A GEOGRAPHICAL APPRAISAL OF THE BRIDGE

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ABSTRACT

A GEOGRAPHICAL APPRAISAL OF THE BRIDGE

by Donald G. Janelle

The crossing of a river may be considered a human problem requiring man's application of ingenuity in satisfying his needs. The bridge and its counterparts--fords, ferries, and tunnels--are products of man's innovative perception which have enabled him to cross to the other side. In facilitating the expansion of his geographical base, bridges have become integral components of man's spatial organization. Within such a system, each bridge may differ in role, significance, and impact.

The role that each bridge plays in an organized area is dependent upon such factors as its location, the nature of the traffic using it, and the nature and extent of the area by which it is served. The significance of a bridge, dependent upon the urgency and frequency of man's need to cross it, is relative. The "impact" of a given bridge upon the society that built it may be considered in terms of the human settlement and human movement focused upon it. The goal of this thesis is to classify bridges such that their individual roles, significances, and "impacts" may be assessed according to their geographical implications.

This classification is a result of field research on the bridges crossing the Kennebec River in the state of Maine. It is based upon such criteria as the functions of bridges, the volume, nature, and origin of traffic crossing them, the accessibility of bridges to their surrounding areas, the nature of these areas, and the locations of competing bridges. The development and application of these criteria have led to the adoption of a classification that is both geographical and hierarchically nested. Thus, a bridge of a given order has all those characteristics of lower-order bridges. The classification, in order of increasing hierarchical significance, includes the rural bridge, the intra-urban bridge, the interregional bridge, the urban-interregional bridge, and the nodal bridge. Thus, whereas rural bridges serve only their immediate areas, intra-urban bridges also connect parts of nucleated settlements, and interregional bridges serve as links on highways joining areas that have differing physical, cultural, or economic characteristics. When an interregional bridge is located in an urban setting, it is referred to as an urban-interregional bridge. It is the nodal bridge, however, that has the greatest significance and the greatest "impact" upon man. Those few special bridges that have laid claim to nodality have played instrumental roles in helping to establish their sites as nodes of human movement and settlement. Considered in light of this classification, bridges are viewed not only as parts of the roads they serve, but also as functional components of man's cultural landscape helping to interconnect his nodes of settlement into a workable pattern of human organization.

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INTRODUCTION

Of all the cultural innovations of man, the bridge must rank among the most significant; and yet, to many, it is considered as merely a part of the road. It is the contention of this thesis, however, that the bridge has special significance of its own; for unlike the road in its character as a continuous access route of lengthy alignment, the bridge is a focus of human movement and settlement at particular points in earth space. Like people, bridges differ in their degree of significance—each bridge has a different role to play, each bridge serves a different clientele, and each bridge has an impact varying in degree and kind upon the civilization that it was built to serve. It is to define these roles, to assess the geographical base of the traffic served, and to analyze the varying impact of individual bridges that this thesis is dedicated.

PART I

THE BRIDGE IN ITS CULTURAL AND PHYSICAL SETTINGS

CHAPTER I

ROADS, FORDS, FERRIES, AND BRIDGES

Cultural geography is a study of man's solutions to his problems and the changes in the cultural and physical landscapes resulting from his efforts. It is in this light that we shall view the bridge—a man-made structure created to solve a specific human problem.

Man is both the force and the principal agent of his own cultural processes; he lives in a world of problems ranging from those which reflect his fundamental survival needs to problems associated with his complex social, economic, and political relationships. The nature and complexity of the problems he seeks to solve are in many ways a measure of the advancement of his civilization. Early man had the task of providing for his own basic needs; but, as his proficiency in meeting these increased, he was able to devote more efforts in fulfilling his desires for other less necessary material goods and in providing for the needs of others. These efforts eventually produced the innovative perception of the agricultural revolution. In practicing agriculture, special tools were needed as well as special techniques. Applying creative ingenuity to meeting these needs, man was able to free himself for still wider productive pursuits; pursuits which, in turn, led to more problems, the solving of which led to still more opportunities and problems which required still more thought and imagination.

In solving this perpetual spiral of increasing problems, man has expanded the geographical base of his operations. The increase of his self-created needs for more land and for new and more resources, for example, first gave him incentive to cross rivers, swamps, and eventually oceans. Today, the geographical base of his operations has been extended to areas heretofore considered uninhabitable and unproductive, and incessant human curiosity has encouraged his genius to provide the means of venturing to other planets. The bridging of planets is indeed an ultimate fraught with far more complex problems than the bridging of a stream; but nonetheless, each represents a stage in the advance of civilization and a stage in the expansion of man's geographical base.

At a relatively early date, man's commercial and social intercourse was able to move freely upon the rivers and ocean margins. This is evidenced by the settlement along the navigable waterways such as the Indus, Nile, Tigris, Euphrates,and Wei rivers. It was, however, the development of traffic transverse to rivers that enabled settlements to develop as break-in-bulk centers. As historic civilizations outgrew their river bank patterns of human habitation, the intercourse of human society began to flow across streams as well as along them, and the hinterlands of river settlements achieved breadth as well as length.

Roads and Bridges

Then, as now, it was a combination of curiosity and need that prompted man to venture to the other side of a river. Where permissible, he could ford the river; but, if his objective were to maintain the continuity of the road, he had to build a bridge. The bridge should thus be considered as part of the road, for the function of the road is to provide rapid and uninterrupted passage from one place to another. In this sense, the road is the progenitor of the bridge, and its understanding is therefore essential to an understanding of the bridge.

Roads represent a complex of lines generated upon the earth's surface by the movement of man. The ability of such a road to surmount an obstacle to its path is dependent upon its "strength." The strength of human commitment to a road varies directly with the volume and intensity of traffic that passes over it. As Christian Barman has noted, if the road is more powerful than the obstacle, ". . . it will pursue its way unyieldingly, cutting a passage for itself out of the crest of the hill or even laboriously burrowing at its foot."[1]

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[1]Christian Barman and Frank Brangwyn, The Bridge: A Chapter in the History of Building (London: John Lane the Bodley Head Limited, 1926), p. 4.

Where flowing water is encountered, the nature of the obstacle poses different problems than those of the hill. Both the road and the stream cling to the earth's surface, yet each seeks to proceed on its way unhindered and undiminished. Regardless of how powerful the road, it cannot dam the waters of the stream. The strength of the water is cumulative--the more you resist it, the more it grows. Man, however, can enable the road to escape its two dimensional bondage by building a bridge. The bridge not only maintains the integrity of the road, but its discontinuous piers or abutment supports permit the continuous flow of water beneath it. Thus, "the principle that governs . . . the behavior of the bridge towards the river is that of least possible interference."[1]

Fords and Ferries

Fords and ferries are also used as a means of crossing to the other side of a river. For the ford, it is desirable that the road approach the river at an optimum point of attack--where the water is sufficiently shallow and its flow is not too swift. In those cases where the water-flow is too swift or too deep, or the traffic transverse to the river is too great to permit the slow process of fording, it is likely that ". . . the road may detach from itself one or more moving particles which travel to and fro across the water with a continuous

[1] *Ibid.*, p. 175.

motion from bank to bank."[1] In this sense, the ferry is also considered a part of the road.

In the settling of North America, ferries necessarily came into existence as early as roads. The smaller rivers and streams were crossed at suitable fording places, but on the larger streams ferry service was frequently provided--particularly on the stronger roads. The first ferry service was established at Boston in 1630. At New Amsterdam, the Dutch licensed a ferry across the Hudson in 1661, and in 1688 the Delaware River was crossed by ferry at Philadelphia. Early Camden was known as Cooper's Ferry.[2] Many of the early bridges were to develop at the sites of ferries, for when the strength of the road and the velocity of the traffic exceeded the capacity of the ferry, it behooved the interest of man to build bridges as the next step towards increased road continuity.

It is important to observe that the demands for increased road continuity at a particular site are dependent not only upon the strength and intensity of the traffic but also upon the productivity of the surrounding hinterlands. These hinterlands may be focused upon an individual river crossing, or the river crossing may be a

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[1] Ibid., p. 9.

[2] See Wheaton J. Lane, "The Early Highway in America, to the Coming of the Railroad," Highways in Our National Life, ed. Jean Labatut and Wheaton J. Lane (Princeton: Princeton University Press, 1950), p. 70.

link on a highway connecting two points of focality having their own individual hinterlands. In either case, however, it is the social, economic, and political interaction of the focal center with its hinterland or the interaction between two or more focal centers joined in a higher order of areal organization that is responsible for the increased road strength and traffic intensity that man perceives as a valid reason for building a bridge.[1]

The Use of Bridges in the United States

By the middle of the seventeenth century England had about 900 bridges to accommodate its increasing mobility.[2] In America, however, the strength of the roads generated at this time did not warrant so many bridges. Few of the large rivers in colonial America were spanned before the Revolution. One notable exception was the Great Bridge built in 1663 across the Charles River at Cambridge.[3] After the Revolution the Americans built a number of timber structures. By the eighteenth century even drawbridges and swinging bridges were in common use.

Most of the cities on the Atlantic seaboard were established on the banks of navigable rivers and thus had sites advantageous as terminal and shipping points for

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[1]For a discussion on the principles of areal functional organization see Allen K. Philbrick, "Principles of Areal Functional Organization in Regional Human Geography," Economic Geography, 33 (October, 1957), pp. 299-336.

[2]Barman and Brangwyn, op. cit., p. 200.

[3]Lane, Highways in Our National Life, p. 71.

goods moving by ship. With the expansion of trade and the spread of colonization beyond the riparian margin, however, there arose a demand for permanent roads and bridges to accommodate the shift from waterborne to overland commerce. Turnpike and ferry companies were formed to pioneer in the development of this new line of communication. But, the increased migration eventually required that the ferries be replaced by bridges.

These bridges, valuable as time and labor saving devices, obviated the necessity of unloading goods and produce for transfer by ferry and reloading on the opposite shore. These bridges also helped to bring about a more closely knit physical, economic, and social union between the agrarian and mercantile centers.

By 1888 there were in the United States 61,562 iron and wood truss bridges and 147,187 wooden trestles.[1] By 1950 there were over 90,000 steel railroad bridges and over 250,000 steel and concrete highway bridges in use.[2] The great increase in the number of bridges has been stimulated not only by the railroad but, since about 1900, by the increased use of automobiles. Whereas there were only 8,000 motor vehicles in the United States in 1900 and only 2,000,000 in 1915, they had multiplied to 30,000,000 by 1940. Today, there are over 70,000,000

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[1] Clarence P. Hornung, Wheels Across America (New York: A. S. Barnes and Co., 1959), p. 149.

[2] David B. Steinman, Famous Bridges of the World (New York: Random House, 1953), p. 94.

motor vehicles using our nation's highways. The mobility provided by the automobile has resulted in the increased strength of roads. The need for more and greater bridges has correspondingly increased.

The Location of Bridges

The specific problems of locating bridges involve the consideration of both the physical and cultural landscapes. For early man, bridges were limited to an occasional tree trunk felled in the right location or to the chance arrangement of stepping stones. The fording of rivers was usually accomplished at the junction of some tributary where sandbars were frequently found. It was discovered that the best locations for bridges were those possessing firm and relatively flat land facing each other on opposite sides of the river. Where such conditions along a river were scarce, their locations were likely to develop as centers of human settlement. According to Arthur E. Smailes, a large number of towns had their original sites determined by such advantageous conditions for crossing rivers, for ". . . the approach of firm ground to the river bank offered both a well-defined constant channel to cross and opportunities for the land-route to reach the crossing-place, as well as advantages for building near the river."[1] As an example, Smailes mentions Chester, England. Chester is located on a ridge

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[1] Arthur E. Smailes, The Geography of Towns (London: Hutchinson and Co. Ltd., 1961), pp. 47-48.

of hard sandstone situated at the head of the Dee River estuary and below an extensive wet clay lowland. At Paris a bridge crossing was favored by the presence of islands below the confluence of the Marne with the Seine. The numerous town names containing "ford" and "bridge" are frequently indicative of settlements that developed where river crossings were favorable.

In the opposite vein, when man is committed to a river site for either economic or political reasons, it is questionable that he would perceive the need for a bridge as a legitimate excuse for moving his community to a site offering a more favorable crossing. The economic and social inertia to such a move might prompt him, instead, to seek either another alternative for crossing the river, i. e., ferry, or to make the necessary technological advances that would facilitate construction of a bridge at the present site. This, then, leads us to the consideration of bridge location and human settlement.

CHAPTER II

THE IMPACT OF BRIDGES UPON HUMAN SETTLEMENT AND MOVEMENT

Bridges and Human Settlement

Hilaire Belloc mentions that an obstacle to travel has the feature that ". . . the point at which it is crossed . . . is certain to become a point of strategic and often commercial importance."[1] Though its certainty may be doubted, it is true that many important settlements have developed near passages provided by narrows of the sea, at the gateways to mountain passes, and near river crossings. Unlike narrows of the sea and gateways to mountain passes, however, the optimum point of crossing a navigable river is less clearly defined by nature. But, as with the passages between seas and over mountains, it is man that chooses the point at which he will cross a river. Depending upon his origin and destination, the optimum point of crossing a river will vary from individual to individual. From the standpoint of society, however, the optimum crossing is that site which permits the greatest number to proceed from their origin to

[1]Hilaire Belloc, The Historic Thames (London: J. M. Dent and Sons Ltd., 1914), p. 36.

destination along the most direct route. Belloc argues that the optimum crossing should be as close to the mouth of the river as possible. To substantiate this claim, he indicates that the further upstream a bridge is, the longer the detour between the parts of the country traversed by the river. Assuming that coastal roads have greater traffic strength than inland roads, that the river is not fordable, and that the area's traffic patterns have not already been firmly established, Belloc's argument takes on some geometrical validity. The assumptions, however, are risky.

With recent advances in bridge technology, it is now considerably easier for man to locate his bridges at points optimumly situated with respect to the patterns of human settlement and movement. The notions of physical and geometrical determinants of optimum crossing tend to lose their validity with the modern suspension, cantilever, and continuous bridges. More significant are the human requirements that necessitate a bridge. These requirements will vary with the nature and extent of the bridge's hinterland and man's perceptive use of its resources and with the locations of the focal centers that the road carried by the bridge joins together into functional units of human habitation.

Man, in building his bridges, has often fixed the convergence of land and water routes and has frequently set the inland limit to navigation. This is particularly true of bridges constructed prior to man's commitment to his regional and interregional traffic patterns and prior to the development of the high-level and moveable bridges which permit unobstructed navigation. The commitment of man to a particular bridge site is augmented not only by the mere presence of the bridge but also by the settlement about it, the inducement of traffic to it, and the cost of its construction. The larger the settlement and the greater the traffic and cost, the greater the commitment to the site.

The first bridge to be constructed over a navigable portion of a river or at the head of navigation so as to set the inland limits to oceanic transportation is, thereafter, likely to have considerable impact upon the movement and settlement in its vicinity. Using the London Bridge as an example, we find that there is but one place on the upper reaches of the tidal estuary of the Thames that a bluff of high and dry land faces a spur of dry land on the opposite bank. Smailes notes that the construction of a bridge at this site helped to facilitate the convergence of land routes, to set the inland limit of the seaport of the Thames at its estuary head, and to impose upon London a break-in-bulk function between sea-going and inland trade. Thus, as a focus of river crossing, we have at London ". . . the endowment of situation with the priceless gift of nodality."[1]

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[1]Smailes, op. cit., p. 56.

Although Smailes states in a recent study that "for most of its history London remained essentially a singlebank urban area, . . ."[1] he does maintain that ". . . the roads diverging from London Bridge . . . were the earliest ribbons of London's urban extension"[2] and that early settlement south of the river, though modest, was confined to the bridge approaches. That the great suburban expansion to South London occurred during and after the Industrial Revolution does not negate the significance of the London crossing as a node of settlement. Rather, the construction of a second bridge at London in 1750 indicates that complementary urban development on opposite banks during this period required the easier communications that an additional bridge could provide.

The Nodal Bridge

Not all bridges have played such a creative role as the London Bridge, and not all bridges are predestined to become the foci of great communities. But, those that have played such a role deserve our special consideration. We shall call them "nodal bridges." The term "nodal bridge," although originally introduced by Belloc, was more fully explained by Barman. Barman uses the word "node" analogously to its definition in natural history as ". . . the point of a vegetable stem from which the

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[1] A. E. Smailes, "Greater London—The Structure of a Metropolis," Geographische Zeitschrift, Vol. III (August, 1964), p. 167.

