**Urban History Review
Revue d'histoire urbaine**

Some Quantitative Approaches to the Study of Central Places in the Guelph Area, 1851-1970

Frederic A. Dahms

Aller au sommaire du numéro

Découvrir la revue

Citer cet article

SOME QUANTITATIVE APPROACHES TO THE STUDY OF
CENTRAL PLACES IN THE GUELPH AREA, 1851-1970*

This paper has two purposes. First it will demonstrate the value to
the urban historian of several quantitative techniques more usually
employed by urban geographers. Second, it will describe and explain
the processes at work between 1851 and 1970 in the area comprising The
Guelph Central Place System of 1970.

Urban historians have tended to ignore a number of useful methods
and approaches employed by urban geographers. Similarly, urban geographers
would benefit enormously if they considered the temporal aspect of urban
development more often. The research reported here attempts to utilize
the methods of both disciplines. Hopefully, the results so achieved are
superior to those relying solely upon either historical or geographical
approaches.

Cities and Systems of Cities

Traditionally, geographers have been concerned with the site and
situation or internal structure of particular cities. During the last ten
years however, much attention has been given to the study of settlements
as central places, and to the analysis of "systems" of central places.
Much of this work was inspired by Walter Christaller (1933) and has been
continued by numerous geographers since Christaller's pioneering efforts
(Smailes, 1944; Brush and Bracey, 1955; Berry, 1967; Marshall, 1969).

Geographic work on cities as central places is concerned mainly with
their commercial functions. A central place is viewed as a supplier of
goods and services to the residents of its trade area or hinterland. A
system of central places is a group of settlements with close economic
linkages. Although numerous methods have been employed to study central
place "systems", most lack a clear definition or delineation of the "system"
being studied. Many early workers merely selected a group of centres in

an administratively defined area and then proceeded to rank them in hierarchical order. John Marshall (1969) has criticized this approach and has developed a method of identifying central place systems in which the centres are functionally linked. In such a system, the functional complexity of each centre is affected by that of all others in the system. Major technological or economic innovations may alter the relationships among centres in the system. Marshall's method has been employed to define The Guelph Central Place System described here (Dahms and Forbes, 1971).

Since geographers have traditionally been concerned with spatial rather than temporal variations, most central place studies have ignored the past. The work of Carter (1966, 1970), Davies (1970), Spelt (1955) and Lewis (1970) is an exception, but is almost lost in the vast central place literature emphasizing contemporary spatial relationships. The research reported here attempts to trace the development of all settlements that have ever functioned as central places in the area now comprising the Guelph Central Place System. It utilizes quantitative data and methods now commonplace in geographic research, but less familiar to urban historians. It is different from many geographic studies in that it applies these techniques to the past as well as to the present.

In the opinion of this writer, it is important to understand the economic linkages among a group of contemporary settlements. However, it is even more important to understand how these settlements evolved into a central place system through time. How have transport innovations affected their growth and development? When did a group of essentially independent settlements begin to function as a system? What processes led to the initial settlement of the area, and how have these changed over the years? When and why did Guelph become the dominant central place in the system? The answers to such questions will help us to understand the settlement process in the area, and to explain why some settlements declined and disappeared while others grew and prospered. Such an understanding of the past should also help us to plan more effectively for the future.

CENTRAL PLACES IN THE STUDY AREA, 1851-1970

Data Sources

It is necessary to have a consistent and reliable data source to list the goods and services provided by central places through time. Fortunately, two consistent and reliable sources are available. Dun and Bradstreet, a firm established to give credit ratings to all possible activities that might require a commercial evaluation, has published its Reference Books since 1864. These attempt to include every industrial and commercial establishment in business when their survey is made. Since the emphasis of Dun and Bradstreet is to list every legitimate business, they include data on firms in settlements too small to be listed separately by the Census. Since their data have been collected by the same company, using the same techniques year after year, Dun and Bradstreet Reference Books are a superb source of comparative temporal data on the service functions of settlements. Extensive field surveys in the study area in 1970 indicated that the directories are almost 100 percent accurate. There is no reason to believe that they were less accurate in the past.

Since much of the study area was settled before 1864, it was necessary to obtain data on central functions for earlier periods. Fortunately, the Canada Directory (Mackay, 1851) lists all commercial functions in each settlement in the study area in a manner comparable to that employed by Dun and Bradstreet. The use of the Directory enables us to extend the time period studies from 1851 to 1970.

