THE UNIVERSITY OF CALGARY

SERVICE CENTRE CHANGE IN METROPOLITAN HINTERLANDS: A CASE STUDY OF CALGARY AND SASKATOON 1951-1971

BY

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ABSTRACT

This study attempts to empirically identify Service Centre hierarchies in the hinterlands of two Canadian Prairie cities, namely, Calgary and Saskatoon. It also tries to examine the changes that have occurred in membership and content of the hierarchical groups, in a "before and after" approach over the period 1951 - 1971, An accurate identification and subsequent discussion of hierarchies and change in them depends on the use of a rigorous method of classification. In this study, Cluster Analysis was the primary technique used, and the groups derived were compared with the Functional Index approach and tested by Discriminant Analysis.

Five groups of centres were found for both 1951 and 1971 in the hinterland of Calgary, of which, four were hierarchical. The fifth group was made up of only the resort town of Banff. Similarly, four hierarchical groups were identified for 1951 and 1971 in the region around Saskatoon. The retail centres in the two regions, however, showed contrary growth trends. Those around Calgary grew in status, whilst those in the hinterland of Saskatoon were found to decline in importance; in addition, there was an apparent "upward shift" of functions in Calgary region and "downward shift" around Saskatoon.

Spatially it was found that the mean distance separating members of the higher order groups in the hinterland of Calgary decreased whilst that in Saskatoon increased. The results obtained in this study provide a background to a more process oriented study designed to isolate the causative factors generating the changes in the Service Centres.

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CHAPTER I

THE BACKGROUND TO THE STUDY

This study is concerned with the changes that have occurred in the size and importance of settlements in two Prairie metropolitan hinterlands, namely Calgary and Saskatoon. In particular it deals with changes in their retail and commercial importance in the period 1951 to 1971. The research is not process oriented, but employs a "before and after" approach to identify and discuss changes in commercial importance in the light of growth pole and central place ideas. The backbone of the whole analysis is the proper identification of groups upon which ideas of hierarchies and change are based. Two bodies of literature are relevant to the study namely "central place" and "growth poles" and they will be reviewed in the rest of this chapter. The former serves as a spring board for identification of change and the latter a possible causative factor of change in the hinterlands.

RELEVANT BACKGROUND LITERATURE

Central Place

The bases for central place theory were laid independently by two German scholars, Christaller and Lösch in the 1930's. In both cases, their conclusions were based on the distributional characteristics of towns and the behaviour of consumers in time and space. Christaller's assumptions were often implicit in his scheme, whereas Lösch adopted the more traditional economic approach by giving a explicit presentation of the theory and assumptions. Both came to rather similar conclusions concerning the spatial organization required

for the optimal distribution of outlets for a single good, but varied in the number of different types of thresholds and market areas that were considered. This produced major differences when the location of many kinds of goods were simultaneously assessed. For example, Lösch was able to theoretically derive an economic landscape containing city-rich and city-poor sectors radiating from the metropolis, a pattern that was also identified especially around some United States cities. By contrast, Christaller's distribution of outlets were regularly distributed. It must, however, be emphasized that neither Christaller nor Lösch regarded central places as settlements; they viewed them as any place at which commercial exchanges were being made.

Berry (1967b) has suggested that these two basic spatial organizations are applicable to different situations. Lösch's system being relevant to secondary production at its market oriented stage and Christaller's hierarchies being most suitable for the analysis of retail and service business in the tertiary sector. The earlier work of E. Von Boventer (1962) supports this suggestion and according to this system, the distribution of retail outlets is such that the highest level has in downward progression of size 2, 6, 18 and 54 lower level outlets associated with it. It is assumed that the higher levels of places perform all the functions of the lower hierarchies.

Despite the proliferation of literature on central places, only very few researchers, for example Berry (1971) and Hodge (1968) have addressed themselves to the specific issues of change in structure within hierarchies once they have developed. Most of the literature, such as the work of Abiodun (1968) and Skinner (1963) have been content

to demonstrate the empirical validity of the theory and system without examining the dynamics of the process. Concerning change, Berry's (1971) paper indicates that there is an upward shift of functions within the hierarchy through time, with the higher order places becoming more important at the expense of the smaller centres. Individual centres in the system may however, change in response to local variations in the economic base. For example, the decline of the oil and gas industry around Turner Valley and Black Diamond have resulted in their decline 1951 to 1971. The opposite effect has been demonstrated by Gibson and Reeves (1974) in Arizona where mobile highway consumers have contributed to the growth of settlements near the routeways.

Growth Poles

In recent years the popularity of the study of central places has been superseded by the analysis of growth poles (Hansen 1968, Berry 1972, Rodwin 1970). The change in emphasis has been primarily due to the fact that classical central place theory, despite Isard's modification (Isard 1956), does not deal with the issues relating to agglomeration economies and market orientation of the tertiary and primary sectors of the economy. The findings of economists about growth sectors have enabled the translation of growth poles ideas into spatial context, thereby including the growth of large centres. In relation to the objective of this study, the literature shows there are two opposing viewpoints concerning the fate of small towns in the hinterlands of major metropolitan centres. One view suggests that "polarization" has occurred, meaning that there has been an "in-migration" of people and

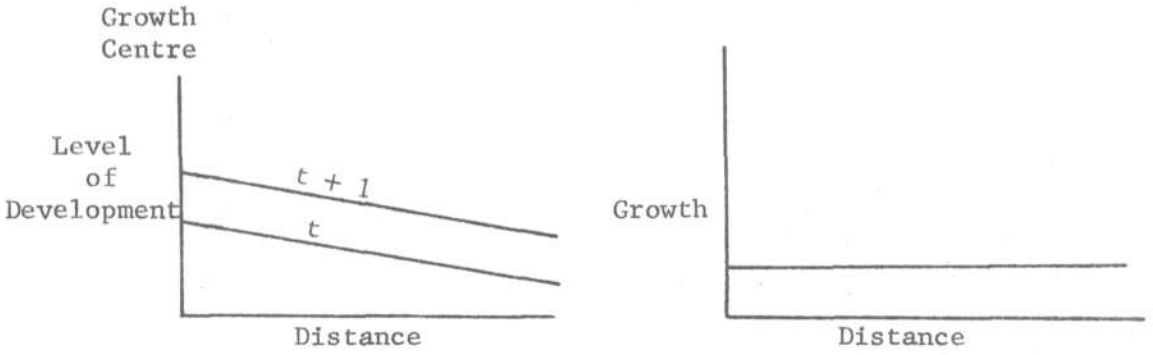
functions from smaller centres to the major cities usually as a result of agglomeration forces. The alternative is that there has been a spread of growth, sometimes called "trickling down," from the centre to small towns in its hinterland.

These alternative forces have been conceptualized by Brown (1973) in a diagramatic manner. He postulates that three types of growth can occur in hinterlands of large cities, namely polarization, peripheral and uniform growth. Starting with the premise that the most likely initial influences of any growing city will be to polarize growth to itself, he suggests a series of regression lines could be used to describe what would happen over time if any of the three expressions of growth prevailed as the dominant trend. Figure 1.1A shows that where "trickling down" effects have equalled "polarization" effects uniform growth is the result. Regression of a level of development measure on distance should yield a zero coefficient. Similarly, "peripheral" growth occurs where "trickling down" effects are greater than "polarization effects," and "core growth" or "polarization" when the "trickling down" has been less than polarization. Figures 1.1B and 1.1C show that peripheral growth should produce a positive regression coefficient and polarization a negative coefficient.

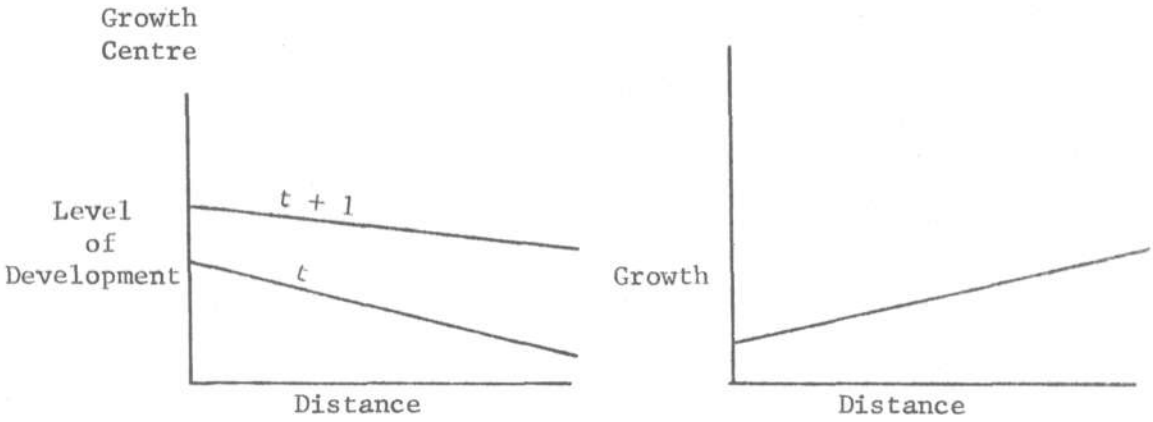
Treadway (1972) in a study of metropolitan dominance in Turkey showed that the impact of large cities is not uniform at all distances but diminishes with increasing distance from the central city. The gradient of dominance is derived from measuring population or functional characteristics in straightline distances from the centre. Such a

FIG. 1.1 THE SPATIAL DISTRIBUTION OF GROWTH IN URBAN HINTERLANDS

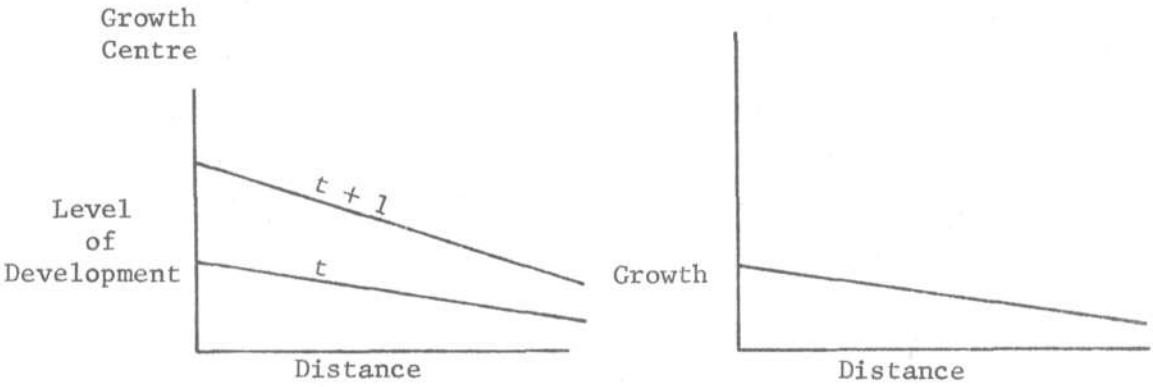
A. Uniform Growth: Trickle Down Effects Balance Polarization Effects



B. Periphery Growth: Trickle Down Effects are Greater than Polarization Effects



C. Polarization or Core Growth: Trickle Down Effects are Less than Polarization Effects



Source: L.Brown(1963) Diffusion in a Growth Pole Context: A Comment

gradient is curvilinear because of the increase in the rate of increase of the frictional effects of movements with distance from the metropolitan centre.

Casetti, Odland and King (1971) attempted to formalize the index of dominance by stating that polarization is implied if:

$$\frac{\partial Z}{\partial t} > 0$$

for all t's and s's, where Z is the intensity of the phenomenon measured in units x, y and t, t is time and x, y the coordinates of the location of intensity Z in the region S. S(x,y) is the euclidian distance of points x, and y from the growth centre in such a way that for any t belonging to T, Z corresponds to the surface which identifies the spatial identity of the phenomenon. They suggest that the model can be fitted to a function of the form:

$$Z = a_0 + a_1 t + a_2 s + a_3 st.$$

Polarization therefore requires that:

$$\frac{\partial Z'}{\partial t} = a_1' + a_3' s = 0$$

where z', a_1' and a_3' are estimates of z, a and a_3 respectively. It is clear from the above that the function used is the same as a regression model of the form:

$$Y = a_0 + a_1 + x + a_2 z + a_3 xz$$

and that the polarization requirements are obtainable from the slope of the regression line where the z represents the dependent variable and s the independent variable.

In the real world, these uniform conditions are not likely to exist. Berry (1972) has demonstrated that most of the growth is concentrated in centres with populations between 25,000 and 50,000 especially when they are near larger cities. Similar results by Hansen (1971) formed the basis for his suggestion that intermediate sized cities with populations between 25,000 to 50,000 be used as growth centres in order to effect growth in depressed areas. Related to this idea, Alonso (1971) suggested that at a threshold size of 500,000 populations and functions begin to overflow into the surrounding regions. Other authors like Lillibridge (1952), Gabler (1969), Doshi (1970), Berry (1971) have suggested various threshold populations ranging from 100,000 to 500,000. In the Canadian prairies, this size spread is covered by the five largest cities as shown in Table 1.1.

TABLE 1.1.

PRAIRIE METROPOLITAN AREAS SHOWING POPULATION CHANGE 1951 - 1971.

City	Population		
	1951	1971	Change %
Edmonton	176,782	495,702	180.40
Calgary	142,315	403,319	183.40
Regina	71,319	140,734	97.33
Saskatoon	53,268	126,449	137.38
Winnipeg	356,813	540,262	51.41

Source: D.B.S. Census of Canada 1951, 1971

If threshold effects have occurred, then a choice of study area may be crucial to the final answer obtained. With this point in mind, the two cities selected, namely Saskatoon and Calgary, bridge

this gap and show similar growth rates. In addition, Calgary and Saskatoon have developed primarily as commercial centres whereas Edmonton owes much of its growth to the presence of oil industry in its hinterland. The choice of Regina on the other hand would have resulted in the presence of Moose Jaw, with a population of 31,000 in its hinterland. The choice of Saskatoon rather than Winnipeg also allows the results obtained here to be directly comparable to those of other researchers namely Hodge (1965) and Stabler and Williams (1972).

Whichever processes have occurred, Hodge's (1965) research have demonstrated that the effect of large cities in Saskatchewan was to inhibit growth in the smaller settlements in their hinterlands. By contrast Hansen (1971), Neutze (1967) and Berry (1971) have shown the settlements in hinterlands have been increasing in importance. Pahl (1965) in a study of the metropolitan fringe of Hertfordshire has suggested that new non-rural populations over time invaded the communities in close proximity to the large cities resulting in the emergence of a new community system associated with dispersed living. The 'invaders' have tended to be mobile middle class commuters who live and work in two distinct and separate social and economic worlds respectively. They maintain their urban orientation giving rise to settlements which have a lower functional complexity than expected for their population sizes. Whichever of the ideas is correct, it is likely that centres nearest the major cities will show the greatest change in structure and composition.

If "spin-offs" or "spread effects" have taken place, in the period 1951 to 1971, it is to be expected that settlements in the

metropolitan region will have:

1. greater population increases;
2. increases in commercial and retail importance.

If, however, growth inhibition has occurred, the settlements should have:

1. smaller population increases, or have experienced decline
2. declined in commercial and retail importance.

Yet there is no need to assume that the two effects are universal or opposites. They may be alternative trends and could have occurred at different times. There might also be different effects arising from regional variations. Besides the regional differences, an overall threshold situation may have occurred with polarization as the initial process and spill-offs after the threshold has been reached. These may, therefore, make the debate on growth processes pointless and empirical results inconclusive.

Despite the many theoretical proposals mentioned above, it is difficult in a "before and after" study such as this to distinguish between changes associated with the region and those related to the central city. Such a distinction cannot be effectively made without a detailed behavioural analysis of the growth and diffusion of industries and commercial presence in the settlements. In addition, individual centres may experience growth that is unrelated to the influence of the city but results from changes unique to its location. Such influences cannot be isolated using a "before and after" approach.

On the Canadian prairies the four most important recent studies related to changes within metropolitan hinterlands have been those

conducted by Hodge (1965), Zimmerman and Moneo (1970), Tjerhelm (1972) and Stabler and Williams (1972). In the next section, the highlights of their studies and conclusions derived are discussed.

RELEVANT LITERATURE ON THE CANADIAN PRAIRIES

Hodge (1965), in his study of service centre change in Saskatchewan from 1941 - 1961, suggested that the change could be related to structural transformation on the farms. As farms became fewer, larger, and more specialized, there was a tendency for the farmers to become less dependent on the local service centre as a source for all their wants and needs. Farm centres have therefore not increased their functional complexity to match the increase in diversity of consumption of rural customers, rather many have been experiencing decline. The settlements have consequently become more dispersed, therefore increasing the cost to the rural farmers for shopping at the local centre. Davies (1967) and Berry (1967) have shown that the rural customers have substituted going to the local centre with multipurpose trips to the major regional centre.

Hodges tested and verified the following five "hypotheses":

(i) that low ranking centres lost services more rapidly than high ranking centres.

(ii) the rate of decline decreased with increasing distance from the central city, that is, settlements nearer the metropolitan centre experienced the greatest rate of decline.

(iii) there was polarization of the number of centres into lower and higher ranking places at the expense of the middle levels.

(iv) there was an increase in the distance between the lowest members of the lowest class. By implication, this hypothesis could only be true if there had been a demise or disappearance of some of the settlements in the lowest class.

(v) if two centres of the same class were sited below the mean distance apart for that group, one or other of the centres experienced demise or decline.

The five hypotheses outlined above, were geared to explaining the decline of the local service centres. The second one is directly related to growth pole ideas; that is, if metropolitan centres stiffle growth in their hinterlands, it is to be expected that growth would be attracted to the metropolitan centre therefore generating decline in the areas around it. The remaining hypotheses could occur only in a situation where there was an overall decline in the importance of settlements in the region.

In Stabler and Williams (1972) study, their conclusions showed that the central place system of the Qu'Appelle river basin of Saskatchewan had evolved from a four tier to a three level one, with the highest and lowest classes gaining at the expense of the middle groups. In the Qu'Appelle region, the change was however downward, that is the dominant tendency was for the settlements to decline in relative importance, resulting in an increase in functional complexity of lower classes. Two reasons are given to account for this transmogrification:

(i) centres with greater than average concentration of functions at the beginning of the time period experienced the greatest decline.

(ii) change in consumer shopping behaviour resulted in the bypassing of some of the settlements (Fig. 1.2) with the result that, the system did not function like a central place hierarchy; the shopping pattern showed two levels of behaviour:

(a) local needs of the rural customers around intermediate centres which were satisfied at the type A centre;

(b) other needs were accomplished by means of a multipurpose trip to the central city.

The results of Stabler and Williams' empirical study are complementary to the theoretical model derived by Hoover (1970) which concludes that "at an advanced stage of development, the substitution effect of transport improvement outweighs the 'income effect', thereby eliminating small centres and fostering agglomeration". Other studies in the U.S.A., such as those by Rushton (1969) and Berry (1960) appear to confirm this view. In this study, consumer behavioural patterns were not investigated.

Zimmerman and Moneo (1970) used crude indices of change that attempted to relate changes in the prairie community system to other variables in the economy. Their descriptive historical account appeared to conclude that changes in the prairie system had been associated with technological advances, mainly transportation. As a result, there was a decline in the number of towns described as "independent towns", which were towns with a post office, telegraph office, newspaper and bank.

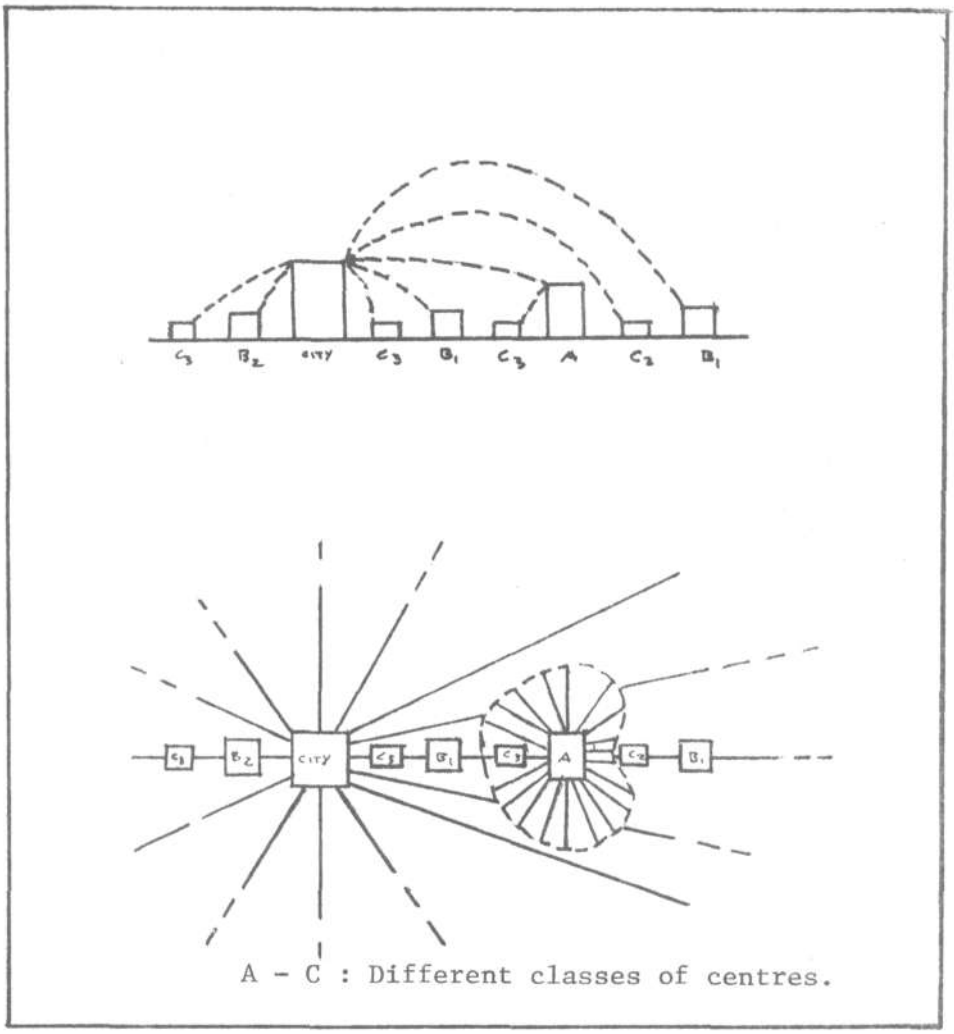


Fig. 1.2: Generalized view of the relationships between classes of centres.

Source: Stabler and Williams (1972) p.28

THE CENTRAL PROBLEM

The central focus of this dissertation is to empirically determine the commercial importance of central places within the hinterlands of Calgary and Saskatoon and examine the changes that have taken place in them from 1951 to 1971. Most of the changes can be summarized by the idea that centres nearer metropolitan centres show greater change in structure, as Hodge (1965), Davidson (1970), and Pahl (1965) have suggested. However, not all of the implications of this statement will be dealt with. Instead this study concentrates upon six basic problems. It is expected that for the areas under investigation:

(i) centres in metropolitan hinterlands are part of an overall urban system and are still organized into hierarchical groups.

(ii) settlements nearer the metropolitan centre should experience greater population change.

(iii) settlements nearer the central city should also experience greater change in commercial and retail structure.

(iv) from Lösch's (1940) description about change around metropolitan centres, commercial and retail importance should be concentrated into sectors radiating from the central city.

(v) from Berry's (1960) findings about change in functional composition of retail centres through time there should be an upward shift in function from 1951 - 1971.

(vi) if centres have decline, there should be an increase in average distance separating members of the same group.

CHAPTER CONTENT

Chapter 2 is a review of technical matters pertaining to this dissertation. It contains first an explanation of data sources used in the analysis. Besides this, an overview of alternative ranking techniques is given, followed by a detailed discussion of the three methods employed namely, Functional Indices, Cluster Analysis and Discriminant Analysis. A review of technical problems and solutions applied is also given. Chapter 3 deals with the population changes in the two regions and examines this by the use of maps depicting rural population densities in 1951 and comparing them with those in 1971. Similar comparisons are made between regression analysis of population in settlements and distance from the central city for the two areas. These results of these examinations are given in Chapter 3. They form a background for the discussion on changes in commercial importance of settlements.

In examining the remaining points, namely those pertaining to hierarchies and change in their content, Cluster Analysis was used to group the settlements and their distinctiveness tested by the use of Discriminant Analysis. This provides the basis for the examination of the hierarchical concept through the use of means and frequency of retail establishments occurring in the groups in Chapter 4, where the hierarchies of settlements in the two study areas in 1971 are identified and described. This establishes the basis for the discussion of structure and measurement of change. The use of Functional Indices as a preliminary ranking technique and Discriminant Analysis as a test for

distinctiveness of groups is also demonstrated. Chapter 5 contains the discussion of change in structure and content of hierarchical groups in the two study areas from 1951 to 1971. The results of the whole analysis and techniques employed are summarized in Chapter 6, which provides a conclusion to the study.

CHAPTER II

DATA AND TECHNIQUES OF ANALYSIS

Introduction. This chapter deals with the methods and problems involved in the dissertation. These may be divided into four parts:

(i) data input

(ii) alternative ranking techniques

(iii) review of techniques used in the analysis

(iv) problems of the analysis.

These subdivisions are discussed in turn in the next four sections.

Data Input

Data for the research involving many variables and settlements may be gathered by:

(i) fieldwork using either the total population or sample;

(ii) using official published sources like censuses and other reference books.

The fieldwork approach is by far the most accurate form since the data so collected is geared towards the fulfillment of the researcher's assumptions and experimental conditions. Unfortunately this ideal method of data assemblage is expensive both in time and in resources and consequently usually out of the reach of the average researcher. Most researchers therefore, resort to the use of data collected by other agencies, even though the data so collected need to be adapted in order to satisfy the research constraints set out by the researcher.

Population data for this thesis was collected from government publications, both federal (Dominion Bureau of Statistics) and

provincial (Department of Municipal Affairs). These sources of data have been widely used by other researchers involved in urban related research projects, (Stone 1965, Baig 1971) in Canada. The results obtained here should therefore be directly comparable to theirs. The only deviation from the general trend is that whereas most other studies have restricted themselves to incorporated places, interest in change in smaller communities have here necessitated the use of data, including the unincorporated settlements. Documentation of data with regard to unincorporated places in Canada is often difficult to come by, which in part explains why hitherto their contribution in the urban system has been largely neglected.

The biggest problem facing researchers utilizing government publications as their source of data, is the fact that as populations have changed, areal units of measurements have also been changed. This problem is easily overcome by reorganizing the data to conform to the data boundaries chosen by the researcher, but it means that the user must acquaint himself with the changes in order to accurately make the required adjustments.

The retail data used in this study was obtained from Dun and Bradstreet Reference Book. Most people studying aggregate retail structures involving many settlements in Canada have also used this data source, for example Hodge (1965) and Stabler and Williams (1972); both their works are referred to later in the thesis. Dun and Bradstreet in addition to its common usage has many other advantages. These are:

(i) it facilitates the speedy collection of data pertaining to level of establishments in many settlements including

information for the smaller settlements. Speed is essential in contemporary research due the speed in which conditions change in modern society.

(ii) it is consistent. Dun and Bradstreet publishers have developed a method of classifying business establishments which they have consistently followed over a long period of time. This characteristic enables the user to utilise data covering a long period of time, with very few alterations if any. Error in results attributable to data source is thus minimized.

(iii) because of its wide acceptance, it allows comparable research to be performed by different users in both time and space.

In the context of the present analysis, Dun and Bradstreet may be said to have the comparable disadvantage, in that the data is recorded as establishments, that is actual physical structures rather than the functions performed in them. It is clear that the importance of an establishment in a settlement may be underestimated because of the many functional types it performs. This problem will however, only occur when this study is being compared with some of the other central place studies which have used functions rather than establishments. Many ways of removing this problem in study comparisons have been suggested, but as Davies (1972) points out, the motives of the proposers are admirable but the methods rather dubious. It is expected that in this analysis, the error of covering up functional types within a single establishment will not affect the results, since it applies equally in all the settlements been studied. In addition to this the analyses which bear direct relation to this both in time and space,

namely Hodge's (1965) and Stabler and Williams' (1972) also utilised the same data source. In this thesis, the terms establishment and functional types are used interchangably except where specified. In most cases, they invariably mean the presence of the establishment in the settlement or hierarchical level. The list of functions used with comments appear in Appendix A.

ALTERNATIVE RANKING TECHNIQUES

In analyzing change in structure of settlements, it is important to arrive at some decision as to how to measure change. Much of the literature on this subject has tended to use population levels as a surrogate for other changes in the settlements. This indicator is not satisfactory whether viewed in terms of analytical methodology or the true nature of trade centre change. The use of population also precludes many of the settlements whose populations are too small to be included in official censuses. Hodge (1965) and Berry (1967) and others have pointed out that the true function of trade centres is restricted to supplying the commercial needs of the agricultural population living in close proximity to the settlement. Hodge goes on further to suggest that the possibilities of population growth in these settlements is restricted to an inflow of farmers choosing to reside in the settlement rather than in the surrounding countryside. This further limits the use of population as a surrogate for change in the settlement and its region. This view is supported by the research findings of Stabler and Williams (1972) in their study of the Qu'Appelle basin of Saskatchewan. They both indicate that this trend does not

show change, but a reallocation of an originally dispersed market to the central supply point. Hodge therefore, suggests that change in retail service level of a centre may be the best measure of growth and decline. Retail service level relates directly to the quality which is basic to the trade centres' existence, namely its power to attract patrons for its business establishments. In his analysis, also in Saskatchewan, he adopts a seven point ordinal system as a basis for the grouping of settlements into classes. Using this classification, centres are said to decline if they shift downward one or more classes on the ordinal scale, conversely, they are said to have grown if they increase in their ordinal rank. Demise or extinction of the settlement occurs when they fall below the threshold level of the lowest functional class. Hodge's functional classes (Table 2.1) are however, descriptive and very generalized. They neither give a clear indication of the functional composition of members nor provide a clear method of deciding into which class a settlement may be classified.

TABLE 2.1.

TYPES OF TRADE CENTRES

1. Primary wholesale and retail
2. Secondary wholesale and retail
3. Complete shopping
4. Partial shopping
5. Full convenience
6. Minimum convenience
7. Hamlet

Source: Hodge (1965); in Berry and Horton (1971) pp.211

Since the measurement of settlement change is most readily related to classificatory schemes, the key question to the solution of structural change is how the settlements may be best classified in order to minimize loss of information.

It is clear that most classificatory schemes, including Hodge's described above and one by Berry (1967) are ultimately based on a few selected dominant characteristics found in the settlements considered. Since these may vary from place to place, both within the same cultural realm and across cultural realms, it is obvious that replication of the functional characteristics will not be successfully achieved. In addition to this, Johnston (1970) has pointed out that different classificatory algorithms produce different results which may still be described as above. The type of algorithm used must then be chosen with great care since it may prove to be crucial to the interpretability of the results obtained.

At this stage, it is worth reviewing the utility of classifications. According to Grigg (1965), they should aim at least one of three things. These are:

(i) to give names to things,

(ii) to facilitate transmission of information,

(iii) to permit the development of inductive generalizations.

