					
	Calloway	Livingston	Lyon	Marshall	Trigg	All Counties
1940						
Food & Kindred Products	43	6	6	18	17	90
Textile Mill Products Man.	116	0	1	19	5	141
Apparel Man.	5	0	106	26	0	137
Lumber, Wood Products, Furniture	37	46	28	31	95	237
Printing and Publishing	25	0	3	11	6	45
Chemical Man.	1	0	1	2	1	5
Electrical and other Machinery	4	0	0	1	1	6
Motor Vehicles and Equipment	4	0	0	9	0	13
Other Transportation Equipment	0	0	0	0	0	0
Miscellaneous Man.	98	8	58	39	3	206
Total Manufacturing Employment (1940)	333	60	203	156	128	880

TABLE 28 (Continued)

Industry	County					
	Calloway	Livingston	Lyon	Marshall	Trigg	All Counties
1960						
Food & Kindred Products	131	18	4	32	35	220
Textile Mill Products Man.	5	12	8	60	25	110
Apparel Man.	366	4	16	78	45	509
Lumber, Wood Products Furniture	54	26	46	43	141	310
Printing and Publishing	59	19	4	20	8	110
Chemical Man.	136	125	62	803	4	1,130
Electrical and other Machinery	451	28	8	111	26	624
Motor Vehicles and Equipment	23	15	0	56	0	94
Other Transportation Equipment	0	14	0	43	0	57
Miscellaneous Man.	154	76	65	411	64	770
Total Manufacturing Employment (1960)	1,379	337	213	1,657	348	3,934

Source: U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, (Washington: U. S. Government Printing Office), V, Southeast, pp. 61-132.

major growth in manufacturing in the Kentucky Lake area has been in the chemical industry primarily at Calvert City in Marshall County. Machinery, apparel and miscellaneous manufacturing have also increased.

Primary Location Determinants of Industries Found in Contiguous Areas

What relationship, if any, exists between the reservoir projects and the development that has occurred in the contiguous areas? This question can be answered by determining the factors that are of primary importance in the location decisions of firms in the industries found to have located in these areas and inspecting to see if the reservoir projects have increased the availability of these factors in the contiguous areas.

The major industries in the Lake Cumberland area include apparel; lumber, wood products, and furniture; and food products. The principal location determinant of the apparel industry is low-wage labor, particularly female labor. The industry has modest transportation requirements, minimal requirements for water and electric power, and presents no special plant site requirements. The lumber, wood products, and furniture industry is attracted primarily by an availability of raw materials in the area. Low-wage labor is another important factor and an adequate land transportation system is of benefit, especially for the shipment of the finished product. The food products industry locates close to the market area to be served. None of the industries locating in the area contiguous to Lake Cumberland are directly influenced by the factors provided by the reservoir project. This evidence indicates that the reservoir has had little impact on the employment in the area.

The primary industries in the area contiguous to Kentucky Lake are chemicals, machinery, and apparel manufacturing. The location determinants of apparel manufacturing were discussed in the preceding section, and there is no reason to believe that the reservoir affected the location decisions of these firms. The primary location determinants of the machinery manufacturing firms in the Kentucky Lake area are labor costs, land transportation system, particularly rail transportation, and market area. The reservoir has been of minimal importance in attracting these firms.

The chemical industry is attracted by raw materials; electric power; water for cooling, processing, and waste dilution and removal; markets; and transportation, both land and water. The site requirements of the firms are often complex requiring large flat sites for efficient plant layout; water frontage for barge loading, cooling water withdrawals, and effluent discharge; and also requiring flood protection and stable flows. The linkage between the factors provided by a reservoir project and the location of chemical firms is evident.

The only industrial development in either of the reservoir areas that is directly related to the reservoir projects is the development of the chemical industry at Calvert City, Kentucky. By studying the development that has occurred at Calvert City and by contrasting the location features of this site to the features of a site in a similar geographical position with respect to Lake Cumberland both the ability of a reservoir project to stimulate economic development and also the inability of a project to overcome all obstacles to development can be demonstrated.

THE CALVERT CITY SITE

The Chemical Complex

The development in the Calvert City area has taken place in the flat. river bottom plain on the west bank of the Tennessee River. Figure 2 shows the location of the chemical plants in relation to the important location features of the area. Table 29 lists the manufacturing firms in the Calvert City area, and from this listing the magnitude of the chemical industry in the area is evident.

The initial plants built by Airco Alloys & Carbide and Pennsalt Chemicals have high electric power requirements, 30,000 kilowatts per hour at Pennsalt and 100,000 kilowatts per hour at Airco.[1] The Airco Ferro-Alloy plant requires

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[1] Industrial Resources-Marshall County (Frankfort, Ky.: The Kentucky Department of Commerce, 1967), pp. 13-15.

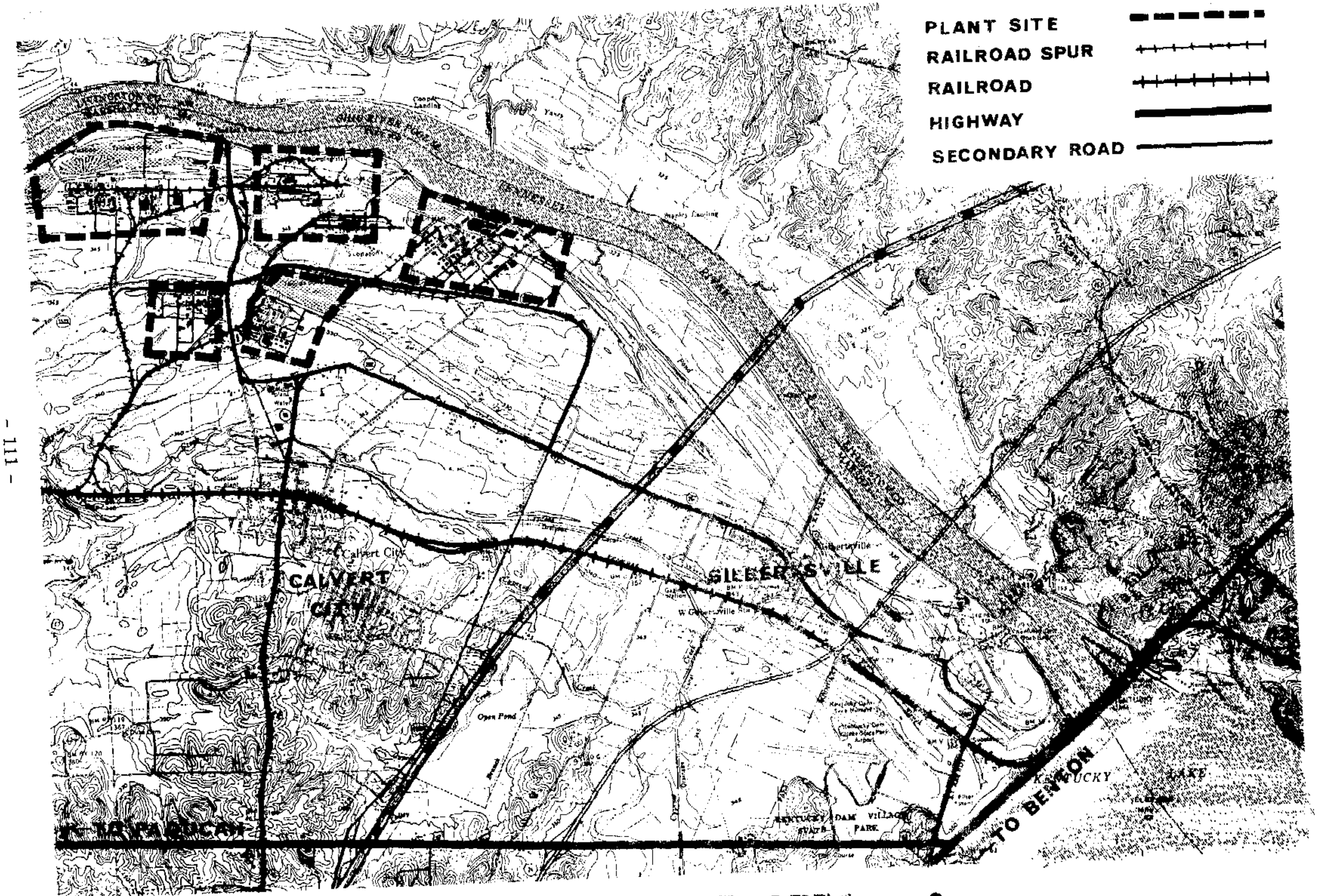

FIG. 2 MAP OF CALVERT CITY AREA

TABLE 29

MANUFACTURING FIRMS IN THE CALVERT CITY AREA IN 1969

Name of Firm	Principal Products	Date of Initial Operation	Employment 1969
Airco Alloys & Carbide	Ferro-Alloys	1949	683
Airco Alloys & Carbide	Calcium Carbide Actelyne	1953	381
Airco Chemicals & Plastics Division	Vinyl Actatte	1955	372
American Aniline & Extract Co.	Chemicals	1954	10
Calvert Reproductions	Furniture	1966	4
General Aniline & Film Corp.	Detergents	1956	336
General Sales & Manufacturing	Fishing Equipment	1953	2
B. F. Goodrich Chemical Co.	Vinyl Chloride	1952	525
Penn Olin Chemical	Sodium Chlorate	1961	35
Pennsalt Chemical	Chlorine Caustic Soda	1949	478
Warren Brothers Co.	Asphalt	1952	30
Total			2, 856

Source: Kentucky. Kentucky Department of Commerce, 1969 Kentucky Directory of Manufacturers (Frankfort, Ky.: Kentucky Department of Commerce, 1969).
Unpublished data provided by the Kentucky Department of Commerce.

water at a rate of 3,000 gallons per minute for cooling.[2] Since the initial development, additional chemical plants with similar site requirements have moved into this area. The later locations have been made in view of potential agglomeration economies obtained by locating adjacent to existing plants as well as the original location features of the area.

The Location Determinants

The linkages between the development of the Calvert City site and the reservoir project are manifold. The plants require cooling water and electric power that could not have been economically provided without the reservoir. The plants transport both raw materials and finished products by barge with the project providing the required navigation channel upstream. The site is near the point where the Mississippi, Ohio, and Tennessee River waterways come together and thus centrally located on one of the largest inland waterway systems in the world. Without the flow stabilization provided by the project, the plant sites would be subjected to periodic severe flooding, and the complex would not locate at the site.

In addition to the location factors provided by the reservoir project, Figure 2 shows that the plant sites are favorably situated with respect to rail lines, highways, and a natural gas pipeline. The land transport factors are important to all the plants as they ship goods by both rail and truck. The highway increases the available labor force. The manpower requirements of the plants have exceeded the labor available in the local area since the initial operation of the first plants; therefore, commuting by workers over considerable distances has been required. The location of the complex on a modern highway near a major intersection has enhanced commuting. The natural gas pipeline provides an additional source of large quantities of energy to the complex at economically attractive prices.

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[2] Ibid.

There can be little doubt that these factors not provided by the reservoir project have added to the attractiveness of the area as a location for chemical manufacturing. The fortuitous combination of the factors provided by the reservoir project and other factors in the area have produced growth in the chemical industry and a high per capita income for Marshall County.

THE LAKE CUMBERLAND AREA

The development at Calvert City is located on protected sites in the flood plain of the Tennessee River immediately downstream from Kentucky Dam. This area receives the maximum development benefits from the reservoir project. The area immediately downstream from Wolf Creek Dam has received similar development benefits from the Lake Cumberland Reservoir project. By inspecting the development that has occurred below Wolf Creek Dam and contrasting this with the development at Calvert City, the importance of the location factors not provided by reservoir projects to the development of an area can be demonstrated.

Figure 3 shows the area immediately downstream from Lake Cumberland. Except for the lack of navigation facilities and the much more remote location even if the facilities were provided, these downstream sites have received from the project benefits similar to those at Calvert City. The contiguous area is more hilly, but sufficient flat, flood protected, bottom land is available for industrial development.

Even though the Lake Cumberland sites have received almost identical benefits from the reservoir project, no industrial development has occurred in this area. Reasons for this lack of development can be seen from Figure 3. The area is not served by rail, and the immediate sites are served only by roads which are clearly unsatisfactory for industrial use. Even if good feeder roads were built, the major roads in the area are narrow, winding, two-lane arteries which are inadequate for industrial traffic. This lack of highways severely hampers the attraction of a work force to a plant at a downstream

FIG. 3 MAP OF CONTIGOUS AREA BELOW WOLF CREEK DAM.

site because there is no significant population center nearby and commuting over long distances by workers would be required.

The lack of rail transportation is an even more serious barrier to development. If a firm were to develop a site, the plant would have to be relatively large to justify the high overhead cost for drinking water, access roads, sewage disposal, fire protection, etc. Plants of this size, particularly chemical plants, require access to rail transportation. The nearest rail service is at Somerset, Kentucky, approximately 40 miles upstream. The provision of rail service to this area is unlikely.

The area below Wolf Creek Dam has been provided most of the location factors provided the area below Kentucky Dam; however, the indigious location features of the two areas are not similar. The differences in the location factors that are not directly provided by the reservoir projects help explain the differing experiences of these areas with respect to industrial development.

SUMMARY

The results of these case studies make it apparent that a reservoir can promote development in its contiguous area, particularly in the area immediately downstream from the dam. In the case of Calvert City, the project is a necessary condition for development to occur. On the other hand these studies indicate that the reservoir projects alone are not sufficient to generate industrial development. If the area is inadaquate with respect to factors which are not directly supplied by the reservoir project, development is unlikely to occurr unless other programs are initiated to remove these deficiencies.

These studies emphasize the need for a multi-program approach to economic development. Reservoir projects affect only a subset of the factors that enter into location decisions; therefore, reservoirs may be part of a development program but the total program for the area must be far more comprehensive in its scope. To best promote the development of a region, the planning agency must have authority in highways; educational programs, both academic and vocational; local community development activities; and other programs for local areas such as water supply and waste disposal programs. The responsibilities of the agencies that administer water development programs are too narrowly defined to allow the most efficient use of reservoir projects in promoting economic development of local areas. Effective development planning requires a much broader scope, and a multi-program approach is required if reservoirs are to be made more effective.

CHAPTER VII

SUMMARY AND CONCLUSIONS

OBJECTIVES OF THE STUDY

This study is devoted to analyzing the effects of multipurpose reservoirs on the economic growth and industrial development of areas contiguous to the project sites.

The study addresses four major questions:

1. Can reservoir projects be used to promote economic development in their contiguous areas?
2. Have existing reservoir projects promoted the economic development of their contiguous areas?
3. If there are differences among projects in the degree of development experienced in their contiguous areas, can the sources of this variation be identified so that planners can better predict the effects of a project on the contiguous area?
4. Can the planning of multipurpose reservoir projects be modified so that the economic development benefits to the contiguous area can be maximized?

In answering these questions, the study attempts to improve the ability of planners to formulate water resources projects to produce development benefits.

The first question is investigated by theoretical analysis of the factors which determine the location of economic activity and the effects of reservoir projects on these location factors. This phase of the study concludes that reservoir projects affect a subset of the factors that determine the attractiveness of an area for economic activities; therefore, a project has the potential to accelerate economic growth. On the other hand, since a reservoir project can affect only a subset of the important factors, the reservoir project cannot remove all restrictions to the attractiveness of an area. If an area has serious deficiencies in location factors not provided by the reservoir project, theory predicts that the area would fail to experience significant economic growth.

The second and third questions are studied by analysis of development occurring in areas contiguous to twenty existing reservoir projects in Kentucky and Tennessee. Analyses are conducted to see whether more economic development has occurred in areas contiguous to reservoirs than in paired control areas. The matter is investigated first for all the reservoirs as a whole to see whether a general rule can be established and then with respect to individual blocks of reservoirs to detect settings where development differences are found. The overall analyses indicate that the areas contiguous to projects have more rapid shifts in employment and more diverse employment patterns, but the evidence on per capita income and population give little support to a contention of a positive effect of the projects in the contiguous areas.

The analyses of the individual blocks of reservoir projects reveal a great deal of diversity in the degree of development. Brief surveys are made of the development occurring in each block in an attempt to isolate the causes of this diversity. These surveys indicate that the variation is associated with the relative locational attractiveness of the contiguous areas. Those projects which removed serious deficiencies in areas that were otherwise desirable locations for economic activity have promoted rapid growth in their contiguous areas while those projects which were located in areas with serious deficiencies in factors not directly affected by the reservoir project have not promoted rapid growth.

Case studies are conducted of the development occurring in the areas contiguous to two projects, one which had developed and one which had not. These case studies reveal that in the area showing rapid development, a fortuitous combination of features, some provided by the reservoir project and others outside the scope of the project had created an attractive site for chemical plants. The study of the area which had failed to experience significant development demonstrated that this is due more to a severe deficiency in land transportation and an isolation from both markets and labor supply than to differences in the features provided by the project.

The empirical phase of the study indicates that there has been a great deal of diversity among the areas contiguous to existing projects in the degree of development experienced. Whether or not an area experiences industrial development after the construction of a reservoir project depends on the particular factors which limit development of the area. If the availability of limiting factors is improved by project construction, the area will develop rapidly, otherwise the project will produce little, if any, industrial growth in the contiguous area.

The answer to the fourth question is induced from the results of the theoretical and empirical analyses. If reservoir projects are to be effective in achieving local development, the planning agency must have the authority over a wider spectrum of public investments than is the current practice. Development planning requires an multi-purpose approach designed to remove the serious limitations to development in the area. For example, in an area that lacks both water supply and land transportation, effective development planning requires both a water resource program and a highway program. Neither program alone will produce the desired results.

IMPLICATIONS FOR PLANNING

This study has two implications for the policies and administrative control that govern reservoir project planning. First, the current project formulation procedure concentrates on the total development benefits produced and pays little attention to the spatial distribution of these benefits. This severely limits the effective design of these water resource projects to promote development of underdeveloped areas. The ecological problems currently confronting the urban centers are created in part by an extreme concentration of industry due to the increasing dominance of agglomeration economies as location determinants in the United States economy. If these problems are to be moderated, ways must be developed to promote future industrial development outside these areas. Ignoring the spatial distribution of the development benefits of reservoir projects reduces the effective use of these projects to develop the rural areas and reduce the concentration of industry in urban centers.

Secondly, this study shows that reservoirs are seldom, if ever, capable of promoting rapid economic development in their contiguous areas unless other programs are initiated to remove shortcomings that can not be removed by the water project alone. The present administrative structure gives the agency charged with the planning of reservoir projects little authority over programs to improve other features of a given area; therefore, the development experienced in these areas is erratic. Those areas that happen to have a desirable combination of location factors develop rapidly as do those which receive needed factors from programs of other agencies, but many less fortunate areas do not receive the benefits that could be provided by better planning.