Data Limitations

Unfortunately, Dun and Bradstreet do not list some central place services such as medical doctor, lawyer, banker and similar professions. These were therefore excluded from the analysis. Population data are available for all incorporated places from the Census, and for most unincorporated places from the Reference Books and Directory. The reliability and availability of population estimates from these sources decreases with settlement size. It is therefore not possible to include population data in statistical analyses for all settlements at all years.
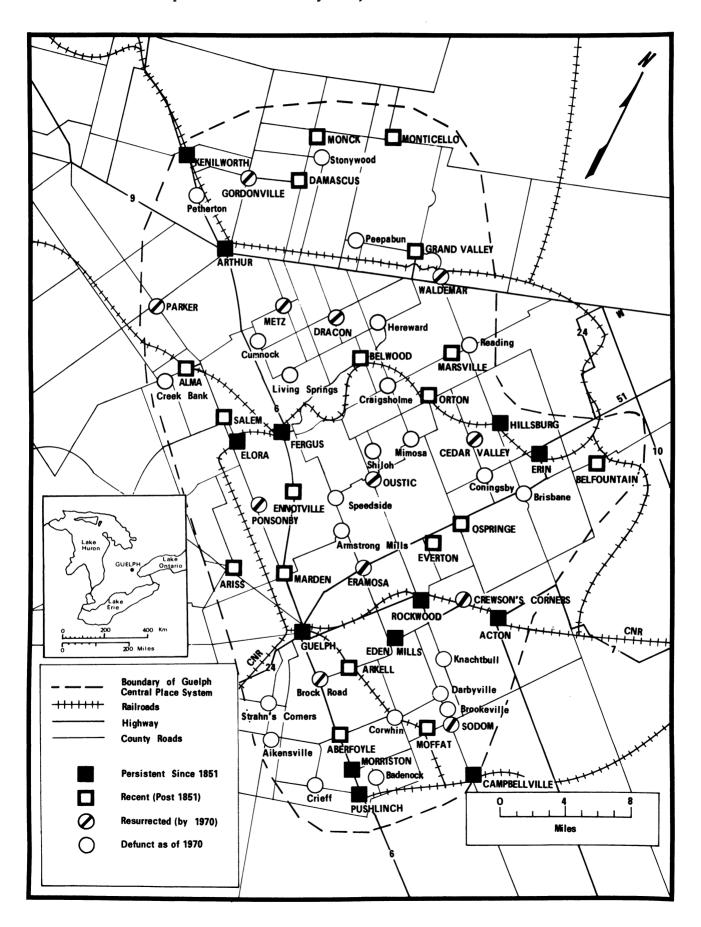
Although schools and churches are 'central' functions, they are excluded from the analysis because they were very ubiquitous and often found outside settlements in the early years. On the other hand, activities such as milling, blacksmithing, tanning and carriage making were included as central place activities. Although they might now be classified as 'manufacturing', all these enterprises either sold goods directly to their customers, or provided a service to their customers in the early days. They were therefore clearly central place activities providing goods and services to the residents of their hinterlands. As time has passed and technology become more sophisticated, most of these early activities have either split into distinct manufacturing and service/sales components, or have been replaced by their modern equivalents.

Methods

A major objective of this paper is to demonstrate the value (or otherwise) of quantitative techniques in the study of urban history. Another is to examine the interrelationships among a group of settlements viewed as central places, through time. The study has therefore included as much quantifiable data as possible, and has considered all settlements that have ever existed as central places in the study area. This study area (Fig. 1) is the Guelph Central Place System as defined (Dahms and Forbes, 1971) for an analysis of the spatial relationships of the central places there in 1970. By using a carefully defined area containing a functional system of central places in 1970 for our historical analysis, we may be able to discover when and how a group of essentially independent settlements evolved into a central place system in this area.

Lists of all functions (any kind of retail or service activity) and establishments (places where functions occur) were prepared for all central places in the study area at approximately ten year intervals from 1851 to 1970 (Table 1). In addition, a sample of the 13 largest settlements in 1970 was selected for detailed study. Statistical analyses as described below were employed to provide the maximum possible insight into the relationships among the central places in the study area. The methods employed are also intended to raise important questions to be answered by more traditional historical methods.

