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FIELD STORAGE

THE SPATIAL DISTRIBUTION OF INTELLIGENCE AROUND

A HAMILTON INTERMEDIATE SCHOOL

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ABSTRACT

The study sought to investigate the spatial distribution of children's intelligence as it occurred around a single intermediate school. This objective was initially intended to be of an exploratory nature, but was subsequently developed as an alternative methodology for the inadequate studies undertaken by earlier researchers. Two problems were defined for investigation - identification of intelligence regions, and explanation of their occurrence. In solving both problems, deficiencies were revealed in techniques available. The major conclusion from the study is that previous research has made false assumptions about the scale at which intelligence is distributed throughout an urban neighbourhood. This conclusion is worthy of further investigation by more sophisticated analytical techniques than those used in the present study.

'There is general agreement that the problems of geography arise out of those every-day real life situations that involve areal differences in the occurrence or intensity of specific phenomena. While it is worth noting that our interest lies primarily in the phenomena themselves, it is equally evident that the study of geography arises because there are differences; and the adequacy of techniques used to define these situations depends largely on their capacity to identify and measure those differences' (McCarty et al., 1956, p.1).

The traditional geographical approach to regional delimitation has involved a simple visual comparison of mapped distributions. Consequently the resulting analysis has depended largely upon the subjective judgement of the individual investigator, and obviously analysis which is based on simple evaluations of the similarities revealed on successive maps or on the degree of overlap present in two distributions is subject to over-generalisation. Timms (1965, p.240) warns that subjective judgement such as this may produce comparisons which are unreal and which may ignore 'awkward' relationships. As a result, there has been a need for devices which can quantitatively provide formally - satisfactory tests of distributional hypotheses, to describe the general features of areal patterns, and to measure the areal associations between distributed phenomena.

The purpose of the present paper is two-fold: to identify a geographic distribution as it appears on the

earth's surface, and to describe the degree of association between this distribution and a variety of geographic phenomena. Need for the study arises from the fact that previous attempts at identifying and describing the particular distribution under study have largely neglected precise and objective measurement and statement.

In the present study, problems were recognised as appearing in the areal distribution of levels of intelligence. Hypotheses purporting to identify regularities and irregularities in the distribution of intelligence levels, and to offer explanations for these phenomena were drawn from a variety of sources, mainly research studies which have explored the relationship between environment and intelligence. These hypotheses were then tested in a real-life situation, and conclusions were drawn as to their validity.

II THE GEOGRAPHICAL DISTRIBUTION OF

INTELLIGENCE:

A SURVEY OF RESEARCH

The application of the techniques of geographical analysis to intelligence-test scores, together with the establishment of accordant relationships between the resultant patterns and other geographical phenomena represents a neglected, yet promising field of research for the geographer. Although there exists a considerable amount of research on rural-urban differentials, selective migration, and on trends in national intelligence, much of this has been executed by sociologists and psychologists - with the result that the concept of a 'geographical problem' has largely been ignored. Scott (1957 a, p.41) has summed up the situation in one of the few contributions. In his introduction he refers specifically to literature in this field.

'Geographically, therefore, the literature is at best of limited value and at worst invalid. This well-nigh universal lack of appraisal of the spatial factor may well have helped to delay solution of the vexed problems of selectivity and national trend. Even those papers purporting to assess regional differences in intelligence fall short of geographical requirement'.

In light of this criticism, a survey of previous studies which have claimed a geographical distribution of intelligence, is necessary. In this task, the present writer has been assisted by Scott's (1957 b)

survey of pertinent literature.

Scott's major criticism of early attempts aimed at expressing areal differentiation in intelligence refers to the methodology employed by the majority of researchers. For Scott, the 'geographical distribution of intelligence' is the cartographic portrayal of intelligence data plotted by the smallest localities for which the data is available - not the arbitrary delimitation of areas which the writers considered to be geographically distinctive. Consequently, it is not altogether surprising that one of the early attempts in this field made by Duff and Thomson (1923) should be judged by Scott as being 'geographically inadmissible', Duff and Thomson calculated the percentage of children aged 11 and 12 years with I.Q.s greater than 99 for four major districts of Northumberland : Tyneside, the sea coast, the coalfield, and the remainder of the county. Their results, illustrated by a simple table portraying the percentage of cases over I.Q. of 99, and the frequency of classes A+ and A for each of the four districts, suggested that the residential suburbs of the Tyneside district contained a greater percentage of high ability children than did the coalfield. Furthermore, when the children were divided into two groups according to whether their parents' occupation included 'brain-work' or 'hand-work', the differences in the average I.Q. scores

for each group (8 points) led Duff and Thomson to conclude that the superiority of the residential suburbs was due to selection, by the operation of the social ladder, from the surrounding districts. The latter conclusion supported a tentative hypothesis made in 1921 by one of the researchers, that :

'The distribution of intelligence suggested by the tests is such that the highest ability appears to be found close to the cities and far away from the cities, the intermediate areas having fewer cases of high ability, as though they were drained by selection'.

Despite Scott's criticism of the above pioneer research, (to which a further criticism may be added, namely the complete absence of mapwork in what is claimed to be a geographical study), this study introduced a field for geographical research containing concepts and problems which have contributed to a better understanding of the location of social groups and social characteristics.

Selective Migration

The suggestion, as proposed by Duff and Thomson, that the geographical distribution of intelligence is related to socio-economic forces, is claimed by Greenhalgh (1949, p. 11), to contain several underlying assumptions : first, that a materialistic society is one of considerable mobility, so that population is able to flow from less attractive localities to more promising ones. A second assumption is that because there is an apparent degree

of inheritance of ability, those people with an insight into, and sensitivity for opportunity tend to produce a greater proportion of more able children than do their less successful counterparts. The third assumption is that areas of promise have a higher proportion of able children than do depressed areas. The movement inherent in these three assumptions has been referred to subsequently as either 'selective migration' or 'talent erosion' (Greenhalgh, 1948, 1949), and the last-named has conducted research which has supported the hypothesis that rural-urban migration tends to be disproportionately selective of those with higher test intelligence. In his study, Greenhalgh (1949), examined the geographical distribution of intelligence in the Armidale district of New South Wales using as his raw material, the test scores of 2,150 sixth-class children in the years 1938-1941.

His study attempted to show that,

'in our world of mobile populations moving in search of material gain, something is happening to the distribution of ability throughout the country ... the best elements are tending to be removed from some areas. and concentrated, perhaps wastefully, in others, thus leaving the denuded areas with a greater proportion of duller children to meet the problems that area has to solve' (p. 25).

Scott has summarized Greenhalgh's paper and has commended the author for his decision to include a cartographic representation of data, (albeit crude), the plotting of test results by all the individual schools in the region

under analysis, the differentiation of sub-areas with above District average I.Q. from those below District average, his identification of socio-economic forces as influencing the pattern, and his criticism of earlier research work for its

'failure to realise that the determining factor is not that a child is urban or rural, but whether that urban or rural area is one of optimistic or pessimistic outlook' (Scott, 1957 b, p. 42).

The latter study introduced a finding that Scott himself has subsequently investigated in a study conducted in Tasmania during 1952-1955 (Scott, 1957 a). While engaged in a long-term survey of the quality and use of land in Tasmania, Scott sought to depict cartographically the widely held belief that the intelligence of Tasmania's population could be regionalised into easily differentiated areas. The resulting map was based upon a four-year sequence of intelligence-test scores for almost the total group of ten-year-old Tasmanian children - the assumption underlying the use of this data being that although the intelligence of a group of children cannot be cited as proof of the intelligence of adults or of the entire population, the group may nevertheless serve as a permissible index to the general quality of the stock because 'intelligence is predominantly determined by genetic factors' (Scott, 1957 a, p. 314). The group tests were devised by the staff of the Psychologist's Office of the Education

Department of Tasmania, and resembled the Otis tests in construction and method of administration. A points-scale approach was utilized to express the results as I.Q.s, and intervals of five points of I.Q. were given letter ratings i.e. A+ represented 133 and above, A 132-128, ... E 72-68, E- 67 and below.

The percentages of children with given letter ratings in each school were used to bring out the areal differences in test performance. Thus in order to locate areas of low intelligence, the percentages were those of children with I.Q. ratings D and E. It was necessary however, in view of the small scale of the map, to combine the results for each geographically distinct urban area and to plot the totals as separate 'stations'; resulting in 236 stations with a detailed coverage of all settled areas.

The pattern produced by the distribution of the percentages was found to be so significant that it was possible to interpolate isopleths (lines assumed to be of constant value) - for which Scott suggested the term 'isonoets' (Greek, noeticos, 'intellectual'). Because the total percentage of ten-year-old children with I.Q. ratings D and E was 30.85, the shading in the map was designed to emphasise the areas of low intelligence : areas with crosshatching have more than twice the state average of duller children, areas with vertical lines up to 50 per cent more, and areas with stippling fewer than

the average. The blank areas are uninhabited. (Figure 1).

The subsequent analysis of the map consists of attempts by Scott to establish accordant relationships between the resultant patterns and other geographical phenomena. In doing so, he is content to merely link the patterns of I.Q. distribution with his comprehensive knowledge of land-use and settlement in Tasmania - and no attempt is made to utilize a more precise and statistical exploration of possible relationships. Although the resulting 'chorographic statement' (Timms, 1964, p. 20) is a well executed and valuable one, it is to be regretted that some appropriate statistical devices were not employed to at least substantiate his subjective assessments.

As a result, Scott is limited to rather generalised conclusions, such as the following :

'In sum, therefore, although the test performance of the four-year group would seem to bear some general relation to the quality of the land, it bears a closer relation, as evidenced by the extremes of superior and inferior performance, to the level of farm productivity' (p. 323).

In seeking a comparison with the earlier studies, Scott concludes that his research would suggest some selection in internal migration - that the more able have remained in, or focussed upon, the better land, and that therefore the less able are likely to predominate in migrations away from the good land and the more able from the poor land. However, although the Tasmanian countryside appears unattractive to the majority of its more intelligent

AN ISONOETIC MAP OF TASMANIA

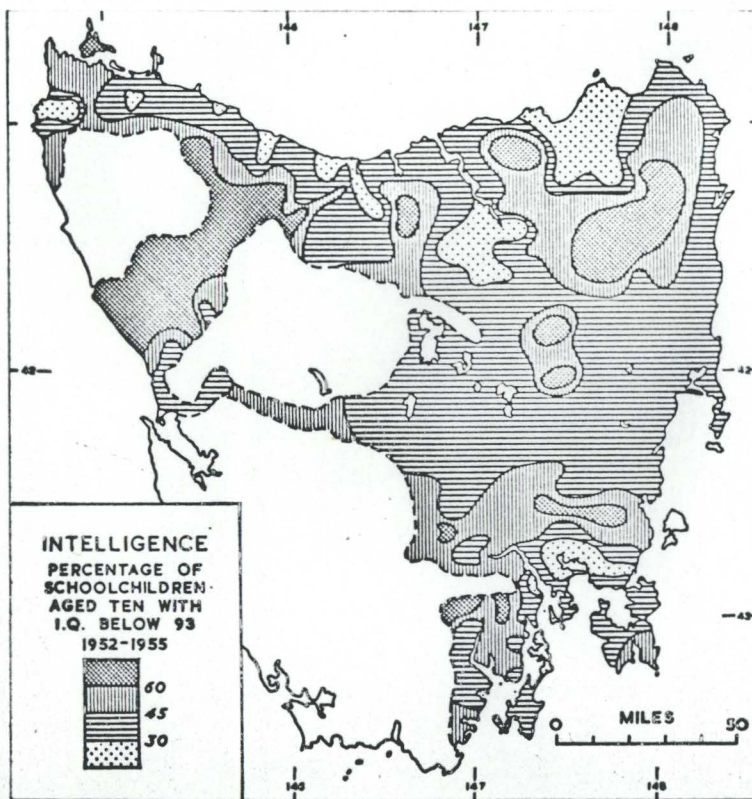


Fig.1

Source : Scott, 1957 a, Geographical Review, 47.

occupants, the hypothesis that the towns attract the extremes while the country retains the means is unsupported - mainly because such generalisations fail to accommodate the marked local variations in the general level of intelligence between and within town and country.

In spite of its shortcomings, Scott's study represents a considerable improvement on previous studies which have attempted to discuss a geographical distribution of intelligence. Nevertheless, certain sections of the study are open to criticism. One such source is the characteristic which he claims to have mapped - intelligence. Throughout the entire report of the study this same characteristic is given a variety of definitions; for instance : 'ability' (p. 312), 'general ability' (p. 329), 'the intelligence of the island's population ... a four-year sequence of intelligence-test scores for a well-nigh complete group of ten-year-old Tasmanian children ... the intelligence of a group of children' (p. 314), and 'the percentages of the duller children plotted by schools' (p. 329). Thus in any attempt at defining what an 'isonoetic' map portrays, the reader has available to him a wide choice of definitions. The reader can assume however that the above definitions are not synonymous with 'innate intelligence', because Scott states (p. 320) that even if such a characteristic could be isolated and measured, the resulting assessment is not

likely to contribute to an understanding of the totality of regional phenomena as well as an assessment of general ability would.

As a consequence one must assume that an 'isoncetic' map, as constructed by Scott, presents the distribution of the percentages of ten-year-old Tasmanian school children with intelligence-test scores of 93 and below, plotted by schools. The pattern presented by the distribution of the percentages is then assumed (by Scott), to represent an index of the general quality of the stock. The premise on which this assumption is based has been referred to above, and would appear to aggravate even further the doubt surrounding the concept of intelligence as used in the study. In order to clarify the situation, a discussion of what 'intelligence' tests actually measure would appear appropriate - although such a discussion, by necessity, must be brief.

A standardized test represents an attempt to overcome the undesirable characteristics of subjective opinions. As such, it comprises a number of selected tasks which can be so ordered that objective observations of how people perform them in a standardized situation can be made. As a result, people can be ranked into an order of merit according to their respective performances (Pidgeon, 1961). A test, then, attempts to measure behaviour, and definition of what a test measures can

only be in terms of the type of behaviour required to complete it.

In the case of an 'intelligence' test, an operational definition is particularly appropriate, for this permits the score from the test to be interpreted in terms of what the test contains or in terms of empirically determined facts known about it. It also avoids entering into the various definitions of 'intelligence' that have been proposed. Thus the view proposed by Pidgeon (1962) and the one taken here is that all tests measure intelligent behaviour whatever titles they may be given. Consequently a child who obtains a standardized score of 70 on a non-verbal 'intelligence' test should not be classified as unintelligent. Rather he should be noted as being, on the occasion tested, decidedly below average on a non-verbal test involving the ability to discover relationships between diagrammatically presented material. The value of this knowledge depends upon what evidence there is relating the scores on this test to something meaningful to the observer. In the case of non-verbal tests, such evidence is very small, but conversely, there is a large body of research showing that the verbal intelligence test is the best test predictor, at the age of 11, of secondary school success (Emmett, 1942; Pidgeon and Yates, 1957; Wrigley, 1955).

Such research would seem to indicate that verbal

'intelligence' tests could measure the same learned intelligent behaviour as that measured by 'attainment' tests - but fortunately the operational viewpoint being suggested here is capable of identifying a difference in the area of intelligent behaviour covered by the two types of test. 'Attainment' tests refer to only very specific groups of situations in which intelligent behaviour is demonstrated (e.g. the items in a reading comprehension or mechanical arithmetic test) whereas a much wider area is sampled by intelligence tests. Viewed in this way, a score on an 'intelligence' test may be tentatively regarded as indicating the average level of performance in the wider area of intelligent behaviour covered by the test (Pidgeon, 1962).

In the context of Scott's study then, it can be assumed that intelligence scores obtained by the verbal test provide a reasonably accurate indication of the quality of those general intellectual skills and abilities which are helpful in achieving success in academic school work. In light of this conclusion Scott's justification for transferring the values of the pattern, (revealed by a distribution of the percentages of categories of test-scores for each Tasmanian school), to the general quality of the stock is a dubious one, not supported by empirical evidence.