Grigg, and Johnston (1970) both maintain that the third aim of classifications listed above is the most important. It has also been suggested by the same authors that classifications should be embarked upon to achieve specific purposes. This restrictive approach to

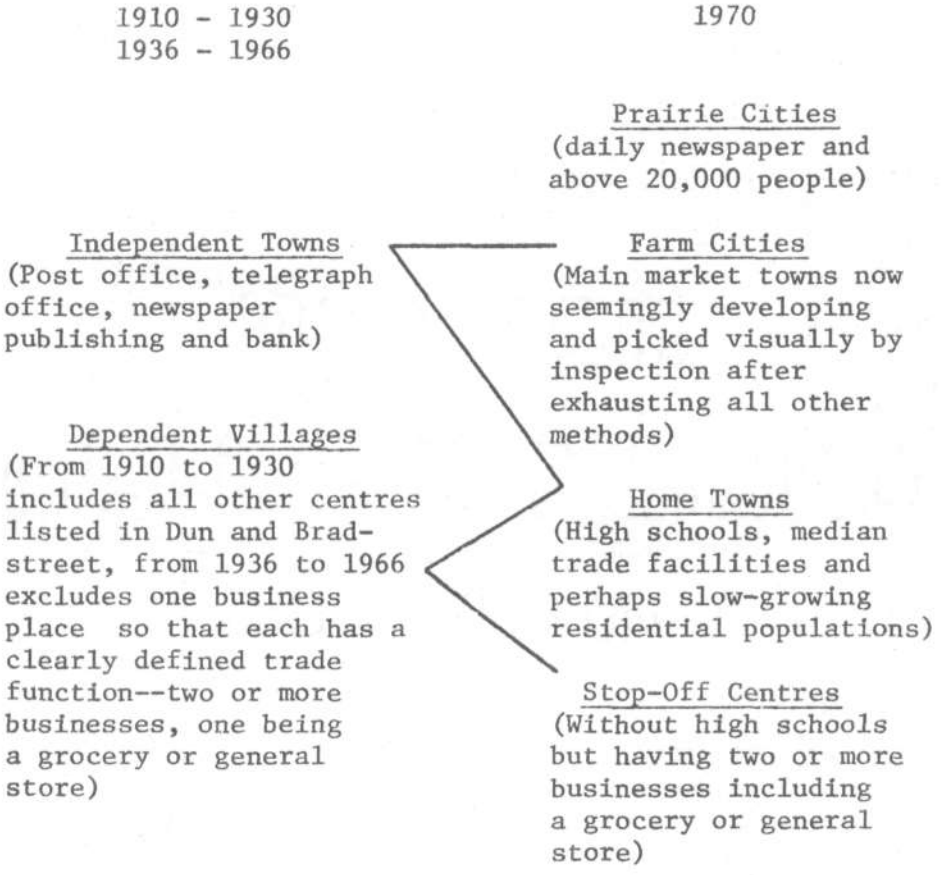
classifications precludes the use of general purpose classifications which tend to cloud rather than illuminate the issues in question.

Several classificatory algorithms have been developed to serve this purpose, both univariate and multivariate. Amongst the univariate approaches, population size has been the most widely used. This approach is widely adopted by official sources at different levels of government. It involves simply a division of the settlements into arbitrary classes on the basis of their population size. The technique ignores the fact that commercial and industrial importance of a place may be completely unrelated to its population size. In addition to this there is no logical cut off point which may be applied to justify the inclusion of any settlement in one group or the other.

Other attempts use a variety of indicants other than population size to distinguish between groups of settlements. Zimmerman and Moneo (1970) for example used the presence or absence of certain activities as a basis for their fourfold classification of prairie communities (Table 2.2).

TABLE 2.2.

PRAIRIE COMMUNITY SYSTEM



Source: Zimmerman and Moneo (1970): Prairie Community System pp.27

Like the use of population alone, this technique of classification lacks a sound statistical base, which consequently prevents its replication, especially in cross-cultural studies.

In order to overcome some weaknesses of univariate approaches to classifications, a number of multivariate techniques have been applied by different researchers. The commonest of these multivariate techniques are:

(i) Functional Indices

(ii) Discriminant Analysis

(iii) Q-mode Factor Analysis

(iv) Cluster Analysis.

The Functional Index is a simple technique based on the derivation of a single measure from a multivariate data set. The derived index can then be treated in the same way as a single measure of differentiation. This approach was adopted by Davies (1967) in a study of centrality and the central place system. The Functional Indices approach does not supply the user any statistical basis for cut-off points to demarcate the data set into groups. The only advantage it has on univariate approaches is the nature of the index which is the weighted sum of all the functional characteristics, (see section below). In this analysis Functional Indices have been used to enable the author to eliminate some of the smallest settlements which constitute 'noise' in the analysis. It has been also used as an additional check on hierarchical grouping.

Q-mode Factor Analysis has also been used by some authors as a means of classification, (Britton 1973, Berry 1972b, Ray and Murdie 1971).

This groups the places on the basis of axes referred to as factors, which are derived by the application of iterative techniques on the original data matrix. The problem with factor analytic techniques including Q-mode analysis is the tendency for all the variables or objects of the comparism to load highly on the first factor, producing a continuum rather than discrete groups. Interpretation of results from Factor Analysis are therefore still subjective. Johnston (1971) however suggests that R-mode Factor Analysis could be used as a data generator for analyses rather than factor analysis being used as the technique itself. The value of this round-about way of arriving at a data set is however dubious. From all indications, it is clear that although Factor Analysis has been used as a basis for classification, the results have been far from being conclusive. Attempts at replication of analyses where the data has been supplied with the study have also been in many cases unsuccessful.

Another classificatory technique which has been used is Discriminant Analysis, but as the name suggests, the search for groups is not the object. Discriminant Analysis starts with the assumption that groups have been given; the purpose of the analysis is therefore to test the groups on the basis of the discriminant function to see if the best groups have been achieved on the basis of the data set. It has been pointed out by King (1969) that groups for Discriminant Analysis may be obtained from other analytic techniques including univariate techniques or even intuition and the result tested via Discriminant Analysis. Because of the preconditions required, Discriminant Analysis is not a satisfactory initial classifactory

methodology, it does however prove very useful for the verification of groups once they have been obtained using other means. It has been used as such in this thesis.

The final method of classification to be discussed is a family of procedures known as Cluster Analysis. Cluster analysis starts by accepting each observation as a group. Groups are then formed from this by linking the observations one at a time on the basis of some index of similarity or dissimilarity. With the advent of modern high speed computers, it is theoretically possible to use an unlimited number of variables for discriminating between groups. In practice, the number of variables allowed is limited by the particular program as well as hardware facilities of the computer system being utilized. Since all the observations are eventually classified into one group, the thorniest question confronting users of cluster analysis is the determination of the number of optimum groups to be found in the data set. In addition to this, the clustering technique does not supply the characteristic functions for the group. In spite of this drawback which is inherrent in all classificatory algorithms, Cluster Analysis has the advantage that one does not have to start with any predefined groups. Groups obtained from Cluster Analysis are also more discrete. It is also obviously superior to univariate methods because of the use of multivariate data.

Of particular significance to the present study, is the fact that by the choice of an appropriate grouping algorithm for the clustering procedure, it is possible to get groups that do not only have the aforementioned qualities, but also are hierarchical (Ward 1963).

From the discussion above it is clear that the main problem of any classification is that of deciding the number of groups in the data being processed. There can not be any one classificatory methodology for all purposes. This underlines the point that each classification should be tested by other independent methods to ascertain optimality and distinctiveness of groups. Discriminant Analysis was used in this study, as a partial test for this quality. The performance of the Discriminant Analysis test is measured by use of a matrix of F-values.

REVIEW OF TECHNIQUES USED

Besides the Regression Analysis used in the population study, three techniques were employed in this thesis. These are: Functional Indices, Cluster Analysis and Discriminant Analysis. Functional Indices, which are simple measures of the relative importance of settlements were used for two purposes:

(i) to obtain a basis for eliminating random location of establishments.

(ii) as a preliminary test to establish the hierarchical nature of cluster analysis groups.

Cluster Analysis was used for obtaining groups on which the hierarchical nature and changes in retail and commercial structures were examined. The distinctiveness of the cluster groups was tested by use of Discriminant Analysis. Since the total number of establishments could not be used, the results of the discriminant test were viewed as partial. The next sections discuss in detail these techniques, their problems, and how they were solved in the context of the analysis.

Functional Indices

Ranking procedures play a prominent role in central place studies; consequently, many criteria for ranking have been utilized. Most of them have been based on one variable, usually population as is the case of Davidson (1970). In recent research, the inadequacies of univariate ranking procedures have been tackled. One such methodology used, which applies particularly to central place studies is one which employs location coefficients to calculate the functional index which can then be used as a ranking variable. This approach to ranking has been successfully applied by Davies (1967) in a study of the relationship between centrality and central place hierarchy.

Applications of location coefficients and its derivatives, centrality values and functional index, assumes that the area being studied is a closed system and that the focality of any function varies in direct relationship to the total number of outlets of that particular type of function in the area. It therefore means that the greater number of outlets of any function, the lower the degree of focality each individual outlet is going to possess. Location coefficients are calculated using the construction:

$$L_t = \frac{t}{T} \times 100$$

where: L_t = location coefficient of function t

t = one outlet of function t

T = total number of outlets of function t in the whole system.

The use of location coefficients in the form described above reduces all the functions to a common base; each functional type is therefore immediately comparable in an objective fashion.

In order to obtain centrality values (C_{ti}), each relevant location coefficient is multiplied by the number of functions of that type in each settlement. The centrality value is a measure of the degree of focality imparted to each settlement for every different functional type:

$$C_{t_1} = L_t \times t_i$$

where: L_t = Location coefficient for function t

t_i = total number of outlets of t in settlement i

Functional index (F) is simply the addition of all the centrality values attained by any settlement:

$$F = \sum_{i=1}^{n} C_{t_i}$$

It can be used as a measure for ranking settlements, including all the functional characteristics found in the settlement.

In order to illustrate the computational procedure, a data set made up of ten hypothetical settlements with seven hypothetical functions was compiled (Table 2.3).

TABLE 2.3.

EXAMPLE OF ORIGINAL DATA FOR FUNCTIONAL INDICES

CASE	VAR001	VAR002	VAR003	VAR004	VAR005	VAR006	VAR007
001	1.00	2.00	3.00	0.00	5.00	6.00	7.00
002	0.00	1.00	0.00	3.00	0.00	1.00	5.00
003	1.00	1.00	1.00	4.00	0.00	0.00	0.00
004	1.00	3.00	0.00	1.00	4.00	1.00	4.00
005	5.00	3.00	4.00	8.00	11.00	7.00	10.00
006	0.00	1.00	2.00	0.00	1.00	0.00	6.00
007	0.00	0.00	0.00	0.00	0.00	0.00	2.00
008	0.00	1.00	1.00	0.00	1.00	0.00	2.00
009	1.00	1.00	0.00	0.00	2.00	1.00	0.00
010	0.00	2.00	1.00	0.00	0.00	0.00	1.00

Each cell shows the number of establishments of a particular type in the appropriate centre.

The next step is the reduction of the total number of establishments by dividing the total into 100. The resultant value is the location coefficient which measures the relative importance of any single outlet of a particular functional type. It is possible at this point to also calculate the total number of establishments (row sum) in each settlement (Table 2.4). This can later be related to the Functional Indices

TABLE 2.4.

LOCATION COEFFICIENTS

CASE	VAR001	VAR002	VAR003	VAR004	VAR005	VAR006	VAR007	ROW SUM
001	1.00	2.00	3.00	0.00	5.00	6.00	7.00	24.00
002	0.00	1.00	0.00	3.00	0.00	1.00	5.00	10.00
003	1.00	1.00	1.00	4.00	0.00	0.00	0.00	7.00
004	1.00	3.00	0.00	1.00	4.00	1.00	4.00	14.00
005	5.00	3.00	4.00	8.00	11.00	7.00	10.00	48.00
006	0.00	1.00	2.00	0.00	1.00	0.00	6.00	10.00
007	0.00	0.00	0.00	0.00	0.00	0.00	2.00	2.00
008	0.00	1.00	1.00	0.00	1.00	0.00	2.00	5.00
009	1.00	1.00	0.00	0.00	2.00	1.00	0.00	5.00
010	0.00	2.00	1.00	0.00	0.00	0.00	1.00	4.00
COLUMN SUM	9.00	15.00	12.00	16.00	24.00	16.00	37.00	
LOC. COEF	11.11	6.67	8.33	6.25	4.17	6.25	2.70	

to show the significance of the actual number of establishments on the relative importance of the place.

From the location coefficients, the centrality values for each cell location are computed by multiplying the location coefficient with the number of outlets of the same function in each settlement. The sum of the rows (if the data is organized as shown above), or the centrality

values for each settlement are added to obtain the functional index (Table 2.5).

TABLE 2.5.

CENTRALITY VALUES AND FUNCTIONAL INDICES

CASE	VAR001	VAR002	VAR003	VAR004	VAR005	VAR006	VAR007	F. INDEX
001	11.111	13.333	25.000	0.000	20.833	37.500	18.919	126.697
002	0.000	6.667	0.000	18.750	0.000	6.250	13.514	45.180
003	11.111	6.667	8.333	25.000	0.000	0.000	0.000	51.111
004	11.111	20.000	0.000	6.250	16.667	6.250	10.811	71.089
005	55.556	20.000	33.333	50.000	45.833	43.750	27.027	275.499
006	0.000	6.667	16.667	0.000	4.167	0.000	16.216	43.716
007	0.000	0.000	0.000	0.000	0.000	0.000	5.405	5.405
008	0.000	6.667	8.333	0.000	4.167	0.000	5.405	24.369
009	11.111	6.667	0.000	0.000	8.333	6.250	0.000	32.361
010	0.000	13.333	8.333	0.000	0.000	0.000	2.703	24.572

The settlements or cases can then be ranked on the basis of the functional index as shown in Table 2.6, and the results used as the

TABLE 2.6.

RANKED FUNCTIONAL INDICES

RANK	CASE	FUNCTIONAL INDEX	NO. OF ESTABLISHMENTS
1	005	275.499	48
2	001	126.697	24
3	004	71.089	14
4	003	51.111	7
5	002	45.180	10
6	006	43.716	10
7	009	32.361	5
8	008	24.572	4
9	010	24.369	5
10	007	5.405	2

basis for preliminary classification or further analysis concerning the importance of places. As has been shown in Table 2.6, the

importance of a place is more related to the type of functions it performs than to the absolute number of functions found in it. As Davies (1967) has pointed out, this approach has contemporary relevance in that if fulfills the following criteria:

(1) it is completely objective and capable of being tested.

(2) the index derived is not based on any particular data which limited application or relevance. It is possible through the use of centrality values to directly compare results with those obtained elsewhere.

(3) the measure incorporates all the central functions of a place, producing a compound index which can be subdivided into its component parts.

As used in this analysis, the Functional index was used to eliminate relatively unimportant places, which in the opinion of the author were likely to create 'noise', rather than increase the illumination of the problem been studied. The decision was reached through empirical comparison to have a cut-off point at a functional index of 5.00 in the original 1951 settlement data. This reduced the number of settlements in Calgary region to 66 and 68; and around Saskatoon to 89 and 80 for 1951 and 1971 respectively. If centres fell below this level in 1971 they were supposed to have suffered virtual demise. Table 2.7 shows the results of this cut off criteria for Saskatoon region in 1971.

Cluster Analysis

As has been stated, it is often desirable to cluster large numbers of objects into a few mutually exclusive groups such that each

TABLE 2.7

FUNCTIONAL INDICES: SASKATOON REGION 1971

RANK	NAME	FINDX	RANK	NAME	FINDX
1	Humboldt	1336.072	54	Dinsmore	15.226
2	Rosetown	619.015	55	Bladworth	15.185
3	Watrous	389.679	56	Laird	15.026
4	Rostherm	381.145	57	Meachum	14.759
5	Biggar	375.432	58	Dundurn	14.004
6	Outlook	353.375	59	Borden	13.732
7	Lanigan	279.570	60	Harwarden	13.186
8	Bruno	206.657	61	Dalmeny	12.511
9	Shellbrook	196.976	62	Loreburn	12.387
10	Langham	180.946	63	Guernsey	12.038
11	Delisle	163.531	64	Drake	11.636
12	Hafford	162.352	65	Yellow Crk	11.254
13	Blaine Lk	157.014	66	Maymount	10.742
14	Davidson	142.015	67	Alticane	9.883
15	Conquest	121.960	68	Dana	9.086
16	Birch Hills	107.662	69	Cando	8.390
17	Leask	102.369	70	Strongfield	8.150
18	Cudworth	98.718	71	Parkside	7.550
19	Hague	72.889	72	Tessier	7.468
20	Duck Lake	64.931	73	Landis	6.936
21	Simpson	63.193	74	Macrorie	6.912
22	Elbow	62.251	75	Elstow	6.567
23	Middle Lake	56.447	76	Birsay	6.242
24	Young	52.596	77	Zealandia	5.879
25	Perdue	52.533	78	Crystal Sp	5.615
26	Colonsay	52.262	79	Herschel	5.087
27	Imperial	49.394	80	Ruthilda	5.001
28	Viscount	48.020	81	Ossler	4.909
29	Allan	46.697	82	Red Deer H	4.762
30	Marcelin	44.991	83	Kinely	4.366
31	Manitou Bch	43.991	84	McDowall	4.009
32	Krydor	40.786	85	Girvin	3.754
33	Speers	40.723	86	Carlton	3.043
34	Waldheim	37.520	87	Arelee	3.005
35	Milden	37.205	88	Soningdale	3.005
36	Radisson	36.625	89	Holbein	2.991
37	Lake Lenore	35.219	90	Glennside	2.416
38	Hanley	29.153	91	Rheinland	2.329
39	Harris	28.792	92	Lockwood	2.329
40	Vonda	27.723	93	Annahem	2.250
41	St. Gregor	27.097	94	Naseby	1.515
42	Asquith	25.925	95	St. Dennis	1.338
43	Hepburn	25.266	96	Bounty	1.333
44	Wiseton	24.504	97	Ardath	1.325
45	Alvena	24.471	98	Fielding	.676
46	Rudell	22.329	99	Duperow	.662
47	Mt. Nebo	21.996	100	Ordale	.662
48	Kenaston	19.113	101	Haggen	.662
49	Warman	18.096	102	Struan	.662
50	Grandora	17.342	103	Cutbank	.662
51	Aberdeen	17.274	104	Bradwell	.662
52	Pilger	15.697	105	Peterson	.662
53	Prud Homme	15.356	106	Zelma	.662

FINDX: Functional Indices
——— : Cut-off point

has an internal similarity which is greater than its similarity to objects of other groups. Ward (1963) suggests that, this clustering makes it easier to understand relations in large collections. Grouping however invariably results in the loss of information, which according to Ward may be quantified as a 'value reflecting' number.

Cluster Analysis is a generic name used to represent a variety of grouping algorithms designed to fulfill the primary objective defined above, namely to perform grouping with a minimum loss of information. The diversity of grouping algorithms is reflected in the number of methodological options to be found in average computer programs. All the algorithms however share a basic similarity namely, they cluster using distance measures by pairwise comparison of observations. The essential difference between them is usually the definition of the distance measure used. Some of the most commonly used methods are described below.

Centroid (single linkage). Algorithms based on centroid technique utilize a symmetrical matrix of associations and evaluate the observations one at a time. Berry (1968) described the distance measure that could be used for centroid method as:

$$D_{tk} = \sum_{i=1}^{r} (U_{it} - U_{ik})^2$$

where: D_{tk} = distance between two observations t and k

U_{it}, U_{ik} = scores of t and k on vector U_i

r = number of vectors U_i i = 1,2,3,...,r

The resultant distances (D_{tk}) are then arranged in a square matrix n X n.

With this matrix, the closest pair of observations or points are linked. The increment distances between pairs and groups tend to increase slowly while natural groups are being formed and becomes larger after this initial stage. Berry (1967c) has shown that the method works well on well-patterned data or densely packed data but "chaining" arises when dispersed data is used. Chaining is the situation in which due to dispersion of data, there is a tendency for the observations to be linked one at a time in a steplike fashion. No distinct groups are found.

Neighbourhood limited algorithm (mode analysis). Neeley utilizes an approach (Lankford 1969) that develops a single linkage by first picking out the high density regions as centres of the groups or regions. The more sparsely occupied spaces are then classified or rejected from the analysis depending on the alternative classification criteria adopted, namely;

(1) nuclei classification, which utilizes only dense spheres the non-dense spheres are regarded as unclassifiable.

(2) basic classification. By this alternative, the critical density criterion is relaxed, thereby including other observations which would have been otherwise rejected if nuclei classification has been adopted.

(3) complete classification, where all points are classified by adopting a 'best fit' criterion. In practice this means linking the points to their nearest basic cluster.

According to Lankford, this algorithm fulfills the conditions of

connectivity, consistency and local stability. It is also supposed to get rid of the tendency for many classificatory algorithms to give equal sized groups, as well as the errors resulting from the distribution of data (see also Thompson 1970).

Ward's method. As has already been stated (Johnson 1970) it is crucial before embarking on any classificatory exercise to have a clear perspective of the purpose of the classification being performed. Johnson's comment based on Grigg's (1965) assessment stresses that general purpose classifications are to be rejected in favour of those designed to meet specific requirements. In this thesis, the hierarchical requirement of the classification is of utmost importance since the intention is to relate the results so derived to central place studies.

Apart from the hierarchical nature, it was intended that the loss of information involved in the computation be minimal. This meant that the similarity coefficient chosen should make it possible to achieve this objective. One method which fulfills the stipulated conditions is that developed by Ward (1963) as a means of determining optimum groupings. Ward aimed at forming groups from n, n-1, ..., 1 in such a way that the loss of information associated with the grouping is kept at a minimum. He achieved this by first assuming that each of the observations constituted a group, and linking them to form new groups, one at a time. At each linkage point, the loss of information was minimized. Ward also evaluated the loss of information in terms of the functional relationship, by using an objective function which provided the 'loss of information' or 'value reflecting', number.

In hierarchical grouping, the 'loss of information'; which occurs as a result of treating all the observations as one group can be indicated by a value reflecting number which is the error of sums of squares (ESS). This is expressed as:

$$ESS = \sum_{i=1}^{n} X_1^2 - \frac{1}{n}\left(\sum_{i=1}^{n} X_1\right)^2$$

where: X_i = value of i^{th} object of score.

n = number of observations.

The most desirable error of sum of squares is 0.0.

The first step in the use of hierarchical grouping with Ward's method is to calculate the matrix of potential errors, which is the mean of sums of squared differences between corresponding scores. For example, the potential error for objects X_1 and X_2 is:

$$\frac{1}{n}\sum_{j=1}^{m}(X_{1j} - X_{2j})^2$$

where: m = number of variables

n = number of cases in the potential group.

Each object is therefore described as a potential group and the error matrix of pairwise comparisons scanned to find out which yields the smallest error. These are linked and in their stead, a single object group is formed from the pair leaving n-1 groups. From the resultant index or error, the mean of the two is used in the next scanning stage. This process is repeated, with the lowest errors been selected at each stage and linked, until one group is formed. As with all grouping algorithms, the linkage points have small gaps while natural groups are

being formed and increases in larger steps after this stage has been passed. A graphical representation of the linkages can be made in the form of a tree diagram. This usually helps to make it easier to see the way the observations are related to each other. The gaps in the linkage points between groups provides a clue into the search for the optimum number of groups. A general practice which has been found satisfactory is to plot the linkage points on a graph and selecting the first distinct break in the line as the natural cutoff point for groups.

In spite of the clarity and practicability of Ward's grouping algorithm, it has weakness which need to be pointed out. These problems are by no means unique to Ward's hierarchical grouping algorithm; they appear to occur in all the other grouping methods. Four of these are briefly discussed here.

(i) According to optimum grouping theory, grouping should minimize within group distance while at the same time minimizing inter-group distances. Ward's method however, accepts the result of previous groupings as the basis for determining the next group. This does not minimize within group distances, even though it is acceptable as the next best option for optimum grouping.

(ii) The method (Cluster Analysis) like all the other grouping techniques discussed above does not provide a statistical basis for establishing the stability of the groups obtained for comparison with other samples. However, it is possible to use other techniques to determine the stability of the solution obtained. The fact that the groups are discrete makes cluster analysis one of the most superior forms of clustering available.

(iii) Cluster Analysis does not provide a statistical basis for determining the cut off point for the number of groups. There is consequently no internal way of testing if the groups obtained are really optimal.

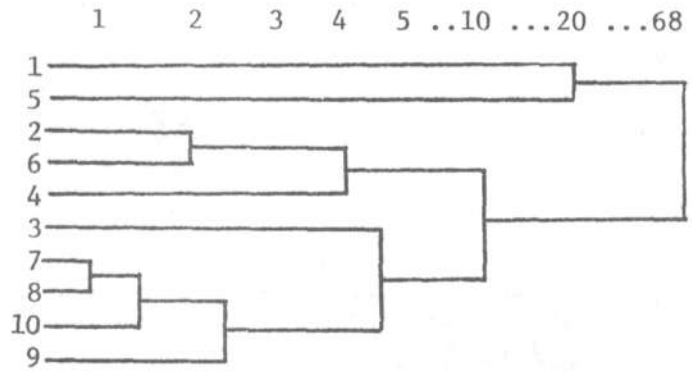
(iv) In dispersed data with little natural clustering, chaining as may be expected, is know to occur. This problem can only be solved by using an alternative data structure or a different technique. In some cases, chaining may occur only with the higher level of the linkage plot, giving rise to many single object groups. Chaining has been given as one of the problems of Cluster Analysis; however, it is the opinion of the writer that, chaining should be used as a type of solution to the grouping situation, namely, that the objects do not have natural groups.

Since most of the problems cited here apply to all analyses using Cluster Analysis, it is recommended that the results of the analysis be tested using other techniques to verify the accuracy and stability of the groups. One such technique, specially designed for testing classifications is Discriminant Analysis.

Example of Cluster Analysis

The 10 × 7 data matrix used for the calculation of functional indices (Table 2.3) was put into a cluster analysis program, CLUSTAN, using Ward's method. The resultant linkage points based on the measure of loss of information (error of sum of squares), column (h) in Fig. 2.1a.

FIG. 2.1a : DENDROGRAM TABLE



FUSION SUMMARY

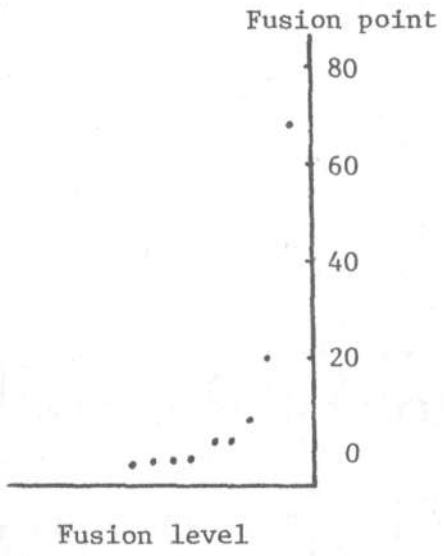
		'h'
7	8	.429
7	10	.715
7	9	1.715
2	6	2.286
2	4	4.000
3	7	4.343
2	3	9.693
1	5	18.286
1	2	67.765

The dendrogram table shows the linkage of cases, thereby providing a graphic impression of the way the objects are clustered. As the diagram shows, there are few natural groups, creating the difficulty of arriving at a completely satisfactory cutoff point, as will be shown shortly.

In order to determine how many groups there are, a plot of the error of sums of squares was made (Figure 2.1b). In this case, a number of options were possible, namely, cutting off at 10.00 yielding 3 groups or at 4.00 giving rise to 5 groups, three of which contain only one observation. It was decided, therefore, to compare the results obtained here with the ranked functional indices from which the final groups were ascertained. In this particular case it may be argued that the number of objects in the total set, were so few that it was unlikely that clear groups will be ascertained, which is why the cut off point was problematic. The results were finally put through a Discriminant Analysis in order to test for the accuracy and the

stability of the groups. This will be discussed in the next section.

FIG. 2.1b : FUSION SUMMARY GRAPH



Discriminant Analysis

Discriminant Analysis employs distance measures as a means of classifying items into classes. It is most applicable in cases where there are marginal objects which pose difficulties in the classificatory exercise. The use of Discriminant Analysis in itself DOES NOT provide the classes (King 1969, page 204), classes are assumed to have been provided either by intuition or other methods of classification like Cluster Analysis. As Kendall (1957, page 144) points out, 'it is not the object of the inquiry to find out what is the best way of dividing heterogeneous material into population or classes', rather it is to test if the best grouping has been achieved. Discriminant Analysis also does not point to any grouping tendencies in the data. Another very important assumption in the use of Discriminant Analysis is that the objects included in the study belong to one group or the other.

There are no marginal or external cases. What happens in practice is therefore to classify each object into its nearest group.

The simplest form of Discriminant Analysis is that which classifies objects into two groups using one characteristic, for example using x in group I and II in Table 2.8.

TABLE 2.8.

DATA FOR DISCRIMINANT ANALYSIS

	GROUP I				GROUP II		
	X_1	Y_1	Z_1		X_2	Y_2	Z_2
1	19	13	9	8	14	11	12
2	18	7	11	9	16	13	10
3	15	6	14	10	15	9	12
4	20	12	8	11	19	15	7
5	18	8	11	12	16	12	9
6	17	8	14	13	17	11	9
7	18	9	10	14	15	13	1

Source: Dr. L.C. Nkemdirim,
Geog. 439,
University of Calgary.

The first step is then to calculate the distance measure upon which the discriminatory tendencies are going to be based. Mahanalobis D^2 is the most widely used measure, although U-statistics based on Wilk's Δ are sometimes used, usually in Stepwise Discriminant Analysis as a test measure at each step of the computations. For the two attributes X_1 and X_2, Mahanalobis D^2 is defined as:

$$D^2 = \frac{d^2}{S^2 X}$$

where: d^2 = difference of the means of X_1 and X_2 squared, $(\bar{X}_1 - \bar{X}_2)^2$

S^2x = standard error of sums of means squared.

$$S^2x = \frac{\sum(x_1 - \bar{x}_1)^2 + \sum(x_2 - \bar{x}_2)^2}{n_1 + n_2 - 2}$$

In Table 2.8 D^2 for X_1 and X_2 is 1.5. From this value the discriminant function which is used to verify the accuracy of the groups is found.

In order to test the accuracy or the significance of the discrimination of the variable, it is useful to apply the F-test in the form,

$$F = \frac{(N - p - 1)}{(N - 2)\, p\, T^2}$$

where:

$$T^2 = (n_1\ n_2\ n_1 + n_2)D^2$$

N = total number of cases

n_1, n_2 = sample size of Group 1 and 2.

In the example being used here the calculated F is 5.25, which falls in the reject zone which indicates that X on its own is not a good discriminator between the two groups.

In the multiple variable case, matrices are employed in the same way as the simple single variable case for the calculation of D^2.

$$D^2 = d^2 / S^2x$$

in matrix form becomes:

$$D^2 = [d]\ [S^2x]^{-1}\ [d]$$

From these results, the multiple discriminant function of the form

$$L = a_1x + a_2y + a_3z$$

is computed. It may be used as a means of classifying new cases into the existing groups. The matrix of a's in the function is derived

using the form:

$$[a] = [S]^{-1} [d]$$

In the analysis, the results for a_1X, a_2Y and a_3Z were 7.70, -0.99 and 5.02 respectively, giving the discriminant function to be:

$$L = 7.7X - 0.99Y + 5.02Z$$

Using the function, the mean results for each group are found. The discriminant line is the means of the two groups to be demarcated.

In the Stepwise Discriminant Analysis involving many groups, the function for each group is computed, on the basis of the variables which through the application of a tolerance test qualify to be included in the analysis. In the 10 × 7 matrix case (Table 2.3) variable 5 did not pass the test, and was consequently not included in the discriminant function. The discriminant functions for the 10 × 7 matrix are listed in Table 2.9.

TABLE 2.9.

DISCRIMINANT FUNCTIONS

$$L = a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_6x_6 + a_7x_7$$

GROUP	a_1	a_2	a_3	a_4	a_6	a_7
1	-347.12	115.45	529.58	33.78	832.38	-112.98
2	- 30.47	12.28	42.43	3.99	65.29	- 8.39
3	- 34.71	13.67	52.44	3.50	80.46	- 11.16
4	14.04	- 4.86	-21.67	-1.37	-33.57	5.12

The resultant reclassification indicated that one case had been misclassified. The new classification yielded four groups with 2, 5, 2 and 1 cases respectively.

PROBLEMS OF THE ANALYSIS

With the retail and commercial data readily available in the widely used Dun and Bradstreet reference book, most of the data problems were pertaining to population data obtainable through official government sources. Besides problems related to population, there were others related to the definition of key terminologies namely growth, metropolitan areas and rural urban population. There are also problems related to the techniques used, namely are clusters groups? Are groups hierarchical? It is proposed to deal with these problems in this section.