Clearly what is required is a multi-program approach to development planning with the authority over reservoir project planning given to an agency which is authorized to plan public investments across a wide spectrum. This would insure the maximum development benefits from reservoir projects and would make reservoirs a more powerful tool for area development planning.

SUGGESTIONS FOR FURTHER STUDY

The suggestion that a spatial dimension be added to the evaluation of the development benefits received from reservoir projects raises a plethora of problems. This suggestion implies a difference in the social cost of alternative locations of economic activity. Much work is required before these costs can be measured and the spatial factor incorporated into the benefit-cost framework of project analysis. This work will require contributions from both economic theory and quantitative methods in planning.

The implication of the need for multiprogram planning for development creates problems in the allocation of total development benefits among projects and the sequencing of individual projects for maximum effectiveness. A basis for work in this area has been established, but many theoretical and practical problems remain.[1]

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[1] Leo T. Surla, Lawrence K. Lynch, and William E. Moyer, Estimation, Evaluation and Allocation of Multipurpose Benefits: A Case Study and Methodology, A study prepared for the Office of Appalachian Studies, U.S. Army Corps of Engineers, February, 1967 (Cincinnati, Ohio: U.S. Army Corps of Engineers, 1967).

APPENDIX A

TABULATION OF COUNTIES IN RESERVOIR CONTIGUOUS CONTROL AREAS

TABLE A-1

KENTUCKY LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Calloway, Kentucky	Fleming, Kentucky	0.9501
Livingston, Kentucky	Larue, Kentucky	.9485
Lyon, Kentucky	Lincoln, Kentucky	.9484
Marshall, Kentucky	Harrison, Kentucky	.9481
Trigg, Kentucky	Taylor, Kentucky	.9481
Benton, Tennessee	Shelby, Kentucky	.9453
Henry, Tennessee	Carroll, Tennessee	.9449
Houston, Tennessee	Henry, Kentucky	.9440
Humphreys, Tennessee	Cheatham, Tennessee	.9437
Stewart, Tennessee	Gallatin, Kentucky	.9426

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9464

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.8111

TABLE A-2

OLD HICKORY LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Sumner, Tennessee	Williamson, Tennessee	0.9563
Trousdale, Tennessee	Giles, Tennessee	.9563
Wilson, Tennessee	Gibson, Tennessee	.9538
	Shelby, Kentucky	.9410
	Robertson, Tennessee	.9401
	Logan, Kentucky	.9397
	Simpson, Kentucky	.9394
	Barren, Kentucky	.9376
	Greene, Tennessee	.9354
	Scott, Kentucky	.9343

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9434

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.8064

TABLE A-3

PICKWICK LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Hardin, Tennessee	Wayne, Tennessee	0.9426
	McLean, Kentucky	.9219
	Hickman, Tennessee	.9191
	Cumberland, Tennessee	.9180
	Van Buren, Tennessee	.9176
	Gallatin, Kentucky	.9127
	Perry, Tennessee	.9116
	Bledsoe, Tennessee	.9115
	Carroll, Kentucky	.9068
	Putnam, Tennessee	.9053

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9167

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.7727

TABLE A-4

ELK RIVER LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Franklin, Tennessee	Williamson, Tennessee	0.9294
	Obion, Tennessee	.9183
	Robertson, Tennessee	.9170
	Giles, Tennessee	.9026
	Rowan, Kentucky	.9013
	Scott, Kentucky	.8997
	Gibson, Tennessee	.8995
	Boone, Kentucky	.8984
	Coffee, Tennessee	.8976
	Rutherford, Tennessee	.8969

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9061

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.7789

TABLE A-5

GUNTHERSVILLE AND HALES BAR LAKES

Contiguous Area	Control Area	
County, State	County, State	IRH
Marion, Tennessee	Hopkins, Kentucky	0.8012
	Muhlenberg, Kentucky	.7912
	Grundy, Tennessee	.7773
	Pike, Kentucky	.7724
	McCreary, Kentucky	.7566
	Webster, Kentucky	.7493
	Anderson, Tennessee	.7364
	Johnson, Kentucky	.7094
	Knott, Kentucky	.7082
	Perry, Kentucky	.7080

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.7510

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.4982

TABLE A-6

CHICKAMAUGA LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Hamilton, Tennessee	Jefferson, Kentucky	0.6474
Meigs, Tennessee	McCracken, Kentucky	.6339
Rhea, Tennessee	Kenton, Kentucky	.5767
	Boyd, Kentucky	.5695
	Fayette, Kentucky	.5532
	Madison, Tennessee	.4345
	Unicoi, Tennessee	.4327
	Daviess, Kentucky	.4258
	Bedford, Tennessee	.4209
	Hamblen, Tennessee	.4139

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.5104

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.2950

TABLE A-7

PARKERSVILLE LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Polk, Tennessee	Sequatchie, Tennessee	0.8324
	Carter, Kentucky	.8314
	Knox, Kentucky	.8144
	Union, Kentucky	.8129
	Lee, Kentucky	.8115
	Knott, Kentucky	.8111
	Crittenden, Kentucky	.8107
	Johnson, Kentucky	.8105
	Fentress, Tennessee	.7988
	Rowan, Kentucky	.7902

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.8124

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.663

TABLE A-8

WATTS BAR LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Meigs, Tennessee	Caldwell, Kentucky	0.8337
Rhea, Tennessee	Hamblen, Tennessee	.8324
Roane, Tennessee	Bedford, Tennessee	.8192
	Monroe, Tennessee	.7950
	Warren, Tennessee	.7753
	Dyer, Tennessee	.7709
	Mason, Kentucky	.7626
	Dickson, Tennessee	.7524
	Cumberland, Tennessee	.7427
	Rutherford, Tennessee	.7389

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.7823

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.6565

TABLE A-9

FORT LOUDON LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Blount, Tennessee	McCracken, Kentucky	0.6810
Knox, Tennessee	Jefferson, Kentucky	.6134
Loudon, Tennessee	Fayette, Kentucky	.5873
	Kenton, Kentucky	.5801
	Boyd, Kentucky	.5588
	Bedford, Tennessee	.5291
	Madison, Tennessee	.5285
	Unicoi, Tennessee	.5278
	Hamblen, Tennessee	.5159
	Daviess, Kentucky	.5061

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.5628

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.3931

TABLE A-10

DOUGLAS LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Cocke, Tennessee	Greene, Tennessee	0.9637
Jefferson, Tennessee	Larue, Kentucky	.9488
Sevier, Tennessee	Logan, Kentucky	.9487
	Cheatham, Tennessee	.9482
	Gibson, Tennessee	.9467
	Overton, Tennessee	.9455
	Taylor, Kentucky	.9449
	Giles, Tennessee	.9443
	Carroll, Tennessee	.9435
	Chester, Tennessee	.9429

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9477

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.8153

TABLE A-11

CHEROKEE LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Grainger, Tennessee	Greene, Tennessee	0.9678
Hawkins, Tennessee	Cheatham, Tennessee	.9618
Jefferson, Tennessee	Overton, Tennessee	.9599
	Nicholas, Kentucky	.9567
	Larue, Kentucky	.9566
	Carlisle, Kentucky	.9561
	Smith, Tennessee	.9554
	Ballard, Kentucky	.9553
	Lincoln, Kentucky	.9544
	Fleming, Kentucky	.9543

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9578

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.8167

TABLE A-12

BOONE LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Sullivan, Tennessee	Maury, Tennessee	0.6740
Washington, Tennessee	Hamblen, Tennessee	.6602
	Madison, Tennessee	.6450
	Bedford, Tennessee	.6425
	Caldwell, Kentucky	.6189
	Henderson, Kentucky	.6160
	Mason, Kentucky	.6113
	Boyle, Kentucky	.5994
	Warren, Kentucky	.5958
	McCracken, Kentucky	.5867

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.6250

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.5115

TABLE A-13

SOUTH HOLSTON LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Sullivan, Tennessee	Maury, Tennessee	0.5887
	Bedford, Tennessee	.5465
	Hamblen, Tennessee	.5397
	Madison, Tennessee	.5209
	McCracken, Kentucky	.5181
	Caldwell, Kentucky	.5134
	Mason, Kentucky	.4983
	Henderson, Kentucky	.4969
	Boyle, Kentucky	.4829
	Warren, Kentucky	.4774

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.5183

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.4147

TABLE A-14

WATAUGA LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Carter, Tennessee	Maury, Tennessee	0.6706
Johnson, Tennessee	Hickman, Tennessee	.5623
	Cumberland, Tennessee	.5468
	Dyer, Tennessee	.5363
	Henderson, Kentucky	.5329
	Rutherford, Tennessee	.5328
	Putnam, Tennessee	.5321
	Giles, Tennessee	.5320
	Warren, Tennessee	.5320
	Greene, Tennessee	.5316

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.5509

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.4881

TABLE A-15

NORRIS LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Campbell, Tennessee	Johnson, Kentucky	0.9304
Claiborne, Tennessee	Knott, Kentucky	.9302
Union, Tennessee	Webster, Kentucky	.9090
	Lee, Kentucky	.9071
	Knox, Kentucky	.8988
	Crittenden, Kentucky	.8965
	Union, Kentucky	.8919
	Pike, Kentucky	.8580
	Sequatchie, Tennessee	.8119
	Whitley, Kentucky	.8103

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.8844

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.6650

TABLE A-16

DEWEY RESERVOIR

Contiguous Area	Control Area	
County, State	County, State	IRH
Floyd, Kentucky	Perry, Kentucky	0.9380
	Letcher, Kentucky	.9205
	McCreary, Kentucky	.8582
	Grundy, Tennessee	.8460
	Muhlenberg, Kentucky	.8442
	Hopkins, Kentucky	.8099
	Pike, Kentucky	.7885
	Bell, Kentucky	.7498
	Harlan, Kentucky	.7261
	Webster, Kentucky	.7187

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.8210

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.3850

TABLE A-17

HERRINGTON LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Garrard, Kentucky	Shelby, Kentucky	0.9786
Mercer, Kentucky	Harrison, Kentucky	.9733
	Barren, Kentucky	.9729
	Simpson, Kentucky	.9674
	Lincoln, Kentucky	.9643
	Logan, Kentucky	.9637
	Scott, Kentucky	.9626
	Henry, Kentucky	.9612
	Carroll, Tennessee	.9594
	Weakley, Tennessee	.9585

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9662

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.8127

TABLE A-18

CUMBERLAND LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Clinton, Kentucky	Cheatham, Tennessee	0.9706
Pulaski, Kentucky	Grayson, Kentucky	.9693
Russell, Kentucky	Hart, Kentucky	.9677
Wayne, Kentucky	Carlisle, Kentucky	.9676
	Ballard, Kentucky	.9659
	Adair, Kentucky	.9656
	Hickman, Kentucky	.9651
	Monroe, Kentucky	.9646
	Overton, Tennessee	.9642
	Lincoln, Kentucky	.9639

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9664

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.8138

TABLE A-19

DALE HOLLOW LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
Clinton, Kentucky	Macon, Tennessee	0.9870
Cumberland, Kentucky	Adair, Kentucky	.9868
Clay, Tennessee	Monroe, Kentucky	.9857
Pickett, Tennessee	Casey, Kentucky	.9806
	Jackson, Tennessee	.9799
	Owsley, Kentucky	.9783
	Cannon, Tennessee	.9762
	Metcalfe, Kentucky	.9740
	Green, Kentucky	.9739
	Hart, Kentucky	.9733

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9795

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.8069

TABLE A-20

CENTER HILL LAKE

Contiguous Area	Control Area	
County, State	County, State	IRH
De Kalb, Tennessee	Hart, Kentucky	0.9847
	Owen, Kentucky	.9834
	Spencer, Kentucky	.9834
	Grayson, Kentucky	.9819
	Adair, Kentucky	.9818
	Monroe, Kentucky	.9810
	Green, Kentucky	.9810
	Crockett, Tennessee	.9804
	Jackson, Tennessee	.9789
	Fayette, Tennessee	.9786

Mean Index of Regional Homogeneity Between Counties in Control Area and Contiguous Area 0.9815

Mean Index of Regional Homogeneity Between All Counties in Study Area and Contiguous Area 0.8045