Figure 1: All Central Places That Have Ever Existed in the Area of the Guelph Central Place System, 1851-1970.

STUDY AREA DATA

Tables 1-3 set out data describing the study area and its settlements at 13 periods between 1851 and 1970. Table 1 illustrates the growth of population and central place activities in the area, while Table 2 demonstrates some relationships among these variables. Table 3 provides more detailed information on the relative importance through time of the 13 largest places in 1970.

Tables 2 and 3 illustrate both the value and shortcomings of statistical approaches to urban history. Their major value is that they enable the researcher to discover and illustrate temporal relationships among the places being studied. Such an approach helps to reveal the manner in which central places in an area have interacted economically, rather than considering them only as isolated entities with unique histories. The major difficulty with the statistical approach is the need to base it on complete data for the most reliable results. This is not possible in most long-term analyses of central places, since many in a study area do not survive the complete time span being considered. As illustrated by Table 1, this is the case in the present study.

Several choices are open to the researcher attempting to analyze an incomplete data set. He must either omit short-lived centres from some analyses, or consider a shorter time span during which the same places have always functioned. If however, the time span used is too short, coefficients of correlation mean little. Here a compromise solution to this problem was employed. Wherever possible, aggregate data for the whole study area were analyzed for the complete time period. This provided insights into the broad sweep of relationships in the area (Table 2). When information on the performance of individual settlements was required, only the 13 largest in 1970 were considered (Table 3). All these survived the 119 year time period considered here.

Fortunately (and logically), the largest places in 1970 are also those which were established first. They have clearly been the economic leaders in the area at all times. In fact, they accounted for over 76 percent of all establishments in the study area at all times, and over

90 percent of establishments at 6 of the 13 dates used for analysis. In other words, their historical development accounts for a large proportion of the development in the whole study area. It is therefore valuable to consider relationships among them, even though such relationships are not based on a complete data set for all places existing in the study area at all times.

General Trends 1851-1970

Table 1 illustrates the variation in population and numbers of central places in the study area. The number of central places reached its peak between 1881 and 1911. Also during this period, the population reached a peak of 63,515 in 1881, not to be surpassed again until 1951. The large number of establishments in the 1881-1911 period is a reflection of the population and settlement numbers during that time span. Unlike the number of establishments which peaked at 991 in 1891, the number of functions reached a maximum of 74 in 1901, not be surpassed until 1961. It is clear that there are relationships amongst the population size, number of central places, number of functions and number of establishments in the study area. More sophisticated methods will be used to quantify these relationships.

As might be expected, the number of establishments in the settlement sample varies directly as the total number in the study area. The degree of association may be established by calculating a co-efficient of correlation which will be explained below.

CORRELATIONS AMONG DATA IN THE STUDY AREA

Table 2 is a correlation matrix which describes precisely the relationships among variables for the settlement sample and the whole study area. This table indicates how the data have varied through time. Many geographic studies have employed correlation analyses to measure central place relationships among settlements at one time period (Berry, 1967; Davies, 1968; Marshall, 1969 for example), but few have extended it to the study of the past (Davies, 1970). Data problems as described above have inhibited statistical analyses of the past for geographers just as they have for historians.

Table 1

STUDY AREA DATA 1851-1970

Year	1851	1864	1871	1881	1891	1901	1911	1921	1931	1941	1951	1961	1970
Number of Places	16	31	41	62	63	61	62	42	37	38	35	34	44
Population of Study Area	21,341*	49,200**	56,324	63,515	57,648	54,397	54,930	54,181	57,145	59,428	65,434	83,147	97,508
Number of Establishments	198	437	629	888	991	905	901	851	1,005	918	1,063	1,081	1,376
Number of Functions	38	55	56	67	64	74	70	70	76	64	71	79	78
Number of Establishments per Central Place	11.6	11.9	15.3	14.3	15.7	14.8	14.5	20.3	27.2	24.2	30.4	31.8	31.2
Number of Establishments in Settlement Sample	186	371	480	699	753	716	733	740	904	827	979	1,010	1,258
Percent of Establishments in Settlement Sample	93.9	84.9	76.3	78.7	76.0	79.1	81.4	87.0	90.0	90.1	92.1	93.4	91.4

* Because of slightly different definitions in the Census before 1871, data are for an area somewhat larger than the study area.