[2] Ibid., p. 174.

leaves spring."[1] This would imply then, that a nodal bridge, by its presence, induces life to come to it. Thus, the construction of a bridge whose situation confers upon it the title of "nodal" will lead to the human generation of roads converging at the bridge. Such was the case at London, and such was the case at Glasgow, Newcastle, and Rouen.[2]

It can be legitimately argued that, to a degree, all bridges are nodal. But, for our purposes, a nodal bridge will most likely occur where a waterway of prime importance is crossed by a roadway of similar importance. And, as was true for the London Bridge, a nodal bridge is most often the first bridge built on the river that sets the inland limit to seaborne craft. Generally, the importance of a waterway is much greater in its tidal reaches, for it is here that its traffic is most apt to equal that of the road transverse to its course. The intersection of these two human pathways is the nodal point—the nodal bridge.

This is not to say that any bridge carrying an important highway across an important waterway is necessarily a nodal bridge. Many bridges on America's interstate highway system span important navigable waterways and, yet, are not the foci of great communities or traffic convergence. Because of the limited access to these

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[1]Barman and Brangwyn, op. cit., p. 47.

[2]Smailes, The Geography of Towns, p. 56.

highways and to the popularity of high-level bridges, it is unlikely that such sites will develop break-in-bulk functions. Their essential purpose is to serve as links on highways connecting the focal centers of distant hinterlands. The nodal bridge, on the other hand, is itself the focal center of a hinterland having the focal centers of other hinterlands focused upon it.

Although this nodal position may befall the first bridge to cross the navigable portion of a river, it is not impossible for bridges constructed at a later date to develop into the nodal crossing. It is logically assumed, however, that the first bridge would have certain strategic advantages in attracting human pathways and settlement. In considering the economic and political geography of his day, man may perceive a particular river site as an optimum crossing point and as a possible transhipment point for break-in-bulk. If, however, the pattern of man's economic and political hinterlands change through time, his perception of this optimum point may also change. If this should occur prior to a firm human commitment to given routes of travel and to a degree that would warrant a reorientation of hinterlands about new focal centers, then it is possible that a later bridge situated optimally with respect to new or changed hinterlands of human commitment would become that river's nodal bridge.

Many of the bridges built across important navigable waterways today are of high-level suspension, arch, cantilever, continuous, or of bascule and swing construction. As a great number of these bridges neither obstruct navigation nor set inland limits to the location of inland ports, it may be questioned as to whether or not they are candidates for the "nodal" label. The answer entails consideration of the historical development of the individual crossing site. Three cases come to mind.

1. If this bridge replaced a previous structure which limited navigation on a waterway of prime importance, it is possible that any economic momentum generated by man in the hinterland focused upon the bridge-site would still hold true—despite the new freedom for ships to proceed further upstream. In this case the existing capital investment in transhipment and storage facilities might be sufficiently great to maintain community commitment to the site. If this is so, then the nodality of the new structure should equal that of the old structure plus whatever may be accrued by the new facility's attraction of additional traffic and settlement.

2. Railroad bridges, aqueducts, and limited access highway bridges frequently fall into the class of high-level and moveable type bridges constructed over navigable waters where no crossing of any kind previously existed. These bridges are likely to represent changes in the transportation patterns in response to economic and technological developments. Thus, recently discovered mining sites may be made accessible only by new highways and railways; or, man may perceive the increasing mobility of the population as a need for expressways free of traffic bottlenecks—such as road intersections and roadside commercial establishments. The nodality of these bridges, however, is again dependent upon the importance of their sites as firmly committed centers of human settlement and movement. When these sites are competing with already established focal centers having productive hinterlands, their chances of being designated "nodal" are diminished.

3. The examples of San Francisco, New York, New Orleans, and other American cities where high-level bridges have replaced ferries, constitute

> the third case. In such examples, the nodality of the bridge would be a function of the nodality of the ferry, the increased road strength induced by the new crossing facility, and the hinterland expansion resulting from the increased road continuity.

Clearly, the concept of the nodal bridge is not static—nodality varies with changes in man's perceptions on the use of earth space and with the resulting settlement and movement patterns that evolve from his implementation of decisions designed to best satisfy these perceptions. Although there is no single determinant for a nodal bridge, there are certain conditions that favor its development. These are:

1. the bridge should carry an important highway across a navigable waterway of similar importance,
2. the bridge should preferably be the first to be built at or below the head of river navigation,
3. the bridge should preferably set or be situated at the inland limit to seaborne craft,
4. it should be situated at a site that is firmly committed to by a sizeable human settlement,
5. this site should be the focal center of a hinterland that has the focal centers of other hinterlands focused upon it, and
6. the bridge itself should play an instrumental role in establishing its site as a nodal point by attracting both traffic and settlement to it.

Nodal Bridges in the United States

In assigning a nodal position to bridges in the United States, those in the famous bridge city of San Francisco rate our consideration. The city is located in a tidal area. Its Golden Gate Bridge, completed in 1937, spans the narrow neck of San Francisco Bay near its lowest possible point and carries U. S. route 101—the major west coast artery of north-south traffic in the United States. The city's central position is augmented further by the San Francisco-Oakland Bay Bridge, which permits U. S. highways 40 and 50 to terminate in San Francisco. Both of these bridges replaced very profitable ferry services which linked the city to a hinterland of considerable economic productivity. In terms of United States exports to the Far East, San Francisco was, in fact, the focal center for most of the United States. By 1929 the Oakland Bay Ferry alone was annually carrying over four and one-half million vehicles.[1] Yet, in its first year of operation (1936-1937) the Oakland Bay Bridge carried a traffic volume approximately 64 per cent above what the projected increase for the ferry would have been had it continued its service. For the Golden Gate Bridge, this increase was 78 per cent.[2] Such increases in traffic volume and road strength indicate the attractiveness of the continuous road over the interrupted—the bridge over the ferry.

In this example, it is evident that San Francisco was a nodal point prior to the construction of any bridge.

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[1]Archibald Black, The Story of Bridges (New York: Whittlesey House, McGraw Hill Book Co. Inc., 1936), p. 16.

[2]Coverdale and Colpitts, Consulting Engineers, Report on Traffic and Revenues, Proposed Mackinac Straits Bridge (New York: Coverdale and Colpitts, January 22, 1952), p. 18.

Nonetheless, the bridges constructed here testify to man's acknowledgment of the city's nodal position in the hierarchy of his areal organization. In becoming functional parts of this nodality, the bridges not only attained nodal significance but also served to augment the nodal position of San Francisco by attracting increased traffic through and to the city and by providing speedier communication between its central core and its hinterland.

There are numerous other nodal bridge crossings in the United States--New York City on the Hudson River, Philadelphia on the Delaware River, and New Orleans on the Mississippi River, to mention a few. Richmond developed as a nodal crossing at the head of the James River estuary. But, because of advances in bridge technology, it may lose its nodal thunder to more recent crossings near the mouth of the river and across the entrance to Chesapeake Bay. It is possible that the induced traffic attracted to the Chesapeake Bay Bridge-Tunnel crossing will help the Norfolk-Portsmouth and Newport News urban complex acquire additional nodal status. Thus, the construction of new river crossings leads us to a consideration of bridges and the movement of man.

Bridges and Human Movement

When a new facility is constructed which benefits movement of traffic, traffic volumes are likely to become greater than the number accounted for by diverted traffic, and the paths of human movement may change to take advantage of the new facility. A comparison of the first year's traffic carried by a new facility with projections of traffic that would have been carried by the old facility had it continued to operate gives us an approximation of the "induced traffic" resulting from the presence of a new and better facility. This induced traffic may represent people making trips on the new facility who were formerly discouraged from making these trips because of the traffic congestions or excess travel distances associated with the older facility.

We have already noted the induced traffic of the Golden Gate Bridge and the San Francisco-Oakland Bay Bridge (78 per cent and 64 per cent respectively) over that of existing ferry facilities. According to Coverdale and Colpitts, the induced traffic for the Tacoma Narrows Bridge was 61 per cent and that for the Philadelphia-Camden Bridge was 72 per cent.[1] This bridge, built in 1926, was by 1931 carrying over twelve million vehicles annually.[2] The induced traffic for other river crossings after one year of operation was as follows:[3]

Holland Tunnel.	68	per cent
George Washington Bridge. . .	65	"
Brooklyn Battery Tunnel . . .	75	"
Delaware Memorial Bridge. . .	63	"
Chesapeake Bay Bridge	100	"

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[1] *Ibid.*

[2] Sara Ruth Watson and Wilbur J. Watson, *Bridges in History and Legend* (Cleveland: J. H. Jansen Co., 1937), p. 177.

[3] George W. Burpee, "Traffic Estimates for Expressways and Other Public Toll Revenue Projects," *Traffic Quarterly*, VII (January, 1953), p. 15.

All of these bridge and tunnel facilities replaced or augmented ferries giving excellent service. The San Francisco-Oakland Bay ferries offered departures every twelve minutes during the day and continuous service, although at longer intervals, during the night. The crossing time was only twenty minutes. The crossing at Philadelphia took only ten minutes, at Tacoma--eleven minutes, and at Golden Gate--twenty-four minutes. For the Chesapeake Bay Bridge, the crossing time of half an hour by ferry (with frequent delays of several hours on week-ends) was cut to less than ten minutes.

The magnitude of induced traffic indicates the importance of the increased road continuity provided by the bridge. Not only does the strength of the road encourage man to build bridges, but the bridge itself, by inducing traffic, serves to augment the strength of the road. The replacement of a ferry by a bridge or a low capacity bridge by a more efficient structure induces traffic for two reasons: one, road continuity results in less loss of time; and two, road distances between two points are frequently shortened. We have already noted examples where road continuity saves time.

Bridges may be strategically located so as to shorten travel distances. For instance, the longest bridge-tunnel in the world--the Chesapeake Bay Bridge-Tunnel--will not only link a coastal highway from Canada to Key West, Florida, but will result in a savings of over sixty miles between southeastern United States and New York City. Tourists, truckers, and businessmen are expected to use this bridge to bypass the traffic congestion of the metropolitan Fall Line cities.

CHAPTER III

A GEOGRAPHICAL CLASSIFICATION OF BRIDGES

The Bridge Hinterland

Thus far, we have considered the impact of the bridge upon the settlement and movement of man. The impact of any given bridge, of course, is dependent upon the strength of the road that it carries. This impact may be expressed geographically by considering the extent of the area from which the traffic originates. We have already noted the widespread impact of those few bridges that have laid claim to "nodality." However, even though the majority of bridges will not meet the criteria of nodality, they nevertheless have a specific function in serving their specific areas.

The traffic using a bridge originates from an area which we have called the bridge hinterland. The size of this hinterland is expressed and partly dictated by the nature and strength of the roads converging upon the bridge and the attractiveness of the bridge-site as a focus of movement and settlement. A bridge in an urban setting joining two cities or parts of a single city may carry large volumes of traffic but serve a comparatively small area. On the other hand, a bridge in a rural setting may support moderate traffic, most of which originates from great distances. As the hinterlands for individual crossings vary, a consideration of the situational factors, road strength, and road function will assist us in classifying them geographically.

Aside from being geographical, this classification will be hierarchically nested, in the sense that a bridge of a given order will embrace those characteristics associated with bridges of lower order. This hierarchical classification of bridges based upon their geographical hinterlands includes:

1. first order bridges . . . rural,
2. second order bridges. . . intra-urban,
3. third order bridges . . . interregional,
4. fourth order bridges. . . urban-interregional, and
5. fifth order bridges . . . nodal (already considered).

One other type of bridge, the national bridge, will be considered as a special case.

Rural and National Bridges

Barman, aside from the nodal bridge, noted the "rural bridge" and the "national bridge." The rural bridge serves only the immediate rural area and occupies a lower place in the hierarchy of bridges than does the national bridge. Such bridges are likely to carry low traffic volumes. The national bridge, according to Barman, is also found in a rural setting; but in this instance, "the claims of the immediate locality [of the bridge] must be waived in favor of others more distant yet more authoritative."[1] Bridges under this classification include aqueducts—carrying water to meet urban demands, railroad bridges—permitting the movement of produce and freight to metropolitan centers, and bridges on the nation's interstate highways which serve the distant authoritative centers more so than their own immediate localities.

Examples of National Bridges

Even without precise means of determining the nature and size of a bridge's hinterland, it is possible to note obvious examples of bridges serving national functions. For instance, the completion of the Carquinez Straits Bridge in 1927 provided the last link in the Pacific coastal highway system extending from Canada to Mexico. The Lower Zambezi railroad bridge, built by the Portugese in 1935, permitted easier access for the produce of Nyassaland to the world market outlet at Beira. Another example of a bridge in a rural setting performing a more than local service is the railroad bridge built between Mexico and Guatemala. This bridge helped to open a land route for the shipment of coffee from Central America to the United States. Prior to construction, railway freight had to be unloaded and ferried across the border river.

The Carquinez, the Lower Zambezi, and the Suchiate River bridges are not only what Barman would consider as

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[1] Barman and Brangwyn, op. cit., p. 170.

national bridges gracing the rural landscape; they are good examples of what this author calls an interregional bridge.

The Interregional Bridge

The interregional bridge is a link on a road connecting areas having either physical, cultural, or economic characteristics complementary to each other. Differences between regions encourage movement so that people can take advantage of what one has to offer that the other does not. In this sense, the Carquinez bridge provided a path for the easier exchange of the forest products of the Northwest and the citrus fruit of southern California; the Lower Zambezi bridge assured the access of ocean transportation, otherwise not available for Nyassaland's products; and, the Suchiate River bridge provided more efficient exchange between areas of coffee production and coffee consumption.

Intra-urban and Urban-interregional Bridges

Unlike Barman's national bridge, the author's interregional bridge need not be located in a rural setting—they are also found in urban areas. Those bridges serving only to connect the various parts of nucleated settlements will be referred to as intra-urban bridges. But, bridges serving as links on highways of interregional significance and located within urban areas may be referred to as urban-interregional bridges. Of the classes of bridges considered, the urban-interregional bridge is the best candidate for nodality.

New York City offers good examples of both the intra-urban and the urban-interregional bridge. In 1954, over 76 million vehicles crossed the Hudson River at New York City.[1] Today, this figure exceeds 80 million. For the most part, the Manhattan, Williamsburg, and Queensboro bridges were designed to accommodate the movement of traffic between the city's various boroughs. In contrast, the George Washington Bridge is a major link for U. S. highway 1—funnelling traffic north into New England and south to New Jersey and beyond. The new Verrazano Narrows Bridge, scheduled for completion in 1965, is expected to provide an additional bypass around New York City for the interregional traffic between New England and points south as well as quick and convenient vehicular interchange for the Borough of Richmond and its four sister boroughs. This bridge will thus serve both intra-urban and interregional traffic.

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[1] Triborough Bridge and Tunnel Authority, Annual Report, 1954 (New York: Triborough Bridge and Tunnel Authority, March 7, 1955), p. 12.

CONCLUSION: PART I

Part I of this thesis has depicted the bridge as an integral part of man's geographical landscape. Originating by chance or human ingenuity, the bridge has played a civilizing role that has permitted man to expand his geographical base—thus facilitating his commerce and cultural contact. We have seen that among the many elements that prescribe the influence that a given bridge will have are its location, the strength of the roads converging upon it, and the extent and productivity of its hinterland. This is well illustrated by the nodal bridge, whose situational characteristics make it a focus of human settlement and movement. The nodal bridge is indeed the champion of all bridges; but whether a bridge be nodal, interregional, urban-interregional, national, intra-urban, or rural, it behooves the interest of the geographer to study the degree to which it is nodal, interregional, rural, and so forth. This will be one of the objectives of Part II.

In Part II, the author has selected the Kennebec River in the state of Maine as being illustrative of man's quest to cross to the other side. In light of our findings in Part I, in Chapter IV we shall investigate the historic and geographic development of Kennebec crossings from the ford and ferry to the present bridges. In Chapter V we shall attempt to classify individual Kennebec highway bridges according to the geographical classification discussed in Chapter III. For our purposes, this classification will be based upon the following criteria:

1. the functions of the bridge,
2. the volume and nature of traffic using the bridge,
3. the accessibility of the bridge to its local hinterland,
4. the degree of a bridge's interregional significance, and
5. the locational and spatial factors associated with the bridge.

While it is realized that this classification may not be inclusive of all possible criteria for classifying bridges, it is believed adequate for the purposes of this thesis, and it is hoped that it will provide information and raise questions that will serve as the basis for further investigation. The six weeks of field research for this study, though highly profitable, proved to be far short of the time necessary to answer or to hypothesize answers for all questions raised. It is thus the policy of the author to keep the conclusions of this study proportional to the reliability of data and to single out any questions requiring further investigation.