Definitions

Growth. Growth is variously defined depending on the object of the analysis. It has been shown by Stabler and Williams (1972) that the use of different indicators gives conflicting results. Growth may be expressed using any of the following parameters;

(i) population increase,

(ii) increase in government activity,

(iii) increase in service centre activity,

(iv) increase in industrial establishments.

Most studies dealing with the impact of the growth of major cities on their hinterlands have tended to concentrate on the demographic change (Davidson 1970, Stone 1965, Baig 1972). In this thesis, population change is to be dealt with as a background to the whole analysis. Emphasis has been placed on service centre change which makes this work comparable to central place theory and other related studies.

Rural-urban population and population data. As defined by Dominion Bureau of Statistics, urban population includes the population: either living in incorporated cities, towns and villages with a population of 1000 or over; or in unincorporated places of 1000 persons or having a population density of more than 1000 persons per square mile; or in built up fringes of both incorporated and unincorporated places with a population of 1000 and a density of at least 1000 persons per square mile. Rural areas are regarded as those not living in urban places as defined above. It is apparent that this rigid and restrictive definition of urban places excludes most of the small towns which form the majority of the settlements being studied here. It is therefore proposed that in this thesis the term settlement will be used to include all centres of populations over 25 persons whether they are officially classified as towns, villages or cities, except for the central city. This information was collected using various publications of the Provincial Department of Municipal Affairs.

Definition of metropolitan areas. For the purpose of this study, a very broad working definition of metropolitan region of the central city is used. This is here defined as 80 miles radius and around from the central city. This limit has been arrived at bearing in mind Treadway's (1972) study of metropolitan dominance in Turkey in which he established the distance as varying between 25 to 50 kilometers from the central city. Berry et al (1968) and Russwurm (1972) also studied this phenomenon and arrived at a distance of 50 miles as the limit of the metropolitan region. It has to be borne in mind however, that all

the studies cited were conducted in areas of higher settlement density than that which is prevailing on the Canadian prairies. Consequently it is expected that the zone of influence will be larger on the Canadian prairies than for cities of similar size in high density areas.

Average travel time was then brought into consideration, on the basis that a one hour travel time is the approximate maximum that consumers will be prepared to travel before the frictional effects of time-distance generate the motivation to seek an alternative centre for the same good or service. Average travel distance based on speed restrictions on the highways is approximately 65 miles from the city limits. Because there are few settlements in the prairie urban system over 100,000, it was decided to increase the outside limit of the metropolitan region to 80 miles in order to exclude the possibility of leaving out settlements which might be under the influence of the large central city. It is recognized that centres of the fringes of the metropolitan regions as defined here may lie within the direct influence of the middle sized settlements with populations between 10,000 and 40,000 and consequently liable to create "noise" in the results of the analysis. This should however not constitute a major defect, since according to central place theory these middle sized centres should be within the zone of influence of the central city. They may in fact be viewed as the natural boundaries of the trade areas of the central city.

Problems of Techniques

Most of the problems encountered in this thesis arise out of

grouping technique, namely Cluster Analysis. Cluster Analysis does not provide an objective way of arriving at optimum number of groups. Many groupings are possible depending on where the cut off point is applied. This problem is more serious in dispersed data which usually results in 'chaining', or non-clustering of single object groups. Chaining was not encountered in this analysis. In order to solve the problem of how many groups, "cut-off" points are introduced on the basis of gaps in a graphical plot fusion points. This however does not solve the problem of whether the clusters are distinctive groups. In this thesis Discriminant Analysis was used to test for misclassifications. Only functions occurring in all clusters were used for this test because of programming constraints. The test is therefore regarded as 'partial'.

In the context of central place theory it is also important to establish the hierarchical nature of the groups. Berry (1958, 1967) Ray (1972) have outlined the basic requirements of a hierarchical system of Christaller and Lösch, namely:

(i) each group should have a distinctive cluster of functions

(ii) higher order places should have more outlets of lower order functions.

In this study, the results of the cluster analysis were first compared with the ranked Functional Indices. After this preliminary test, the means and frequency of occurrence of each establishments were computed for the groups. An establishment was said to initially belong to the group in which it first has a mean occurrence of at least 1.0 and a frequency of 66% if the group has more than three members. These issues are further discussed and illustrated in the following chapters where they occur.

CHAPTER III

POPULATION CHANGES AROUND CALGARY AND SASKATOON

Introduction. It is proposed as a background study, to discuss population change around the two cities in the light of current theory and expectations derived from tenets of central place and growth pole theories. Central place studies, especially the work of Lösch (1940) and subsequent followers, for example Davidson (1970), lead us to expect that population concentrations should be along sectors radiating for the central city. In between these, there should be areas of low population and settlement densities termed 'city-poor' sectors. From growth pole ideas, for example, Brown (1973), one or more of three possible growth trends may have occurred in the hinterlands of major cities. These are polarization, peripheral growth and uniform growth. The two sets of ideas, central place and growth poles put together imply that settlements nearest the central city should have experienced the greatest population change and this change should be in sectors corresponding to the "city-rich" and "city-poor" sectors.

In this chapter it is intended to examine these changes in respect to population in both areas and in settlements. The method used is not process oriented but 'before and after' based on graphical means. Maps showing rural population densities for the 1951 and 1971 for the two study areas are compared and the trends described and explained. It is expected that if central cities have been spilling off population, two things should occur:

(i) there should be a zone of higher population density around the city.

(ii) through time this zone should expand or increase in density.

It is assumed that even if the city has attracted population to itself, there ought to be a thin zone of higher population density around the city due to residential preferences of some urban inhabitants, that is, some of them might prefer to live on acreages and small plots of land adjacent to the city. However the overall effect through time should be the declining of population densities around the city.

Change within hinterland communities in general and in sectors is examined using regression analysis. A regression of overall and sectoral distribution of population and distance from the city was performed for 1951 and 1971 and the results compared. Prior to detailed discussion of population change in the two areas, an overview of population change in the Alberta and Saskatchewan is made.

Rural and Urban Population in the Canadian Prairies 1951 - 1971

Table 3.1 shows the obvious fact that Canada as a whole has been experiencing rapid population increases, not only through natural increase but also in the form of new immigrants from outside the country. After a steady increase, a peak was reached in 1961 and the rate of increase levelled off. On the prairie provinces namely Manitoba, Saskatchewan and Alberta, the first two have been experiencing net losses in population, with the greater loss occurring in Saskatchewan. Alberta has experienced small declines with larger increases.

TABLE 3.1.

POPULATION CHANGE BY NATURAL INCREASE AND MIGRATION: 1941-66*

(CANADA AND PRAIRIE PROVINCES)

		Canada	Alberta	Manitoba	Saskatchewan
Natural Increase	1941-51	1,972,394	150,303	107,303	135,106
	1951-61	3,148,198	265,195	149,690	172,324
	1961-66	1,517,893	134,607	70,340	75,691
	1966-71	1,765,290	147,545	83,000	78,150
Population Increase according to Census	1941-51	2,141,358	143,332	46,797	- 64,264
	1951-61	4,228,818	392,443	145,145	93,453
	1961-66	1,776,633	131,259	41,380	30,163
	1966-71	3,330,064	295,930	66,561	1,061
Net Migration	1941-51	+ 168,964	- 6,971	- 60,713	-199,370
	1951-61	+1,080,620	+127,248	- 44,555	- 78,871
	1961-66	+ 258,740	- 3,480	- 28,960	- 45,528
	1966-71	+1,564,774	+148,385	- 16,739	- 77,089

*Source: Atlas of Saskatchewan, J.H. Richards, University of Saskatchewan at Saskatoon, 1969, D.B.S. Population Census of Canada 1971.

Population increases or decline may have occurred in either rural areas or urban centres. According to the census classification of urban centres, namely centres with populations over 1000, there has been an increase in the percentage of people living in urban centres. Table 3.2 shows that from 1901 to 1971 the proportion of urban dwellers has increased from 20.4 to 73 percent in Alberta and 15.6 to 52 percent in Saskatchewan. The rate of increase has been higher in Alberta than in Saskatchewan.

TABLE 3.2.

PERCENTAGE URBAN IN ALBERTA AND SASKATCHEWAN

1901 - 1971

	Alberta			Saskatchewan		
Year	population	% increase	% urban	population	% increase	% urban
1901	73,022	-	20.4	91,279	-	15.6
1911	374,295	412.6	36.9	492,432	439.5	26.3
1921	588,454	57.2	38.3	757,510	53.8	28.9
1931	731,605	24.3	38.1	921,785	21.7	31.6
1941	796,169	8.8	38.5	895,992	- 2.8	32.9
1951	939,501	18.0	52.0	831,728	- 7.2	44.6
1961	1,331,944	41.8	67.6	925,181	11.2	48.2
1971	1,627,874	22.2	73.4	926,242	0.1	52.9

Figure 3.1 shows diagramatically the annual percentage increases for the two provinces. After slow increases between 1911 and 1941 there since has been rapid increases with that in Alberta greater than in Saskatchewan. These percentages however do not include settlements below 1000 persons, which if included will add to the urban population.

Change in Rural Population Densities

To be able to grasp the full effect of what has happened in the hinterlands of the major cities, it is important to examine what background changes have occurred in the rural areas surrounding them. This is important because the service centres not only serve the population in the settlements but also the rural population surrounding them. Changes occurring in rural areas could therefore be crucial to the explanation of changes in the settlements. These changes, in particular, population are shown in Figures 3.2 to 3.5. Figure 3.2 shows that in the Calgary

region in 1951 there was a distinct north-south linear distribution of population corresponding to the north south major provincial highway which links the two most important settlements in the province. The map also shows clearly that the northern portion of this linear trend is stronger than the portion to the south. In addition to this north-south linear distribution, there were local concentrations of population in the Banff region (including Canmore), Drumheller to the far east of the overall region, and Turner Valley/Black Diamond areas to the south of the central city. All three areas are dominantly non-agricultural areas. Banff area is a resort town, with the exception of Canmore which is a coal mining area and Turner Valley/Black Diamond areas are oil and gas mining areas.

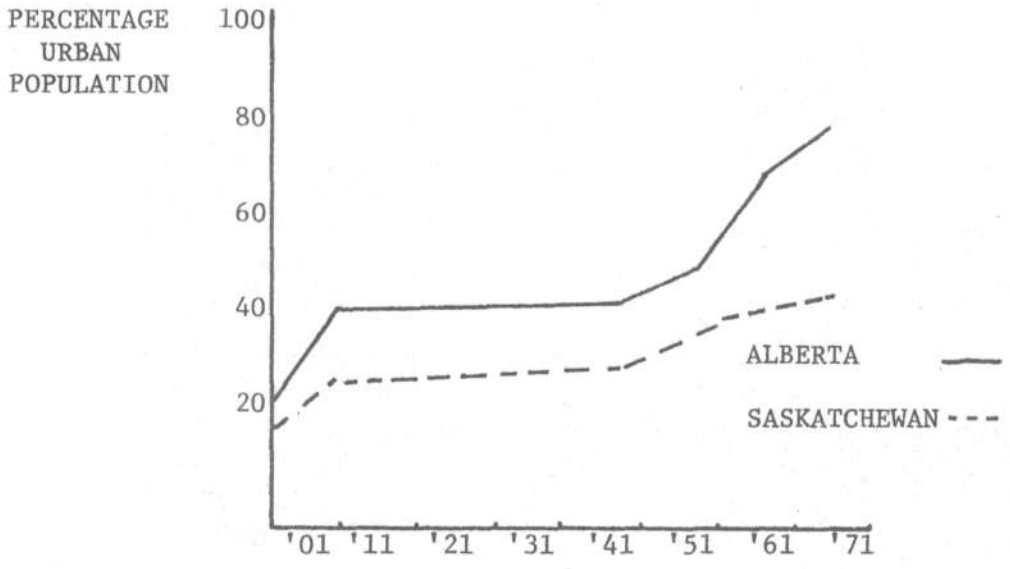
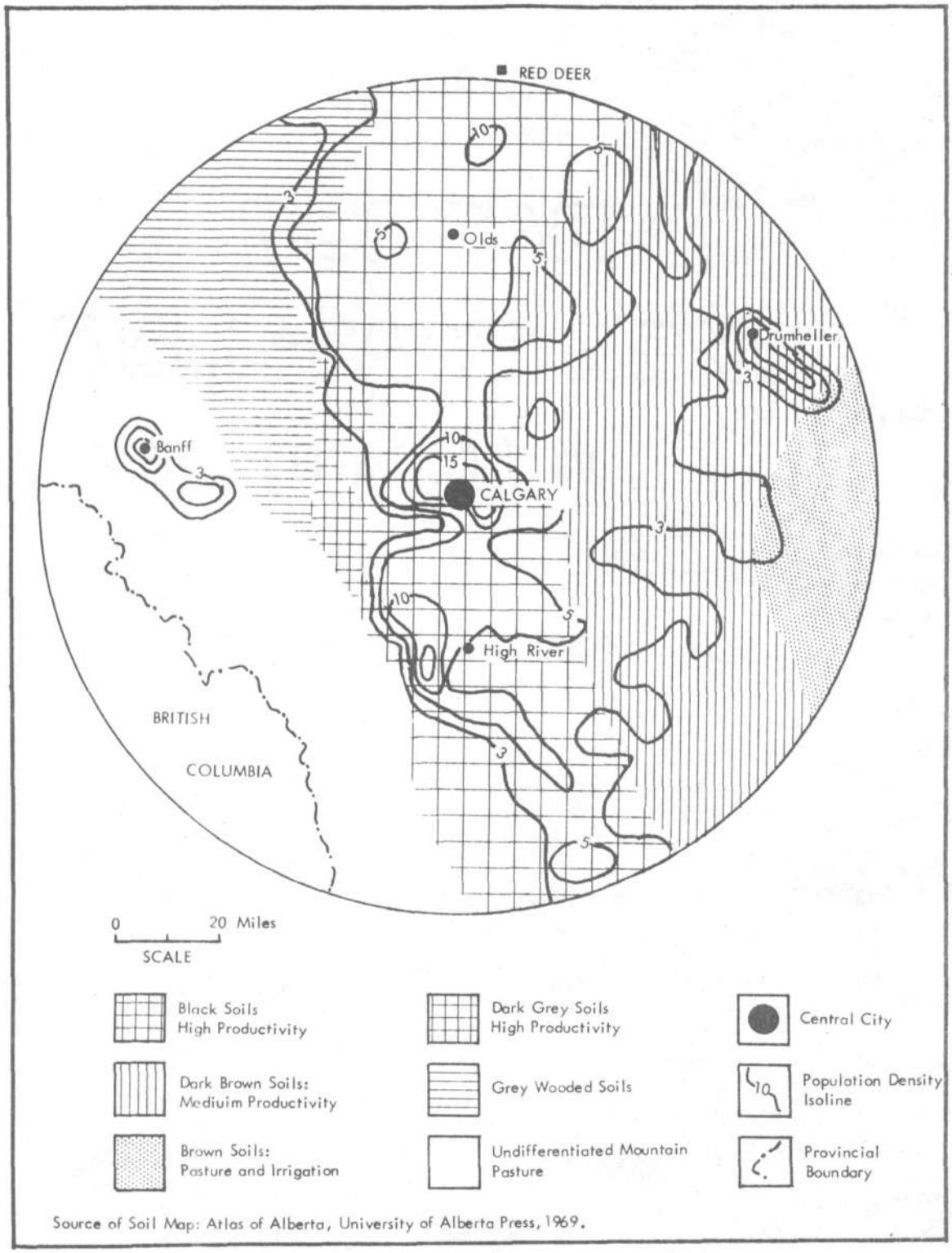


FIG. 3.1 : PERCENTAGE OF URBAN POPULATION IN ALBERTA AND SASKATCHEWAN 1901 - 1971

FIG. 3.2 RURAL POPULATION DENSITY AND AGRICULTURAL PRODUCTIVITY IN THE HINTERLAND OF CALGARY 1951



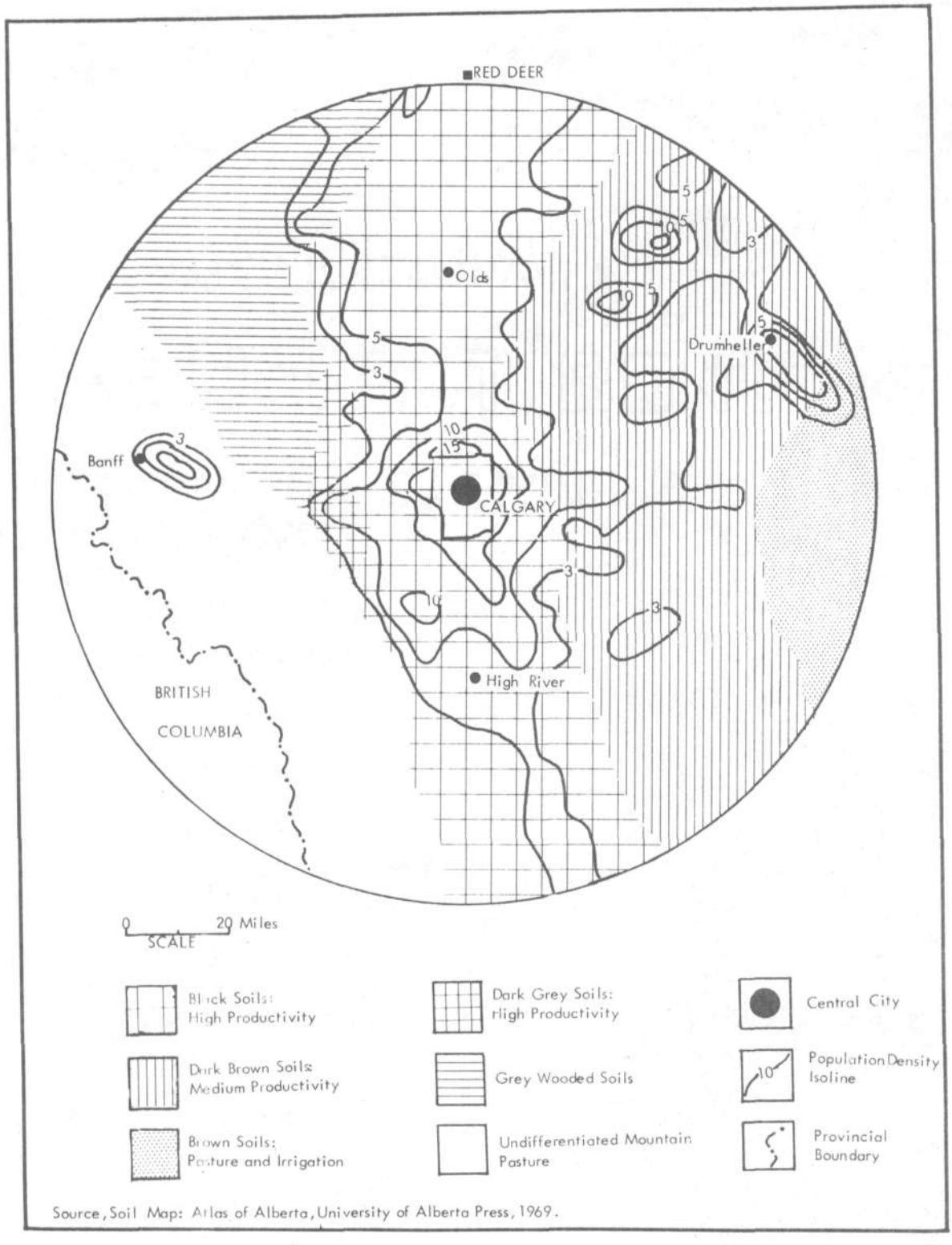
Source of Soil Map: Atlas of Alberta, University of Alberta Press, 1969.

In 1971 (Fig. 3.3) there is an increase in the width of the north-south band of higher population density as well as an increase in the density of population around the city of Calgary itself. The city itself has increased from 36 square miles to more than 150 square miles with a major southern expansion. There has also developed an east west extension of the higher density area along the trans-Canada highway, further emphasizing the highway orientation of population around Calgary. Besides this strong linear tendency, there are also cells of high population density to the north east around the towns of Three Hills and Trochu. The overall regional trend is however decline, especially away from the central city and highways. Overall rural densities declined from 5.7 persons per square mile in 1951 to 5.03 in 1971.

Fig. 3.4 shows that in the region around Saskatoon 1951 there was a strong indication that the population did not display any increase in concentration along transport networks. The whole area tended to have population densities of between 3 and 10 persons per square mile with an overall mean density of 4.4 persons per square mile and the greatest concentration being towards the north and east of the central city. This area has the greatest agricultural potential. Highest rural density, apart from the immediate vicinity of Saskatoon were found to the north of the city in an area mainly occupied by Hutterites. There are no linear tendencies comparable to the situation in Calgary region in the same time period.

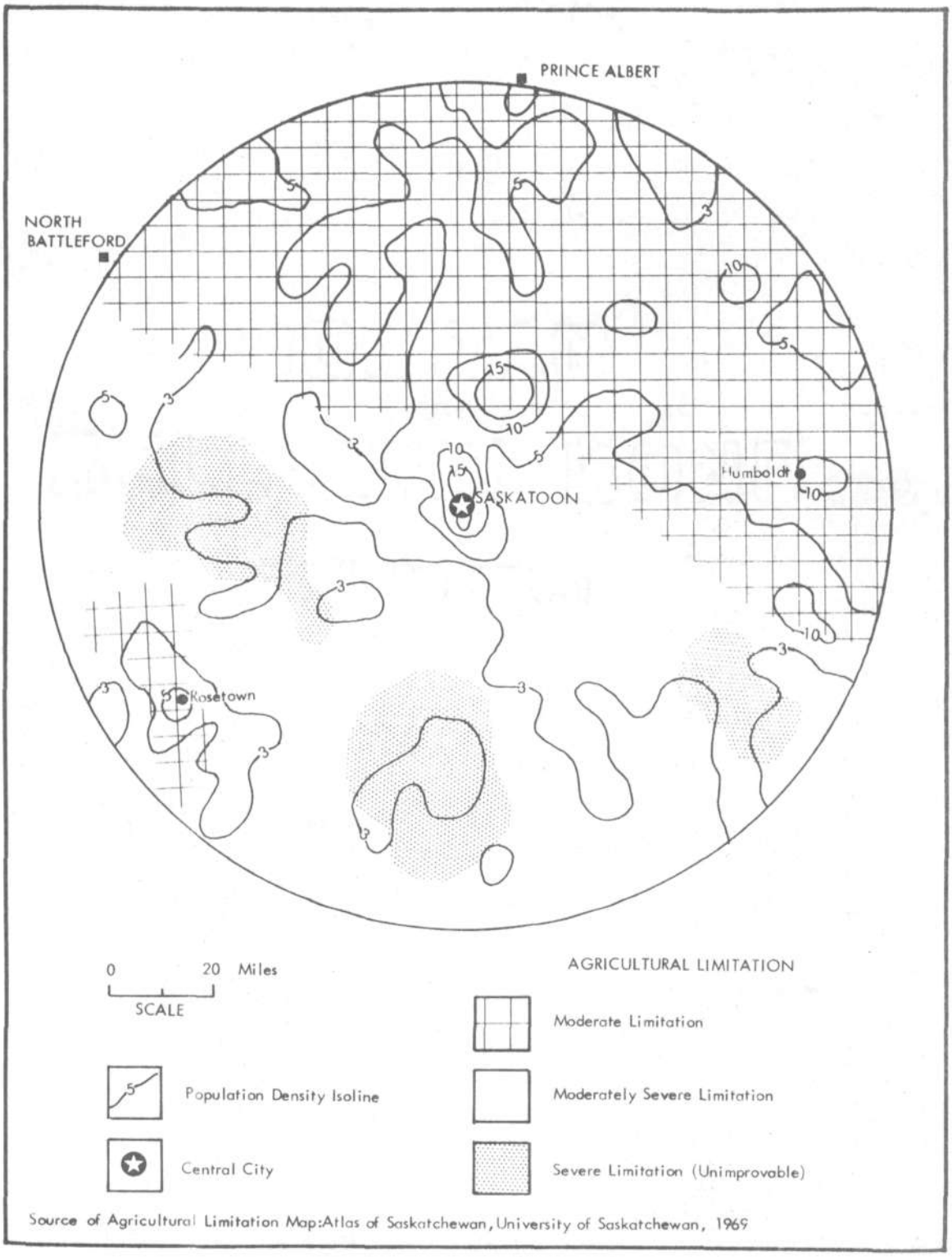
In 1971 (Fig. 3.5) the density distribution showed an overall decline in the density, including the region in the immediate vicinity

FIG. 3.3 RURAL POPULATION DENSITY AND AGRICULTURAL PRODUCTIVITY IN THE HINTERLAND OF CALGARY 1971



Source, Soil Map: Atlas of Alberta, University of Alberta Press, 1969.

FIG. 3.4 RURAL POPULATION DENSITY AND AGRICULTURAL POTENTIAL IN THE HINTERLAND OF SASKATOON 1951



Source of Agricultural Limitation Map: Atlas of Saskatchewan, University of Saskatchewan, 1969

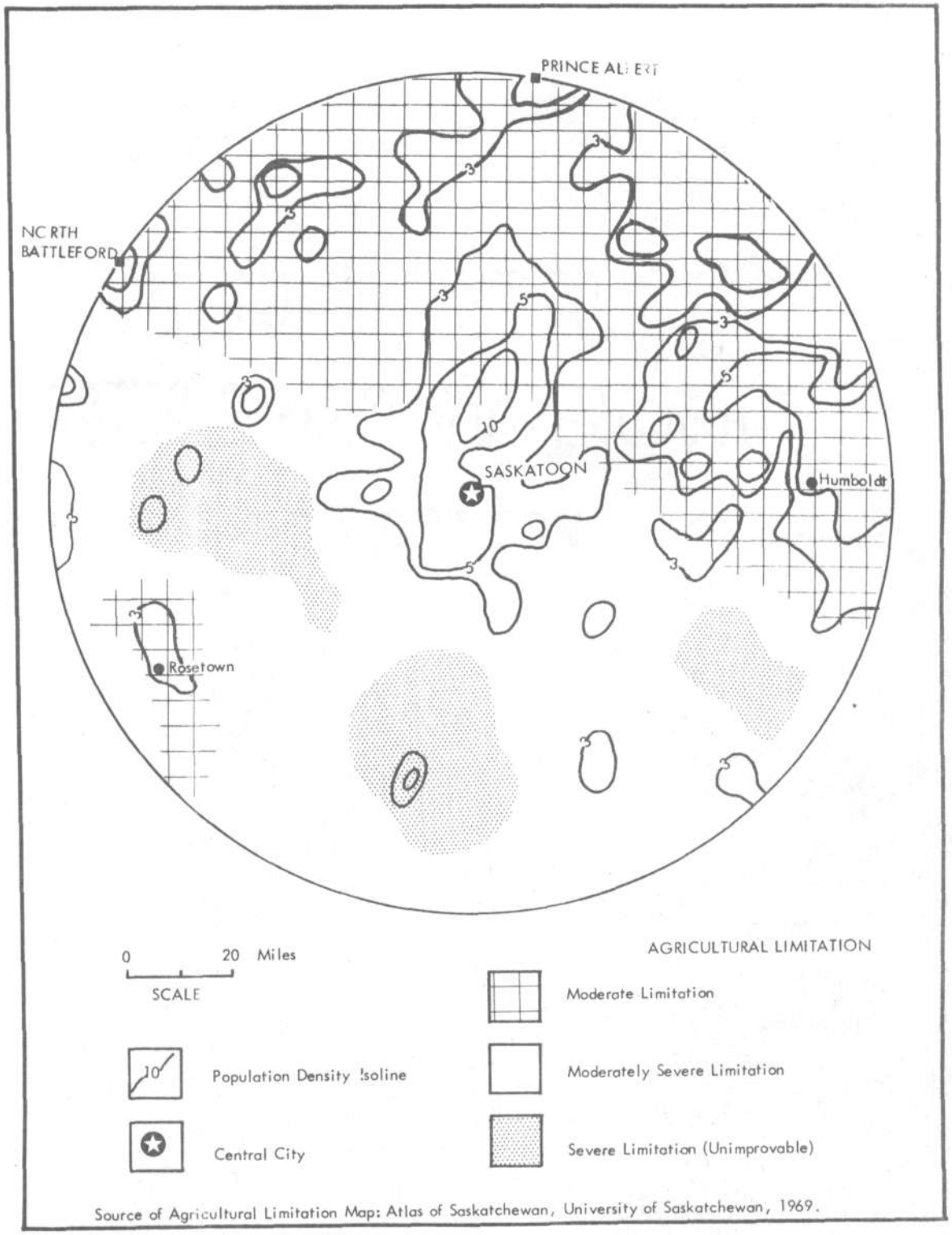
of the central city. The most densely populated area in the whole region was roughly elliptical area with a north-south axis passing through Saskatoon. Overall rural population density however declined from 4.4 persons per square mile in 1951 to 3.0 in 1971.

It is clear from the above discussion that both regions have experienced overall decline in rural population densities. However in the hinterland of Calgary the area immediately around the central city and along the major highways has shown an increase. Around Saskatoon there was a more even distribution of rural population decline. Consequently, Calgary region had a linear distribution of population while population in Saskatoon region tends to be uniformly distributed over the region.

Growth in Hinterland Settlements

The results of the rural population density distributions showed that rural population around Calgary is concentrated in four main sectors, along the highways, while Saskatoon area had declining rural densities with no sectoral tendencies. It has been suggested by Lösch (1940), and tested by others, Davidson (1970) that population and settlements ought to be concentrated in sectors radiating from the central city. Furthermore, Pahl (1965) has shown that if change is related to central city the settlements immediately around the central city should show the greatest change. The dual possibilities, namely growth is related to distance from the central city and sectoral distribution of centres was examined for the hinterlands of Calgary and Saskatoon.

FIG. 3.5 RURAL POPULATION DENSITY AND AGRICULTURAL POTENTIAL IN THE HINTERLAND OF SASKATOON 1971



Source of Agricultural Limitation Map: Atlas of Saskatchewan, University of Saskatchewan, 1969.

Table 3.3 and 3.4 shows that there was no significant relationship between population and distance in 1951 and 1971. This was tested at both 95% and 99% significance levels. Olds and Drumheller more than doubled their population and all the settlements with a population of more than 1000 in 1951 increased their population except Black Diamond which declined from 1154 to 955. This has been mainly due to decline in oil and gas mining in the area. Losses in population have occurred mainly in settlements below 500 in 1951. The centres immediately around the city, namely Airdrie, Okotoks and Cochrane increased in population. Airdrie from 267 in 1951 to 1033 in 1971, Okotoks 767 to 1175, Cochrane from 530 to 1059, suggesting that "spilling out" of population could have taken place. The overall changes however do not show relationship to distance from the city.

Table 3.4 and 3.5, show that in both time periods there was no relationship between population and distance for the sectors. In all of them there were regression coefficients of less than 0.20. Figure 3.6 shows the spatial distribution of settlements, indicating decline or increase in population.

TABLE 3.3.