Indeed, Scott's claim that intelligence (as measured

by the verbal test which he utilized for his study) is predominantly determined by genetic factors, is no longer a valid one, since it is now clear that success in such tests is 'considerably dependent on the quality of a child's educational environment' (Elley, 1969, p. 152). Recent theoretical work of psychologists such as Hebb, Piaget, and Vernon, on the growth of intellectual ability suggests that verbal intelligence tests sample a mixture of verbal-intellectual skills which are considerably influenced by the kind of stimulation which children receive from home, school and kindergarten and other agencies within the community. Elley (1969, p. 53) concludes by stating that

'although the results of these verbal intelligence tests are more stable over time and dependent on specific school experiences than are achievement test scores, nevertheless it is apparent that the verbal I.Q. can be raised by the effects of better educational methods and strategies. It is certainly difficult to attribute the gains shown in this (1969) study to hereditary factors'.

Before going on to consider the area or problem selected for this study, one might examine a second area in Scott's study which is open to criticism, namely, his failure to make better use of mapping techniques to emphasize the significance of his isonoetic map - a weakness which he himself is quick to recognise in studies prior to his own. Although analysis which is based on assessments of the similarities revealed on successive

maps or on the degree of overlap present in two distributions is open to grave errors of approximation, the apparently high significance of the pattern revealed by Scott's map would certainly minimize the likelihood of such errors occurring. Consequently had Scott, for instance, constructed, or obtained, maps which depicted patterns of farm productivity, and compared the directions of the gradients at the same places on his isonoetic map, he could have obtained a visual analysis of internal correspondence between the two phenomena which would add considerably to one's understanding of the relation the two mapped surfaces bear to one another. Robinson (1962, p. 415) was subsequently to illustrate this in a study which compared rural farm density in the Great Plains with average annual precipitation.

A third area of possible criticism has obvious affiliation with the latter, namely the lack of a rigorous statistical analysis of the data - Scott himself admits that the statistical treatment of the data is 'unsophisticated' (1957 b, p. 45). From this comment, and the context from which it was drawn, one is led to assume that Scott intended the study to be a provocative one. Indeed Scott compiled his 'Note ...' (1957 b) in order to : draw attention to the geographical shortcomings of some previous studies; illustrate a method by which areas selected for systematic study might be determined; and

to demonstrate that Australia contains a wealth of data which could be well utilized for the study of the geographical distribution of intelligence by rigorous statistical method. Consequently, although Scott has appeared to recognise the nature of his geographical problem, he has not undertaken to extend fully his research beyond the recognition and descriptive stages of the problem - the analysis has comprised only a subjective 'interpretation of the distributional pattern' (Scott, 1957 b, p. 45). For Scott then, map compilation was the final product of research.

Educational Studies

A final area of contribution to the problem of mapping the spatial distribution of intelligence has been provided by the child psychologist. Two such contributions will be outlined as representing the type of research in child education in which a geographical description of different levels of intelligence have proved valuable.

The first example cited refers to a study undertaken by Burt (1937) while acting as a psychologist to the Education Department of the London County Council. Working in London schools, Burt conducted a series of surveys which aimed at investigating the incidence, distribution, nature, and remedial treatments of backward school children. Of particular relevance to the present study is Burt's map 'indicating the geographical distribution of educational

ability throughout the County' (Burt, 1937, p. 95). Each London borough has been graded on a five-point shading scale (Figure 2), the estimation of backwardness being based upon the results of the preliminary examinations for junior county scholarships. The latter was executed by selecting the best, worst, and median school in each division and testing the complete age groups, thereby enabling an assessment of the percentage of backward children in schools of every class. The definition of backwardness was the proportion of children in any division below the standard which cut off the bottom ten per cent in London as a whole. As a result of his areal analysis Burt is able to conclude 'that there is a close and local association between the material handicaps of families living in particular districts and the backwardness of the school population' (p. 105).

Having identified the geographical distribution of backwardness, Burt sought 'any general features, economic, social, or psychological, characterizing such backward districts and capable of explaining the educational weakness which the school population displays'. Table 1 abstracts from his Table I the coefficients obtained between the figures for educational backwardness and various social factors for each metropolitan borough.

TABLE I

CORRELATIONS OF BACKWARDNESS WITH SOCIAL FACTORS

Variable	r
Infant Mortality	.934
Mentally Defective Children	.914
Overcrowding	.890
Junior County Scholarships Obtained	.875
Death Rate	.873
Per cent below Poverty Line	.727
Juvenile Delinquency	.687
Unemployment	.676
Per cent of Children attending Elementary Schools	.669
Birth Rate	.623
Poor Relief	.568
Size of Family	.348
Per cent of Children in Special Schools	.257

Source: based on table in C. Burt, The Backward Child, 1937, pp. 100-101.

Burt sums up the inferences suggested by the figures in the above table as implying that educational backwardness is most prevalent in the poor, overcrowded, insanitary households, where families are large, where the children are dependent solely on the State for their education, where parents are dependent on charity or relief, where both birth-rates and infantile death-rates are high, and where the infant's health is undermined from the earliest days of its life.

The influence which Burt's study has had in the field of education is made obvious by Wiseman (1964)

'Burt's classic study has never been paralleled, in this country or elsewhere. Although 'The Backward Child' has been a bible for the discerning teacher for nearly

thirty years, of the many promising avenues of research made bare by his efforts, few have been explored further. This was a pioneer survey : its implications have never been fully investigated.'

Wiseman, in fact, was sufficiently impressed with Burt's (1937) survey to attempt a similar survey in which the main objective was to try to obtain comparative data for Burt's pre-war conditions. This direct connection with the only existing British enquiry had a strong effect on the design of Wiseman's survey, on the choice of variables, and even on the choice of Manchester as the city for investigation - the only city which provided medical service statistics for separate wards.

In summary, Wiseman's survey was concerned with the distribution of 6 educational variables and 12 environmental variables over 26 wards (the smallest unit of local government) of Manchester. The level of intelligence and attainment in each ward unit was expressed as a rate of 'backwardness' and 'brightness' and was calculated as a percentage of the number of children attending secondary modern schools per ward. The educational variables were : verbal intelligence, reading, and mechanical arithmetic - thus children with standard scores of 115 and over were classified as 'bright', and those with scores below 85 were classified as 'backward'.

Initial analysis of the data obtained from the environmental and educational variables consisted of a

visual analysis of the data as plotted on maps. This very subjective technique revealed a broad, single measure of environmental conditions i.e.

'an elongated, sausage-shaped city, lying roughly north and south, having a west-central area ... where social conditions are much the worst ... Outwards from this focus, conditions get better : population intensity is reduced, socio-economic level rises, the birth-rate and death-rate both get smaller, the number of mentally deficient and of T.B. cases falls ... However ... for deaths under one year, and number of problem families ... the pattern departs significantly from the general picture.' (Wiseman, 1964, pp. 81-85)

In contrast to the above observed pattern, a similar method of analysis applied to the results of the three educational tests revealed differences sufficiently distinct for Wiseman's decision to reject a single global measure of attainment to be well justified. As a result Wiseman's conclusions are confined to comments such as 'low rates (of backwardness and brightness) in the central areas, high in the southern suburbs, but with discernible differences between the results for reading and for arithmetic' (p. 85). Figure 3 shows the distribution of one of the three educational variables, (backwardness intelligence), over the Manchester City Wards.

In light of the extremely generalised nature of these conclusions, and the fact that 'the subtleties of relationships which exist are incapable of resolution by the human eye' (p. 89), Wiseman utilized a more precise statistical exploration of the possible relationships. Product-

BACKWARDNESS INTELLIGENCE

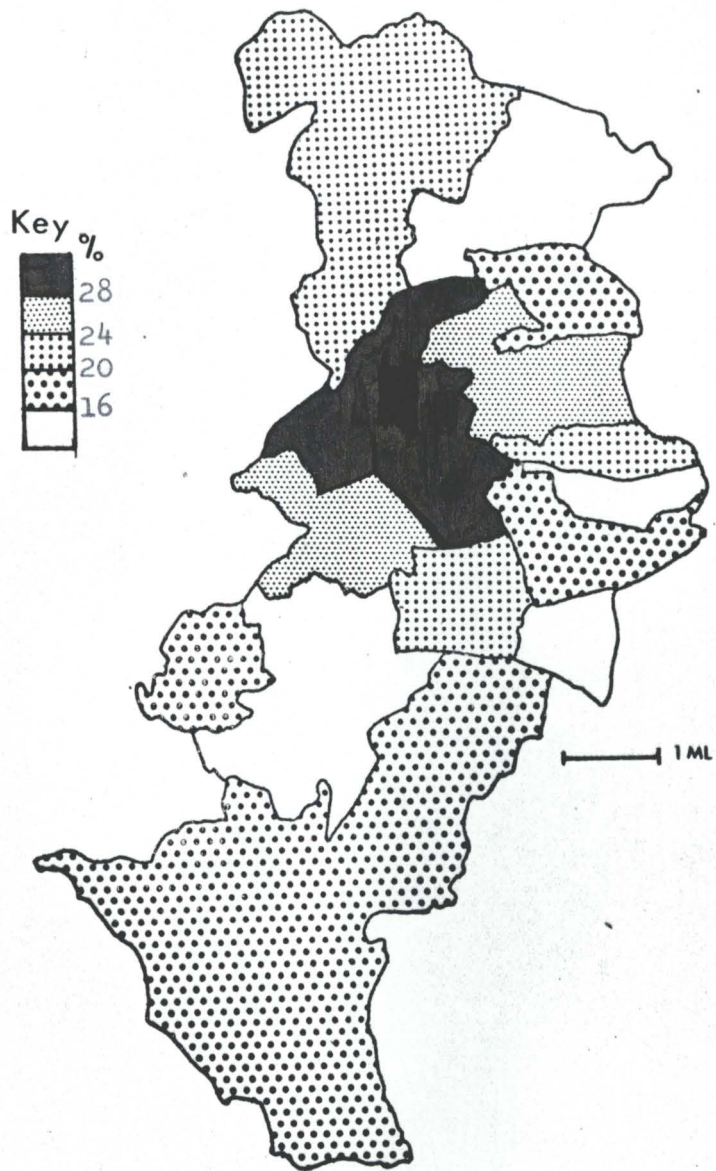


Fig. 3

Source: Wiseman, 1964, Education and Environment, Manchester.

moment correlation analysis was undertaken by calculating the percentage of backwardness and brightness in each ward, and correlating each of these with the separate rates for the social variables.

Factor analysis was also used for exploring the inter-relationships of the environmental variables, and as a result of these two statistical procedures Wiseman was able to conclude that backwardness as defined for his survey, could be accounted for almost entirely by the effect of a factor of intellectual inferiority called social disorganisation. Brightness, on the other hand, appeared to have the strongest connection with maternal care, although social disorganisation contributed almost as much (Wiseman, 1964, p. 95).

A second survey, conducted by Wiseman in 1957, was undertaken to remedy some of the deficiencies of the earlier work and to examine more thoroughly some of the tentative hypotheses which had emerged. In the latter survey the distribution of 9 educational variables, and 20 social variables was examined over the 30 wards of Manchester. The maps showing variation in intensity of these variables over the wards revealed a similar type of picture as was obtained in 1951, with conclusions very similar to those cited earlier. Correlation and factor analysis indicated that the major part of the educational variance was accounted for by a general 'ed. soc.' factor

characterized as containing a low economic level, a high rate of prosecutions for cruelty to and neglect of children, dirty living conditions, many children on probation, many illegitimate children, and mental deficiency rates above average.

As a result of this analysis, Wiseman suggests that

'although there are many regional differences among towns, some of the associations of social and educational variables found in the Manchester survey may possess a fairly broad degree of generalisation. To claim more than this would be hazardous in the extreme' (p. 177).

In assessing the contribution which the two latter studies have made to the problem of defining intelligence cartographically it is necessary to judge them in terms of their objectives. Burt was primarily concerned with the compilation of a manual for the diagnosis, classification, treatment, and education of intellectually sub-normal children. In order to elaborate on these aspects of the problem, Burt found it necessary to identify the causes of educational backwardness, and by way of a preliminary, enquired into the places and circumstances where backwardness was characteristic. It was in this context then that a map was invaluable, in that it revealed clearly the type of neighbourhood in which provision for backward children was urgently needed (Burt, 1937, p. 95). As a result, Burt was able to conclude that there was a close and local association between the material handicaps of families living in particular districts and the

backwardness of the school population.

However Burt was well aware of the dangers of forming definite conclusions from such a generalised map, and in order to discover more precisely how poverty and backwardness interact, devoted the major part of his study to an intensive analysis, not of districts, but of individual case studies. Consequently, it is apparent that Burt's original choice of 'neighbourhood' had the effect of disguising information - a problem which Wiseman recognized as being important in his later study.

Of perhaps less relevance to the present study, is the fact that Burt was not concerned with the cartographic representation of intelligence, but educational attainment. The literature surveyed in this chapter is cited primarily for its various methodological solutions to the problem of differentiating areas of human intelligence. Although Burt was not expressly concerned with intelligence, he was nevertheless confronted with the problem of mapping test-scores in order to indicate the person-environment interaction that possibly produced associations of particular test-score levels. The solution offered by him revealed an especially high level of generalisation which he not only recognized, but also sought to improve through the use of individual case studies. The map therefore, was subordinate to the study of the individual.

Fundamentally developed from the methodology and

findings of Burt's study, the mapping procedure in Wiseman's study assumed a similar function. The study was divided into two phases : the construction and standardization of tests of educational achievement; and an investigation of the relationship between educational attainment and social and environmental factors. In the context of each phase the maps were used to identify and summarize a particular situation which could only be comprehensively solved by a detailed statistical analysis - they suggested a solution which could then be submitted to more precise scrutiny.

Because the mapping procedure was thus subordinate to statistical analysis, criticism in terms of the total study is difficult to sustain. Nevertheless some comment is necessary, as the apparent success of the technique in, for example, delimiting associations of levels of intelligence with similar levels of home background, is to a considerable extent aided by the nature of the data.

Wiseman undertook his research in a region that formed part of one of the world's great conurbations, within which could be found great environmental variations. Repairs and rebuilding following war damage, slum clearance, and the concomitant growth of suburban and overspill housing promised at least two decades of rapid change, development, and population movement. Thus strong contrasts in density of housing, quality of housing, and

general socio-economic level were predicted by Wiseman (p. 4). This same factor could have had a similar influence in Burt's surveys, as these were undertaken between the years 1925 and 1935 when economic conditions for large sections of the population were rigorous in the extreme.

One also suspects that Wiseman was not altogether satisfied with the method which he adopted for illustrating the distribution of the educational variables. The first-phase research had been completed using the school and the authority as the main sorting variables. Thus, the schedule completed for each child, and from which the data for the punched cards were obtained, did not include the child's home address. Wiseman notes that,

'It would have been possible to secure this information but with the many thousands of children involved we were unable to contemplate an analysis involving such great labour, and we were forced to rely upon the score distributions for each school' (p. 76) (my underlining).

This resulted in two serious handicaps. Where the catchment area of a school clearly fell within a single ward, the task of matching the school with a ward was simple. However because there were many schools situated very close to ward boundaries, the school and the education office staff had to be consulted in order to decide from which ward the majority of children were drawn. The school was then allocated to that ward, with the result that error was introduced which was likely to blur the

results of the analysis.

The second handicap has been alluded to already and has resulted from the method of allocating schools to wards. Because allocation was only tenable for schools with a local and fairly clearly defined catchment area, the selective schools (grammar, technical and central) could not be included in the subsequent analysis. These schools had, therefore, to be excluded from the analysis, with the remaining schools having been effectively 'creamed' by the 11 plus examination. This meant that the relatively few children classified as 'bright', were regarded in one sense as 'misfits' produced by the selection system. Furthermore, because the range of brightness was necessarily much smaller than the range of backwardness, the correlations of brightness with other factors were also smaller than the correlations of backwardness.

It would seem therefore that the second-phase research was primarily concerned with the distribution of backwardness (as measured by two attainment tests and one verbal intelligence test) among schools of predetermined survey units. The criteria affecting the eventual choice of the ward as the survey unit were as follows. First, the unit had to be small enough to yield a sufficiently large number of units in the area as a whole for stable statistical analysis, and yet large enough for the data from each unit to be based on the results of an adequate number of children.