PART II

THE GEOGRAPHY OF KENNEBEC RIVER CROSSINGS

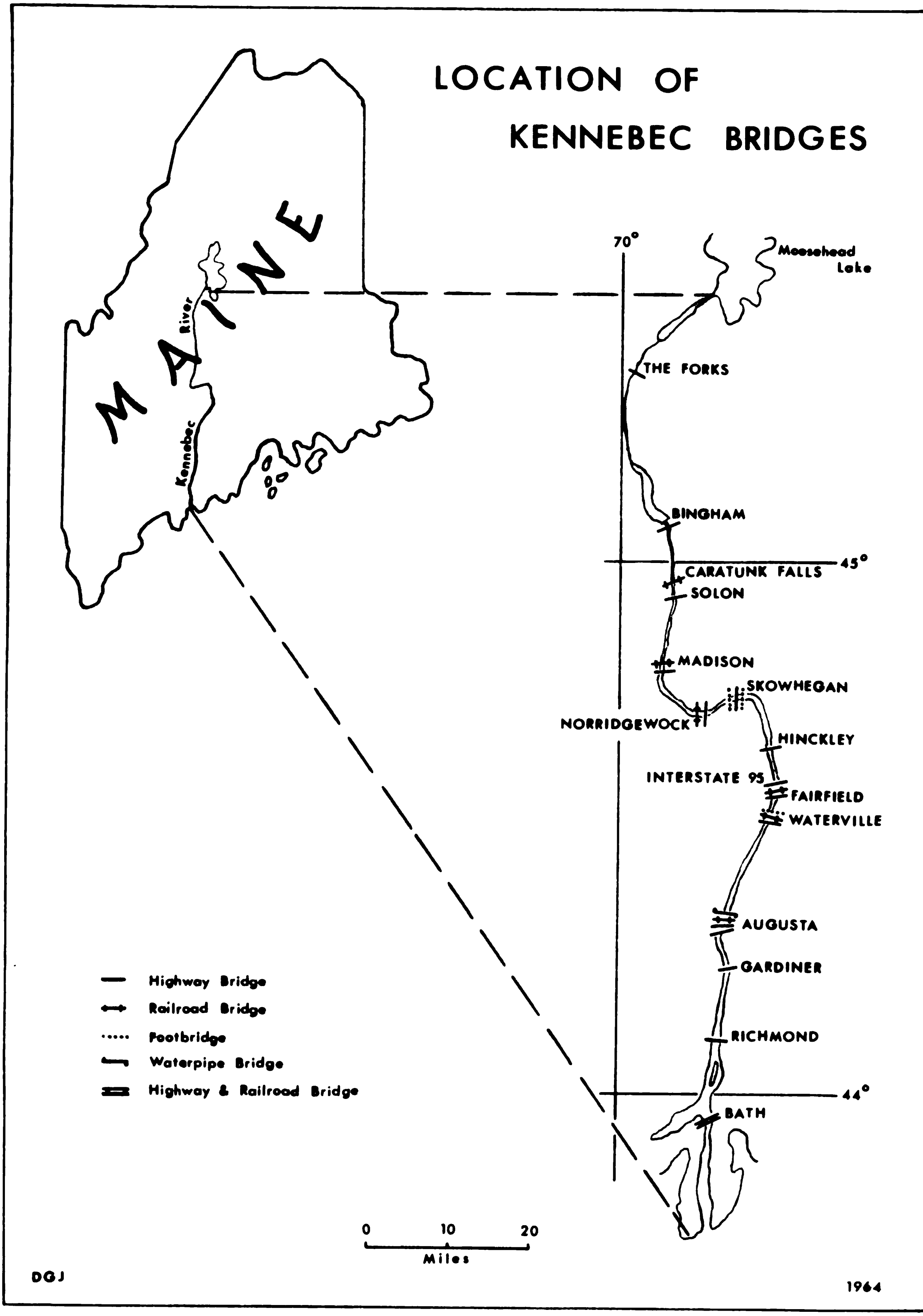
CHAPTER IV

THE HISTORICAL GEOGRAPHY OF KENNEBEC CROSSINGS

From its headwaters in Moosehead Lake, Maine's Kennebec River descends over 1,000 feet on its 140 mile plunge to the mouth of its tidal estuary. This river, once the main avenue of Indian nations, the path of English settlement, the artery of fishing and trading vessels, and the famed route of Benedict Arnold, is today a sea of logs bounded by pulp and paper mills, factories, farms, and forests. In comparison with yesteryear, today's Kennebec traffic is of minor consequence—for more important is the movement transverse to its course. As shown in Figure 1, fourteen highway bridges, a combination railroad and highway bridge, six railroad bridges, three footbridges and a waterpipe bridge span this river from Bath to The Forks—no longer does the mighty Kennebec impede the movement of man. In this discourse, our prime concern will be the river's highway bridges.

Fords and Ferries on the Kennebec

The history of man's attempts to cross this watery divide date back to the days of the Kennebec Indians. At low water the Kennebec could be forded at many points—


LOCATION OF
KENNEBEC BRIDGES
MAINE
Kennebec
River
70°
Moosehead
Lake
THE FORKS
BINGHAM
45°
CARATUNK FALLS
SOLON
MADISON
SKOWHEGAN
NORRIDGEWOCK
HINCKLEY
INTERSTATE 95
FAIRFIELD
WATERVILLE
AUGUSTA
GARDINER
RICHMOND
44°
BATH
Highway Bridge
Railroad Bridge
Footbridge
Waterpipe Bridge
Highway & Railroad Bridge
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10
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chief of which, for the Indians, were those above the falls at Madison and at Waterville. Even for the Indians, the swiftly flowing water posed a danger, and below Augusta, the fording of the Kennebec was limited by depth to so few points that it was of necessity that man turned to ferries. The first of these was Mayne's Ferry, established in 1718 at Bath. For the next 212 years the ferry was the principal means of crossing the Kennebec any point south of Gardiner. By the 1870's two dozen ferries were plying the waters of the Kennebec, one for every 4.6 miles of its course between Bath and The Forks.

Many of these early crossings, such as the one at Vassalboro and the two between Skowhegan and Hinckley (Prentiss' Ferry and Spearin's Ferry) were short lived, but others were to become the foci of settlement and movement. The Pishon and Noble Ferries, north of Fairfield, were the centers of life in their respective localities—cattle were driven to these points to cross the river on their way to market, and in 1830 the Waterville to Canaan Stage used Noble's Ferry and later Pishon's Ferry to meet the stage from Bangor to Skowhegan.[1] Taverns and accommodations for travelers developed at these places. Other crossings, such as those at Madison and Norridgewock, encouraged break-in-bulk functions to develop.

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[1]For a discussion on these crossings see Clinton Old Home Week Association, Old Home Week, Clinton, Maine, August 7-14, 1921 (Clinton, Maine: Old Home Week Association), p. 9.

The ferry at Bath was highly significant as a link between the early Brunswick to Bath Turnpike and the Woolwich and Wiscasset Pike, which in turn connected with the Wiscasset and Augusta Turnpike. Such interconnections eased the communications in the area. Day's Ferry, a few miles above Bath, served a similar function. The last ferry to operate on the Kennebec was the one at Hallowell. It was discontinued in 1960. The ferry--a skif holding six passengers--was used by the residents of Chelsea to attend churches and schools in Hallowell.

Most of the early ferries were powered by pulling on a cable suspended from bank to bank; but some, such as the ferry at Bingham, were poled through shallow water and powered by a scull oar in deep water. The Bingham ferry had "driving bats" for foot passengers and a small scow for ox teams.[1] The ferry between Embden and Solon used a windlass and, with the aid of the wind and river currents, was guided by a cable suspended over the river.

The ferry, as the ford, was plagued by the forces of nature. During periods of high water, the Kennebec freshets made ferrying unsafe. In winter and spring, it was necessary to cancel service. At night, crossings were limited only to emergencies. Waterville residents sought to overcome some of the difficulties of winter crossings

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[1]The History Committee of the Bingham Sesquicentennial, Bingham Sesquicentennial History, 1812-1962 (Skowhegan, Maine: Skowhegan Press, 1962), p. 63.

by swinging a huge cake of ice across the current. As soon as the water on the sides of the river had frozen, they would cut an appropriate piece of ice for their bridge.[1]

The Spacing of Ferries and Bridges

Of the bridges crossing the Kennebec today, all but one, the new interstate highway bridge north of Fairfield, were preceded by ferries. But, not all ferries were followed by bridges. Compared with the average 4.6 mile spacing of river crossings in 1820 between Bath and The Forks, the average spacing of today's highway bridges is 7.4 miles. It can be inferred from this comparison that the intermediate ferry crossings that existed between the present bridges were redundant features whose operations were no longer necessary. The ferry has been superseded by a higher order of river crossing—the bridge. By 1910 the only ferries in regular service on the Kennebec were those at Richmond, Bath, and Hallowell.

The First Bridge

Early settlers along the Kennebec were well aware of the advantages that might befall the site of the first bridge. The optimum point for such a crossing was indeed relative—depending upon one's viewpoint and location. To

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[1]William Mathews, "Recollections of Waterville in Olden Times," The Centennial History of Waterville, ed. Edwin Carey Whittemore (Waterville, Maine: Executive Committee of the Centennial Celebration, 1902), p. 141.

the fishing and shipping interest along the river, any point below the head of navigation was objectionable, but to the commercial interests at Bath, an estuarial crossing at their site would have been welcomed--such a bridge, in setting the inland limits to sea navigation, might have imposed upon its site a nodal position. It was, however, the desires of the fishing and shipping interests that prevailed. Consequently, in the late 1700's a fight ensued between the citizens of The Hook (Hallowell) and those of The Fort (Augusta--then a part of Hallowell) to see which would reap the potentially strategic benefits of the first bridge. Both settlements claimed to be at the head of navigation; but, finally, in 1796 the Massachusetts Legislature granted the charter for a bridge at The Fort to be built by a private company.

That the whole river valley was concerned with the location of this bridge is reflected in the Records of the Plantation of Canaan and the Town of Canaan (Skowhegan), 1783-1821. At a May 6, 1795, Town Meeting it was

> . . . voted unanimously as the sense of this town that a bridge across the Kennebeck River at the place called the Hook will be highly Injurious to the Publick by obstructing the Navigation of Vessels and Rafts . . . [and it was] voted unanimously that a bridge across the Kennebeck at the place called Fort Western [Augusta] will not be attended with the same Inconveniency, But will more extensively promote the Conveniency of travelling and better serve the Interest of the Publick. . . .[1]

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[1]The Plantation of Canaan and the Town of Canaan, Constable's Office, Records of the Plantation of Canaan and the Town of Canaan (Skowhegan), 1783-1821 (Canaan, Maine: Constable's Office, 1783-1821), p. 104.

According to the historians Kingston and Deyo, the construction of the bridge at Augusta in 1797 ". . . settled the final question of supremacy between the villages and radically effected the future of both."[1] The jealousy that resulted necessitated a division of the Hallowell civil unit. In the same year The Fort became known as "Harrington," only to be changed to "Augusta" shortly thereafter. This, the first bridge, was of great significance, for as James W. North states, the ". . . roads as they were constructed in the surrounding country converged to it as a place of crossing. This gave to Augusta a central position and laid the foundation of much of her subsequent prosperity."[2]

Judging from North's conclusions on the early significance of this bridge and from Augusta's present significance as a bridging site for approximately thirty-three per cent of all vehicles crossing the Kennebec,[3] we have some validity for considering this site, as historically, the river's nodal crossing. Such a position for Augusta was favored by the meeting here of ocean and land transportation, by the commitment of a sizeable community of people to its site, and by the convergence of

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[1]Simeon L. Deyo and Henry D. Kingston, Illustrated History of Kennebec County Maine, 1625-1892 (New York: H. Blake and Co., 1892), p. 402.

[2]James W. North, The History of Augusta (Augusta, Maine: Chapp and North, 1870), p. 314.

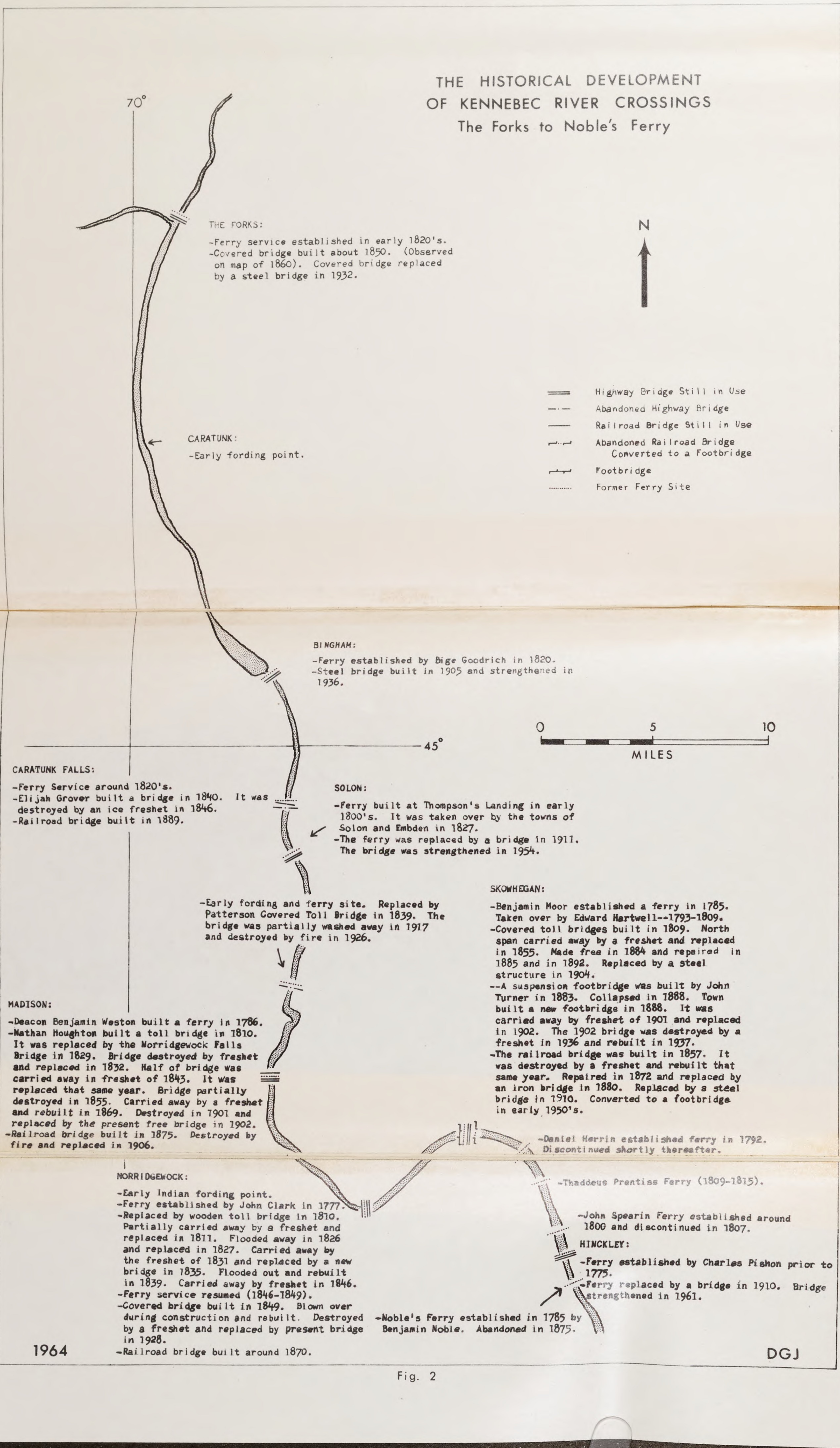
[3]Based upon the most recent traffic data made available by the Planning and Traffic Division of the Maine State Highway Commission.

interregional routes to this point. The continued human commitment to these routes has maintained Augusta as the Kennebec's leading bridging point. That Augusta has maintained this lead reflects the significance of the first bridge. Prior to the construction of this bridge, both Hallowell and Bath had considerably larger populations than Augusta. However, since 1830, Augusta has ranked as the Kennebec Valley's leading city in population.

As ocean transportation is of little significance on the Kennebec today, Augusta no longer meets the criteria for nodality as established in Chapter II. It is important to recall, however, that, to a degree, all bridges used by man are nodal. And, though the Augusta Bridge is not comparable to the nodal London Bridge or to the Golden Gate Bridge, it is still the most significant crossing on the Kennebec. For information on the historical evolution of the Augusta Bridge or any of the other Kennebec crossings, refer to Figures 2 and 3.