APPENDIX B

MAPS SHOWING CONTIGUOUS AND CONTROL AREAS OF RESERVOIR PROJECTS

Plate B-I Study Area Showing Contiguous and Control Areas for Kentucky Lake

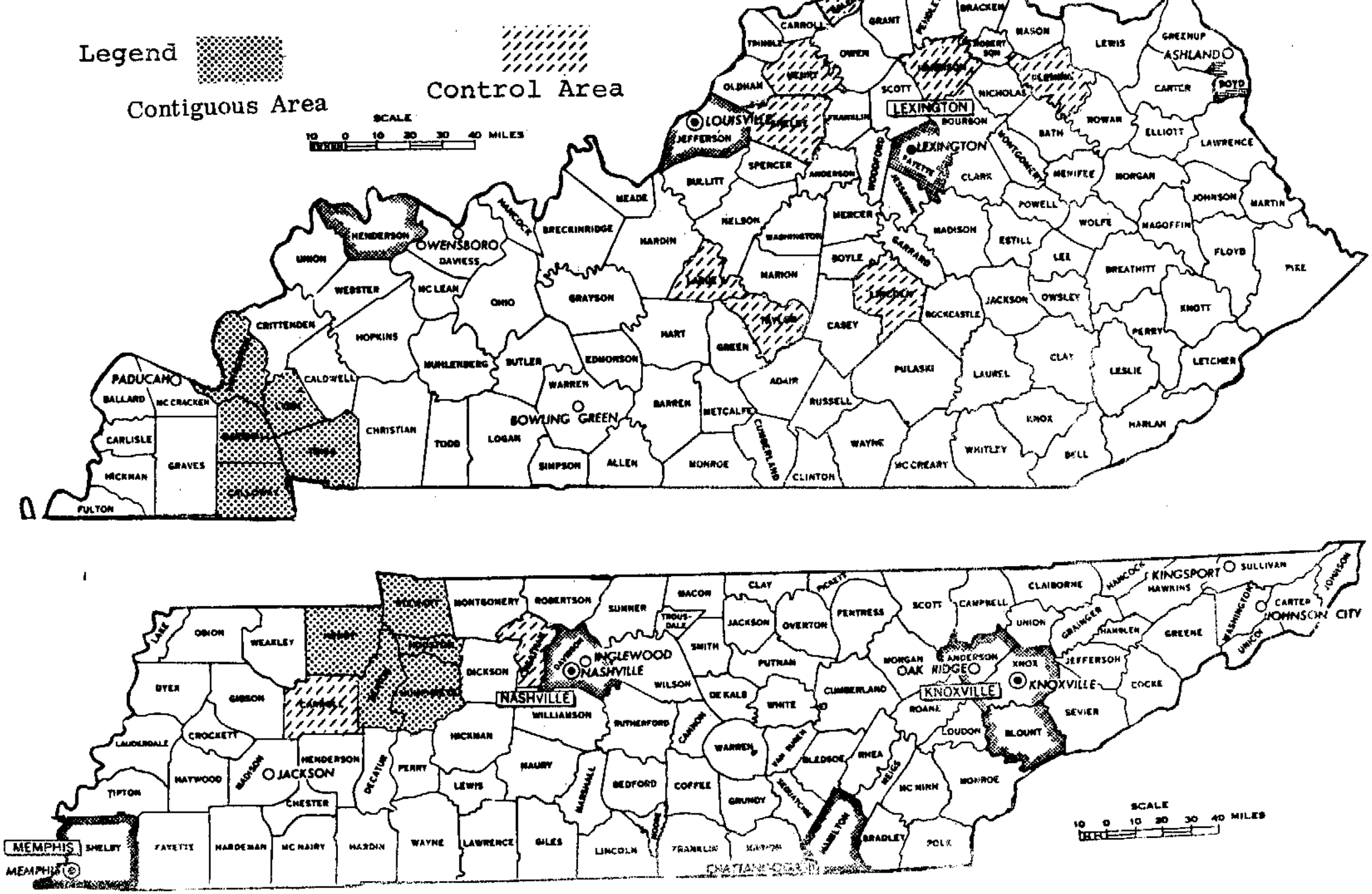


Plate B-II Study Area Showing Contiguous and Control Areas for Old Hickory Lake

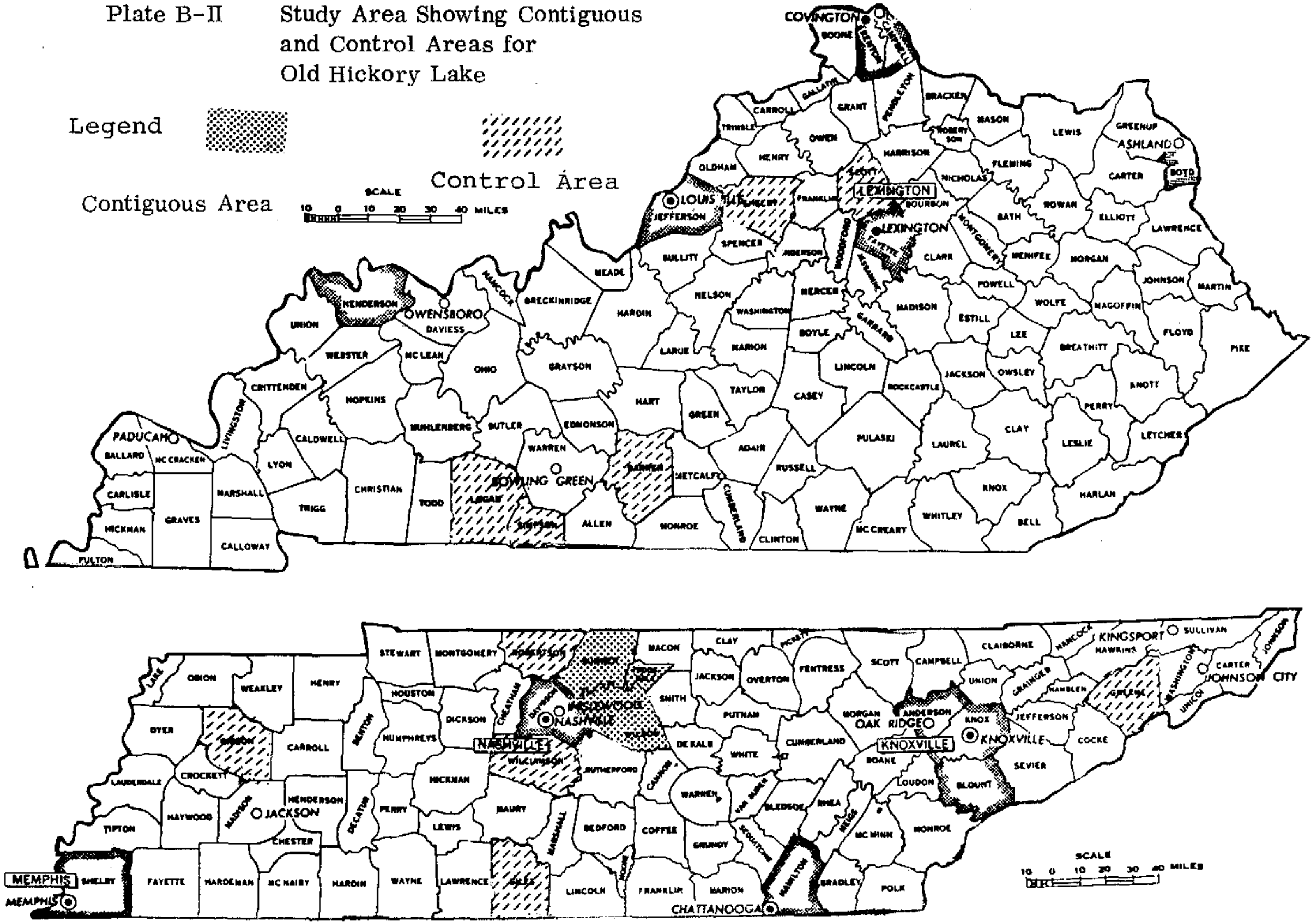


Plate B-III Study Area Showing Contiguous and Control Areas for Pickwick Lake

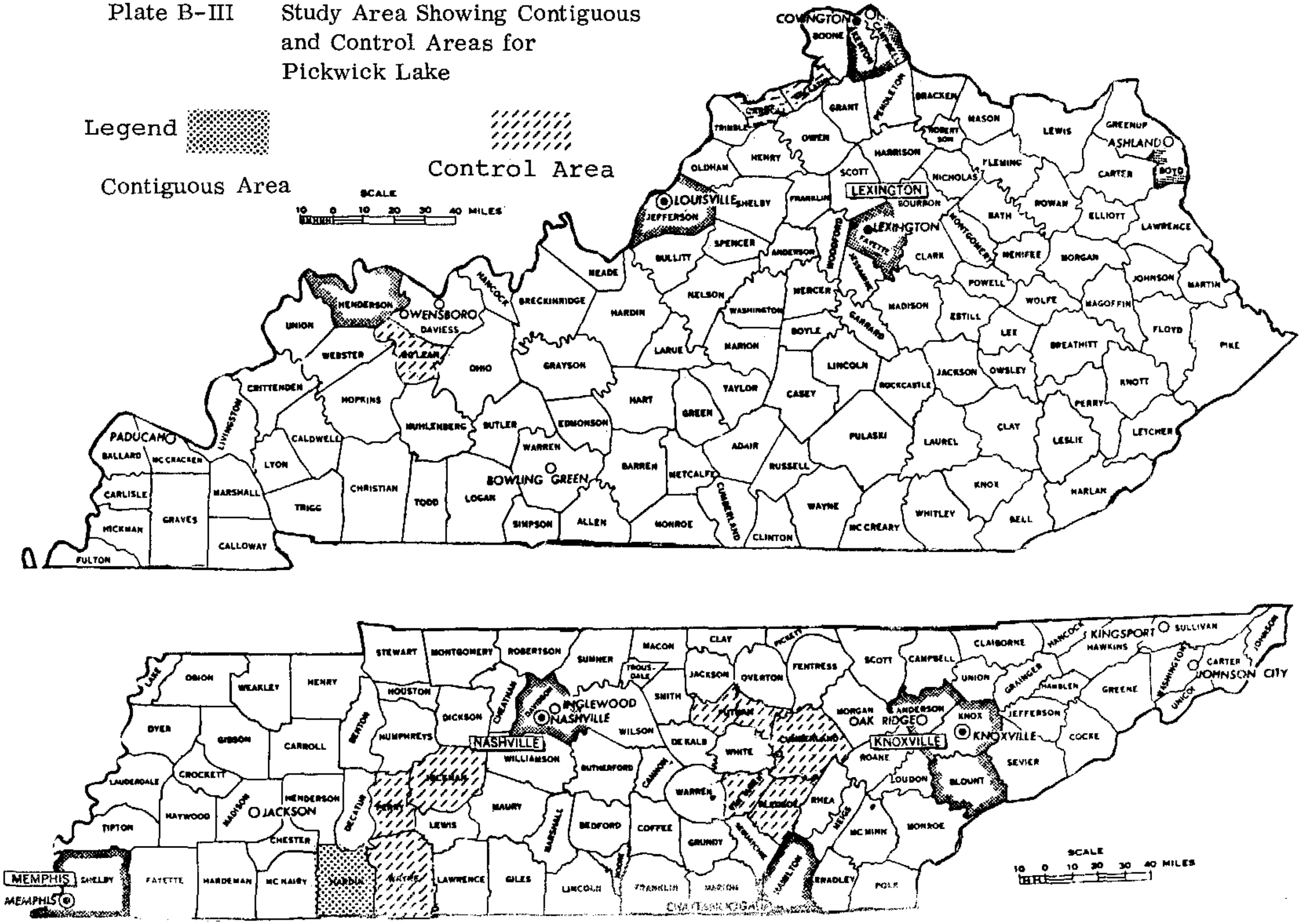


Plate B-IV Study Area Showing Contiguous and Control Areas for Elk River Lake

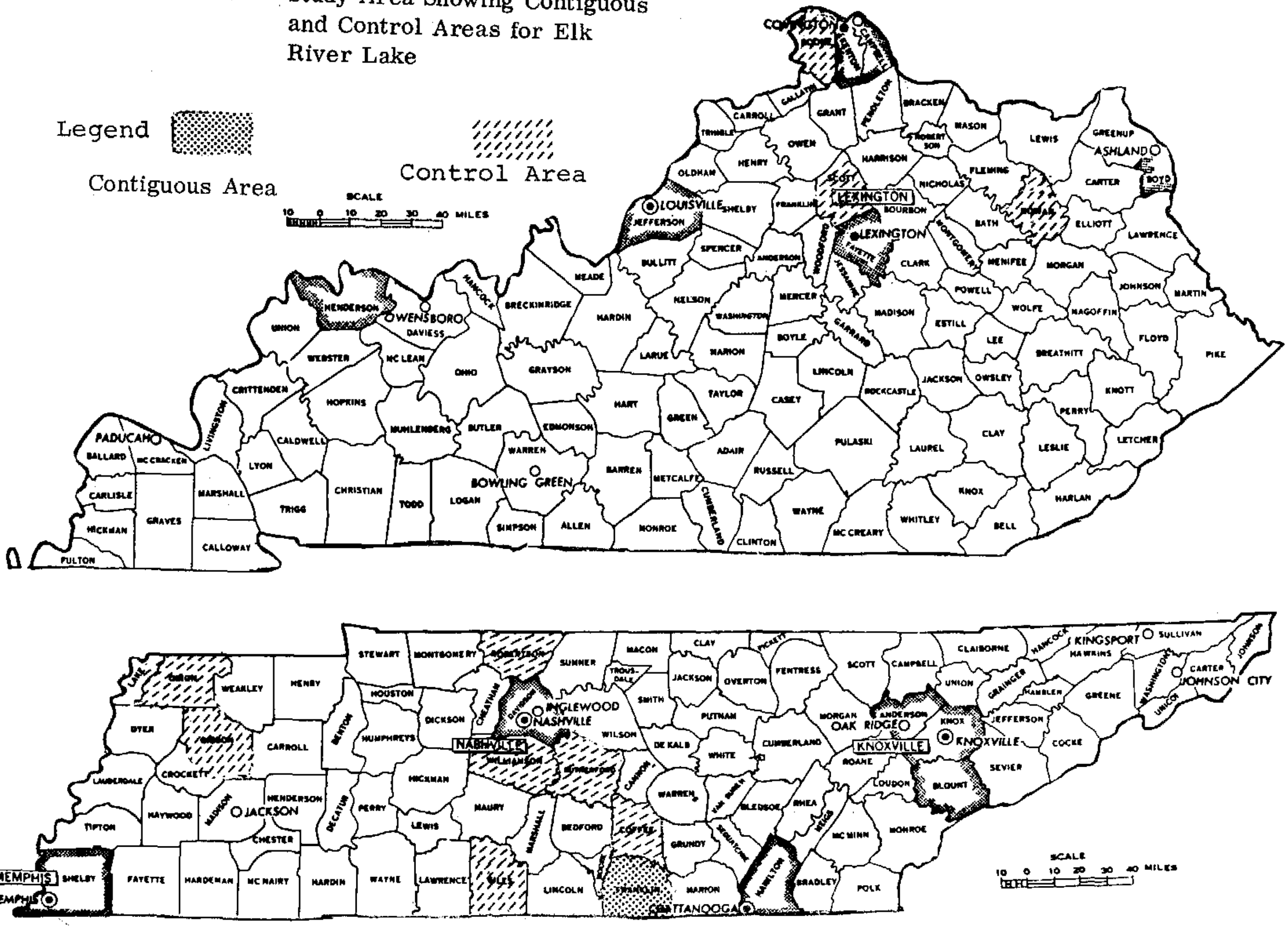


Plate B-V Study Area Showing Contiguous and Control Areas for Hales Bar and Guntersville Lakes

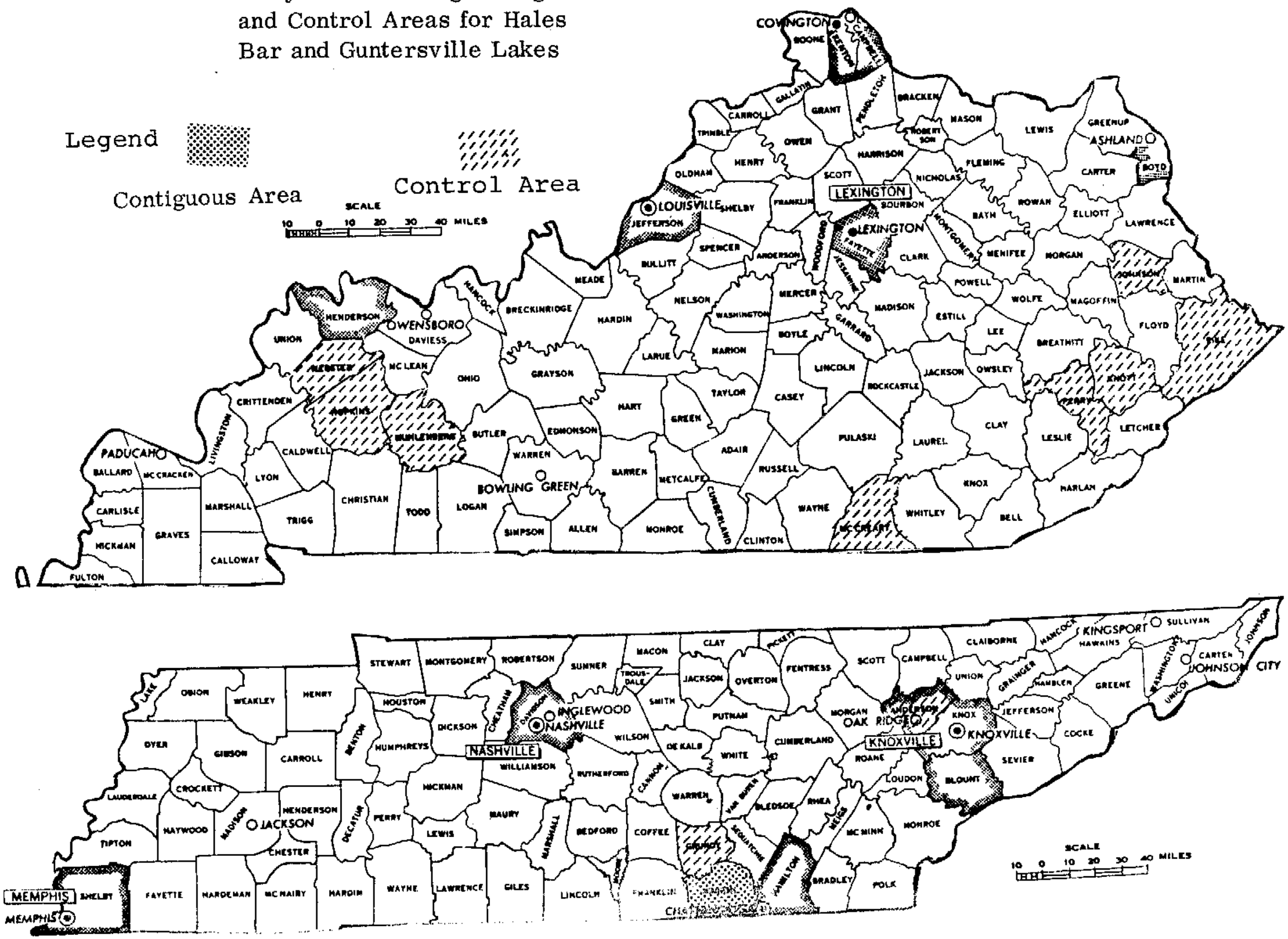


Plate B-VI Study Area Showing Contiguous and Control Areas for Chickamauga Lake

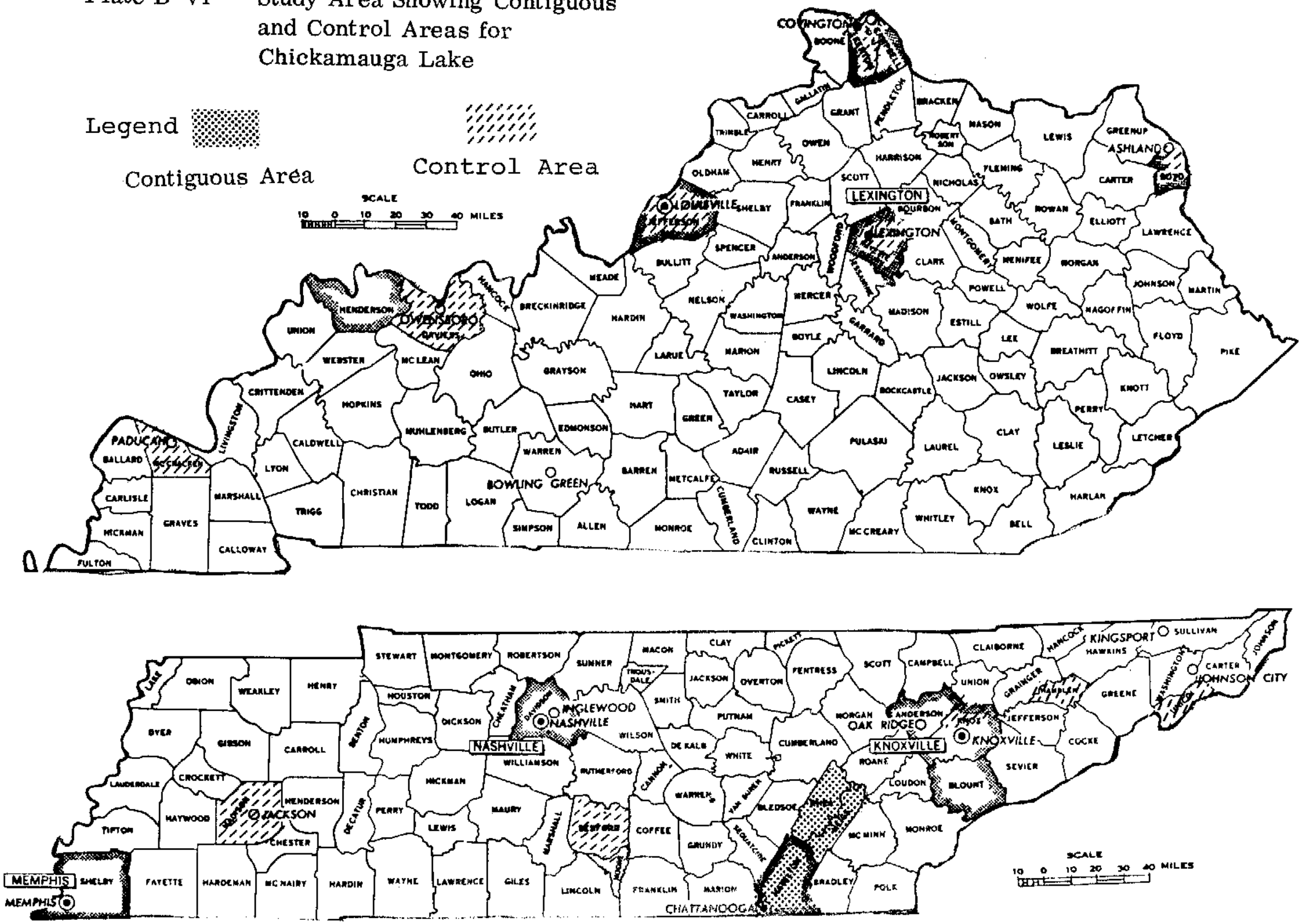


Plate B-VII Study Area Showing Contiguous and Control Areas for Parkersville Lake