Second, the unit had to be socially homogeneous and free from large variations in density and quality of housing; and third, the unit had to have available relevant data (p. 74).

In light of the biased nature of the sample of schools, and the necessarily high degree of generalisation assumed in allocating a value of backwardness to the individual schools in local government districts, Wiseman's contribution to an essentially geographical problem may therefore be regarded as unsatisfactory.

Summary

The majority of the researches reviewed in the present chapter have attempted to identify areal associations of similar intellectual ability by examining the dominant or unusual intellectual characteristics of individual schools and relating these findings to the physical and socio-economic environment in which a school may be located.

Major criticisms of such researches relate to the lack of definition of the phenomenon which has been studied, the frequent neglect of satisfactory mapping and statistical analysis of the information yielded by the maps, and the choice of unit used for expressing the initial observation (the school) and the final expression of regional differentiation (the ward, or other conveniently delimited areas). In light of these criticisms, further research on the whole problem of applying techniques of

geographical cartography to intelligence-test scores is obviously required.

III OUTLINE OF THE PRESENT INVESTIGATION

In an endeavour to remedy some of the apparent flaws in previous attempts at describing the geographical distribution of intelligence, it was decided in the present investigation to illustrate another method by which areas selected for systematic study might be defined. The method proposed represented a significant departure from any of the approaches described in the previous chapter.

First, the extent of the overall area subjected to analysis was drastically reduced. Whereas previous studies had been concerned with islands, countries, counties, and large conurbations, it was decided to limit the present study to the catchment area of an Intermediate School located in Hamilton City, New Zealand. Second, instead of generalising from the percentage of children in a particular category of intellectual level, or above or below a district average, each child's score from a verbal intelligence test was ranked on a 7 point scale, (Table II) and plotted on a map of the school's catchment area according to the child's home address.

TABLE II
CONVERSION TABLE FOR I.Q. SCORES

I.Q. Score	Verbal Equivalent	Ranking
130 and above	Very Superior	1
120-129	Superior	2
110-119	Bright - Normal	3
90-109	Average	4
80-89	Dull - Normal	5
70-79	Borderline	6
69 and below	Mental Defective	7

Source : Wechsler, D, 1949, Wechsler Intelligence Scale for Children, New York.

Third, a computer programme was constructed whereby the co-ordinate reference for each child's home address was determined and assigned its particular intelligence rank. A mapping procedure was incorporated into the programme which produced a statistical map depicting the distribution of the various ranks of intelligence over the catchment area. Fourth, a 'schedule' was compiled for each pupil so that all the data available, and considered relevant to a subsequent explanation of the distribution of intelligence could be collected.

The following working hypothesis could thus be investigated :

1) The distribution of intelligence data will tend to cluster into groups of similar intelligence levels.

If this hypothesis could be confirmed, a second working hypothesis could then be proposed for further investigation :

2) The intelligence rankings of the pupils attending the school are spatially differentiated into areas which reflect corresponding levels of socio-economic status.

The area, materials, and methods by which it was proposed to test the working hypotheses, and some of the problems associated with their investigation will now be discussed in more detail.

Choice of Method

The reasons for choosing to depart from the method-

ology employed in previous studies are three-fold. First, because previous research had been conducted over large areas, prolonged and extensive surveying had been essential. The limited time available for the present investigation meant that a large reduction in the size of the survey area was necessary. Thus the investigation was initially regarded as a 'pilot study' to see whether the techniques and findings of earlier research had relevance in a smaller area.

However, following a detailed study of earlier research, it was considered that the size of the area subjected to investigation was an important factor in determining the 'power' of the conclusions. (This contention is elaborated on at a later stage in the paper). As a result, the method chosen originally for reasons of convenience, is claimed by the present writer to be a considerable improvement on earlier approaches.

Third, following a criticism of previous research made by Scott (1957 b, p. 41) the writer agreed that the geographical distribution of intelligence could best be described by plotting the intelligence data by the smallest localities for which the data were available.

However, whereas Scott utilized the school, in order to improve earlier research methodology, the present writer believes that the location of the home provides the most appropriate unit for the subsequent statistical map.

The obvious advantage gained from using the location of the home is that the over-generalisation inherent in calculating a percentage, and then assigning a value to that school on the basis of comparative percentage figures from other schools, is avoided.

A second advantage accrued from adopting home location as a cartographic unit, is the added validity which the final map distribution will gain. If, as hypothesized, similar rankings of intelligence form associations, the delimitation of such groupings from each other should be able to be explained in terms of their particular socio-economic neighbourhood. Previous research has been conducted under the assumption that socio-economic neighbourhoods exist over large areas. The 'census tracts' of the United States are considered by Wiseman (1964, p. 74) to represent the ideal units.

Conversely, Scott (1957 a) and Greenhalgh (1949) regarded the catchment area of a school as representing a neighbourhood unit, and in view of the large area being surveyed, this decision would appear unavoidable.

Nevertheless such an assumption necessitates a high level of abstraction and loss of information, and was not considered appropriate in the present circumstances. Furthermore in any study of urban life the main framework is considered, by the present writer, to be the individual streets and neighbourhoods; for in the process of urban

evolution, the physical units formed by the pattern of streets often tend to become human units. Under this assumption, the spatial and symbolic boundaries which are anticipated for identifying 'regions' of intelligence, cannot be expected to be explained by census divisions, suburban divisions, or any other arbitrary delimitation of areas which are considered to be geographically distinctive. Rather, it is expected that they can only be explained in terms of processes of the physical and social environment; and described as units which will frequently, but not necessarily, correspond with the physical units formed by the pattern of streets.

Choice of Study Area

The results of the investigation in terms of confirming or refuting the two hypotheses outlined above would suggest that the choice of study area was important. Confirmation of the hypotheses, in light of the literature reviewed in the previous chapter, could thus be facilitated if a school was chosen whose catchment area included either a predominantly poor socio-economic environment, or conversely, a predominantly good socio-economic environment. This assumption was supported by recent research findings outlined by Elley (1969). In an attempt to support an hypothesis that New Zealand school children today are reaching a higher degree of mental maturity at an earlier age than formerly, Elley re-standardized the Otis

Intermediate Test of Mental Ability - a test which had initially been administered to a representative sample of New Zealand pupils between the ages of ten and fourteen years, in 1936. Prominent among the conclusions made by Elley, is the following

'Despite its egalitarian philosophy, New Zealand is not exempted from the universal tendency for ability to flourish more in the home of the professional man than in that of his non-professional neighbour. Intelligence in New Zealand is distributed throughout the social status hierarchy in the same way as it occurs in other westernised countries' (149).

In light of these findings, the earlier decision to choose a school whose catchment area included a variety of neighbourhood environments - in the hope that the full range of intelligence levels would thus be included in the population, appeared to be a fortunate one. Melville Intermediate School satisfied this requirement, as the Principal's following description testifies¹:

'The school district is one of mixed population. Some very old areas are to be found in (the suburbs of) Melville and Hamilton West, while Richmond Park, Glenview, and parts of Melville (suburb) itself are newly established housing areas. This poses problems of security for children in some cases, and later must raise the school problem of rapid growth in the roll. This is difficult to estimate but it appears that there will be an explosion at the Intermediate Age level in approximately 3 - 4 years'.

Compilation of 'Schedules'

Because an Intermediate school catchment was chosen for study, a considerable amount of information pertaining

¹ The description was outlined in the School Scheme of Melville Intermediate School (1970). Permission to use the description was given by its author, Mr. J. Silcock, Principal of the school.

to the home environment of each child was readily available from the school's records. From the information that was available, data was selected that was considered relevant to an explanation of the socio-economic situation of each pupil who attended the school. This was then verified, and catalogued in a manner prescribed by Lloyd (1965), in which data, punched directly onto 80-column punched cards, was made available in a compact and easily sorted file (Appendix A).

Scores for each child from the Otis Self-Administering Test of Mental Ability, Intermediate Examination : Form B, were also punched onto the cards, as well the rank to which each pupil's score belonged (Table II). In keeping with the discussion undertaken in Chapter II, the phenomenon referred to as 'intelligence' throughout the remainder of the investigation is regarded as 'those verbal reasoning skills which make for success in academic school work'. This definition has strong affiliations with the phenomena which are claimed to be measured by the Otis Test of Mental Ability (Elley, 1969, p. 140). Details of the standardization procedure, as outlined by Elley are included in Appendix B.

Although it was originally intended that each pupil attending the school should be included in the survey, it became obvious that this ideal could not be achieved. Because a small number of pupils came to the school from

isolated locations (including farms, other suburbs, and a Mormon community some seven miles away), and thus could not be located in the main suburban areas comprising the catchment area, these children had to be excluded. Second, children who belonged to the Deaf Unit, and the Special Class for Slow Learners were excluded, if their homes were located outside the catchment area. Finally children whose fathers were deceased, or whose occupation could not be reliably determined were also excluded from the analysis.

Consequently, the final 'sample' of children totalled 402, distributed over a catchment area comprising the suburbs of Hamilton West, Richmond Park, Glenview, and Melville (Figure 4). The decision to use the total number of children for whom data was available, as opposed to a random sample, meant that a more comprehensive coverage of the catchment area was afforded - an advantage that was considered necessary in view of the method and hypotheses chosen for the investigation.

It should be noted also, that Melville Intermediate is the only school in the above four suburbs which caters for Form I and II children. It is expected therefore, that the group of 402 children used as subjects in the investigation, represents a very high percentage of the total 10.6 - 13 year-old age group in the area¹. The problem of drawing generalisations from the spatial dis-

¹ It was later established that only 3 children from the total number eligible to attend Melville Intermediate School in 1969 and 1970 were admitted to private schools.

THE MELVILLE INTERMEDIATE SCHOOL CATCHMENT

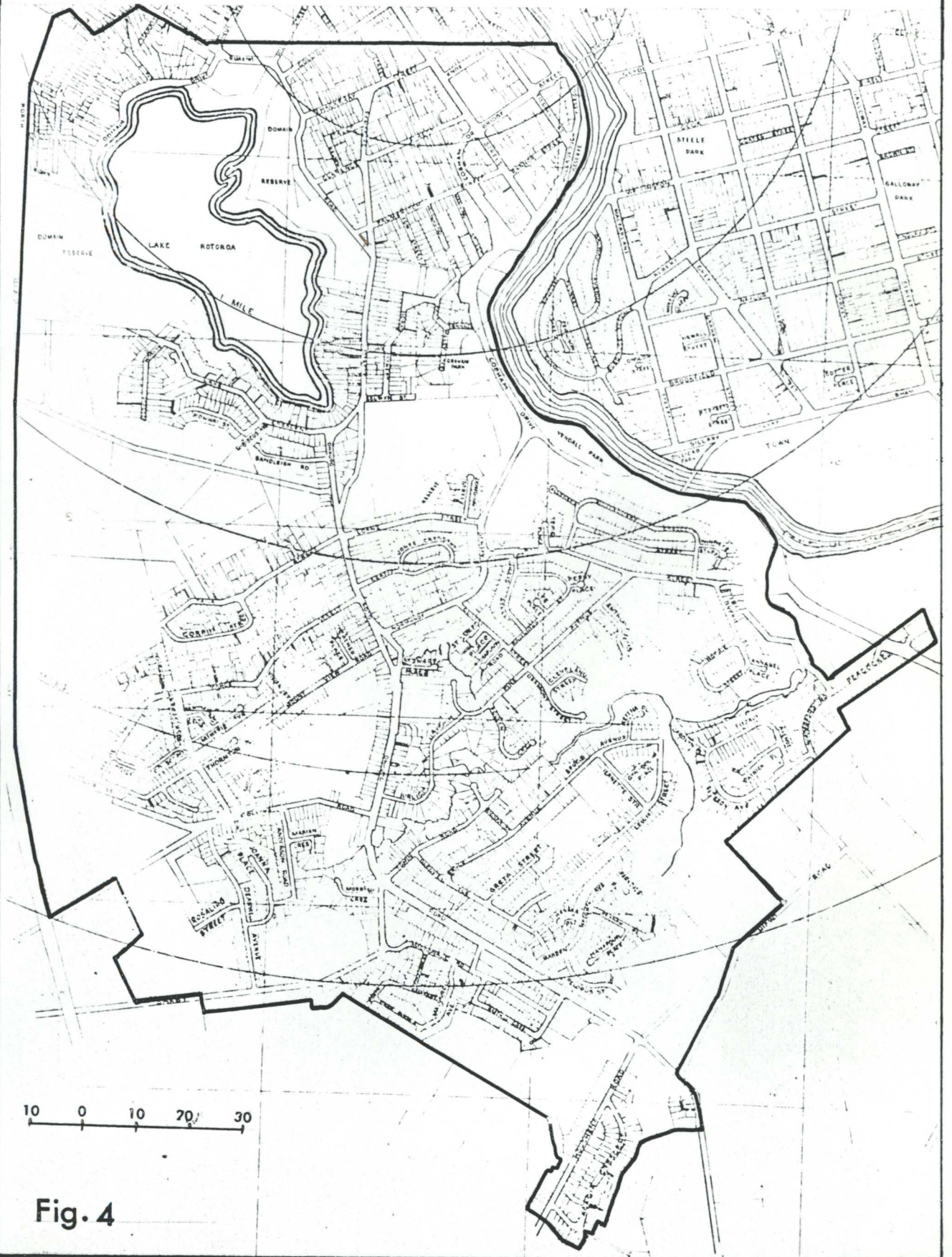


Fig. 4

tribution of intelligence to the neighbourhood environment, then, is limited only by the observed relationship between intelligence and environment - not by the problem of drawing inferences from random samples.

Construction of Map

The main problem faced in constructing the statistical map of intelligence arose from the limitations imposed by the mapping procedure incorporated into The IBM 1130 computer mapping programme. The mapping procedure could produce a map no larger than 45 square inches, or 3,600 units, i.e., 60 one-tenth-of-an-inch units (horizontal) by 60 one-eighth-of-an-inch units (vertical). Each of these units corresponded closely in size with the average land section unit used on a Lands and Survey Department map of Hamilton (License Number 1951/6, scale six inches to one mile), and therefore the statistical map of the catchment was constructed originally at this same scale. Because the catchment area being analysed at this scale was too large to be accommodated by one 'computer map', it was necessary to sub-divide the catchment into six computer maps, which are subsequently referred to as map-sets. The final map showing the spatial distribution of the pupil's intelligence rankings was constructed by combining each of the map-sets into a complete unit which covered the entire catchment (Figure 5). The computer programme devised and used for mapping the intelligence rankings is included in Appendix C.