SUMMARY RESULTS OBTAINED FROM REGRESSION

OF POPULATION IN SETTLEMENTS AND DISTANCE FROM CALGARY 1951

Sector	a	b	R^2	F-ratio	TABULATED F-RATIO 95%	99%
I	787.88	-5.78	0.06	0.71	4.75	9.33
II	628.93	-2.19	0.01	0.10	4.35	8.10
III	60.98	3.59	0.11	1.39	4.84	9.65
IV	340.11	10.25	0.08	0.79	5.12	10.56
OVERALL	752.93	-3.52	0.02	1.33	4.01	7.15

FIG. 3.6 CHANGE IN SETTLEMENT POPULATION
IN THE HINTERLAND OF CALGARY 1951-1971

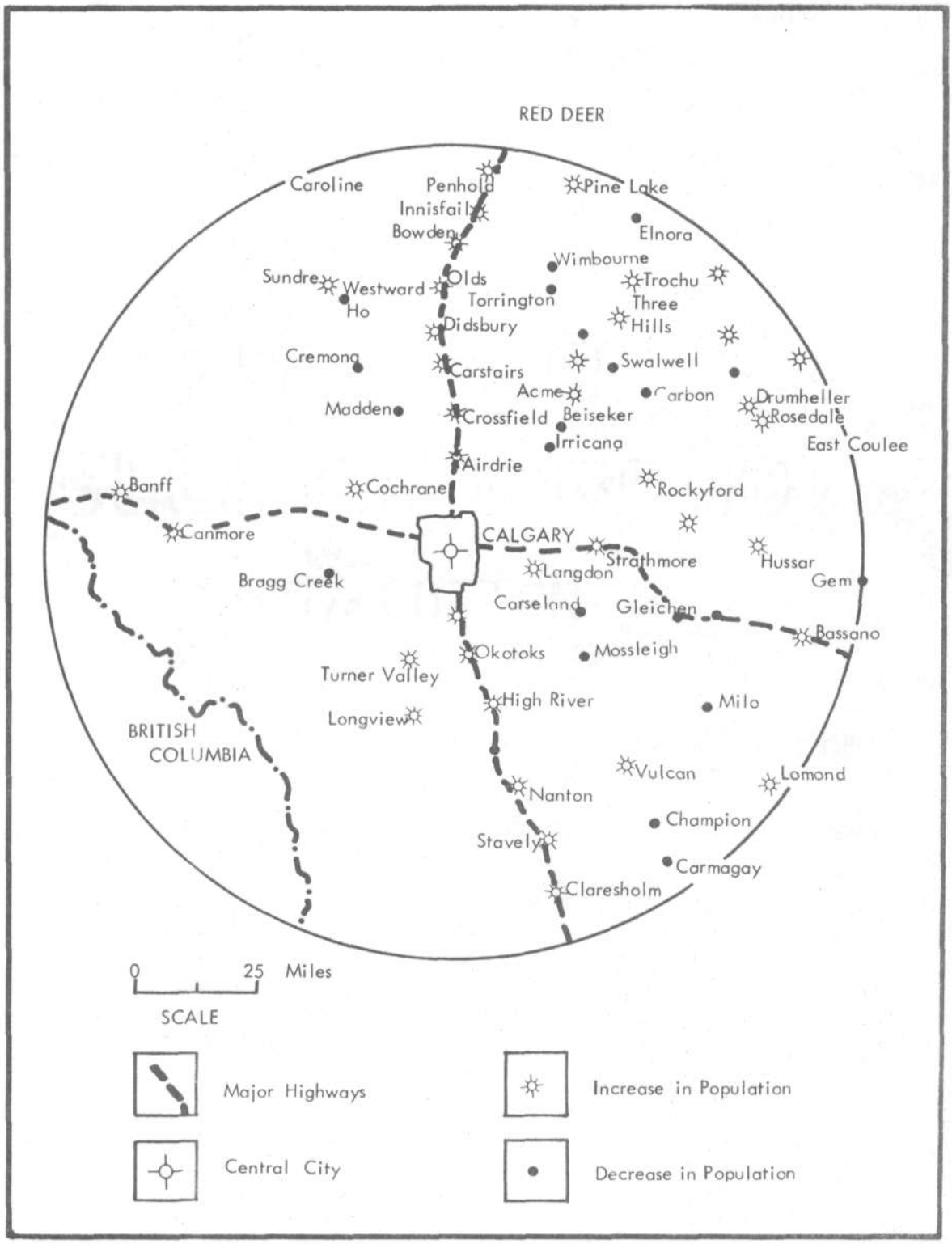


TABLE 3.4.

SUMMARY RESULTS OBTAINED FROM REGRESSION OF POPULATION OF SETTLEMENTS AND DISTANCE FROM CALGARY 1971.

Sector	a	b	R^2	F-ratio	95%	99%
I	1508.47	-12.88	0.10	1.60	4.54	8.68
II	357.90	3.45	0.01	0.01	4.35	8.18
III	85.25	3.31	0.05	1.00	4.96	10.04
IV	-264.06	33.90	0.27	2.55	5.59	12.25
OVERALL	695.75	0.16	0.00	0.00	3.99	7.04

In the hinterland of Saskatoon, Table 3.5 and 3.6 also shows that there was no overall relationship between population size and distance from the central city. In both instances regression coefficients of 0.0 were obtained with an F-ratio of 14.43 and 22.20 for 1951 and 1971 respectively and therefore not within the limits of acceptability at both 95% and 99% significance level.

TABLE 3.5.

SUMMARY RESULTS OBTAINED FROM REGRESSION OF POPULATION IN SETTLEMENTS AND DISTANCE FROM SASKATOON 1951

Sector	a	b	R^2	F-ratio	95%	99%
I	481.16	- 1.76	0.02	0.25	4.67	9.07
II	341.03	0.38	0.01	0.13	4.49	8.53
III	262.20	1.16	0.01	0.13	4.60	8.86
IV	482.84	-3.72	0.09	1.35	4.67	9.07
V	Insufficient level for computation. r^2 = 0.00, F-ratio < 0.005					
VI	379.91	-4.21	0.62	14.43	5.12	10.56
OVERALL	344.91	-0.30	0.00	0.02	3.93	6.93

FIG. 3.7 CHANGE IN SETTLEMENT POPULATION IN THE HINTERLAND OF SASKATOON 1951-1971

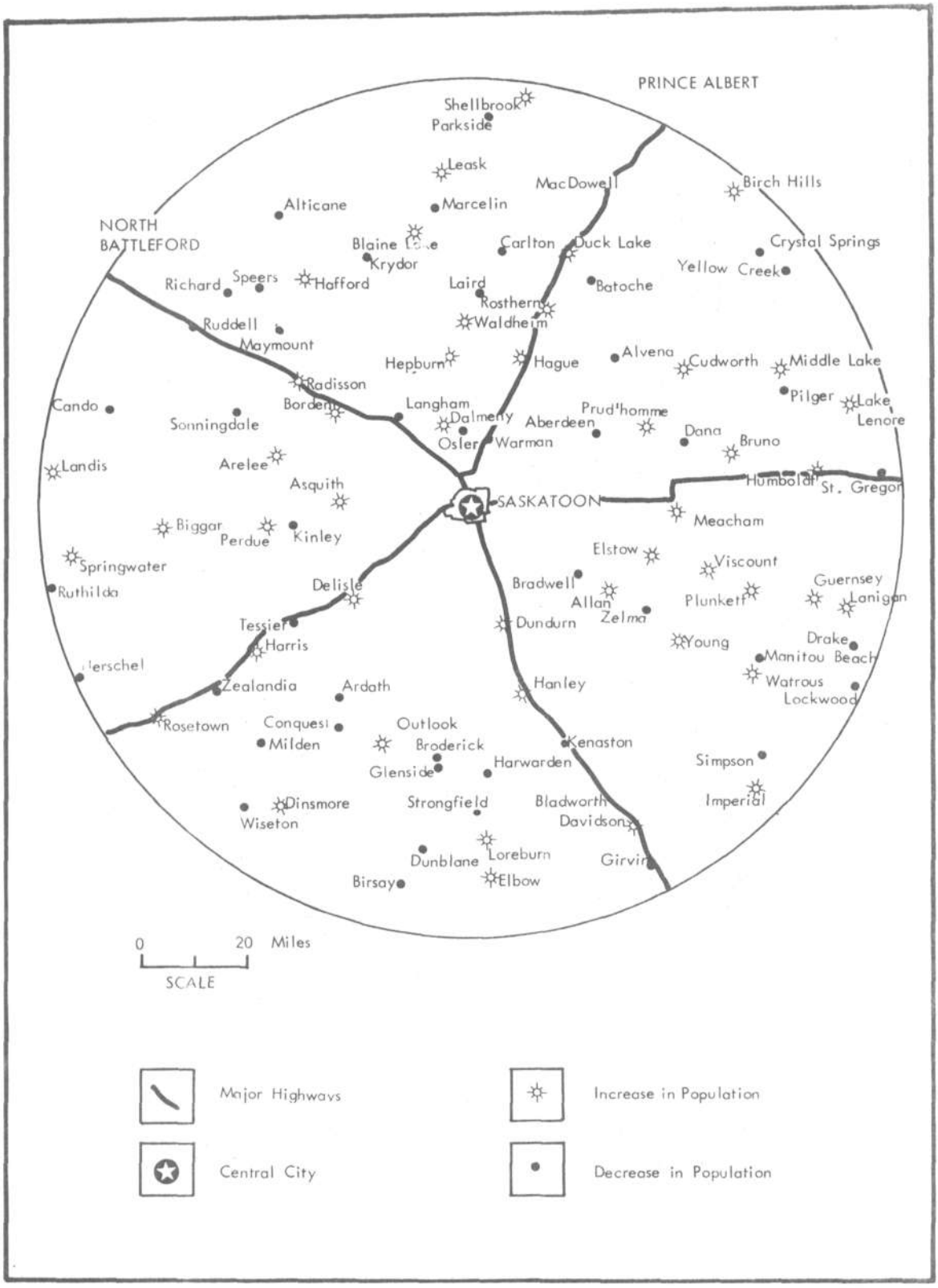


TABLE 3.6.

SUMMARY RESULTS OBTAINED FROM REGRESSION OF POPULATION IN SETTLEMENTS AND DISTANCE FROM SASKATOON 1971

Sector	a	b	R^2	F-ratio	95%	99%
I	50.00	0.00	0.00	0.00	4.67	9.07
II	530.92	0.45	0.00	0.06	4.49	8.53
III	Insufficient level for computation					
IV	756.23	-6.64	0.04	0.60	4.67	9.07
V	Insufficient information for computation					
VI	561.60	-7.55	0.70	22.20	5.15	14.56
OVERALL	425.95	-0.00	0.00	0.00	3.95	6.93

However as Figure 3.7 shows, there were increases in population in all parts of the region. Most of the increase occurred in centres over 500 in 1951. Humboldt increased its population from 2435 to 3881 an increase of 1446 or 59.4%. Centres with the greatest amount of increase were located in the southern half of the region, for example Outlook increased its population from 676 to 1767 and Colonsay from 228 to 526. The figure also shows that most of the settlements experiencing decline were sited away from the main highways. In view of this and the fact that the provincial trend has been declining, we may conclude that the increase in population in these settlements is from the rural areas and not from outside the area. Empirical findings supporting this view have been put forward by Hodge (1965).

Amongst sectors, in only one, that leading towards the Battlefords along Highway 5, was the F-test within acceptable limits. This suggests

that there has been increase in population size with distance from the central city. However this area has no settlements over 1000 and is contained in an area of low agricultural potential rating.

SUMMARY

(i) We may then conclude that in the Saskatoon region as in Calgary, there was no relationship between population and population change in settlements and distance from the central city. Change in population was more related to the initial population of the settlements than to relationship to the metropolitan centre.

(ii) The greatest change occurred in settlements along accessible routeways. Around Calgary, this has resulted in the development of 'city rich' and 'city poor' sectors along the highways. No similar pattern developed around Saskatoon, probably because of the greater number of accessible locations.

(iii) In Calgary area, there appears to have been population spill-offs to the neighbouring settlements. The communities of Airdrie, Cochrane and Okotoks have experienced rapid increases in population. Whether or not the characteristics of the inhabitants resemble those found by Pahl (1965) is not within the scope of a descriptive analysis employing a 'before and after' approach.

CHAPTER IV

CONTEMPORARY SERVICE CENTRE STRUCTURES 1971

Introduction. This chapter answers the question of whether or not there are distinctive levels of hierarchies of settlements in the hinterlands of Calgary and Saskatoon. This was done by first establishing the existence of groups of settlement via the use of potential errors matrix, namely the mean of the sums of the squared differences between corresponding scores, as the index of discrimination in Ward's method of Cluster Analysis. The distinctiveness of the groups were tested using Discriminant Analysis. The results of the Cluster Analysis were compared with the ranked Functional Indices as a preliminary measure of the hierarchical nature of the groups. The types of retail establishments contained in each group was then examined to show that distinct functions are associated with each level and provide additional information concerning the hierarchies. Berry (1958) has shown that in a hierarchical system, the higher levels perform all the functions of the lower levels and have additional establishments unique to themselves. The spatial distribution of settlements according to groups was also examined and related to central place and growth pole literature.

CALGARY AND SASKATOON REGIONS

In Calgary region, there were five groups of settlements with Banff, a resort town, isolated as a one member group. The other settlements were classified into one of the remaining four groups

hereafter referred to as groups I, II, III and IV. These may be termed village, town, large town and small city in the common terminology of central place studies, (Berry 1967, Hodge 1968). Such labels should be used with reservation because they do not give an accurate consistent definition of the settlements. Figure 4.1 shows the dendrogram table showing the distribution of the settlements in their respective groups. The inset graph shows how the cut-off point of 4.0 was arrived at.

Table 4.1 is the classification matrix resulting from a Discriminant Analysis of the four groups. The table shows that three group I centres were reclassified into group II. These were Arrowwood, Beiseker and Turner Valley. This variation with the Cluster Analysis was considered insufficient to warrant rejection since only twenty nine of the sixty seven variables could be used in the discriminant test.

TABLE 4.1.

CLASSIFICATION MATRIX: CALGARY 1971

GROUP	IV	III	II	I
IV	2	0	0	0
III	0	6	0	0
II	0	0	14	0
I	0	0	3 ←	40
TOTAL	2	6	17	40

← Direction of Relocation

The matrix of F-ratio Table 4.2 shows that at both 95% and 99% probability the null hypothesis that the discrimination is not significant was rejected.

FIG. 4.1 DENDROGRAM TABLE OF CLUSTERS OF SETTLEMENTS IN CALGARY REGION 1971

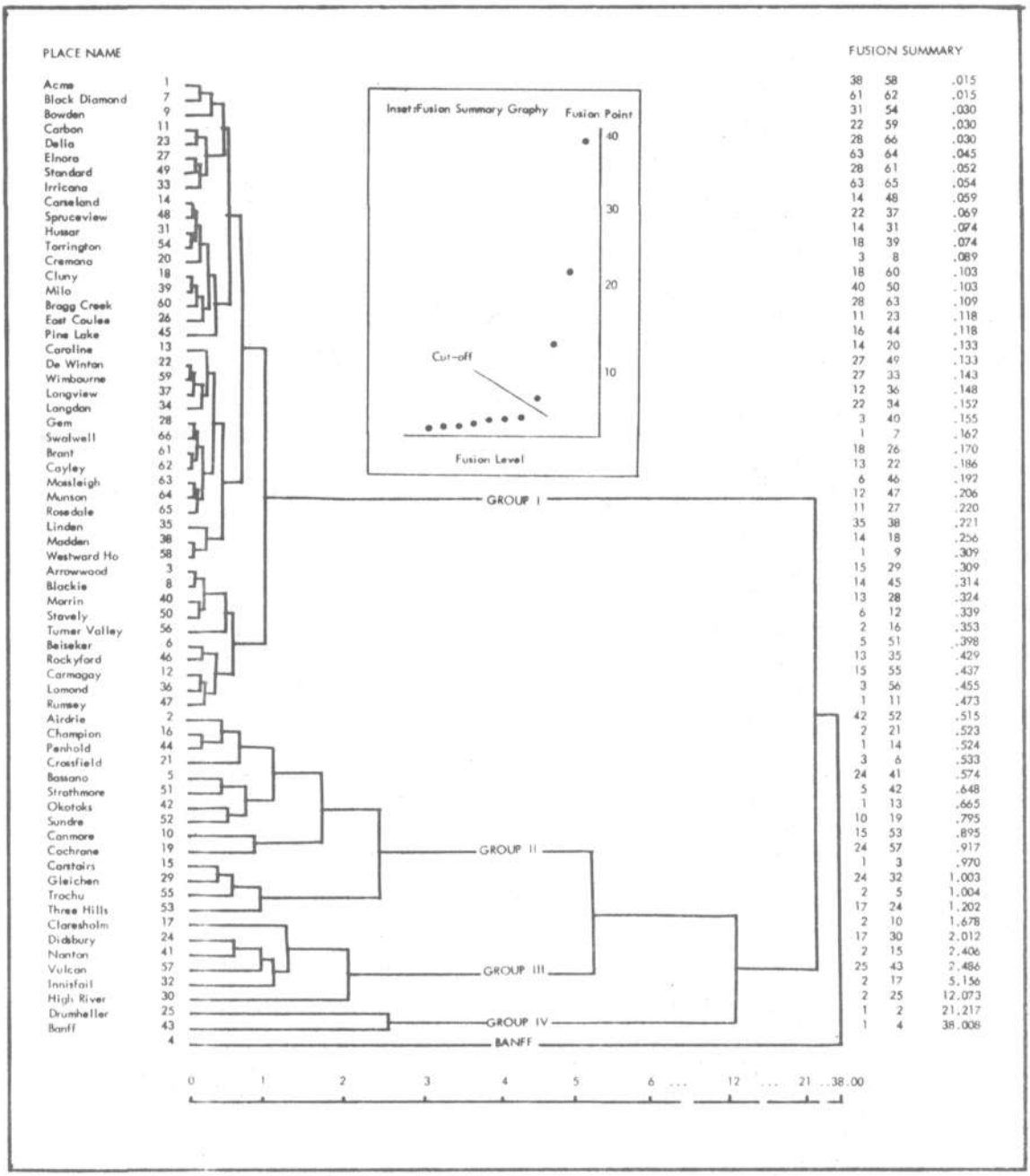


TABLE 4.2.

F-MATRIX OF CLASSIFICATION: CALGARY 1971

GROUP	IV	III	II	I
IV				
III	6.66			
II	9.61	6.67		
I	11.40	9.29	3.40	

Tabulated F-ratio 95% = 1.84 99% = 2.39

In the hinterland of Saskatoon four groups of settlements were obtained. Figure 4.2 shows the linkages of members of the group. A cut off point was applied at 4.0 as shown on the inset graph. The results of the Cluster Analysis were tested using Discriminant Analysis on the basis of twenty four variables. Table 4.3 shows that one settlement in group II namely Dinsmore was reclassified into group I, all the other groups remained unchanged.

TABLE 4.3.

CLASSIFICATION MATRIX: SASKATOON 1971

GROUP	IV	III	II	I
IV	1	0	0	0
III	0	7	0	0
II	0	0	14 →	1
I	0	0	0	57
TOTAL	1	7	14	58

→ Direction of Relocation

F-ratios of the discrimination among groups shows that the level of distinctiveness was acceptable for all groups (Table 4.4).

FIG. 4.2 DENDROGRAM TABLE OF CLUSTERS OF SETTLEMENTS

IN SASKATOON REGION 1971

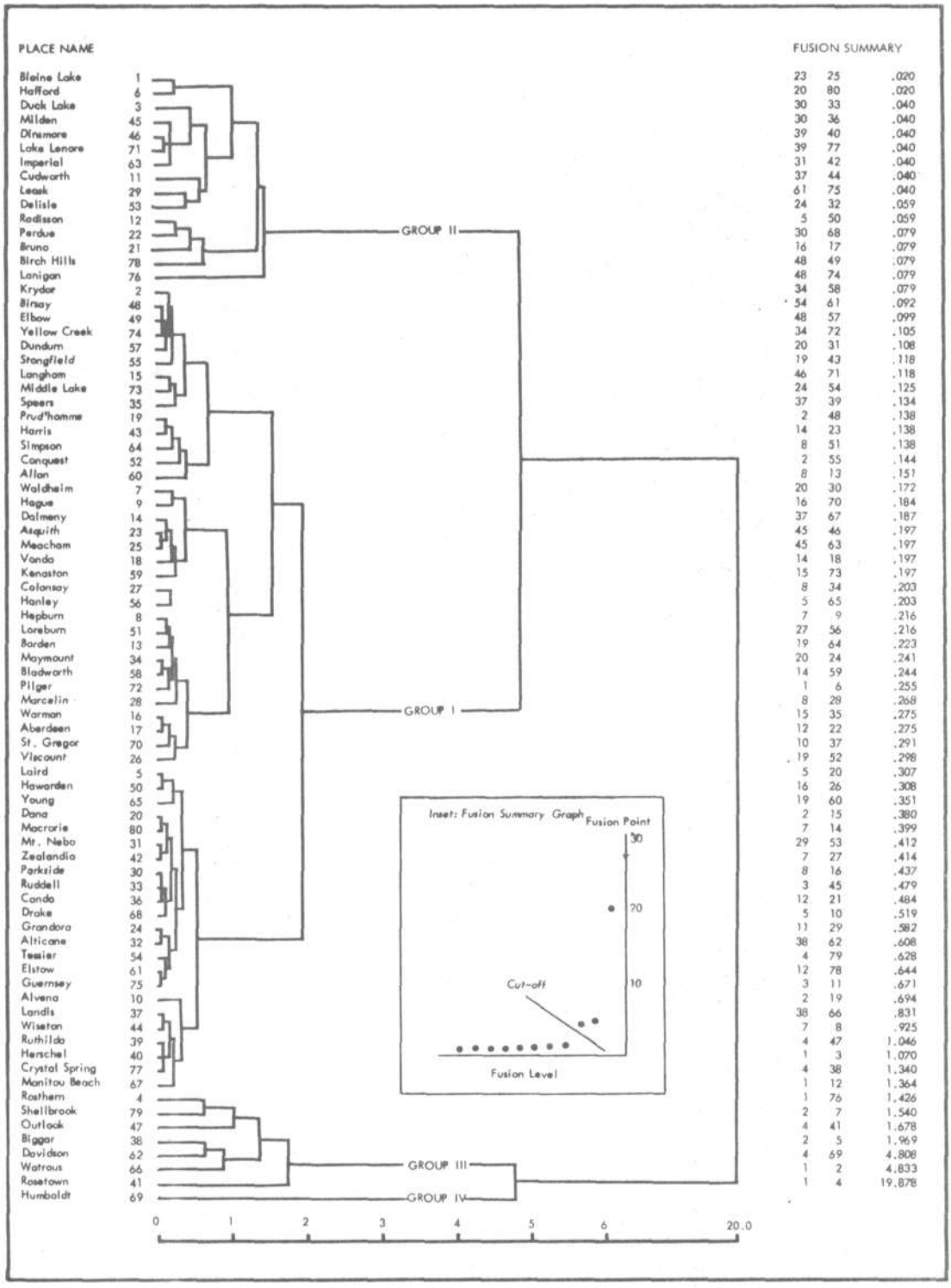


TABLE 4.4.

F-MATRIX OF CLASSIFICATION: SASKATOON 1971

GROUP	IV	III	II	I
IV				
III	13.81			
II	24.48	27.17		
I	32.91	50.77	11.32	

F - at 95% = 1.70 F at 99% = 2.40

Since only the twenty four variables occurring in every group could be used instead of the whole fifty one, and even on that basis, only one settlement was misclassified, the results of the Cluster Analysis were accepted as being sufficiently optimal groupings for the settlements.

The cluster groups were compared with ranked Functional Indices as a preliminary test for hierarchies. Table 4.5 shows that, only four settlements occupied ranks different from those that should be occupied by members of their group. The highest nine ranks were taken by the nine members of groups IV and III with Banff. Two group II settlements Champion and Penhold, were included among group I and Beiseker and Bowden in group I with group II ranks. It may be noticed that the lowest settlements have Functional Indices of less than 5.0. This occurred because the whole analysis was repeated after the initial study that cut out settlements with Functional Index of under 5.00. However the similarity between Cluster Analysis groups and ranked Functional Indices lead to the tentative conclusion that the clusters are hierarchical.

TABLE 4.5.

RANKED FUNCTIONAL INDICES AND CLUSTER GROUP

CALGARY REGION 1971

RANK		FUNCTIONAL INDEX	CLUSTER GROUP	
1	Drumheller	883.176	IV	
2	Banff	811.657	S	GROUP IV
3	Olds	571.888	IV	RANKS
4	High River	544.155	III	
5	Claresholm	405.132	III	
6	Innisfail	289.751	III	GROUP III
7	Vulcan	251.238	III	RANKS
8	Didsbury	217.042	III	
9	Nanton	135.632	III	
10	Three Hills	193.893	II	
11	Sundre	182.897	II	
12	Canmore	167.725	II	
13	Trochu	161.592	II	
14	Bowden	139.383	I	
15	Carstairs	129.025	II	
16	Airdrie	121.489	II	GROUP II
17	Crossfield	115.535	II	RANKS
18	Strathmore	112.806	II	
19	Cochrane	109.916	II	
20	Okotoks	98.412	II	
21	Bassano	90.838	II	
22	Gleichen	65.839	II	
23	Beiseker	64.232	I	
24	Black Diamond	61.582	I	
25	Mossleigh	50.649	I	
26	Standard	47.867	I	
27	Rockyford	41.152	I	
28	Linden	40.343	I	
29	Turner Valley	35.109	I	
30	Delia	34.243	I	GROUP I
31	Carbon	31.443	I	RANKS
32	Elnora	30.916	I	
33	Cluny	30.010	I	
34	Lomond	28.496	I	
35	Rumsey	27.037	I	
36	Carmangay	26.877	I	
37	Cremona	24.943	I	
38	Acme	24.469	I	
39	Caroline	24.414	I	
40	Blackie	23.584	I	
41	Stavely	23.550	I	

Table 4.5 Cont'd

RANK		FUNCTIONAL INDEX	CLUSTER GROUP	
42	Champion	21.923	I	
43	Hussar	21.378	I	
44	Pine Lake	21.063	I	
45	Arrowwood	21.029	I	
46	Morrin	20.459	I	
47	Rosedale	17.316	I	
48	Penhold	15.171	I	
49	East Coulee	11.799	I	
50	Mile	11.799	I	
51	Irricana	10.219	I	GROUP I
52	Madden	9.993	I	RANKS
53	Bragg Creek	9.906	I	
54	Carseland	9.032	I	
55	Westward Ho	9.032	I	
56	Gem	8.183	I	
57	Torrington	7.916	I	
58	Spruceview	7.911	I	
59	Langdon	7.498	I	
60	Wimbourne	5.891	I	
61	Longview	5.669	I	
62	Swalwell	4.841	I	
63	De Winton	4.310	I	
64	Cayley	2.861	I	
65	Munson	2.439	I	
66	Brant	2.212	I	

Similar comparisons of Cluster Analysis groups and ranked Functional Indices of settlements in the hinterland of Saskatoon show that only five settlements differed from the expected ranks. Most of the difference was between the lowest two groups. Four group II settlements namely Lanigan, Milden, Lake Lenore and Dinsmore exchanged ranks with other groups. The first with Davidson in group III and the latter three members of group I.

TABLE 4.6

CLUSTER ANALYSIS GROUPS COMPARED WITH RANKED

FUNCTIONAL INDICES

SASKATOON REGION 1971

RANK		FUNCTIONAL INDEX	CLUSTER GROUPS	
1	Humboldt	703.356	IV	
2	Rosetown	439.533	III	
3	Rosthern	375.440	III	
4	Biggar	367.327	III	GROUP III
5	Outlook	310.245	III	RANKS
6	Watrous	289.704	III	
7	Shellbrook	198.040	III	
8	Lanigan	175.373	II	
9	Davidson	130.900	III	
10	Bruno	109.074	II	
11	Birch Hills	108.540	II	
12	Blaine Lake	106.663	II	
13	Cudworth	85.846	II	GROUP II
14	Delisle	84.750	II	RANKS
15	Simpson	63.690	II	
16	Hafford	61.947	II	
17	Duck Lake	61.062	II	
18	Leask	57.508	II	
19	Middle Lake	57.002	II	
20	Perdue	53.354	II	
21	Young	53.044	II	
22	Langham	50.662	II	
23	Imperial	50.014	II	
24	Colonsay	48.316	I	
25	Viscount	47.601	I	
26	Man Beach	44.315	I	GROUP I
27	Conquest	42.328	I	RANKS
28	Allan	42.183	I	
29	Speers	41.259	I	
30	Marcelin	41.175	I	
31	Hague	39.625	I	
32	Waldheim	38.381	I	
33	Milden	38.037	I	
34	Lake Lenore	35.845	I	
35	Radisson	32.776	I	
36	Krydor	32.088	I	
37	Hanley	29.544	I	
38	St. Gregor	27.555	I	
39	Hepburn	25.745	I	
40	Wiseton	24.846	I	

Table 4.6 Cont'd

RANK		FUNCTIONAL INDEX	CLUSTER GROUPS	
41	Vonda	22.976	I	
42	Ruddell	22.606	I	
43	Mt. Nebo	22.157	I	
44	Albenia	20.481	I	
45	Warman	18.486	I	
46	Aberdeen	17.841	I	
47	Grandora	17.381	I	
48	Harris	15.969	I	
49	Prud'Homme	15.923	I	
50	Dinsmore	15.766	I	
51	Kenaston	15.634	I	
52	Meacham	15.363	I	
53	Bladworth	15.298	I	
54	Borden	14.477	I	
55	Asquith	13.993	I	
56	Hawarden	13.768	I	
57	Dundurn	13.659	I	GROUP I
58	Loreburn	12.773	I	RANKS
59	Elbow	12.748	I	
60	Dalmeny	12.364	I	
61	Drake	12.009	I	
62	Yellow Creek	11.735	I	
63	Pilger	11.516	I	
64	Laird	10.916	I	
65	Aiticane	9.994	I	
66	Dana	9.211	I	
67	Strongfield	8.450	I	
68	Guernsey	7.723	I	
69	Tessier	7.475	I	
70	Landis	7.261	I	
71	Macrorie	7.037	I	
72	Elstow	6.898	I	
73	Birsay	6.537	I	
74	Maymont	6.474	I	
75	Crystal Springs	5.887	I	
76	Herschel	5.376	I	
77	Ruthilda	5.218	I	
78	Cando	4.193	I	
79	Parkside	3.320	I	
80	Zealandia	1.370	I	

SPATIAL DISTRIBUTION OF SETTLEMENTS AND POPULATION LEVELS OF GROUPS IN 1971

Calgary Region

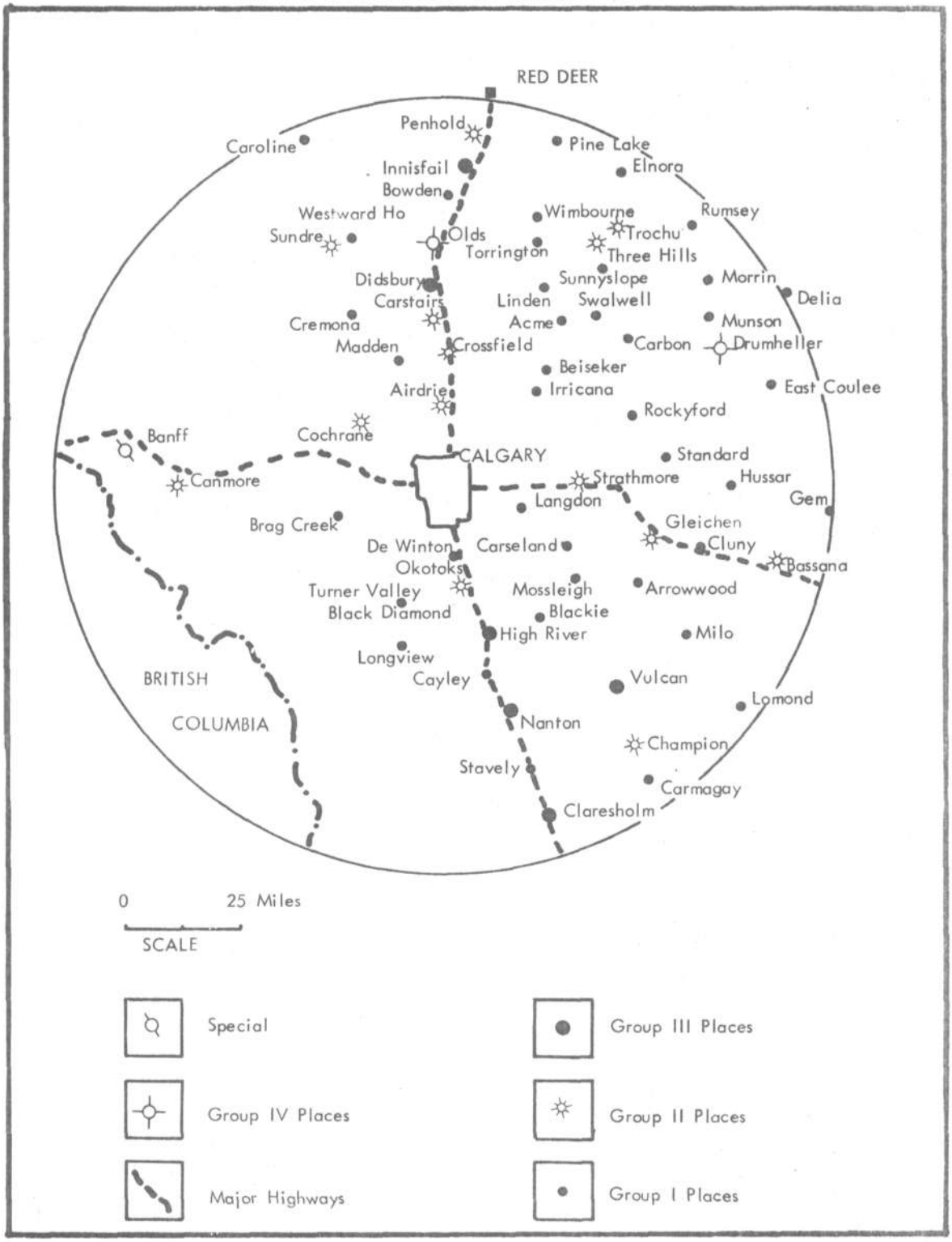
Figure 4.3 shows the distribution of settlements according to their groups around Calgary. Banff and Canmore are the only settlements in the forest area west of the city. The two group IV settlements, Olds and Drumheller are located in agricultural areas north and east of the city respectively. Drumheller owes its growth partly to the development of coal mining in the area. This industry has since declined in importance. The two settlements have a mean population of 4324, Olds having 3408 and Drumheller 5240.