Legend

Contiguous Area

Control Area

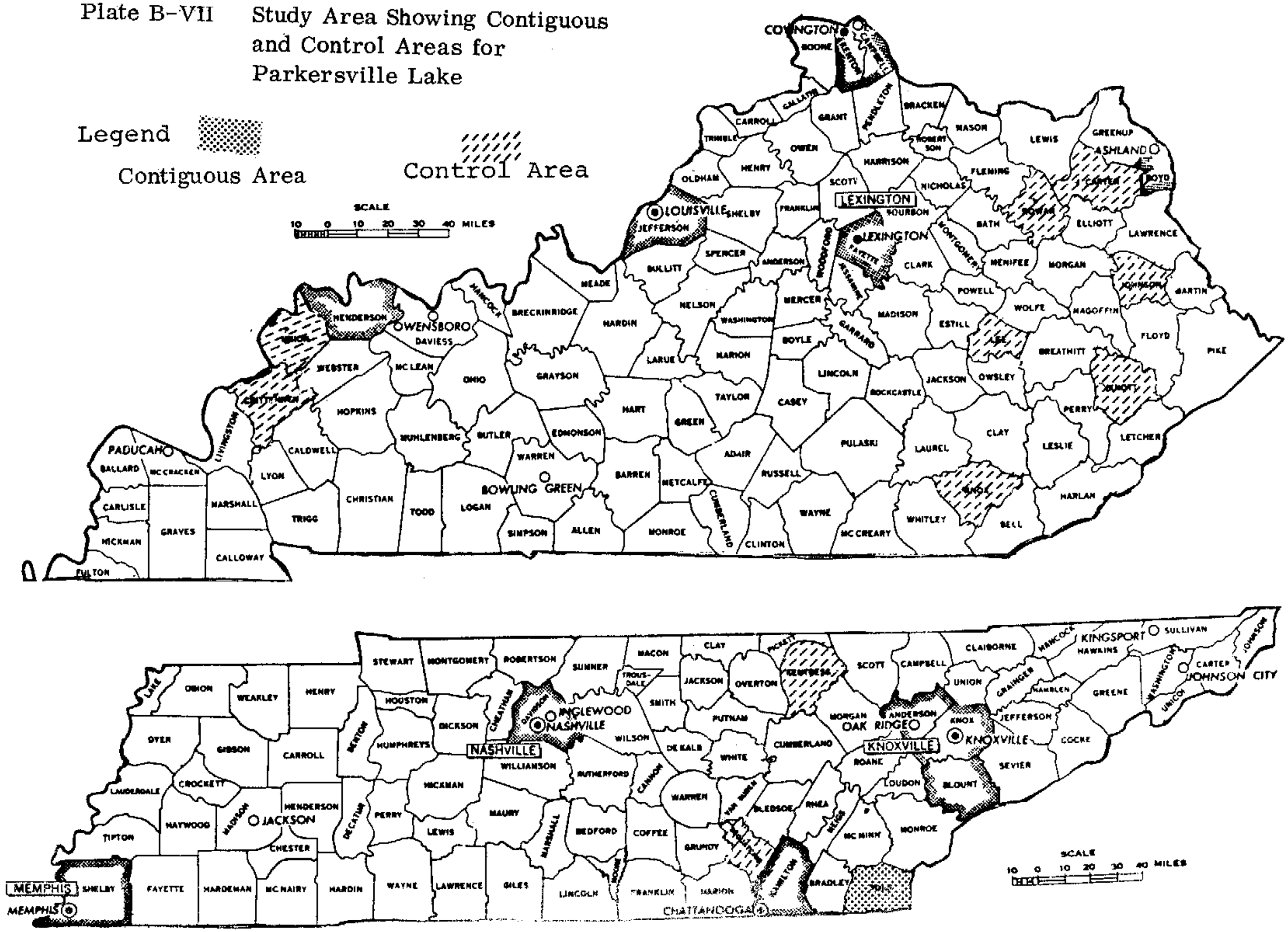


Plate B-VIII Study Area Showing Contiguous and Control Areas for Watts Bar Lake

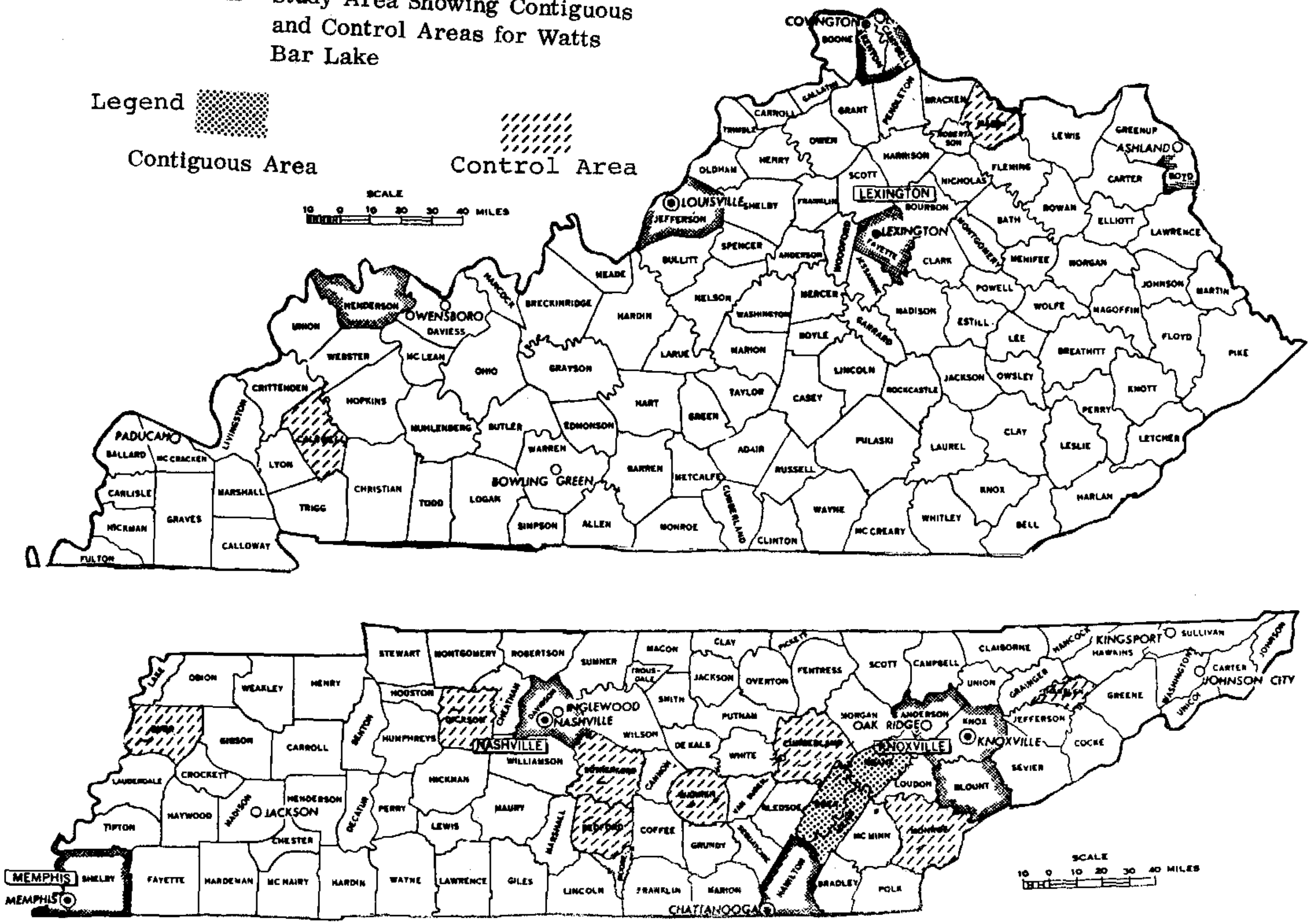


Plate B-IX Study Area Showing Contiguous and Control Areas for Fort Loudon Lake

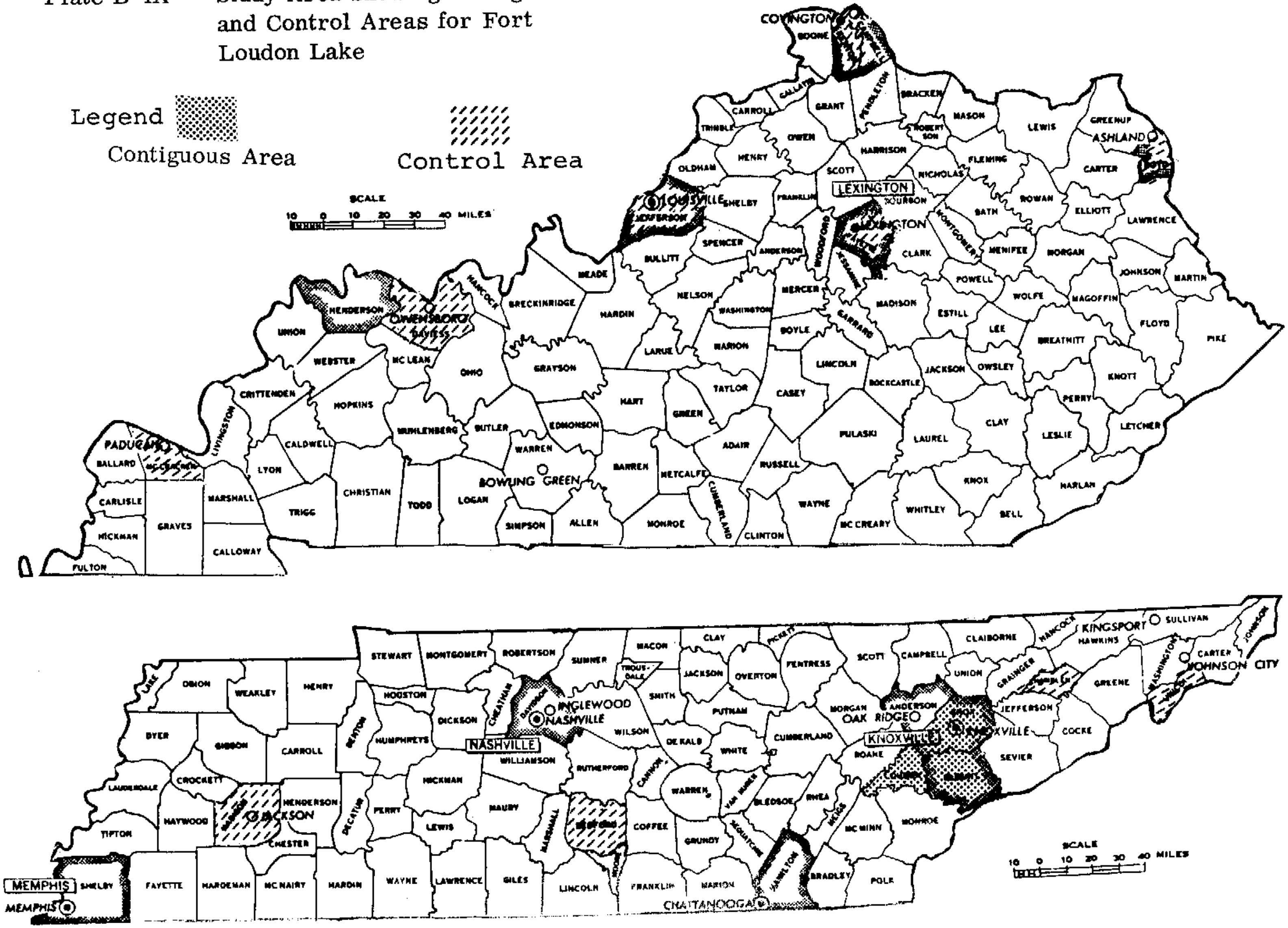


Plate B-X Study Area Showing Contiguous and Control Areas for Douglas Lake

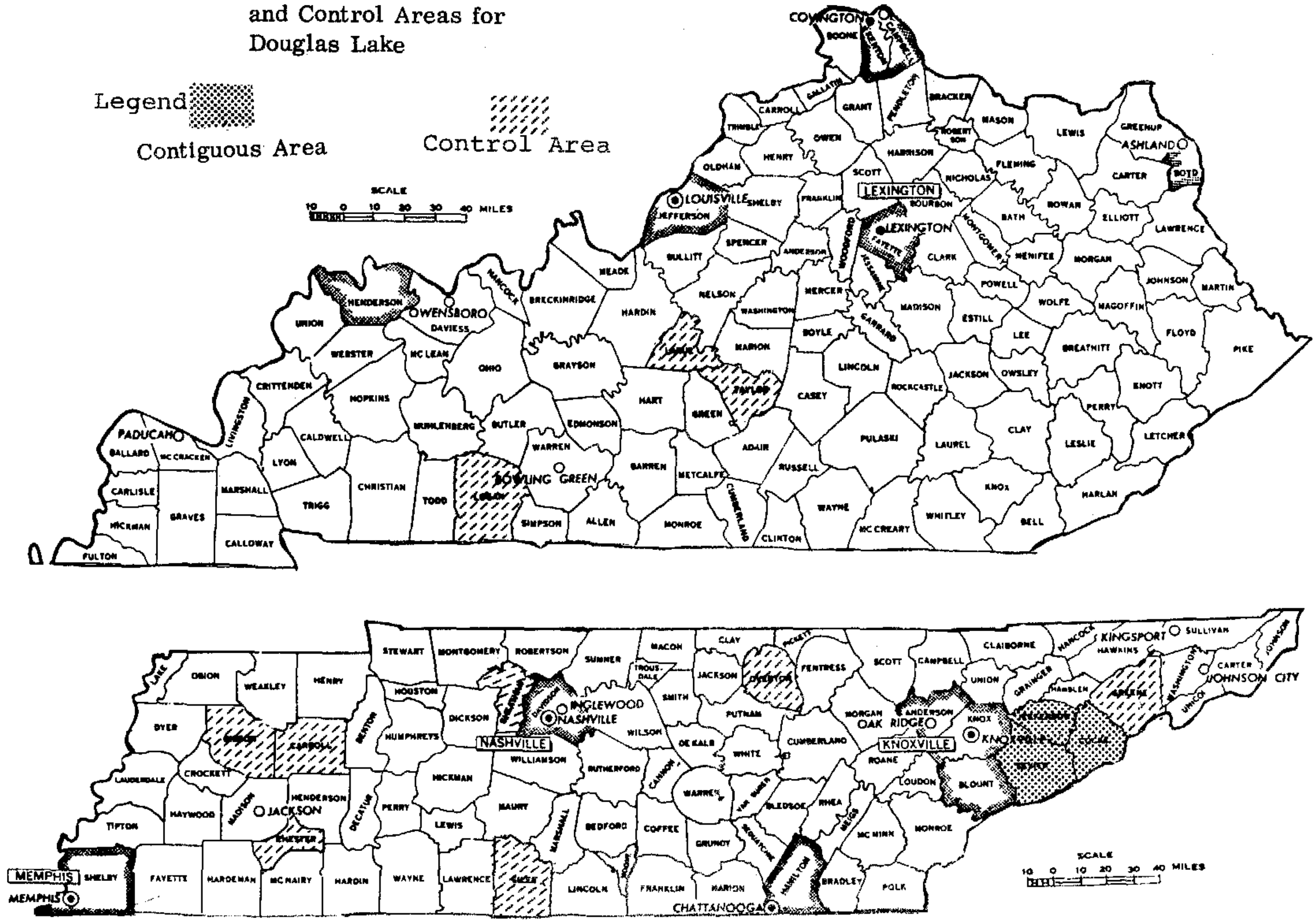


Plate B-XI   Study Area Showing Contiguous and Control Areas for Cherokee Lake

Legend

Contiguous Area

Control Area

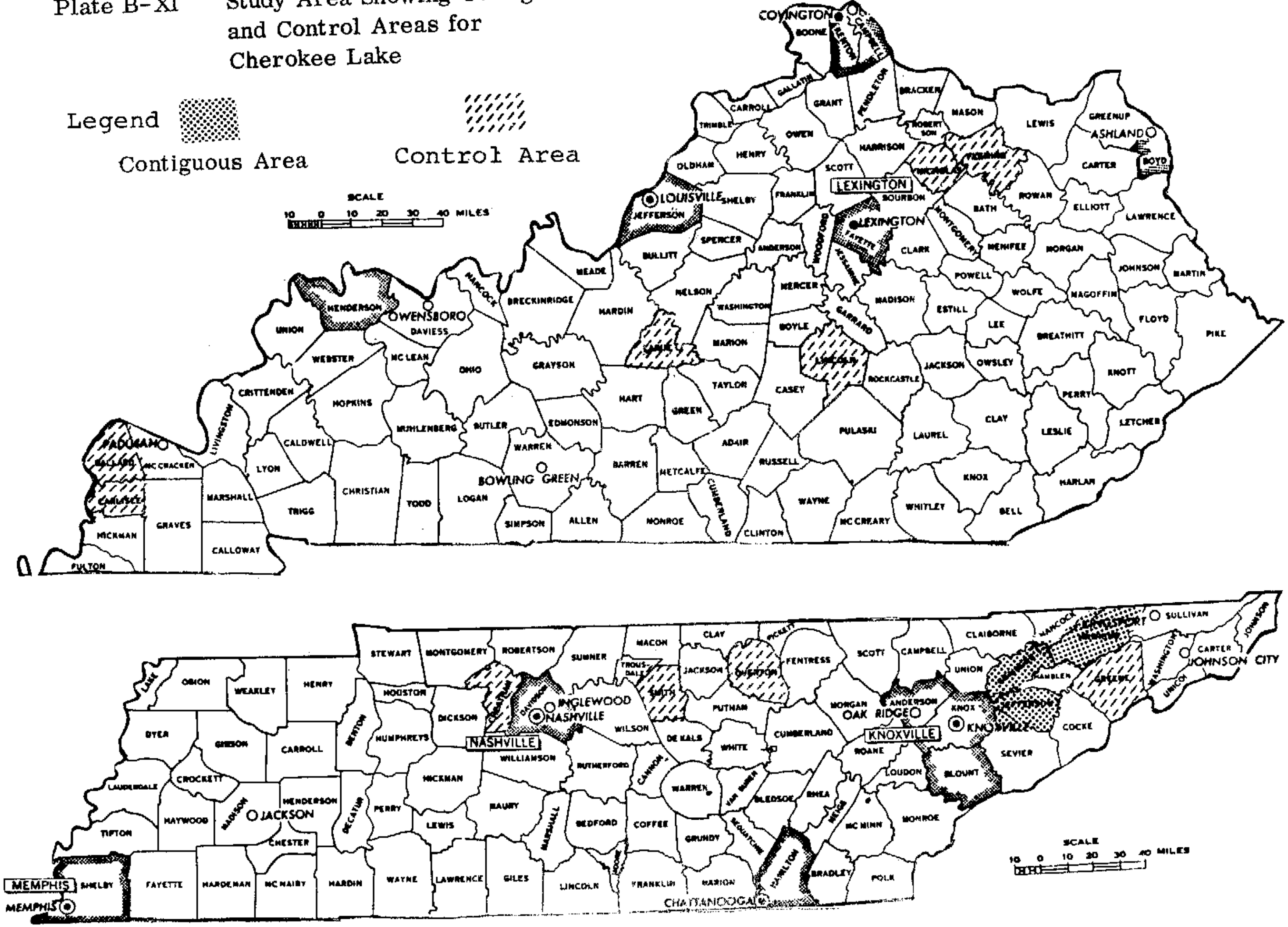


Plate B-XII Study Area Showing Contiguous and Control Areas for Boone Lake

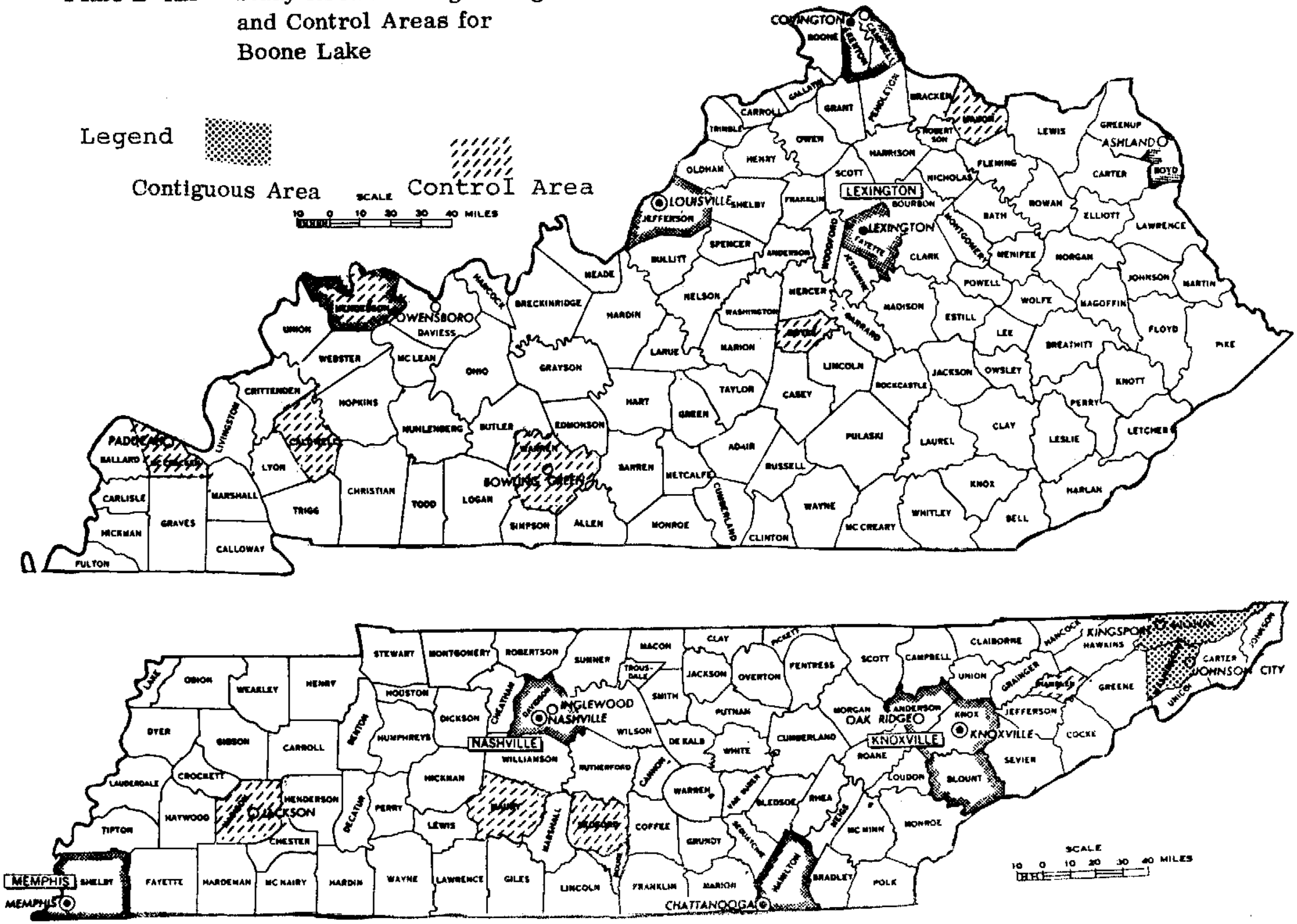


Plate B-XIII Study Area Showing Contiguous and Control Areas for South Holston Lake