SPATIAL DISTRIBUTION OF INTELLIGENCE RANKINGS

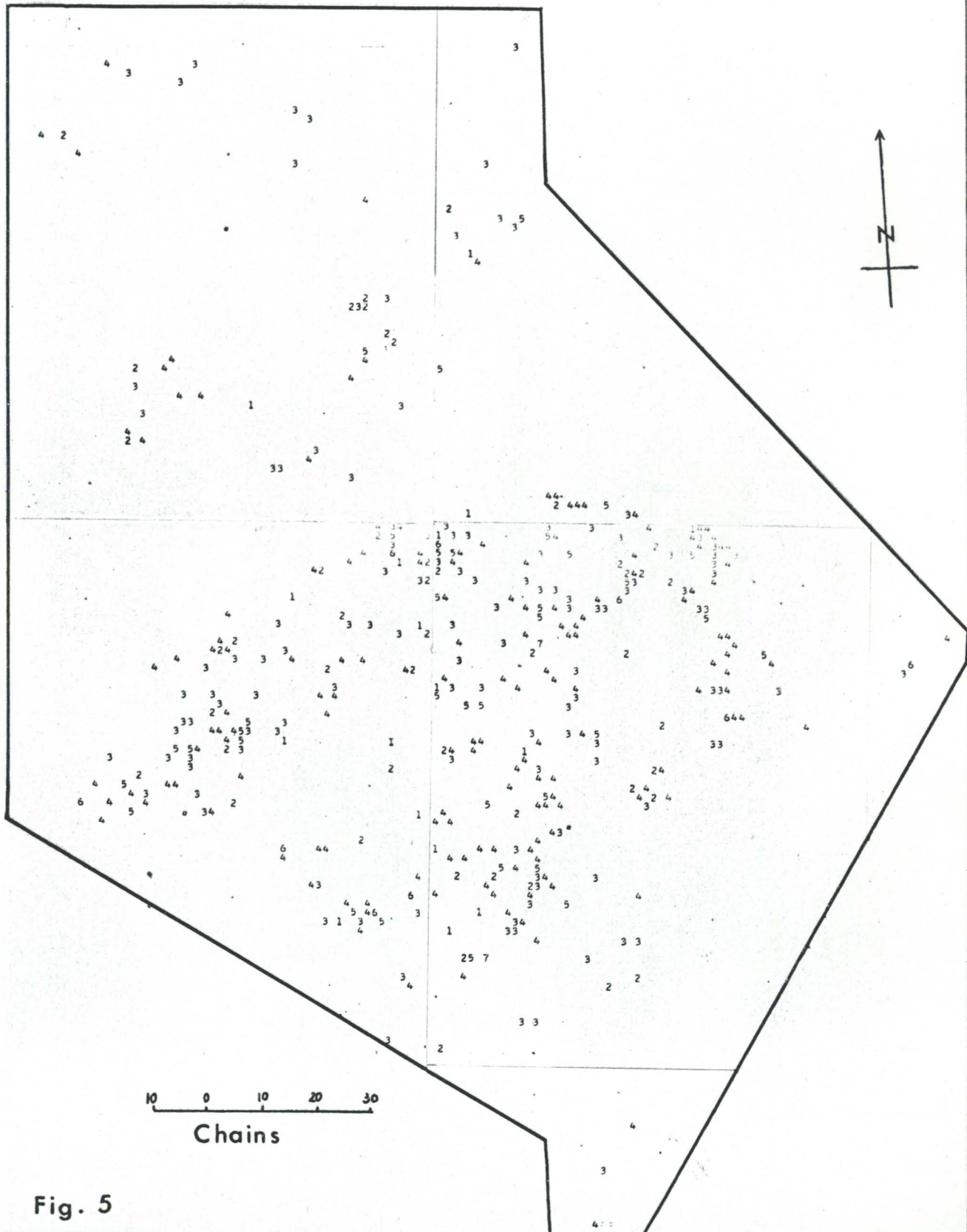


Fig. 5

IV INVESTIGATION OF HYPOTHESES

Once the statistical map of the distribution of intelligence within the catchment area was constructed, the two hypotheses were able to be investigated.

Procedures for Identifying Groupings of Similar Intelligence Rankings

The procedures adopted for testing the first hypothesis utilized an approach in which the possible outcomes of an investigation are expressed as a null hypothesis and its alternatives. In other words, it is the rejection of the null hypothesis which is interpreted as a significant finding, and the anticipated outcome of the investigation. Rejection of the null hypothesis implies acceptance of some alternative hypothesis, and is valid if the probability that it is a true statement is lower than some pre-determined probability. This probability is called the level of significance.

The present writer is unaware of any conventional statistical device which can be considered appropriate for establishing a level of significance which has meaning for the hypothesis under investigation, i.e., defining what constitutes a grouping of similar intelligence rankings. Timms (1965, pp. 251-252) has recognised this problem also by stating that :

'The choice of a regional system appropriate to the project in hand is the greatest single problem which faces the investigator of urban social distributions. The concept of region as an abstract or as a partial model of reality has been widely explored by geo-

graphic theorists, but much less attention has been given to the definition of methods by which the requirements of a formally-valid regional system may be satisfied' (my underlining).

Timms is, however, able to suggest three conditions which a system of sub-areas intended as the framework for the study of areal variation should satisfy :

1) The individual areas should be strictly comparable one with another.

2) Each area should be so formulated as to provide a maximum of external variation and a minimum of internal variation.

3) The item or items on which the typology is delimited should be directly relevant to the problem being studied.

Consequently the null hypothesis was tested within the boundaries suggested by this framework, albeit with some subjective judgement.

Since in an American Study (Pihlblad and Gregory, 1954, p. 318), and subsequently in Scott's (1957 a) study, the difference in test performance between areas had been found to emerge more sharply by dividing the scores into high, medium, and low categories, it was decided to adopt a similar approach in the present investigation. Following this procedure, intelligence ranks 1-3 were classified as 'high'; rank 4 was classified as medium; and ranks 5-7 were classified as low.

Evidence of groupings of intelligence rankings in terms of each of the three categories were then sought

by reference to the original statistical map (Figure 5). The complete absence of information other than intelligence data on the map meant that the procedure of regionalization was unbiased by further factors - the regions of rankings included in each category were delimited independently of any previous definitions of areas or boundaries, even streets. Given the prior decision to define regional types in terms of a particular division of the data, the only subjective element in the procedure involved allocation of the interstitial areas¹ exhibiting non-conforming, mixed characteristics.

Once identified, the 'regions' of high, medium, and low intelligence were then overlaid with a map showing the streets and section locations of the catchment area, on an identical scale (six inches to one mile). Where necessary the shapes of the regions were then modified to conform with the actual section locations, thus adding a degree of reality to the delimited areas. The final product, a map of the groupings of similar intelligence is given in Figure 6.




Procedures for Explaining the Areal Differentiation in Intelligence

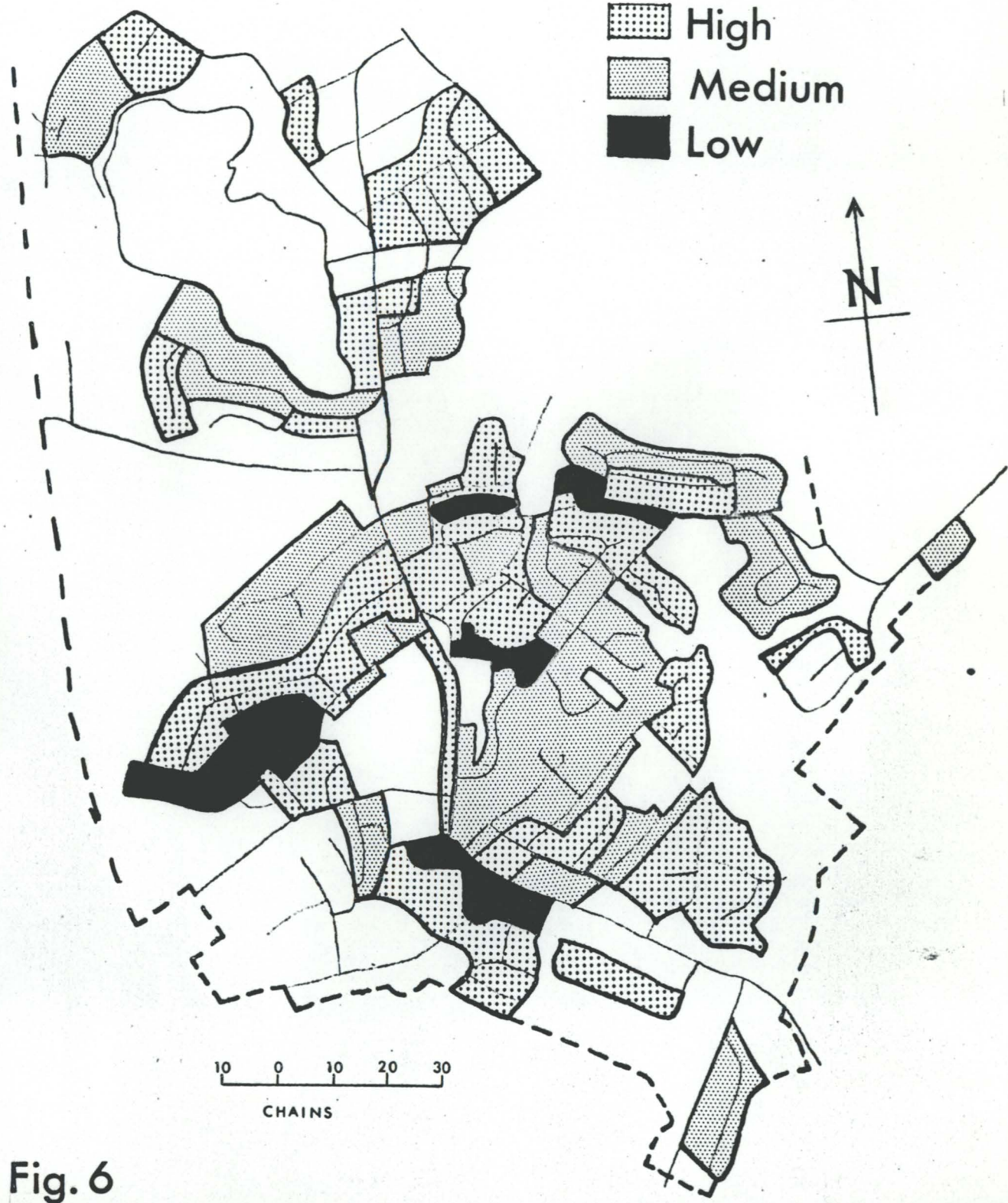
In view of the findings of previous research summarized

¹ The term 'interstitial' was adopted from a paper presented by Hatt (1946, p. 424). In outlining one possible approach to the delineation of natural areas, Hatt used the term to describe heterogeneous areas of rental value in the central residential district of Seattle, Washington.

INTELLIGENCE REGIONS

I.Q. Ranking

-  High
-  Medium
-  Low



10 0 10 20 30
CHAINS

Fig. 6

in Chapter II, an examination of the aetiology of the regions identified in Figure 6 could be expected to reveal a close relationship with socio-economic status. As a consequence, it was desirable that some method be found which enabled socio-economic status to be analysed quantitatively.

Under the assumption that socio-economic status could be measured along a single dimension, it was thought that this requirement was best met by a modified version of Guttman's scalogram technique¹ (1950). Information was obtained on a variety of items thought to represent dimensions of socio-economic status. The items selected were :

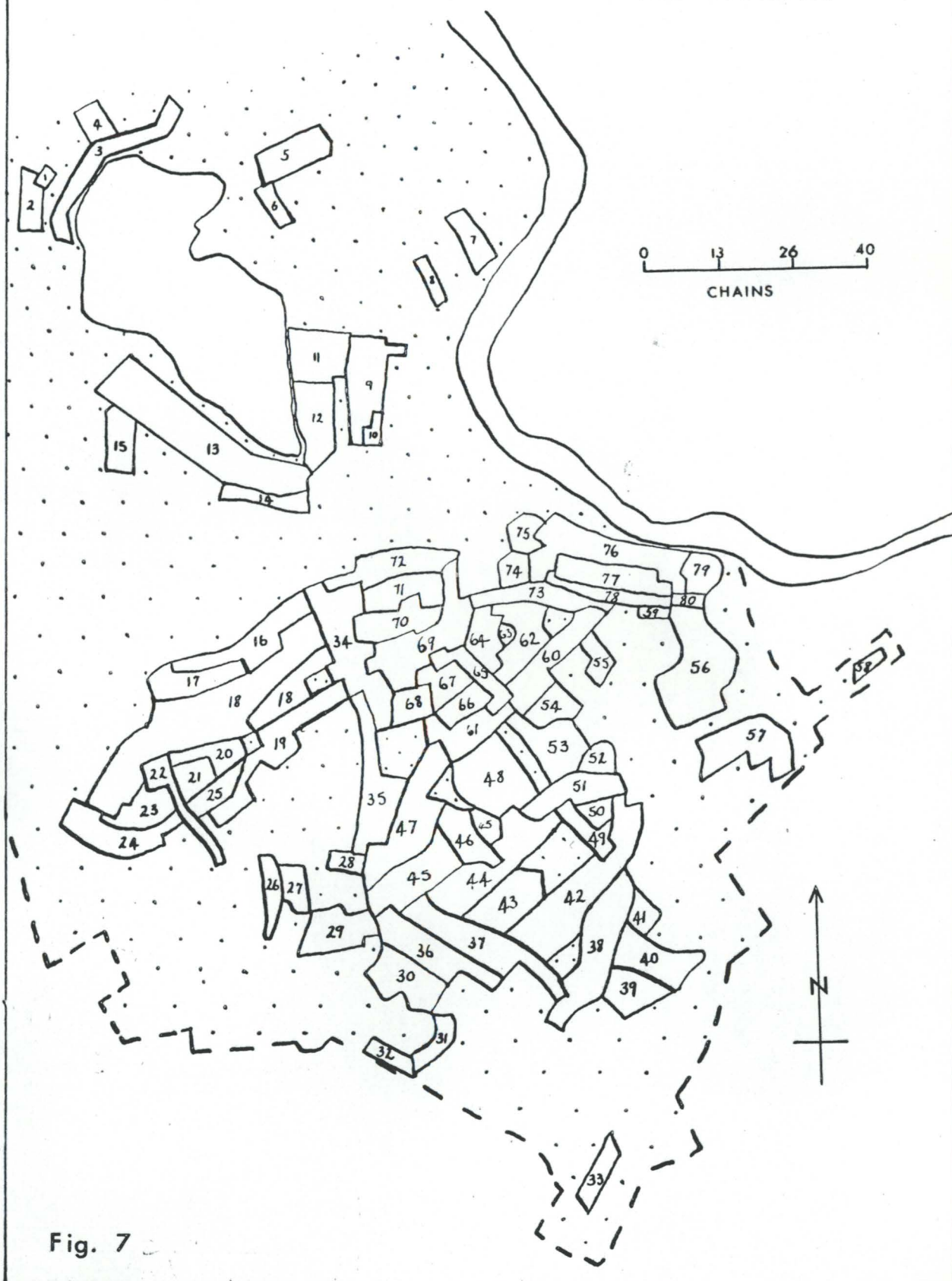
- 1) Occupation of the father of each pupil in the survey.
- 2) Value of unimproved sections.
- 3) The number of persons per dwelling.

Definitions of the three items and a rationale for their selection are outlined in Appendix E. The data obtained was tabulated for the smallest practicable area (a street or part of a street), in terms of the scale criteria summarized in Table A/II. The areas thus defined totalled 81 (Figure 7).

The validity of the scale was then tested by calculating

1 The modified version of the technique was developed in the course of a study dealing with the geographical pattern of criminality and mental illness in two British cities (Timms, 1962). Basic assumptions of the techniques are included in Appendix D.

URBAN REGIONS IDENTIFIED BY SCALOGRAM ANALYSIS



the coefficient of reproducibility¹ - 'a measure of the relative degree with which the obtained multi-variate distribution corresponds to the expected multi-variate distribution of a perfect scale' (Guttman, 1950, p. 77). The coefficient produced was .81. The full implications of this figure will be discussed in the following chapter. Needless to say, it was sufficiently low to warrant cancellation of the second part of the analysis described by Timms (1965, p. 259). Furthermore, the 81 sub-areas defined by the streets, bore little relation to the groupings of intelligence previously defined in a more objective manner. In view of this, it was decided to test the second hypothesis by utilising a more conventional statistical procedure.

Statistical Measures of Association

Because scalogram analysis had indicated that a single dimension of socio-economic status could not be obtained using the available information, the single factor, occupational prestige, was adopted as an index. This decision finds support not only in the literature cited in Appendix E, but also in Elley's (1969) research. In order to investigate the effects of socio-economic background on Otis scores, Elley classified fathers' occupations into six broad categories :

- 1) Professional and technical.

1 The significance of the coefficient of reproducibility is discussed in Appendix D.

- 2) Clerical and highly skilled.
- 3) Skilled.
- 4) Semi-skilled repetitive.
- 5) Unskilled repetitive.
- 6) Farmer.

He then obtained, from the pupils in the survey, the present occupation of their fathers. The differences between the mean scores of the children, classified according to their fathers' occupation, enabled Elley to conclude that a positive correlation exists between socio-economic status and intelligence as measured by the Otis test.

In order to be consistent with research dealing specifically with the Otis test, the use of occupation as a single index of socio-economic status in the present study is therefore not only considered justified, but necessary.