** Data for 1861. Area as above.

Source: <u>Census of Canada</u>, 1871-1970; <u>Upper Canada Personal Census by Origin</u>, 1861.

Table 2

INTERCORRELATIONS AMONG DATA FOR STUDY AREA 1851–1970

	Population of Study Area	Number of Central Places	Number of Functions	Number of Establishments	Number of Establishments in Sample	Percentage of Establishments in Sample
Population of Study Area	1.00					
Number of Central Places	0.26	1.00				
Number of Functions	0.79	0.46	1.00			
Number of Establishments	0.88	0.46	0.91	1.00		
Number of Establishments in Sample	0.89	0.28	0.90	0.98	1.00	
Percentage of Establishments in sample	0.13	−0.76	0.05	0.07	0.26	1.00

A coefficient of correlation may have a value between plus and minus one. If two variables change at exactly the same rate and in the same direction, their coefficient of correlation is plus one. If one decreases precisely as the other increases, the coefficient of correlation is minus one. Zero means that there is no relationship between the variables considered. A 0.98 coefficient of correlation such as that between the number of establishments in the sample settlements and the number in the whole study area indicates a very strong relationship. This is logical, since the sample settlements contain a large percentage of the total establishments at all times. Generally, a coefficient of correlation greater than plus or minus 0.7 indicates a significant relationship. Blalock (1960) provides an excellent description and explanation of correlation techniques of use to geographers or historians.

Table 2 reveals many interesting relationships among the variables for the study area and sample settlements between 1851 and 1970. Some are obvious to any intelligent observer of urban history, but others require careful interpretation. As expected, there is a strong positive relationship between the study area population and the number of establishments there (0.88). The 0.79 coefficient of correlation between functions and population is also significant. Both correlations are logical, since one would expect an increasing population to demand more types of goods and services (functions) and more outlets to provide these functions (establishments). The number of both tends to increase or decrease with similar population fluctuations.

Population and Central Places

The reason for the weak (0.26) relationship between the study area's population and the number of central places at each date are not so obvious. At first glance one might expect the number of central places to increase and decrease with population changes. It seems logical that more central places would be created as population increased and that some would lose their commercial functions as the population declined. The weak correlation between population and number of central places leads us back to Table 1 for an explanation.

Both population and the number of central places increased rapidly between 1851 and 1881. However, after 1881, population decreased until 1931 whereas the number of settlements remained relatively stable until 1911. After 1911, the number of settlements declined until 1970, while population increased steadily from 1921 to 1970. In other words, there is little consistent direct relationship between population and the number of central places at any time. They vary both positively and negatively.

Interpretation of a Weak Statistical Relationship

In this case, the very weak relationship between study area variables may provide more insight into the temporal processes at work in the study area than the strong correlations described above. The weak relationship demands a non-statistical explanation, and leads to some specific historical interpretations of events in the area.

During the years of early settlement (1851-1891), the number of central places does increase rapidly as new settlers demand accessible service centres to provide them with goods and services. Given average travel speeds of from 2 to 3 m.p.h. by walking or horse and wagon, up to possibly 6 m.p.h. by horse and carriage, central places had to be close to their customers. Figure 1 illustrates the dense network of evenly spaced places that did exist in the study area. In 1891, no central place was more than three and one-half miles from any part of its hinterland. At that time, a return day trip to some central place was possible for all living in the study area, regardless of mode of transport. This situation continued until 1911, after which central places began to disappear rapidly.

As population declined after 1881, economic inertia, transport technology and habitual shopping patterns worked together to keep the number of central places relatively constant. As long as there was no convenient and inexpensive alternative to the early modes of travel, a dense network of central places persisted. A drop of almost 10,000 in population between 1881 and 1911 did not decrease the number of central places. However, reduced buying power in the study area was reflected by a decrease in the number of establishments from 991 in 1891 to 851 in 1921.

Detailed historical data indicate that the process of centralization of business in fewer large centres began in earnest after 1911. By then, the full effects of railway services, brought to the study area between 1856 and 1905 (Cumming, 1972) had been felt. Furthermore, major road improvements after 1914 and the designation of King's highways in 1917 made automobile travel much more convenient than before (Vandeweghe, 1972, pp. 55-57, pp. 63-72). By 1930, most of the towns in the study area were joined by paved roads (Spelt, 1955, p. 212).