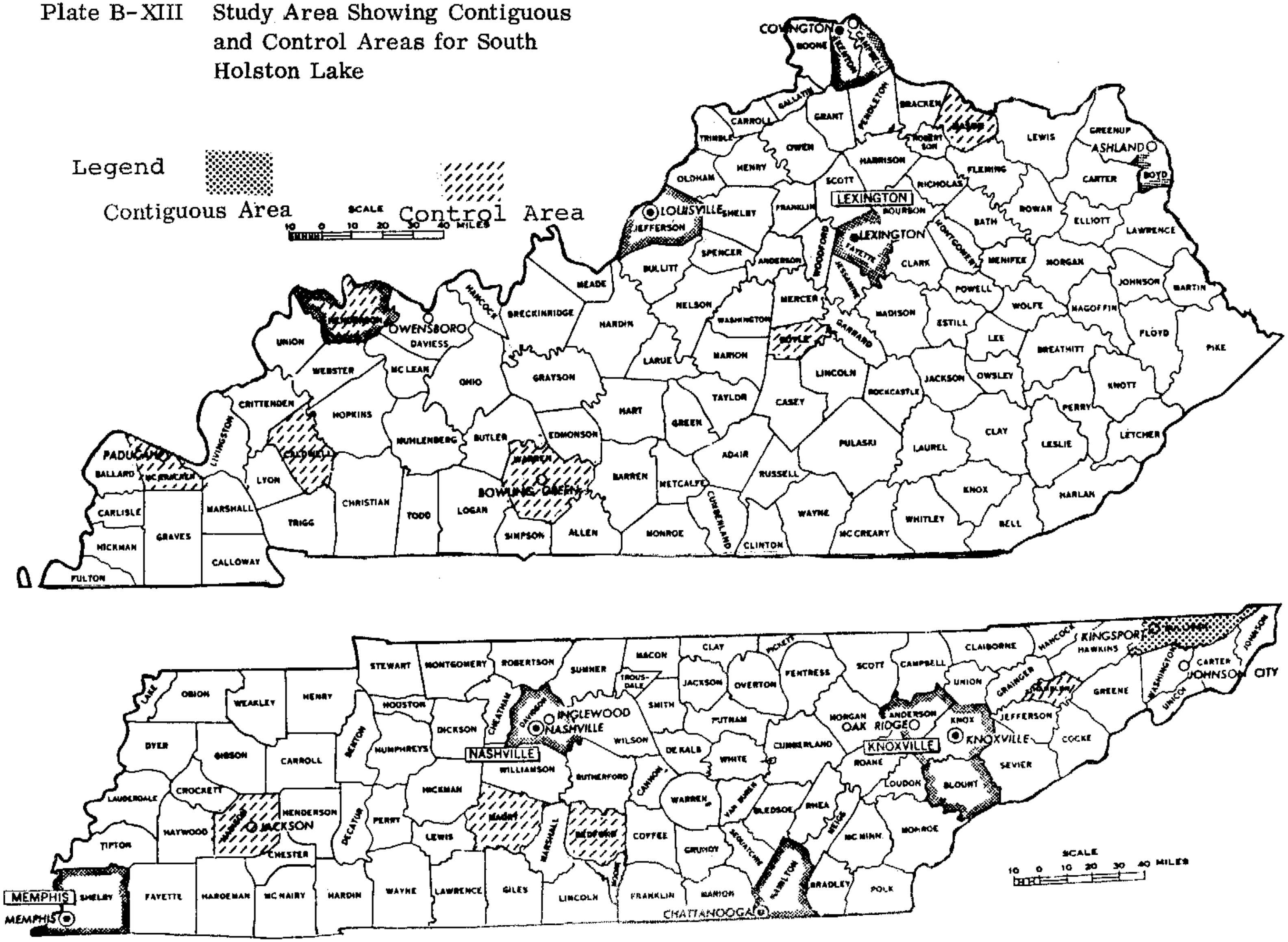


Plate B-XIV Study Area Showing Contiguous and Control Areas for Watauga Lake

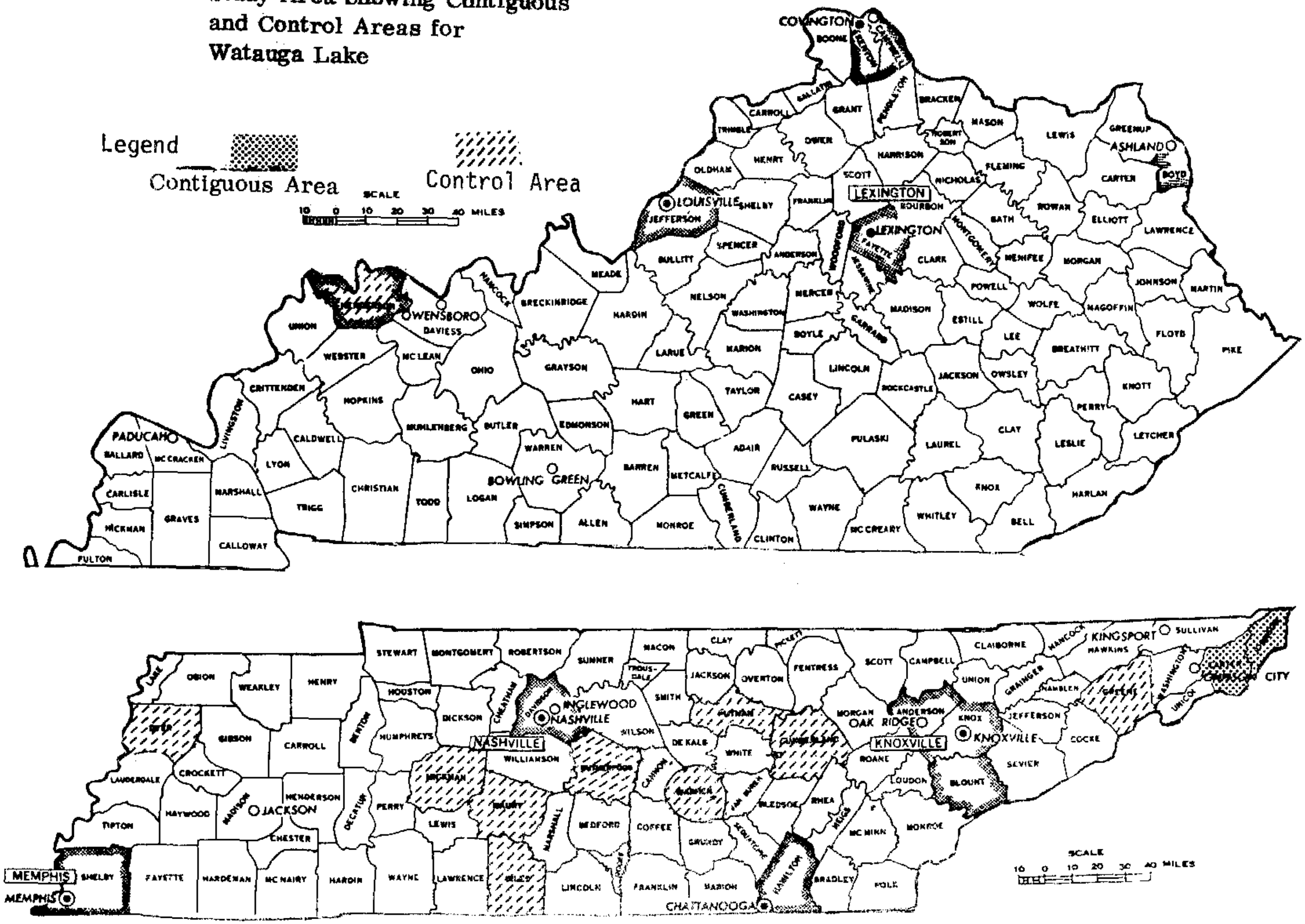


Plate B-XV Study Area Showing Contiguous and Control Areas for Norris Lake

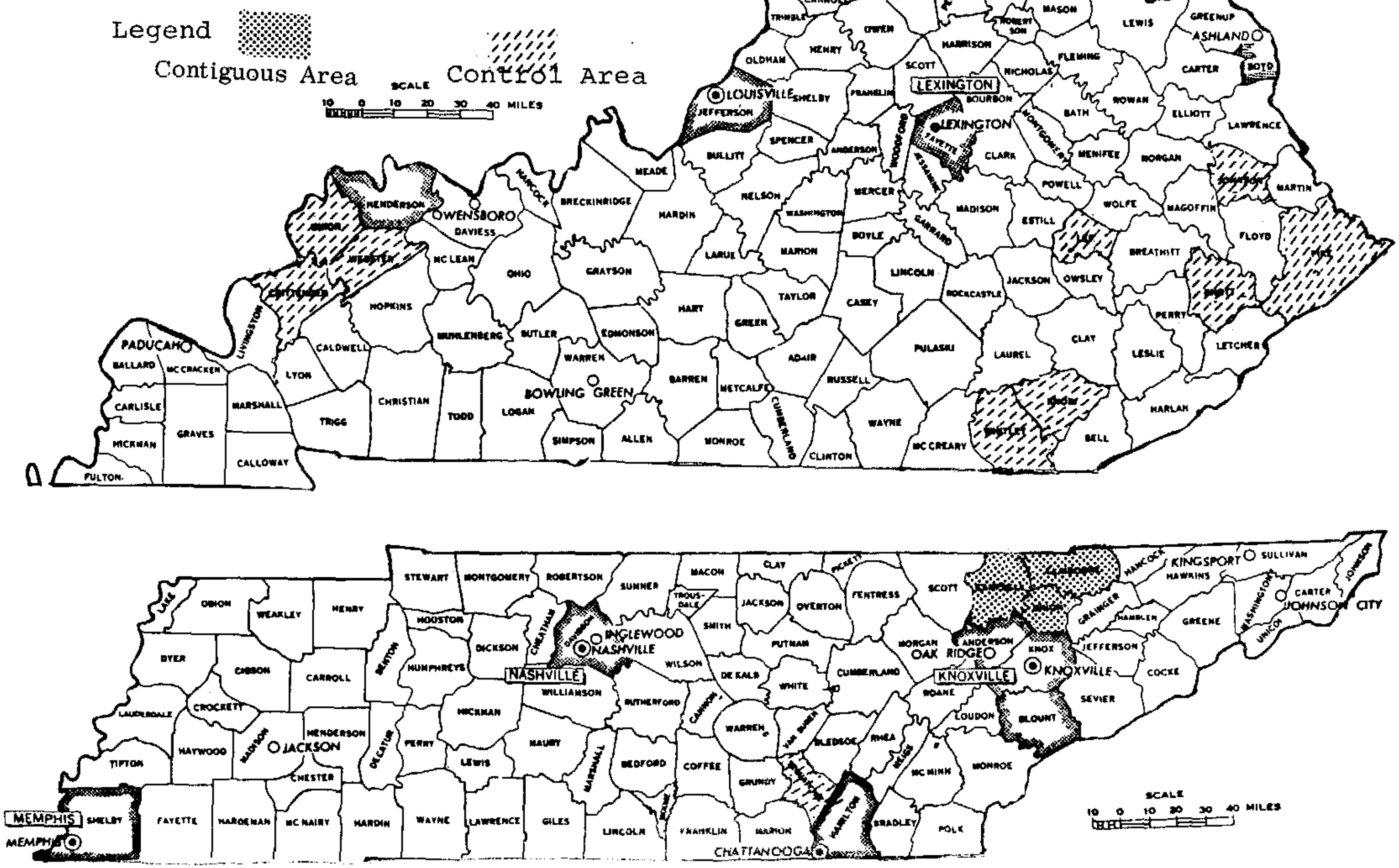


Plate B-XVI Study Area Showing Contiguous and Control Areas for Dewey Reservoir

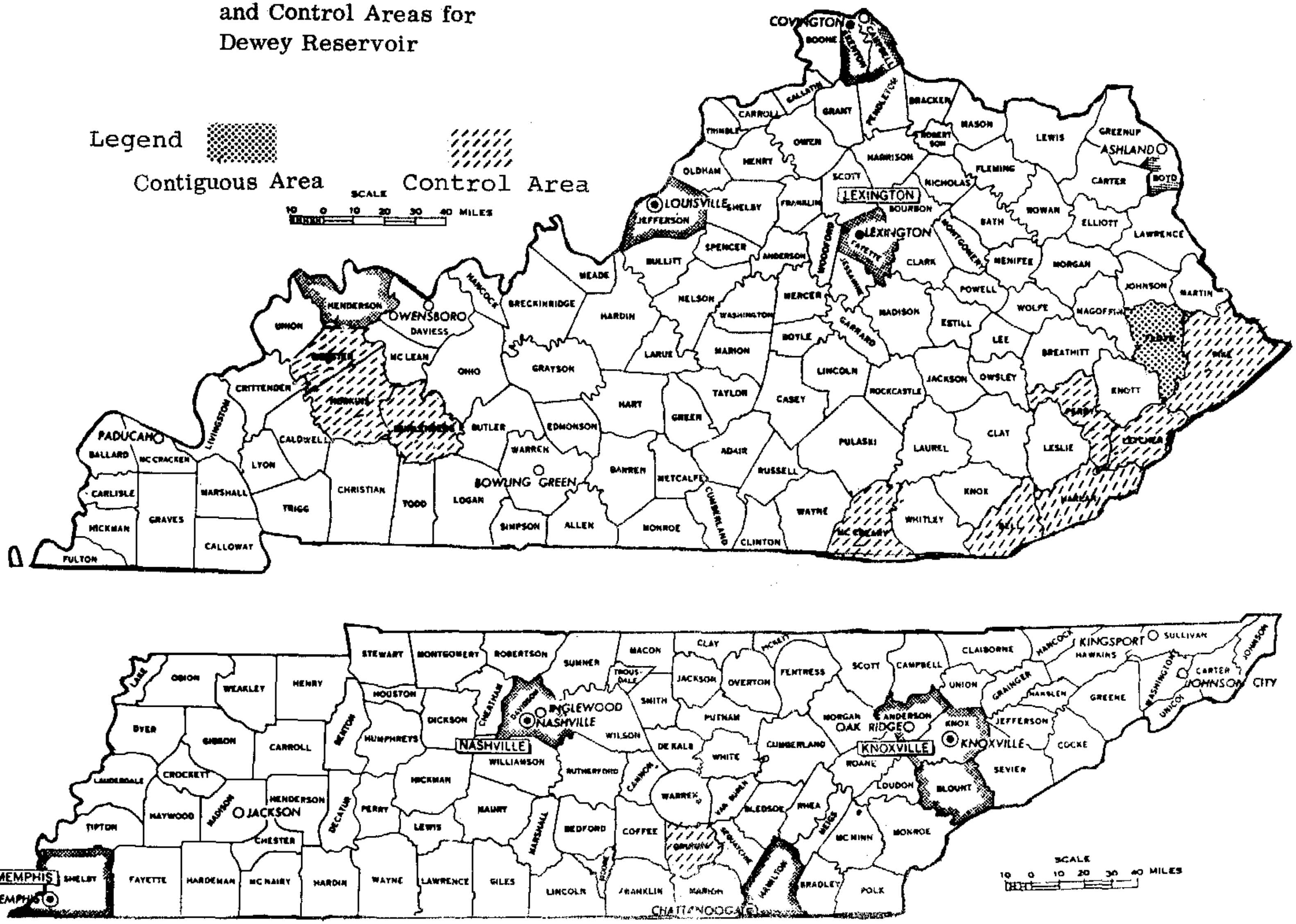


Plate B-XVII Study Area Showing Contiguous and Control Areas for Herrington Lake

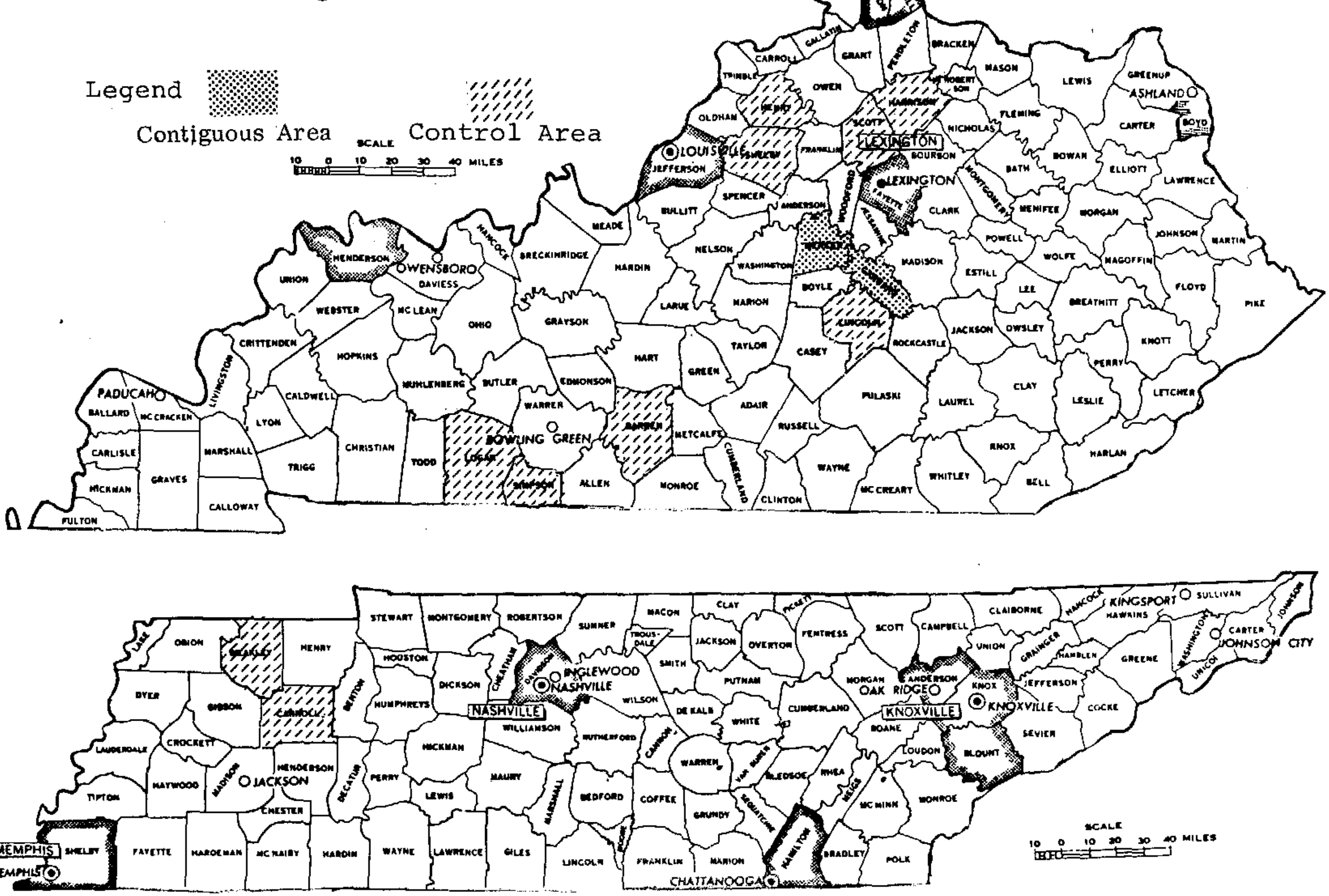


Plate B-XIII Study Area Showing Contiguous and Control Areas for Cumberland Lake

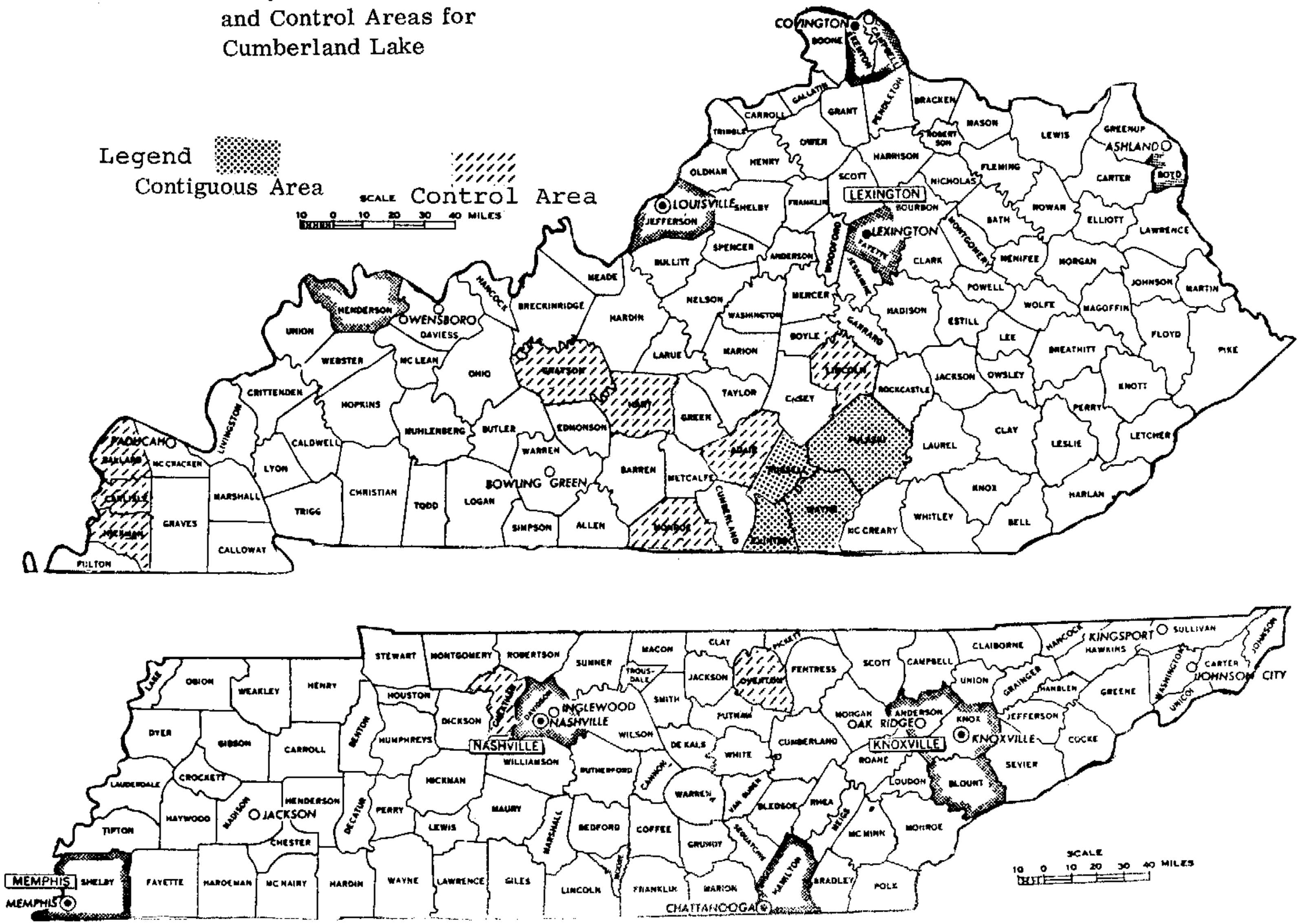


Plate B-XIX Study Area Showing Contiguous and Control Areas for Dale Hollow Lake

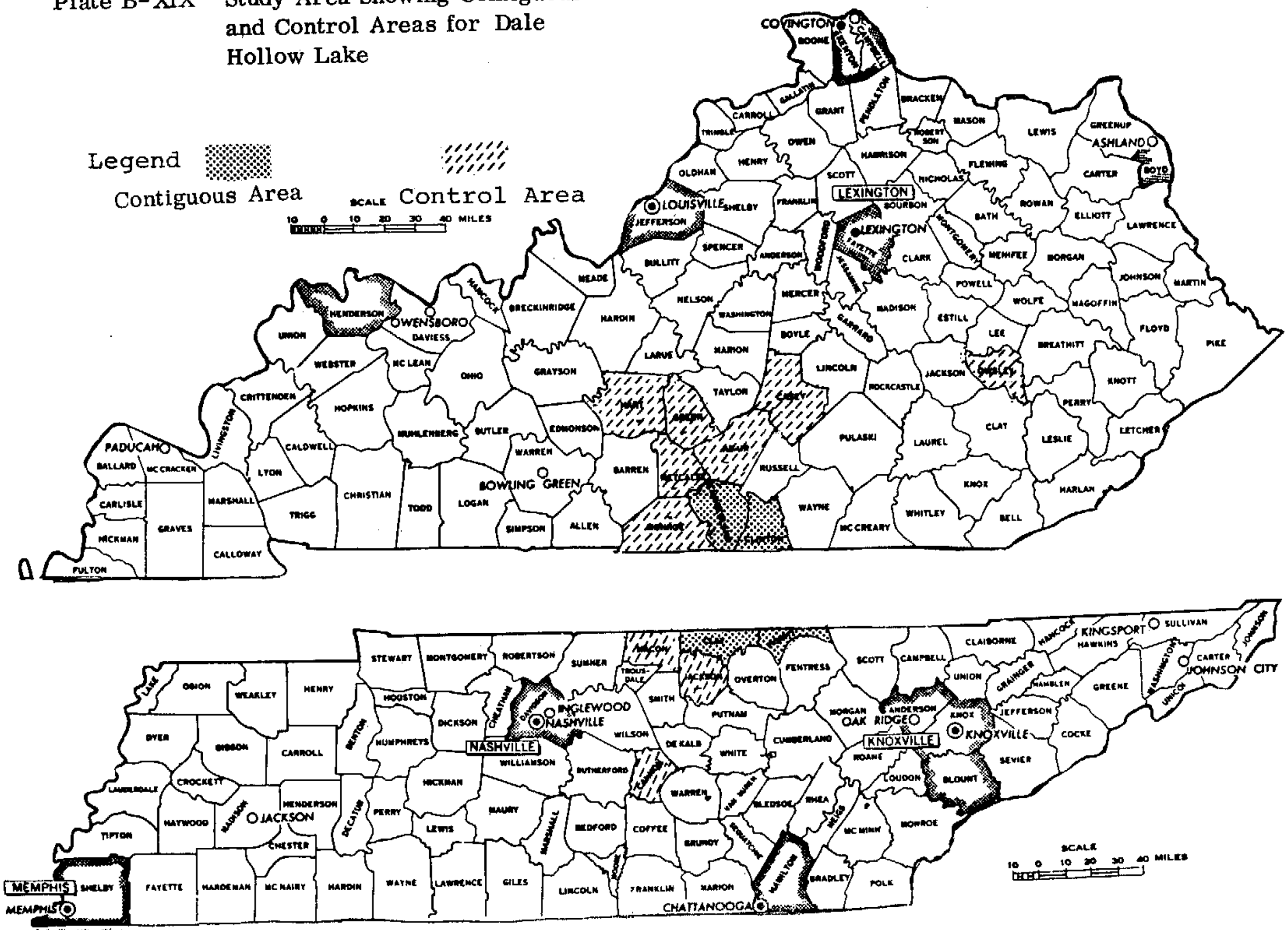
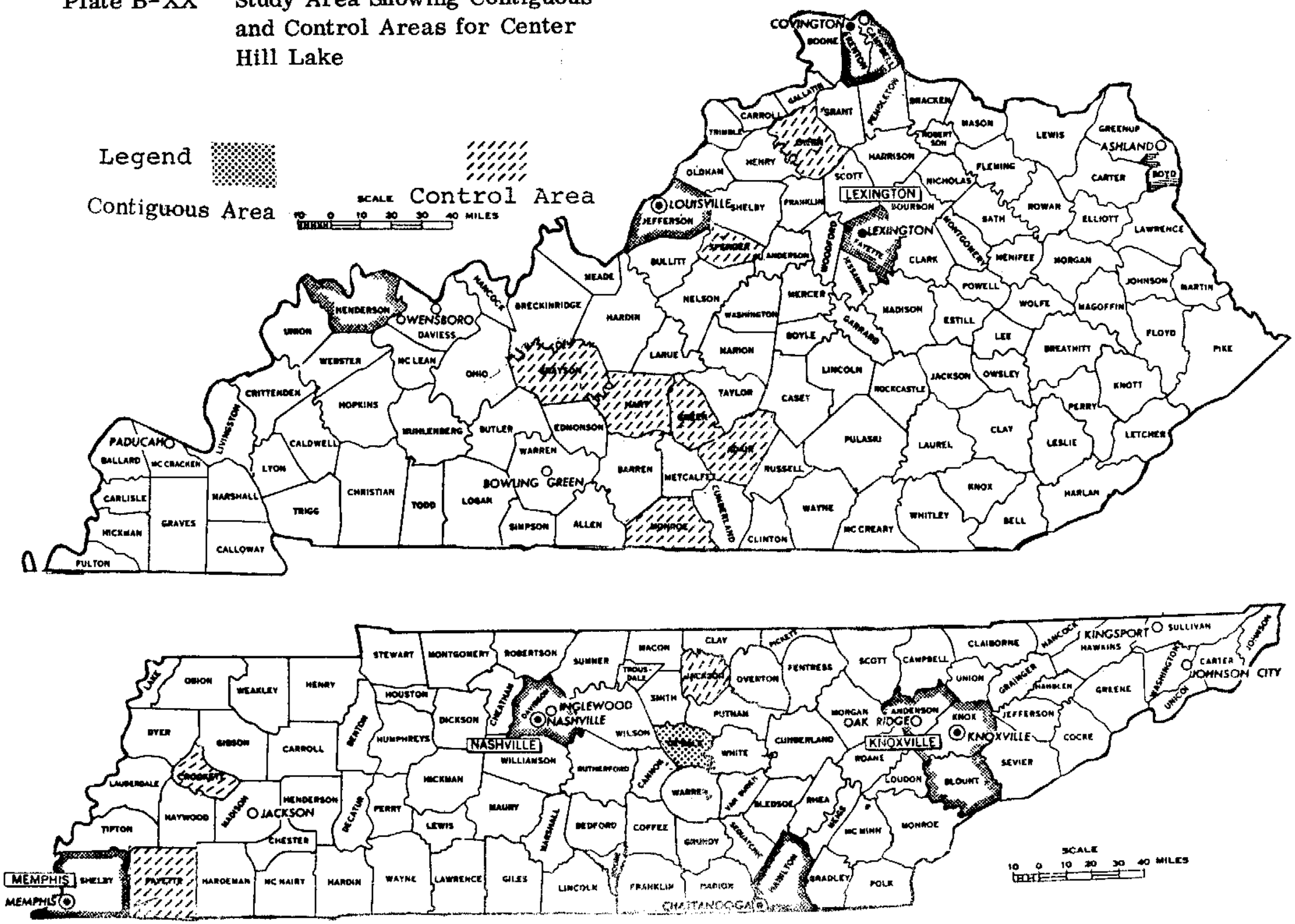


Plate B-XX Study Area Showing Contiguous and Control Areas for Center Hill Lake



APPENDIX C

DETAILED RESULTS WITH THE MODELS OF EQUATIONS 19 AND 20

TABLE C-1

EQUATION 19 AND BLOCK 1

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	13.66	2	6.83	78.48*
Time-Treatment Interaction	0.42	2	0.21	2.39
Treatment	1.75	1	1.75	20.11*
Residual	4.71	54	0.09	
Per Capita Income as the Dependent Variable				
Time	8,598,035	2	4,299,017	93.92*
Time-Treatment Interaction	30,709	2	15,354	0.34
Treatment	15,232	1	15,232	0.33
Residual	2,471,644	54	45,771	
County Population in Thousands as the Dependent Variable				
Time	22.09	2	11.05	0.31
Time-Treatment Interaction	6.37	2	3.18	0.09
Treatment	29.09	1	29.09	0.83
Residual	1898.28	54	35.15	

*Significant at $\alpha = 0.05$

TABLE C-2

EQUATION 19 AND BLOCK 2

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	6.71	2	3.35	76.22*
Time-Treatment Interaction	0.18	2	0.09	2.04
Treatment	0.17	1	0.17	3.93
Residual	1.47	33	0.04	
Per Capita Income as the Dependent Variable				
Time	6,719,310	2	3,359,655	69.48*
Time-Treatment Interaction	97,942	2	48,971	1.28
Treatment	742,241	1	742,241	15.35
Residual	1,595,629	33	48,352	
County Population in Thousands as the Dependent Variable				