Having the information already in an accessible form (on punched cards), it was relatively simple to adjust the computer mapping programme previously used, to accommodate the occupation data. The modified programme was then able to map the occupation categories in ranked form (Figure 8). Similarly, 'regions' of similar ranks were able to be identified, using only the second method, (described earlier), for defining regions of intelligence (Figure 9).

SPATIAL DISTRIBUTION OF OCCUPATION RANKINGS

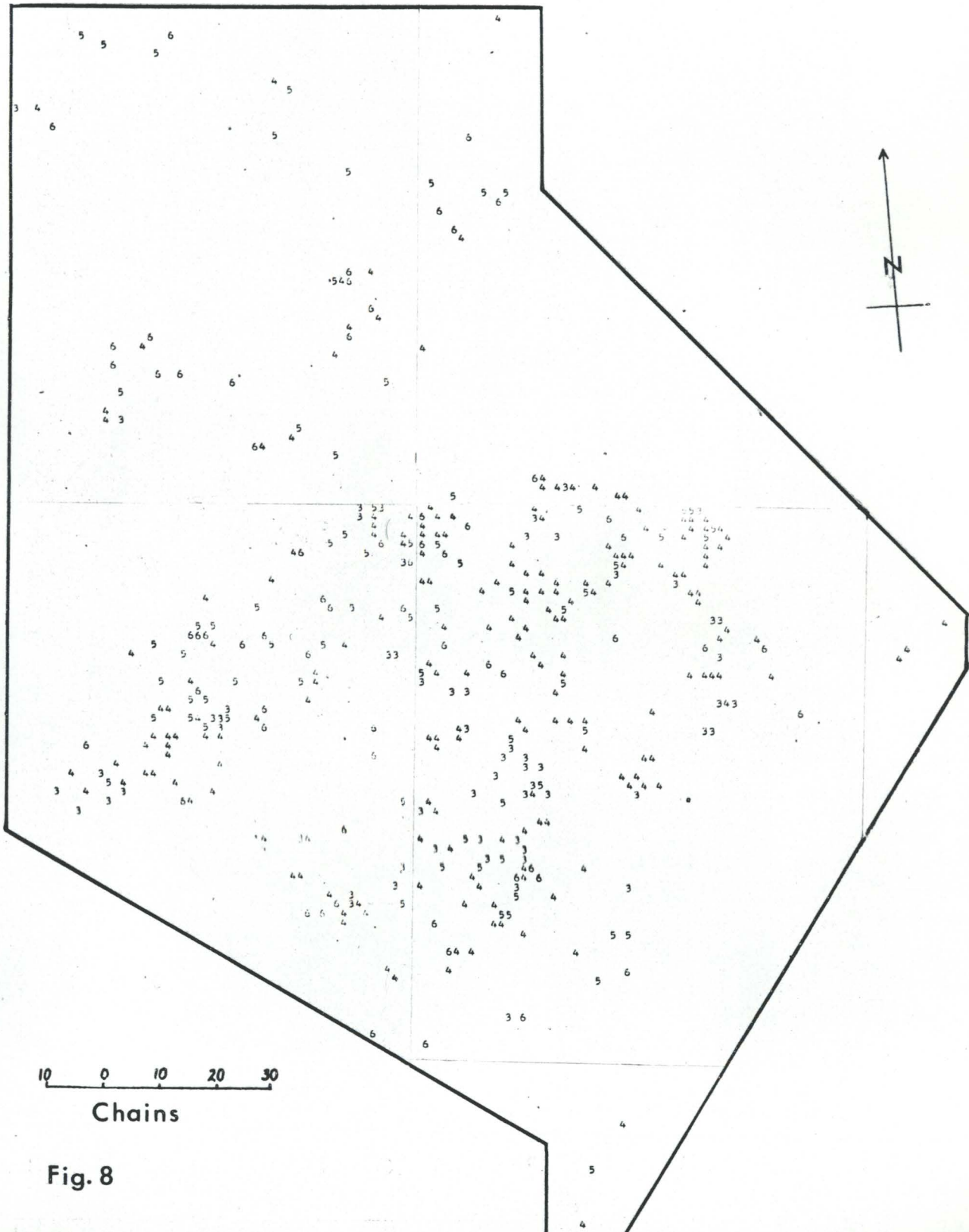


Fig. 8

OCCUPATIONAL STATUS REGIONS

Ranking

-  High
-  Medium
-  Low

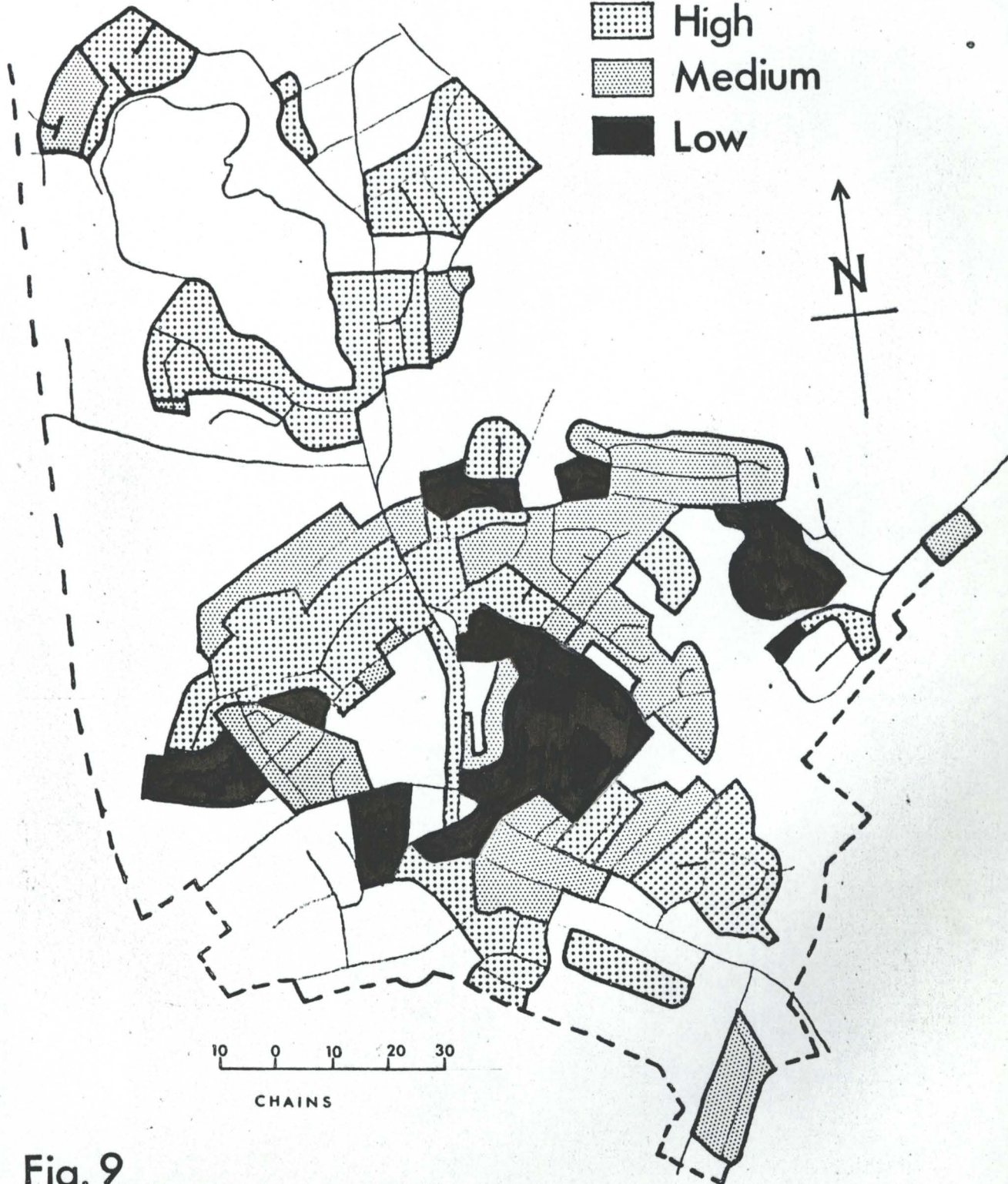


Fig. 9

The general impression obtained from a scrutiny of the geographical spread of the two regional distributions, intelligence and occupation, is one which suggests that they are closely associated. However, the existence of discrepancies demands that a more precise and statistical exploration of these relationships be undertaken.

The problem now faced was one of choosing a technique which could assess spatial links of association between the two statistical maps. Ideally, the technique should have the power to measure how similar the two maps may be, and also to assess the probability of that degree of similarity occurring by chance. If it could be shown that the observed association between the two distributions was extremely unlikely to occur as a result of chance, then the utilization of correlation analysis to investigate the strength of the relationship is warranted.

The statistic chi-square has been found by McGlashan and Bond (1970) to satisfy one of these requirements

'In principle, it (chi-square) provides a comparison of two variables on the null hypothesis, in this case that no relationship exists between the variables ... A low chi-squared value, indicating little similarity between two maps, may signify only that the maps are not alike and that spatial association is not indicated. Conversely, a high chi-squared value and a high degree of significance point only to the rejection of the null hypothesis that no spatial relation exists between the pair of maps concerned' (pp. 244-245).

The statistic described above is actually the chi-square test of independence, and is particularly appropriate where the data of research consist of frequencies

in discrete categories. The measurement involved may be as weak as nominal scaling, and the use of the statistic requires large samples (Roscoe, 1969, p. 196).

In the present investigation, the two distributions being compared were the original statistical maps showing intelligence and occupations ranks (Figures 5 and 9). The null hypothesis being tested was that the spatial distribution of pupil's intelligence rankings bore no significant association with the spatial distribution of the pupil's fathers' occupational status. Paired observations for the two rankings at each point source of information were entered in a bivariate frequency table as shown in Table A/III. The expected cell frequencies, (those expected if the two distributions were independent of each other, given the marginal totals of the rows and columns), were calculated from the bivariate frequency table, using the conventional formula preparatory to calculating a chi-squared value :

$$\text{Expected Value} = (\text{Row total} \times \text{Column total}) / \text{Grand Total}.$$

The expected values obtained are contained in Table A/IV. From the two tables, the difference between observed and expected value for each cell was squared, divided by the expected value, and the totals summed to produce the chi-square value (Table A/V). Because the chi-squared test for independence may be used only if fewer than 20 per cent of the cells have an expected

frequency of less than 5 and if no cell has an expected frequency of less than 1, adjacent categories were combined, as shown by the pecked lines on Table A/III and A/IV, to give Table A/V.

The value of chi-square thus obtained is 52.52. The number of degrees of freedom associated with this value is 4. The value of chi-square required for significance at the .001 per cent level is 18.46. The decision to reject the hypothesis of independence between the spatial distributions of intelligence and occupation is thus justified. Apparently there is an association between these two variables, although the test of independence does not specifically identify the strength of the association.

The strength of the association may be tested statistically however, by using the contingency coefficient - 'an index of relationship between two variables for the situation in which data are organised into a bivariate frequency table' (Roscoe, 1969, p. 202). Computation of the coefficient is relatively simple once a chi-square value has been determined - as illustrated in the following formula :

$$C = \text{square root of } (\text{chi-square} / N + \text{chi-square})$$

In the context of the present investigation, the correlation, expressed by a contingency coefficient, between the spatial distribution of occupational status

and intelligence is $C = .34$. This coefficient is significantly different from zero, (zero indicating a complete lack of any association), for the rejection of the null hypothesis to be confirmed (Siegel, 1956, p. 200).

Summary

The results produced from the investigation of the two working hypotheses may be summarized as follows:

1) A method was developed which satisfied the three conditions claimed to be critical in defining formally - valid regional groupings. Two regional maps were produced, using this method.

2) Attempts at constructing a single dimension of socio-economic status by scalogram analysis proved unsuccessful (Rep. = .81). A single indicator of socio-economic status, occupational status, was utilized instead.

3) Non-parametric statistical techniques were employed to measure spatial links of association between two statistical maps. The chi-square test of independence indicated that an association did exist between the two maps, and that the possibility of the association resulting from chance factors was extremely remote ($\chi^2 = 52.52$, $df = 4$, $p < 0.001$). The contingency coefficient (.34) indicated that the observed association was sufficiently strong for the writer to conclude that intelligence and socio-economic status are related in the population of which pupils attending Melville Intermediate School are a sample.

V DISCUSSION OF RESULTS

Because the results yielded by the investigation were to a large extent determined by the methods used for defining regional groupings, discussion of the results is necessarily accompanied by a critical analysis of the two methods used for this purpose.

Design of the Investigation

Fundamental to an understanding of the method employed to test the first working hypothesis is an appreciation of the assumptions on which the actual hypothesis were based. In previous studies the city, county, island, or country had been broken up into administrative units such as the ward or school district. The reasons for this division are rarely stated, but one suspects that availability of data is the primary one. Conversely the desire to apportion either the population, or area of the city into equal units is also recognised as a justification used for expressing areal variation in terms of administrative areas (Wiseman, 1964). It would appear therefore that scant regard has been paid to the concept of 'natural area'¹ as a means of expressing the variations in intelligence².

1 Zorbaugh (1926) has defined a natural area as 'a unit in the physical structure of the city, typified by a physical individuality and the characteristic attitudes, sentiments, and interests of the people segregated within it'.

2 Morris (1957, p. 115) has criticized the use of ward statistics in describing the social and economic characteristics of towns for an identical reason.

In view of the nature of intelligence, and its association with the quality of a child's educational environment, it is suggested by the present writer, that its areal variation will be accounted for more meaningfully if the assumptions inherent in the natural area concept are heeded.

The implication for the current investigation then, is that the most appropriate method of identifying areal variations in intelligence is to allow the distribution of the phenomena under investigation to determine its own natural bounds. This is the antithesis of earlier research methodology which had in effect, forced data into a pattern which conformed with ecological theory.

Scalogram Analysis

Scalogram analysis was originally employed to test the first hypothesis, under the misapprehension that it could delimit regions of intelligence. It was discovered in the context of its initial application in this role however, that the regions claimed to have been identified (Timms, 1965, pp. 259-261), had actually been defined by super-imposing maps of six variables thought to be representative of the dimensions of residential desirability. On the basis of their coincidence a number of 'urban regions', were delimited, which were generally bounded by streets, or parts of a street (Timms, 1962, pp. 74-75). The 117 areas delimited in this manner were used as the main frame-

work for all subsequent analyses - including the scalogram analysis designed to measure a single dimension of residential status.

Thus, its significance in the present study is limited to its professed ability to identify a single uni-dimensional scale from a number of variables (Timms, 1965, p. 258). Upon application of the technique as prescribed by Timms, it was found that the coefficient of reproducibility was .81 - a figure which indicated that the three items used were 'unscalable'. In view of this finding, it was decided to investigate the premises on which scalogram analysis was based. Three areas of criticism were identified which indicate that the technique as developed and used by Timms is suspect :

- 1) The original arrangement of items to form the scale - or the selection of the items to secure greater reproducibility (as undertaken by Timms, 1962, p. 74) - involved much subjective judgement.

- 2) The minimum number of items in the scale should be at least 10 (Guttman, 1950, p. 78). Timms used six items initially for his map comparisons, and only three for his scalogram of residential status.

- 3) The technique devised by Guttman, (and modified by Timms) includes no measure of chance reproducibility, i.e., the coefficient of reproducibility that could be expected by chance from a given distribution of item

popularities, if the items were actually independent (Freyburg, 1964, p. 178).

In light of these findings and the coefficient of .81 produced in the present situation, the utility of scalogram analysis is sufficiently limited for alternative techniques to be sought.

The Problem of Regionalisation

The criteria by which a region may be tested for meaningfulness are in dispute, and according to Timms, 'largely depend on the methodological position adopted by the investigator concerned'. Progress has been evident in the identification of multi-variable urban regions, using such techniques as social area analysis, factorial designs, and cluster analysis, but there appears to be a chronic shortage of techniques available to the researcher who wishes to describe a one-factor areal distribution.

