A STUDY OF THE RELATIONSHIP BETWEEN AGE AND DETERIORATION OF HOUSING IN THE CITY OF BOSTON

by

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Professor Frederick J. Adams
Head, Department of City and Regional Planning
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Cambridge, Massachusetts

Dear Professor Adams:

I herewith submit my thesis entitled "A Study of the Relationship Between Age and Deterioration of Housing in the City of Boston" in partial fulfillment of the requirements for the degree of Master in City Planning.

Yours very truly,

ACKNOWLEDGMENTS

I wish to thank Professors Burnham Kelly and Kevin Lynch for their suggestions and helpful criticisms in regard to this thesis, and also Professor Solow of the Economics Department for his help with the statistical aspects of this study. My thanks also to Bill Johnson and Leo Young of the Boston Housing Authority, and to Leon Pollard of the City Planning Board for their assistance. Finally, I want to express my great appreciation to Genie Elder for the many hours she put into the final preparation of this thesis.

D. H. W.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

A STUDY OF THE RELATIONSHIP BETWEEN AGE AND DETERIORATION OF HOUSING IN THE CITY OF BOSTON

I. INTRODUCTION

Many studies have been made during the last half-century or more about the deterioration of housing in urban areas and the development of so-called slums. As a result of these studies, a great many factors--physical, economic, sociological--have been claimed to be causally related to the deterioration of housing and of residential areas. Yet there is still a great deal of disagreement even among the experts as to just which factors, and how many, are really significant in this process; and the relative importance of each is seldom even discussed.

It is felt that most existing studies on housing deterioration, though valuable as pilot studies, suffer from two great weaknesses:

1. Such studies generally have been case studies that were limited to particular neighborhood areas. This has meant that any conclusions drawn from them could not be extrapolated to other areas even within the same city. A further difficulty is that these studies have not been systematically related to one another; their terms of reference therefore are often so different that comparisons between different studies are made difficult or impossible.

2. There has been no common denominator by which the relative importance of each asserted causal factor could be weighed. It is difficult to see how a full understanding of deterioration processes can be achieved until there is developed a consistent set of

relationships that would make all measurable factors mathematically comparable.

While there is still a great deal of valuable work to be done along the present lines of housing research, it is felt that this work might be made far more valuable if it could be tied together under a systematic program for housing study; and that a quite different approach to such research is needed if a truly comprehensive and consistent body of knowledge about the life cycle of residential structures and neighborhoods is to be attained.

The method of analysis to be suggested here would be centered around the determination of mathematically expressible relationships between the various factors that are thought--and eventually proved--to be significant in the deterioration process. The objective of such a method would be to obtain an over-all framework of reference, which would be developed by accepted statistical methods from the broadest possible base of statistical data. Such a framework eventually would not only indicate within fairly rigorous bounds what were the principal factors involved in the deterioration of any particular area, given the necessary economic, sociological and physical data, and thereby outline the most effective remedial steps to be taken; it would also enable planners and others to predict within known probabilities what the future course of this process would be, with and without various kinds of remedial action.

Within the first stages of such an overall plan for study, individuals engaging in research about deterioration would be encouraged to choose only two or three of the many possible variables and to investigate

their relationship as thoroughly as possible over a sufficiently large area that all varieties of conditions would be well represented. This would be in contrast to the more usual procedure of investigating rather superficially the relationships among a great number of factors over a very limited geographical area. Once such a statistical framework was established, studies of small areas could be made on a much more rational basis than is now possible; for the investigator could feel assured that he was not dealing with an exceptional case or a biased sample unless he had deliberately chosen to do so.

The remainder of this thesis is an example of the type of studies envisioned above. Although it is hoped that the conclusions of this study may have at least some usefulness in themselves (aside from being the basis for future research), they will be most useful only after a set of parallel studies relating deterioration to each of a number of other variables for Boston have been made. Such parallel studies would include research on the relationship of deterioration to such physical factors as type and quality of original construction of dwelling units, land coverage, admixture of land use, and geographical relationship to the whole metropolitan area. They would also include the influence of such historical factors as the diversity of housing age in small areas, population shifts and ownership patterns, and such economic factors as the influences of depressions and booms on housing deterioration.

II. OBJECTIVES

The purpose of the remainder of this thesis is to explore in detail the relationship between age and deterioration of housing in the city of Boston. Within this framework, there were three principal objectives:

1. To get a picture of the total range and distribution of housing age and deterioration conditions by census tracts over the entire City,

2. To see if there is any similarity between the geographical distribution of census tracts according to housing age and deterioration and the distribution of tracts according to their rate of housing deterioration,

3. To see if there is a sufficient relationship between age and deterioration that one might be able to predict the future deterioration pattern of any particular area within definite limits of confidence.

In connection with the third objective, it should be stated that although the author is attempting to find functional relationships between age and deterioration, he is not assuming that age in itself is necessarily a cause of deterioration. The author's concept is only that age may be used as an effective index to represent a number of other factors which tend to cause deterioration and which tend to increase in relative importance as an area becomes more aged.

An important methodological objective throughout this study has been to try to draw conclusions that are based on the largest portion of

the Metropolitan area for which both suitable and consistent data is available. The city of Boston was chosen because it fulfilled both of these objectives, and at the same time was known to have a good cross section of housing types and of old and new neighborhoods.[0]

This study differs from most others on housing condition in that it is concerned only with whether a dwelling has been maintained in (or returned to) a state of relatively good repair, or whether it has been allowed to deteriorate. It is not concerned with whether or not a dwelling meets any set of standards in terms of its equipment, location, or basic design. These are considered to be problems of housing obsolescence, as distinguished from housing maintenance which this study is attempting to measure.[1] It would be quite possible for a dwelling unit to be in good condition in the sense that that word is used in this study, and yet also be substandard because it lacks certain kinds of plumbing or heating equipment that are now considered as necessities. The problem of obsolescence is related to this study only in the sense that the design of a dwelling unit or the lack of standard facilities may contribute to a lack of proper maintenance of a property.

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[0]It was originally hoped that this study could cover the entire Boston Metropolitan area, but only the city of Boston was found to have sufficiently detailed data. It should be noted that the age distribution of tracts in the City probably is not typical of that of the Metropolitan area; and that there would have been a much larger sample of relatively young tracts (see Figures 7 and 8, pp. 21 and 22) if all the cities and towns of the Metropolitan area could have been included in this study.

[1]There is some question as to whether the lowest category of housing condition in the data used for this study ("unfit for use" or "unfit for human habitation") is exempt from direct consideration of factors of obsolescence or not. See footnote 11 on page 10.

III. DETERMINATION OF AGE AND CONDITION INDEXES

With one minor exception, all of the basic data used in this study was collected in a Real Property Inventory survey conducted in 1934 by the Boston City Planning Board with staff assistance from the Federal Emergency Relief Administration. This Inventory presumably covered every dwelling unit that then existed in the City, and amassed a large amount of information about each one, including the enumerator's opinion of the condition of each structure and the owner's or tenant's opinion of its age.[2] While it is probable that the data used for this study may be quite inaccurate in its application to individual dwelling units because of the large element of personal judgment involved in obtaining it, it is assumed that these errors or biases have been largely cancelled by the grouping of this information into areas as large as census tracts.[3]

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[2]Unfortunately the final report on this study (Report on Real Property Inventory for the City of Boston--1934, Boston Planning Board, August, 1935, Volumes I and II) tabulated dwelling age only in terms of structures. Since is was felt desirable that this study should be made in terms of dwelling units, it was necessary to obtain the 1934 data for this study from a set of worksheets that were tabulated by the Boston Housing Authority in 1940. These worksheets (which measure 22 in. by 28 in. and are labelled "Boston Housing Authority Table 1A") are kept in a plan file in a basement storage room of the Old Harbor Village Project in South Boston. A summary of these worksheets for the City as a whole and for each Health and Welfare district (but not for each census tract) is available at the central office of the Housing Authority in Boston. Maps showing the boundaries of these districts and the tracts each one includes may be found in Appendix A.

[3]A majority of Boston census tracts have more than a thousand dwelling units.

Whatever bias may remain after this grouping is assumed to be insignificant in relation to the generality of the conclusions sought from this study.

In addition to being far more complete in its system of classifications than any other data available, the data used was felt to be advantageous for this study because it was gathered before the active entrance of government into the field of housing, either in terms of public housing or in terms of stimulating rehabilitation; and therefore reflects housing characteristics under free market conditions better than any more recent survey would.[4]

From this data, two index numbers were calculated for each of the City's 155 census tracts.[5] One of these, an age index, is a measure of the average age of dwelling units in each tract; the other, a condition index, is a measure of the average condition of dwelling units in each. Since these indexes are the units upon which all of the statistical work of this thesis is based, a full description of each one will now be given.

The Age Index

The age index (I_a) is a measure of the mean age in 1934 of all dwelling units in a tract that were built between 1860 and 1934. More precisely, it is a number arrived at by multiplying the percentage of

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[4]The data also of course reflects those characteristics after five years of depression. Whether or not this had resulted in an abnormal amount of deterioration of housing in Boston by 1934 is not known.

[5]Tract B-6, which covers the islands of Boston Harbor, is not included in this number, and was not included in this study. Figure 14 (Appendix A) shows the location of each of these tracts.

dwelling units in each age group appearing in the original tabulation by the number of years from 1934 to the median year of that group, adding the products, and dividing by 100.[6] Houses listed as being built before 1860 were not included in this index calculation because they were classified in an open-ended age group which had no median value; and no dependable method was available by which one could calculate a quantity to be used in place of such a median.[7] Since the oldest age group tabulated in the data has a median of 62 years, it is impossible for I_a to have a value any larger than this figure. The age of each dwelling unit in any multi-family structure was assumed to be identical with the age of the structure itself.[8]

Schematically,

$$I_a = \frac{\Sigma d_1 n_1}{\Sigma n_1} \quad \text{for each tract,}$$

where d_1 = number of years from 1934 to median of each age group,

n_1 = number of dwelling units in each age group.

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[6]The form in which this data was tabulated and the methods used in making these calculations may be found in Appendix D, Section 1.

[7]When an attempt was made to include these dwellings, it was found that the results of the major calculations of this study differed very little from those made with I_a. See page 9.

[8]This assumption was made by the original designers of the survey. It produces at least a theoretical error in those structures in which the number of dwelling units has been increased since the structure was built. However, since the condition of a dwelling unit is not likely to differ very greatly from the condition of the structure that contains it, it would seem that any distortion of the age-condition relationships due to this assumption would be very minor.

A fairly careful attempt was made to include the dwellings in each tract that were built before 1860 in a revised version of the age index which will be referred to as $I_{a'}$. It was assumed that all of the pre-1860 houses still standing in 1934 were built after 1800; and the proportions of these built between 1800 and 1830 and between 1830 and 1859 were estimated on the basis of population growth of different parts of the City during these decades.[9]

Although $I_{a'}$ has a significantly different frequency distribution from I_a (see Figures 2 and 3), the results of the calculations made with $I_{a'}$ proved to be very close to those results obtained by using I_a. Since the calculation of I_a is easier and far less arbitrary than that of $I_{a'}$, all of the numerical results to be quoted in the body of this thesis, unless labeled otherwise, will be those calculated on the basis of I_a. A comparison of these results with those determined through use of $I_{a'}$ may be found in Appendix F, Section 2.

The Condition Index

The condition index (I_c) is a measure of the average condition of all dwelling units in each tract (including those built before 1860). The method of calculation of this index was as follows:

The number of dwelling units in each of the four condition groups found in the survey data was listed as a percentage of the total number of dwelling units in each tract. The percentage of dwelling units in

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[9]These figures were obtained from Table 12 of the Decennial Census of the Commonwealth of Massachusetts, 1945.

good condition was then multiplied by an arbitrarily assigned value of 1; the percentage estimated to be needing minor repairs by 2; the percentage needing major repairs by 3; and the percentage considered unfit for habitation by 4. The condition index is the sum of these four weighted percentages divided by 100.[10]

The theoretical minimum value of this index is 1.00, which would occur if every dwelling unit in the tract had been considered to be in good condition. The theoretical maximum would be 4.00, if every dwelling unit had been tabulated as unfit for habitation.[11]

Schematically,

$$I_c = \frac{\Sigma d_2 n_2}{\Sigma n_2} \quad \text{for each tract,}$$

where d_2 = the assigned values of 1 (good condition),
2 (needing minor repairs),
3 (needing major repairs), or
4 (unfit for habitation);

and n_2 = number of dwelling units in each condition category.

The relationship between various values of the condition index and the distribution of dwelling units in the four condition categories that resulted in those values is shown in Figure 1.[12] It is evident from a

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[10]A sample calculation of I_c may be found in Appendix D, Section 3.