Of the group III settlements, only Vulcan is not located along the north-south highway. All the others are in this high population density belt. They have an average distance of 30 miles separating them. Their population sizes range from 940 to 2631 persons, with a mean of 1873. The larger settlements in this group are located north of Calgary in the area with higher population densities.

The settlements belonging to group II are also located on the major highways except Three Hills and Trochu which are located in the high rural population density 'pocket' in the intermediary area north east of the city. They have a mean distance apart of 21 miles, and north of the city are located close together without any member of another group between them. It may be speculated that the higher population densities have allowed their growth but proximity to Calgary has prevented them from attaining higher status. More detailed process

FIG. 4.3 DISTRIBUTION OF TRADE CENTRES BY GROUPS

IN THE HINTERLAND OF CALGARY 1971



oriented research will be needed to prove that this is the case. There are fourteen settlements in this group with populations ranging from 450 to 1604 and a mean of 892.

Group I centres are found throughout the study area. The mean distance separating them is 14 miles. The forty members of this group have a mean population of 209 with individual populations ranging from 31 to 955 persons.

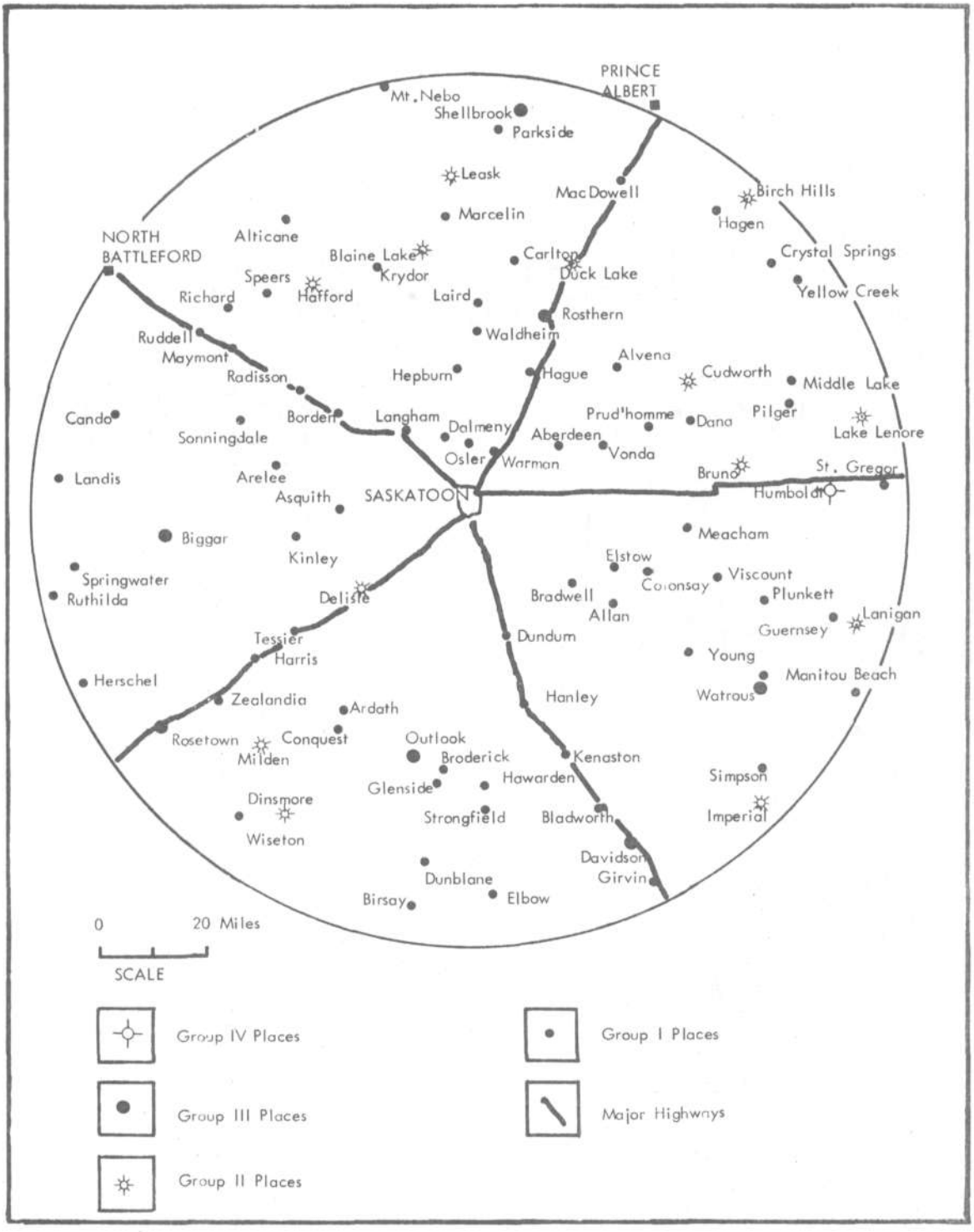
It is clear that the distribution of settlements around Calgary especially the higher order places is similar to the Löschian scheme, with the city rich sectors aligned to the highways and the poor sectors in the intermediary areas. Distance between members of decreases with decreasing order of group.

Saskatoon Region

Higher order settlements in the hinterlands of Saskatoon are not concentrated in sectors as was the case around Calgary. They are arranged in a ring with the centre at the central city. Figure 4.4 shows that the only group IV settlement, Humboldt, is located 65 miles east of Saskatoon. Humboldt has a population of 3881.

The seven group III settlements are situated in a ring at distances of 45 to 65 miles from Saskatoon. They are farthest away when they are not located on a major highway leading from the city. These cities together with Humboldt, surround the city on all sides earning it the nickname of "hub-city". The area between Saskatoon and the Battlefords has low agricultural potential and is consequently thinly populated. This could be the reason why there are no third order

FIG. 4.4 DISTRIBUTION OF TRADE CENTRES BY GROUPS IN THE HINTERLAND OF SASKATOON 1971



settlements in the area. The seven members of this group have a mean population of 1719 with a range of between 690 and 2614 persons, and a sited 40 miles from each other.

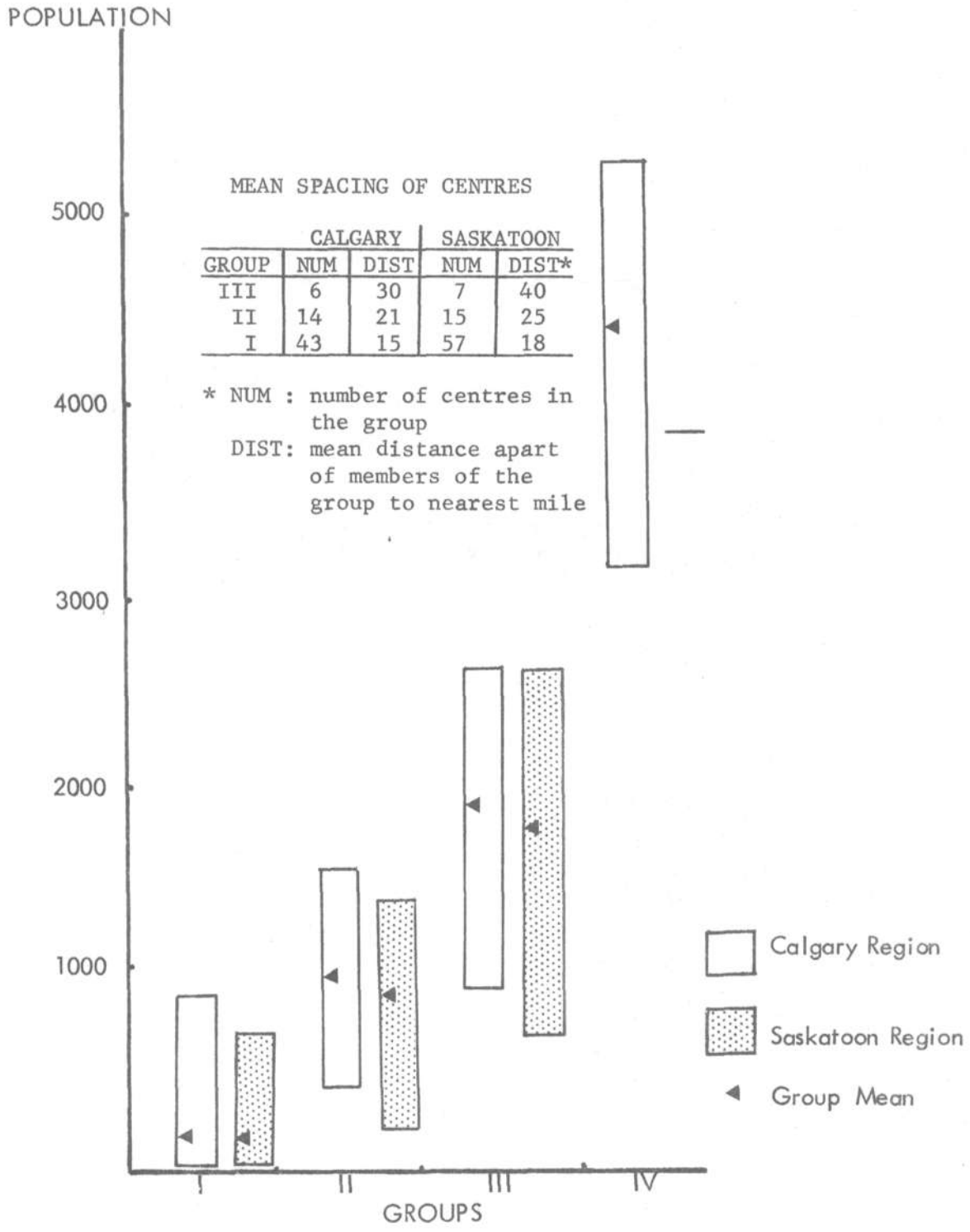
Fifteen settlements were classified into group II. These are found in all sectors of the study area but are concentrated in a zone 40 to 60 miles from Saskatoon. They have a mean distance apart of 25 miles and tend to be located on transportation corridors including rural highways. Their mean population is 622 with individual settlements having populations of between 229 and 1604 persons. The hinterland of Saskatoon has fifty seven group I settlements with an average population of 219 and a range of between 24 and 712. They do not show any propensity to be located in any particular distance range, though more of them are found in the rich agricultural area north east of Saskatoon.

Comparison Between Calgary and Saskatoon Regions

It is clear from the above discussion that the two study areas have the same number of hierarchical groups. Figure 4.5 shows that the mean population levels for equivalent groups is very similar although minimum and maximum levels of their members vary. The hinterland of Calgary generally has higher levels of both values.

The mean distance separating members of group decreased with level of settlements. This is similar to the central place idea, namely that lower level outlets should be closer together than higher order ones. Other empirical verifications of this idea are found in works of Berry (1967) and Hodge (1965). Distances apart from the higher level groups is however higher around Saskatoon than around Calgary.

FIG. 4.5 POPULATION LEVELS AND MEAN SPACING OF TRADE CENTRES BY GROUPS IN THE HINTERLAND OF CALGARY AND SASKATOON 1971



This is possibly a result of lower population densities around Saskatoon and the tendency for settlements in Calgary region to be clusters along sectors.

CONTEMPORARY SERVICE CENTRE STRUCTURE 1971

This section deals with the content of the five groups derived using cluster analysis. This solves the question of whether or not there are distinct clusters of retail and commercial functions associated with the groups previous section. In a hierarchical situation it is expected that the higher groups will have all the lower group function as well as a distinct group of its own. In this analysis, establishments are said to initially belong to the group in which they first have a mean occurrence of 1.0 or more.

Calgary Region

Banff. Banff with a population of 3219 in 1971 is well known as a resort centre. It is situated in the Banff National Park, 80 miles west of Calgary. In the summer it is a centre for tourists, hikers and campers and in the winter a skiing centre. Table 4.7 shows that Banff had a higher occurrence of all traditionally tourist type goods in 1971. It had 83% of all camera and photographic equipment outlets in the hinterland of Calgary, 20% of eating places, 25% of tourist accommodation and the only two automobile rental outlets. It is therefore not surprising that it was singled out as a one member group.

TABLE 4.7.

COMPARISON BETWEEN SELECTED RETAIL OUTLETS IN

BANFF AND THE HINTERLAND OF CALGARY IN 1971

	Establishment	B	IV	L.Coef	TR	%B
1.	Eating places	25	10.0	0.80	125	20.0
2.	Hotels and Trailer courts	20	4.0	1.21	82	24.4
3.	Gift and Souvenir shops	13	0.5	6.67	15	86.7
4.	Gasoline service stations	11	10.0	0.65	154	6.5
5.	Sports and amusement	6	1.0	7.14	14	42.9
6.	Camera and photo. equipment	5	0.5	16.67	6	83.3
7.	Drug stores	4	2.5	2.70	37	10.8
8.	Photographic studios	3	0.5	14.28	7	42.5
9.	Plumbing, painting & masonry	3	5.0	2.44	41	7.3
10.	Automibile rental	2	0.0	50.00	2	100.0
11.	Vending machines	1	0.0	50.00	2	50.0

B = number in Banff
IV = mean for group IV
L.Coef = Location coefficient
TR = Total for region
%B = % occurring in Banff

Group I places. This group is the lowest functional cluster around Calgary. The forty three members are characterized by two types of retail outlets as shown in Table 4.8.

TABLE 4.8.

GROUP I FUNCTIONS

	Establishment	Mean	Frequency
1.	Gasoline Service Stations	1.33	81.4
2.	General Stores	1.14	81.4

Group II places. The second level of the hierarchy had all the functions occurring in the first level but as Table 4.9 shows the mean occurrence and the frequency of gasoline service stations is higher in the second hierarchical level, whilst general stores, experienced decline in both. The decline was caused by the increase in the number of specialized retail outlets, which because of the increased market potential in the larger communities found it profitable to locate instead of marketing through the general store. For example, groceries and hardware stores and farm equipment dealers were found at this level, whereas the services they offer probably include the types of activities performed by the general store in first level places. Eating places, which occurred for the first time in the system, have lower frequencies.

4.9 GROUP II FUNCTIONS

TABLE 4.9

GROUP		Establishments	Mean	Frequency
I	1.	Gasoline Service Stations	2.57	98.9
	2.	General Stores	1.00	85.7
II	3.	Petroleum and Petroleum products	1.93	92.9
	4.	Farm equipment dealers	1.21	71.4
	5.	Eating places	1.14	50.4
	6.	General Hardware Store	1.07	85.4
	7.	Hotels and Trailer Courts	1.00	71.4
	8.	Retail Groceries	1.00	71.4

This is explained by the fact that most of the hotels which also are characteristic of this level of the hierarchy probably have dining facilities on their premises.

Group III places. The six members of this group are similar to what Berry (1967) and Hodge (1965) have described as large towns. Of the twenty seven hierarchical functions performed by this level of the hierarchy, nineteen were typical of the class while the remaining eight were those performed by the lower levels of the hierarchy, as shown in Table 4.10. This table shows the third level of the hierarchy had a sharp increase in the functional composition and increased in the specialization of retail outlets. Professional services such as banks, and drug stores occur significantly for the first time in the system at this level. It is at also in group III that the types of establishments which may be termed non-essentials to rural life, for example clothiers and jewellers began to be part of the hierarchy.

According to economic theory, it is to be expected that the types of establishments with the highest means and frequencies of occurrence will be representative of the most desirable functions for the communities they serve. In the region around Calgary, these types of establishments with the exception of those performed by the lower levels of the hierarchy are automobile, clothing stores and drug stores. All of them are considered necessities according to the life-style of the inhabitants of North America. It is conceivable that whereas the patients may be prepared to go to the city for consultation of a physician, they would prefer to fill their prescription in the nearby town. It is important to note that drug stores are also outlets for a variety of other goods, especially cosmetics for both men and women.

TABLE 4.10

GROUP III FUNCTIONS

GROUP		Establishment	Mean	Frequency
I	1.	Gasoline service stations	4.67	100.0
	2.	General stores	1.33	66.7
II	3.	Petroleum and petroleum products	3.83	100.0
	4.	Farm equipment dealers	3.33	100.0
	5.	Eating places	4.50	100.0
	6.	General Hardware store	2.33	100.0
	7.	Hotels and trailer courts	1.17	83.3
	8.	Retail groceries	3.83	100.0
III	9.	Motor vehicle dealers	3.17	100.0
	10.	Men's and boy's wear	2.00	100.0
	11.	Drug stores	2.00	83.3
	12.	Plumbing, painting and masonry	1.67	100.0
	13.	Retail lumber and building material	1.67	100.0
	14.	General automobile repair	1.50	83.3
	15.	Banks	1.33	83.3
	16.	Retail meat and sea food	1.33	83.3
	17.	Heavy construction	1.33	66.7
	18.	Retail tire, batteries & accessories	1.17	83.3
	19.	Women's wear stores	1.17	83.3
	20.	General building contractors	1.17	66.7
	21.	Retail bakeries	1.17	100.0
	22.	Tire retreading and repair	1.00	83.3
	23.	Jewellery stores	1.00	83.3
	24.	Auto body and repair shops	1.00	66.7
	25.	Electrical works	1.00	66.7
	26.	Radio and TV repairs	1.00	66.3
	27.	Other repair	1.00	50.0

Group IV places. Apart from the central city of Calgary, group IV settlements were the most important in the hierarchy of settlements in the region. Their functional composition and their population (mean 4324) makes it possible for them to be characterized as small cities. There were only two settlements in this group. The larger of the two, Drumheller, is situated 82 miles east of the central city, in an area that was once a thriving mining community. The other, Olds, is situated about midway between Calgary and Red Deer. This group had fifty two types of retail outlets performed in them. Of these, twenty five were added to the system at this level (Table 4.10). Tables 4.10 and 4.11 show that groups III and IV were the most complex groups of settlements in the system. The main difference between them is the size of the market required to support their respective goods and services.

Hierarchical functions for Calgary 1971. The fifty two establishments which distinguish the different levels of the hierarchy are called 'hierarchical functions'. Two of the basic tenets of central place theory (Berry 1958, Christaller 1933, Ray 1970) are:

(i) higher order places perform all the functions of lower order places as well as having its own unique set,

(ii) an increase in functional complexity with increasing size of places.

Table 4.12 shows that the first point was the characteristic distribution of hierarchical functions around Calgary. There was an increase in the mean occurrence of retail outlets as well as frequency of its occurrence in the level as one moves from lower to higher levels within the

TABLE 4.11

FUNCTIONS ADDED AT GROUP IV

GROUP		Establishment	Mean	Frequency
	28.	Household appliances	2.50	100.0
	29.	Sports and bicycle shops	2.50	100.0
	30.	Construction (not elsewhere class.)	1.50	100.0
IV	31.	Furniture and floor coverings	1.50	100.0
	32.	Shoe stores	1.50	100.0
	33.	Laundromats	1.50	100.0
	34.	Watch, clock and jewellery repair	1.00	100.0
	35.	Other automobile repair	1.00	100.0
	36.	Funeral services	1.00	100.0
	37.	Miscellaneous retail services	1.00	100.0
	38.	Stationery and books	1.00	100.0
	39.	Retail candy stores	1.00	100.0
	40.	Retail plumbing and painting supply	1.00	100.0
	41.	Retail tire and tube supply	1.00	100.0
	42.	Automotive equipment supply	1.00	50.0
	43.	Farm and garden supply	1.00	50.0
	44.	Radio and TV stores	1.00	50.0
	45.	Family clothing stores	1.00	50.0
	46.	Wholesale groceries	1.00	100.0
	47.	Other contractors	2.00	100.0
	48.	Highway construction	1.00	100.0
	49.	General building contractors	1.00	100.0
	50.	Wholesale tires and tubes supply	1.00	100.0
	51.	Amusement and sporting goods	1.00	50.0
	52.	Wholesale specialty foods	1.00	100.0

TABLE 4.12

HIERARCHICAL FUNCTIONS FOR CALGARY REGION 1971

	Function	HIER I		HIER II		HIER III		HIER IV[1]	
		M	cmF	M	cmF	M	cmF	M	cmF[2]
1	Gasoline Service Stations	1.33	81.4	2.57	78.6	4.67	100.0	10.0	100.0
2	General Stores	1.14	81.4	1.00	85.7	1.33	66.7	3.5	100.0
3	Petroleum and products	0.95	69.9	1.93	92.9	3.83	100.0	6.0	100.0
4	Farm Equiiment dealers	0.37	23.3	1.21	71.4	3.33	100.0	5.0	100.0
5	Eating places	0.86	55.6	1.14	50.0	4.50	100.0	10.0	100.0
6	General Hardware Stores	0.54	41.9	1.07	85.7	2.23	100.0	1.5	100.0
7	Hotels and Trailer Coures	0.77	62.8	1.00	71.4	1.17	83.3	4.0	100.0
8	Retail Groceries	0.54	32.6	1.00	71.4	3.83	100.0	4.5	100.0
9	Motor vehicle dealers	0.49	32.6	0.64	50.0	3.17	100.0	4.5	100.0
10	Men and boy's wear	0.16	16.3	0.21	21.4	2.00	100.0	2.0	100.0
11	Drug Stores	0.21	18.6	0.50	50.0	2.00	83.3	2.5	100.0
12	Plumbing,printing and masonry	0.23	14.0	0.57	42.9	1.67	100.0	5.0	100.0
13	Retail lumber and building	0.44	39.5	0.57	50.0	1.67	100.0	2.0	100.0
14	General Automobile repair	0.40	30.2	0.36	35.7	1.50	83.3	1.5	100.0
15	Banks	0.30	30.2	0.86	85.7	1.33	83.3	2.5	100.0
16	Retail Meat and Seafood	0.23	23.2	0.57	50.0	1.33	83.3	2.5	100.0
17	Heavy Construction	0.14	9.3	0.14	7.1	1.33	66.7	2.0	100.0
18	Retail tire and battery	.0.14	14.0	0.29	28.9	1.17	83.3	2.5	100.0
19	Womens' wear stores	0:12	11.6	-	-	1.17	83.3	3.0	100.0
20	General building contractors	0.21	14.0	0.29	28.6	1.17	66.7	1.5	50.0
21	Retail bakeries	0.09	9.3	-	-	1.17	100.0	1.0	50.0
22	Tire retreading and repair	-	-	0.14	14.3	1.00	83.3	1.0	100.0
23	Jewlery stores	0.05	4.7	0.07	7.1	1.00	83.3	2.0	100.0
24	Auto body and repair shops	0.05	4.7	0.29	28.6	1.00	66.7	2.0	100.0
25	Electrical works	0.30	25.6	0.36	28.6	1.00	66.7	3.0	100.0
26	Radio and TV repair	0.09	9.3	0.21	21.4	1.00	66.3	2.0	100.0
27	Other repairs (n.e.c.)	-	-	0.29	21.4	1.00	50.0	1.0	100.0
28	Household appliances	0.19	16.3	0.07	7.1	0.67	66.7	2.5	100.0
29	Sports and bicycle shops	0.05	4.7	-	-	0.17	16.7	2.5	100.0
30	Construction (n.e.c.)	0.17	9.3	0.21	21.4	0.33	33.3	1.5	100.0
31	Furniture and floor covering	0.05	4.7	-	-	0.50	33.3	1.5	100.0
32	Shoe Stores	0.05	4.7	-	-	0.83	66.7	1.5	100.0
33	Laundromats	0.05	4.7	0.07	7.1	0.67	66.7	1.5	100.0
34	Watch,clock and jewelry	-	-	-	-	0.33	33.3	1.0	100.0
35	Other auto repair (n.e.c.)	-	-	0.14	14.3	0.17	16.7	1.0	100.0
36	Funeral services	-	-	0.14	14.3	0.17	16.7	1.0	100.0
37	Misc. retail stores	0.05	4.7	0.21	22.4	0.17	16.7	1.0	100.0
38	Stationary and books	-	-	-	-	-	-	1.0	100.0
39	Retail candy stores	0.05	4.7	0.14	14.3	0.67	66.7	1.0	100.0
40	Retail plumbing & painting	0.09	7.0	-	-	-	-	1.0	100.0
41	Tires and tubes supply	0.02	2.3	-	-	-	-	1.0	100.0
42	Automotive equipment supply	-	-	0.07	7.1	0.17	16.7	1.0	50.0
43	Farm and garden supply	0.12	11.6	0.29	22.4	0.67	66.7	1.0	50.0
44	Radio and TV stores	0.02	2.3	0.29	28.6	0.67	50.0	1.5	50.0
45	Family clothing stores	0.05	4.7	0.29	21.4	0.33	33.3	1.0	50.0
46	Amusement and sporting goods	-	-	-	-	-	-	1.0	50.0
47	Wholesale Specialty foods	-	-	-	-	-	-	1.0	100.0
48	Wholesale groceries	-	-	-	-	-	-	1.0	100.0
49	Other contractors	0.07	7 1	0.17	16.7	-	-	2.0	100.0
50	Highway and heavy construction	-	-	-	-	-	-	1.0	100.0
51	General building contractors	0.05	5.4	-	-	-	-	1.0	100.0
52	Wholesale tires & tube supply								

notes: 1 Hierarchical group
2 M = Mean occurence of function in the group
cmF = cumulative frequency of occurence of the function in the group.

hierarchy. The exceptions to this trend were general stores, general contractors and retail bakeries. In the first two instances, the general nature of the functions performed by the outlets was superseded by more specialized outlets dealing in the same commodities. The result was a decline in the number of such general outlets and replacement by more specialized outlets. In the case of retail bakeries, the result as shown did not show the full effect of marketing of bakery products, since it is to be expected that many competitive outlets for bakery products such as groceries, might get their supplies from commercial bakeries probably located in the central city or other cities over 20,000 within the commercial range of these settlements.

The second point is also borne out, namely that there should be an increase in functional complexity with increasing order of places. As the table shows, the higher the order of a place the greater its complexity and the degree of specialization of its retail outlets.

Non-hierarchical functions in Calgary region 1971. Local differences in the requirements of the populations produce some functions which are unique to the area they serve. These types of functions have been designated 'non-hierarchical' functions. There are twelve such functions in Calgary region (Table 4.13). The non-hierarchical functions as shown in Table 4.13 include many of the wholesale establishments in the region. It has been suggested by Berry (1967) that wholesale functions will tend to be performed by what he calls a regional city, because of the larger trade areas needed to support one such outlet. None of the settlements in the analysis fall into that

category since they are within the hinterland of Calgary, hence the infrequency of wholesale outlets in the system studied.

Highly specialized and consumer oriented facilities, such as florists, and vending machine dealerships, are generally associated with urban dwellers, consequently, it was not surprising that they did not constitute a part of the hierarchical functions for central places studied. Similarly automobile rentals are associated with the tourist industry, or large cities. They did not occur in the region outside the central city of Calgary and the resort town of Banff.

TABLE 4.13

NON-HIERARCHICAL FUNCTIONS IN CALGARY REGION 1971

	Establishment	Hier M	I cmF	Hier M	II cmF	Hier M	III cmF	Hier M	IV cmF
1.	Automobile wholesale	0.02	2.3	-	-	-	-	-	-
2.	Wholesale electrical apparatus	-	-	-	-	0.17	16.7	-	-
3.	Farm equipment and machinery	-	-	-	-	0.07	16.7	-	-
4.	Camera and photo. equipment								
5.	Gift and souvenir shops	-	-	-	-	-	-	0.50	50.0
6.	Other wholesale (n.e.c.)	0.05	4.7	0.07	7.1	0.51	33.3	-	-
7.	Retail electrical supplies	0.02	2.3	-	-	0.33	33.3	-	-
8.	Vending machines	-	-	0.07	7.1	-	-	-	-
9.	Drinking places	0.07	7.0	0.14	14.3	0.17	16.7	-	-
10.	Florists	0.02	2.3	0.07	0.1	0.67	50.0	-	-
11.	Automobile rental	-	-	-	-	-	-	-	-
12.	Furniture repair	-	-	0.07	7.1	0.33	33.3	-	-
13.	Welding repair	0.07	7.0	0.07	7.1	0.17	16.7	-	-
14.	Billiards and pool houses	0.05	4.7	-	-	0.33	33.3	0.50	50.0
15.	Photographic studios	-	-	-	-	-	-	0.90	50.0

n.e.c. : not elsewhere classified

Saskatoon Region

Group I places. The fifty seven settlements in group I represented 70.25% of all the settlements in the region. Similar to the hinterland of Calgary, they were characterised by two types of retail establishments; General stores and Gasoline service stations, (Table 4.14).

TABLE 4.14

GROUP I FUNCTIONS: SASKATOON 1971

GROUP	Establishment	Mean	Frequency
I	1. General stores	1.58	81.5
	2. Gasoline service stations	1.21	77.2

Group II places. Nine commercial establishments were found to occur at this level of the urban system. These included the two lower order and seven additional functions. Table 4.15 shows that there were more outlets of gasoline service stations but a decrease in occurrence of general stores. This decline was attributed to the increase in the number of specialized outlets providing the functions normally performed by general stores in lower order settlements.

TABLE 4.15

GROUP II FUNCTIONS: SASKATOON REGION 1971

ENTRY GROUP	Establishment	Mean	Frequency
I	1. General stores	1.47	100.00
	2. Gasoline service stations	2.40	100.00
II	3. Farm equipment dealers	1.80	86.7
	4. Retail groceries	1.73	93.3
	5. Hardware stores	1.60	86.7
	6. Eating places	1.47	93.3
	7. Petroleum and petroleum products	1.33	80.0
	8. Lumber and building materials	1.07	80.0
	9. Banks	1.00	93.3

Group III places. A total of seventeen retail establishments constituted the characteristic functions of this level, (Table 4.16). Of these, eight were occurring in the hierarchy for the first time with mean occurrence of 1.00 or more.

At the third level, establishments that may be termed non-essential to rural farm life began to occur. Because the province is agricultural, it is expected that the most demanded types of establishments will be those related to the smooth transaction of a rural farm economy. These were typified by group I and II places.