The decision to develop and utilize a method which has not been used previously (to the writer's knowledge) is evidence of this dearth. Thus it is believed that under the present circumstances, no other technique is available which can effectively investigate the first hypothesis better than the method developed and described in Chapter IV. In developing the method, the three criteria suggested by Timms were at all times applied, so that the inevitable degree of subjectivity in allocating

the interstitial areas in particular, was minimized.

Perhaps the most meaningful test of the validity of the intelligence regions is afforded by the statistical tests used to account for their pattern of distribution. Once it can be shown that the distribution of intelligence is significantly associated with another variable, then a regional expression of the latter, (using the cartographical and delineation technique) should exhibit patterns which are similar to the regions of intelligence. If the intelligence regions are 'valid' delineations of the total distribution, then the two regional maps should reveal similarities sufficiently alike to be obvious to the human eye. Discussion of the two regional maps will thus be delayed until the significance of the statistical tests has been assessed.

Statistical Analysis

In choosing nonparametric statistical tests to investigate the second working hypothesis, the writer acknowledges the fact that some loss in power is a frequent concomitant. However, under certain circumstances nonparametric tests can retain the same power to reject null hypotheses as parametric tests. One such circumstance applies when data is in rank form, i.e., the researcher can only say of his subjects that one has more or less of the characteristic than another, without being able to say how much more or less. Under such circumstances parametric methods

are precarious, as unrealistic assumptions are frequently required about the underlying distributions (Siegel, 1956, p. 33).

In view of this, the nonparametric statistical procedures adopted in this study appear appropriate. Furthermore, that the power of any nonparametric test may be increased simply by increasing the size of N (Siegel, p. 31), implies that the large population used in the present study ($N = 402$) has given the tests used, considerable power.

The chi-square test for independence was used to determine the significance of differences between the two statistical maps of intelligence and occupation. The null hypothesis under test was that the two maps differed with respect to their distributions, and therefore with respect to the relative frequency with which the rank scores fell into the categories used, i.e. that no relationship existed between the variables. The high chi-squared value (52.52), and the high degree of significance obtained ($p < .001$) meant that the null hypothesis could be rejected, and thus indicated that intelligence and occupational status have very significantly similar distributions in the catchment area surveyed.

The extent of association between the two distributions was measured by the contingency coefficient. Ideally, a more powerful, parametric test for correlation such as the Pearson product-moment correlation coefficient, would have

proved more valuable, but in view of the fact that the requirements concerning interval scaling and a bivariate normal population were not strictly satisfied, it was decided not to include this test in this investigation. Nevertheless, Siegel (1956, p. 201) regards the contingency coefficient as an extremely useful measure of association and thus the value obtained (.34) implies that a significantly high degree of association exists between the two distributions.

The findings of the investigation can be summarized as follows:

1) The statistical description used indicates that the intelligence of pupils in the Melville Intermediate catchment is spatially differentiated into groupings of similar intelligence levels.

2) The statistical measures used indicate that :

i) The distribution thus defined, bears a close areal association with the distribution of occupational status over the catchment, i.e., areal association being indicated when a variation from place to place in the occurrence of one variable is accompanied by a similar place to place variation in the occurrence of another variable.

ii) Because areal association was observed to exist between the two distributions, the validity of the statistical description used may be tested

by comparing the two regional maps (Figures 6 and 9) for regional similarity.

A visual examination of the two regional maps cannot yield the critical values earlier produced by statistical analysis, but it is the opinion of the writer, that in the present investigation such critical values are unnecessary as areal association has already been shown to exist. Furthermore, in view of the results of the statistical analysis, one could expect that a visual examination would be sufficient to identify regional similarity. Under these assumptions then, a comparison of the two maps will be attempted. The analysis is introduced by a chorographic statement¹ of the catchment area in order to bring out more fully the varying social character of the regional types, or of the detailed inter-relationships between intelligence and occupational status.

The catchment area is part of one of New Zealand's fastest growing urban areas. For the period 1956-61 an average annual population increase of 4.41 per cent was recorded for Hamilton City, and this rate increased to 4.70 per cent for the following 5 years. Comparative New Zealand figures were 2.11 per cent for each period (Hamilton Transportation Study, 1969, p. 15).

In 1926, Hamilton Urban Area contained 1.22 per cent of

1 This type of statement has been identified and used by Timms (1964, p. 20) to compensate for the abstract and generalised picture regional types produced by statistical analysis.

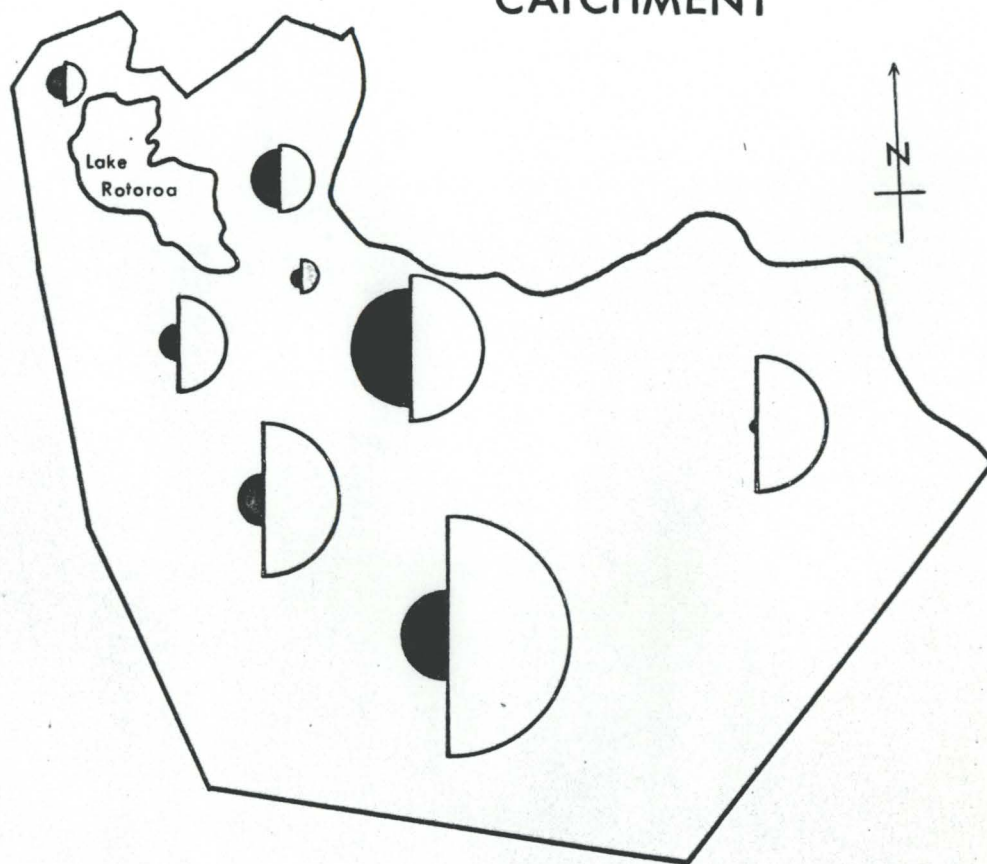
New Zealand's total population, by 1966 this had risen to 2.4 per cent, and projections to 1986 indicate this proportion to be 3.1 per cent (Population Estimates 1966 - 1986, M.O.W., 1967). The same projections predict that by 1986 the Hamilton Metropolitan Area will contain 125,000 people.

Extrapolating from these projections, the Technical Advisory Committee of the Hamilton Transportation Study estimate that by 1988, the Hamilton Metropolitan area will contain a population of 133,000. The expected distribution of this population, together with the present distribution is illustrated in Figure 10. It is obvious from Figure 10 that large population increases, as predicted by the Principal of Melville Intermediate School, are expected in the catchment area within the next 20 years - along with the problems commonly associated with rapid population growth.

This prediction is supported by Figure II, which shows that the dominant age groups in the catchment area (Richmond and Melville) are the 20-29 and 30-39 groups. The Department of Statistics (1969, p. 92) has shown that these two age groups together account for approximately 86 per cent of the legitimate living children whose births were registered in New Zealand in 1967.

It would seem that both the Hamilton City Council and the Department of Education are aware of the situation

POPULATION DISTRIBUTION OVER THE CATCHMENT



Population Scale

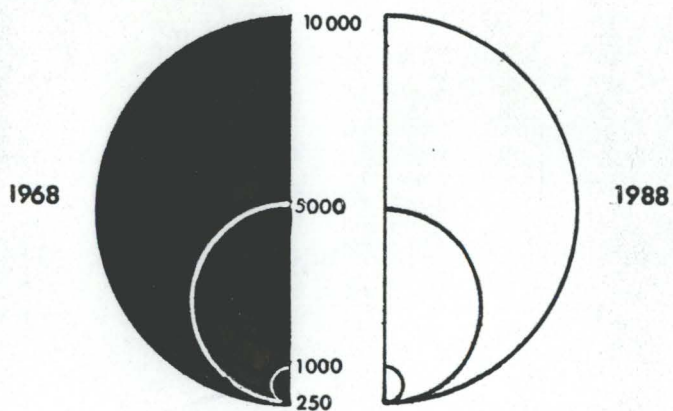
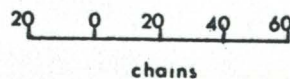
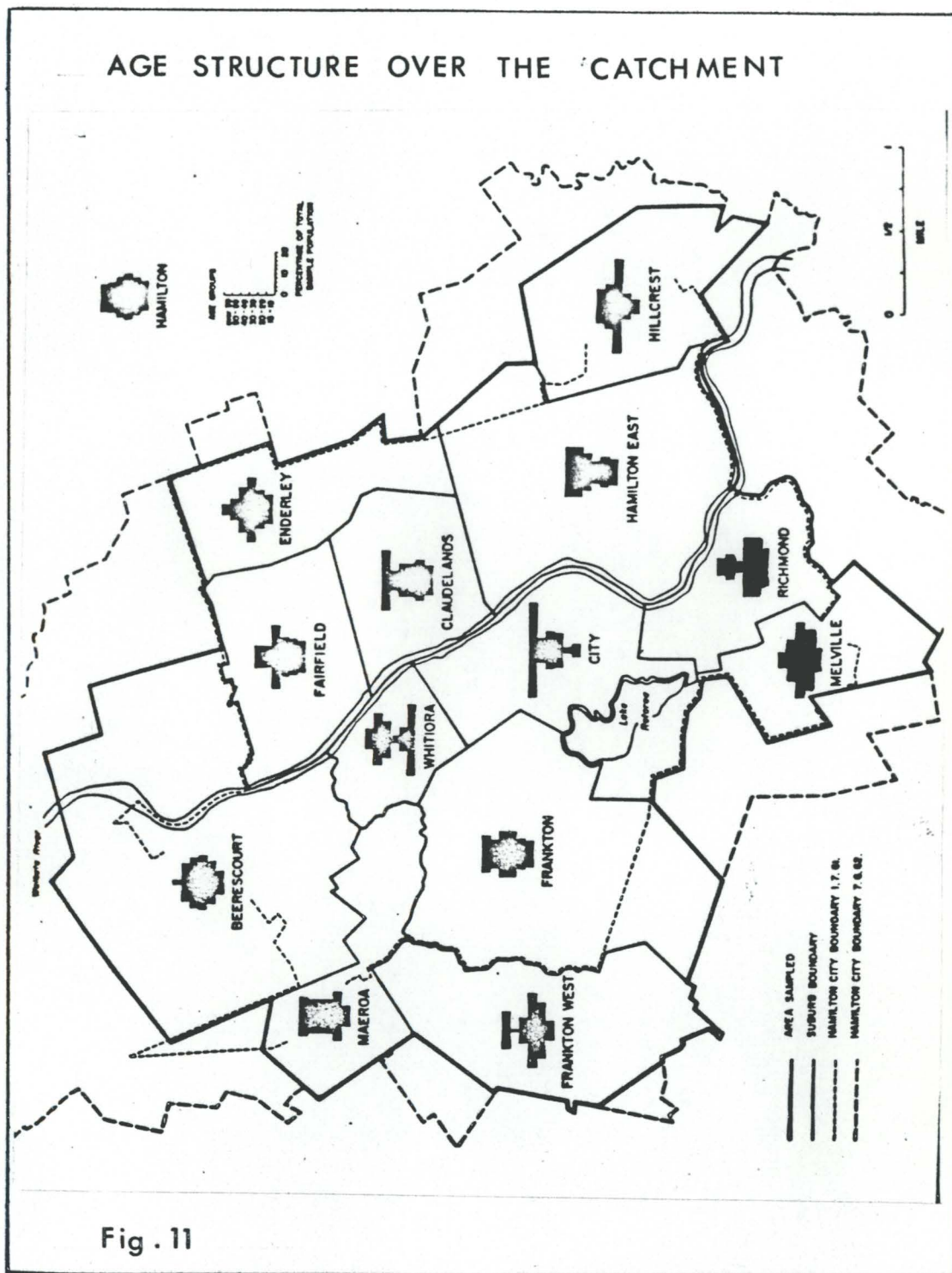


Fig. 10



Source: Hamilton City Council, 1969, Hamilton Transportation Study, Hamilton.



Source: Vandenburg et al., 1964, A Social Survey of Hamilton, Wellington.

however. Extensive city boundary extensions are anticipated within 3-4 years, and the construction of a new primary school is due to begin in Collins Road in the very near future.

The physical aspect of the catchment area is illustrated in Plate 1 - an aerial photograph of the area in which the catchment is located. The photograph, chosen to emphasize the areal differences in topography, were taken in 1943.

The pattern of settlement shown in this photograph is significant, as the city boundary in 1943 did not include the small housing settlement in the vicinity of Tawa Street - Mahoe Street/Ohaupo Road, nor the properties along Lake Crescent (Figure 12). This would suggest that these sites exhibited some desirable characteristic which motivated people to choose them as a place of residence. In view of the impending boundary extensions (1949), it is unlikely that economic motives, (i.e., low purchase cost), would have provided this incentive. In fact, Figure 13 indicates that these two sites possess the highest unimproved value of any, located within the catchment. Rather, it is suggested that their elevation, and proximity to Lake Rotoroa (respectively) accounts for their early settlement - and their currently high residential value.