Bridging the Kennebec

The desire to replace the ferry with the continuous and uninterrupted bridge was soon voiced from one end of the Kennebec to the other. Twelve years later, in 1809, a second bridge was built across the Kennebec--this one at Skowhegan. This bridge was especially important as a crossing for the cattle droves and sheep flocks collected along the Canada road and driven through Skowhegan to the markets to the south. Louise H. Coburn reports that there



THE HISTORICAL DEVELOPMENT
OF KENNEBEC RIVER CROSSINGS
The Forks to Noble's Ferry
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N
THE FORKS:
-Ferry service established in early 1820's.
-Covered bridge built about 1850. (Observed on map of 1860). Covered bridge replaced by a steel bridge in 1932.
Highway Bridge Still in Use
Abandoned Highway Bridge
Railroad Bridge Still in Use
Abandoned Railroad Bridge Converted to a Footbridge
Footbridge
Former Ferry Site
CARATUNK:
-Early fording point.
BINGHAM:
-Ferry established by Bige Goodrich in 1820.
-Steel bridge built in 1905 and strengthened in 1936.
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10
MILES
45°
CARATUNK FALLS:
-Ferry Service around 1820's.
-Elijah Grover built a bridge in 1840. It was destroyed by an ice freshet in 1846.
-Railroad bridge built in 1889.
SOLON:
-Ferry built at Thompson's Landing in early 1800's. It was taken over by the towns of Solon and Embden in 1827.
-The ferry was replaced by a bridge in 1911. The bridge was strengthened in 1954.
-Early fording and ferry site. Replaced by Patterson Covered Toll Bridge in 1839. The bridge was partially washed away in 1917 and destroyed by fire in 1926.
SKOWHEGAN:
-Benjamin Moor established a ferry in 1785. Taken over by Edward Hartwell--1793-1809.
-Covered toll bridges built in 1809. North span carried away by a freshet and replaced in 1855. Made free in 1884 and repaired in 1885 and in 1892. Replaced by a steel structure in 1904.
--A suspension footbridge was built by John Turner in 1883. Collapsed in 1888. Town built a new footbridge in 1888. It was carried away by freshet of 1901 and replaced in 1902. The 1902 bridge was destroyed by a freshet in 1936 and rebuilt in 1937.
-The railroad bridge was built in 1857. It was destroyed by a freshet and rebuilt that same year. Repaired in 1872 and replaced by an iron bridge in 1880. Replaced by a steel bridge in 1910. Converted to a footbridge in early 1950's.
MADISON:
-Deacon Benjamin Weston built a ferry in 1786.
-Nathan Houghton built a toll bridge in 1810. It was replaced by the Norridgewock Falls Bridge in 1829. Bridge destroyed by freshet and replaced in 1832. Half of bridge was carried away in freshet of 1843. It was replaced that same year. Bridge partially destroyed in 1855. Carried away by a freshet and rebuilt in 1869. Destroyed in 1901 and replaced by the present free bridge in 1902.
-Railroad bridge built in 1875. Destroyed by fire and replaced in 1906.
-Daniel Herrin established ferry in 1792. Discontinued shortly thereafter.
NORRIDGEWOCK:
-Early Indian fording point.
-Ferry established by John Clark in 1777.
-Replaced by wooden toll bridge in 1810. Partially carried away by a freshet and replaced in 1811. Flooded away in 1826 and replaced in 1827. Carried away by the freshet of 1831 and replaced by a new bridge in 1835. Flooded out and rebuilt in 1839. Carried away by freshet in 1846.
-Ferry service resumed (1846-1849).
-Covered bridge built in 1849. Blown over during construction and rebuilt. Destroyed by a freshet and replaced by present bridge in 1928.
-Railroad bridge built around 1870.
-Thaddeus Prentiss Ferry (1809-1815).
-John Spearin Ferry established around 1800 and discontinued in 1807.
HINCKLEY:
-Ferry established by Charles Pishon prior to 1775.
-Ferry replaced by a bridge in 1910. Bridge strengthened in 1961.
-Noble's Ferry established in 1785 by Benjamin Noble. Abandoned in 1875.
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were often as many as 500 sheep in a flock.[1] One year later, in 1810, the river at Norridgewock was bridged by a structure that has since been the subject of more washouts than any other on the Kennebec. Surprisingly, a bridge at Waterville was not constructed until 1824. Yet, as Ernest Marriner notes, it was precisely because of this difficulty in crossing the river to attend town meetings and church services that the people of Waterville separated from Winslow in 1802.[2] It is reported that this structure had a favorable effect upon the business of the town and helped establish it as a center for stage coach operations. Not until 1853 was a bridge built below Augusta; and then, this structure at Gardiner was approved only after great legislative debate and Supreme Court sanction.[3] The bridge had a swinging span to allow for free navigation to Augusta. By 1910 there were ten bridges crossing the Kennebec above Gardiner.

The Low Bridge

Even in the 1920's, an era of debate over the location of a bridge south of Gardiner, there was consternation over possible obstruction to navigation. But this issue had little bearing with the advent of modern swing

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[1] Louise Helen Coburn, Skowhegan on the Kennebec (Skowhegan, Maine: The Independent Reporter Press, 1941), p. 417.

[2] Ernest Marriner, Kennebec Yesterdays (Waterville, Maine: Colby College Press, 1954), p. 60.

[3] North, op. cit., p. 624.

and lift bridges. More important was the fact that the state was cut in two by the Kennebec from its mouth to the Gardiner bridge, forty miles upstream. All coast-wise traffic from Bath to Bar Harbor had to halt at the brink of this bridgeless stream and wait for what the Lewiston Journal referred to as "an antique system of transportation."[1] As The Kennebec Bridge Advocate of September 15, 1925, noted, "one hundred and sometimes double that number of cars in line are awaiting transportation across the Kennebec River on a boat which has a capacity of but 16 or 18 cars. . . . [This is] the weakest link in the entire highway system of the state."[2] Such delays were particularly great in the months of July through September, at the height of Maine's tourist season. That this outmoded system of transportation had adverse effects upon the economy of the area is indicated by a Portland Press Herald editorial of February 13, 1923.

> The building of a bridge across the Kennebec River at or near Bath is essential to the proper development of a section of the state which, since the advent of the automobile . . . has been comparatively isolated. The break in the line of communication by the Kennebec River has proved a serious handicap to the business interest of that [the eastern] part of the state.[3]

The rivalry to build a bridge south of Augusta began as early as 1799 when the people of Dresden sought to

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[1] Lewiston Journal, January 9, 1923, p. 1.

[2] The Kennebec Bridge Advocate (Bath, Maine), September 15, 1925.

[3] Press Herald (Portland, Maine), February 13, 1923, p. 4.

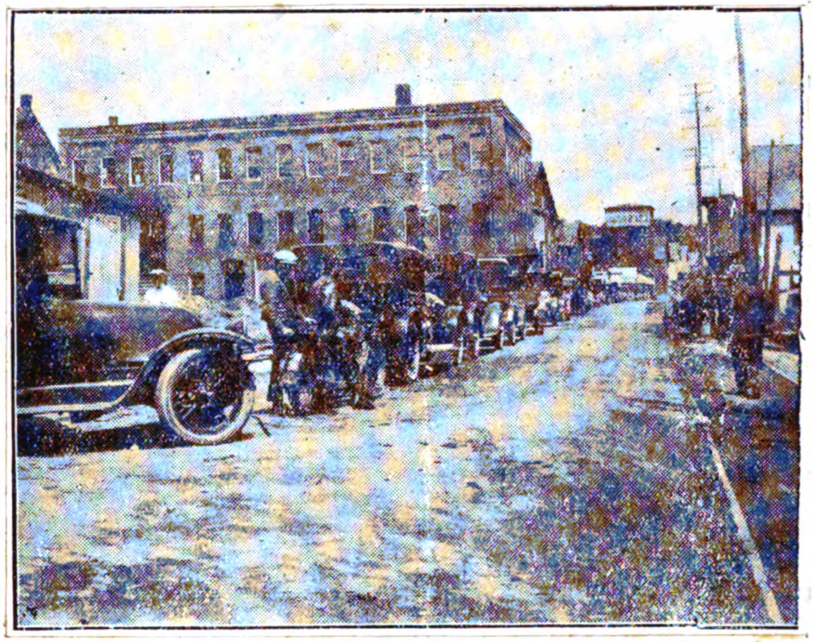

Figure 4.--In 1925, traffic congestion was the rule on the Bath-Woolwich ferry. Photograph from the Kennebec Bridge Advocate, September 15, 1925.

replace Call's Ferry with a bridge. This scheme was proposed again in 1805, but on both occasions it came to grief because of objections by navigation conscious people who lived upstream.[1] At Bath, agitation for a bridge was not officially broached until 1860, six years after the construction of the Gardiner bridge.[2] It was not before

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[1]For information on these proposals, see Silas Adams, The History of the Town of Bowdoinham, 1762-1912 (Fairfield, Maine: Fairfield Publishing Co., 1912), p. 7, and Charles Edwin Allen, History of Dresden Maine (Dresden, Maine: Bertram E. Packard, 1931), pp. 502-503.

[2]Henry Wilson Owen, The Edward Clarence Plummer History of Bath, Maine (Bath, Maine: The Times Co., 1936), p. 374.

the 1920's, however, that a bridge at Bath became a matter of state rather than local concern. That the Bath ferry was placed under state control in 1921 is evidence that it had become an important link on a trunk highway. In 1923 the ferry carried 337,188 passengers, 88,000 automobiles, and 9,136 horse drawn vehicles.[1] Such traffic volumes, along with the congestion and delays during the tourist season, warranted state action.

The local jealousy of the citizens of Richmond and Dresden prompted them to seek a bridge crossing at the expense of Bath. The state, however, voted to build bridges at both locations. In 1930, a bridge with a swing span was completed at Richmond, and, in 1931, a three million dollar combination railway and highway lift-bridge was dedicated at Bath. In that year the Bath bridge carried an impressive 397,000 vehicles—representing a great magnitude of induced traffic.[2]

Despite the many efforts to secure the bridge between Bath and Woolwich, the Kennebec Journal of September 23, 1927, notes that there were many businessmen in both towns that believed a bridge would obviate the necessity of traffic to stop and thus threaten their existence. Traffic could sweep right through Bath and

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[1] Ibid., p. 345.

[2] Maine State Planning Board, Maine State Planning Board Report: March 15, 1934–March 15, 1935 (Augusta, Maine: Maine State Planning Board, 1936), p. 60.

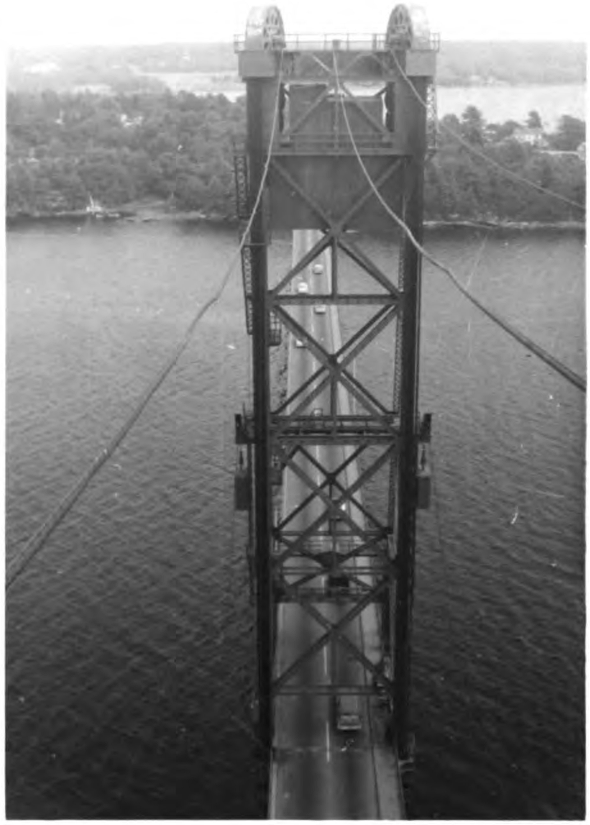

Figure 5.—This modern combination highway and railway lift-bridge now spans the Kennebec at Bath. It was completed in 1931.

Woolwich to Portland and Lewiston.[1] Census counts of 1920 through 1960, however, show no signs of decay in either town.

The Covered Toll Bridges

Most of the bridges built across the Kennebec prior to 1890 were covered wooden structures such as the one at The Forks, pictured in Figure 6. Although the covered bridge was built to outlast the open wooden structures by fifty years or more, few of the Kennebec covered bridges lasted more than a decade. The great ice freshets of winter and spring carried away a high toll in bridges.

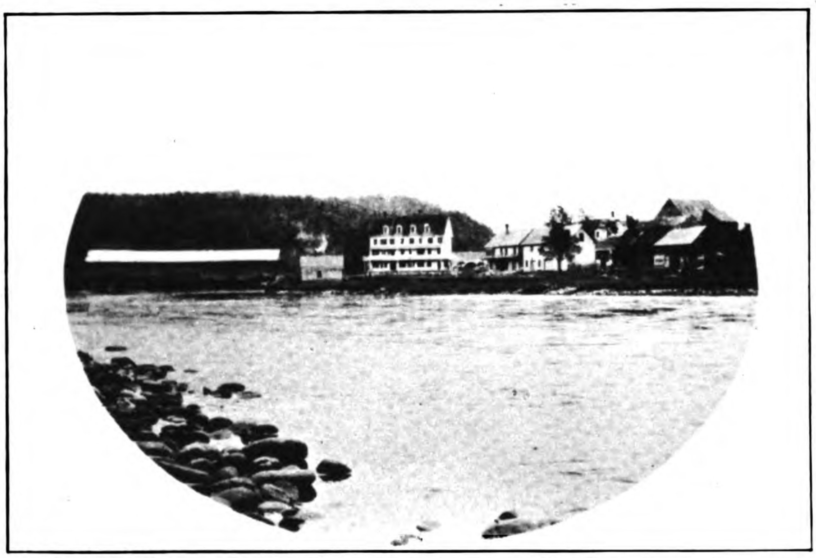

Figure 6.--This bridge at The Forks was built during the 1850's and was not replaced until 1932. The original photo (dated 1870) is in the possession of Mrs. Eva Farley of The Forks.

[1] The Kennebec Journal (Augusta), September 23, 1927, p. 1.

Norridgewock had six of its early crossings swept away by the raging ice. The greatest of these freshets was in 1832 when every bridge on the Kennebec went swirling down river.

All bridges built before 1870 were constructed by private toll companies. At this time municipalities were, for the most part, unable to shoulder the expense of building adequate structures. But, as soon as they attained any degree of financial stability, they made the toll bridge the object of much dissatisfaction and sought to buy out the private companies and establish free bridges. By 1890 all of the bridges on the Kennebec were free to the public except the Madison-Anson bridge which was not made free until 1902. (See Figures 2 and 3 for information on individual bridge crossings.) The state operated the Richmond and Bath bridges as toll crossings until their financing bonds were repaid. Presently, only the Augusta Memorial Bridge operates on a toll basis. Representative of the tolls charged on the early bridges are those of the proprietors of the Skowhegan bridge built in 1809.[1]

Chariot, coach or phaeton	37-1/2	cents
Single horse and chaise	20	"
Chaise drawn by two horses. . . .	25	"
Foot passengers	2	"
Rider on horse.	6-1/4	"
Single horse drawing a sleigh . .	12-1/2	"
Wheelbarrow or hand cart.	4	"
Sheep or hogs	6-1/4	" per dozen.

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[1]Marriner, op. cit., p. 60.

Despite the added convenience of the bridge over the ferry, toll charges of the Prentiss' Ferry (established in the same year as the Skowhegan bridge and located just a few miles downstream), as shown below, were more than double those for the bridge.[1]

Passenger on foot . . .	5	cents
Passenger and horse . .	12-1/2	"
Pair of oxen and man. .	17	"
Horse and chaise. . . .	25	"

Very few of the early bridges operated at a profit, for the cost of rebuilding them after destruction by freshets ate up most of the earnings. After the 1832 freshet, stocks in the Ticonic Bridge at Waterville were selling at a low 25 cents a share.[2]

Abandoning a Bridge

We have already seen the abandonment of ferry crossings after the construction of competing bridges. Needless to say, bridges are sometimes abandoned as well. One good example is the old Patterson Bridge which crossed the river about five miles north of Madison. This covered bridge, built in 1839, was unlike many of its sister bridges—it defied the successive annual freshets for 78 years until part of it was washed away in 1917. Despite a state legislative appropriation to repair the bridge, the

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[1]Coburn, *op. cit.*, p. 414.