TABLE 4.16

GROUP III FUNCTIONS

ENTRY GROUP		Establishment	Mean	Frequency
I	1.	General store	1.86	85.7
	2.	Gasoline service station	3.86	100.0
II	3.	Farm equipment dealers	4.57	100.0
	4.	Retail groceries	1.43	71.4
	5.	Hardware stores	2.14	100.0
	6.	Eating places	3.14	100.0
	7.	Petroleum and petroleum products	1.29	57.1
	8.	Lumber and building materials	1.29	85.7
	9.	Banks	1.43	100.0
III	10.	Hotels and tourist courts	2.85	100.0
	11.	Automobile sales dealerships	2.28	100.0
	12.	Electrical construction	1.57	100.0
	13.	Drug stores	1.43	100.0
	14.	Plumbing and heating construction	1.86	100.0
IV	15.	General constructors	1.29	71.4
	16.	Dry cleaning	1.00	85.7
	17.	Jewellery stores	1.00	71.4

Group IV and hierarchical functions. Only one settlement, Humboldt fell into this class in 1971. It had a population of 3881 which is comparable to that of group IV places around Calgary. There were thirty nine hierarchical functions in the settlement, twenty two of them occurring with means of greater than 1.0 for the first time. Table 4.17 shows that there was an increase in both mean and frequency of occurrence of establishments with order of settlement. The exception was general stores which declined to be replaced by more specialized outlets in the more important settlement. This increase in outlets confirms the results of Berry (1958) and Ray (1970) concerning the relationships between settlements in a hierarchical system.

Non-hierarchical functions. Besides the thirty nine hierarchical functions, there were twelve that were not part of the descriptive features of the central place system. Table 4.18 shows these establishments did not belong to the hierarchical group because they were probably those performed at regional cities. None of them occurred in Humboldt and the means and frequencies of their occurrence in the lower three groups was not sufficient to include them in the hierarchical group.

TABLE 4.17

GROUP IV AND HIERARCHICAL FUNCTIONS: SASKATOON REGION 1971

SASKATOON 1971

	HIER I		HIER II		HIER III		HIER IV	
	M	cmF	M	cmF	M	cmF	M	cmF
General Stores	1.58	81.5	1.47	100.0	1.86	85.7	2.0	**
Gasoline Service Stations	1.21	77.2	2.40	100.0	3.86	100.0	8.0	
Farm Equipment Dealers	0.77	45.6	1.80	86.7	4.57	100.0	6.0	
Retail Groceries	0.37	33.3	1.73	93.3	1.43	71.4	6.0	
Hardware Stores	0.40	33.3	1.60	86.7	2.14	100.0	-	
Eating Places	0.32	31.6	1.47	93.3	3.14	100.0	8.0	
Petroleum & P. products	0.46	35.1	1.33	80.0	1.29	57.1	3.0	
Lumber and Building Mat.	0.23	22.8	1.07	80.0	1.29	85.7	3.0	
Banks	0.33	29.8	1.00	93.3	1.43	100.0	2.0	
Hotels and Tourist Courts	0.65	63.2	0.93	93.3	2.85	100.0	1.0	
Automobile Sales Dealers	0.07	1.2	0.27	20.0	2.28	100.0	5.0	
Electrical Construction	0.12	12.3	0.47	40.0	1.57	100.0	2.0	
Drug Stores	0.02	1.2	0.73	73.3	1.43	100.0	4.0	
Plumbing and Heat Const.	0.11	10.5	0.20	20.0	1.86	100.0	4.0	
General Constructors	0.11	10.5	0.26	26.7	1.29	71.4	1.0	
Dry Cleaning	-	-	0.07	6.7	1.00	85.7	1.0	
Jewelry Stores	-	-	0.13	13.3	1.00	71.4	1.0	
Shoe Stores	-	-	-	-	0.29	28.6	3.0	
Radio and TV Repair	0.11	10.5	0.53	46.3	0.14	14.3	2.0	
Car Wash	-	-	0.07	6.7	0.29	28.6	2.0	
Auto top and Body repair	0.05	5.3	0.20	20.0	0.86	85.7	2.0	
Furniture Store	-	-	0.20	20.0	0.43	42.9	2.0	
Family Clothing Store	-	-	0.13	13.3	0.57	57.1	2.0	
Women's clothing and Asse.	-	-	0.27	26.7	0.86	71.4	2.0	
Tire and Battery Dealers	0.02	1.8	0.07	6.7	0.86	71.4	2.0	
Paint, plumbing & Elec.	0.02	1.2	0107	6.7	0.14	14.3	2.0	
Carpentering	0.04	3.5	0.07	6.7	0.14	14.3	2.0	
Heavy const. (exc. street)	0.12	10.5	0.27	13.3	0.43	28.6	2.0	
Automotive Equipment	0.02	1.8	-	-	0.43	28.6	3.0	
Billiard and Pool, Bowling	0.14	14.0	0.40	26.7	0.29	28.6	1.0	
Welding Repair	-	-	-	-	0.14	14.3	1.0	
Furniture Repair	-	-	-	-	0.14	14.3	1.0	
Tire retreading and repair	0.02	1.8	-	-	0.14	14.3	1.0	
Florists	0.02	1.8	-	-	0.28	18.6	1.0	
Farm, hay, garden supply	0.12	1.8	0.07	6.7	0.28	14.6	1.0	
Radio and TV stores	0.02	1.8	0.13	13.3	0.57	57.1	1.0	
Men and boys clothing	0.02	1.8	0.20	20.0	0.43	42.9	1.0	
Retail Bakeries	-	-	0.33	33.3	0.86	85.7	1.0	
Meat and Seafood	0.05	3.5	-	-	0.29	28.6	1.0	

TABLE 4.18

NON-HIERARCHICAL FUNCTIONS: SASKATOON 1971

	Establishment	Hier I Mean	Hier I Freq.	Hier II Mean	Hier II Freq.	Hier III Mean	Hier III Freq.
1.	Street construction	0.07	7.0	-	-	0.14	14.3
2.	Painting and paper handling	-	-	-	-	0.43	42.9
3.	Roofing and sheet metal work	-	-	0.13	13.0	0.2	14.3
4.	Water well drilling	0.12	1.8	-	-	0.29	28.6
5.	Excavation and foundation laying	.12	12.3	0.27	20.0	0.71	51.1
6.	Special trade contractors	0.04	3.5	0.13	13.3	0.29	28.6
7.	Department stores	-	-	-	-	0.14	14.3
8.	Candy stores	0.05	3.5	-	-	0.29	28.6
9.	Household appliance stores	0.04	3.5	0.13	13.3	0.71	57.1
10.	Books and stationery	-	-	-	-	0.29	28.6
11.	Funeral services	0.02	8.8	-	-	0.86	85.7
12.	Repair shops (n.e.c.)	0.08	8.8	0.47	33.3	0.14	14.3

n.e.c.: not elsewhere classified

Comparison of Service Centre Structure around Calgary and Saskatoon

It has already been shown that the two areas have similar population thresholds and means for groups. Their mean distances apart are also similar except that members of the groups tend to be farther apart around Saskatoon than around Calgary. In this section the differences and similarities between the functional content of the hierarchical groups will be examined.

The relationship between the functional characteristics of the two study areas may be best shown by means of Table 4.19. This table shows that groups I, and II in 1971 had almost identical characteristic retail and commercial functions. The only difference being banks which occurred in group III around Calgary and group II in the hinterland of Saskatoon. Major differences were however found at the third level.

TABLE 4.19

COMPARISON OF HIERARCHICAL FUNCTIONS FOR CENTRES IN THE HINTERLAND OF CALGARY AND SASKATOON 1971

CALGARY 1971	SASKATOON 1971	GROUP
1 Gasoline Service Stations	1 Gasoline Service Stations	
2 General Stores	2 General Stores	I
3 Petroleum and Petroleum Products	3 Petroleum and Petroleum Products	
4 Farm Equipment Dealers	4 Farm Equipment Dealers	
5 Eating Places	5 Eating Places	II
6 General Hardware Stores	6 Hardware Stores	
7 Retail Groceries	7 Retail Groceries	
8 Hotels and Trailer Courts →	8 Lumber and Building Materials	
9 Retail Lumber and Building Materials	9 Banks	
10 Banks	10 Hotels and Tourist Courts	
11 Drug Stores	11 Drug Stores	
12 Plumbing, Printing and Masonry	12 Automobile Sales Dealers	
13 Motor Vehicle Dealers	13 Electrical Construction	
14 General Automobile Repair	14 Plumbing and Heat Construction	III
15 General Building Contractors	15 General Constructors	
16 Jewelry Stores	16 Jewelry Stores	
17 Electrical Works	17 Dry Cleaning	
18 Other Repair		
19 Men's and Boys' Wear →	18 Men's and Boy's Clothing	
20 Retail Meat and Seafood	19 Retail Meat and Seafood	
21 Heavy Construction	20 Heavy Construction	
22 Retail Tire and Batteries	21 Tire and Battery Dealers	
23 Women's Wear Stores →	22 Women's Clothing and Accessories	
24 Retail Bakeries	23 Retail Bakeries	
25 Auto body and Repair Shops	24 Auto Top and Body Repair	
26 Radio and TV Repair	25 Radio and TV Repair	
27 Tire Retreading and Repair	26 Tire Retreading and Repair	IV
28 Household Appliances	27 Shoe Stores	
29 Sports and Bicycle Shops	28 Car Wash	
30 Construction (not elsewhere classified)	29 Furniture Store	
31 Furniture and Floor Coverings	30 Family Clothing Stores	
32 Shoe Stores	31 Paint Plumbing and Electrical Supply	
33 Laundromats	32 Carpentering	
34 Watch, Clock and Jewelry	33 Automotive Equipment	
35 Other Auto Repair	34 Billiards, Pool and Bowling	
36 Funeral Services	35 Welding Repair	
37 Miscellaneous Retail Stores	36 Furniture Repair	
38 Stationery and Books	37 Florists	
39 Retail Candy Stores	38 Farm, Hay and Garden Supply	
40 Retail Plumbing and Painting	39 Radio and TV Stores	
41 Tires and Tubes Supply		
42 Automotive Equipment Supply		
43 Farm and Garden Supply		
44 Radio and TV Stores		
45 Family Clothing Store		
46 Amusement and Sporting Goods		
47 Wholesale Specialty Foods		
48 Wholesale Groceries		
49 Other Contractors		
50 Highway and Street Construction		
51 General Building Contractors		
52 Wholesale Tires and Tube Supply		

→ indicates difference in the group of entry of establishments as hierarchical functions.

Nine of the group III establishments in Calgary region are shifted to group IV around Saskatoon. Besides, there were fifty two hierarchical functions in the hinterland of Calgary and only thirty nine around Saskatoon. The former region is therefore more complex than the latter. The greater functional composition around Calgary could be because of its higher population densities. Areas of high population density are expected to have correspondingly greater purchasing power and are therefore able to support more types of central functions.

SUMMARY

The results contained in this chapter may be summarized in the context of the research objectives as follows:

(i) Centres around Calgary and Saskatoon were organized into hierarchies. Looking at the region as a whole it may be argued on the basis of the Löschian system that they are a continuum. However in a spatial view point, the hierarchies appear to be discrete.

(ii) There are distinct types of retail and commercial establishments associated with each level of the hierarchy. Higher order places perform all the functions of the lower levels and in addition have distinct retail establishments of their own.

(iii) The system around Calgary is functionally more complex than that around Saskatoon.

(iv) Higher order settlements in the hinterland of Calgary are situated in sectors along the major highways that pass through high population density areas. Around Saskatoon their spatial arrangement describes a circle with the centre on Saskatoon. Settlements along highways are further away than those in the intermediary area.

CHAPTER V

CHANGING STRUCTURE OF SERVICE CENTRES 1951-1971

Introduction. In the preceding chapters it was shown that the two areas have experienced similar rural population trends in the period 1951 to 1971. Although Calgary area experienced growth along the highways decline occurred around Saskatoon. It was also shown that the two hinterlands had distinct hierarchies based on their functional composition in 1971 and had groups of retail establishments associated with each level of the hierarchy. In this chapter the changes that have occurred in the system are examined. This is done by first identifying the nature of the system in 1951 and then comparing it with the results of the 1971 situation.

CHANGE IN HIERARCHICAL GROUPS 1951-1971

Calgary Region 1951

Using the same methodology as was applied to 1971 data, five groups of settlements were found in the settlements in the hinterland of Calgary in 1951. Even in 1951, Banff was isolated as a single member group. Figure 5.1 shows that Drumheller was also singled out as the only centre in group IV. The figure also shows the groupings of the remaining settlements. The inset graph shows the derivation of the cut off point of 4.0 which was used for demarcating the groups.

The results of the cluster analysis were tested using Discriminant Analysis. Table 5.1 shows even on the basis of only functions occurring in all the groups, the cluster classification were distinct.

FIG. 5.1 DENDROGRAM TABLE FOR CLUSTERS OF TRADE CENTRES

IN THE HINTERLAND OF CALGARY 1951

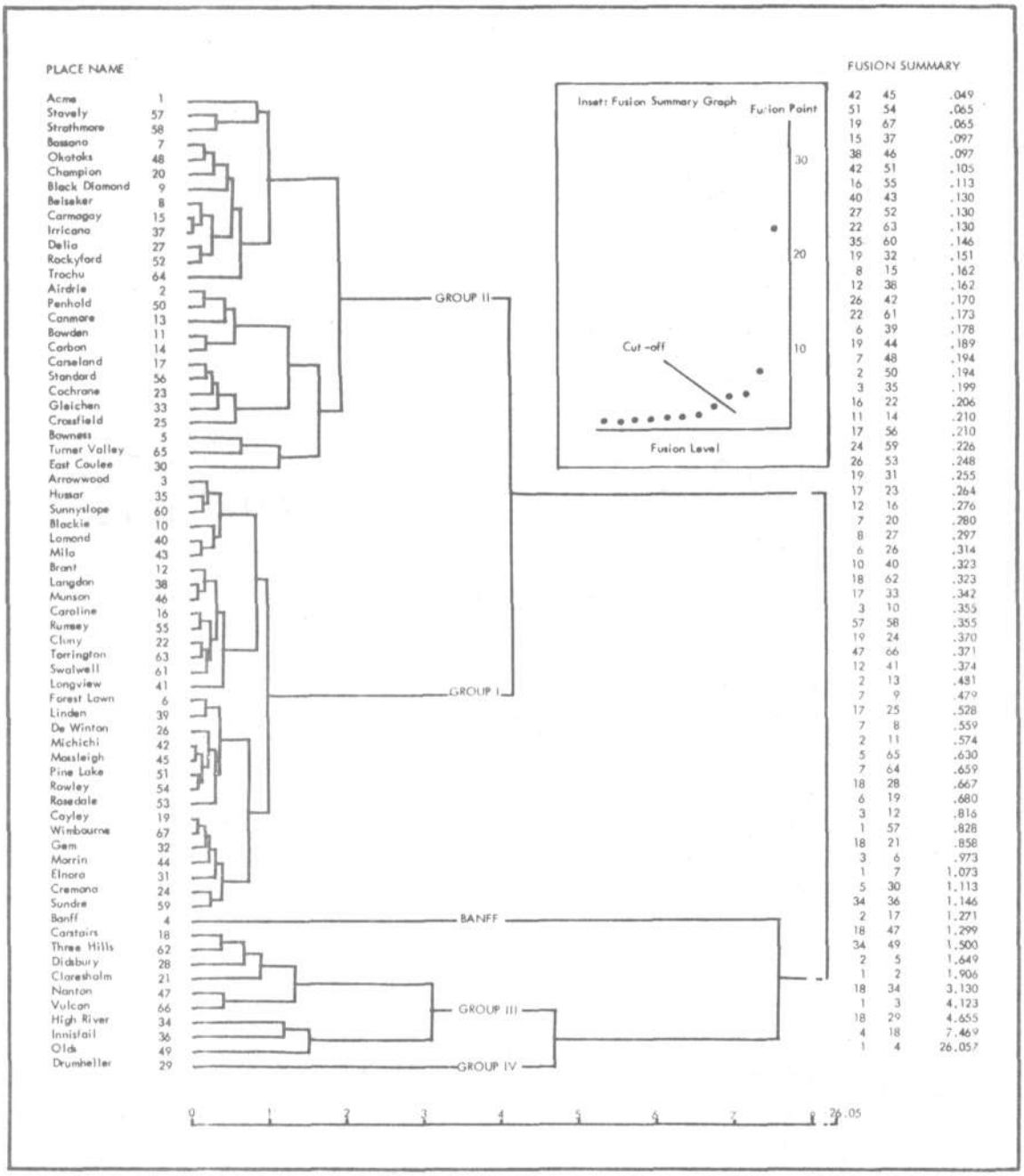


TABLE 5.1.

CLASSIFICATION MATRIX: CALGARY REGION 1951

GROUP	SPECIAL	IV	III	II	I
SPECIAL	1	0	0	0	0
IV	0	1	0	0	0
III	0	0	3	0	0
II	0	0	0	6	0
I	0	0	0	0	56
TOTAL	1	1	3	6	56

Table 5.2 shows that the F-matrix of the classification fell within the region of acceptability; the cluster groups were distinct.

TABLE 5.2.

F-MATRIX: GROUPS IN CALGARY REGION 1951

GROUP	IV	III	II	I
IV				
III	9.971			
II	11.194	8.848		
I	18.507	25.650	10.954	

F at 95% confidence limits = 1.84 and 99% = 2.39

The results of the Cluster Analysis were compared with the 1951 ranked Functional Indices as a preliminary test for the hierarchical nature of the groups. Table 5.3 shows that only nine out of the sixty seven settlements did not occupy ranks that might be taken by members of their groups. Most of the variation affected members of group I and II. This suggests that the cluster groups were not random, but according to the importance of the settlements. Since higher groups occupy higher ranks it may be the cluster may be tentatively accepted as being hierarchical.

TABLE 5.3

FUNCTIONAL INDICES AND CLUSTER GROUPS CALGARY REGION 1951

RANK	NAME	FUNCTIONAL INDEX	CLUSTER GROUP	
1	Drumheller	1044.015	IV	
2	Banff	560.628	S	
3	Olds	428.143	III	
4	High River	326.024	III	GROUP III RANKS
5	Strathmore	232.274	I	
6	Didsbury	230.972	II	
7	Innisfail	193.205	III	
8	Claresholm	182.992	II	
9	Black Diamond	168.446	I	GROUP II RANKS
10	Turner Valley	163.513	I	
11	Vulcan	158.149	II	
12	Nanton	152.483	II	
13	Bowness*	122.342	I	
14	Three Hills	114.228	II	
15	Trochu	113.595	I	
16	Sunnyslope	112.037	I	
17	Gleichen	99.232	I	
18	Carstairs	84.090	II	GROUP I RANKS
19	East Coulee	77.538	I	
20	Longview	77.280	I	
21	Bassano	72.960	I	
22	Bowden	70.913	I	
23	Irricana	68.265	I	
24	Cochrane	67.239	I	
25	Blackie	65.723	I	
26	Stavely	65.275	I	
27	Okotoks	61.854	I	
28	Forest Lawn*	61.521	I	
29	Carron	61.514	I	
30	Acme	60.045	I	
31	Crossfield	58.405	I	
32	Canmore	55.080	I	
33	Champion	54.764	I	
34	Brant	53.502	I	
35	Airdrie	49.074	I	
36	Standard	46.044	I	
37	Delia	44.927	I	
38	Sundre	43.297	I	
39	Wimbourne	40.045	I	
40	Linden	34.239	I	

Table 5.3 Cont'd

RANK	NAME	FUNCTIONAL INDEX	CLUSTER GROUP	
41	Rockyford	32.235	I	
42	Carseland	29.658	I	
43	Beiseker	29.020	I	
44	Elnora	27.327	I	
45	Arrowwood	23.806	I	
46	Carmangay	23.430	I	
47	Cluny	21.046	I	
48	Penhold	20.859	I	
49	Morrin	20.047	I	
50	Torrington	18.254	I	
51	Caroline	19.062	I	GROUP I
52	Cremona	18.621	I	RANKS
53	Milo	18.692	I	
54	Rosedale	18.312	I	
55	Rumsey	16.999	I	
56	Swalwell	15.543	I	
57	Gem	15.194	I	
58	Lomond	15.129	I	
59	Hussar	13.106	I	
60	Langdon	11.896	I	
61	Munson	10.317	I	
62	De Winton	10.063	I	
63	Pine Lake	9.624	I	
64	Cayley	7.194	I	
65	Rowley	6.695	I	
66	Michichi	6.492	I	
67	Mossleigh	5.087	I	

* became part of metropolitan Calgary in 1971

Change in Hierarchies of Centres Around Calgary 1951-1971

Table 5.4 is a list of settlements according to their groups. The arrows indicate diagramatically the shifts which have occurred in the status of the centres during the study period. The table shows that there was no change in the status of Banff. It remained a separate group in 1951 and 1971. Besides Banff, there was an overall increase in the status of settlements. Olds joined Drumheller as a group IV settlement, and four group II settlements became group III. Similarly, twelve group I settlements rose to group II, creating a net loss in membership of the lowest group. All the settlements experiencing increase, except Sundre and Trochu, are located along major highways. They also include the three centres immediately around Calgary namely Okotoks, Cochrane and Airdrie. This trend suggests that Calgary might have spilled out growth into its hinterland between 1951 and 1971.

Saskatoon Region 1951

Using similar techniques, four groups were obtained from the settlements around Saskatoon. Figure 5.2 shows the fusion levels of members of each group. The inset graph shows a plot of these fusion points indicating the level at which a cut-off point was applied. These groups were tested using a Discriminant Analysis on all the variables that occurred in all the groups. The results (Table 5.5) show that there was an exchange of one settlement each by the lowest two groups. Ossler in group I was reclassified into group II and Strongfield from group II to group I.

FIG. 5.2 DENDROGRAM TABLE OF CLUSTERS OF SETTLEMENTS

IN THE HINTERLAND OF SASKATOON 1951

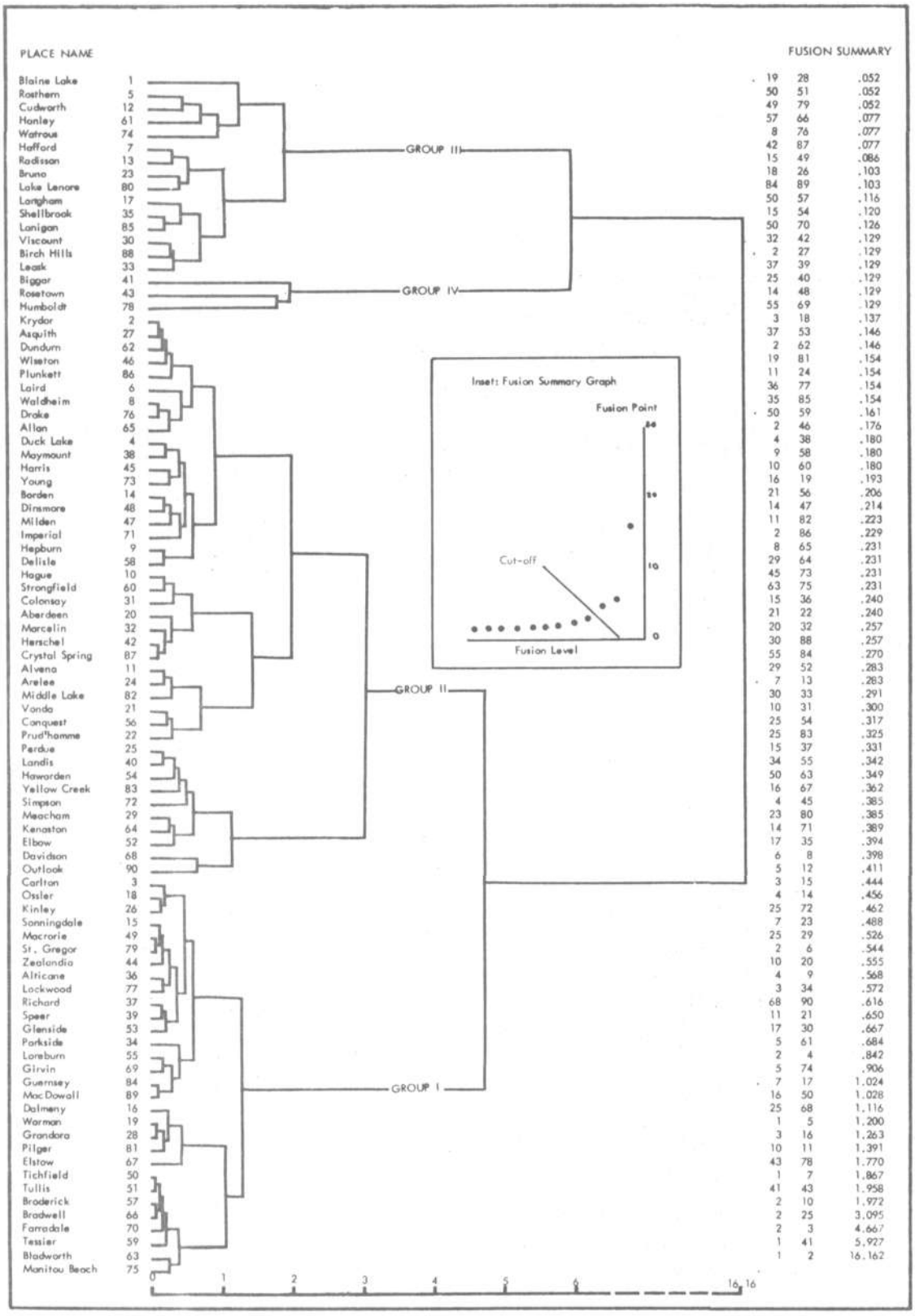


TABLE 5.4

HIERARCHICAL CLASSIFICATION OF SETTLEMENTS:

CALGARY REGION 1951-1971

GROUP	1951	1971
Special	Banff	Banff
IV	Drumheller	Drumheller
		Olds
III	Olds	High River
	High River	Innisfail
	Innisfail	Vulcan
		Nanton
		Claresholm
		Didsbury
II	Vulcan	Three Hills
	Nanton	Carstairs
	Claresholm	Crossfield
	Didsbury	Gleichen
	Three Hills	Cochrane
	Carstairs	Canmore
		Penhold
		Airdrie
		Trochu
		Champion
		Okotoks
		Bassano
		Strathmore
		Sundre
I	Crossfield	Rumsey
	Gleichen	Lomond
	Cochrane	Carmagay
	Canmore	Rockyford
	Penhold	Beiseker
	Airdrie	Turner Valley
	Trochu	Stavely
	Champion	Morrin
	Okotoks	Blackie
	Bassano	Arrowwood
	Strathmore	Westward Ho
	Sundre	Madden
	East Coulee	Linden
	Turner Valley	Rosedale
	Bowness*	Munson
	Standard	Mossleigh
	Carseland	Cayley
	Carbon	Brant

TABLE 5.4 cont'd

GROUP	1951	1971
I	Bowden	Swalwell
	Rockyford	Gem
	Delia	Langdon
	Irricana	Longview
	Carmagay	Wimbourne
	Beiseker	De Winton
	Black Diamond	Caroline
	Stavely	Pine Lake
	Acme	East Coulee
	Cremona	Bragg Creek
	Elnora	Milo
	Morrin	Cluny
	Gem	Cremona
	Wimbourne	Torrington
	Cayley	Hussar
	Rosedale	Spruceview
	Rowley	Carseland
	Pine Lake	Irricana
	Mossleigh	Standard
	Michichi	Elnora
	De Winton	Delia
	Linden	Carbon
	Forest Lawn*	Bowden
	Longview	Black Diamond
	Swalwell	Acme
	Torrington	
	Cluny	
	Rumsey	
	Caroline	
	Munson	
	Langdon	
	Brant	
	Milo	
	Lomond	
	Blackie	
	Sunnyslope	
	Hussar	
	Arrowwood	

notes: centres that have grown in status are shown by a SOLID arrow, those that have declined by BROKEN arrow:

——→ increase in status

– – → decrease in status

* became part of Metropolitan Calgary in 1971

TABLE 5.5.

CLASSIFICATION MATRIX: SASKATOON REGION 1951

GROUP	IV	III	II	I
IV	3	0	0	0
III	0	15	0	0
II	0	0	41 →	1
I	0	0	1 ←	29
TOTAL	3	15	42	30

↛ direction of relocation

The performance test of this classification using F-ratios shows that the groups are distinct. The matrix of F-ratios (Table 5.6) show that at both 95% and 99% confidence limits the ratios fall with the reject region.

TABLE 5.6.

F-MATRIX SHOWING PERFORMANCE OF GROUPING

SASKATOON REGION 1951

GROUP	IV	III	II	I
IV				
III	7.087			
II	10.191	7.102		
I	12.125	9.912	3.593	

F- at 95% confidence limits = 1.75, 99% = 2.30

Since even with only a portion of the total variable set, only a few settlements were misclassified, the Cluster Analysis results were accepted as being distinct.

A comparison of the cluster groups in 1951 with the ranked Functional Indices for the same year (Table 5.7) showed that only in

eight cases did centres occupied ranks different from those expected for members of their group. The relatively little difference between the two results provide an initial basis for accepting the hierarchical nature of the cluster groups.

Change in Hierarchies of Centres in Saskatoon Region 1951-1971

Unlike the hinterland of Calgary, the overall trend around Saskatoon was a decline in status of centres. Table 5.8 shows that only two settlements Outlook and Davidson increased in status from group II to III. Two members of group IV Biggar and Rosetown declined to group III, and thirteen of the latter group also experienced decline. The greatest change in one class however occurred in group II. Forty two of its members declined in status between 1951 and 1971. This trend is in agreement with finding of Hodge (1965) and Stabler and Williams (1972), but contrary to their findings only the lowest group experience net gain in members. Spatially the greatest loss in status occurred in the north eastern part of the study area. This region has high agricultural potential and between 1951 and 1971 experienced rural population decline. It is possible that the decline in status of settlements in this area has been in response to competition over declining rural consumers.

TABLE 5.7.