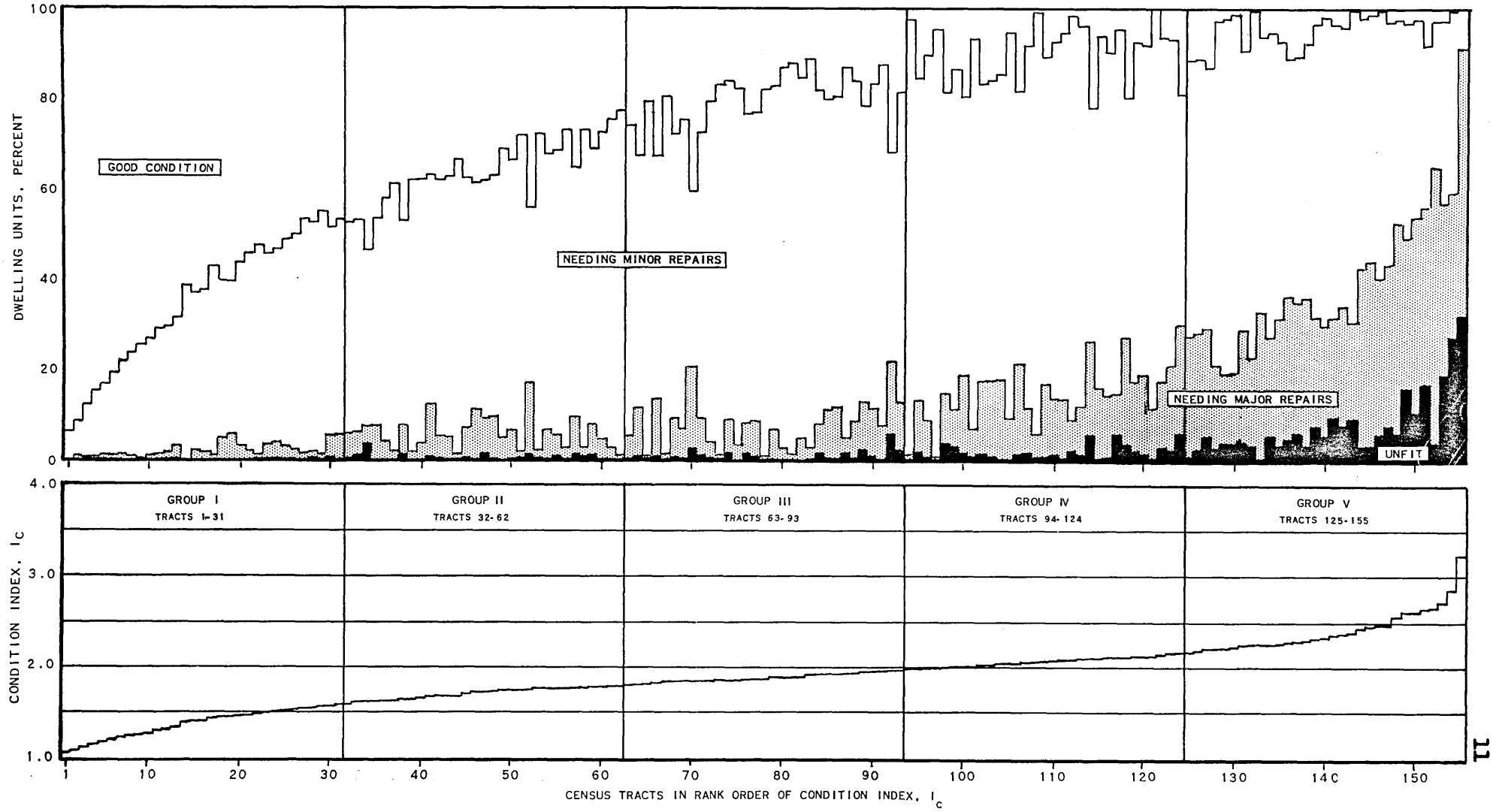
[11]There is some question as to whether or not this worst category (sometimes referred to as "unfit for use" or "unfit for human habitation") is exempt from direct consideration of factors of obsolescence or not. Of the three slightly differing descriptions of this category found with the survey data, two appear to exclude independent consideration of obsolescence and one appears to include it. The exact quotations and sources of these descriptions may be found in Appendix B.

[12]The tabulations upon which this figure is based may be found in Appendix F, Section 3.

Figure 1

PERCENTAGE OF DWELLING UNITS IN EACH OF FOUR CONDITION CATEGORIES AND VALUES OF THE CONDITION INDEX I_c

vs. CENSUS TRACTS IN RANK ORDER OF THE CONDITION INDEX



comparison of the two parts of this figure that two or more tracts can have practically the same value of I_c and yet have quite different distributions of dwelling units in the four condition categories. This is due to the fact that I_c is an average value for the dwelling unit conditions in each tract. (It will be noted that each tract that has an unusually high percentage of units in need of "major repairs" for its value of I_c also has an unusually high percentage in "good condition" for that value.) Of perhaps greater significance is the strong indication this graph gives that within the first two thirds of the total number of census tracts in Boston, the rank that a tract may have in terms of "needing major repairs" (the only criterion of deterioration in the 1940 Census) gives no indication whatsoever of what the average condition of dwelling units may be in that tract.[13, 14]

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[13]The 1950 Census does not have any tabulation of condition as an independent variable. See footnote 23 on page 35.

[14]A scatter diagram of this relationship between need of major repairs and average condition (I_c) may be found in Appendix C.

IV. STATISTICAL AND GEOGRAPHICAL DISTRIBUTION OF BOSTON CENSUS TRACTS BY AGE AND CONDITION INDEXES

Frequency Distribution of Census Tracts by Age Index

Figures 2 and 3 show the frequency distribution of Boston census tracts by values of their age indexes, I_a and $I_{a'}$, described in Section III. Figure 2 shows the frequency distribution of tracts in terms of $I_{a'}$, which is assumed to be a close approximation to the true distribution that existed in Boston in 1934, while Figure 3 shows this distribution in terms of I_a, the index used throughout this study. Comparison of these figures shows the extent to which the distribution of age indexes is distorted by excluding the dwelling units built prior to 1860 in the calculation of I_a.

It was originally anticipated that the distribution of $I_{a'}$, if not also that of I_a, would take roughly the shape of a normal curve, centering about the mean value of each of the indexes. The reason for the bimodal distribution so evident in these figures is somewhat obscured by the fact that the age index for any tract does not necessarily coincide with the period at which the greatest number of dwellings were built in that tract.

For example, an area might have experienced a building boom 25 years before this data was taken and another one 40 years before, and a bad slump in the intervening years. Such an area could very easily have a condition index of 30 to 35 years, even though there might be very few dwellings of that age in the area. The dwelling age figures for Boston

Figure 2

FREQUENCY DISTRIBUTION OF BOSTON CENSUS TRACTS BY AGE INDEX I_a'

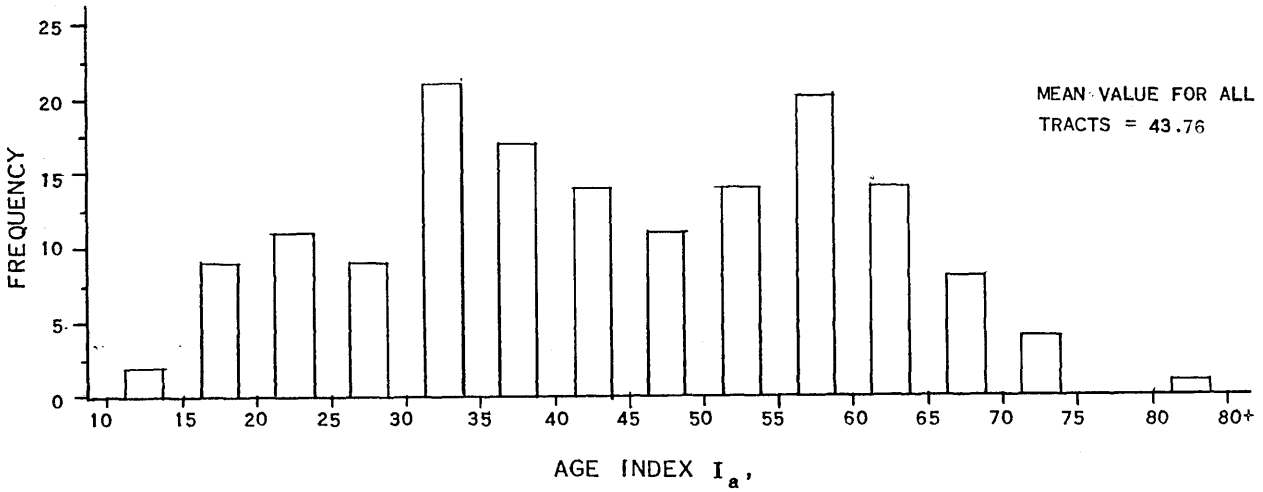
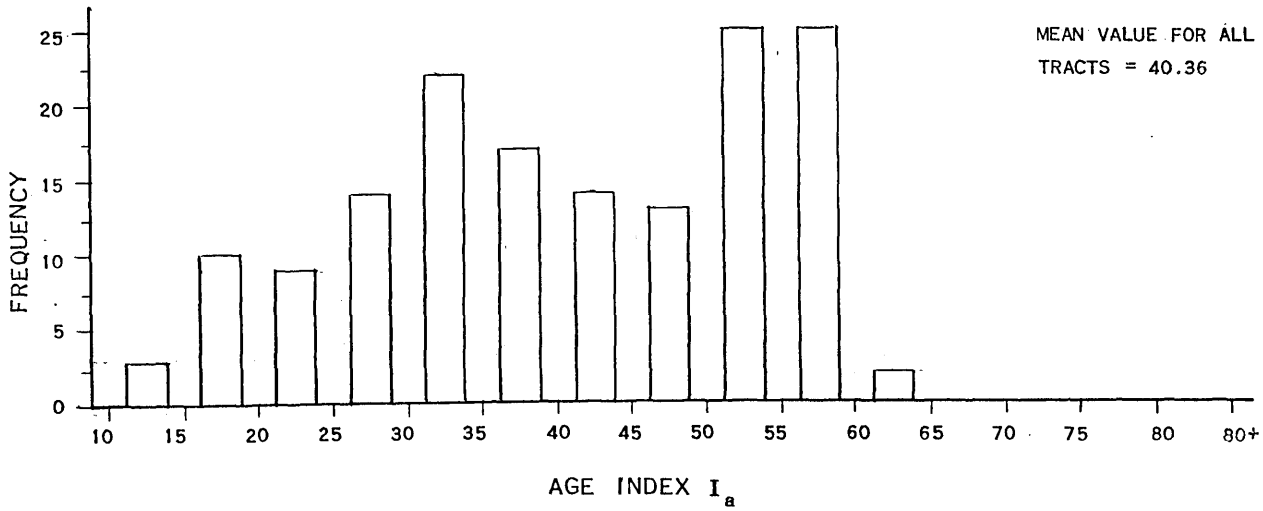


Figure 3

FREQUENCY DISTRIBUTION OF BOSTON CENSUS TRACTS BY AGE INDEX I_a



as a whole indicate that there was a building boom between 1895 and 1904, which would correspond with the 30-35 year peak in Figures 2 and 3. Although it is probable that dwellings were being constructed at a high rate between 1875 and 1880, the period of the second peak in Figure 2, the data from this survey was insufficiently detailed to corroborate this.

Frequency Distribution of Census Tracts by Condition Index

Unlike the distributions of the age indexes, the distribution of condition indexes resembles quite closely the shape of a normal curve (see Figure 4). This confirms what may be observed in Figure 1--that the great majority of tracts in Boston are deteriorated at least to the extent that over 50 percent of their dwelling units are in need of minor repairs. Conversely, the number of tracts in which the majority of units are either in good repair on the one hand, or in need of major repairs on the other, is comparatively small.

Geographical Analysis of Boston by Age and Condition Indexes

In order to observe the geographical patterns in which the indexes previously described are arranged in Boston, a pair of maps (Figures 5 and 6) was made. For each map, the tracts of the City were arranged in rank order of the value of the index being analyzed. Each rank order list was then divided into five equal groups of 31 tracts each, and each group was represented by a different color.[15] The colors progress from light to dark as the index numbers and group numbers increase in value.

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[15]These rank order lists may be found in Appendix F, Sections 2 and 3. The five groups for the condition index I_c are illustrated graphically in Figure 1 (page 11).