CENTRALIZATION OF GOODS AND SERVICES

The number of central places in the study area declined from 62 in 1911 to 34 in 1961. However, the number of establishments increased from 901 to 1081 in the same period. The process of centralization of functions and establishments in the larger places had begun in earnest. A central place system, dominated by Guelph and begun to emerge. Newly mobile farmers and small-town dwellers had begun to bypass the local central place that had served them so well in the early days. The use of the car enabled them to travel to a town or city with a large variety of functions and establishments. One stop in a large centre now eliminated the necessity for more frequent but shorter trips to the local hamlet.

As a result of the increased mobility described above, many small central places lost all their service and retail functions. Twenty-one places with five or fewer functions in 1881 had lost them all by 1961. The demise of many of these central places was undoubtedly hastened by the introduction of rural mail delivery in Canada in 1908. As a result, 24 central places in the area lost their post offices between 1913 and 1916 (Vandeweghe, 1972, p. 84). Numerous general stores that had "captive customers" when they were post offices did not survive the loss. The number of functions in all places losing their post offices decreased dramatically after 1911, and 15 of these places lost all their functions by 1961. Temperance movements also reduced the number of functions in the small towns of the study area. Although prohibition did not come until 1898, the number of taverns in the study area fell from 43 in 1871 to none by 1891 (Vandeweghe, 1972, p. 82). No doubt the Crooks Act of 1876 which set limits to the number of taverns per capita hastened their

demise before 1898 (Middleton and Landon, 1927, p. 547). Hotels, which also sold spirits, declined from a high of 73 in 1891 to 13 in 1961. These changes, caused by legislative action combined with the use of motor vehicles for transport, helped to decrease the number of central places, while population and the number of establishments were once again increasing. Centralization of establishments in larger places after 1911 is clearly reflected by the ration of 14.5 establishments per central place in 1911, as against 31.8 in 1961 (Table 1).

The large numbers of establishments in the early years were the result of a different process from that which created many establishments after the decline in central place numbers in 1921. Between 1881 and 1911, large numbers of establishments reflect both population size and the number of central places in the area. Most establishments were still located in the numerous small centres scattered evenly about the study area. After 1911, the number of central places declined rapidly whereas establishments first fluctuated but then steadily increased. More establishments, often duplicating functions, began to appear in the largest centres. This centralization enabled those with cars to comparison shop in the largest settlements. After 1911, many of the smallest places lost all their functions to those better served by transport routes.

Technological changes help to explain the variation in numbers of functions in the Study Area. Rapid increases from 1851 to 1901 reflected demands for new kinds of goods and services in an era when technology was rapidly advancing. The number of functions in the system remained relatively stable after 1901 as early enterprises such as harness maker, cooper, saddler, and cabinet maker disappeared altogether or were replaced by their modern equivalents. A detailed analysis of Dun and Bradstreet data has shown that many relatively ubiquitous early functions (tailor, milliner, blacksmith) centralized in the larger places after 1911 (Vandeweghe, 1972, p. 100).

Central Places, Functions and Establishments

The relatively weak association between numbers of central places, numbers of functions, and numbers of establishments (both 0.46, Table 2),

reinforces the conclusions reached above. Early in the history of the
area, the numbers of both functions and establishments increased as new
central places appeared (Table 1). Later however, the number of
functions become relatively stable, the number of central places decreased,
but the number of establishments increased. In other words, lack of
direct covariation produced a relatively low coefficient of correlation.
Both functions and establishments centralized in larger but fewer places
after 1911, reversing the trends that had persisted until that date.

The high positive coefficient of correlation between numbers of
functions and establishments in the system (0.91) is both logical and
expected. As the area developed economically, a greater variety of goods
and services was consistently accompanied by an increasing number of
functions and establishments declined together in periods such as 1941
when war demands decreased the variety of consumer oriented goods and
services available to the public.

THE SAMPLE SETTLEMENTS

Table 3 presents some detailed data on the 13 largest settlements
in 1970. It illustrates the stability of these settlements through the
119 year study period. Since they are being considered as central places,
all settlements are ranked according to the number of establishments they
contain, rather than on the basis of their population. This is reasonable
since a central place serves both its resident population and its
hinterland. Some of its establishments are supported by customers from
the hinterland, rather than solely by residents of the central place.
Hence an establishment count is a better indication of a central place's
rank than its population. Davies' (1967) Functional Index is a slightly
more sophisticated measure of centrality, but cannot appropriately be
applied to the past.