[2]Clement M. Giveen, *A Chronology of Municipal History and Election Statistics, Waterville, Maine: 1771-1908* (Augusta, Maine: Maine Farmer Press, 1908), p. 85.

county (Somerset) refused to maintain it. Finally in 1927, it was destroyed by fire. The reason for county abandonment was clear--the roads leading to this bridge were no longer commonly travelled routes. Today, there are no roads leading to this site, and only the granite piers remain as testimony to the existence of the Kennebec's most enduring covered bridge.

Another Kennebec bridge to be abandoned was the Hallowell bridge, built in 1860 and destroyed by freshets in 1869 and in 1870. As a toll structure could not operate profitably with a free bridge at Augusta, the proprietors of the Hallowell bridge deemed it unwise to rebuild the bridge. Other abandoned bridges over the Kennebec include a footbridge and a highway bridge to the island at Fairfield.

Figure 7.--The remains of the Patterson Bridge--a covered wooden structure built in 1839 and destroyed by fire in 1927.

Kennebec Footbridges

Two of the most picturesque crossings of the Kennebec are footbridges, one at Skowhegan and the other at Waterville. In 1883 John Turner constructed a wire suspension footbridge across the south channel of the river from Skowhegan Island. This bridge was intended to give access to building lots which he was selling on the south side. Due to faulty cables the bridge collapsed in 1888, but it was replaced by the town that same year. Since then the bridge has been destroyed by two freshets—the last in 1936. Today, the more sturdy structure shown in Figure 8 is in service. There is one other footbridge at Skowhegan. The railroad bridge, which has always had a footpath on it, was converted into a permanent footbridge following the abandonment of regular rail service to Skowhegan in the early 1950's.

The Ticonic suspension footbridge at Waterville was built by a private company in 1903 at a cost of $18,000.[1] The bridge replaced a wooden structure that was erected in 1902 and swept downstream that same year. Traditionally, this bridge has been known as the "two cent bridge," but the cost of living has helped up the toll to five cents. The toll-keeper, who lives in a small house attached to one of the bridge towers, fifty feet above the water, estimates that approximately one hundred people use the

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[1]Henry Gratton Tyrrell, History of Bridge Engineering (Chicago: by the author, 1911), p. 251.

Figure 8.—This footbridge at Skowhegan was built in 1937.

Figure 9.—The Ticonic Footbridge, spanning the Kennebec between Waterville and Winslow, is one of the last toll footbridges in the United States. The small building to the left is the home of the toll-keeper.

"two cent bridge" daily.[1] Obviously, the bridge is not a paying proposition. In earlier years, when walking was the fashion, the bridge was made profitable by the hundreds of mill workers and travelers who crossed it each day. To attract clientele, the bridge offered commuter rates—one hundred tickets for $1.25. Pedestrians now use the free city-owned bridge, one-half mile down river. The foot-bridge was recently purchased by a group of local citizens seeking to preserve it as a tourist attraction. According to Harry A. Packard, this bridge is the last of its kind in New England and, perhaps, in the United States.[2]

Conclusion

This brief survey of the historical geography of the Kennebec River crossings has sought to illustrate the evolution of man's attempts to solve the problem of river crossing and, to a lesser extent, it has touched upon the impact of these structures upon man's patterns of settlement and movement. In the next chapter our emphasis will be on the present function of Kennebec highway bridges as integral components of Maine's highway system. The nature, density, and origin of traffic using these bridges will be graphically and statistically scrutinized to give us a more meaningful picture of the utility and classification of these bridges.

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[1]Interview with the toll-keeper of the Ticonic Footbridge, July 15, 1964.

[2]Harry A. Packard, "Bridging the Gap," The New York Times, April 12, 1964.

CHAPTER V

THE CLASSIFICATION OF KENNEBEC BRIDGES

Having seen in the last chapter how the individual Kennebec River crossings have progressively advanced from the ford and ferry to the bridge, we shall now attempt to fit them into the geographical classification developed in Chapter III. This classification is geographical because it is based upon the areal extent and nature of the bridge's hinterland. The classification is also nested, in the hierarchical sense, in that a bridge of given order will also include all lower order designations. As noted previously, the hierarchical order of this classification includes the:

1. first order bridges . . . rural,
2. second order bridges. . . intra-urban,
3. third order bridges . . . interregional,
4. fourth order bridges. . . urban-interregional, and
5. fifth order bridges . . . nodal.

Thus, an urban-interregional bridge is also an interregional bridge, an intra-urban bridge, and a rural bridge. The national bridge, discussed in Chapter III, belongs to a special class of bridges and does not fit into our hierarchical classification. Sometimes in the future, it may be feasible to include the inter-continental bridge in our classification.

In this chapter we shall make the distinction between a bridge's local hinterland and its interregional hinterland and proceed to clarify the two concepts by classifying bridges in accordance with the following criteria:

1. The function of individual bridges.
2. The volume and nature of traffic crossing them.
3. The origin of traffic and the proportion of non-local (out-of-state) traffic using the bridge.
4. The traffic and bridge hinterland associations with: one, the number and orientation of roads served by the bridge; two, the population density of the area about the bridge; and three, the locations of neighboring bridges.
5. The accessibility that a bridge has to its surrounding area, as the principal criteria used in delimiting its local hinterland; and its proportion and volume of out-of-state traffic, as the criteria for determining its interregional significance.

Thirteen highway bridges along the Kennebec were classified according to the above criteria. Although this sample was deemed adequate for developing a foundation for classifying bridges geographically, it is clear that a more detailed study of a larger sample of bridges over a longer period would lead to more precise conclusions than is possible now. As the field study covered a six-week period at the height of Maine's tourist season (August and September), it is realized that the greater than average volumes and the greater proportions of out-of-state traffic using Maine highways during this period would have bearing upon any attempted conclusions. It has, therefore, been this author's objective to keep conclusions tentative, i. e., commensurate with the time and methods of field research and with the reliability of information and data used. With this in mind, we shall begin classifying the bridges spanning the Kennebec.

Classifying Bridges According to Functions

In the chapter on the historical geography of Kennebec River bridges, we indicated the presence of footbridges, a waterpipe bridge, railroad bridges, and highway bridges. This was a functional classification based on the nature of traffic crossing the bridge. In this sense, many bridges are multifunctional—carrying both a footwalk and a vehicular highway. The Bath bridge combines a foot, automobile, and railroad crossing. In essence, however, all bridges have the same function—to enable someone or something to cross or be carried to the other side without breaking the continuity of the pathway. In that our primary attention is focused upon automobile bridges, we must seek a more detailed functional classification. Such a classification is found in Table 1. This classification is based upon the roadways carried by the bridge—interstate highways, U. S. highways, and state highways. The table shows the number of traffic lanes carried by the bridge, the nature of its water clearance for navigation,

TABLE 1

KENNEBEC BRIDGES CLASSIFIED ACCORDING TO THE TYPES OF ROADWAYS CARRIED

Bridge	No. Traffic Lanes	Boat Clearance	1st Br. Built	No. Times Replaced	Present Br. Built
Bridges Carrying Interstate Highways					
Int. Hwy. 95	4	No	1964	0	1964
Bridges Carrying Both National and State Highways					
Augusta	2 Bridges, 6 Lanes	For small craft	1797	4	1894—Ken. Br. 1949—Toll Br.
Norridgewock	2	No	1810	9	1928
Madison	2	No	1810	7	1902
Waterville	2	No	1824	5	1884 (Reconstr. in 1936)
Bridges Carrying National Highways					
Skowhegan	2	No	1809	2	1904
The Forks	2	No	1850[a]	1	1932
Solon	2	No	1911	0	1911
Bath	2	Lift Span	1931	0	1931
Bridges Carrying State Highways					
Fairfield	2	No	1848	2	1934
Gardiner	2	Sw. Span	1853	1	1896
Bingham	2	No	1905	0	1905
Hinckley	2	No	1910	0	1910
Richmond	2	Sw. Span	1930	1	1936

[a] Estimate

and, in addition, historical data that affords us an idea of the strength of human commitment to the bridge.

This classification will be of significance to us in a number of future considerations. For instance, if a bridge carries an interstate or a national highway, we could expect it to handle greater volumes of interregional traffic than it would if it carried a state highway. Those providing navigational clearance for river traffic help us to identify the portion of a river having the greatest potential for a nodal crossing. The year that the first bridge was built indicates how early human commitment to a site warranted a continuous crossing; and, the number of times that the bridge has been replaced, either after destruction by natural forces or after decay of an older structure, indicates the strength of this human commitment to the bridge crossing. In contrast with the abandonment of the Patterson Bridge, for example, the Norridgewock bridge has been replaced nine times in 118 years--six times after destruction by floods and ice freshets. The Madison bridge has been replaced seven times, and the Waterville bridge has been replaced five times. The commitment to these river crossings is clearly evident.

Classifying Bridges According to Traffic

All but three of the bridges across the Kennebec are vestiges of the last century. These bridges, however, have been strengthened to meet the traffic demands associated with this century's technological impact upon man's mobility. From the latest available traffic counts, it is estimated that approximately 85,000 motor vehicles cross the Kennebec River daily.[1] As people tend to distribute themselves unevenly over earth space and as different roads have different degrees of human commitment or are "stronger" than others, it can be expected that certain of the Kennebec bridges will carry a greater burden of this traffic than others. This is shown in Figure 10 on the next page. By arranging these traffic volume figures in a diagram organized according to the geographical positioning of these bridges along the river north to south, we see that the primary area of river crossing lies along the river's lower middle course, from Skowhegan to Gardiner. Over seventy-five per cent of all traffic across the Kennebec is by way of the eight bridges along this forty mile stretch of the river. The Augusta and Waterville crossings alone account for over half of the traffic crossing the river.

Since World War II the Augusta and Waterville crossings have shown significant traffic increase. This increase exceeds 100 per cent for the Waterville Bridge and for the Augusta Memorial Toll Bridge. As shown by Figure 11, traffic on the other briges has remained relatively

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[1]From counts made available by the Planning and Traffic Division of the Maine State Highway Commission. Average daily traffic is determined by taking the average weekday count, multiplying by 5, adding the average counts for Saturday and Sunday, and dividing by 7.

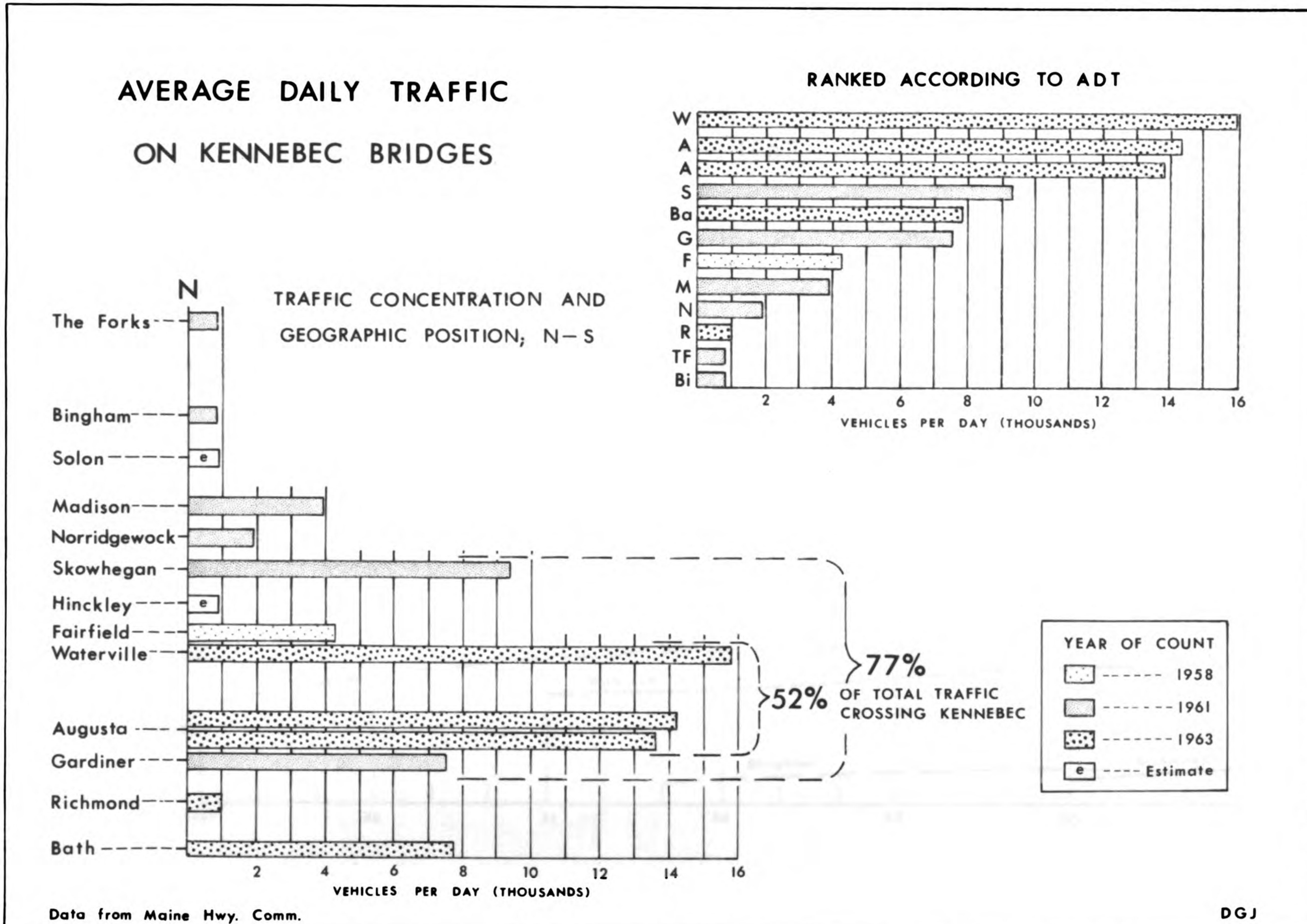
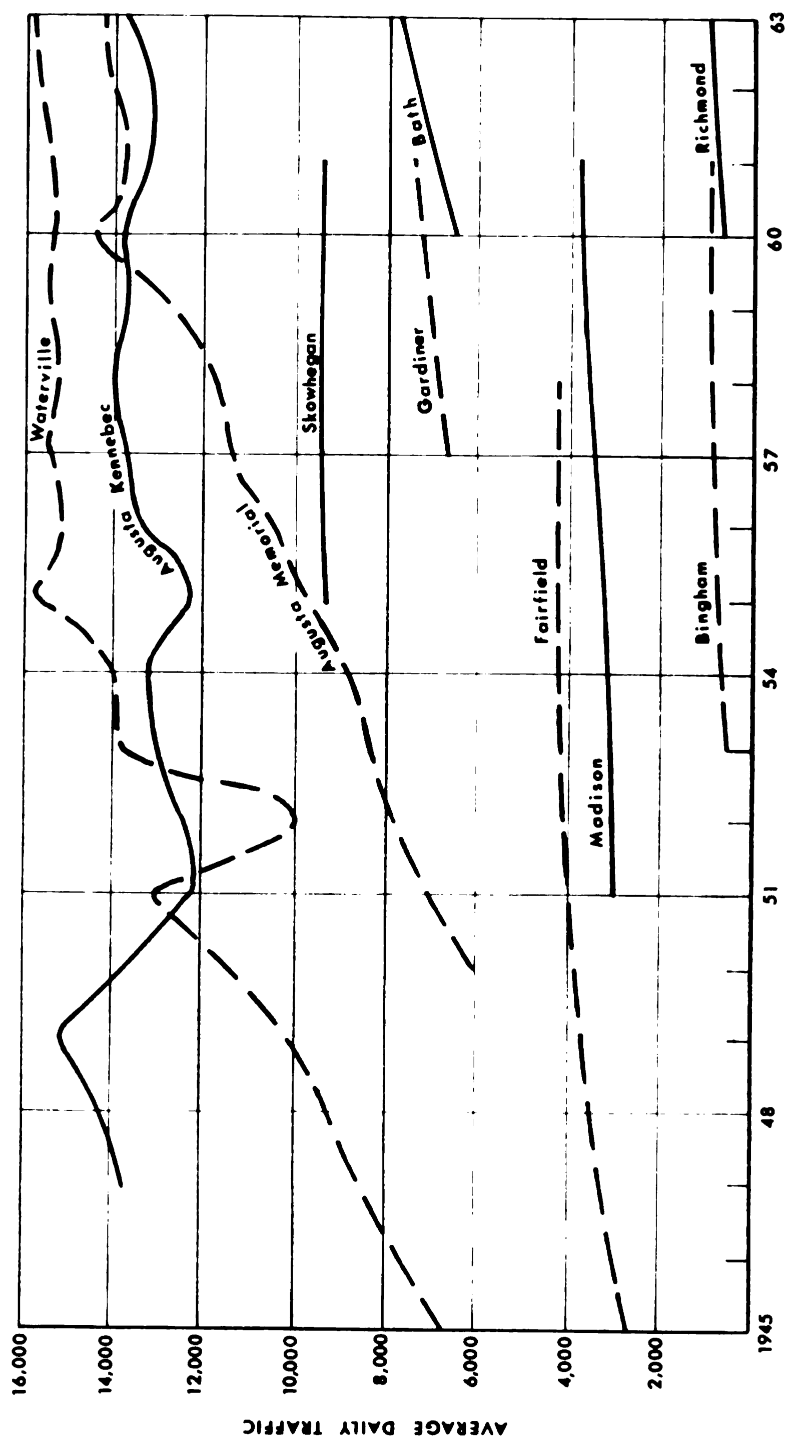

AVERAGE DAILY TRAFFIC
ON KENNEBEC BRIDGES
TRAFFIC CONCENTRATION AND
GEOGRAPHIC POSITION; N—S
N
The Forks
Bingham
Solon
Madison
Norridgewock
Skowhegan
Hinckley
Fairfield
Waterville
Augusta
Gardiner
Richmond
Bath
e
2 4 6 8 10 12 14 16
VEHICLES PER DAY (THOUSANDS)
RANKED ACCORDING TO ADT
W
A
A
S
Ba
G
F
M
N
R
TF
Bi
2 4 6 8 10 12 14 16
VEHICLES PER DAY (THOUSANDS)
52%
77%
OF TOTAL TRAFFIC
CROSSING KENNEBEC
YEAR OF COUNT
1958
1961
1963
Estimate
Data from Maine Hwy. Comm.
DGJ

Fig. 10

AVERAGE DAILY TRAFFIC ON KENNEBEC BRIDGES

1945 —— 1963



DATA FROM MAINE HWY. COMM.