Time	0.37	2	0.18	0.00
Time-Treatment Interaction	6.19	2	3.09	0.02
Treatment	112.75	1	112.75	0.83
Residual	4457.09	33	135.06	

*Significant at $\alpha = 0.05$

TABLE C-3

EQUATION 19 AND BLOCK 3

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	7.38	2	3.69	3.87*
Time-Treatment Interaction	0.74	2	0.37	0.38
Treatment	0.23	1	0.23	0.23
Residual	40.03	42	0.95	
Per Capita Income as the Dependent Variable				
Time	12,537,421	2	6,268,710	51.12*
Time-Treatment Interaction	124,623	2	62,311	0.51
Treatment	579,077	1	579,077	4.72*
Residual	5,149,456	42	122,606	
County Population in Thousands as the Dependent Variable				
Time	8,114.00	2	4,057.00	0.24
Time-Treatment Interaction	308.00	2	154.00	0.01
Treatment	1,546.00	1	1,546.00	0.09
Residual	716,340.00	42	17,055.00	

*Significant at $\alpha = 0.05$

TABLE C-4

EQUATION 19 AND BLOCK 4

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	7.31	2	3.65	19.53*
Time-Treatment Interaction	0.03	2	0.01	0.08
Treatment	0.90	1	0.90	4.79*
Residual	6.16	33	0.19	
Per Capita Income as the Dependent Variable				
Time	5,543,312	2	2,771,656	79.28*
Time-Treatment Interaction	58,187	2	29,093	0.83
Treatment	245,790	1	254,790	7.03*
Residual	1,153,761	33	34,962	
County Population in Thousands as the Dependent Variable				
Time	63.31	2	31.66	0.03
Time-Treatment Interaction	0.32	2	0.16	0.001
Treatment	214.10	1	214.10	2.16
Residual	3274.31	33	99.22	

*Significant at $\alpha = 0.05$

TABLE C-5

EQUATION 19 AND BLOCK 5

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	8.84	2	4.43	107.86*
Time-Treatment Interaction	0.05	2	0.02	0.54
Treatment	0.34	1	0.34	8.32*
Residual	1.37	33	0.04	
Per Capita Income as the Dependent Variable				
Time	4,510,868	2	2,255,434	102.48*
Time-Treatment Interaction	8,732	2	4,366	0.29
Treatment	38,977	1	38,977	1.77
Residual	726,269	33	22,008	
County Population in Thousands as the Dependent Variable				
Time	4.74	2	2.37	0.02
Time-Treatment Interaction	8.20	2	4.10	0.03
Treatment	0.09	1	0.09	0.001
Residual	4466.23	33	135.34	