Average ranks on Table 3 indicate the relative importance of all the
places during the 119 year period. Standard deviations indicate how much
the rank of each has varied over the years. Large standard deviations
indicate major variations from the mean; small standard deviations
signify smaller variations. Of course, larger standard deviations

Table 3

RANKS, NUMBERS OF FUNCTIONS AND NUMBERS OF

ESTABLISHMENTS, SAMPLE SETTLEMENTS 1851-1970

Central Place	Average Rank 1851-1970	Standard Deviation	Average Number of Functions 1851-1970	Average Number of Establishments 1851-1970	1970 Data			
					Population	Rank	Number of Functions	Number of Establishments
Guelph	1.00	0.00	62.54	334.54	55,625	1	78	668
Fergus	2.54	0.63	35.08	72.92	5,191	2	55	119
Acton	3.85	0.86	32.54	60.38	4,790	3	53	115
Arthur	3.85	1.66	28.62	60.77	1,308	4	36	73
Elora	4.23	1.31	28.92	56.31	1,766	6	29	61
Erin	6.38	1.15	24.00	37.08	1,284	5	38	68
Grand Valley	8.00	4.56	19.23	30.69	872	7	23	44
Hillsburgh	8.15	1.10	18.92	26.08	505	9	18	29
Rockwood	8.69	1.14	15.08	21.62	985	8	18	30
Campbellville	11.08	1.59	9.46	12.46	275	10	14	18
Morriston	11.15	1.75	9.38	11.62	212	13	7	9
Alma	11.46	3.65	7.54	10.08	172	11	10	13
Kenilworth	11.77	5.79	5.62	7.54	73	12	10	11

generally accompany the largest means. Where the average rank for two places is equal, the one with the smallest standard deviation is ranked first, since its rank has fluctuated least below the mean.

It is clear that Guelph has always ranked first in the study area, since its mean is one and its standard deviation is zero (Table 3). Fergus is a clear second, but Acton and Arthur have obviously fluctuated in importance over the years. Grand Valley with an average rank of 8.00, but a standard deviation of 4.56 has had the most varied rank history of all the centres considered. Inspection of detailed data reveals that Grand Valley has fluctuated from a low rank of 17th in 1871 to a high of 5th in 1921. Kenilworth, the next most variable centre, ranked only 27th in 1891, but rose to 10th in 1961. Average numbers of functions and establishments corroborate the rank order indicated by average ranks 1851-1970.

In general, the smallest places that survived the complete study period have fluctuated most in relative importance (Table 3). During the years between 1881 and 1911, many central places served a declining population. A number of the small surviving centres fell in relative status because of competition from places that eventually lost all their central functions. These survivors then rose again in rank as their transient competitors disappeared.

In spite of the fluctuations discussed above, Table 3 reveals remarkable stability in the relative importance of the places being considered. Their average ranks over 119 years are very close to their rank order in 1970. The first four centres are in the same order in 1970 as over the years. Elora's early prominence and later decline are reflected by an average rank higher than its 1970 position. Differences between mean ranks and 1970 ranks for smaller places are not great, but these variations do reflect the susceptibility of smaller centres to competition. Nevertheless, comparisons between 1970 ranks and mean ranks indicate a great degree of stability in the study area between 1851 and 1970.

Relationships between Settlement Sample Data and Study Area Data

Tables 1 and 2 provide an indication of the importance of settlement sample data and their relationship to data for the whole study area. From Table 1 it is clear that the sample settlements have always contained a major proportion of establishments in the study area. Thus the 0.98 coefficient of correlation between the number of establishments in the sample and the total is not unexpected. Similarly there is a 0.89 relationship between the population of the study area and the number of establishments in the sample. This is slightly higher than the coefficient of correlation between total establishments and the study area population (Table 2). It indicates that the number of establishments in the sample is slightly more responsive to population changes than the total number. This is no doubt partially a reflection of the increasing centralization of establishments in the larger places of the sample as the study area population rose again after 1911.