Figure 4

FREQUENCY DISTRIBUTION OF BOSTON CENSUS TRACTS BY CONDITION INDEX, I_c

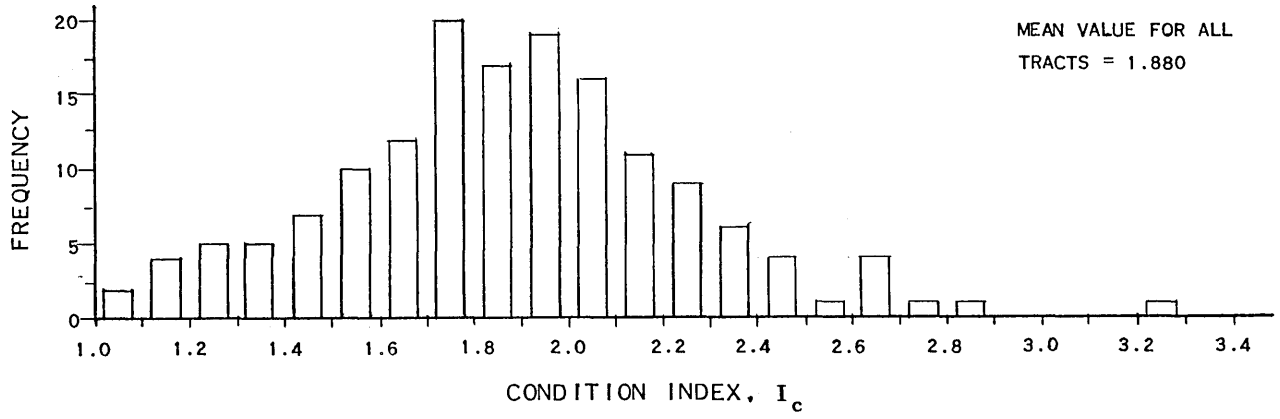


Figure 5

GEOGRAPHICAL DISTRIBUTION OF BOSTON CENSUS TRACTS BY AVERAGE AGE OF DWELLING UNITS

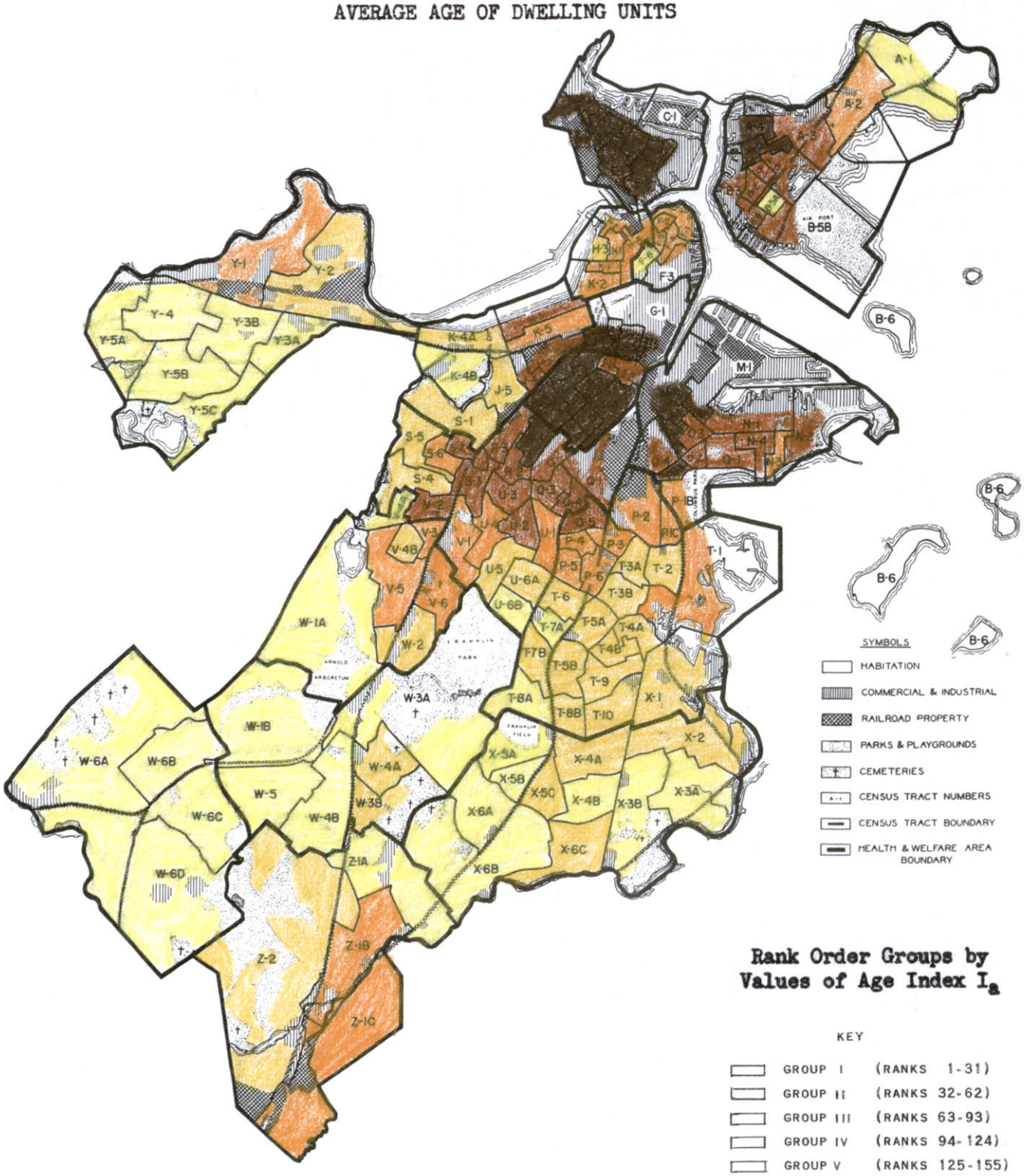
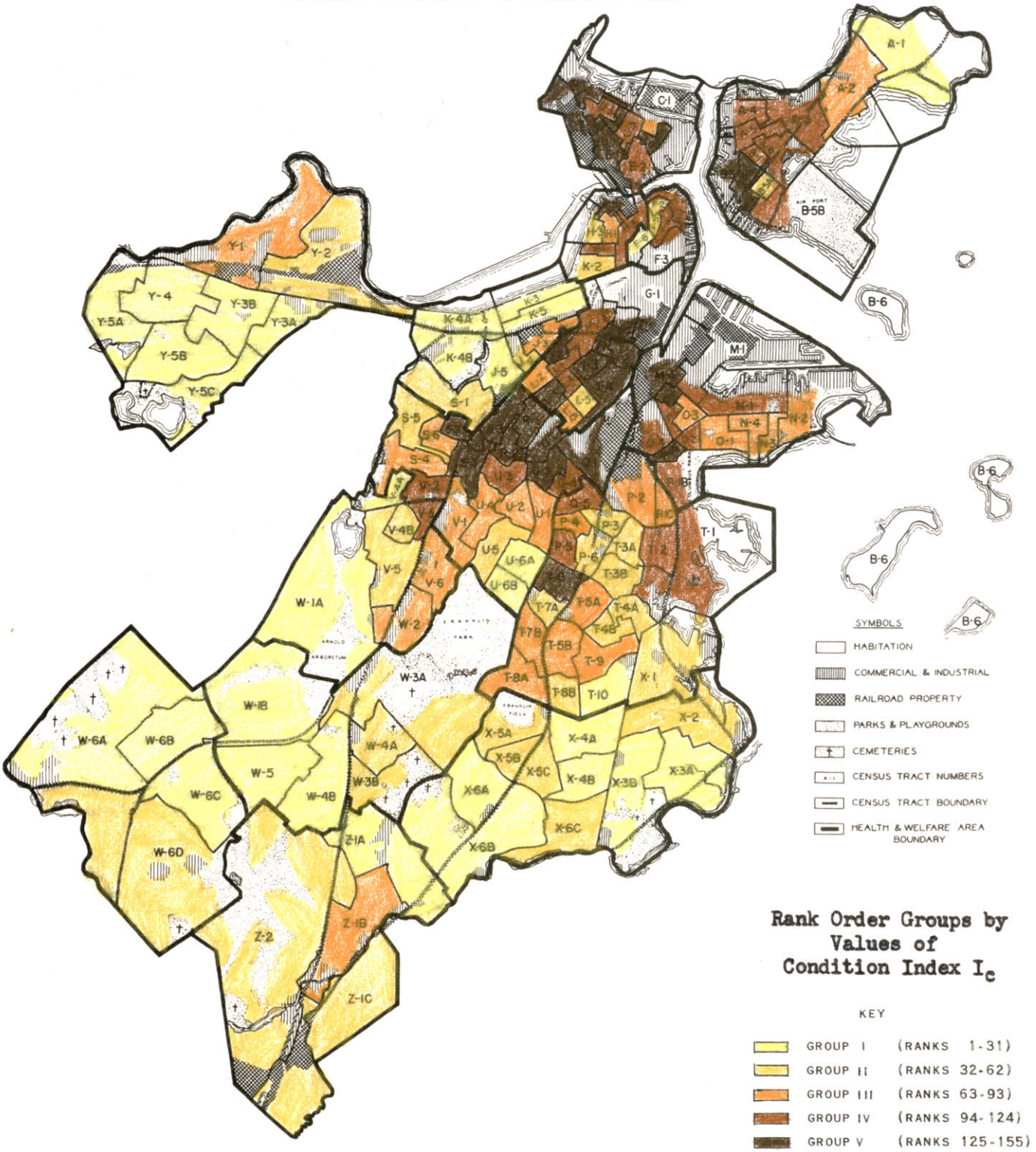


Figure 6

GEOGRAPHICAL DISTRIBUTION OF BOSTON CENSUS TRACTS BY AVERAGE CONDITION OF DWELLING UNITS



Unfortunately the City of Boston does not cover a sufficiently large part of the Metropolitan Area that any conclusions about the residential structure of the Boston Region can be drawn from this study. The following observations can be made in reference to the City itself, however.

Both the age and the condition maps exhibit a strong circumferential pattern emanating from the City center. The North End and the West End, however, appear to have had a sufficient renewal of housing that the average dwelling age in those areas is less than that in the next circumferential band which includes East Boston, Charlestown, the South End, and South Boston. The only other major exceptions to a circumferential pattern within the City occur in tracts that probably developed early as a result of the railroads passing through them. The strong degree of correlation found between age and condition indexes is clearly evident from a comparison of these two maps.

V. ESTIMATION OF HOUSING DETERIORATION FROM AGE INDEX

Correlation Between Age and Condition Indexes

Figures 7 and 8 show the relationship that exists between the condition index and the age index of each census tract in Boston. Figure 8 differs from Figure 7 only in that the dwelling units built before 1860 (if any) were not included in the calculation of the individual tract age indexes, while in Figure 7 they were included. The vertical position of each dot (tract) is the same in each figure--only the horizontal positions may differ.

It is obvious that both scatter diagrams exhibit a fairly high degree of correlation between age and deterioration. The values calculated for the coefficient of correlation in each case were as follows:[16]

$I_{a'}$ and I_c: $r = +0.760$

I_a and I_c: $r = +0.766$

This is considered to be quite a high correlation for socio-economic data of this sort.

The basic or average relationship between each of the age indexes and the condition index is expressed graphically by the regression line

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[16] The correlation coefficient, r, is the most common indicator of the degree of correlation between two variables. It has a minimum value of -1.00 when there is a perfect negative correlation, a value of 0.00 when there is no relation at all between the two variables, and a value of +1.00 when there is a perfect correlation. The methods used in calculating r may be found in Appendix E, Section 1.

Figure 7

SCATTER DIAGRAM AND REGRESSION LINE OF CONDITION INDEX I_c VS. AGE INDEX I_a,

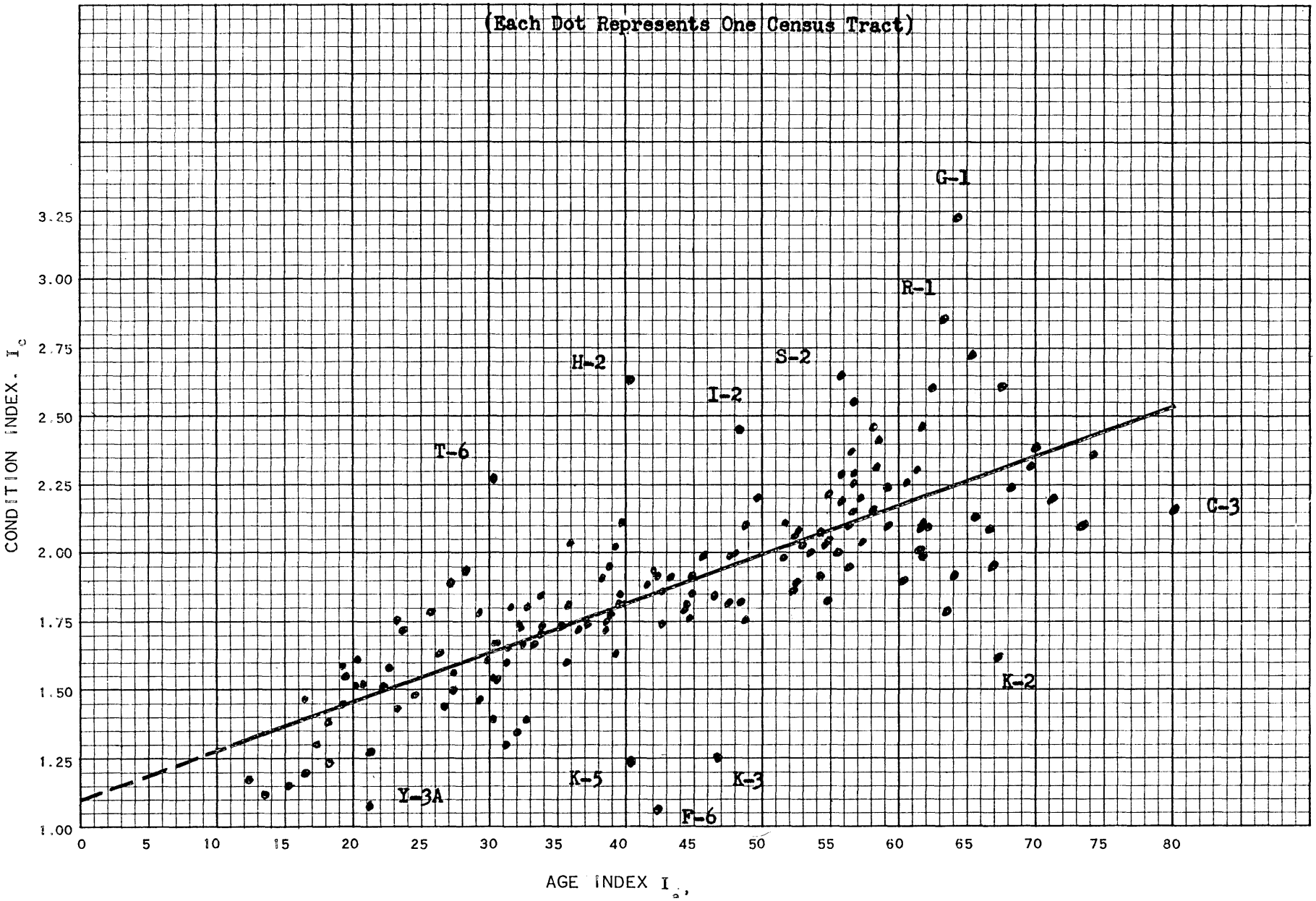
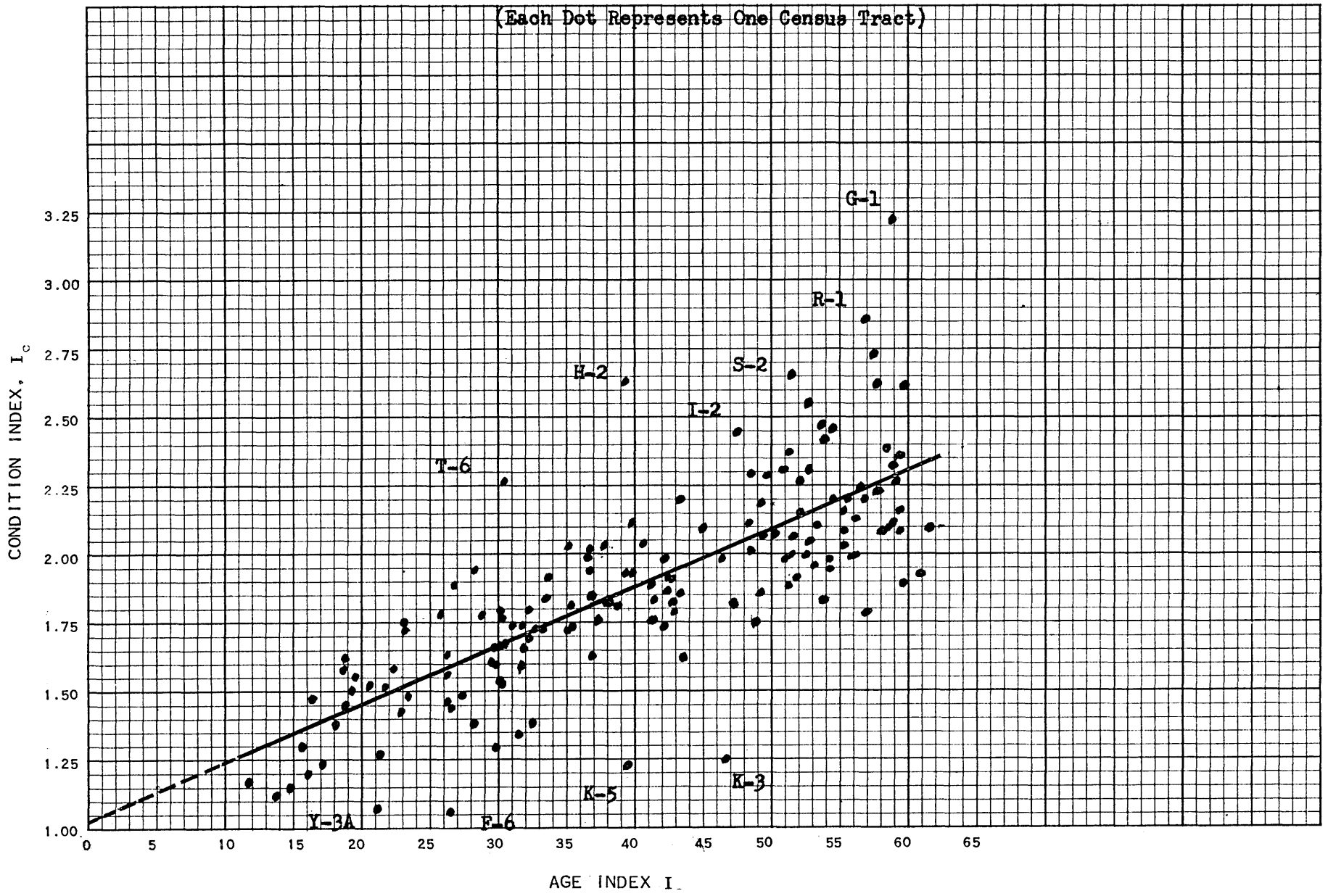