Conversely, it is noticeable that the extensively gullied area of land between Ohaupo Road and the Waikato

PLATE I
Catchment Area, 1943



HAMILTON - BOUNDARY EXTENSIONS 1912 - 1965

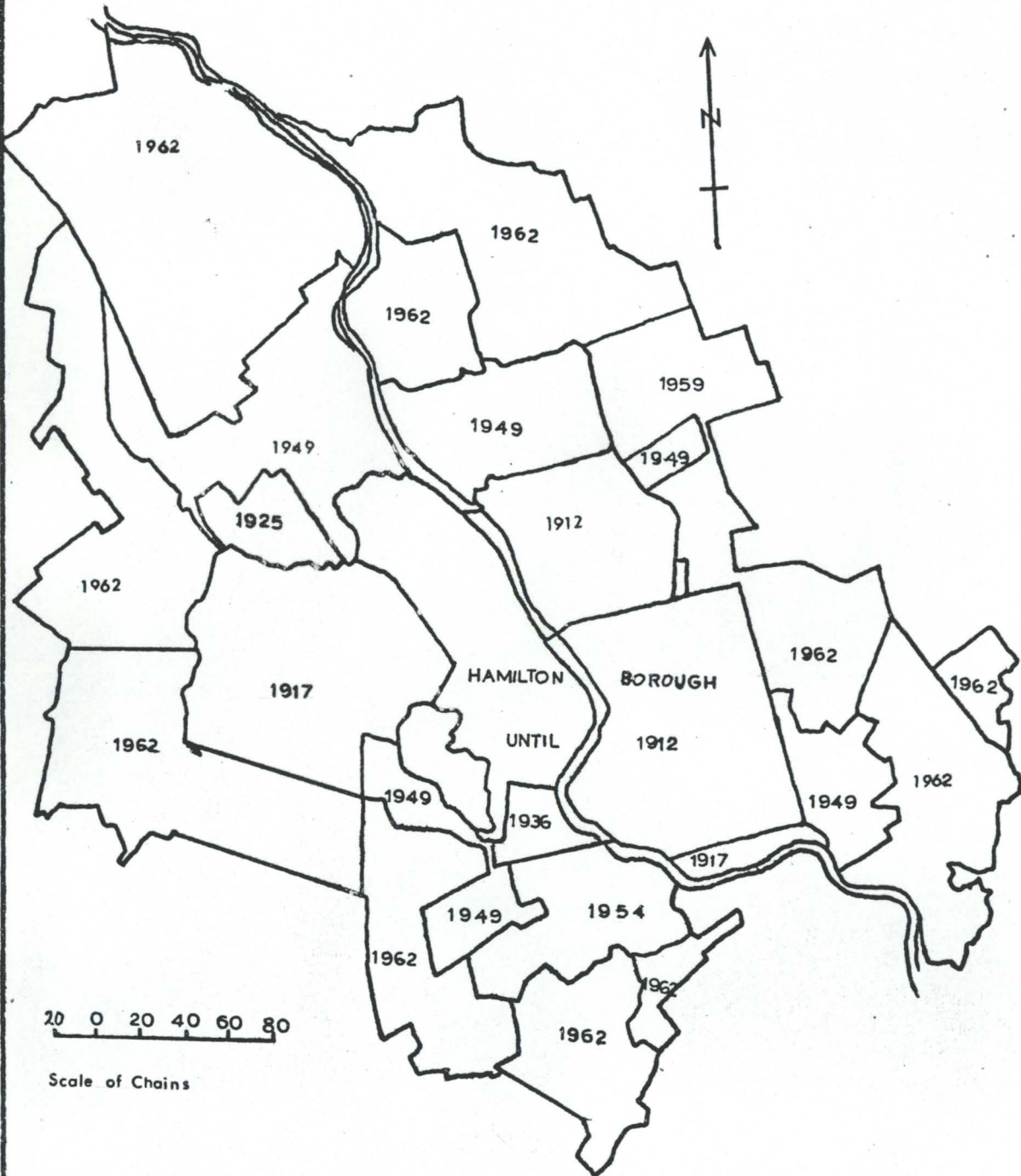


Fig.12

VALUE OF UNIMPROVED SECTIONS OVER THE CATCHMENT

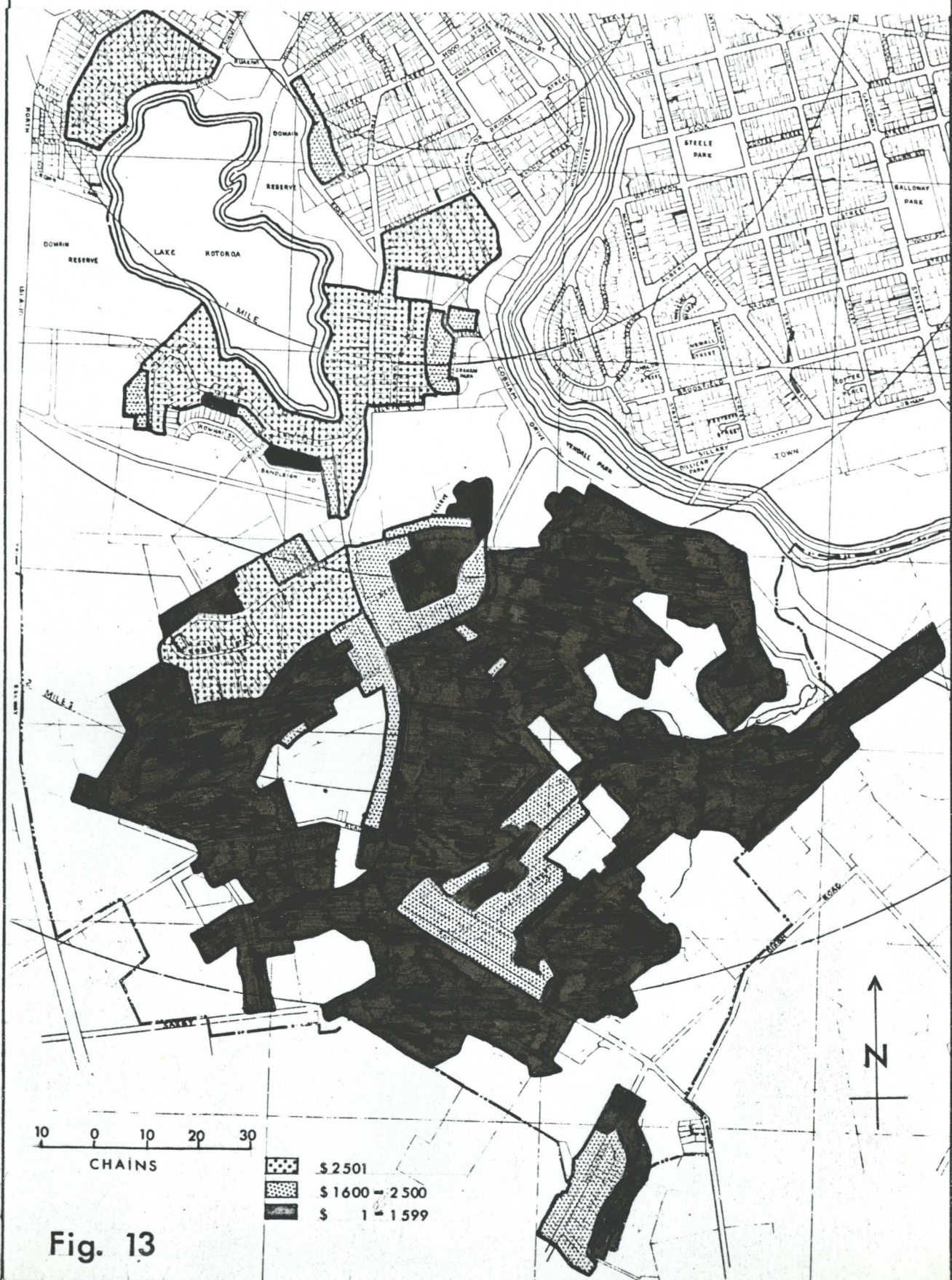


Fig. 13

River was largely undeveloped. In view of its proximity to the Waikato River, this factor would appear incongruous, as access to an expanse of water such as a river, has been found to contribute significantly to variations in the value surface of urban areas (Yeates, 1965). It is suggested however, that the main reason for the lack of development was the fact that the Housing Division of the Ministry of Works had acquired a large portion of this land for development into State rental units, in 1936 (Figure 14).

The influence which the topography of the land exerted in the Ministry of Works choice of area is readily apparent. The area chosen consisted of a flat piece of land (easily developed), which was bounded on three sides by natural barriers. Subsequent residential development has also been affected by these barriers, with the streets in the Bruce Avenue - Willis Street - Garden Heights Avenue area, corresponding very closely with the land contours. Similarly, the large peat swamp area to the west of the catchment has acted, and continues to act, as an effective barrier to residential development.

In addition to illustrating how the physical features of the catchment have influenced settlement, Plate 1 indicates the rapid growth rate of the area, which was identified earlier. When compared with Plate 2, (a recent (1967) photograph which includes the catchment area, taken from an altitude of 20,000 feet), it is obvious

STATE HOUSE AREAS IN THE CATCHMENT

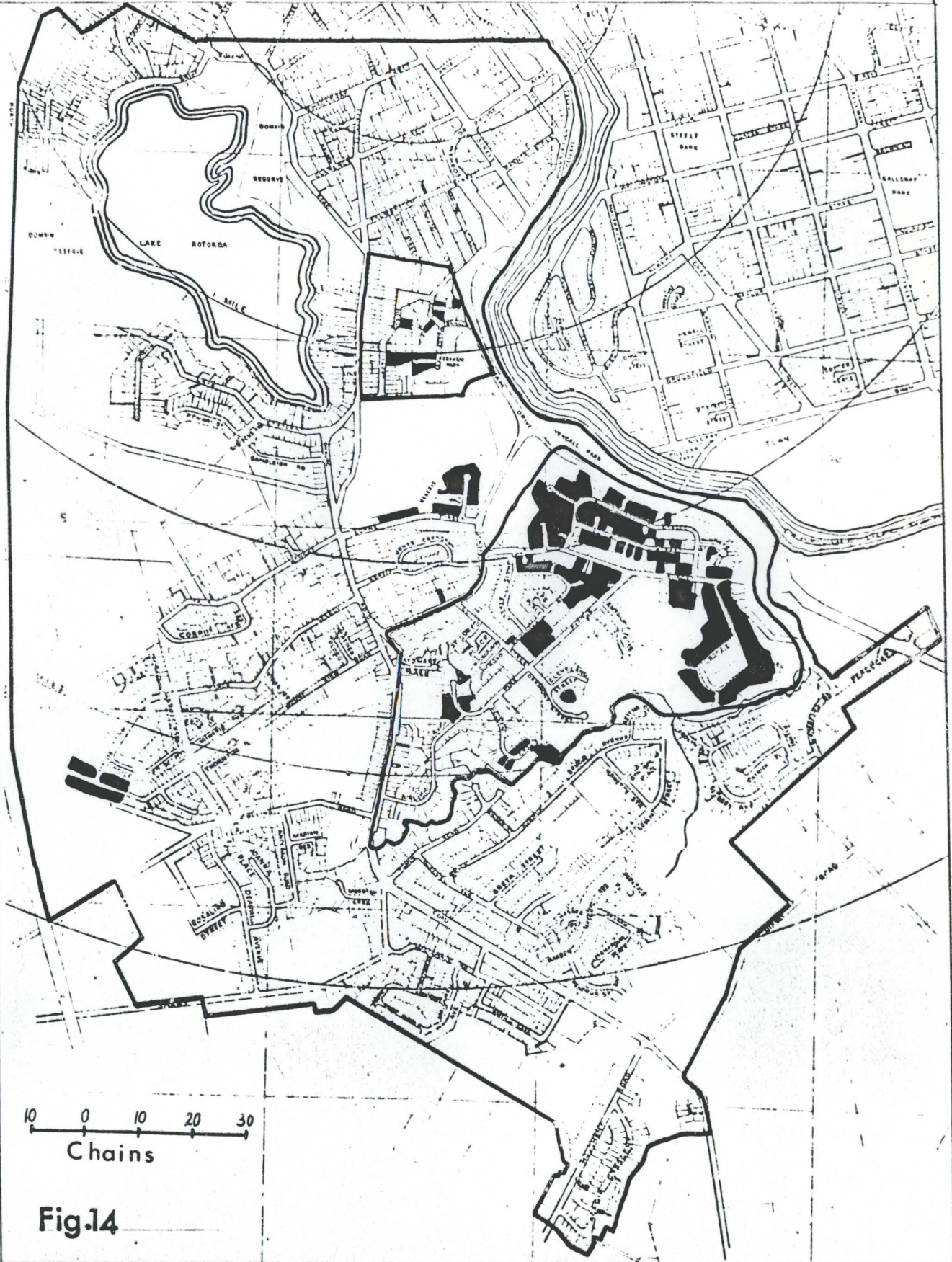


Fig.14

PLATE II
Catchment Area, 1967



that the population growth rate figures are readily reflected in the pattern of settlement.

Throughout its 107 years of existence, Hamilton City has functioned primarily as a supply and service centre. Vandenburg et al., in the course of their social survey, attribute Hamilton's rapid growth rate to its pre-eminence as the administrative, commercial, and professional centre of the South Auckland area. Since the 1950's however, this first major function has been augmented by a second which is gradually matching it in importance (Robinson, 1965). In the year 1966-67, Hamilton ranked third in New Zealand by number of factories (837), and third by value of production (195.4 million dollars) (Department of Statistics, 1969, p. 476). The impending establishment of the largest industrial estate in New Zealand (140 acres) at Te Rapa confirms this new role.

In spite of the rapid industrial development which is occurring however, data obtained during the Hamilton Transportation study¹ show that from the catchment area population, only 334 are employed in industry. Although a considerable increase is predicted in this sector by 1988 (1,229 out of an expected total employed population of 4,455), the catchment area promises to continue to

1 Surveying for the Study was carried out by dividing Hamilton into 79 zones. These were defined on the basis of size, topography, potential and existing land use, the location of major roads and population included. The catchment area corresponded with zones 17 - 24, and 79 (Figure 15).

STUDY ZONES USED FOR THE HAMILTON TRANSPORTATION STUDY

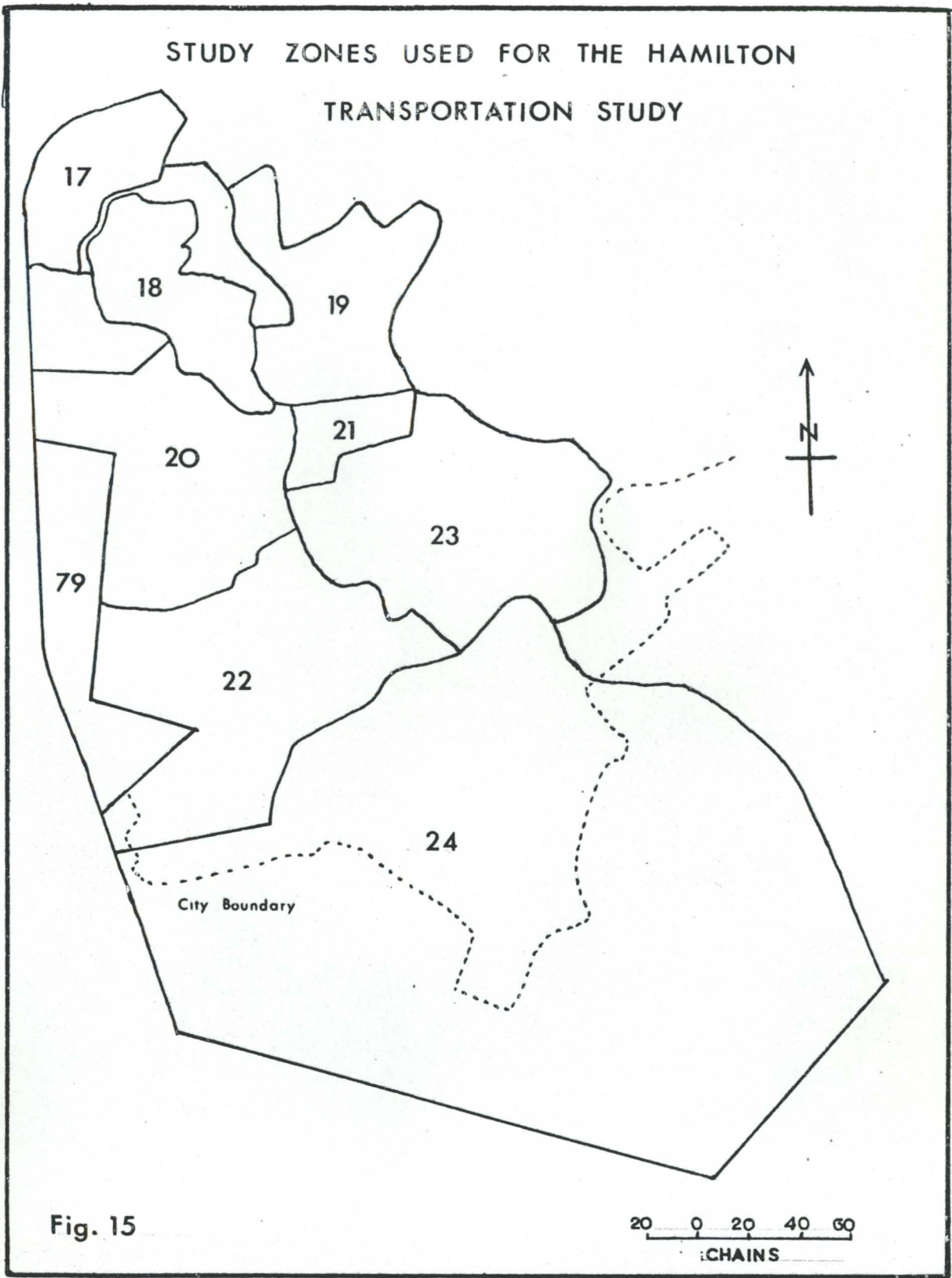


Fig. 15

20 0 20 40 60
CHAINS

to provide residence for administrative, commercial, and professional people primarily (Table III).