The 0.28 relationship between the number of central places in the study area and establishments in the sample is considerably weaker than the 0.46 figure for total establishments and population. This indicates more commercial stability in the sample in that the number of establishments there did not fluctuate much with total population changes. This is logical since none of the sample settlements ever disappeared, and they are the largest places in the study area. The -0.76 correlation between percentage of establishments in the sample and number of central places simply indicates that the percentage of establishments in the sample was high when there were few central places, and lower where there were many. From Table 1 it is clear that the sample had the lowest percentages of establishments between 1871 and 1911, the period with many transient central places.

None of the other correlations between sample and study area data are statistically significant or subject to meaninfgul interpretations.

SUMMARY AND CONCLUSIONS

These conclusions should answer two questions. First, what have we learned about the historical development of central places in the Guelph

area between 1851 and 1970. Second, how has the use of a number of quantitative techniques helped us with this study?

Historical Findings

The major insight produced by this research is some understanding of the processes which enabled a group of essentially independent settlements in the Guelph area to evolve into a system of central places. The other major finding is a realization of the remarkable commercial stability of the largest central places during the 119 years under consideration. Although conventional historical research would have led to the same conclusions, it appears that the quantitative methods used here greatly expedited this work.

Correlations, and raw data on population, numbers of establishments and the number of settlements in the study area all indicated that the Guelph central place _system_ began to evolve in earnest after 1911. Although the number of central places continued to decline until 1961, both population and the number of establishments increased. After 1911, a process of centralization of functions and establishments in the largest centres contributed to the demise of many small places in the study area. Improved roads and the use of the motor car enabled the largest central places to 'capture' many functions earlier provided by smaller centres which ultimately died. When this happened a real central place system began to evolve. One of the major diagnostic criteria of a central place _system_ is the degree to which the larger places affect the economic functioning of the smaller. Clearly there is little effect until transport technology enables competition among centres to affect their relative status. This happened in the Guelph system after 1911 when roads were greatly improved and the full effects of railway transport had been felt.

The second major finding here is that of the remarkable stability of the largest places in the system. As demonstrated above, the rank order of the 13 largest places in 1970 changed little through the years. With only one or two exceptions, these places were established earliest, and were originally mill sites. There is much evidence to indicate that those which grew fastest had the advantage of a "head start" historically, and

the help of strong local entrepreneurial initiative. (Spelt, 1955; Cumming 1972). Most never lost the momentum gained in their early days.

The evidence of inertia carrying the largest and oldest places to the top of the Guelph central place hierarchy does not accord well with central place theory. Classical central place theory suggests almost simultaneous settlement of an area with no impediments to free trade. The "rational economic men" in the area then produce a system of settlements governed solely by competition. The size and spacing of these settlements maximizes market areas and consumer access to goods and services (Christaller, 1933). This may be a reasonable explanation of rapid settlement of a virgin area, but it ignores completely the real world aspects of long, slow, settlement history; innovations in transport technology; and entrepreneurial initiative. The results of these "real world" factors show in the study area where the pattern of major settlement has remained static, while numerous marginal centres have come and gone over the years.

This research indicates that central place theory provides a reasonable framework for the study of existing settlement patterns, but is of little value to the student of urban history. Its simplifying assumptions simply do not hold in the past. In this study area, John Galt established the settlement of Guelph in 1827 to open up a land tract for the Canada Company (Spelt, 1955, p. 63). Settlement then spread north and east from Guelph, along rivers and newly formed roads. In this agricultural subsistence economy, most places were originally mill sites, rather than central places established to serve the consumer! Only much after initial settlement did some Christaller's economic principles begin to work, but by then it was too late to alter the earlier settlement pattern radically. Instead, the original pattern was reinforced as transport facilities were improved. Rail service and surfaced roads almost always came first to the largest and oldest settlements. They had the most political and economic influence, and it showed in their acquisition of improvements of all kinds.

Quantitative Methods

How has the statistical approach used here helped us to understand settlement processes in the study area between 1851 and 1970? Does it add a dimension of comprehension not provided by more traditional

historical methods? In the author's opinion, the use of means, standard deviations and coefficients of correlation should not be an end in itself. It should lead the investigator to knowledge and understanding more quickly and accurately than otherwise might occur.