Figure 8

SCATTER DIAGRAM AND REGRESSION LINE OF CONDITION INDEX I_c VS. AGE INDEX I_a



superimposed upon Figures 7 and 8. The equations for determining these regression lines are as follows:[17]

$$\text{for } I_{a'} \text{ and } I_c: \qquad I_c = 1.10 + 0.018\, I_{a'}$$

$$\text{for } I_a \text{ and } I_c: \qquad I_c = 1.02 + 0.021\, I_a$$

It may be observed that on the average the condition index increases by approximately 0.02 per added year of average age. This means that the condition index increases at an average rate of one full point every 50 years (every 56 years when age is measured by $I_{a'}$, and every 48 years when measured by I_a).

It will be noted from these figures that there is a slightly better correlation between age and deterioration when the pre-1860 dwelling units were excluded from the age index calculation than when they were included. No general conclusion about the validity of including or excluding pre-1860 data can be drawn from this result, however. Any analysis which involves finding an average age for an open-ended category, as is the case with $I_{a'}$, is at least partially based upon the personal judgment of the statistician. Different methods of handling these pre-1860 statistics might very easily have produced contrary results from the very same data.

Because I_a' has been found to behave very similarly to I_a, and because it is felt to be a less reliable statistic than I_a, only the

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[17]The methods used in calculating these equations may be found in Appendix E, Section 2. A discussion of the confidence limits within which I_c may be calculated from values of I_a may be found on page 27ff.

results of calculations using I_a as the age index will be presented in the remainder of this thesis.

Deviation of Condition Indexes from Regression Line

By substituting the I_a value for each tract into the regression formula for I_c (see page 23), a theoretical condition index, I_{ct}, was calculated for each tract. Graphically, this theoretical condition index is the ordinate of the regression line (see Figure 8) at the age index value for each tract. The difference was then found between I_c and I_{ct} for each tract. For this procedure the following sign convention was adopted:

1. When the actual index is higher than the theoretical (i.e., I_a is above the regression line), the difference is called positive.

2. When the actual index is less than the theoretical (i.e., I_a is below the regression line), the difference is called negative.

The tracts were then arranged in order according to this difference.

Since the regression line is a measure of the average rate of deterioration of tracts in the city of Boston, those tracts having a condition index above this line have deteriorated at a rate faster than average, and those with an index below this line have deteriorated at a slower rate than average for the City. The vertical deviation of the actual condition index from this line (or from the theoretical condition index) is therefore a measure of the relative rate of deterioration of any tract. Under the sign convention described in the previous paragraph,

those tracts with the highest negative difference value have deteriorated least for their age, while those with the highest positive values have deteriorated most rapidly.

Geographical Distribution of Tracts by Rate of Deterioration

In order to observe the geographical distribution of Boston tracts by their rate of deterioration, the tracts were arranged in order of rank of their deviations from the regression line and divided into five equal groups as the age and condition indexes were in Section IV.[18] The resulting distribution is shown in Figure 9. In this map, tracts in groups I and II, which have deteriorated less rapidly than the City average, are shown in shades of green; while those in groups IV and V, which have deteriorated more rapidly than the City average, are shown in shades of orange. Tracts in group III, which coincides most closely with the deterioration rate for the City as a whole, have been left white.

The following observations are considered significant with respect to this map:

Tracts showing high and low rates of deterioration are found in practically all sections of the City. Of the 15 Health and Welfare Districts of Boston (see map, Figure 14, Appendix A), all have at least one tract in the first two quintiles (those in which deterioration has been least with respect to age), and all but one district have one or more tracts in the last two quintiles (those tracts in which deterioration

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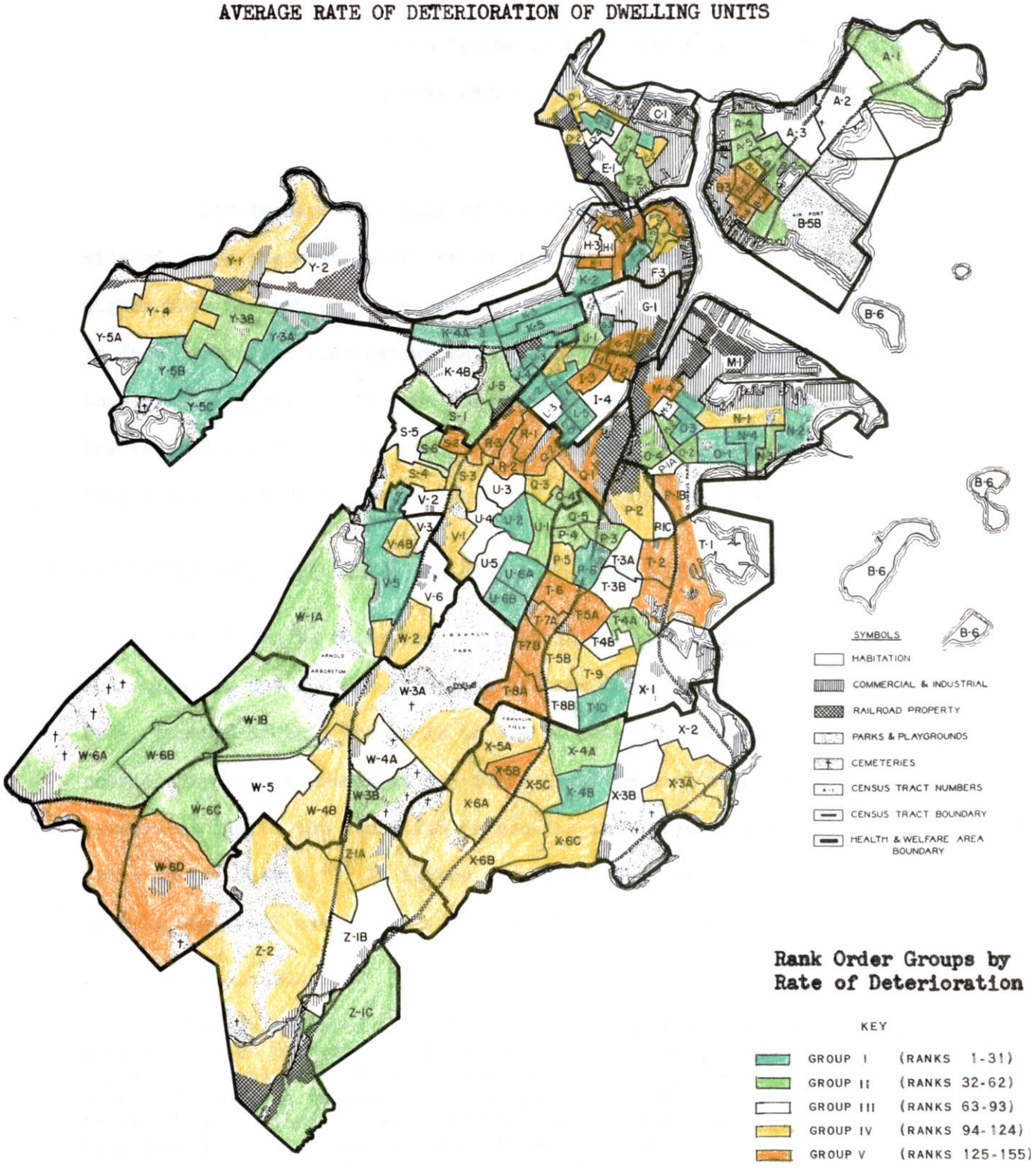
[18]This list may be found in Appendix F, Section 4.

Figure 9

GEOGRAPHICAL DISTRIBUTION OF BOSTON CENSUS TRACTS BY AVERAGE RATE OF DETERIORATION OF DWELLING UNITS



has been greatest with respect to age). The 31 tracts showing the slowest rates of deterioration (group I) are found in 11 of the 15 districts, and the 31 showing most rapid deterioration (group V) are located in 9 of the districts.

It also appears that many of the areas of Boston that are now considered to be the most deteriorated have not deteriorated at a rate any higher than the rate for the rest of the City. A majority of the tracts in East Boston and Charlestown have deteriorated at a rate that is less than or just equal to the rate for the City as a whole. A number of tracts in South Boston and in the South End are in that quintile of tracts that have deteriorated least for their age (group I).

Confidence Bands for Estimating Condition Index from Age Index

In addition to observing the statistical and geographical patterns determined by the age and condition indexes developed here, the remaining basic purpose of this thesis is to try to determine whether there is any possibility that a predicted age index might be used to estimate within reasonable limits the condition of housing in a give area 20 or more years in the future.[19] It is the purpose of this section to shed light on only one small part of this problem; that is, whether or not the

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[19]The age index of a tract 20 years in the future would be 20 years greater than at present only if there were to be no new residential building and no demolition of residential structures (unless every age category were to be reduced in equal proportion) during that time. In order to predict the age index 20 years in the future, therefore, it would be necessary to predict the quantity of new construction by 5 or 10 year periods and both the amount and the age distribution of the demolition (intentional or accidental) that will take place in that time, and recalculate I_a on the basis of these new assumptions.

relationship between age and deterioration indexes is such that the deterioration index for a tract could be estimated within useful limits from a known (or assumed) value of I_a.

For the city of Boston in 1934, it was found that the standard of error for estimating values of I_c from given values of I_a is 0.240.[20] This means that a band about the regression line defined by $I_{ct} \pm 0.240\ I_a$ units can be expected to include 68% of the I_c values, and that defined by $I_{ct} \pm 0.480\ I_a$ units to include over 95% of the I_c values.[21]

On the scatter diagram in Figure 10 are superimposed the bands within which 75% and 90% of the I_c values for Boston tracts can be expected to fall.[22] The range of values of I_c defined by these limits may also be found in Table I below:

Table I

BAND OF VALUES FOR I_c AS ESTIMATED FROM I_a

Values of I_a in years	Values of Condition Index (I_c)			
	75% Confidence Band		90% Confidence Band	
	Min.	Max.	Min.	Max.
20	1.2	1.7	1.1	1.9
40	1.6	2.2	1.5	2.3
60	2.0	2.6	1.9	2.7