*Significant at $\alpha = 0.05$

TABLE C-6

EQUATION 19 AND BLOCK 6

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	7.50	2	3.75	49.99*
Time-Treatment Interaction	0.01	2	0.004	0.05
Treatment	0.29	1	0.29	3.92
Residual	2.47	33	0.06	
Per Capita Income as the Dependent Variable				
Time	3,660,580	2	1,830,290	113.69*
Time-Treatment Interaction	1,119	2	559	0.03
Treatment	8,611	1	8,611	0.53
Residual	531,282	33	16,099	
County Population in Thousands as the Dependent Variable				
Time	6.83	2	3.42	0.04
Time-Treatment Interaction	7.92	2	3.96	0.04
Treatment	296.78	1	296.78	3.08
Residual	3182.05	33	96.43	

*Significant at $\alpha = 0.05$

TABLE C-7

EQUATION 19 AND BLOCK 7

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	2.72	2	1.38	10.54*
Time-Treatment Interaction	0.67	2	0.34	2.56
Treatment	1.84	1	1.84	14.06*
Residual	3.94	30	0.13	
Per Capita Income as the Dependent Variable				
Time	8,932,850	2	4,446,425	110.57*
Time-Treatment Interaction	31,843	2	15,921	0.39
Treatment	66,432	1	66,432	11.64
Residual	1,211,809	30	40,393	
County Population in Thousands as the Dependent Variable				
Time	477.29	2	238.64	0.87
Time-Treatment Interaction	498.40	2	249.30	0.91
Treatment	9446.81	1	9446.81	33.99*
Residual	8248.63	30	274.95	

*Significant at $\alpha = 0.05$

TABLE C-8

EQUATION 19 AND BLOCK 8

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	6.58	2	3.29	23.66*
Time-Treatment Interaction	0.20	2	0.10	0.07
Treatment	0.20	1	0.20	1.45
Residual	4.16	30	0.14	
Per Capita Income as the Dependent Variable				
Time	4,675,064	2	2,337,532	39.43*
Time-Treatment Interaction	173,232	2	86,616	1.47
Treatment	24,734	1	24,734	0.42
Residual	1,778,486	30	59,282	
County Population in Thousands as the Dependent Variable				
Time	71.89	2	35.95	0.25
Time-Treatment Interaction	38.81	2	19.90	0.14
Treatment	138.33	1	138.33	0.95
Residual	4380.93	30	146.03	

*Significant at $\alpha = 0.05$

TABLE C-9

EQUATION 19 AND BLOCK 9

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	4.73	2	2.36	25.98*
Time-Treatment Interaction	0.06	2	0.03	0.31
Treatment	0.86	1	0.86	9.47*
Residual	3.27	36	0.09	
Per Capita Income as the Dependent Variable				
Time	2,581,992	2	1,290,996	40.22*
Time-Treatment Interaction	6,943	2	3,471	0.11
Treatment	13,532	1	13,532	0.42
Residual	1,155,664	36	32,101	
County Population in Thousands as the Dependent Variable				
Time	121.76	2	60.88	0.19
Time-Treatment Interaction	0.43	2	0.23	0.01
Treatment	207.48	1	207.48	0.66
Residual	11,368.85	36	315.81	

*Significant at $\alpha = 0.05$

TABLE C-10

EQUATION 19 AND BLOCK 10

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	4.16	2	2.08	67.13*
Time-Treatment Interaction	0.01	2	0.01	0.19
Treatment	0.01	1	0.01	0.19
Residual	0.92	30	0.03	
Per Capita Income as the Dependent Variable				
Time	5,894,755	2	2,947,577	164.90*
Time-Treatment Interaction	13,965	2	6,982	0.39
Treatment	21,255	1	21,255	1.19
Residual	536,242	30	17,874	
County Population in Thousands as the Dependent Variable				
Time	11.51	2	5.76	0.16
Time-Treatment Interaction	0.13	2	0.06	0.001
Treatment	204.78	1	204.78	5.60*
Residual	1097.88	30	36.60	

*Significant at $\alpha = 0.05$

TABLE C-11

EQUATION 19 AND BLOCK 11

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	6.39	2	3.19	4.84*
Time-Treatment Interaction	0.12	2	0.06	0.88
Treatment	0.001	1	0.001	0.15
Residual	2.39	36	0.07	
Per Capita Income as the Dependent Variable				
Time	3,364,200	2	1,682,100	118.42*
Time-Treatment Interaction	20,172	2	10,086	0.71
Treatment	117,970	1	117,970	8.30*
Residual	511,411	36	14,205	
County Population in Thousands as the Dependent Variable				
Time	49.46	2	24.73	0.45
Time-Treatment Interaction	1.89	2	0.94	0.02
Treatment	313.50	1	313.50	5.71*
Residual	1975.76	36	54.88	

*Significant at $\alpha = 0.05$

TABLE C-12

EQUATION 19 AND BLOCK 12

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	2.70	2	1.35	90.00*
Time-Treatment Interaction	0.06	2	0.02	1.47
Treatment	0.02	1	0.02	1.13
Residual	0.55	36	0.02	
Per Capita Income as the Dependent Variable				
Time	2,921,189	2	1,460,594	82.24*
Time-Treatment Interaction	71,062	2	35,531	2.00
Treatment	109,998	1	109,998	6.19*
Residual	639,431	36	17,761	
County Population in Thousands as the Dependent Variable				
Time	65.60	2	32.80	3.27*
Time-Treatment Interaction	0.42	2	0.21	0.02
Treatment	150.62	1	150.62	15.00*
Residual	361.51	36	10.04	

*Significant at $\alpha = 0.05$

TABLE C-13

EQUATION 19 AND BLOCK 13

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
IED as the Dependent Variable				
Time	25.34	2	12.67	57.58*
Time-Treatment Interaction	0.16	2	0.08	0.36
Treatment	1.23	1	1.23	5.60*
Residual	35.56	162	0.22	
Per Capita Income as the Dependent Variable				
Time	17,880,422	2	8,940,211	126.91*
Time-Treatment Interaction	6,047	2	3.023	0.04
Treatment	22,544	2	22,544	0.32
Residual	11,411,889	162	70,443	
County Population in Thousands as the Dependent Variable				
Time	138.68	2	69.34	0.29
Time-Treatment Interaction	2.91	2	1.45	0.01
Treatment	19.67	1	19.67	0.08
Residual	38,940.98	162	240.38	

*Significant at $\alpha = 0.05$

TABLE C-14

EQUATION 20 AND BLOCK 1

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.40	1	0.40	6.32*
Residual	1.13	18	0.06	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	50,300	1	50,300	1.69
Residual	534,329	18	29,684	
Dependent Variable: Percent Change in Population				
Treatment	845.00	1	845.00	4.09
Residual	3,716.00	18	206.00	

*Significant at $\alpha = 0.05$

TABLE C-15

EQUATION 20 AND BLOCK 2

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.09	1	0.09	3.28
Residual	0.29	11	0.03	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	20,826	1	20,826	12.63*
Residual	18,127	11	1,647	
Dependent Variable: Percent Change in Population				
Treatment	12.56	1	12.56	0.10
Residual	1, 372.67	11	124.79	

*Significant at $\alpha = 0.05$

TABLE C-16

EQUATION 20 AND BLOCK 3

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.07	1	0.07	1.37
Residual	0.67	14	0.05	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	2,202	1	2,202	0.51
Residual	60.047	14	4,289	
Dependent Variable: Percent Change in Population				
Treatment	700.00	1	700.00	1.02
Residual	9,629.00	14	687.00	

*Significant at $\alpha = 0.05$

TABLE C-17

EQUATION 20 AND BLOCK 4

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.03	1	0.03	0.79
Residual	0.41	11	0.04	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	494	1	494	0.12
Residual	46,344	11	4,213	
Dependent Variable: Percent Change in Population				
Treatment	128.65	1	128.65	0.14
Residual	10,430.27	11	948.21	

*Significant at $\alpha = 0.05$

TABLE C-18

EQUATION 20 AND BLOCK 5

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.03	1	0.03	0.62
Residual	0.49	11	0.04	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	1,245	1	1,245	0.23
Residual	60,257	11	5,477	
Dependent Variable: Percent Change in Population				
Treatment	241.66	1	241.66	1.42
Residual	1,871.57	11	170.14	

*Significant at $\alpha = 0.05$

TABLE C-19

EQUATION 20 AND BLOCK 6

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.02	1	0.02	0.21
Residual	0.96	11	0.09	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	3,668	1	3,668	1.16
Residual	34,706	11	3,115	
Dependent Variable: Percent Change in Population				
Treatment	628.27	1	628.27	3.68
Residual	1,880.50	11	170.95	

*Significant at $\alpha = 0.05$

TABLE C-20

EQUATION 20 AND BLOCK 7

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.001	1	0.001	0.05
Residual	0.15	10	0.02	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	1,401	1	1,401	0.34
Residual	41,843	10	4,184	
Dependent Variable: Percent Change in Population				
Treatment	1,353.00	1	1,353.00	2.16
Residual	6,268.00	10	626.80	

*Significant at $\alpha = 0.05$

TABLE C-21

EQUATION 20 AND BLOCK 8

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.27	1	0.27	5.77*
Residual	0.47	10	0.05	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	103,667	1	103,667	13.68*
Residual	75,741	10	7,574	
Dependent Variable: Percent Change in Population				
Treatment	28,253.00	1	28,253.00	8.26*
Residual	34,214.00	10	3,421.00	

*Significant at $\alpha = 0.05$

TABLE C-22

EQUATION 20 AND BLOCK 9

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.08	1	0.08	2.10
Residual	0.46	12	0.04	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	1,757	1	1,757	0.27
Residual	77,567	12	6,469	
Dependent Variable: Percent Change in Population				
Treatment	1.40	1	1.40	0.01
Residual	2,225.60	12	188.05	

*Significant at $\alpha = 0.05$

TABLE C-23

EQUATION 20 AND BLOCK 10

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.02	1	0.02	0.33
Residual	0.52	10	0.05	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	881.67	1	881.67	0.36
Residual	24,718.00	10	2,471.90	
Dependent Variable: Percent Change in Population				
Treatment	13.07	1	13.07	0.15
Residual	849.60	10	84.96	

*Significant at $\alpha = 0.05$

TABLE C-24

EQUATION 20 AND BLOCK 11

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.06	1	0.06	0.67
Residual	1.08	12	0.09	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	12,276	1	12,276	6.79*
Residual	21,686	12	1,807	
Dependent Variable: Percent Change in Population				
Treatment	11.43	1	11.43	0.31
Residual	447.50	12	37.30	

*Significant at $\alpha = 0.05$

TABLE C-25

EQUATION 20 AND BLOCK 12

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.10	1	0.10	1.21
Residual	0.96	12	0.08	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	4,323	1	4,323	0.39
Residual	132,152	12	11,012	
Dependent Variable: Percent Change in Population				
Treatment	68.60	1	68.60	0.68
Residual	1,205.40	12	100.45	

*Significant at $\alpha = 0.05$

TABLE C-26

EQUATION 20 AND BLOCK 13

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F Ratio
Dependent Variable: Index of Intraregional Change				
Treatment	0.44	1	0.44	5.80*
Residual	4.09	54	0.08	
Dependent Variable: Percent Change in Per Capita Income				
Treatment	33.30	1	33.30	0.01
Residual	375,693.96	54	6,957.29	
Dependent Variable: Percent Change in Population				
Treatment	48.64	1	48.64	0.05
Residual	48,384.20	54	896.00	

*Significant at $\alpha = 0.05$

APPENDIX D

NORMALIZING TRANSFORMATIONS ON THE IED AND IIC INDICES

Both the multiple regression and covariance statistical models are based on the assumption that errors in estimating the dependent variable are normally distributed.[1] In many cases, the stochastic error term, ϵ_i, represents the summation of independent errors arising from a number of sources. The central limit theorm supports the assumption that errors that arise in this manner tend to be normally distributed.[2] However, the values of the IED and IIC indices are not linear transformations of the number of employees in a given employment category in a given county. Under these conditions, even if the error in estimating the number of employees observed in each employment category is approximately normally distributed, the IED and IIC indices may not follow a normal distribution; thus, the shape of the distribution of these indices should be investigated.

The method by which the distributions are investigated is simulation. By building a model which randomly samples n workers each from two populations with P_{11}, P_{12}, . . . , P_{1k} proportion of the employment in the 1, 2, . . . , k^{th} employment category in the first population, and P_{21}, P_{22}, ..., P_{2k} proportion of the employment in the 1, 2, ..., k^{th} employment category in the second population, one can simulate the distribution of the IIC. By randomly sampling from one population with known proportions of total employment in the 1, 2, ..., k^{th} category, the distribution of the IED can be simulated. After the distributions for the IIC and IED indices have been simulated, they can be compared to the normal distribution by testing the

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[1]See Franklin A. Graybill, An Introduction to Linear Statistical Models, (New York: McGraw-Hill Book Company, Inc., 1961), pp. 106-110.

[2]B. W. Lindgren, Statistical Theory (New York: The MacMillan Company, 1969), pp. 143-144.

null hypothesis that the sampling distribution is normal using a standard chi-square goodness of fit procedure.[3]

If the distribution of the IIC and IED indices as the number of employees by employment categoty are varied over a normal distribution is approximately normal, there is no problem in using the IIC and IED indices as dependent variables in regression models. However, if the distributions are non-normal, then the indices must be subjected to normalizing transformation before they are used as dependent variables.

THE SIMULATION MODEL

The simulation model contains four distinct phases: 1) the simulation of N pseudo random samples from a population or pairs of populations with specified employment proportions, 2) the calculation of the IIC and IED indices for each of the N pseudo random samples, 3) the grouping of the N values of the indices into a frequently distribution, and 4) the comparison of these generated frequency distributions to the normal frequency distribution by use of the chi-square goodness of fit test. A program for this procedure was written in FORTRAN V for execution on the UNIVAC 1108 computer. The computer model can best be understood by considering each of the phases of the simulation model in detail.

The pseudo random sampling is from a multinominal population with fraction P_1 of the total work force in each of k employment categories. One restriction is that the $\sum_{i=1}^{k} P_i = 1$, or all workers must fall into one and only one employment category. If the population is of this nature, X_i, the number of workers in the i^{th} employment category observed in a random sample of n workers taken from the population, follows the multinomial distribution subject to the restriction that $\sum_{i=1}^{k} X_i = n$. If the sample size is large enough

[3]Richard L. Anderson and T. A. Bancroft, Statistical Theory in Research (New York: McGraw-Hill Book Company, 1952), pp. 131-135.

for the expected value of X_i to exceed 5 for all k employment categories, the distribution of an X_i from sample to sample will be approximately normal with mean equal to $n P_i$ and variance equal to $n P_i (1-P_i)$.[4]

The generation of a pseudo random sample is accomplished by choosing P_i and a sample size, n. The expected values and variances of the X_i are computed for all k employment categories. A pseudo number generation is used to generate X_i which represent the appropriate normal distribution. These values are adjusted to make sure that $\sum_{i=1}^{k} X_i = n$. This procedure is repeated N times to produce N pseudo random samples of n workers, each with X_i workers in the ith of k employment categories.

By simulating N pairs of pseudo random samples, one can compute N values of the IIC whose distribution approximates the distribution of the IIC. Likewise, from N pseudo random samples, one can compute N values of the IED whose distribution approximates the sampling distribution of the IED. Given the N pseudo random samples of size, n, computation of the N values of the IIC and IED and the grouping of these values into a twenty class frequency distributions is straightforward.

The final phase of the simulation is to compare the generated frequency distributions to the normal frequency distribution by the chi square goodness of fit test procedure. The chi square statistic for this test is computed from

$$X^2 = \sum_{h=1}^{c} \frac{(O_h - e_h)^2}{e_h} \qquad (1)$$

Where

O_h	=	the observed frequency in the h^{th} class
e_h	=	the frequency expected in the h^{th} class if the distribution is normal
c	=	the number of classes in the frequency distribution

[4]Lindgren, Statistical Theory, pp. 181-183.

If the null hypothesis, the distribution is normal, is true, this statistic will follow the chi square distribution with c-3 degrees of freedom. This chi square test procedure is available as a subroutine in the MATH-STAT Library on the UNIVAC 1108.[5]

By changing the parameters of (Pi) of the population and repeating this process of sampling and testing for normality, the distribution of the random variation of the IIC and IED indices as the expected value of the indices varies over their range from 0 to 1.

RESULTS OF THE COMPUTER SIMULATION

The results of computer simulations of the distributions of the IIC and IED indices for nine different populations characterized by their Pi are shown in columns three and five of Tables D-1 through D-9. From these tables, the tendency of the IIC and IED indices to be approximately normal when the mean of the index is near 0.50 and to become highly skewed as the mean of the index approaches zero or one becomes apparent.

TRANSFORMATION TO ACHIEVE NORMALITY

The tendency of the IIC and IED indices to be normally distributed when their values are near the middle of the range of possible values and to become skewed as their values approach the limits of the range of possible values is quite similar to the sampling behavior of the coefficient of correlation in the regression model. R. A. Fisher proposes the transformation,

$$Z = \frac{1}{2} \ln \left(\frac{1 + R}{1 - R}\right) \qquad (2)$$

to produce Z as a normally distributed transformation of the coefficient of correlation.[6] Perhaps Fisher's transformation applied to the IIC and IED will produce normally distributed variables.

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[5] UNIVAC 1108 STAT-PACK Programmers Reference. (New York: Sperry Rand Corporation, 1967), pp. 5-17-5-22.

[6] R. A. Fisher, "The General Sampling Distribution of the Multiple Correlation Coefficient," Proceedings of the Royal Society of London, Ser. A, Vol. CXXI (1928), pp. 654-673.

TABLE D-1

FIRST INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics				
	P_1	P_2	P_3	P_4	P_5
Population One	0.01	0.01	0.01	0.01	0.96
Population Two	0.20	0.20	0.20	0.20	0.20

Value Range[a]	Distribution of Simulated Indices				
		IIC Between Populations		IED Population One	
	Normal	Simulated	Transformed	Simulated	Transformed
<-1.80	26	30	27	30	28
-1.80 to -1.60	37	35	32	30	44
-1.60 to -1.40	51	56	50	48	56
-1.40 to -1.20	68	63	55	45	60
-1.20 to -1.00	87	96	84	52	78
-1.00 to -0.80	106	100	83	95	96
-0.80 to -0.60	124	128	121	99	121
-0.60 to -0.40	140	159	148	117	141
-0.40 to -0.20	152	144	154	150	176
-0.20 to 0.00	158	155	155	182	177
0.00 to 0.20	158	138	137	181	156
0.20 to 0.40	152	167	172	164	131
0.40 to 0.60	140	111	134	148	122
0.60 to 0.80	124	124	132	143	124
0.80 to 1.00	106	109	117	140	109
1.00 to 1.20	87	93	104	122	99
1.20 to 1.40	68	78	84	77	80
1.40 to 1.60	51	60	57	46	57
1.60 to 1.80	37	47	39	29	36
> 1.80	26	20	24	11	17
	Mean[c]	0.3074	-0.4132	0.0969	-1.1290
	Chi Square	23.70	24.32	82.32[b]	23.88

[a]Range of simulated value minus mean of n values divided by the standard deviation of the n values.