Fig. 11

DGJ—64

stable since the war. Unfortunately, regular counts are not made at a number of these crossings, and no official counts were available for the Hinckley and Solon bridges.

The Association of Bridge Traffic with Different Indirect Measures of Accessibility

It is logical to suspect that the number of radiating paved roads converging upon a bridge, the spacing of bridges along the river, and the density of population in the area about the bridge would have a bearing upon the frequency of bridge crossings. Table 2 has the Kennebec bridges ranked according to their average daily traffic volumes and shows the number of radiating paved roads converging within a three mile radius of each bridge midpoint, the distance from each bridge to the next nearest bridge, and the population densities for a selected area about each bridge.

The values in Table 2 are presented in graph form on page 65. As indicated by the graphs, these values reveal a general trend for traffic volumes to increase as the number of radiating paved roads and the population densities increase and as the distance of the next nearest bridge decreases.

Bridges Classified According to Traffic Accessibility--Measuring the Local Hinterland of a Bridge

As indicated in Chapter III, the hinterland of a bridge is that area from which the traffic using the bridge

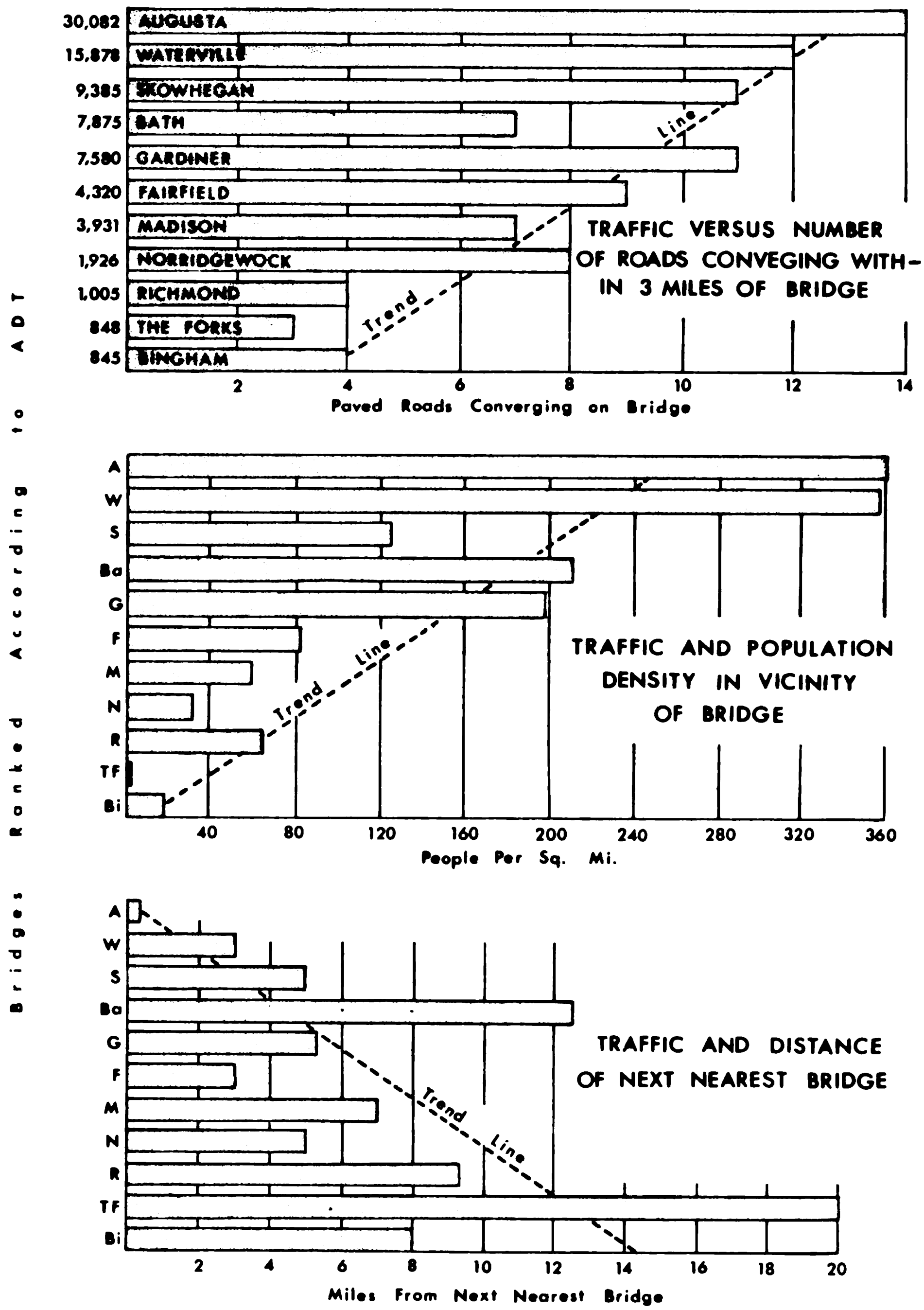
TABLE 2

THE RELATIONSHIP OF KENNEBEC BRIDGE TRAFFIC TO
THREE INDIRECT MEASURES OF ACCESSIBILITY

Bridges Ranked in Order of ADT	Number of Paved Highways Converging within 3 mile Radius of Bridge	Distance of Next Nearest Ken. Bridge	Density of Population in Select Area about Each Bridge*		
			Pop.	Sq. Miles	Pop. Dens.
Augusta Ken. / Mem.	14	.4 miles / .4 "	21,680	60.0	361.33
Waterville	12	3.1 "	27,661	77.1	358.76
Skowhegan	11	5.0 "	7,661	61.7	124.17
Bath	7	9.3 "	12,134	57.0	212.81
Gardiner	11	5.4 "	9,843	50.3	195.68
Fairfield	9	3.1 "	7,350	87.8	82.45
Madison	7	7.1 "	6,187	104.0	59.49
Norridgewock	8	5.0 "	1,634	49.7	32.88
Richmond	4	9.3 "	4,584	67.0	68.42
The Forks	3	20.1 "	53	42.0	1.26
Bingham	4	8.0	1,423	75.4	18.87

*These areas include the civil units (towns or plantations) in which the bridges are located or join. The figures for the Waterville-Winslow bridge include the population and area of the Town of Oakland, and figures for the Gardiner-Randolph bridge include the population and area of the Town of Pittston.

ASSOCIATION OF BRIDGE TRAFFIC WITH INDIRECT MEASURES OF ACCESSIBILITY



Trend Lines Established Graphically

DGJ

Fig. 12

originates. One of the more accurate ways of determining this traffic origin would be to interview a sample of vehicle operators crossing each bridge. However, aside from the illegality of stopping traffic on Maine highways, this procedure was impracticable. As an alternative, it was decided to approach the delimiting of a bridge's local hinterland by studying its traffic accessibility. This was accomplished by assessing the capacity of the roads radiating from the bridge to accommodate the populace having need to cross the river and by measuring the outward extent of the area having relatively easy access to the bridge.

For our purposes, the area of bridge accessibility will be defined as that area in which all human establishments are within one and one-half miles of a paved road having direct access to the bridge. This one and one-half mile distance was chosen after experimentation aimed at avoiding, where possible, overlapping bridge hinterlands and, at the same time, providing maximum coverage of the river valley. Geometrically, it can be proven that the greater the number of highways having direct access to the bridge, the greater is the area that will fall into the defined area of bridge accessibility. This is illustrated by the diagram on the following page.

In delimiting the area of greatest accessibility (i. e., the local bridge hinterland) for Kennebec bridges, a road radiating from the bridge must meet the following requirements:

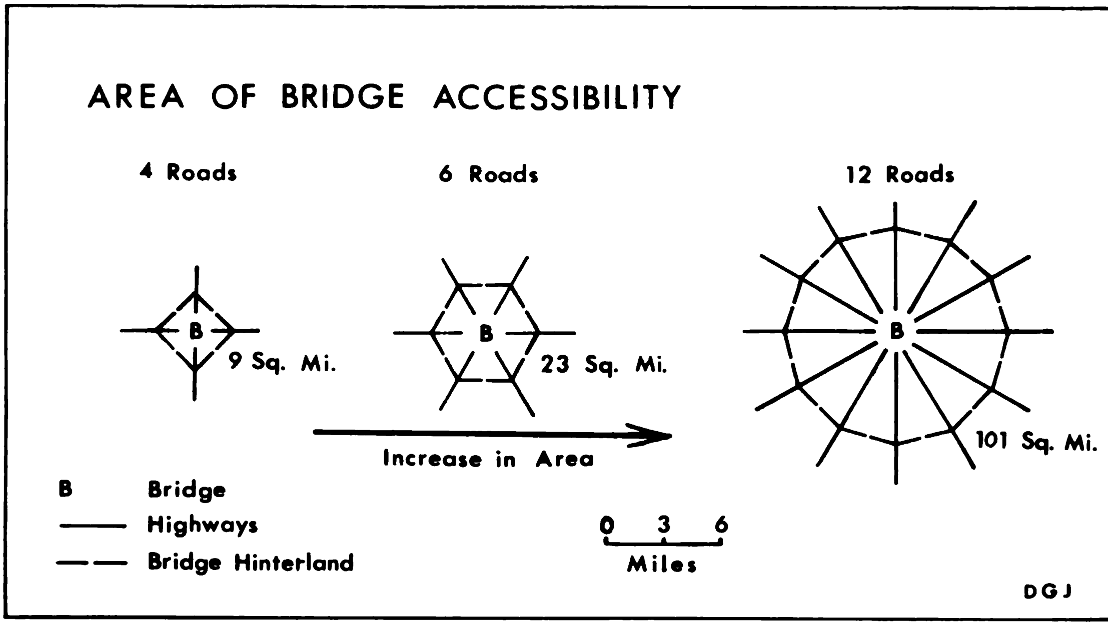


Fig. 13

1. It must be a paved road that has either direct access to the bridge or that converges within a three mile radius of it onto a road having direct bridge access.

2. It must lead to a community or other significant human establishment, or it must be paralleled by a significant alignment of settlement.

3. It must not run parallel within one and one-half miles of another road leading to the same focal center—such as roads paralleling both the right and left banks of a river. The latter instance would be counted as one road.

As an example of the procedure used in this study, let us define the area of greatest accessibility for the Waterville-Winslow bridge. As shown on the map on the next page, this bridge has twelve significant paved highways converging within a three mile radius of it. Average highway alignment lines were assigned and oriented as closely as possible with each of these roads. The two highways

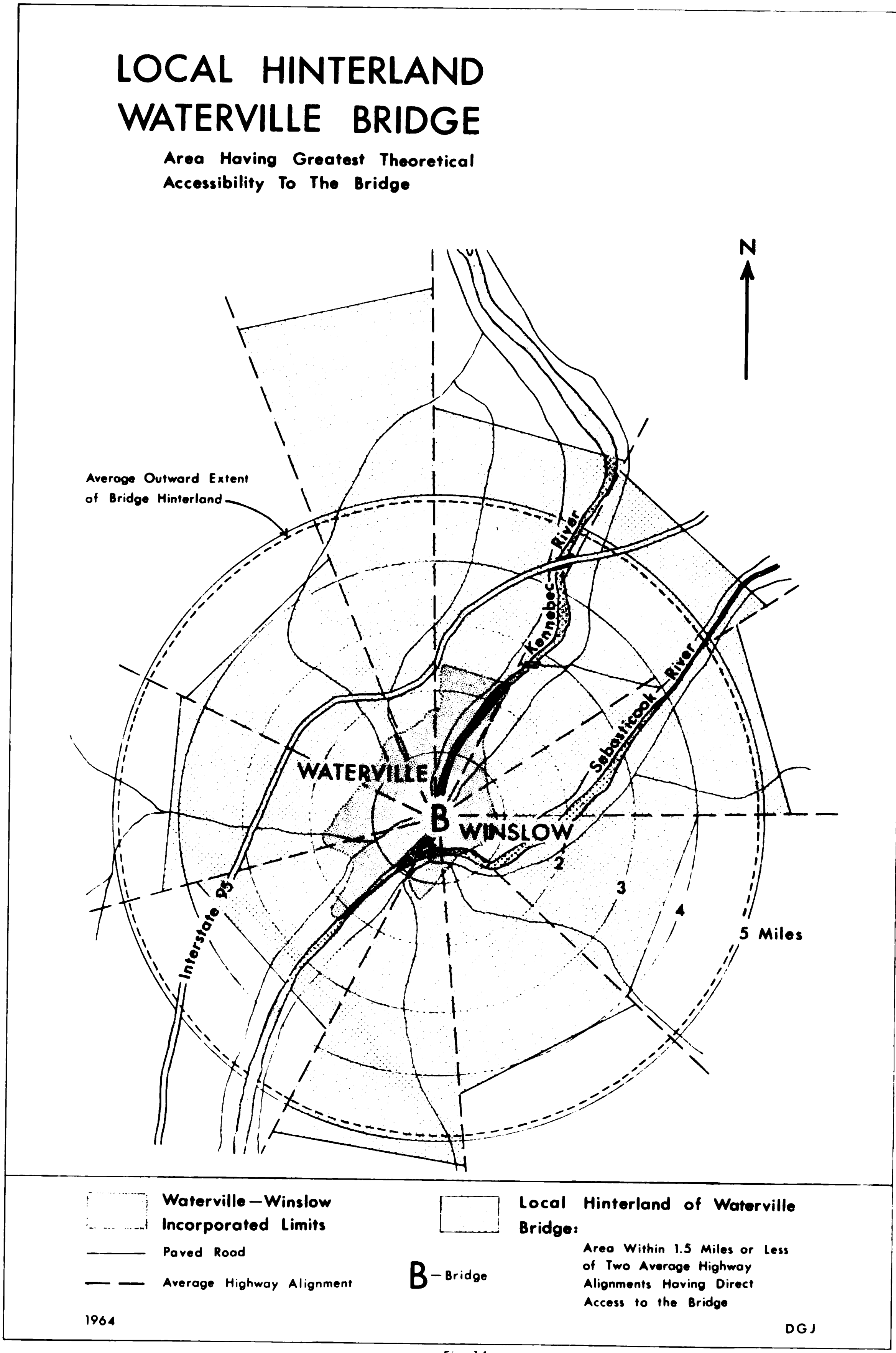

LOCAL HINTERLAND
WATERVILLE BRIDGE
Area Having Greatest Theoretical
Accessibility To The Bridge
N
Average Outward Extent
of Bridge Hinterland
Kennebec River
Sebasticook River
WATERVILLE
B
WINSLOW
2
3
4
5 Miles
Interstate 95
Waterville—Winslow
Incorporated Limits
Paved Road
Average Highway Alignment
B — Bridge
Local Hinterland of Waterville
Bridge:
Area Within 1.5 Miles or Less
of Two Average Highway
Alignments Having Direct
Access to the Bridge
1964
DGJ

Fig. 14

paralleling the river north of the bridge counted as one average highway line. A three mile distance was then measured between successive sets of average highway lines such that they formed isosceles triangles. Having done this, we have delimited an area in which all points are within one and one-half miles of a road having direct access to the bridge. It is now possible to secure an index of the average extent of the Waterville bridge hinterland by averaging the heights of the isosceles triangles formed by the road alignment lines and the three mile base. For the Waterville bridge this was 4.86 miles.