It is very likely that refinements might be developed by which the future

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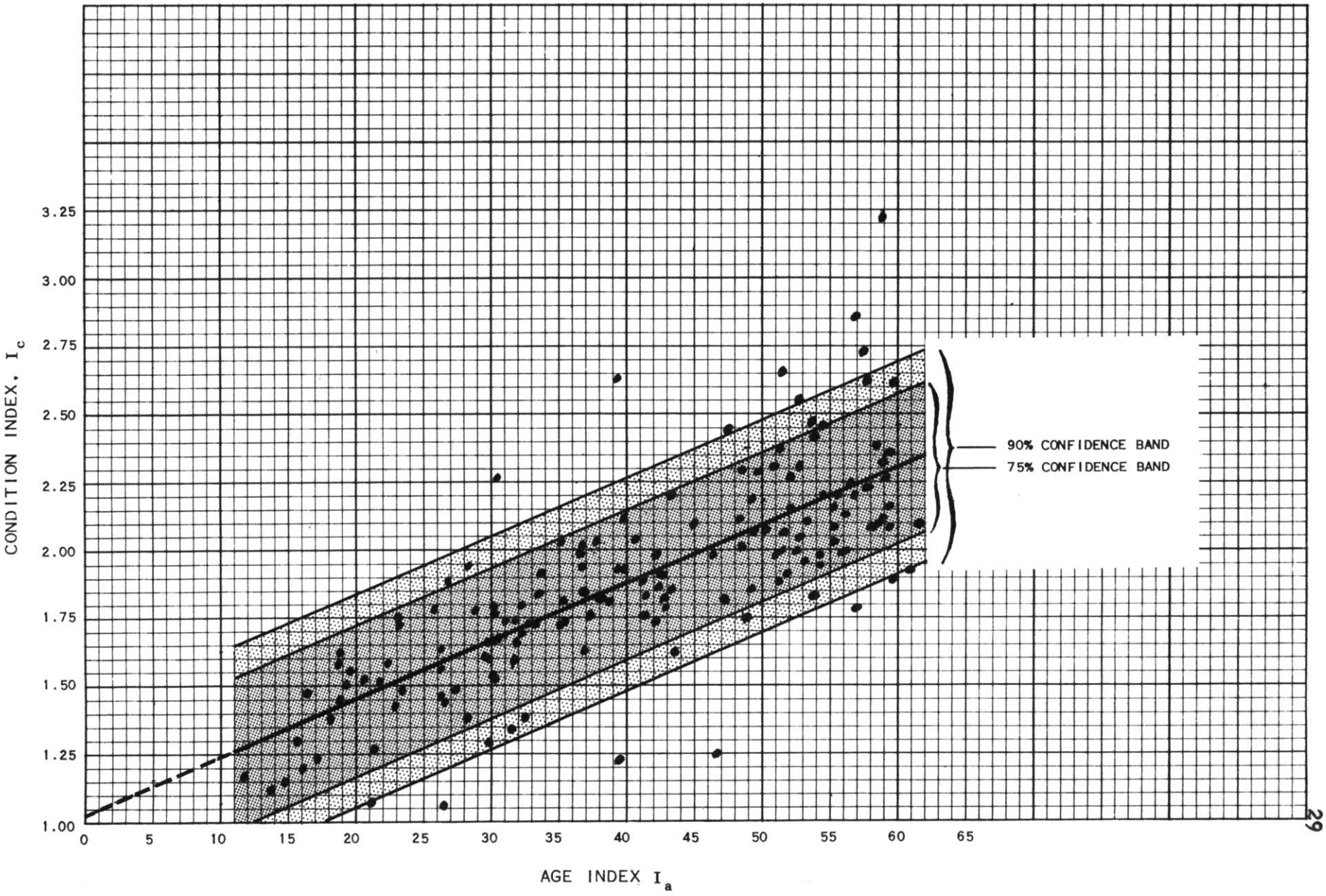
[20]For the method of calculating this value, see Appendix E, Section 3.

[21]Adapted from Arkin and Colton, Statistical Methods, New York, 1939, p. 77.

[22]The method of calculation of these lines may be found in Appendix E, Section 3.

Figure 10

75% AND 90% CONFIDENCE BANDS FOR ESTIMATING I_c FROM I_a



of particular tracts or areas could be predicted within considerably narrower limits than those listed above. For example, the fact that a tract has deteriorated at a rate less than average up to the present may be found to indicate that it will continue to have a slower than average deterioration rate. When the effects on deterioration of factors other than age are known, these also could be utilized to predict within narrower limits the future deterioration patterns of particular areas.

The bands of Figure 10, of course, cannot be extended indefinitely, and probably should not be extended beyond the range of the data. There are two reasons for this: First, there would be no justification for assuming that as tracts exceed the present range of age data, they would continue to deteriorate at the same average rate found within the range of the present data. It is quite conceivable, for example, that an extended regression line might become asymtotic to any value of the condition index between 2.5 and 4.0. Second, there appears to be a slight tendency for the $I_a - I_c$ scatter to flare outward with increasing average age. If this observation is correct, the confidence bands plotted in Figure 10 are misleading to the extent that they do not reflect this flare.

Although it may be of value to know the range of I_c within which a tract with an age index of X is likely to fall, it is perhaps more useful for planners to be able to estimate either the least amount of deterioration that is likely at age X, or alternatively, the greatest amount of deterioration that is likely for that age index. Each line of Figure 11 defines the upper limit of I_c below which 75% or 90% of the census tracts fall. Figure 12, on the other hand, shows those lower limits of I_c above

Figure 11

75% AND 90% CONFIDENCE LIMITS FOR MAXIMUM VALUES OF THE CONDITION INDEX

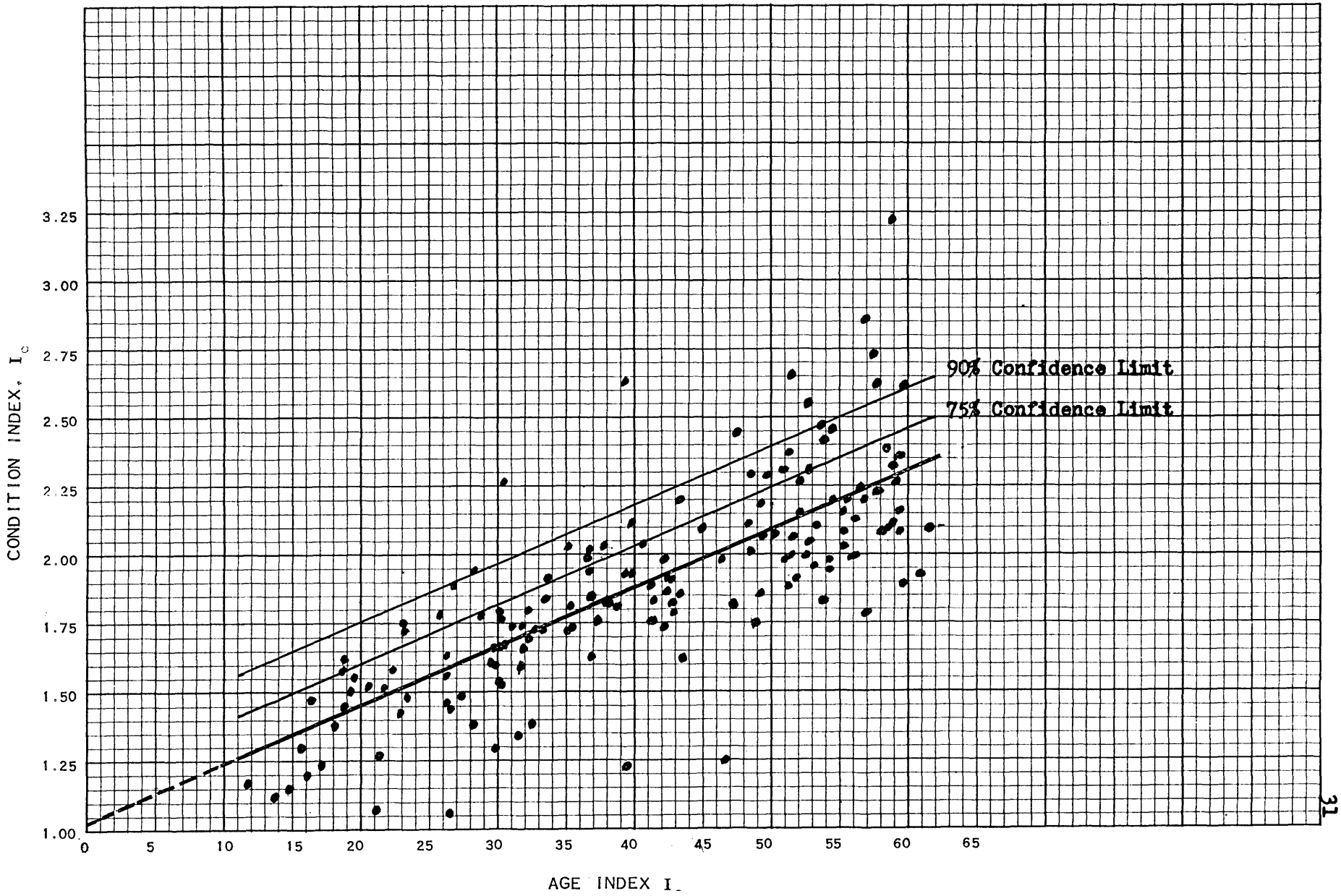
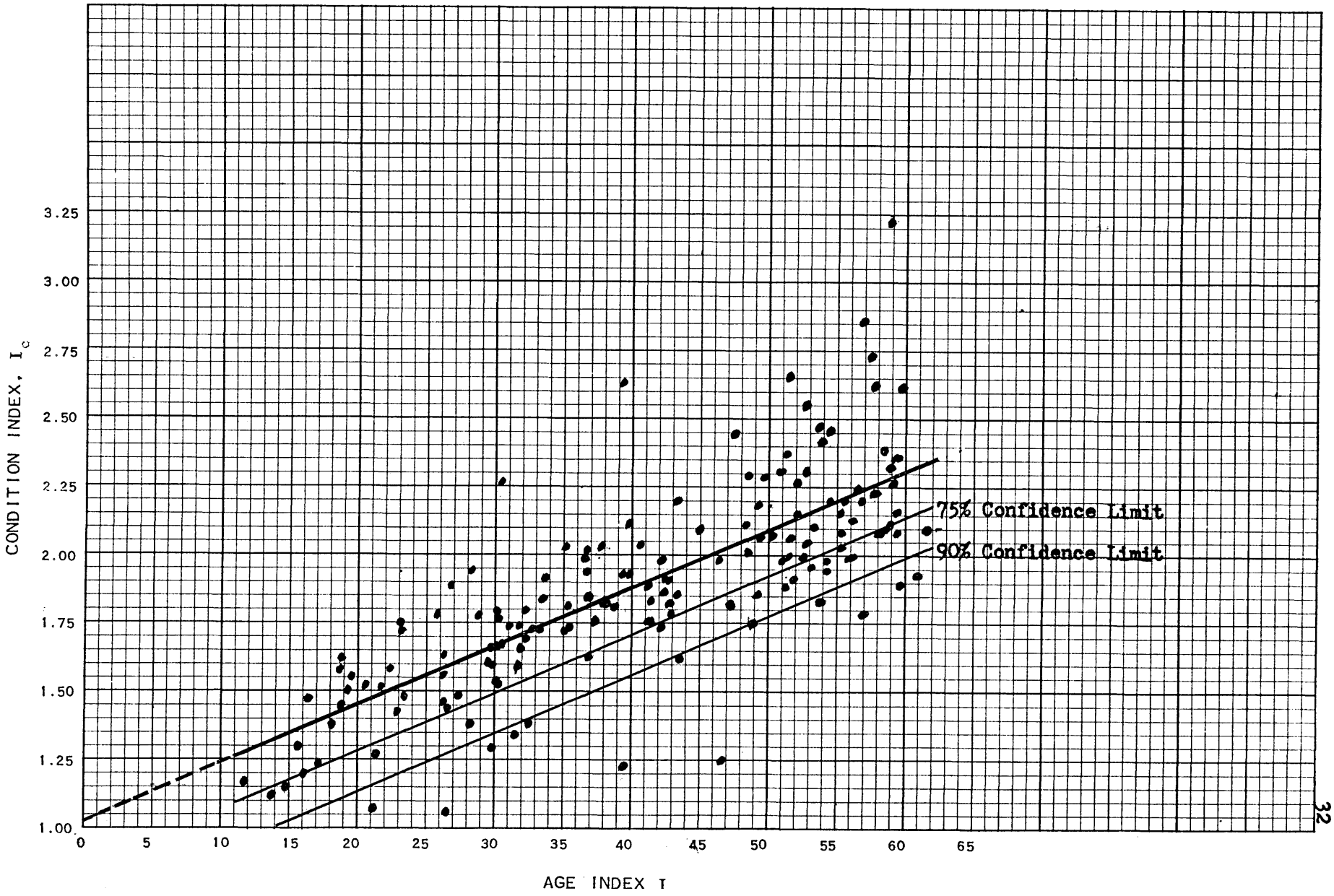


Figure 12

75% AND 90% CONFIDENCE LIMITS FOR MINIMUM VALUES OF THE CONDITION INDEX



which 75% or 90% of the tracts fall. In contrast, the hatched areas of Figure 10 define concurrent upper and lower limits within which 75% or 90% of the I_c values would fall. The limitations described on page 30 apply equally well to Figures 11 and 12 also.

Tabulated values from Figure 11 (Table II) and Figure 12 (Table III) for selected values of I_a appear below.

Table II

MAXIMUM PROBABLE VALUES FOR I_c AS ESTIMATED FROM I_a

Values of I_a in years	Values of Condition Index (I_c)	
	75% Probability	90% Probability
20	1.6	1.8
40	2.0	2.2
60	2.5	2.6

Table III

MINIMUM PROBABLE VALUES FOR I_c AS ESTIMATED FROM I_a

Values of I_a in years	Values of Condition Index (I_c)	
	75% Probability	90% Probability
20	1.3	1.2
40	1.7	1.6
60	2.2	2.0

VI. CONCLUSIONS

It is not the purpose of this thesis to try to develop a fully workable method by which age data might be used to estimate future deterioration of residential areas, but only to make an initial exploration to see if there is a sufficient relationship between age and deterioration that further studies of the problem would be justified. It is the conclusion of the author that this is a very valid field for future research; and that although there are some difficult problems that require investigation first, the value to planners of being able to set specific statistical limits on the expected deterioration of urban and suburban areas would make such research very worth while.

There are several important difficulties that still remain between this thesis and the practical application of its conclusions. Perhaps the simplest to remedy is the fact that shorter methods need to be developed for calculating indexes to replace the age and condition indexes used in this study. It is possible, for example, that either the median or the mode of the frequency distribution of dwelling unit ages in each tract would be at least as satisfactory as the mean for the purposes of correlation with condition indexes. Another problem that requires study is whether or not the Census tabulations of 1940 and 1950 are sufficiently detailed that they could be used for

this kind of correlation analysis.[23] If the analysis of age and condition data were simplified, comparisons could be made with other cities to see if they exhibit similar relationships between the age and deterioration of census tracts or other areas. It would also then be more practicable to make follow-up studies to investigate what areas of a city may be changing their relative positions with respect to age or condition or may be stabilizing in an absolute sense, and why.