TABLE III
EMPLOYMENT IN LAND USE GROUPS

Zone	1968				1988			
	Com.	Ind.	Other	Total	Com.	Ind.	Other	Total
17	2	-	-	2	8	-	44	52
18	5	-	-	5	10	-	-	10
19	18	4	53	75	30	-	61	91
20	5	289	12	306	32	300	22	354
21	-	-	1774	1774	-	-	2500	2500
22	36	-	79	115	55	-	96	151
23	94	13	19	126	94	13	21	128
24	17	11	76	104	170	16	83	209
79	-	17	-	17	-	900	-	900
TOTAL	177	334	2013	2524	399	1229	2827	4455

Source: Hamilton Transportation Study, Basic Data Report, p. 94.

In light of the above introductory description, several suggestions can be proposed which may assist in assessing the legitimacy of the regional distributions of intelligence. It is evident that the two maps (Figures 6 and 9) possess a large number of regions which not only covary in their regional boundaries but also in their category values (high, medium, or low). Particularly prominent in this respect are the regions located in close proximity to :

- 1) Lake Rotoroa.
- 2) Tawa and Mahoe Streets.
- 3) Yvonne, Priscilla, and Minifie Streets.

- 4) Morrison Crescent and McDonald Road .
- 5) Houchens and Peacockes Roads.
- 6) Garden Heights Ave., Glenview Tce., Greta and Lewis Sts.
- 7) Ohaupo Road and Urlich Ave.
- 8) Pine Ave., and Stewart Place.
- 9) Anthony Cres., Odette, Willis, and Dermont Streets.
- 10) Beatty, Lorne, and Dowding Streets.
- 11) Montgomery and Trigg Places.

The predominance of these regions over the catchment area supports the hypothesis that the statistical description used, provides a valid means of identifying groupings of similar intelligence levels.

The discrepancies which exist, and which appear to contradict the above hypothesis are few, but nevertheless demand explanation. These regions include the following:

- 1) Pollen Cres., Tomin Road, Bruce Avenue area.
- 2) Norrie Street.
- 3) Slim Street - Bader Street.
- 4) Lake Crescent.
- 5) Prisk Street - Anderson Road.

Their presence within the study area can be expected in view of the fact that the contingency coefficient did not indicate perfect correlation between the two variables under investigation. However the factors which have contributed to their existence are difficult to identify. For example, one would expect Norrie Street to exhibit a

predominantly low intelligence characteristic in terms of its occupational structure. This expectation is reinforced when Figures 13, 14, and 16 are consulted - not only is it almost entirely a State housing area, but also, it has a particularly high persons-per-dwelling figure (5), and its unimproved section values are among the lowest in the catchment.

A similar situation is apparent in the Pollen Crescent - Tomin Road - Bruce Avenue region. A considerable portion of the area consists of State housing units, the dwelling density is high (4.5), and unimproved section values are low - yet the region is ranked as medium intelligence.

Laké Crescent, as a third example of this paradoxical situation, shows characteristics which necessarily indicate a high socio-economic rating, yet its intelligence ranking appears as medium.

The presence of these regions can be attributed to an apparent weakness in the method used for identifying them. In the process of being classified, it was observed that all of these regions exhibited interstitial characteristics, i.e., intelligence rankings which spanned a broad range of values. The problem which confronted regionalisation has been referred to already, and it was found that the most satisfactory means of determining their respective classification was achieved by averaging the rankings and

assigning the value obtained, to that region. It is suggested therefore, that by using a measure of central tendency, the internal variations of intelligence within each of the 'discrepant' regions were smoothed over to produce a mean value.

In view of this, the validity of the statistical description used may be questioned. It is the writer's opinion that, although the method has shortcomings in classifying such areas, it is a nevertheless valid means of approaching the problem being investigated. By far the majority of regions were found to correspond both in location and internal homogeneity and it is suggested that the few regions which did not conform to the expected pattern, in fact, confirm the relative objectivity of the technique.

VI SUMMARY AND CONCLUSIONS

The main objective of the writer in undertaking this investigation was to extend investigations of the geographical distribution of intelligence beyond the mere description of areas selected on the basis of convenience. Whereas previous research had primarily been undertaken in large areas selected because a wealth of data was available, and which offered a situation particularly suited to an investigation of this nature, the present investigation aimed at exploring the distribution of intelligence within the catchment area of one school.

Realization of this objective required formulation of a problem which could be investigated satisfactorily within the limitations imposed by lack of available data, and absence of a suitable methodology. The problem ultimately identified involved investigation of two hypotheses, which were developed from the findings and criticisms of earlier research. Investigation of the problem also demanded the construction of a satisfactory methodology so that the two hypotheses could be tested. Consequently, considerable time and space has been devoted to this aspect of the problem in this paper.

Investigation of the first hypothesis called for a technique which could objectively identify and define a spatial distribution as it appears on the earth's surface.

The technique ultimately adopted appears to satisfy these requirements, in spite of its susceptibility to subjective judgement. Regions of similar intelligence rankings were able to be identified, and the only apparent weakness in the technique occurred in the assignment of a value to those regions exhibiting a wide range of intelligence rankings. In such cases, a fourth category, 'interstitial regions' might have given the final regional map added value, instead of attempting to create a reality where none might exist.

The second hypotheses called for a technique which could accurately describe the degree of association between the regions identified, and other phenomena which might assist in identifying the aetiology of the regions. Previous research has suggested that socio-economic status is highly associated with intelligence, and in the present study this same factor is found to account for much of the regional variation in intelligence.

The major conclusion that has resulted from the investigation of these two hypotheses, is that regions of intelligence need not necessarily correspond with administrative, statistical, or suburban regions - rather, they are the products of the physical and social environment, and their regional expression may ignore the existence of administrative boundaries. This conclusion implies that the problem identified for study

is an important one, as the assumptions on which earlier research were based, have been shown to be disputable.

It suggested that future research be undertaken which incorporates a more rigorous statistical test of regional identification, in order that this conclusion may be substantiated.

APPENDIX A

INTERPRETATION OF CODE USED FOR CATALOGUINGINTELLIGENCE AND SOCIO-ECONOMIC DATAOBTAINED FROM SCHOOL RECORD CARDS

- 1) Card Identification, a seven column code in which the first six columns denoted an abbreviation of the study title, the last one denoting the Form to which the child belonged. (Columns 1-7.)
- 2) Card Number, a three digit code used for identification purposes. (Columns 8-10.)
- 3) Home Location, a ten-digit code combining one digit for the map-set used, and nine digits for the x and y co-ordinates of the map-set in which the child's home was located. Because the computer could only map an area comprising 60 horizontal and 60 vertical units (one map-set), the total catchment area necessitated a combination of nine map-sets. (Columns 11-21.)
- 4) I.Q. Category, a seven-digit code referring to one of the seven rankings of intelligence illustrated in Table II. (Column 22)
- 5) Street Location, an eighteen-column code describing the street number and street in which each child lives. (Columns 23-40.)
- 6) Occupation, a ten-digit code denoting the occupational status of the child's father, expressed as T-scaled

scores. (Columns 41-44.) This method of describing occupational status was devised by Lovegrove (1964) in order to minimize economic components and maximize the contribution of factors related to the more general cultural level of the home. Construction of the scale was achieved by re-arranging the occupations listed in the Congalton - Havighurst (1954) scale into random order, and asking fifty teachers to assign each occupation into one of two groups on the basis of the extent to which the average individuals engaged in them would be more likely than not to provide a home environment which was congruent with that of the school.

The resulting data was analysed to provide T-scaled scores for each occupation. Reliability was assessed by submitting the inventory to four judges and asking them to rate each occupation on a 1-30 scale utilizing the 'cultural level' criterion. Ratings were inter-correlated and values ranging from $r = .817-.897$ were obtained.

Considerable difficulty was experienced with some of the occupations listed on the school record cards, so that on numerous occasions clarification was sought either from the classroom teacher in the first instance, or from the parents themselves if the second attempt proved fruitless.

7) Race, a two-digit code based on a Department of

Education survey. (Column 45.)

8) Number of Schools Attended, a nine-digit code denoting the number of admissions each child has experienced at individual schools. (Column 47)

9) Marital Status, a combined four-digit code denoting the current marital status of each child's parents. (Columns 49-50.)

10) I.Q. Score, a ten-digit code based on each child's score on the Otis Self-Administering Test of Mental Ability, Intermediate Examination: Form B. (Columns 52-54.)

11) School Attendance, a ten-digit code denoting the number of half-days that each child has spent at school during the 1970 school year. (Columns 55-57.)

APPENDIX B

STANDARDIZATION PROCEDURE FOR THE OTIS TEST OF MENTAL
ABILITY

The proposal to re-standardize the Otis Test was made by the Test Development Division of NZCER when plans were being prepared for the standardization of a battery of reading tests developed for New Zealand schools at the request of the Government.

A sample of 6,000 children between the ages of nine and fifteen years was selected, representing proportionately all board districts, all sizes of community and each type of public school. No private school children were included, while Maori and immigrant pupils were included in approximately the same proportions as they occurred in the total population. As in the 1936 survey, schools were selected at random to represent each category adequately, but this time, only a sample of pupils at each school was tested. Each chosen school submitted a list of all their pupils in the relevant age groups, from which children were selected at random to represent adequately each age level and both sexes. Substitute pupils were also indicated in case of absences on the day of testing. Of the 94 schools asked to participate, only three secondary schools were unable to co-operate at the time appointed. These schools were replaced by others in the same categories.

All testing was carried out on 8 March 1968 by head-teachers or their deputies, following instructions provided by NZCER staff. Marking and tabulation were performed in the Council's office, and results transferred to cards for computer analysis.

XXXXXXXXXX

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** PHIL LAURENCE - GEOGRAPHY MAPPING PROGRAM.

APPENDIX D

SCALOGRAM ANALYSIS

Basically, the scalogram technique consists of ordering ranked data in such a way that a single unidimensional scale is produced along which effective measurement is possible. Thus a number of observations are reduced to a single dimension, which may then be used as a stratification and correlative instrument.

The consistency of the scale of observations is tested by identifying the 'errors' in predictability which are created. If the scale were perfect, no errors would exist, and one could conclude that the observations being scaled comprise a single dimension. A perfect scale assumes the form of a parallelogram, (Table A/I).

TABLE A/I

DICHOTOMIZED THREE ITEM SCALOGRAM

Items	High Values (Score 1)			Low Values (Score 0)			Scale type	Scale score
	A	B	C	A	B	C		
Area 1	x	x	x				I	3
Area 2		x	x	x			II	2
Area 3			x	x	x		III	1
Area 4				x	x	x	IV	0

x indicates area response to item.

Source: D.W.G. Timms, 'Quantitative Techniques in Urban Social Geography', in Frontiers in Geographical Teaching, eds. R.J. Chorley and P. Haggett, 1965, p. 258.

The coefficient of reproducibility measures the degree with which the obtained multi-variate distribution corresponds to the expected multi-variate distribution of a perfect scale - a coefficient of .90 being regarded as the minimum level of significance before a series of observations can be assumed 'scalable'.

In the context of Timm's study, the technique was used to test an apparent similarity between a series of maps showing the physical and socio-economic structure of Luton. The scale analysis technique enabled this impression to be tested since the scale scores from a valid scale correlate with an external variable to the same extent as would a multiple correlation of all the scale items. Application of the technique yielded a coefficient of reproducibility of .91 for the various physical, social, and economic attributes scaled, enabling Timms to conclude that Luton possessed a uni-dimensional scale of residential status as described by the test scores (Timms, 1962, p. 212).

APPENDIX E

SOCIO-ECONOMIC DIMENSIONS USED FOR SCALOGRAM ANALYSIS

Vellakop (1969, pp. 265-268), in discussing the problem of constructing a reliable index of socio-economic position suitable for New Zealand conditions; identifies two approaches : the prestige scores of occupations as a single index, and multiple-item indexes which combine indicators such as occupation, education, house type, residential area, and subjective class placement.

Occupational status therefore is well documented as a most reliable single index (Lovegrove, 1966; Mitchell, 1962; Nixon, 1954; Porterfield and Gibbs, 1960), and its use is considered justified in the present investigation both as a single index, and included in a multiple-index of socio-economic status. Details of its application in the present study are contained in Appendix A, and Table A/II below.

Differentiation in land-section values is considered by the present writer to be a valid indicator of socio-economic status. The rationale for purchasing land on which to reside, is influenced not only by economic factors, but also by social factors. Certain people are quite prepared to sacrifice large sums of money merely to increase their prestige by residing in an area which is regarded

as having certain desirable status connotations. This suggestion has been documented by Chapman (1955, pp. 149-167) who cites evidence that there is a movement from areas of low status to areas of higher status, and a process of residential segregation of status groups in English cities.

In the New Zealand situation, Johnstone (1965, p. 104) has suggested that the average valuation of residential improvements is significantly related to the economic prosperity of the people living in certain areas of Christchurch - that valuation, in other words, might be a fair indicator of areal variations in levels of income. By extrapolation, the decision to include the value of unimproved sections as an indicator of socio-economic status is thus warranted. The data used to determine the areal variation in the value of unimproved sections was obtained from a survey conducted by the Hamilton City Council. The results of the survey are illustrated by Figure 13, necessarily generalised into categories in view of the confidential nature of the information.

The number of persons per dwelling was included as a dimension in the investigation, with the intention of identifying areas in which overcrowding was evident. This characteristic was utilized in a social survey of Hamilton conducted by the School of Social Science from Victoria University of Wellington (1961) for identical

reasons. Information on this characteristic was also obtained from a survey conducted by the Hamilton City Council. The areal differential of persons per dwelling is illustrated by Figure 16. The categories defined in Table A/II are based on a 1961 average of 3.62 persons per dwelling in Hamilton and a national average of 3.74 (Vandenburg et al., 1964, p. 21).

TABLE A/II

ITEMS AND CATEGORIES USED TO CALCULATE AN INDEX OF SOCIO-ECONOMIC STATUS IN THE MELVILLE INTERMEDIATE CATCHMENT

ITEM	SCORE 0	SCORE 1	SCORE 2
Occupation (t-scaled score)	31-46	47-55	56 and above
Valuation (dollars)	1-1600	1601-2500	2501 and above
Persons/ Dwelling	4.6 and above	3-4.5	1-2.9

APPENDIX F

TABLE A/III

OBSERVED FREQUENCIES OF OCCURRENCE FOR INTELLIGENCE AND
OCCUPATION

		INTELLIGENCE ^a								
OCCUPATION ^b	CASES	130-	120-129	110-119	90-109	80-89	70-79	69-	TOTAL	
		Rank	1	2	3	4	5	6	7	
	60-69	1	9	16	20	18	1	0	0	64
50-59	2	5	10	33	24	4	0	0	76	
40-49	3	3	20	67	87	19	5	2	203	
30-39	4	0	2	8	32	14	3	0	59	
TOTAL		17	48	128	161	38	8	2	402	

a Intelligence Test Scores

b T-scaled Scores

TABLE A/IV

EXPECTED VALUES FOR INTELLIGENCE AND OCCUPATION

		INTELLIGENCE							
RANK		1	2	3	4	5	6	7	TOTAL
OCCUPATION	1	2.70	7.64	20.38	25.63	6.05	1.28	0.32	64
	2	3.22	9.08	24.19	30.44	7.18	1.51	0.38	76
	3	8.58	24.24	64.64	81.30	19.19	4.04	1.01	203
	4	2.50	7.04	18.79	23.63	5.58	1.17	0.29	59
	TOTAL	17	48	128	161	38	8	2	402

TABLE A/V

CHI-SQUARED DATA FOR INTELLIGENCE AND OCCUPATION

		INTELLIGENCE				
OCCUPATION	(observed)	RANK	1-3	4	5-7	TOTAL
	1-2		93	42	5	140
	3		90	87	26	203
	4		10	32	17	59
	TOTAL		193	161	48	402
(expected)	1-2		67.21	56.07	16.72	140
	3		97.46	81.30	24.24	203
	4		28.33	23.63	7.04	59
	TOTAL		193	161	48	402

$$\chi^2 = 52.52$$

df = 4

p < 0.001

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