FUNCTION INDICES AND CLUSTER GROUPS: SASKATOON REGION

RANK	NAME	FUNCTIONAL INDEX	GROUP	
1	Humboldt	434.262	IV	GROUP IV
2	Biggar	355.466	IV	RANKS
3	Rosetown	230.318	IV	
4	Davidson	144.914	III	
5	Watrous	135.381	III	
6	Rosthern	99.487	III	
7	Bruno	97.737	III	
8	Shellbrook	89.538	III	
9	Cudworth	89.121	III	
10	Blaine Lake	78.261	III	GROUP III
11	Imperial	77.714	II	RANKS
12	Lake Lenore	77.406	III	
13	Young	75.138	II	
14	Birchhills	73.855	III	
15	Elbow	73.616	II	
16	Delisle	72.587	II	
17	Lanigan	72.334	III	
18	Middle Lake	64.795	II	
19	Simpson	61.085	II	
20	Langham	57.350	III	
21	Hawarden	57.243	II	
22	Hafford	55.837	III	
23	Strongfield	54.198	II	
24	Prud'Homme	48.958	II	
25	Laird	44.252	II	
26	Hanley	44.089	III	
27	Duck Lake	43.262	II	
28	Waldheim	40.034	II	GROUP II
29	Harris	36.616	II	RANKS
30	Wiseton	35.185	II	
31	Drake	34.933	II	
32	Radisson	33.855	III	
33	Conquest	33.572	II	
34	Leask	32.327	III	
35	Viscount	28.559	III	
36	Milden	27.593	II	
37	Dalmeny	26.549	II	
38	Hague	26.278	II	
39	Perdue	25.947	II	
40	Manitou Beach	23.195	II	
41	Lockwood	22.950	II	
42	Dinsmore	21.615	II	
43	Parkside	21.423	II	
44	Plunkett	21.276	II	
45	Speer	20.937	II	

RANK	NAME	FUNCTIONAL INDEX	GROUP	
46	Girvin	20.681	II	
47	Kenaston	20.007	II	
48	Allan	19.898	II	
49	Loreburn	19.636	II	
50	Maymont	19.528	II	
51	Hepburn	17.670	II	GROUP II
52	Yellow Creek	17.218	II	RANKS
53	Landis	17.185	II	
54	Colonsay	17.171	II	
55	Meacham	16.634	II	
56	Aberdeen	16.485	II	
57	Carlton	16.395	II	
58	Guernsey	16.366	II	
59	Bladworth	16.307	I	
60	Alvena	16.061	II	
61	Elstow	16.018	I	
62	Borden	15.955	I	
63	Vonda	15.680	I	
64	Macdowall	15.221	I	
65	Dundurn	14.923	III	
66	Marcelin	14.585	I	
67	Glenside	14.408	I	
68	Bradwell	14.115	I	
69	Krydor	13.339	I	
70	Tessier	13.283	I	
71	Arelee	12.720	I	
72	Alticane	12.118	I	
73	Herschel	11.243	I	
74	Asquith	11.236	I	
75	Warman	11.094	I	
76	Pilger	10.004	I	
77	Zealandia	9.513	I	
78	Crystal Springs	9.415	III	
79	Grandora	9.226	I	
80	Tichfield	8.697	I	
81	Macrorie	7.792	I	
82	Broderick	7.596	I	
83	Ossler	7.061	I	
84	St. Gregor	6.952	I	
85	Richard	6.927	I	
86	Tullis	6.449	I	
87	Soningdale	6.081	I	
88	Farrardale	5.480	I	
89	Kinley	3.475	I	

TABLE 5.8

CHANGE IN HIERARCHICAL CLASSIFICATION OF SERVICE CENTRES :

SASKATOON METROPOLITAN REGION 1951-1971

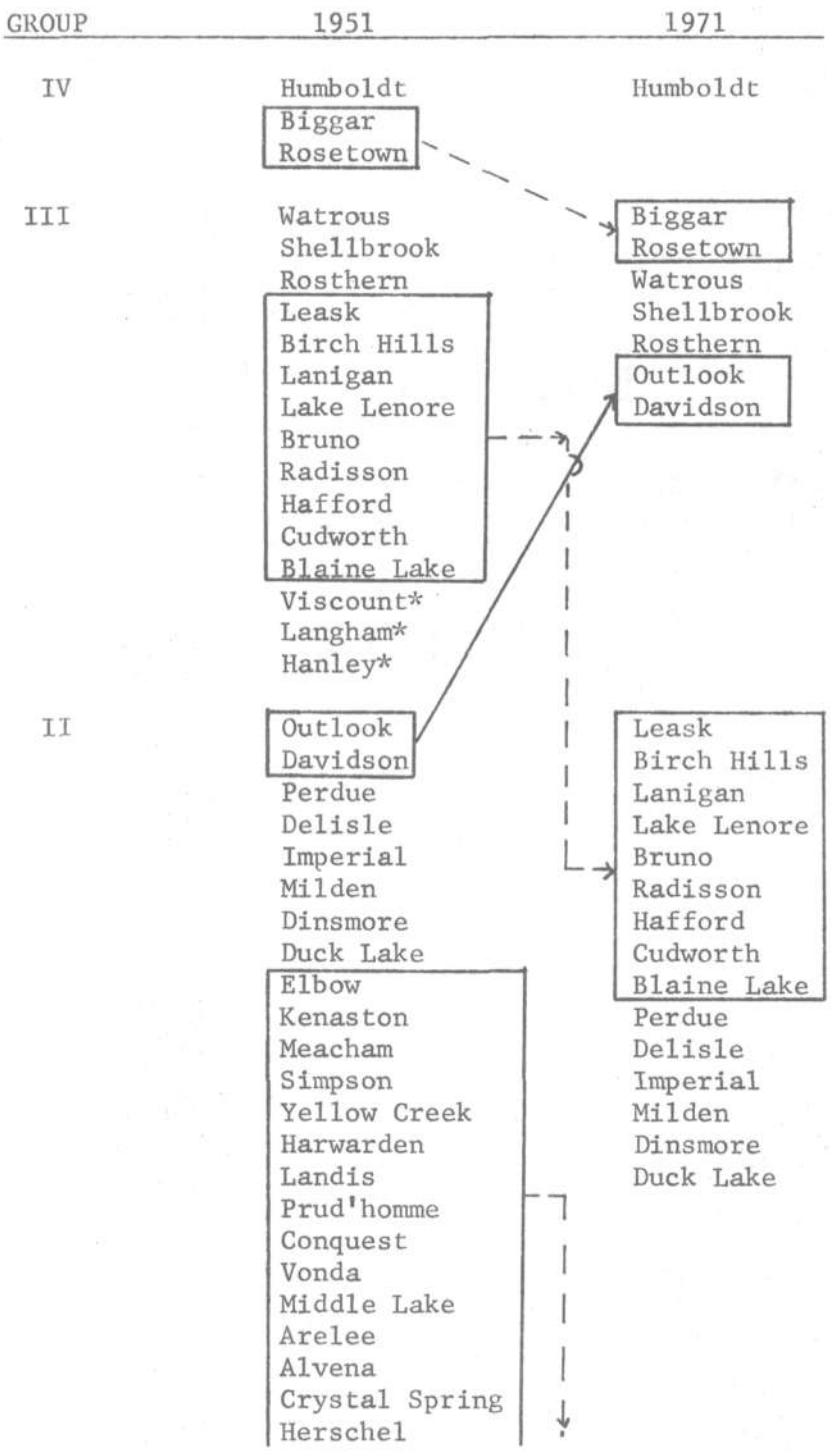


TABLE 5.8 cont'd

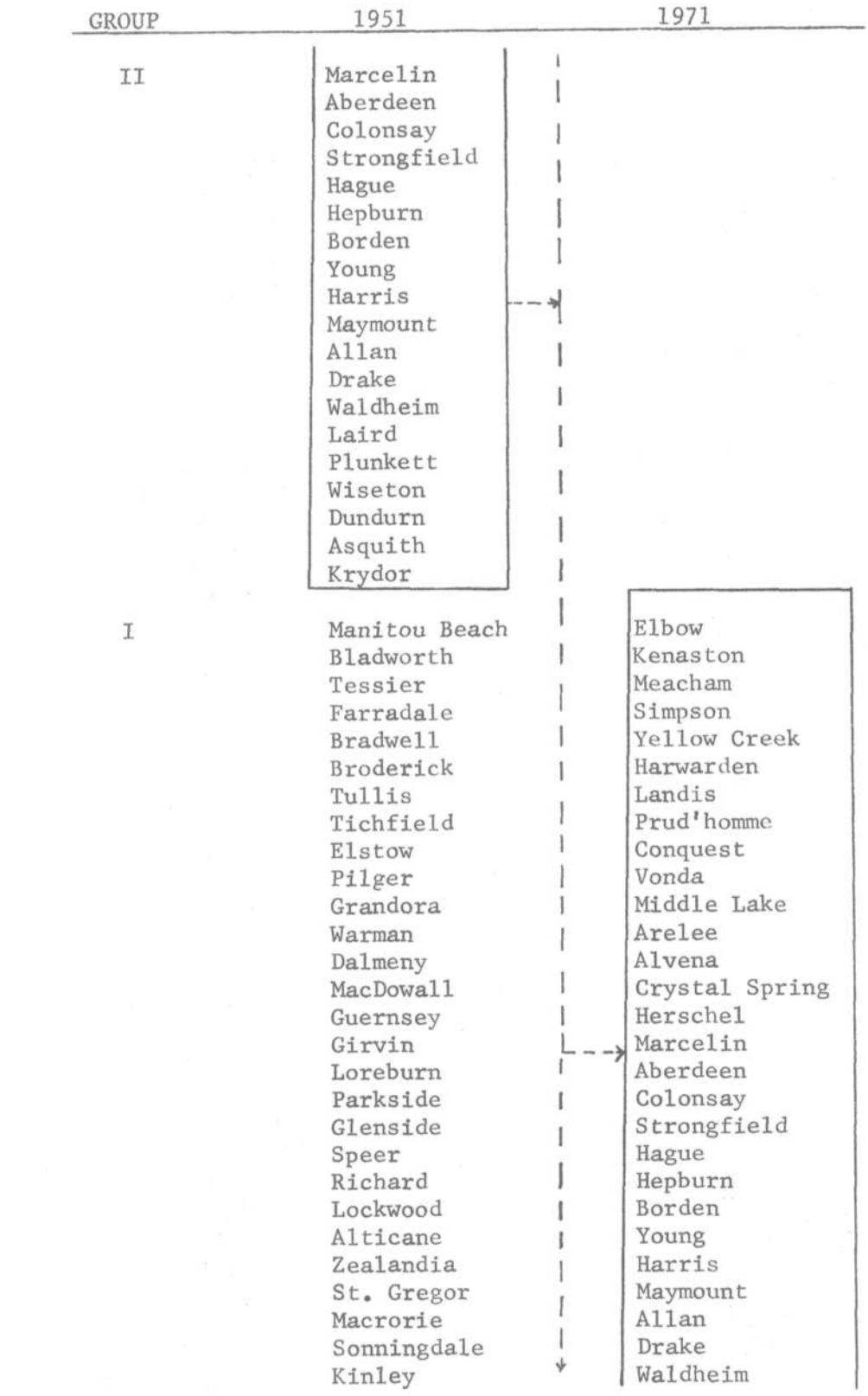


TABLE 5.8 cont'd

GROUP	1951	1971
I	Osler	Laird
	Carlton	Plunkett
		⇢ Wiseton
		Dundurn
		Asquith
		Krydor
		Viscount*
		Hanley*
		Langham*
		Manitou Beach
		Ruthilda
		Guernsey
		Elstow
		Tessier
		Alticane
		Grandora
		Cando
		Ruddell
		Parkside
		Zealandia
		Mt. Nebo
		Macrorie
		Dana
		St. Gregor
		Warman
		Pilger
		Bladworth
		Loreburn
		Dalmeny
		Speer
		Birsay

notes:

centres that have increased in status are indicated by a SOLID arrow, those that have declined are indicated by a BROKEN arrow:

⟵ increased in status

⇠ decreased in status

* declined by more than one group

CHANGE IN POPULATION LEVELS AND SPATIAL DISTRIBUTION OF SERVICE CENTRES 1951-1971

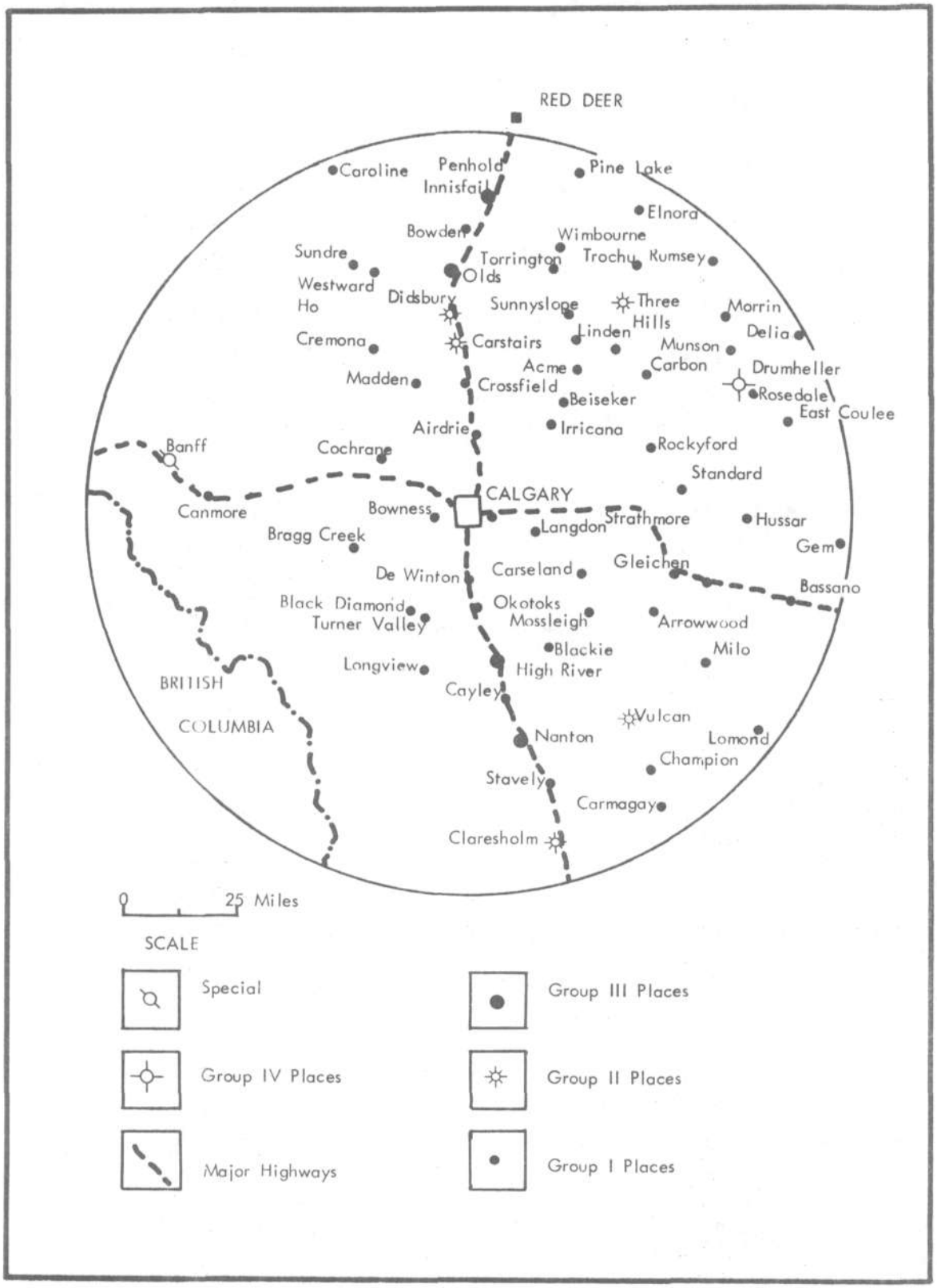
Calgary Region 1951-1971

Figure 5.3 shows the distribution of settlements around Calgary in 1951. Banff a resort town was situated 80 miles west of the city in the Banff National Park. The only group IV centre, Drumheller had a population of 2601 and was 82 miles east of Calgary in the coal mining area. In 1951, there were only three group III settlements, Olds, Innisfail and High River. They had a mean population of 1641, ranging from 1417 to 1889. All three were located in the high population density area, north and south of the city along Highway 2.

Similarly most of the group II settlements were found along this highway. Only two of the six were not in this group, and they were located in high population density pockets in the intermediary areas between the highways. Members of this group were separated by 30 miles from each. This was farther apart than the 21 mile average in 1971. The distance between them decreased because there were more group II settlements in 1971 than in 1951. This group had similar population ranges in both time periods, although there was a slight decline in population mean. In 1951, the range was 468 to 1608 and in 1971 it was 450 to 1604. The average population however declined from 1138 to 892 between 1951 and 1971.

In 1951, the fifty six group I settlements were situated throughout the area except for the forest land west of the city. They had a mean distance apart of 9 miles compared to 14 miles in 1971. The

FIG. 5.3 DISTRIBUTION OF TRADE CENTRES BY GROUPS IN THE HINTERLAND OF CALGARY 1951



increase in dispersion of group I centres is a result of the decline in numbers from fifty six in 1951 to forty three in 1971.

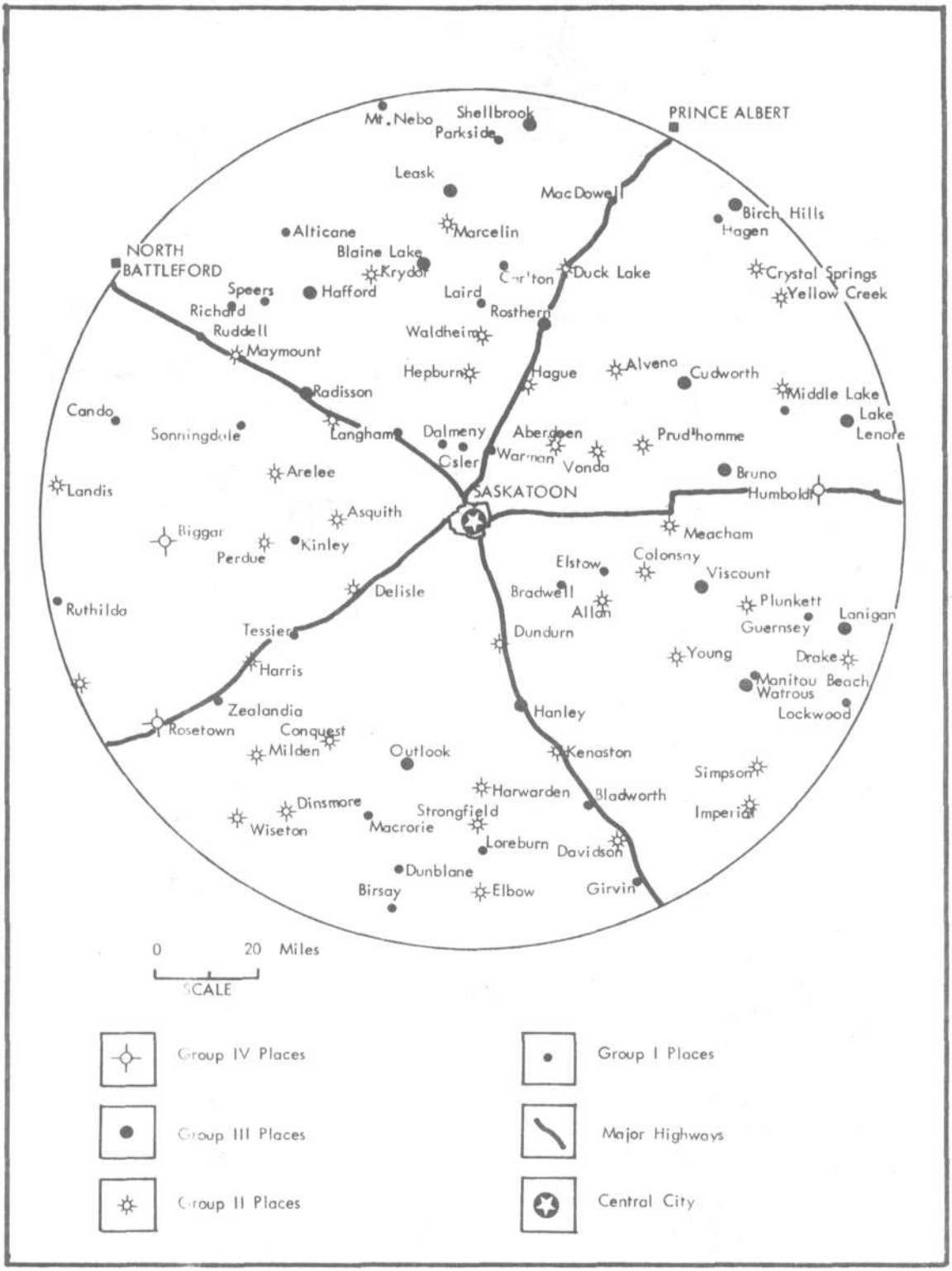
Saskatoon Region 1951-1971

Figure 5.4 shows the spatial distribution of settlements around Saskatoon in 1951. There were three group IV settlements in 1951, namely Humboldt, Biggar and Rosetown. These had a mean population of 2171 and were situated at distances of 60 to 65 miles from the central city. The latter two, located in low quality agricultural land in the south west part of the region, declined to group III status, leaving only one group IV settlement, Humboldt.

The fifteen 1951 group III settlements were concentrated in the density populated rich agricultural land north east of the city. Most of these declined. One settlement in the southern part of the area, and together with Biggar and Rosetown and the remaining group III centres gave rise to the ring of higher level centres situated 45 - 65 miles from Saskatoon in 1971. In 1951 group III settlements had a mean distance apart of 30 miles; this increased to 40 miles in 1971 due to decline of some of the centres, and their mean populations had slight decrease from 2171 to 1719 in 1971.

The decline from forty two centres in 1951 to only fifteen in 1971 gave rise to major changes in the spatial distribution of group II settlements. In 1951 they were found in all parts of the region, by 1971 all group II settlements within 40 miles of Saskatoon experienced decrease. The overall decrease in this group caused an increase in the mean distance apart of members from 15 miles in 1951 to 25 miles in 1971.

FIG. 5.4 DISTRIBUTION OF TRADE CENTRES BY GROUPS IN THE HINTERLAND OF SASKATOON 1951



The population average however increased from 272 to 622, indicating that most of the decrease occurred in settlements with initially low population base.

The net recipient of decline in economic status was group I. Membership to this group increased from 33 in 1951 to 57 in 1971. This caused a decrease in distance between them from 23 miles to 18 miles. Their mean populations also declined from 219 to 144 in the 1951 to 1971 period.

The overall change in spatial distribution around Saskatoon resulted in the absence of settlements in the immediate vicinity of the city. This confirms the results of a similar study by Hodge (1965) in which he found that there was a "zone of attrition" or total decline of centres up to 20 miles from the largest cities. The absence of many commercial centres within 40 miles of the city suggests that an increase in this zone might have occurred.

Conclusions on Change in Spatial Distribution of Service Centres

The changes in distribution of retail centres in the two areas shows that change has been associated with population densities. In areas which experienced population density increases, the settlements have also grown in status. As the hinterland of Calgary had population increases along the major highways and that of Saskatoon showed decreases it is not surprising that retail centres situated near highways in the hinterland of Calgary have grown and those around Saskatoon have declined. In addition the final distribution of higher order centres in the region around Calgary showed concentration in sectors along the highways while

in the hinterland of Saskatoon, the higher order centres were located at distances of 45 - 65 miles, forming a 'ring' with Saskatoon at the centre.

CHANGE IN FUNCTIONAL COMPOSITION OF HIERARCHICAL GROUPS

It has been shown in the previous section that there was an overall decline in the status of retail centres around Saskatoon from 1951 to 1971. At the same time the hinterland of Calgary experienced overall increases in the rank of its settlements. These changes have been shown to be related to population density changes in the respective areas. In this section it is proposed to deal with change in content of hierarchical groups in the two study areas from 1951 to 1971. These changes are then related to other trends in the regions and previous works on the subject. First, using the same approach as was used in 1971 the content of 1951 groups is analysed, then they are compared with the 1971 situation.

Calgary Region 1951

Group I places. The lowest group of the hierarchy was characterized by five types of retail establishments, as shown in Table 5.9. This group had fifty six retail centres.

TABLE 5.9

GROUP I FUNCTIONS: CALGARY 1951

GROUP	Establishment	Mean	Frequency (%)
I	1. General stores	1.70	94.6
	2. Eating places	1.63	82.1
	3. Gasoline service stations	1.39	74.8
	4. New and used cars	1.13	58.9
	5. Farm equipment dealers	1.09	58.9

Group II places. The six commercial centres in group II had a total of twenty establishments associated with them. These included fifteen additional types as well as the five performed by group I. Table 5.10 shows that the means and frequency of occurrences of group type of function is higher in group II, except for General Stores which declined because of competition from specialized outlets.

TABLE 5.10.

GROUP II FUNCTIONS: CALGARY 1951

GROUP	Establishments	Hier I M	Hier I cmF	Hier II M	Hier II cmF
I	1. General stores	1.70	94.6	0.50	50.0
	2. Eating places	1.63	82.1	4.17	100.0
	3. Gasoline service stations	1.39	74.8	1.50	100.0
	4. New and used cars	1.13	58.9	6.00	100.0
	5. Farm equipment dealers	1.09	58.9	2.00	100.0
II	6. Groceries with no meat	0.46	35.7	3.33	100.0
	7. Meat markets	0.66	53.6	2.17	100.0
	8. Hardware stores	0.73	53.6	2.00	100.0
	9. General automobile repair	0.91	60.7	2.00	100.0
	10. Lumber yards	0.68	60.7	1.83	100.0
	11. Drug stores	0.45	41.1	1.67	100.0
	12. Special trade contractors	0.27	19.6	1.50	83.3
	13. Bowling, pool & billiards	0.47	46.4	1.33	100.0
	14. Year round hotels	0.82	73.2	1.17	100.0
	15. Men's and boy's clothing	0.18	16.1	1.17	100.0
	16. Electrical repair	0.24	11.4	1.17	83.3
	17. Banks	0.34	33.9	1.00	100.0
	18. Repair shops (n.e.c.)	0.18	17.2	1.00	83.3
	19. Household appliances	0.18	17.9	1.00	83.3
	20. Shoe repair and cleaning	0.30	28.6	1.00	83.3

Group III places. Table 5.11 shows that only eight types of commercial establishments were added in group III. This brought the total number of functions characteristic of that level to twenty eight. As was expected, lower order establishments occurred more frequently at higher levels of hierarchy.

TABLE 5.11

GROUP III FUNCTIONS: CALGARY 1951

GROUP	Establishments	Hier I M	Hier I cmF	Hier II M	Hier II cmF	Hier III M	Hier III cmF
	1. General stores	1.70	94.6	0.50	50.0	5.00	100.0
	2. Eating places	1.63	82.1	4.17	100.0	5.00	100.0
I	3. Gasoline service stations	1.39	74.8	1.50	100.0	5.00	100.0
	4. New and used cars	1.13	58.9	6.00	100.0	7.00	100.0
	5. Farm equipment dealers	1.09	58.9	2.00	100.0	2.67	100.0
	6. Groceries with no meat	0.46	35.7	3.33	100.0	3.67	100.0
	7. Meat markets	0.66	53.6	2.17	100.0	2.00	100.0
	8. Hardware stores	0.73	53.6	2.00	100.0	3.00	100.0
	9. General automobile repair	0.91	60.7	2.00	100.0	2.67	100.0
	10. Lumber yards	0.68	60.7	1.83	100.0	2.67	100.0
	11. Drug stores	0.45	41.1	1.67	100.0	1.67	100.0
II	12. Special trade contractors	0.27	19.6	1.50	83.3	2.67	100.0
	13. Bowling, pool and billiards	0.47	46.4	1.33	100.0	2.00	100.0
	14. Year round hotels	0.82	16.1	1.17	100.0	2.00	100.0
	15. Men's and boy's clothing	0.18	16.1	1.17	83.3	1.33	100.0
	16. Electrical repair	0.24	11.4	1.17	83.3	1.67	100.0
	17. Banks	0.34	33.9	1.00	100.0	1.67	100.0
	18. Repair shops (n.e.c.)	0.18	17.2	1.00	83.3	0.67	66.7
	19. Household appliances	0.18	17.9	1.00	83.3	1.33	100.0
	20. Shoe repair and cleaning	0.30	28.6	1.00	83.3	1.00	100.0
	21. Blacksmiths	0.27	25.0	0.83	66.7	1.67	100.0
	22. Other retail stores	0.11	10.7	0.67	66.7	1.67	100.0
	23. Bulk petroleum supplies	0.38	30.4	0.17	16.7	1.67	66.7
III	24. Jewellery stores	0.02	7.8	0.83	83.3	1.33	100.0
	25. Funeral services	0.36	5.6	0.50	33.3	1.00	100.0
	26. Tire repair	0.04	5.6	0.33	33.3	1.00	100.0
	27. Auto body repair	0.04	5.6	0.17	16.7	1.00	66.7
	28. Cleaning and dyeing plants	0.02	7.8	0.33	33.3	1.00	66.7

Group IV places and hierarchical functions. The only group IV settlement in 1951 contributed twenty eight additional types of establishments. This brought the total number of retail outlets characteristic of this level of centre to forty nine. These together distinguish between the different levels of the hierarchy. Table 5.12 shows that there is an increase in the mean and frequency of occurrence of lower order outlets in the higher levels of the hierarchy. Each

TABLE 5.12

GROUP IV AND HIERARCHICAL FUNCTIONS FOR CALGARY 1951

GROUP	Establishment	HIER I		HIER II		HIER III		HIER IV	
		M	cmF	M	cmF	M	cmF	M	cmF
I	General Stores	1.70	94.6	0.50	50.0	5.00	100.0	2.00	100.0*
	Eating places	1.63	82.1	4.17	100.0	5.00	100.0	7.00	
	Gasoline service stations	1.39	74.8	1.50	100.0	5.00	100.0	7.00	
	New and used cars	1.13	58.9	6.00	100.0	7.00	100.0	8.00	
	Farm equipment dealers	1.09	58.9	2.00	100.0	2.67	100.0	3.00	
II	Groceries with no meat	0.46	35.7	3.33	100.0	3.67	100.0	9.00	
	Meat markets	0.66	53.6	2.17	100.0	2.00	100.0	2.00	
	Hardware stores	0.73	53.6	2.00	100.0	3.00	100.0	2.00	
	General automobile repair	0.91	6017	2.00	100.0	2.67	100.0	3.00	
	Lumber yards	0.68	60.7	1.83	100.0	2.67	100.0	3.00	
	Drug stores	0.45	41.1	1.67	100.0	1.67	100.0	2.00	
	Special trade contractors	0.27	19.6	1.50	83.3	2.67	100.0	4.00	
	Bowling,pool & billiards	0.47	46.4	1.33	100.0	2.00	100.0	1.00	
	Year round hotels	0.82	16.1	1.17	100.0	2.00	100.0	4.00	
	Men's and boy's clothing	0.18	16.1	1.17	100.0	2.00	100.0	6.00	
	Electrical repair	0.24	11.4	1.17	83.3	1.33	100.0	2.00	
	Banks	0.34	33.9	1.00	100.0	1.67	100.0	2.00	
	Repair shops (n.e.c.)	0.18	17.2	1.00	83.3	0.67	66.7	2.00	
	Household applicance	0.18	17.9	1.00	83.3	1.33	100.0	2.00	
	Shoe repair and cleaning	0.30	28.6	1.00	83.3	1.00	100.0	3.00	
III	Blacksmiths	0.27	25.0	0.83	66.7	1.67	100.0	-	
	Other retail stores	0.11	10.7	0.67	66.7	1.67	100.0	1.00	
	Bulk petroleum supplies	0.38	30.4	0.17	16.7	1.67	66.7	-	
	Jewlery stores	0.02	7.8	0.83	83.3	1.33	100.0	2.00	
	Funeral services	0.36	5.6	0.50	33.3	1.00	100.0	1.00	
	Tire Repair	0.04	5.6	0.33	33.3	1.00	100.0	2.00	
	Auto body repair	0.04	5.6	0.17	16.7	1.00	66.7	1.00	
	Cleaning and dyeing plants	0.02	7.8	0.33	33.3	1.00	66.7	1.00	
IV	Groceries with meat	0.32	26.8	0.33	33.3	-	-	5.00	
	Photographic studios	-	-	-	-	0.67	66.7	2.00	
	Furniture stores	-	-	0.50	50.0	0.67	66.7	2.00	
	Retail bakeries	0109	8.9	0.83	50.0	0.67	66.7	2.00	
	Other contractors	0.07	7.1	0.07	16.7	-	-	2.00	
	Machine shops	0.25	21.4	0.67	50.0	0.67	66.7	1.00	
	Watch,clock, and jewelry	0.07	7.1	-	-	0.67	66.7	1.00	
	Power launderies	0.04	1.8	0.17	16.7	0.67	66.7	1.00	
	Camps and seasonal accom.	0.07	5.4	0.33	16.7	0.33	33.3	1.00	
	Sporting goods	0.02	1.2	-	-	0.33	33.3	1.00	
	Family clothing store	0.07	5.4	-	-	-	-	2.00	
	Children and infants wear	-	-	-	-	0.33	33.3	1.00	
	Tire and batteries	0.04	5.4	-	-	-	-	1.00	
	Milk retailers	0.08	5.6	-	-	-	-	1.00	
	Candy stores	0.07	7.1	-	-	0.33	33.3	1.00	
	Metals and minerals	-	-	-	-	-	-	1.00	
	Amusement and sporting goods	-	-	-	-	-	-	1.00	
	Wholesale specialty foods	-	-	-	-	-	-	1.00	
	Wholesale groceries	-	-	-	-	-	-	1.00	
	Construction,heavy & highway	0.04	5.4	0.17	16.7	-	-	1.00	
	General building contractors	0.05	5.4	-	-	-	-	1.00	

* All frequencies 100.00%

higher group performs all lower functions and has a distinct set of its own. These results confirm the fact that the pattern in 1951 as that in 1971 describes a hierarchy of retail centres.

Non-hierarchical functions. Similar to 1971, there were some establishments in 1951 that were found in the region but were not part of the hierarchical structure. Table 5.13 shows that there were such establishments in the system in 1951. These functions occurred because of local idiosyncracies in establishment location. Most of them are found in group I, the lowest level of the system. In 1971 they were mainly wholesale outlets; in 1951 however they included establishments which possibly due to overall increase in demand for them, became part of hierarchical structure, for example wholesale dairy and poultry products.

TABLE 5.13.