[b]Chi square value exceeds the critical value at the 5 percent level of significance of

[c]Mean of actual values before adjustment to place in tabulated ranges.

TABLE D-2

SECOND INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics				
	P_1	P_2	P_3	P_4	P_5
Population One	0.10	0.10	0.10	0.10	0.10
Population Two	0.20	0.20	0.20	0.20	0.20

Value Range	Normal	Distribution of Simulated Indices: IIC Between Populations Simulated	IIC Between Populations Transformed	IED Population One Simulated	IED Population One Transformed
< -1.80	26	26	25	21	17
-1.80 to -1.60	37	42	42	48	38
-1.60 to -1.40	51	58	58	45	58
-1.40 to -1.20	68	67	65	74	72
-1.20 to -1.00	87	106	101	60	72
-1.00 to -0.80	106	108	113	106	115
-0.80 to -0.60	124	129	125	120	127
-0.60 to -0.40	140	122	115	118	134
-0.40 to -0.20	152	143	145	147	146
-0.20 to 0.00	158	157	158	160	163
0.00 to 0.20	158	165	168	150	157
0.20 to 0.40	152	137	140	173	153
0.40 to 0.60	140	143	142	150	155
0.60 to 0.80	124	133	132	153	138
0.80 to 1.00	106	102	104	105	95
1.00 to 1.20	87	100	99	88	82
1.20 to 1.40	68	74	69	68	59
1.40 to 1.60	51	51	51	58	53
1.60 to 1.80	37	37	35	32	53
> 1.80	26	23	24	26	26
	Mean	0.4983	-0.0033	0.7482	0.5485
	Chi Square	17.66	13.41	30.08*	14.74

*See Table D-1 for footnotes.

TABLE D-3

THIRD INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics P_1	P_2	P_3	P_4	P_5
Population One	0.01	0.01	0.20	0.20	0.58
Population Two	0.20	0.20	0.20	0.20	0.20

Value Range	Normal	Distribution of Simulated Indices: IIC Between Populations Simulated	IIC Between Populations Transformed	IED Population One Simulated	IED Population One Transformed
< - 1.80	26	36	33	28	28
-1.80 to -1.60	37	42	42	39	30
-1.60 to -1.40	51	56	54	45	53
-1.40 to -1.20	68	52	51	53	58
-1.20 to -1.00	87	83	80	76	77
-1.00 to -0.80	106	95	98	94	99
-0.80 to -0.60	124	141	137	128	135
-0.60 to -0.40	140	125	128	125	133
-0.40 to -0.20	152	163	161	146	145
-0.20 to -0.00	158	165	168	157	156
0.00 to 0.20	158	154	156	172	171
0.20 to 0.40	152	149	148	158	162
0.40 to 0.60	140	141	143	151	139
0.60 to 0.80	124	114	114	140	132
0.80 to 1.00	106	121	120	117	111
1.00 to 1.20	87	78	80	96	89
1.20 to 1.40	68	94	95	77	83
1.40 to 1.60	51	43	38	41	40
1.60 to 1.80	37	25	25	35	30
> 1.80	26	28	28	27	24
	Mean	0.4861	-.0280	0.7268	0.4911
	Chi Square	34.41*	33.20*	18.78	16.00

*See Table D-1 for footnotes.

TABLE D-4

FOURTH INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics				
	P_1	P_2	P_3	P_4	P_5
Population One	0.20	0.20	0.20	0.20	0.20
Population Two	0.20	0.20	0.20	0.20	0.20

Value Range	Distribution of Simulated Indices				
		IIC Between Populations		IED Population One	
	Normal	Simulated	Transformed	Simulated	Transformed
< -1.80	26	25	26	14	21
-1.80 to -1.60	37	30	36	25	42
-1.60 to -1.40	51	43	48	29	59
-1.40 to -1.20	68	51	69	41	83
-1.20 to -1.00	87	61	90	42	103
-1.00 to -0.80	106	88	125	63	114
-0.80 to -0.60	124	92	125	65	116
-0.60 to -0.40	140	102	141	82	144
-0.40 to -0.20	152	124	170	92	167
-0.20 to 0.00	158	159	183	134	149
0.00 to 0.20	158	182	167	181	158
0.20 to 0.40	152	184	146	218	148
0.40 to 0.60	140	180	151	289	134
0.60 to 0.80	124	174	106	337	126
0.80 to 1.00	106	128	78	253	98
1.00 to 1.20	87	117	70	01	79
1.20 to 1.40	68	81	63	0	52
1.40 to 1.60	51	55	41	0	62
1.60 to 1.80	37	23	33	0	31
> 1.80	26	8	22	0	25
	Mean	0.9087	1.1201	0.9968	3.078
	Chi Square	118.87*	28.15*	1142.18 *	21.25

*See Table D-1 for footnotes.

TABLE D-5

FIFTH INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics				
	P_1	P_2	P_3	P_4	P_5
Population One	0.90	0.02	0.02	0.02	0.04
Population Two	0.20	0.20	0.20	0.20	0.20

Value Range	Normal	Distribution of Simulated Indices: IIC Between Populations Simulated	IIC Between Populations Transformed	IED Population One Simulated	IED Population One Transformed
< -1.80	26	32	28	29	38
-1.80 to -1.60	37	25	32	35	33
-1.60 to -1.40	51	62	60	57	60
-1.40 to -1.20	68	64	68	50	58
-1.20 to -1.00	87	77	80	79	86
-1.00 to -0.80	106	88	91	86	99
-0.80 to -0.60	124	102	108	99	107
-0.60 to -0.40	140	130	138	131	130
-0.40 to -0.20	152	177	179	155	166
-0.20 to 0.00	158	161	150	179	173
0.00 to 0.20	158	160	165	150	146
0.20 to 0.40	152	143	139	128	122
0.40 to 0.60	140	142	138	146	148
0.60 to 0.80	124	110	106	165	147
0.80 to 1.00	106	121	113	109	98
1.00 to 1.20	87	105	103	89	90
1.20 to 1.40	68	82	78	83	65
1.40 to 1.60	51	59	63	58	58
1.60 to 1.80	37	35	33	43	51
> 1.80	26	27	25	28	24
	Mean	0.3282	-0.3594	0.2328	-0.5997
	Chi Square	33.17*	24.63	42.44*	34.07*

*See Table D-1 for footnotes.

TABLE D-6

SIXTH INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics P_1	P_2	P_3	P_4	P_5
Population One	0.01	0.01	0.01	0.01	0.96
Population Two	0.24	0.24	0.24	0.24	0.04

Value Range	Normal	Distribution of Simulated Indices: IIC Between Populations, Simulated	IIC Between Populations, Transformed	IED Population One, Simulated	IED Population One, Transformed
< -1.80	26	0	29	16	27
-1.80 to -1.60	37	0	32	21	23
-1.60 to -1.40	51	2	44	37	44
-1.40 to -1.20	68	243	71	55	66
-1.20 to -1.00	87	162	82	73	98
-1.00 to -0.80	106	124	121	96	105
-0.80 to -0.60	124	125	122	107	137
-0.60 to -0.40	140	138	151	130	138
-0.40 to -0.20	152	151	160	129	138
-0.20 to 0.00	158	146	158	162	159
0.00 to 0.20	158	142	153	172	156
0.20 to 0.40	152	105	161	148	132
0.40 to 0.60	140	106	132	172	145
0.60 to 0.80	124	92	127	160	130
0.80 to 1.00	106	99	104	141	124
1.00 to 1.20	87	82	90	111	82
1.20 to 1.40	68	63	69	68	77
1.40 to 1.60	51	59	49	44	46
1.60 to 1.80	37	46	30	33	30
> 1.80	26	28	23	16	22
	Mean	0.0712	-1.4236	0.0980	-1.1223
	Chi Square	666.50*	32.14*	69.44*	20.53

*See Table D-1 for footnotes.

TABLE D-7

SEVENTH INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics				
	P_1	P_2	P_3	P_4	P_5
Population One	0.25	0.25	0.15	0.15	0.20
Population Two	0.15	0.15	0.25	0.30	0.15

Value Range	Normal	Distribution of Simulated Indices: IIC Between Populations		IED Population One	
		Simulated	Transformed	Simulated	Transformed
< -1.80	26	29	23	22	18
-1.80 to -1.60	37	21	28	30	29
-1.60 to -1.40	51	47	42	44	48
-1.40 to -1.20	68	65	63	54	71
-1.20 to -1.00	87	86	86	62	80
-1.00 to -0.80	106	100	95	84	106
-0.80 to -0.60	124	134	129	97	126
-0.60 to -0.40	140	118	123	121	139
-0.40 to -0.20	152	138	129	167	180
-0.20 to 0.00	158	184	179	168	157
0.00 to 0.20	158	150	160	155	168
0.20 to 0.40	152	177	173	183	153
0.40 to 0.60	140	154	162	174	146
0.60 to 0.80	124	115	116	150	119
0.80 ro 1.00	106	98	102	129	101
1.00 to 1.20	87	95	98	93	69
1.20 to 1.40	68	67	72	73	68
1.40 to 1.60	51	52	52	59	43
1.60 to 1.80	37	33	30	26	33
> 1.80	26	19	23	13	35
	Mean	0.6028	0.2099	0.9723	1.7938
	Chi Square	28.15*	24.55	64.99*	20.13

*See Table D-1 for footnotes.

TABLE D-8

EIGHTH INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics				
	P_1	P_2	P_3	P_4	P_5
Population One	0.24	0.24	0.24	0.24	0.04
Population Two	0.96	0.01	0.01	0.01	0.01

Value Range	Normal	Distribution of Simulated Indices: IIC Between Populations Simulated	IIC Between Populations Transformed	IED Population One Simulated	IED Population One Transformed
< -1.80	26	15	17	0	16
-1.80 to -1.60	37	45	42	7	43
-1.60 to -1.40	51	54	55	103	54
-1.40 to -1.20	68	73	69	281	71
-1.20 to -1.00	87	78	71	60	78
-1.00 to -0.80	106	107	112	98	109
-0.80 to -0.60	124	127	122	99	122
-0.60 to -0.40	140	139	134	108	135
-0.40 to -0.20	152	139	139	94	132
-0.20 to 0.00	158	140	140	105	140
0.00 to 0.20	158	162	162	126	158
0.20 to 0.40	152	158	160	121	162
0.40 to 0.60	140	148	150	141	153
0.60 to 0.80	124	136	141	157	137
0.80 to 1.00	106	96	98	128	99
1.00 to 1.20	87	86	92	90	93
1.20 to 1.40	68	72	71	92	91
1.40 to 1.60	51	53	57	72	64
1.60 to 1.80	37	39	36	46	42
> 1.80	26	25	24	22	21
	Mean	0.3414	-0.3295	0.9580	1.6089
	Chi Square	14.48	16.39	877.97*	18.48

*See Table D-1 for footnotes.

TABLE D-9

NINTH INVESTIGATION OF NORMALITY OF IIC AND IED INDICES BY SIMULATION

Employment Fractions	Population Characteristics				
	P_1	P_2	P_3	P_4	P_5
Population One	0.96	0.01	0.01	0.01	0.01
Population Two	0.01	0.01	0.01	0.01	0.96

Value Range	Normal	Distribution of Simulated Indices: IIC Between Populations Simulated	IIC Between Populations Transformed	IED Population One Simulated	IED Population One Transformed
< -1.80	26	7	24	31	22
-1.80 to -1.60	37	37	35	29	37
-1.60 to -1.40	51	74	49	38	42
-1.40 to -1.20	68	73	85	26	74
-1.20 to -1.00	87	119	96	69	86
-1.00 to -0.80	106	171	105	93	88
-0.80 to -0.60	124	149	126	120	112
-0.60 to -0.40	140	145	150	107	122
-0.40 to -0.20	152	153	148	138	149
-0.20 to 0.00	158	162	158	144	140
0.00 to 0.20	158	119	134	163	161
0.20 to 0.40	152	141	168	174	161
0.40 to 0.60	140	103	117	191	146
0.60 to 0.80	124	102	142	145	154
0.80 to 1.00	106	98	98	156	121
1.00 to 1.20	87	67	68	109	82
1.20 to 1.40	68	59	66	89	71
1.40 to 1.60	51	44	51	50	48
1.60 to 1.80	37	46	27	17	46
> 1.80	26	34	34	11	25
	Mean	0.0142	-2.1944	0.0998	-1.1084
	Chi Square	117.69*	28.08*	128.30*	24.44

*See Table D-1 for footnotes.

One modification appears appropriate. The range of the coefficient of correlation is from -1 to +1 while the IIC and IED range from 0 to +1. The ranges of the IED and IIC can be made -1 to +1 by the transformation

$$Y = 2I - 1 \quad (3)$$

where I is the IIC or IED, and Y is the IIC or IED transformed to have range -1 to +1. By substituting Y from equation 3 for R in equation 2, the total transformation becomes

$$Z = 1/2 \ln \frac{2I}{2 - 2I} \quad (4)$$

where Z is the IIC on IED transformed for normality.

The results of a simulation of the distribution of the IIC and IED after transformation for normality are shown in columns four and six of Tables D-1 through D-9. Except for two cases where the distribution was already accepted as normal, the deviation of the simulated distributions from normal is reduced by using the Fisher transformation (as indicated by lower values of chi square). In five of the nine cases, the transformed IIC is normal with 95 percent confidence while in eight of the nine cases the transformed IED is indicated to be normal. All 18 values are now normal with 90 percent confidence. The Fisher transformation appears to have a significant normalizing effect on both variables; therefore, the IIC and IED indices are transformed before being used as dependent variables in statistical models described in the body of the text.

APPENDIX E

DEFINITIONS OF EMPLOYMENT CATEGORIES USED IN STUDY

The raw data on employment patterns by category of employment are based on the 32 industrial sectors reported in Growth Patterns in Employment, 1940-1950-1960.[1] Table E-1 lists these categories and relates them to the Standard Industrial Classification used by the Bureau of the Census and other U. S. government agencies.[2] The industrial sectors were grouped into eight categories for this study. The correspondence between the 32 industrial sectors and the eight grouped employment categories are listed in Table E-2. The industrial sectors 30 through 32 are not included in the grouped categories.

Industrial sector 31, armed forces, was excluded to keep the effect of military base locations from entering into the statistical models. The determinants of military base location are quite different than the industrial location factors of interest in this study; therefore, the inclusion of military employment in the computation of the indices would have added an undesirable element of variation.

To examine the effect of this exclusion, the indices (IIC and IED) were computed from the data with the military included and the military excluded. The results of these tests are shown in Table E-3. As is evident from these results, the exclusion of the military did not have a significant effect on the indices of the entire study area; however, in specific countries near large military instilations there were significant differences.

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[1] U. S. Department of Commerce, Office of Business Economics, Growth Patterns in Employment by County, 1940-1950, 1950-1960, Vol. V, Southeast, (Washington: Government Printing Office, 1965).

[2] Executive Office of the President, Bureau of the Budget, Standard Industrial Classification Manual, (Washington: Government Printing Office, 1957).

TABLE E-1

INDUSTRIAL SECTORS AND STANDARD INDUSTRIAL CLASSIFICATION EQUIVALENTS

Industrial Sector	Name	Equivalent SIC Codes[a]
1.	Agriculture	01, 02, 07
2.	Forestry and Fisheries	08, 09
3.	Mining	10, 11, 12, 13, 14
4.	Contract, Construction	15, 16, 17
	Manufacturing:	
5.	Food and kindred products	20
6.	Textile mill products	22
7.	Apparel	23
8.	Lumber, wood products, furniture	24, 25
9.	Publishing and Painting	27
10.	Chemical and allied products	28
11.	Electrical and other machinery	35, 36
12.	Motor vehicles and equipment	371
13.	Other transportation equipment	37 (Except 371)
14.	Other and miscellaneous	19, 21, 26, 29, 30
15.	Railroads and railway express	40
16.	Trucking and warehousing	42
17.	Other transportation	41, 44, 45, 46, 47
18.	Communications	48
19.	Utilities and sanitary service	49
20.	Wholesale Trade	50
21.	Food and dairy products stores	54
22.	Eating and drinking places	58
23.	Other Retail trade	52, 53, 55, 56, 57, 59
24.	Finance, insurance, and real estate	60 through 67
25.	Hotels and other personal services	70, 72
26.	Private Households	88
27.	Business and repair services	73, 75, 76
28.	Entertainment, recreation services	78, 79
29.	Medical, other professional services	80, 81, 82, 84, 86, 89
30.	Public Administration	91, 92, 93
31.	Federal Government	91
32.	Industry not reported	99

[a]For definition of Standard Industrial Classifications see Executive Office of the President, Bureau of the Budget, Standard Industrial Classification Manual, (Washington: U.S. Government Printing Office, 1957).

TABLE E-2

GROUPED EMPLOYMENT CATEGORIES AND INDUSTRIAL SECTOR EQUIVALENTS

Grouped Employment Category	Name	Industrial Sector[a]
1	Agriculture	1, 2
2	Mining	3
3	Construction	4
4	Manufacturing	5 through 14
5	Transportation and Utilities	15 through 19
6	Trade Services	20 through 23
7	Financial Services	24
8	Services	25 through 29

[a]Industrial Sectors as defined in Table E-1.

TABLE E-3

TEST FOR SIGNIFICANT DIFFERENCES BETWEEN INDICES COMPUTED WITH AND WITHOUT MILITARY EMPLOYMENT INCLUDED

Year	Index	Mean Index		Difference	T Value[a]
		Military Included	Military Excluded		
1940-50	IIC	0.8665	0.8716	-0.0051	-0.56
1950-60	IIC	0.7408	0.7407	+0.0001	+0.01
1940-60	IIC	0.6478	0.6528	-0.0050	-0.35
1940	IED	0.6579	0.6586	-0.0007	-0.04
1950	IED	0.7742	0.7762	-0.0020	-0.15
1960	IED	0.8924	0.8964	-0.0040	-0.60

[a]Computed by paired -T test method as presented in Statistical Program Library For the S 360, (Lexington, Ky. University Computing Center, University of Kentucky, 1967) TMISS, pp. 184-189.

The degrees of freedom are 214 in all cases. The critical region for $= 0.05$ is $|T| \geq 1.96$; therefore, none of the differences are significant at the 0.05 level of significance.

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