A more serious difficulty to using age as a predictor of deterioration is that there is no knowledge as yet about the way in which the regression between these two factors may change with time. A speculation could be made, for example, that if this study were to be repeated on the basis of data taken in 1954, that the whole regression line would be found to be flatter than it was in 1934, due to the increased prosperity, the high level of demand for all types of housing, and the effect that rent control may have had in forcing owners to make renovations in order to raise their rentals. Any marked changes in the modes of living, whether

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[23] In the 1940 Federal Census, age of housing was tabulated by 5 or 10 year periods back to 1900; and state of repair was recorded in two categories--"needing major repairs" and "not needing major repairs." The 1950 tabulation is even less detailed; housing age data is listed by decades only back to 1920, and state of repair for census tracts is combined with plumbing into the two categories of "no private bath or delapidated" and "no running water or delapidated."

A scatter diagram of the relationship between the percentage of dwelling units "needing major repairs" according to the 1934 Inventory and the condition index used in this study may be found in Appendix C.

caused by social or technological change, might even make the age-condition regression pattern a curve rather than a straight line as it appeared to be for Boston in 1934.

A further field that needs study is the effect that other variables may have on the relationship between age and condition. The confidence bands and probability lines presented in this thesis are very pure in the sense that they are derived from the entire City and therefore are not biased by special conditions peculiar to one segment of it. By the same token, however, they are also very rough and unrefined for use in regard to any particular area of the City. If a few key variables other than age, such as those listed on page 3, that have a strong correlation with deterioration could be determined and perhaps combined with age into a new index, it is probable that far more refined predictions about the future of particular tracts might be made.

From these comments it is very evident that considerably more study must be given to this relationship of age and deterioration before the latter can be predicted for future decades with any degree of reliability. However, it is felt that there is a sufficient relationship between these two variables that additional exploration toward the goal of prediction of housing deterioration is very much justified.

APPENDIXES

APPENDIX A

MAPS OF THE CITY OF BOSTON

Figure 13: Boston Health and Welfare Districts, 1940

Figure 14: Boston Census Tracts, 1940

Figure 13

BOSTON HEALTH AND WELFARE DISTRICTS

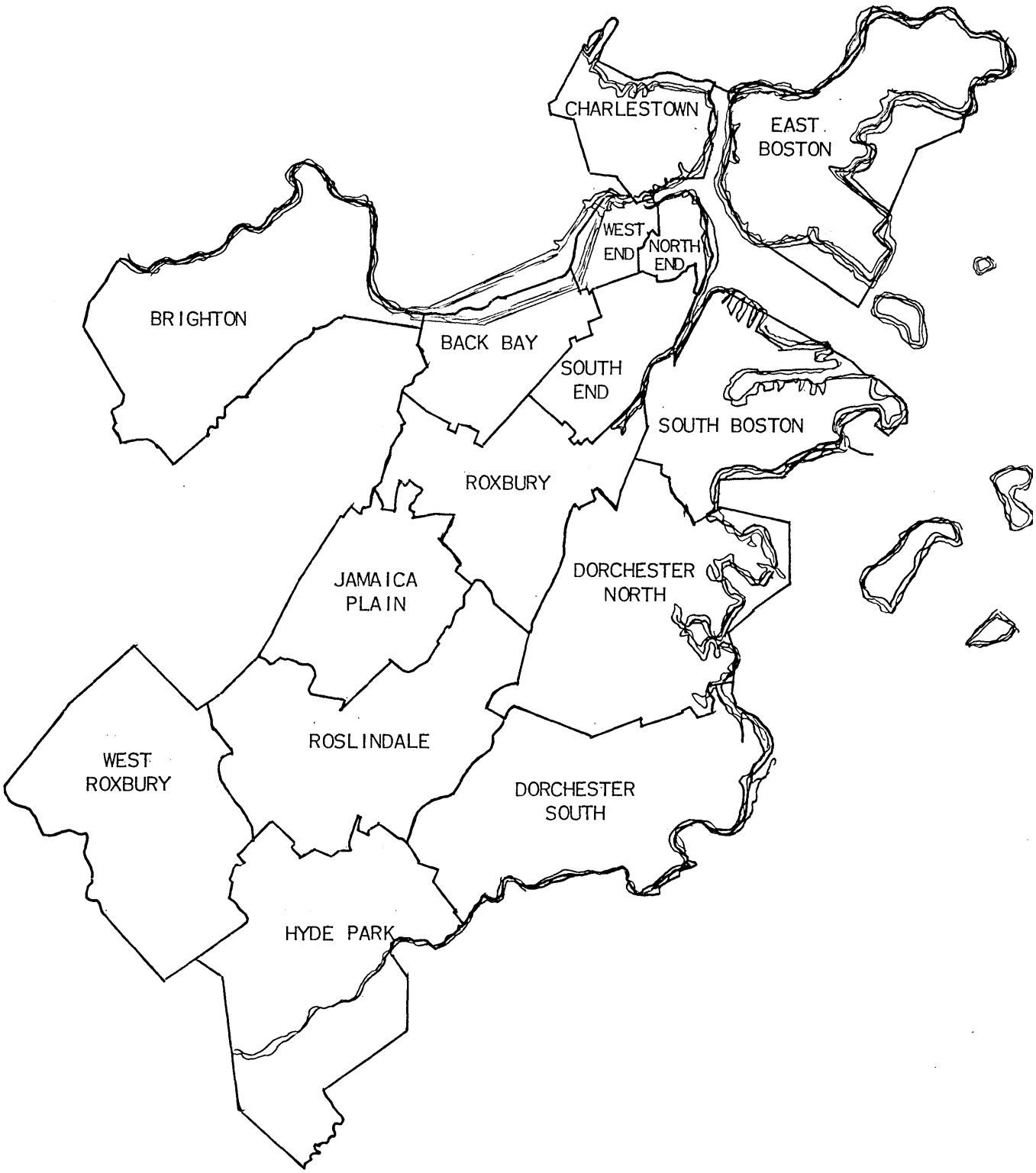
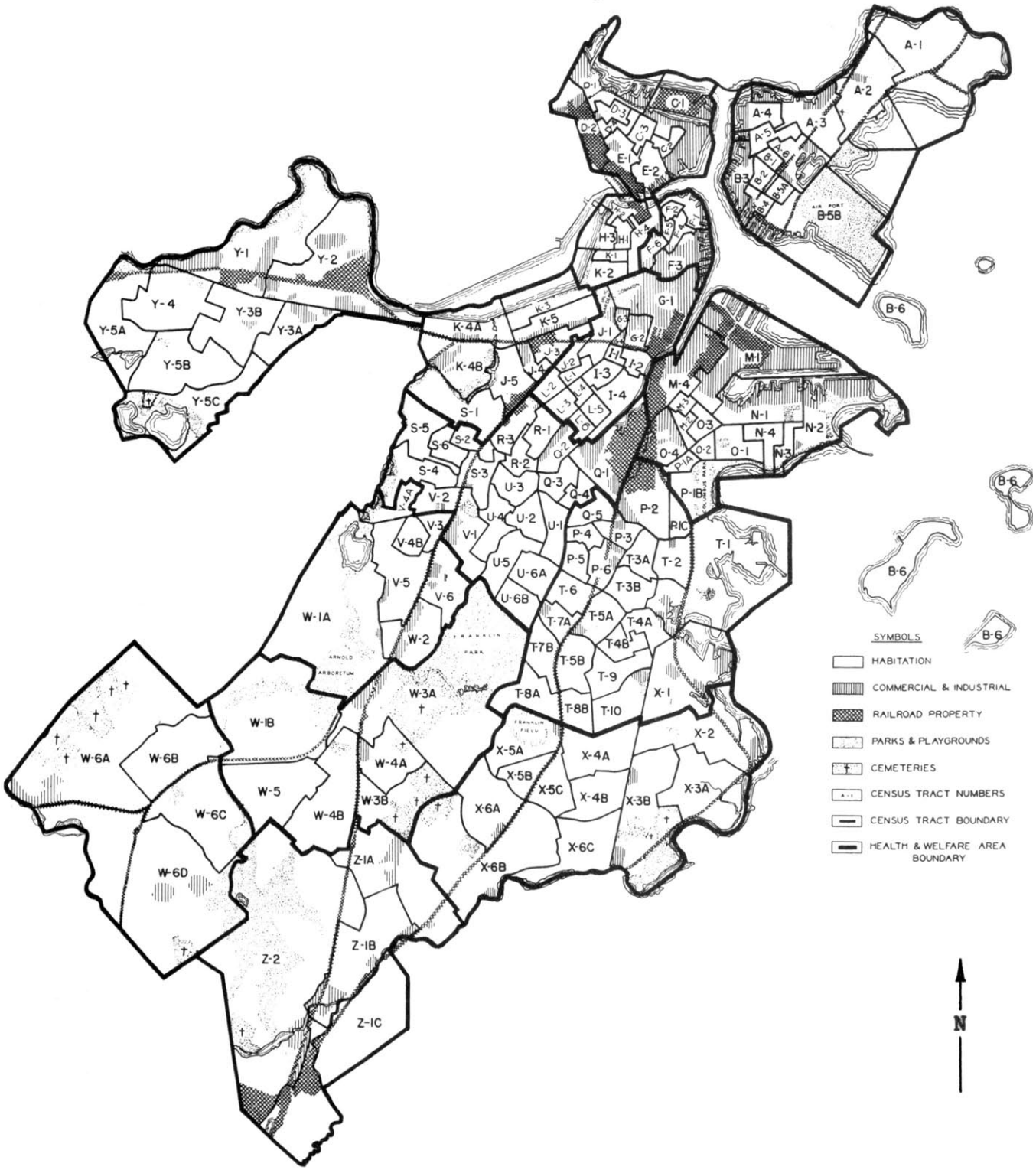


Figure 14

BOSTON CENSUS TRACTS, 1940



Source: Research Division
United Community Services

APPENDIX B

DEFINITIONS AND DESCRIPTIONS OF HOUSING CONDITION CATEGORIES USED IN THE REAL PROPERTY INVENTORY

The Boston Housing Authority, which now has all the records from the 1934 Real Property Inventory, unfortunately was not able to locate the instructions for enumerators for that survey. It therefore is not known just what definitions the enumerators used in collecting the data upon which the condition index of this thesis is based.[24] However, information on the meanings of the condition categories as they were used by the Boston Housing Authority in its resurvey of housing in 1940 was found in three different sets of instructions. Since this resurvey leaned very heavily on the data gathered in 1934, it is assumed that the 1940 use of these categories was essentially the same as that in 1934.

Because each of the three sets of instructions sheds a somewhat different light on the meaning of each category, the definitions from each source will be quoted separately for each condition category. The three sources are as follows:

A. Application by the Boston Housing Authority to the Works Progress Administration: Resurvey of Housing and Low Income Housing

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[24]This original survey was taken by the Boston City Planning Board, but the records from it were turned over to the Boston Housing Authority in January, 1939, so that they might be used as the basis for a resurvey of housing by that agency. On page 45 of the Boston Housing Authority's application to the Works Progress Administration for making this resurvey, it is stated that instructions for enumerators had been secured from Mr. McCormick (director of the Boston City Planning Board). As mentioned above, however, these instructions could not be located.

Area Survey in the City of Boston, February 20, 1939. Mimeographed. (On file at the Boston Housing Authority central office.) Descriptions of categories on page 57.

B. Procedure I, Instructions to Field Workers. House to House Canvass with Forms D-3 and E-3. Mimeographed. (Located in file cabinets of Boston Housing Authority storeroom at Old Harbor Village.) A footnote on page 172 of this book states:

> Procedure I is adapted from Federal Housing Administration, Division of Economics and Statistics, Technique for a Resurvey of Housing, Washington, 1939--Procedure V, p. 54.

Definitions of condition categories are found on pages 214 and 215.

C. (No title) A set of instructions for enumerators apparently abstracted from source B above. Carbon copy of a typewritten original. Apparently made for use in the field. Ten sheets in orange paper binder. (Located in file cabinets of Boston Housing Authority storeroom at Old Harbor Village.) Descriptions of condition categories on seventh page. (This source is included because it appears to give at least one interpretation of the very lengthy instructions issued by the central office (source B)).

Each definition or description below is preceded by A, B, or C to indicate from which of the above sources it is taken.

1. Good Condition

   A. (No description)

   B. Refers to structures which are in good condition and need no repairs or paint.

   C. Not in need of repairs or paint.

2. Minor Repairs

A. By minor repairs is meant the need of painting, papering, and of repairs which are evident to you.

B. Refers to structures which while structurally sound need minor repairs, such as painting, papering, stopping of small leaks, pointing up of masonry, etc.

C. Structure sound but needs paint, paper, leaks repaired or pointing up.

3. Major or Structural Repairs:

A. Structural repairs means repair to the roof, foundation, walls, etc., which if neglected much longer will seriously impair the value of the property.

B. (Major repairs) Refers to structures which need major repairs, such as new roof, replastering, new foundations, new porches, etc., and which if neglected much longer will impair the property but which if made will put the structure in reasonably good condition.

C. Need major repairs, new roof, replastering, new porches, etc.

4. Unfit

A. You should never use 4) (unfit for human habitation) unless the structure is obsolete or in apparently dangerous condition and should in your opinion be destroyed.

B. Record the building as unfit for use if you consider it unfit for human habitation, that is, if it is so obsolete and so hazardous to the safety and health of a family or in such dangerous condition that it should be destroyed.

C. Unfit for use_if unsafe_unsanitary_dangerous.

In regard to the question raised in footnotes 1 and 11 as to whether the fourth category includes considerations of obsolescence or not, it will be seen that reference A regards a structure as unfit if it is

". . . obsolete or in . . . dangerous condition . . ." while reference B considers a structure unfit if it is ". . . obsolete and . . . hazardous . . ." (underscoring by the author). The first definition implies the possibility (though not the likelihood) that a dwelling might be classified "unfit" for no other reason than obsolescence alone. Because reference A is only an application for aid so that a 1940 resurvey of housing might be made, it can be assumed that reference B is a later version of instructions to enumerators, and the one actually used in 1940. In the condition section of the dwelling unit cards (Form D-3) used by the enumerators in 1940, columns were provided and utilized for both the 1934 and the 1940 condition category entries; it is evident therefore that the 1940 condition data was intended to be comparable with that found in 1934. Whether this intent was carried to the extent of using identical definitions for the condition categories in 1940 as in 1934 is not known.