This procedure was followed for all of the Kennebec bridges. The results are shown in the table on the next page and on the map on page 71.

An analysis of the map enables us to visualize a number of significant factors concerning the Kennebec bridge hinterlands and to make comparisons among them. As a result, the following generalizations may be made:

1. The bridge hinterlands along the Kennebec tend to cluster into three groups:
   a. The Solon to Waterville group
   b. Augusta and Gardiner
   c. Richmond and Bath.

   Each of these clusters is associated with areas of more dense population than is to be found about the isolated bridge hinterlands of The Forks and Bingham.

2. There is an overlapping of bridge hinterlands in the more densely populated areas. This is noted between Augusta and Gardiner, but is most pronounced between the Waterville and Fairfield

TABLE 3

INDEX OF THE AVERAGE EXTENT OF KENNEBEC BRIDGE HINTERLANDS

Bridges Ranked According to ADT Counts	Number of Paved Roads Converging within 3 mile Radius of Bridge	Number of Road Alignments	Index of the Average Extent of Kennebec Br. Hinterlands (In miles)
Augusta	14	10	5.24
Waterville	12	10	4.86
Skowhegan	11	8	4.75
Bath	7	6	4.40
Gardiner	11	7	3.88
Fairfield	9	6	3.50
Madison	7	7	3.40
Norridgewock	8	6	2.80
Richmond	4	4	1.70
The Forks	3	3	.93
Bingham	4	3	1.00
Hinckley	5	4	2.93*
Solon	5	4	1.90*

*Average daily traffic counts were not available for the Hinckley and Solon bridges.


LOCAL HINTERLANDS
KENNEBEC RIVER BRIDGES
N
THE FORKS
BINGHAM
45°
SOLON
MADISON
SKOWHEGAN
NORRIDGEWOCK
HINCKLEY
FAIRFIELD
WATERVILLE
AUGUSTA
GARDINER
RICHMOND
44°
BATH
70°
Bridge
Average Alignment of Highway
3 Miles
A SECTOR OF A LOCAL HINTERLAND:
THE AREA WITHIN 1.5 MILES OR LESS OF TWO AVERAGE HIGHWAY ALIGNMENTS HAVING DIRECT ACCESS TO THE BRIDGE.
0 5 10
Miles
1964
DGJ

Fig. 15

bridges. This overlapping could be referred to as a mutual invasion of bridge hinterlands. It will be recalled from the last chapter that it was competition with the Augusta bridge that forced the abandonment of the Hallowell bridge in 1870. There is, however, little danger of the Fairfield or Waterville bridge being abandoned. In fact, there is presently much talk about the need for an additional bridge in this area.

3. Of all the Kennebec bridge hinterlands, the ones for the Waterville and Madison bridges conform most closely to the theoretical circle of accessibility. This is due to a greater equality of angles formed by the highway alignment lines.

4. The significant skewness of the bridge hinterlands for The Forks, Bingham, and Hinckley is most likely the result of the uneven spread of population in directions outward from these bridges and, in this case, is associated with three of the valley's smaller communities.

5. The elongation of the hinterlands for the Augusta, Bath, and Skowhegan bridges indicates either significant settlement aligned with the river or, as for Skowhegan, an alignment of settlement along the old Canada Road (now U. S. 201) and along routes leading to the recreational area about Wesserunsett Lake.

6. As shown by the graph on the following page, there is a correspondence between the average daily traffic counts and the average extent of hinterlands for the Kennebec bridges.

Bridges Classified According to Interregional Significance

Our efforts to develop an index of the bridge's area of accessibility have given us an indication of the geographical extent of its local hinterland. It is safe to assume that certain bridges, particularly those on well traveled national highways, also have an interregional hinterland. Although it is not essential to the purpose of this paper that the interregional hinterlands for these

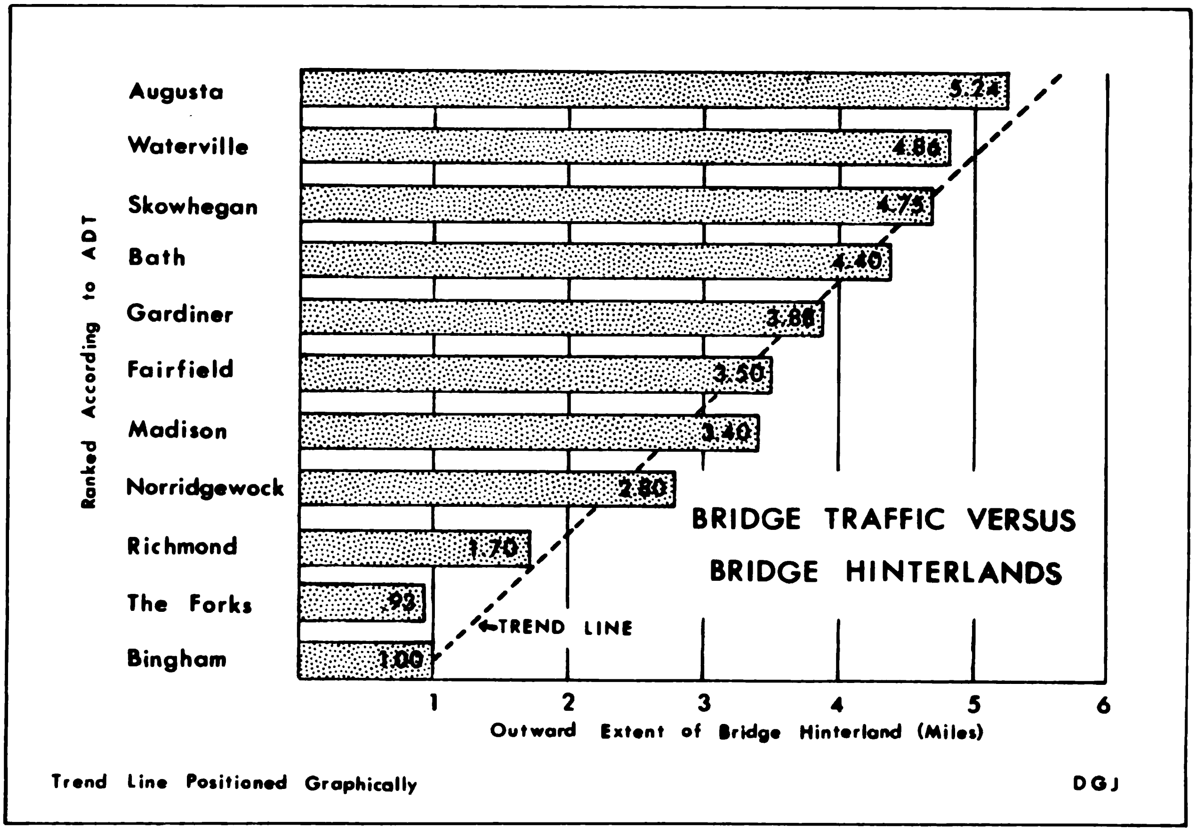


Fig. 16

bridges be defined, it is incumbent that we be able to measure their interregional significance. The criteria for this measurement will be the volume and proportion of interregional traffic using each bridge. Consequently, the states of origin are recorded for a sample of vehicles crossing thirteen of the Kennebec bridges. So that this study could be viewed in the framework of the broader picture, similar counts were made at key points on Maine's southwestern border. In this way, since the data may be assumed to be of a comparable nature, it was possible to measure the fall-off of out-of-state traffic across the state from west to east.

The four border stations selected account for approximately 81 per cent of the total traffic[1] and approximately 90 per cent of all out-of-state traffic[2] crossing Maine's southern and western borders. The greater proportion of this traffic enters the state by way of the two Kittery crossings—the Maine Turnpike and U. S. highway 1.

For the traffic surveys, only origins of vehicles entering Maine or crossing the Kennebec from west to east were counted. It is safe to assume, however, that these counts were representative of traffic crossing from both directions, for as noted in a study conducted for the Washington State Highway Commission, "previous experience has shown statistically that interviews conducted in one direction give an accurate representation of two-way travel by assuming the opposite direction of travel is equal in volume but opposite in origin and destination."[3]

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[1]Maine State Highway Commission, Planning and Traffic Division, State of Maine Traffic Flow Map, 1961 (Augusta, Maine: Maine State Highway Commission, October, 1962).

[2]Interview with Roger L. Mallar, Assistant Director of Planning and Traffic Division, Maine State Highway Commission, August 4, 1964.

[3]Review and Analysis of a Report on Second Lake Washington Bridge Location, Engineering Studies and Estimates by DeLeuw and Co., A report prepared by the Dept. of Hwys. Plan. Div. (Olympia, Washington: Washington State Highway Commission, December, 1956), p. 6.

Where possible, all surveys were conducted during daytime hours at times of normal traffic flow. With a few exceptions, week-end surveys were avoided as the week-end out-of-state traffic in Maine is estimated to run about 10 per cent above the weekday average.[1] Maine traffic was subtracted from the total counts for each crossing to determine the number and proportion of non-local (out-of-state) vehicles crossing the Kennebec. To determine the number and proportion of non-local vehicles crossing the Maine-New Hampshire border, both Maine and New Hampshire traffic was subtracted from the total count. Table 4 shows the location, time, and duration of each count and records the total traffic counted and the percentage of non-local vehicles using each bridge.

To compare the significance of each bridge as a channel of interstate traffic, it is necessary to adjust the original counts to a one hour base. This is accomplished in Table 5. This table shows the importance of the Bath and the Skowhegan bridges as links on roads handling considerable interregional traffic. Together, these bridges account for nearly half (46 per cent) of all out-of-staters crossing the Kennebec. The two other bridges carrying a large total of out-of-state traffic across the Kennebec are the Fairfield Bridge and the Augusta Memorial Toll Bridge. The high degree of

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[1]Interview with Harold Houdlette, Manager of Augusta Memorial Toll Bridge, August 13, 1964.

TABLE 4

BASIC TRAFFIC SURVEY DATA FOR KENNEBEC RIVER BRIDGES AND MAINE-NEW HAMPSHIRE BORDER

Bridge	Date	Day	Time	Hrs.	Total* Count	Total, exc. Local	Per Cent Non-Local
Kennebec River Bridges							
Waterville	Aug. 21	Fri.	10AM-11AM	1	527	42	7.97
Augusta Mem.	Aug. 13	Thurs.	7AM-4PM	9	3,322	584	17.58
Skowhegan	Aug. 24	Mon.	1PM-2PM	1	446	101	22.65
Bath	Aug. 20	Thurs.	6AM-12PM	6	1,749	718	41.05
Gardiner	Aug. 20	Thurs.	4PM-5PM	1	341	21	6.16
Fairfield	Aug. 14	Fri.	7AM-4PM	9	2,415	610	25.25
Madison	Aug. 24	Mon.	2PM-3PM	1	146	11	7.53
Norridgewock	Aug. 24	Mon.	3PM-4PM	1	63	3	4.76
Richmond	Aug. 20	Thurs.	2PM-3PM	1	42	3	7.14
The Forks	Aug. 22	Sat.	10AM-11AM	1	59	39	67.24
Bingham	Aug. 22	Sat.	1PM-2PM	1	36	0	.00
Solon	Aug. 22	Sat.	3PM-4PM	1	38	3	7.89
Hinckley	Aug. 17	Mon.	1PM-2PM	1	19	1	5.26
Totals				34	9,203	2,136	
Maine-New Hampshire Border							
Me. Turnpike	Aug. 19	Wed.	2PM-8PM	6	4,112	2,491	60.58
U. S. Hwy. 1	Aug. 19	Wed.	7AM-1PM	6	3,391	916	27.01
Berwick, Me.	Aug. 18	Tues.	7AM-10AM	3	448	36	8,04
S. Lebanon, Me.	Aug. 18	Tues.	12PM-3PM	3	301	84	27.91
Totals				18	8,252	3,527	

*West to east traffic on Kennebec bridges; traffic entering Maine for border counts.

TABLE 5

OUT-OF-STATE TRAFFIC CROSSINGS OF KENNEBEC RIVER AND MAINE-NEW HAMPSHIRE BORDER

Me.-N. H. Border—Entering Maine			Kennebec River—West to East		
Bridge	No. Per Hour[1]	% of Tot. Non-Local Ent. Me.	Bridge	No. Per Hour[2]	% of Tot. Non-Local Ent. Me.
Me. Turnpike	415	68.30	Bath	120	25.12
U. S. Hwy. 1	153	25.12	Skowhegan	101	21.20
Berwich	12	1.97	Fairfield	68	14.23
S. Lebanon	28	4.61	Augusta Mem.	65	13.62
Total Per Hour	608	100.00	Waterville	42	8.82
			The Forks	39	8.19
			Gardiner	21	4.41
			Madison	11	2.31
			Norridgewock	3	.63
			Richmond	3	.63
			Solon	3	.63
			Hinckley	1	.21
			Bingham	0	.00
			Total Per Hour	477	100.00

[1] States other than Maine and New Hampshire

[2] States other than Maine

out-of-state traffic using the Fairfield Bridge (14 per cent of all non-local traffic transverse to the river), however, may be regarded as a temporary phenomenon. During the study period, the traffic on recently completed Interstate highway 95 was diverted to the Fairfield crossing while the new interstate highway bridge (one mile north of the Fairfield Bridge) was under construction. Figure 17 helps to illustrate the role that each bridge plays in permitting interregional travelers to cross the Kennebec.

The Geographical Classification of Kennebec Bridges

At this point it is possible to make some conclusions as to the geographical classification of the bridges studied. In the preceding chapter we established that none of the present Kennebec bridges fully satisfied the criteria for a "nodal" title and indicated that the railroad bridges would fall in with Barman's definition of a "national" bridge. (See Chapter III.) Our objective now is to label the Kennebec highway bridges as either urban-interregional, interregional, intra-urban, or rural.