The major advantage of the quantitative approach used here is its ability to summarize important relationships among many places over a long period of time. This is almost impossible without accurate quantitative information and a method of analyzing it rapidly. Furthermore, the relationships suggested by the quantitative analyses often lead the researcher very quickly to key areas for detailad investigation. He need not spend as much time pursuing blind leads as he might without the clues provided by the quantitative analysis. He is able to identify and explain expected results quickly, and is forced to investigate unexpected or apparently anomolous findings as well. These often suggest hypotheses which may then be tested using traditional methods of historical investigation. This was certainly the case here, where a 0.26 coefficient of correlation between study area population and the number of central places led to a detailed investigation of the transport history of the area.

The use of simple statistical methods will enable urban historians to learn much from directories, assessment rolls, and realtors' records. Multiple regression and other multivariate techniques can be applied to data from these sources, as they might have been applied to some of the data analyzed in this article. If urban historians adopt quantitative methods as an aid to research, they may well tap some relatively untouched sources, and may greatly increase their understanding of past settlement systems. Undoubtedly however, more traditional methods will remain paramount in explaining the detailed histories of individual urban places.

Frederic A. Dahms

REFERENCES

Berry, B.J.L. (1967). Geography of Market Centres and Retail Distribution, Englewood Cliffs: Prentice-Hall.

Blalock, H. M. (1960). Social Statistics. Toronto: McGraw-Hill.

Brush, J. E. (1953). "The Hierarchy of Central Places in Southwestern Wisconsin." Geographical Review, Vol. 43, 380-402.

Carter, H. (1966). The Towns of Wales. A Study in Urban Geography, Second edition. Cardiff: University of Wales Press.

Carter, H. (1970). "The Urban Hierarchy and Historical Geography: A Consideration with Reference to North-east Wales." Geographical Interpretations of Historical Sources. Edited by A.R.H. Baker, J.D. Hamshere and J. Langton. Newton Abbot: David and Charles, pp. 269-286.

Christaller, W. (1933). Die zentralen Orte in Suddeutschland. Jena: Gustav Fisher. Translated by Carlisle W. Baskin as Central Places in Southern Germany, Englewood Cliffs: Prentice-Hall, 1966.

Cumming, R. Editor. (1972). Historical Atlas of the County of Wellington Ontario. Toronto: Historical Atlas Publishing Company 1906. (Reprint edition 1972, published by Corporation of County of Wellington).

Dahms, F.A. and Forbes, J.A. (1971). "Central Places in the 'Golden Triangle': The Guelph System, 1970." The Waterloo County Area: Selected Geographical Essays. Edited by A.G. McClellan, Waterloo: University of Waterloo, pp. 113-127.

Davies, W.K.D. (1967). "Centrality and the Central Place Hierarchy." Urban Studies, Vol. 4, pp. 61-79.

Davies, W.K.D. (1968). "The Morphology of Central Places." Annals of the Association of American Geographers. Vol. 58, pp. 91-110.

Davies, W.K.D. (1970). "Towards an Integrated Study of Central Places: A South Wales Case Study." Urban Essays: Studies in the Geography of Wales. Edited by H. Carter and W.K.D. Davies. London: Longman, pp. 193-227.

Dun and Bradstreet of Canada Limited. Reference Book. July, 1864, 1871, 1881, 1891, 1901, 1911, 1921, 1931, 1941, 1951, 1961, 1970. Toronto: Dun and Bradstreet.

Lewis, C.R. (1970). "The Central Place Pattern of Mid Wales and the Middle Welsh Borderland". Urban Essays: Studies in the Geography of Wales. Edited by H. Carter and W.K.D. Davies. London: Longman, pp. 228-268.

Mackay, R.W. (1851). Canada Directory. Montreal: J. Lovell.

Marshall, J.U. (1969). The Location of Service Towns. University of Toronto, Department of Geography Research Publications No. 3. Toronto: University of Toronto Press.

Middleton, J.E. and Landon, F. (1927). The Province of Ontario: A History. Toronto: Dominion Publishing Ltd.

Smailes, A.E. (1944). "The Urban Hierarchy in England and Wales". Geography, Vol. 29, pp. 41-51.

Spelt, J. (1955). Urban Development in South Central Ontario. Assen: Von Gorcum. Reprinted in 1972 in the Carleton Library Series (Toronto: McClelland and Stewart).

Vandeweghe, W.R. (1972). "A Study of Central Places in the Guelph Area 1851-1961". Unpublished B.A. Thesis. Department of Geography, University of Guelph.