APPENDIX C

RELATIONSHIP BETWEEN CONDITION INDEX I_c AND PERCENT OF DWELLING UNITS IN CONDITION CATEGORIES "NEEDING MAJOR REPAIRS" AND "UNFIT"

Although the condition index I_c may be very easily calculated from a distribution of dwelling units among several condition categories, it would be advantageous if the reverse were also true; that is, if a distribution of dwellings into condition categories could be determined from any given value of the condition index.

In order to test this, the 1934 condition data was divided into two major classifications, the higher of which is the sum of the "good condition" and "minor repairs" categories of the original data, and the lower of which is the sum of the "major repairs" and "unfit" categories of the original data.[25] The percentage of dwelling units in the lower classification was then plotted against I_c for each tract; and the resulting scatter diagram is shown in Figure 15.

In terms of this study and of the proposal stated above, the usefulness of the scatter produced by this relationship is very limited. For example, it can be seen that for $I_c = 2.00$, no tract (as of 1934) is likely to have more than 24% of its dwelling units in the lower classification. However, it is also quite possible that a tract with this same index value might have less than 1% of its dwellings in this classification.

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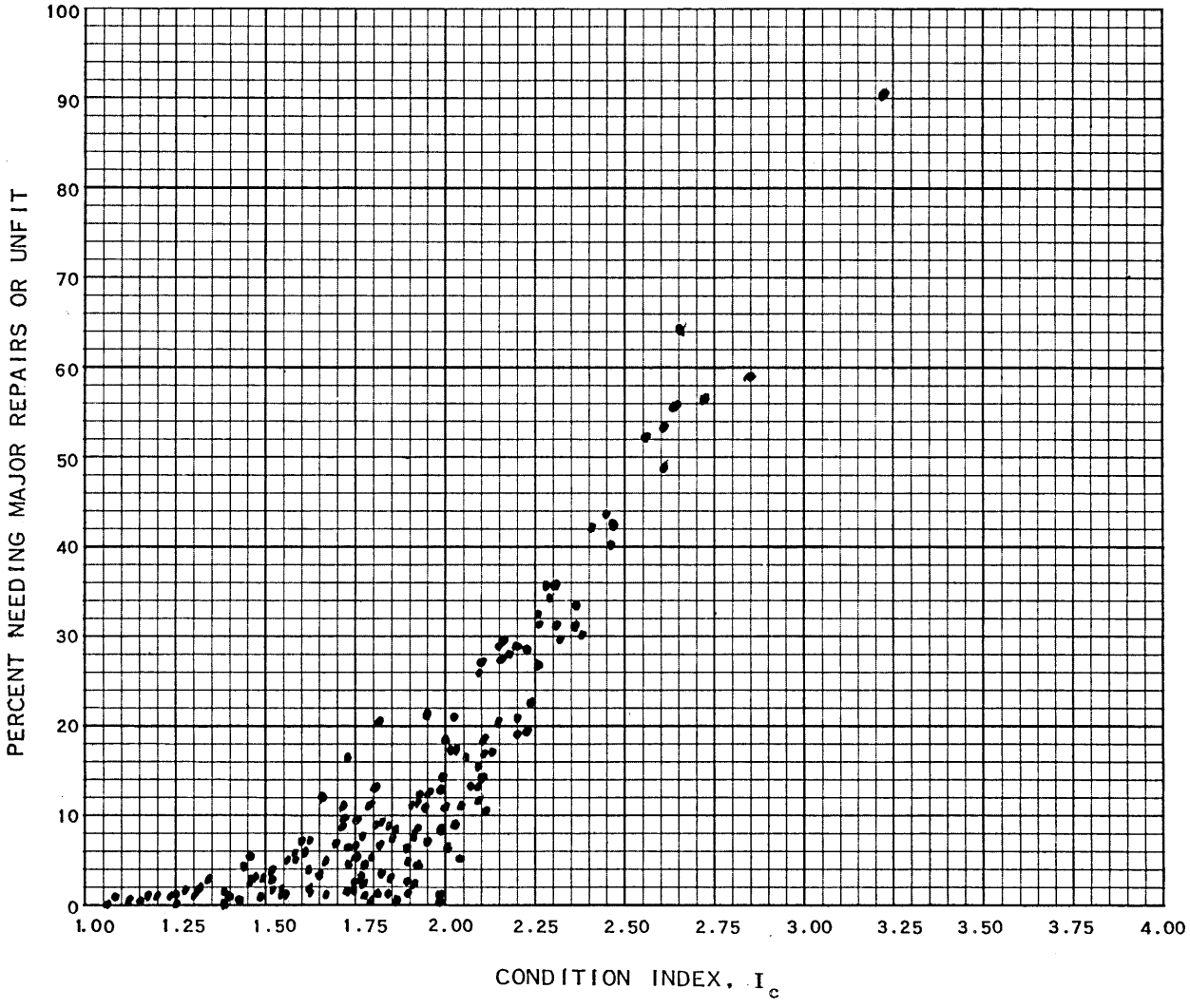
[25]This two-way division corresponds to the tabulation of housing condition data in the 1940 census.

Figure 15

RELATIONSHIP BETWEEN CONDITION INDEX I_c AND
PERCENT OF DWELLING UNITS IN EACH TRACT IN CONDITION CATEGORIES
"NEEDING MAJOR REPAIRS" AND "UNFIT"



The utility of this relationship is much further reduced when it is realized that in practical usage, I_c itself would be an estimate obtained from its relationship to I_a. For this reason, all that would ordinarily be known about I_c is the range within which it would probably be located, or alternatively the probable maximum or minimum values that it might have. When the percentages of dwellings in the lower classification are found for the extreme values of I_c that may be estimated from I_a, the range of values is so large that the results are practically worthless (except perhaps when I_a is less than 30 years). If it is desired to make predictions of housing condition using the classifications found in existing data, it will probably be necessary to develop direct relationships between age and the condition classifications desired, instead of relationships that go through an intermediate statistic such as I_c.

APPENDIX D

METHODS OF CALCULATION OF AGE AND CONDITION INDEXES

1. Calculation of Age Index, I_a (defined on page 7)

The following table shows the method used in calculating I_a and $I_{a'}$. The calculation of each of these indexes is identical except for the fact that those dwelling units in the category "1859 or before" were excluded from the calculation of I_a. (For the calculation of $I_{a'}$, see Section 2 below.) The categories in which dwelling unit age was tabulated on the data sheets used for this study (see footnote 2, page 6) are shown in column 1 of Table IV (see next page). The example used here is for tract T-4A.

I_a is the sum of column 6 (line 9) divided by the difference between 100.00% and the percent of dwelling units built in 1859 or before (line 10, col. 5). This had the same effect as if column 5 had been calculated with the sum of lines 1 through 8 equal to 100%. The former method was used to facilitate calculation of $I_{a'}$.

$$I_a = \frac{3314.48}{(100.00 - 5.54)} = \frac{3314.48}{94.46} = 35.1 \text{ years}$$

In this tract there were 10 dwelling units for which age was not reported, so that the total number of dwelling units in the tract was 1256. (This is a higher than average number of no reports for this survey.) Line 11 of column 5 was considered satisfactory if it came within the limits of 100.00 ± 0.03.

Table IV

SAMPLE CALCULATION OF AGE INDEX I_a

Line	Col. 1 Years of Construction	Col. 2 Age in 1934 (years)	Col. 3 Median Age of Category Group (years)	Col. 4 Number of d.u. Built in Age Group	Col. 5 Col. 4 as % of Total d.u. Reporting Age	Col. 6 Product of Col. 3 x Col. 5
1	1930 - 1934	0 - 4	2	4	.32	.64
2	1925 - 1929	5 - 9	7	75	6.02	42.14
3	1920 - 1924	10 - 14	12	24	1.93	23.16
4	1915 - 1919	15 - 19	17	75	6.02	102.34
5	1905 - 1914	20 - 29	25	385	30.90	772.50
6	1895 - 1904	30 - 39	35	227	18.22	637.70
7	1885 - 1894	40 - 49	45	139	11.16	502.20
8	1860 - 1884	50 - 74	62	248	19.90	1233.80
9						3314.48
10	1859 or before	75+	(97.0)*	69	5.54	(537.4)
11				1246	100.01	(3851.9)

*Figures in parentheses apply to I_a' in Section 2.

For the purpose only of making a rank order list of tracts by I_a, values of I_a were used to four or occasionally more significant figures whenever two or more tracts had the same value of I_a to three significant figures. For all other purposes in this study, however, only three significant figures were used.

2. Calculation of Age Index I_a, (described on page 9)

In this calculation, an attempt was made to include those dwelling units built before 1860 in the age index. Since little consistent data was available about dwelling houses in this period, it was decided to use population growth of various parts of the present City as an indicator for estimating the age distribution of dwellings before this date. It was assumed that all of the pre-1860 dwelling units still in existence in 1934 were built after 1800. To obtain a value for these dwellings corresponding to the median values used in the calculation of I_a, therefore, the population growth between 1800 and 1860 of each section of the present City was divided into two groups--that which occurred before 1830, and that which occurred after this date but before 1860. Calling the 1800 to 1860 growth 100%, the percentage of this growth that took place in each of the above periods was then calculated. The median ages from 1934 to each of these groups (90 years to the 1830-1860 group, 120 years to the 1800-1830 group) were then weighted by the percentage of 1800 to 1860 population growth that had been calculated for each period.

This new age factor was then placed in column 3 of Table IV (line 10), and multiplied by the percentage in column 5 (line 10). I_a, is the sum of this product (column 6, line 10) and the sum found in line 9 of column 6 divided by 100.

Continuing with tract T-4A, this procedure is outlined below:

(a) Calculation of age factor for pre-1860 dwellings for Dorchester (where tract T-4A is located):

Dorchester population in thousands,[26] 1800: 2.35
1830: 4.07
1860: 9.77

Population change, 1800-1830: 1.72
1830-1860: 5.70
1800-1860: 7.42

$$\frac{\text{1800-1830 change}}{\text{1800-1860 change}} = \frac{1.72}{7.42} = 0.232$$

$$\frac{\text{1830-1860 change}}{\text{1800-1860 change}} = \frac{5.70}{7.42} = 0.768$$

1.000

1934 to median of 1800-1830 period: 120 years
1934 to median of 1830-1860 period: 90 years

120 x 0.232 = 27.83
90 x 0.768 = 69.13
weighted average = 96.96 or 97.0 years.

(This age value was used for each Dorchester tract having dwelling units built before 1860.)

(b) Calculation of $I_{a'}$ for tract T-4A (see Table IV):

$$I_{a'} = \frac{\text{sum of age-percentage products (column 6, line 11)}}{100.00}$$

$$= \frac{3851.9}{100.00} = 38.5 \text{ years.}$$

The age factors calculated for all parts of the City followed as closely as possible the pattern of calculation shown above for Dorchester;

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[26] Decennial Census of Massachusetts, 1945, Table 12.

gaps in the data, however, made variations in the method necessary in some cases. A list of the age factors found on the basis of population growth for various parts of present-day Boston appears below.

Table V

AGE FACTORS FOR PRE-1860 DWELLINGS IN SECTIONS OF BOSTON

	Ratios of Population Growth		Age Factor
	1800-1830 / 1800-1860	1830-1860 / 1800-1860	
East Boston	0	1.000	90.0
Charlestown	0.270	0.730	98.1
South Boston	---	---	92.7
Roxbury	0.111	0.889	93.3
Dorchester	0.232	0.768	97.0
Brighton	---	---	91.7
West Roxbury	0.263	0.737	97.9
Hyde Park	---	---	98*
Boston Proper	0.416	0.584	102.5

*An estimated value, since no statistics were available for this area before 1855.

A map made by the Boston City Planning Board in 1926 of the areas annexed to Boston at various times was used to determine which of the above areas each tract belonged to. Tracts which straddled division lines between these areas were assigned values half way between the age factors calculated for the adjoining sections.

In the case of Boston Proper (i.e., the area covered by Boston when it became a city in 1822), it was felt that there was so much variation in the rates of growth of different parts of the City that age factors would be worthless unless they could be estimated by wards. However, Boston ward boundaries in the nineteenth century experienced many

metamorphoses, so that ward populations in 1800, 1830, and 1860 could not be compared with one another. However, it was known that the ward boundaries were not changed between 1838 and 1848, and it was found that the Census of Boston of 1845 listed the number of dwelling houses in each ward in both 1840 and 1845.[27] As a first approximation, the rate of growth during these 5 years was utilized to estimate the percentage of building that was done in each half of the period from 1800 to 1860. As a second approximation, these figures were examined in the light of maps showing what areas of Boston were filled and at what time periods, of historical references concerning particular areas of Boston, and in some cases of maps of present-day land use. (The percentage distributions in only 3 of the 11 wards examined were changed as a result of these second approximations.) With the exception of ward 11 (which included the South End), age factors were then calculated in the same manner as for the rest of the City. In the case of ward 11, the results obtained by the method used for the rest of the City of interpolating between two median age figures produced results which were known to be untenable in terms of historical development. (By this method of calculation, the smallest value the age factor could have is 90 years, which corresponds to the year 1844. Yet it is known that very little development took place in this area until after 1856, when the area suddenly began to develop very rapidly.[28])

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[27]Shattuck, Lemuel, Census of Boston 1845, Boston, 1846.

[28]Firey, Walter, Land Use in Central Boston, Cambridge, 1947, pp. 60-61.

The age factors for the wards of Boston Proper and the estimated growth distribution they were calculated from appear below.[29]

Table VI

AGE FACTORS FOR PRE-1860 DWELLINGS

FOR WARDS OF BOSTON PROPER (1846)

Ward	Ratio to Increase of Dwellings 1800-1860		Age Factor
	1800-1830	1830-1860	
1	75%	25%	112.5
2	85	15	115.5
3	50	50	105
4	30	70	99
5	50	50	105
6	70	30	111
7	40	60	102
8	75	25	112.5
9	35	65	100.5
10	25	75	97.5
11	5	95	75-80

3. Calculation of Condition Index

The following table shows the method used for calculating the condition index, I_c. The example used here is again tract T-4A.