It must be borne in mind that this classification is based upon data collected in the month of August—at the height of Maine's tourist season. Consequently, the resultant classification is valid only for the summer months. It is possible that data collected in December would lead to an entirely different classification. The

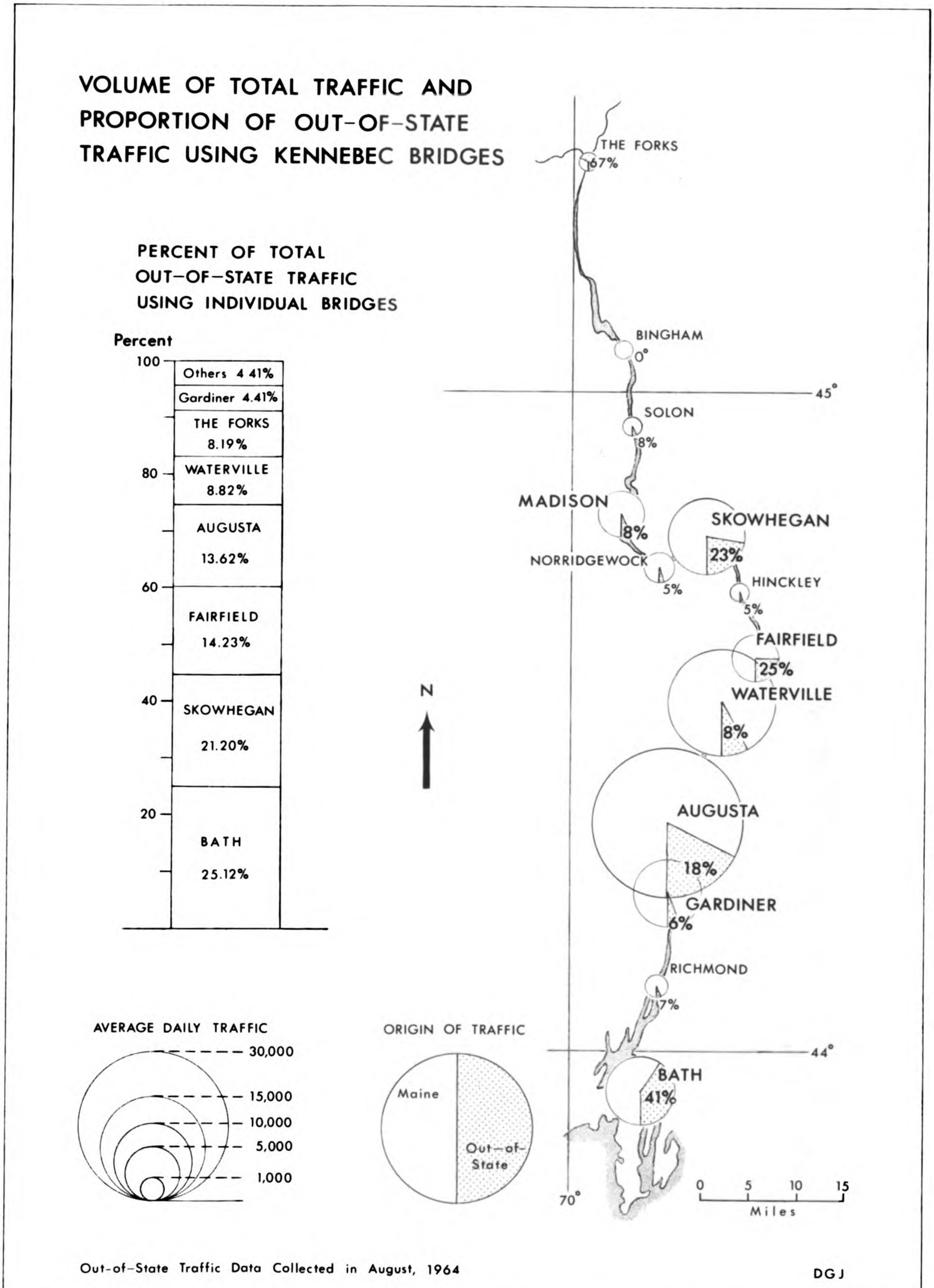
VOLUME OF TOTAL TRAFFIC AND PROPORTION OF OUT-OF-STATE TRAFFIC USING KENNEBEC BRIDGES
PERCENT OF TOTAL OUT-OF-STATE TRAFFIC USING INDIVIDUAL BRIDGES
Percent
100
80
60
40
20
Others 4.41%
Gardiner 4.41%
THE FORKS 8.19%
WATERVILLE 8.82%
AUGUSTA 13.62%
FAIRFIELD 14.23%
SKOWHEGAN 21.20%
BATH 25.12%
N
THE FORKS
67%
BINGHAM
0%
45°
SOLON
8%
MADISON
8%
SKOWHEGAN
23%
NORRIDGEWOCK
5%
HINCKLEY
5%
FAIRFIELD
25%
WATERVILLE
8%
AUGUSTA
18%
GARDINER
6%
RICHMOND
7%
44°
BATH
41%
70°
0 5 10 15
Miles
AVERAGE DAILY TRAFFIC
30,000
15,000
10,000
5,000
1,000
ORIGIN OF TRAFFIC
Maine
Out-of-State
Out-of-State Traffic Data Collected in August, 1964
DGJ

Fig. 17

map on the preceding page will provide a helpful reference in understanding this classification. Our first problem is to determine the degree to which a bridge is interregional. This is accomplished by an index of interregionality that takes into consideration the percentage and numerical values of out-of-state traffic. Thus, a bridge with a low ratio of non-local traffic can still qualify as an interregional bridge providing it has a high numerical count of non-local traffic. The interregionality index figure is derived by multiplying the one hour numerical average of non-local traffic by the percentage of total traffic that is non-local. Thus, the Bath-Woolwich bridge, having 240 non-local vehicles crossing it per hour or the equivalent of 41 per cent of its total hourly traffic, has an interregionality index rating of 98.4. An index of twenty is the minimum for a bridge to be designated "interregional."

The index of twenty as a dividing point was not based upon rigid objective standards,but rather upon what subjectively appeared a reasonable place to draw the line. Further study, beyond the scope of a Master's thesis, would be necessary to determine the optimum cut-off point of interregionality. In the table on the next page the Kennebec bridges are classified according to their geographical hinterlands. At this point it is well to recall the hierarchical nature of this classification.

The designations "urban," "intra-urban," and "rural" were based upon empirical observations of the

TABLE 6

GEOGRAPHICAL CLASSIFICATION OF KENNEBEC HIGHWAY BRIDGES

Bridge	Number Non-Local Autos Per Hour	% of Total Traffic that's Non-Local	Interregionality Index	Geographical Classification
Bath	240	41	98.4	Interregional
The Forks	78	67	52.3	Interregional
Skowhegan	202	23	46.5	Urban-Interreg.
Fairfield	136	25	34.0	Urban-Interreg.
Augusta Mem.	130	18	23.4	Urban-Interreg.
Waterville	84	8	6.7	Intra-Urban
Gardiner	42	6	2.5	Intra-Urban
Madison	22	8	1.7	Intra-Urban
Solon	6	8	.48	Rural
Richmond	6	7	.42	Rural
Norridgewock	6	5	.30	Rural
Hinckley	2	5	.10	Rural
Bingham	0	0	.00	Rural

bridge's cultural setting, the nature and extent of its local hinterland as defined earlier, an analysis of population densities in the vicinity of the bridge, and the type of traffic seen crossing it. As examples, traffic on the Hinckley and Richmond bridges consisted mostly of farm and service type vehicles; whereas, for the Waterville bridge, local business trucks and white and blue collar workers comprised the greater portion of the traffic. Where bridges were in the middle of nucleated settlements (such as at Augusta, Skowhegan, and Waterville), they clearly warranted an "urban" designation.

One other criteria not considered by the interregionality index is that for a bridge to be interregional, it must be a link on a road connecting areas having either physical, cultural, or economic characteristics complementary to each other. (See Chapter III, p. 28.) According to a Maine Turnpike traffic study of August, 1950, 72 per cent of all through traffic entering Maine by this route was vacation oriented—the greater portion being from the eastern urban centers of southern New England, New York, and the states bordering the eastern seaboard. On the average August day in 1950, 13,450 vehicles from New England (excluding Maine), 1,065 from New York, 347 from New Jersey, and 263 from Pennsylvania entered the state by way of the turnpike.[1] This traffic of

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[1]J. C. Carpenter, "Proportionate Use of Maine Turnpike by Traffic Through Portsmouth-Portland Corridor," Proceedings of the Highway Research Board, 32nd Annual Meeting, 1953, p. 463.

a distinctly urban origin had come to a region offering recreational opportunities differing from those of their home area—recreational opportunities of a more rural and outdoor flavor. Thus, based upon the above mentioned study, it is logical to believe that the out-of-state traffic crossing the Kennebec is motivated to enter eastern Maine for reasons that would confer upon those bridges so designated—an interregional status.

Fall-Off of Out-of-State Traffic Across Maine—West to East

Viewing this study of Kennebec bridges in a broader geographical setting, we shall now determine what proportion of out-of-state traffic entering Maine eventually crosses the Kennebec, and we shall consider the roles of the various states as contributors to the summer traffic on Maine highways. To do this, it is necessary to adjust counts made on the Kennebec so that they are numerically equal to counts made at the border crossings. This is done by subtracting 10.33 per cent of the total for Kennebec counts.[1] Thus, on the basis of numerically equal counts, it was seen that approximately 54 per cent of the out-of-staters entering the state eventually traversed the Kennebec. As a further comparison, we find that 43 per cent of all traffic crossing the Maine-New Hampshire border is from states other than Maine and New Hampshire and that

[1]The counts along the Kennebec included 10.33 per cent more observations than those along the Maine-New Hampshire border.

nearly 24 per cent of all traffic crossing the Kennebec is from beyond the Maine border.

The original station counts have been summarized in table form on the next page to show the states of origin of vehicles entering Maine from the west and crossing the Kennebec from west to east. This fall-off of out-of-state traffic from the border to the Kennebec is illustrated in Figure 18.

A study of Table 7 and Figure 18 suggests that the more highly urban northeastern states and the eastern Canadian provinces are the principal contributors to the out-of-state traffic on Maine highways. The states of the southeastern seaboard and the Midwest, along with Texas and California, also add significantly to this traffic--traffic which has conferred upon a number of Kennebec bridges an interregional status.

Aside from showing the movement of out-of-state traffic across Maine, this last chapter, based primarily upon field research, has sought to illustrate both the local and interregional significance of individual Kennebec bridges and to classify them according to the nature and extent of the geographical areas they serve. In this way it is hoped that these structures have been accorded their due recognition as functional parts of man's cultural landscape.

TABLE 7

ORIGIN OF TRAFFIC ENTERING MAINE FROM NEW HAMPSHIRE AND CROSSING THE KENNEBEC FROM THE WEST

Origin	Number Vehicles Entering Maine	Per Cent of Total Traffic Entering Maine	Number Vehicles* Crossing Ken. West to East	Per Cent of Total Traffic Crossing Ken.
Maine	2,257	27.36	6,336	76.78
Massachusetts	1,416	17.16	536	6.49
New York	476	5.77	287	3.48
Connecticut	279	3.39	164	1.98
New Jersey	203	2.46	126	1.53
Pennsylvania	159	1.92	97	1.17
New Hampshire	2,468	29.90	80	.97
Rhode Island	91	1.10	73	.88
Florida	79	.96	66	.81
Ohio	74	.90	51	.62
Maryland	68	.84	34	.41
Quebec	68	.84	45	.54
Virginia	67	.81	18	.22
Illinois	62	.63	25	.31
California	44	.54	17	.21
Michigan	44	.54	23	.28
Vermont	34	.42	17	.21
Nova Scotia	31	.39	48	.58
Ontario	31	.39	33	.40
Indiana	27	.34	8	.10
New Brunswick	22	.27	58	.71
Texas	22	.27	12	.14
Other areas	230	2.80	98	1.18
Totals	8,252	100.00	8,252	100.00

*The original counts, made in August, on Kennebec River bridges have been adjusted for comparability with those counts made along the Maine-New Hampshire border.

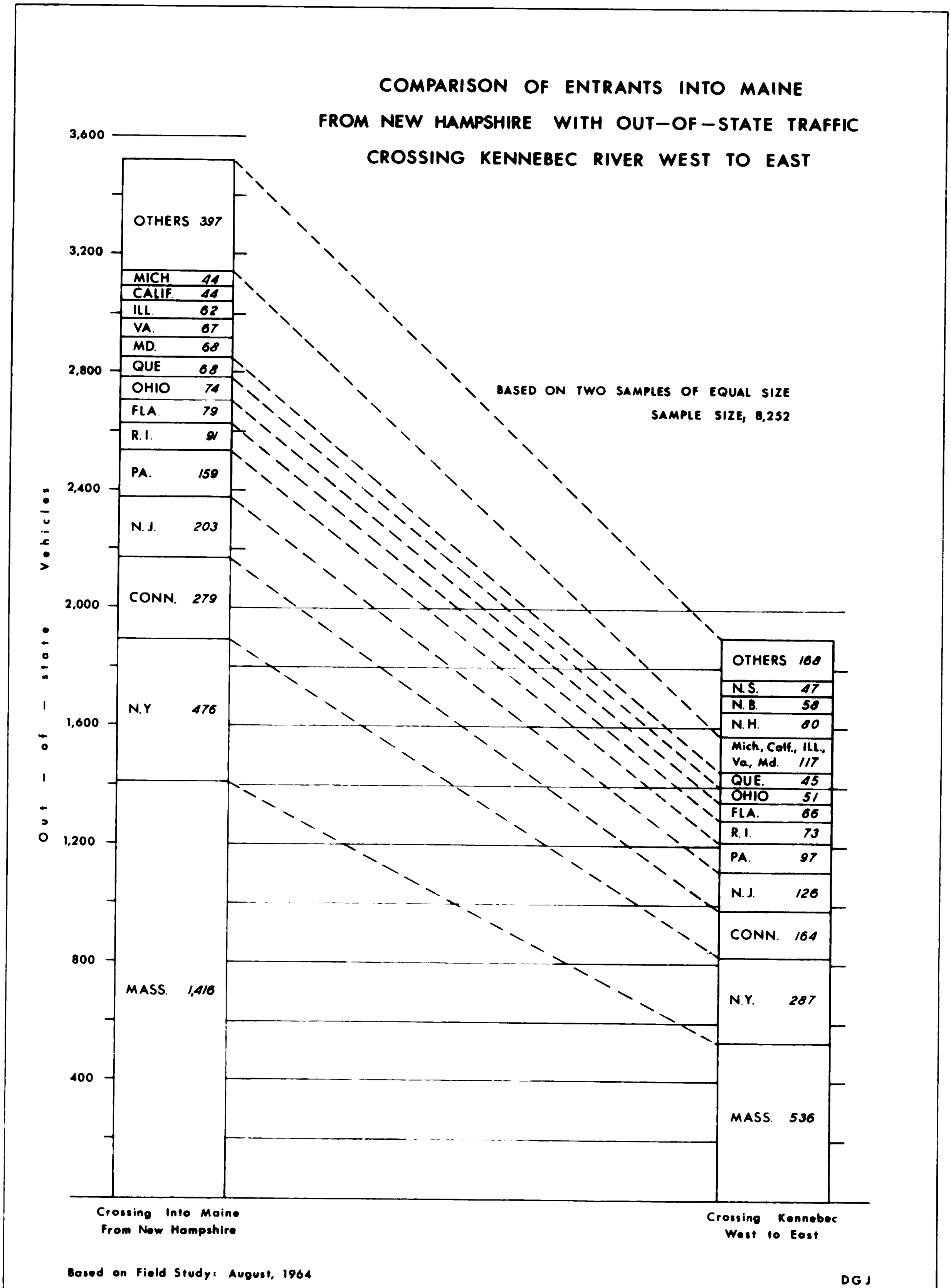
COMPARISON OF ENTRANTS INTO MAINE
FROM NEW HAMPSHIRE WITH OUT-OF-STATE TRAFFIC
CROSSING KENNEBEC RIVER WEST TO EAST
BASED ON TWO SAMPLES OF EQUAL SIZE
SAMPLE SIZE, 8,252
Out - of - state Vehicles
3,600
3,200
2,800
2,400
2,000
1,600
1,200
800
400
OTHERS 397
MICH. 44
CALIF. 44
ILL. 62
VA. 67
MD. 68
QUE 68
OHIO 74
FLA. 79
R.I. 91
PA. 159
N.J. 203
CONN. 279
N.Y. 476
MASS. 1,416
OTHERS 168
N.S. 47
N.B. 58
N.H. 80
Mich., Calf., ILL., Va., Md. 117
QUE. 45
OHIO 51
FLA. 66
R.I. 73
PA. 97
N.J. 126
CONN. 164
N.Y. 287
MASS. 536
Crossing Into Maine From New Hampshire
Crossing Kennebec West to East
Based on Field Study: August, 1964
DGJ

Fig. 18

CONCLUSION: PART II

Through this study of Kennebec River crossings, we have not only observed the historical development of individual crossing sites, but we have considered the ford, the ferry, and the bridge within the realm of geography. This was facilitated by looking upon the bridge as a human innovation designed to solve a specific human problem. In meeting the task of spanning the Kennebec, man expanded the geographical base of his operations and augmented his interregional contacts. By studying the function of individual Kennebec bridges, by noting the volume, nature, and origin of traffic crossing them, and by measuring their accessibility to local traffic, we found that it was possible to classify bridges in accordance with their geographical hinterlands and to assess both their local and interregional significances.

In Part II of this thesis we have used specific examples to illustrate the principles and concepts developed in Part I. We have witnessed man's quest to assure the continuity of his pathways, noted the strength of his commitment to significant crossing sites, and his abandonment of outmoded and redundant ones. We have seen how traffic is induced to new and better crossing facilities, and we have indicated the role of regional complementarity in conferring upon a bridge the designation "interregional."

Be that as it may, this study has merely opened the door to a subject rich in research potential. Many questions remain to be answered. What criteria should one use in determining the optimum point to cross a river with a bridge or in assessing the economic impact of the traffic induced to a new river crossing? It is possible that future research geared to answering these and other questions may warrant re-evaluation of some of the conclusions in this paper. But, in the meantime, it is believed that this study sheds light upon a topic that throughout historic times has been the subject of human curiosity, human need, and human ingenuity.

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