NON-HIERARCHICAL FUNCTIONS: CALGARY 1951

	Establishments	Hier I M	Hier I Freq.	Hier II M	Hier II Freq.	Hier III M	Hier III Freq.	Hier IV M	Hier IV Freq.
1.	Wholesale paints and varnishes	0.02	1.8	-	-	-	-	-	-
2.	Wholesale dairy and poultry	0.02	1.8	-	-	-	-	-	-
3.	Other wholesale	0.05	5.4	-	-	0.33	33.3	-	-
4.	Branch retail groceries	-	-	0.17	16.7	-	-	-	-
5.	Machinery and equipment supply	-	-	-	-	-	-	-	-
6.	Assembler of farm products	0.02	1.8	-	-	0.33	33.3	-	-
7.	Used vehicles only	0.04	3.6	-	-	-	-	-	-
8.	Family shoe store	0.02	1.8	-	-	0.33	33.3	-	-
9.	Hobby and antiquities	0.05	3.6	0.17	16.7	-	-	-	-
10.	Hay, grain and feed stores	0.02	1.8	-	-	0.33	33.3	-	-
11.	Household Fuel dealers	0.05	5.4	0.17	16.7	-	-	-	-

Change in Functional Composition 1951 - 1971

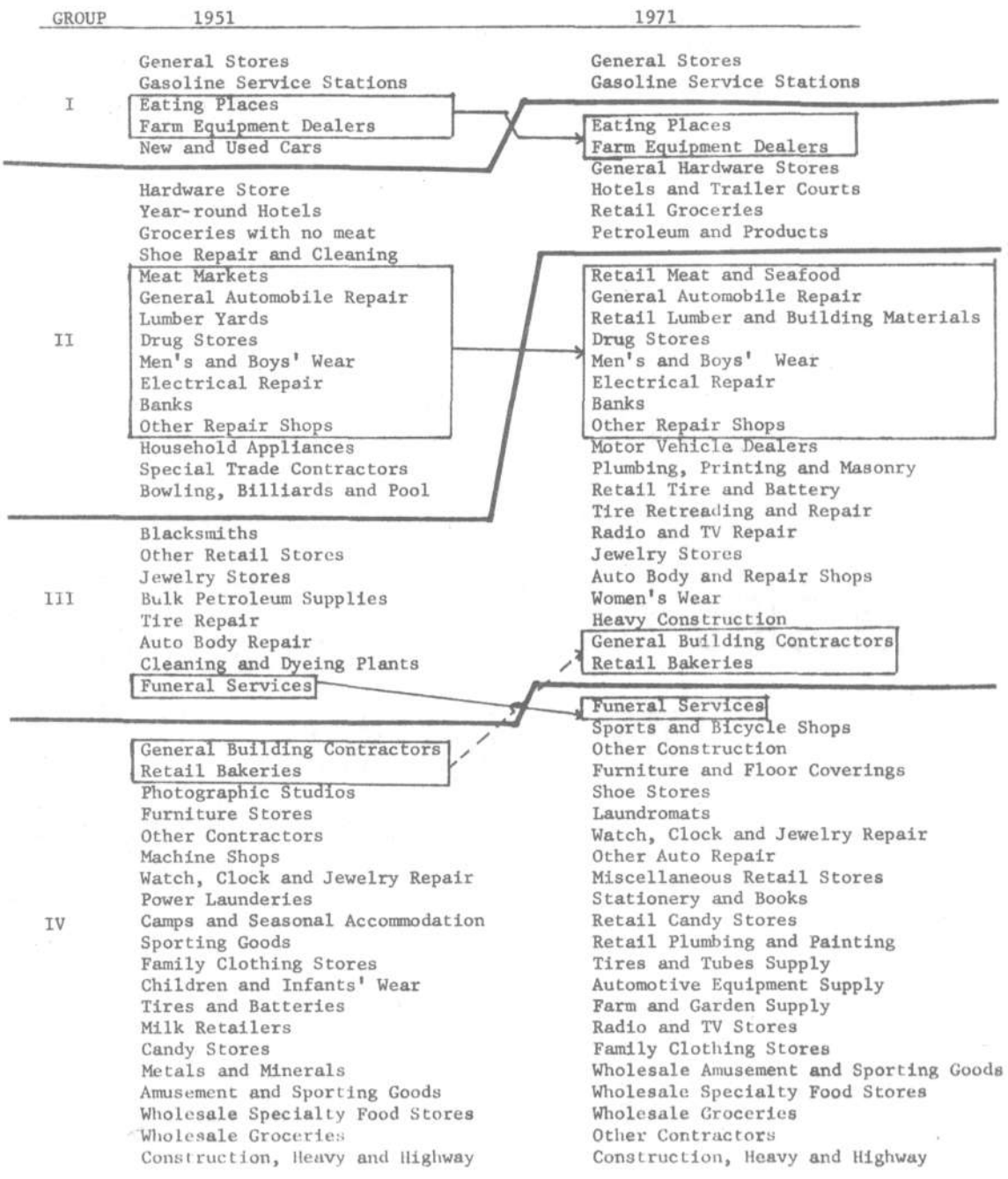
Hodge (1965) and Stabler and Williams (1972) have pointed out that there was a downward shift of functions over time due to the overall decline of centres into lower level places. But as Table 5.4 shows, this was not the case in the region around Calgary. While it was true that a few fourth level functions were in 1971 being performed at lower levels, it may be argued that this was in response to the growth in the income and population levels of the settlements rather than declining centres. The overwhelming trend was an upward shift in functions as has been indicated should happen by Berry (1960).

Table 5.14 shows that three of the five 1951 group I retail establishments namely, Eating Places, New and Used Cars, and Farm Equipment Dealers shifted to higher levels. Similarly thirteen group II and one group III establishments rose in level of occurrence. Only three types of functions, all in group IV, appeared earlier in the system. This upward shift in functions is similar to results found by Berry (1960). They affected only the composition of the lowest two levels of the hierarchy. The upper two groups did not experience an overall change in functional complexion.

This upward shift is paralleled by an upward shift in the status of settlements. As was already shown in section 5.2, Olds joined Drumheller in group IV, and four and twelve lower level settlements became members of groups III and II respectively. It is obvious that they brought into their new group their formerly lower level attributes.

TABLE 5.14

HIERARCHICAL FUNCTIONS : CALGARY REGION 1951 AND 1971



Saskatoon Region 1951

Group I places. The lowest of the four groups of settlements around Saskatoon in 1951 had thirty centres and was characterized by two types of retail establishments. (Table 5.15).

TABLE 5.15.

GROUP I FUNCTIONS: SASKATOON 1951

ENTRY GROUP	Establishments	Mean	Frequency (%)
I	1. General stores	1.77	93.3
	2. General automobile repair	1.23	86.7

Group II, III, IV and hierarchical functions. Table 5.16 shows that only two functions were added at the second level, and three in group III. These additions brought the total number of commercial establishments for the three lowest levels of the hierarchy to seven.

TABLE 5.16.

GROUP II AND III FUNCTIONS: SASKATOON 1951

GROUP	Establishments	Mean	Freq.	Mean	Freq.
I	1. General stores	2.77	100.0	2.22	100.0
	2. General automobile repair	2.31	100.0	1.33	100.0
II	3. Eating places	1.14	83.3	1.88	86.7
	4. Farm equipment dealers	1.83	76.2	2.53	100.0
III	5. Retail hardware	0.83	63.4	1.93	93.3
	6. Electrical repair	0.55	53.4	1.13	80.0
	7. Lumber yards	0.76	69.9	1.07	93.3

Most of the hierarchical establishments were found in group IV centres. Table 5.17 shows that fifteen retail outlets were added in group IV making the total characteristic of that level to twenty two. The table also shows that in spite of the few number of characteristic

functions at each respective level, higher groups had more of lower order function. These results are similar to those in 1971 and also Calgary region, bearing out Berry's (1958) point that in a hierarchical system higher groups should perform all lower group functions and have a distinct additional set of their own.

TABLE 5.17

GROUP IV AND HIERARCHICAL FUNCTIONS: SASKATOON 1951

GROUP	Establishment	HIER I		HIER II		HIER III		HIER IV	
		M	cmF	M	cmF	M	cmF	M	cmF
I	1 General Store	1.77	93.3	2.77	100.0	2.22	100.0	3.53	100.0
	2 General Automobile Repair	1.23	86.7	2.31	100.0	1.33	100.0	4.26	100.0
II	3 Eating places	0.33	33.3	1.14	83.3	1.88	86.7	3.66	100.0
	4 Farm equipment	0.37	26.7	1.33	76.2	2.53	100.0	4.67	100.0
III	5 Retail Hardware	0.37	3 30	0.83	63.4	1.93	93.3	2.00	100.0
	6 Electrical Repair	0.40	36.7	0.55	53.4	1.13	80.0	1.00	100.0
	7 Lumber Yards	0.23	23.3	0.76	69.0	1.07	93.3	2.00	100.0
IV	8 Drinking Places	0.03	3.3	0.26	26.2	0.80	80.0	2.67	100.0
	9 Year Round Hotels	0.50	46.7	0.86	83.3	0.93	86.7	2.00	100.0
	10 Retail Groceries(no meat)	0.27	26.7	0.36	33.3	0.53	46.7	2.00	100.0
	11 Plumbing & Heating Const.	0.03	3.3	0.02	2.4	-	-	1.67	100.0
	12 Bowling,Billiards & Pool	-	-	0.55	54.8	0.60	60.0	1.67	100.0
	13 Other Repairs (n.e.c.)	-	-	0.14	11.9	0.54	53.3	1.67	66.7
	14 Shoe Repair	0.07	6.7	0.21	21.4	0.60	53.3	1.67	100.0
	15 Banks	0.20	3.3	0.43	42.9	0.80	80.0	1.67	100.0
	16 Dry Cleaning	-	-	0.02	2.4	-	-	1.67	100.0
	17 Specialist Auto Repair	-	-	-	-	-	-	1.67	33.3
	18 Watch and Jewlery Repair	-	-	-	-	0.07	6.7	1.00	100.0
	19 Funeral Services	-	-	0.07	7.1	0.13	13.3	1.00	100.0
	20 Retail Bakeries	-	-	0.07	7.1	0.20	20.0	1.00	100.0
	21 Meat Markets	0.03	3.3	0.43	42.9	0.60	53.3	1.00	100.0
	22 Blacksmiths Shops	0.03	3.3	0.02	2.4	0.07	6.7	1.00	66.7

The remaining sixteen establishments were termed non-hierarchical. They did not attain a mean occurrence of 1.0 or more in any of the groups. They were therefore regarded as random in their location and not part of the overall system. Table 5.18 shows the identity and the distribution of these outlets. It is likely that these establishments were of the

type performed at the regional city level.

TABLE 5.18.

NON-HIERARCHICAL FUNCTIONS: SASKATOON REGION 1951

Establishments	Hier I		Hier II		Hier III		Hier IV	
	M	cmF	M	cmF	M	cmF	M	cmF
1. General building contractors	-	-	0.02	2.4	-	-	0.33	33.3
2. Heavy construction	-	-	-	-	-	-	0.33	33.3
3. Electrical,painting,roof const.	-	-	0.07	7.1	0.07	0.7	0.33	33.3
4. Wholesale groceries	-	-	-	-	0.20	20.0	0.33	33.3
5. Wholesale dairy & poultry prod.	0.07	6.7	0.05	4.8	0.20	20.0	0.33	33.3
6. Petroleum bulk stations	-	-	0.05	4.8	-	-	-	-
7. Building materials	0.03	3.3	0.14	14.3	-	-	-	-
8. Electrical & paper hanging	-	-	0.07	7.1	0.27	26.7	0.67	66.7
9. Retail groceries with meat	0.07	6.7	0.07	7.1	0.33	26.7	0.67	66.7
10. Candy,fruit & Veg. stores	0.07	6.7	0.07	7.1	0.20	20.0	0.33	33.3
11. Motor vehicle dealers	0.03	3.3	0.24	11.9	-	-	-	-
12. Gas stations,tires & batteries	0.50	26.7	0.24	21.4	0.60	40.0	0.67	33.3
13. Drug stores	-	-	0.05	4.8	0.13	12.3	-	-
14. Hay, grain & feed stores	0.07	6.7	0.05	4.8	0.13	13.3	0.33	33.3
15. Jewellery stores	-	-	0.02	2.4	0.20	20.0	0.67	33.3
16. Clothes repair shops	-	-	-	-	0.13	13.3	0.33	33.3

Change in functional composition 1951 - 1971. Table 5.19 shows that most of the change in content of the different hierarchical levels was not associated with shifts of functions within the system but with injection of new type of outlets. The total number of hierarchical functions rose from twenty two in 1951 to forty nine in 1971. However, it is also shown that amongst the retail establishments that occurred in 1951, the general trend was a decline. Group one places replaced general automobile repairs with gasoline service stations, a non-hierarchical outlet in 1951. Six members of group III and IV functions declined to lower level types. A net gain in functional composition was experienced by lowest and highest groups. This confirms Stabler and Williams (1972) point that the middle levels of the hierarchy were

TABLE 5.19

CHANGE IN HIERARCHICAL LEVELS OF ESTABLISHMENTS:

SASKATOON REGION 1951-1971

GROUP	SASKATOON REGION 1951	SASKATOON REGION 1971
I	General Stores	General Stores
	General Automobile Repair	Gasoline Service Stations *
II	Farm Equipment Dealers	Farm Equipment Dealers
	Eating Places	Eating Places
		Hardware Stores
		Lumber and Building Materials
		→ Retail Groceries
		→ Banks
		Petroleum and Petroleum Products*
III	Hardware Stores	→ Hotels and Tourist Courts
	Lumber Yards	→ Dry Cleaning
	Electrical Repair	Automobile Sales Dealers*
		Drug Stores*
IV	Retail Groceries →	General Construction*
	Banks →	Jewelry Stores*
	Year Round Hotels →	Electrical Construction
	Dry Cleaning →	Plumbing and Heating Construction
	Drinking Places	
	Plumbing and Road Construction	Shoe Stores
	Bowling, Billiards and Pool	Paint, Plumbing and Electrical
	Other Repair	Billiards, Pool, and Bowling
	Shoe Repair	Furniture Repair
	Specialist Auto Repair	Retail Bakeries
	Watch and Jewelry Repair	Tire Retreading and Repair
	Funeral Services	Retail Bakeries
	Retail Bakeries	Meat and Seafood
	Meat Markets	Radio and TV Repair *
	Blacksmith Shops	Car Wash*
		Auto Top and Body Repair*
		Furniture Store*
		Family Clothing Stores *
		Women's Clothing and Accessories*
		Tire and Battery Dealers*
		Carpentering*
		Heavy Construction except Streets*
		Automotive Equipment*
		Welding Repair*
		Florists*
		Farm, Hay and Garden Supply*
		Radio and TV Stores*
		Men's and Boys' Clothing *

→ upward shift

--→ downward shift

* hierarchical fuctions added in 1971

experiencing net decline and the lowest and highest gain. In the hinterland of Saskatoon, the downward shift of functions is paralleled by an overall decline in the importance of retail centres.

CHANGE AROUND CALGARY AND SASKATOON: A COMPARISON

It has been suggested by Brown (1970), Berry (1971) and Pahl (1965) that in a growth pole situation change is going to be greater immediately around the metropolitan centre. The nature of the change will however depend on whether "polarization" effects or "spilling off" of retail and commercial importance has occurred in the metropolitan hinterlands. Where "polarization" effects have occurred there will be decline in the commercial importance of centres around the central city. If spilling off effects have taken place, these centres should show in a before and after study an increase in their functional complexity.

In central place context, it is expected that if changes have occurred, they should be in the spatial organization of settlements and their content. Hodge (1965) and Stabler and Williams (1972) have shown that on the Canadian prairies, the predominant trend has been that of decline. The centres on both ends of the hierarchy have gained in numbers at the expense of those in the middle.

In the analysis of change around Calgary and Saskatoon, it has been found that the two regions have shown contrary growth patterns. In the hinterland of Calgary settlements have increased in retail and commercial importance especially those sited along the major routeways. The three settlements nearest the city, namely Okotoks, Cochrane and Airdrie have grown in importance, although their functional complexity

is lower than that of other settlements of comparable population. It may be said that some "spill overs" have occurred in the period 1951 to 1971 but it is not possible without going into a detailed study of process to provide conclusive evidence of this. The growth of settlements along high population and highway corridors has given rise to a Löschian pattern with the city rich sectors along the highways going through high population densities and "city-poor" sectors in the intermediary areas.

In the hinterland of Saskatoon, the general pattern of change was decline. Settlements especially those belonging to group III and IV were shown to have suffered the greatest amount of decline. The decline of settlements from higher to lower levels of the hierarchy resulted in the increase in functional complexity of lower order settlements. However some of the change could have been as a result of the increase in the total number of retail and commercial establishments found in the region. These findings are comparable to those of Stabler and Williams (1972) and Hodge (1965) who also found similar declining tendencies with accompanying changes in functional composition of settlement hierarchies.

The analysis also showed that the settlements immediately around Saskatoon declined to the lowest level of the hierarchy. The higher order of settlements no longer concentrated in the north eastern area of the hinterland but were found to form a ring at 45 to 65 miles from the central city. There was no concentration into sectors comparable to that found around Calgary.

It has also been shown that the contrary population and status trends in retail centres had been paralleled by similar opposing shifts in the commercial content of the settlements. Around Calgary, it was found that there was an upward movement of functions, resulting in a net loss of the composition of group I settlements. In the hinterland of Saskatoon, most of the change seemed to have been associated with non-hierarchical and new types of establishments becoming part of the commercial content of the retail centres. Most of these gains occurred in group IV. Among the 1951 functions, the general trend was decline, mostly from group III thereby increasing the composition of group II places. Many suggestions may be put forward to account for these contrary trends. The most obvious is the different economic structure of the two provinces in which the study areas are situated. Although both started as agricultural provinces, Alberta has since added extensive economic base in the form of oil and gas industry. With the decline in agriculture as the dominant sector of the prairie economy, it is to be expected that areas without additional resources are going to experience losses in population and retail importance. It is not possible in the context of a descriptive 'before and after' analysis such as this one, to verify these assertions. A process oriented study will have to be performed as an addition to the empirical framework outline here.

CHAPTER VI

SUMMARY AND CONCLUSIONS

This chapter provides a brief review of the study and is composed of two sections. The first section summarizes the procedures and results of the analyses, the second suggest guidelines for future research.

THE STUDY: PROCEDURES AND RESULTS

Procedures

The main objective of this study was to empirically identify the existence of hierarchies in metropolitan hinterlands of Calgary and Saskatoon and examine the changes that have taken place within them between 1951 and 1971. The study was not concerned with the detailed analysis of behavioural processes of change; instead a 'before and after' study of the population size and commercial composition of the settlements was adopted.

The central objective was studied relative to six general assumptions:

(i) centres in metropolitan hinterlands are organized into hierarchical groups.

(ii) settlements nearer metropolitan centres should experience greater change in population.

(iii) settlements nearer the central city should also experience greater change in commercial and retail importance.

(iv) change and commercial importance should be concentrated into sectors radiating from the central city.

(v) there should be an upward shift of functions through time.

(vi) if centres have experienced decline, the average distance separating members of the same hierarchical group should increase.

Since hierarchical groups were central to the problem it was important that an adequate method of classification be used for grouping. Criticisms of alternative methods formed the basis of Chapter II and eventually it was decided to apply Cluster Analysis using Ward's (1963) hierarchical grouping algorithm. In this technique, the errors of sums of squares are used to form groups on the basis of minimum loss of information. While natural groups are being formed, there is little "loss of information". After this stage, the loss increases creating the "gaps" in the fusion summary. These provided the basis for "cut-off" points used in deriving optimal groups from the analysis.

In order to find out if the groups were distinctive, the results were tested using Step-wise Discriminant Analysis. Because of the computation of within-group statistics needed for the analysis, only retail and commercial establishments occurring in all the groups could be used. The results were therefore accepted as partial confirmation of the distinctiveness of the clusters. The tested cluster analysis results were then compared with ranked functional indices as a preliminary measure of the hierarchical nature of the groups.

After establishing the existence of groups, their content was examined using Christaller's (1933) and Berry's (1958) ideas about

central place hierarchies, namely, that higher level places should contain all the functions of the lower groups as well as additional types of their own. The content study was accomplished by the use of means and frequencies of occurrence of the hierarchical functions in the study areas in 1951 and 1971. The results of both the membership and content of the groups were then compared and the changes identified.

Summary of Results

1. The study of population change showed that rural population was greater near the central city. The two study areas however experienced contrary trends. The hinterland of Calgary experienced overall decline, although growth occurred along the major highways. This gave rise to sectoral distribution similar to the Lösch's empirically derived pattern. Around Saskatoon, rural population declined, but it was not associated with sectors. Most of it occurred in the north eastern part of the study area. This area is predominantly agricultural. This area has been described by Christiansen (1970) as having moderate agricultural potential as compared to severe limitations or unimprovable land in the rest of the study area.

2. The application of Cluster Analysis to the retail and commercial data showed that the service centres around Calgary and Saskatoon are organized into five and four hierarchical groups respectively. As one of the groups around Calgary was made up of the resort settlement of Banff, the two studies were very similar in structure. However the content of each level in the hierarchy did vary with more types of retail and commercial establishments found in the Calgary example.

3. Over time, it was found that the settlements around Calgary increased in status and functional complexity, while those in the hinterland of Saskatoon declined, with the result that around Calgary, the basic change was an upward shift of functions similar to that described by Berry (1958, 1960), while in Saskatoon region the decline in settlement status was paralleled by a downward shift of functions, most of it occurring in group II and III, similar to findings of Stabler and Williams (1972).

4. Service centres around Calgary increased in status causing a decrease in the mean distance separating members of higher order settlement. Around Saskatoon, the opposite trend occurred. Centres lost in status, causing distances between higher order centres to increase.

5. Change in status of retail centres resulted in higher orders of settlements being concentrated in sectors along the highways leading out of Calgary, suggesting the development of Löschian 'city rich' and 'city poor' sectors. There was no parallel development around Saskatoon, instead a ring of higher order service centres were found at mean distances of fifty miles from the central city.

6. The growth in status and population of Airdrie, Okotoks and Cochrane suggest that spill offs might have occurred around Calgary. Around Saskatoon the absence of any higher order settlements immediately around it suggests that polarization might have taken place. However a more process oriented study would be needed to verify such trends.

GUIDELINES TO FUTURE RESEARCH

In the context of a "before and after" study, the intermediary processes that combined to produce the resulting pattern and composition were beyond the scope of this dissertation. Consequently, it was not possible to arrive at a definite conclusion about why or how the changes have occurred. Hence the study should be viewed as being the preliminary to a detailed study of the process of change.

Contrary trends have been found to have occurred in the two study areas. It may be argued that a threshold effect as suggested by Alonso (1968) and Doshi (1971) has occurred. To be able to answer this it will be necessary to study the diffusion of commercial and retail establishments in the region. However what evidence there is, suggests that this is not a likely explanation except for the towns of Airdrie, Cochrane and Okotoks. A more appropriate explanation is that these are primarily related to rural population changes in the areas and are not directly influenced by the central city. This too will involve the analysis of economic data of a broader scope than retail and commercial establishments in the metropolitan hinterlands, and the central city.

Finally it is hoped that the descriptive analysis reported here will provide some illumination into the structure of urban systems on the Canadian prairies as a whole and provide a background to a more process oriented study aimed at isolating the causative factors responsible for the changes in the system.

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APPENDIX

APPENDIX A

CHOICE OF FUNCTIONS

Using the code for all retail and commercial establishments according to Dun and Bradstreet the number and type occurring in each of the study regions was obtained. Apart from the wholesale types, only establishments with greater than two outlets in the study area were used. In the Calgary region 1951 the sorting resulted in sixty-two types of commercial establishments that we have shown in Table A-1.

TABLE A-1: TYPES OF RETAIL AND COMMERCIAL ESTABLISHMENTS IN CALGARY REGION 1951

1. General building contractors
2. Heavy construction
3. Special trades contractors
4. Other contractors
5. Paints and varnishes (wholesale)
6. Wholesale groceries
7. Wholesale specialty foods
8. Wholesale dairy and poultry products
9. Amusement and sporting goods (wholesale)
10. Other wholesale
11. Branch retail groceries
12. Metals and minerals
13. Machinery and equipment supply
14. Bulk petroleum supplies
15. Assemblers of farm products
16. Lumber yards
17. Electrical supplies
18. Hardware stores other than electrical
19. Farm equipment dealers
20. General stores
21. Groceries with no meat
22. Groceries with meat
23. Meat markets
24. Confectionery and candy stores
25. Milk retailers
26. Manufacturing retail bakeries
27. New and used cars

28. Used vehicles dealers only
29. Tire and batteries
30. Gasoline service stations
31. Men's and boy's clothing
32. Children and infants clothing
33. Family clothing stores
34. Family shoe stores
35. Furniture stores
36. Household appliances
37. Eating places
38. Drug stores
39. Hobby and antiquities
40. Sporting goods
41. Other retail establishments
42. Hay, grain and feed stores
43. Jewellery stores
44. Household fuel dealers
45. Other specialized retail establishments
46. Banks
47. Year round hotel
48. Camps and seasonal accommodation
49. Power launderies
50. Cleaning and dyeing plants
51. Photographic studios
52. Shoe repair
53. Funeral parlours
54. Automobile body repair shops
55. Tire repair shops
56. General automobile repair
57. Blacksmith shops
58. Electrical repair shops
59. Watch/clock and jewellery repair shops
60. Other repair shops
61. Machine shops
62. Bowling/Pool and Billiard Hall.

Using the same methodology sixty-eight functions were obtained for Calgary 1971 as shown in Table A-2.

TABLE A-2: RETAIL AND COMMERCIAL ESTABLISHMENTS FOR CALGARY 1971

1. General building contractors
2. Heavy construction
3. Plumbing, painting and masonry
4. Electrical works
5. Carpentry, floor laying and roofing
6. Other construction
7. Wholesale automobile sales
8. Automotive equipment
9. Tires and tubes
10. Chemicals and allied products
11. Wholesale groceries
12. Wholesale electrical apparatus
13. Farm equipment and machinery
14. Professional equipment and supplies
15. Petroleum and petroleum products
16. Lumber and construction materials
17. Other wholesale
18. Lumber and general building
19. Retail plumbing and paint shops
20. Electrical supplies
21. General hardware stores
22. Farm equipment dealers
23. Vending machines
24. General stores
25. Grocery stores
26. Meat and sea foods
27. Candy stores
28. Retail bakeries
29. Motor vehicle dealers
30. Tire, batteries and accessories
31. Gasoline service stations
32. Men's and boy's wear
33. Women's clothing stores
34. Children and infants wear
35. Family clothing stores
36. Shoe stores
37. Furniture and floor coverings
38. Household appliances
39. Radio and TV stores
40. Eating places
41. Drinking places
42. Drug stores
43. Stationery and books

44. Sports and cycle shops
45. Farm and garden supply
46. Jewellery stores
47. Liquified gas stores
48. Florists
49. Camera and photographic equipment
50. Gift and souvenir shops
51. Miscellaneous retail stores
52. Banks
53. Hotels and trailer courts
54. Laundromats
55. Photographic studios
56. Funeral services
57. Business services
58. Automobile rentals
59. Automobile body repair
60. Tire retreading and repair
61. General automobile repair
62. Other automobile repair
63. Radio and TV repair shops
64. Watch, clock and jewellery repair
65. Furniture repair
66. Welding repair
67. Other repair
68. Billiards and Pool Halls

The total number of functions increased from sixty-two to sixty-eight. Twelve retail establishments dropped from significant occurrence. These are:

1. Metals and minerals
2. Groceries with no meat
3. Groceries with meat
4. Household fuel dealers
5. Camps and seasonal accommodation
6. Hobby and antiquities
7. Cleaning and dyeing plants
8. Shoe repair shops
9. Blacksmith shops
10. Electrical repair shops
11. Machine shops
12. Assemblers of farm products.

At the same time, eighteen new types of establishments started occurring in the region, namely,

1. Electrical works
2. Wholesale automobile sales
3. Automotive equipment
4. Tires and tubes
5. Chemicals and allied products
6. Wholesale electrical repair
7. Wholesale farm equipment and machinery
8. Professional equipment and supplies (wholesale)
9. Wholesale petroleum and petroleum products
10. Wholesale lumber and construction materials
11. Vending machines
12. Radio and TV stores
13. Stationery and books
14. Camera and photographic equipment
15. Florists
16. Gift and souvenir shops
17. Business services
18. Furniture repair

Nine of these new establishments are wholesale, possibly due to increase in consumer demand in the non-metropolitan areas. Besides the new wholesale outlets, others are specialized services handling one main commodity, for example radio and TV stores and florists.

The application of minimum number criteria on retail data for Saskatoon region gave thirty-nine retail and commercial establishments in 1951 and fifty-one in 1971. Table A-3 and A-4 show the functions for 1951 and 1971 respectively.

TABLE A-3: RETAIL AND COMMERCIAL ESTABLISHMENTS IN SASKATOON REGION 1951

1. Heavy building contractors
2. Heavy construction including street construction
3. Plumbing and heating
4. Electrical, heating and sheet metal construction
5. Wholesale groceries
6. Wholesale dairy and poultry products
7. Bulk petroleum stations

8. Lumber yards
9. Building materials
10. Electrical, painting and paper hanging
11. Hardware stores
12. Farm equipment dealers
13. General stores
14. Retail groceries with no meat
15. Retail groceries with meat
16. Meat markets
17. Candy, fruit and vegetables
18. Retail bakeries
19. Motor vehicle dealers
20. Gasoline station, tire and battery dealers
21. Eating places
22. Drug stores
23. Drinking places
24. Hay, grain and feed stores
25. Jewellery stores
26. Fuel, excluding fuel oils
27. Banks
28. Year round hotels
29. Dry cleaning
30. Shoe repair stores
31. Funeral services
32. Clothes repair shops
33. Specialist automobile repair
34. General automobile repair
35. Electrical repair
36. Blacksmith shops
37. Watch and Jewellery repair
38. Other repair
39. Bowling, billiards and pool halls

TABLE A-4: RETAIL AND COMMERCIAL ESTABLISHMENTS SASKATOON 1971

1. General contractors
2. Street construction
3. Heavy construction
4. Plumbing and heating
5. Painting and paper hanging
6. Electrical work
7. Carpentry
8. Roofing and sheet metal work
9. Waterwell drilling
10. Excavation and foundation laying
11. Special trade contractors
12. Wholesale automotive equipment
13. Petroleum and petroleum products
14. Lumber and building materials

15. Paint, plumbing and electrical supply
16. Hardware stores
17. Farm equipment dealers
18. Department stores
19. General stores
20. Grocery stores
21. Meat and sea food
22. Candy stores
23. Retail bakeries
24. Automobile dealers
25. Gasoline service stations
26. Tire and battery dealers
27. Men's and boy's clothing
28. Women's clothing and accessories
29. Family clothing stores
30. Shoe stores
31. Furniture stores
32. Household appliance stores
33. Radio and TV stores
34. Eating places
35. Drug stores
36. Books and stationery stores
37. Farm, hay, grain and garden supply
38. Jewellery stores
39. Florists and gift shops
40. banks
41. Hotels and tourist courts
42. Dry cleaning
43. Funeral services
44. Automotive and body repair
45. Tire retreading and general repair
46. Car wash
47. Radio and TV stores
48. Furniture repair
49. Welding repair
50. Other repair
51. Billiards, pool and bowling halls

Eight types of establishments dropped from the occurrence 1951-1971, these are,

1. Wholesale groceries
2. Wholesale dairy and poultry products
3. Retail groceries with no meat
4. Retail groceries with meat
5. Fuel excluding fuel oils
6. Shoe repair stores
7. Clothes repair
8. Electrical repair

At the same time twenty new functions appeared in the system, namely

1. Street construction
2. Carpentering
3. Waterwell drilling
4. Excavation and foundation laying
5. Special trade contractors
6. Automotive equipment
7. Department stores
8. Tire and battery dealers
9. Men's and boy's clothing stores
10. Women's clothing and accessories
11. Family clothing stores
12. Shoe stores
13. Furniture stores
14. Household appliance stores
15. Radio and TV stores
16. Books and stationery stores
17. Florist and gift shops
18. Car wash
19. Radio and TV repairs
20. Furniture repair