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[29]A map showing these ward boundaries may be found in Lloyd Rodwin's Ph.D. thesis: Middle Income Housing Problems in Boston, An Historical Analysis, Harvard University, 1949. Map follows p. 256.

Descriptions of all the ward boundaries up to 1845 may be found in the Census of Boston 1845, op. cit.

Table VII

SAMPLE CALCULATION OF CONDITION INDEX

Line	Col. 1 Condition Categories	Col. 2 Number of d.u. in Each Category	Col. 3 Col. 2 as % of Total d.u. Reporting Condition	Col. 4 Weighting Factors Assigned to Each Category	Col. 5 Product of Col. 3 x Col. 4
1	Good	482	38.38	1	38.38
2	Minor Repairs	660	52.55	2	105.10
3	(Subtotal)		(90.93)		
4	Major Repairs	95	7.56	3	22.68
5	Unfit	19	1.51	4	6.04
6	(Subtotal)		(9.07)		
7	Total	1256	100.00		172.20

$$I_c = \frac{\text{sum of weighted percentages}}{100} = \frac{172.20}{100} = 1.72$$

The subtotals in lines 3 and 6 of Table VII correspond roughly to the 1940 census classifications of housing condition. It is the subtotal in line 6 that is plotted against I_c in Figure 15, Appendix B.

APPENDIX E

STATISTICAL ANALYSIS OF AGE AND CONDITION INDEXES

1. Index Factors Used in Statistical Analysis

In order to calculate the various quantities used in this thesis, it was necessary to reduce the 465 index numbers which had been calculated (see Appendix D) to about 20 factors to be used in the statistical equations which follow in Section 3. In the factors listed in Table VIII, I represents the value of one index (I_a, $I_{a'}$ or I_c) for one tract. $\bar{I}$ is the mean value of one index for all tracts, or ΣI divided by 155. Where Σ is used, the sum of values for all 155 tracts is indicated.

Table VIII

VALUES OF INDEX FACTORS USED IN STATISTICAL ANALYSIS

Factor	I_a (years)	$I_{a'}$ (years)	I_c (I_c units)
ΣI	6255.4	6783.4	291.37
$(\Sigma I)^2$	39,130,029.2	46,014,515.6	84,896.48
$\bar{I}$	40.36	43.76	1.880
$\bar{I}^2$	1628.93	1914.94	3.534
$\Sigma(I^2)$	280.040×10^3	335.090×10^3	569.06

$\Sigma(I_a I_c) = 12,348$

$\Sigma(I_{a'} I_c) = 13,438$

2. Quantities Calculated from Index Factors

From the factors in Table VIII above, the quantities listed in Tables IX and X were calculated. The methods used in obtaining these quantities are given in Section 3 of this appendix.

Where possible, two or even three methods of calculation were employed in finding these quantities; the results obtained by each method and the values selected for use in this study are shown in these tables. Table IX shows quantities based on $I_{a'}$ and I_c, while Table X shows the same quantities calculated from I_a and I_c.

Table IX

VALUES OF QUANTITIES USED IN STATISTICAL ANALYSIS BASED ON $I_{a'}$ AND I_c

Quantity*	Method				Value Selected for Use
	Product Moment	Least Squares	Prof. Solow**	Machine Computation (Walker & Lev)	
σ_x	15.74				15.74
σ_y	0.3712		0.3711		0.3711
r	0.7584	0.7606		0.7603	0.7598
a	1.151	1.093			1.10
b	0.0179	0.0180			0.018
S_y	0.2413		0.2413		--
S'_y			0.2421		0.2421

*Definitions of quantities:
- a = value of I_c when $I_{a'} = 0$ in the regression equation for I_c *vs.* $I_{a'}$.
- b = slope of regression line between I_c and $I_{a'}$.
- r = coefficient of correlation between I_c and $I_{a'}$.
- σ_x = standard deviation of $I_{a'}$.
- σ_y = standard deviation of I_c.
- S_y = standard error of estimate for I_c from $I_{a'}$.
- S'_y = S_y multiplied by (N-1)/(N-2).

**Suggested by Dr. Robert M. Solow, Professor of Statistics, M.I.T.

Table X

VALUES OF QUANTITIES USED IN STATISTICAL ANALYSIS BASED ON I_a AND I_c

Quantity*	Method				Value Selected for Use
	Product Moment	Least Squares	Prof. Solow	Machine Computation (Walker & Lev)	
σ_x	13.43				13.43
σ_y	0.3712		0.3711		0.3711
r	0.7626	0.7671		0.7677	0.7656
a	1.029	1.018			1.018
b	0.0211	0.0214			0.0214
S_y	0.2390		0.2387		--
S'_y			0.2395		0.2395

*Definitions of quantities:
a = value of I_c when I_a = 0 in the regression equation for I_c vs. I_a.
b = slope of regression line between I_c and I_a.
r = coefficient of correlation between I_c and I_a.
σ_x = standard deviation of I_a.
σ_y = standard deviation of I_c.
S_y = standard error of estimate for I_c from I_a.
S'_y = S_y multiplied by (N-1)/(N-2).

3. Methods of Calculation

In all of the following examples, equations have been altered to read in terms of I_a and I_c instead of X and Y. In these equations, I_a corresponds to X, the presumed independent variable, and I_c to Y, the possible dependent variable. Other symbols used in the formulae are explained in Table X above. N equals the number of tracts examined.

The calculations given in this section are entirely for I_a and I_c. Similar calculations, the results of which appear in Table IX above, were

carried out with I_a, for all computations in this section except the determination of confidence bands and confidence limits.

(a) Standard Deviation of I_a

(i) Product Moment Method[30]

$$\sigma_x^2 = \frac{\Sigma(I_a^2)}{N} - \left(\frac{\Sigma I_a}{N}\right)^2$$

$$= \frac{280,040}{155} - \left(\frac{6255.4}{155}\right)^2$$

$$= 1809.032 - 1628.687$$

$$= 180.345$$

$$\sigma_x = 13.429$$

(b) Standard Deviation of I_c

(i) Product Moment Method

$$\sigma_y^2 = \frac{\Sigma(I_c^2)}{N} - \left(\frac{\Sigma I_c}{N}\right)^2$$

$$= \frac{569.06}{155} - \left(\frac{291.37}{155}\right)^2$$

$$= 3.6714 - 3.5336$$

$$= 0.1378$$

$$\sigma_y = 0.3712$$

---

[30]Equation adapted from Arkin and Colton, op. cit., p. 81. All Product Moment equations used in this section may be found in this book on pages 80-81.

(ii) Method Suggested by Professor Solow

$$\sigma_y^2 = \frac{\Sigma(I_c^2) - N\,\bar{I}_c^2}{N}$$

$$= \frac{569.06 - 155(1.8798)^2}{155}$$

$$= \frac{569.06 - 547.71}{155}$$

$$= 0.1377$$

$$\sigma_y = 0.3711$$

(c) Correlation Coefficient (r)

(i) Product Moment Method

$r = \frac{p}{\sigma_x \sigma_y}$, where p = the product moment.

$$p = \frac{\Sigma(I_a I_c)}{N} - (\frac{\Sigma I_a}{N})(\frac{\Sigma I_c}{N})$$

$$= \frac{12,348}{155} - (\frac{6255.4}{155})(\frac{291.37}{155})$$

$$= 79.6645 - 75.8631$$

$$= 3.8014$$

$$r = \frac{3.8014}{(13.429)(0.3712)}$$

$$= 0.7626$$

(ii) Least Squares Method[31]

$$r^2 = \frac{(a\ \Sigma I_c + b\ \Sigma(I_a I_c)) - \bar{I}_c\ \Sigma I_c}{\Sigma(I_c^2) - \bar{I}_c\ \Sigma I_c}$$

$$= \frac{(1.0181 \cdot 291.37 + 0.02135 \cdot 12348) - 1.8748 \cdot 291.37}{569.06 - 1.8798 \cdot 291.37}$$

$$= \frac{296.64 + 263.63 - 547.72}{21.34}$$

$$= \frac{12.55}{21.34}$$

$$= 0.5881$$

$$r = 0.7669$$

(iii) Method for Machine Computation[32]

$$r = \frac{N\ \Sigma(I_a I_c) - (\Sigma I_a)(\Sigma I_c)}{\sqrt{(N\ \Sigma(I_a^2) - (\Sigma I_a)^2)(N\ \Sigma(I_c^2) - (\Sigma I_c)^2)}}$$

$$= \frac{155 \cdot 12,348 - 6255.4 \cdot 291.37}{\sqrt{(155 \cdot 280,037 - 39,130,029)(155 \cdot 569.06 - 84,896.48)}}$$

$$= \frac{91,304}{\sqrt{4,275,706 \cdot 3,307.8}}$$

$$= \frac{91,304}{\sqrt{1.41432 \cdot 10^{10}}}$$

$$= \frac{91,304}{118,925}$$

$$= 0.7677$$

---

[31]Adapted from Croxton and Cowden, Applied General Statistics, New York, 1949, p. 671. The calculation of a and b by the least squares method is shown below.

[32]Adapted from Walker and Lev, Statistical Inference, New York, 1953, p. 234, formula 10.8.

(d) Calculation of Regression Line Equation

(i) Product Moment Method

$$I_c - \bar{I}_c = r\frac{\sigma_y}{\sigma_x}(I_a - \bar{I}_a)$$

$$I_c - 1.8798 = 0.7626\ \frac{0.3712}{13.429}\ (I_a - 40.3574)$$

$$I_c = 0.021078(I_a - 40.3574) + 1.8798$$

$$= 1.029 + 0.0211\ I_a$$

(a) (b)

(ii) Least Squares Method

This method involves solving two simultaneous equations for a and b of the general regression equation $Y = a + bX$, or in this case $I_c = a + bI_a$.

$$\Sigma I_c = Na + b\Sigma I_a \qquad (1)$$

$$\Sigma(I_a I_c) = a + b\,\Sigma(I_a^2) \qquad (2)$$

$$291.37 = 155a + 6255.4b \qquad (1)$$

$$12{,}348 = 6255.4a + 280{,}040b \qquad (2)$$

b can be eliminated by multiplying through equation (1) by $\frac{280{,}040}{6255.4} = 44.7677$:

$$13{,}044 = 6939.0a + 280{,}040b \qquad (1)$$

$$\underline{12{,}348 = 6255.4a + 280{,}040b} \qquad (2)$$

$$696 = 683.6a$$

$$a = 1.0181$$

b is found by substituting a into equation (1):

$$291.37 = 155 \cdot 1.0181 + 6255.4b \qquad (1)$$

$$b = \frac{291.37 - 157.81}{6255.4}$$

$$b = 0.021351$$

This result can be checked by substitution into equation (2):

$$12,348 = 6255.4 \cdot 1.0181 + 280,040 \cdot 0.02135$$

$$12,348 = 12,347.47$$

The equation of the regression line then becomes

$$I_c = 1.018 + 0.0214\ I_a$$

The solutions for a and b by the least squares method were felt to be more reliable than those found by the product moment method, since the former method for obtaining these quantities is far more direct than the latter.

(e) Calculation of Confidence Limits for Estimating I_c from I_a

(i) Standard Error of Estimate (S_y or S'_y)[33]

$$S'_y{}^2 = \frac{N-1}{N-2}\sigma_y{}^2(1 - r^2)$$

$$= \frac{154}{153}\ (0.3711)^2\ (1 - 0.7656^2)$$

$$= 1.00654 \cdot 0.1377(1 - 0.5861)$$

$$= 0.57367$$

$$S'_y = 0.2395$$

---

[33] Ibid., p. 240. Method adapted from equation 10.22.

Note: The $\frac{N-1}{N-2}$ factor is sometimes omitted and the above equation given as $S_y^2 = \sigma_y^2(1-r^2)$. When the latter form of this equation is followed for the above calculation, $S_y = 0.2387$.

(ii) Confidence Bands

The objective of this calculation is to find the distance above and below the regression line that lines parallel to it would have to be drawn to form a band which would include 75% or 90% of the points on the scatter diagram of Figure 8.

The exact method to be used in making this type of calculation depends upon the form of normal curve areas and ordinates table that is available for use. The following example is adapted to Table III (pages 456-457) of Statistical Inference by Walker and Lev. It should be noted that some of the steps shown here might be inapplicable for use with a normal curve table that is set up in a different form.

(1) Degree of confidence desired (in decimal form).	0.750	0.900
(2) Values of step (1) divided by 2.	0.375	0.450
(3) x/σ values corresponding to values in step (2), taken from Table III in Walker and Lev. (The values in step (2) are portions of the area under the normal curve. The values in step (3) are the abscissas from the center of the normal curve that correspond to the areas of step (2).)	1.150	1.655
(4) Step (3) multiplied by S_y (= 0.2395).	0.276	0.397

The values obtained in step (4) of this calculation indicate the vertical distances above and below the regression line within which 75%

or 90% of the tracts in Figure 8 fall. These values are expressed in I_c units, and are plotted in Figure 10. For the values for other percentages not shown in Figure 10, see Table XI.

(iii) Confidence Limits

The object of this calculation is to find in Figure 8 the distance above the regression line that a line would have to be drawn to include either 75% or 90% of the tracts below it; or the distance below the regression line that a line would have to be drawn to include either 75% or 90% of the tracts above it.

The steps outlined below are identical with the steps used in calculating the confidence bands, with the exception of step (2). In this calculation, step (2) equals the step (1) values minus 0.500 instead of the step (1) values divided by 2.

(1) Degree of confidence desired.	0.750	0.900
(2) Step (1) minus 0.500.	0.250	0.400
(3) $\frac{x}{\sigma}$ values corresponding to step (2) values.	0.672	1.282
(4) Step (3) values times S_y (= 0.2395).	0.161	0.307

The values obtained in step (4) are expressed in units of I_c, and are plotted in Figures 11 and 12.

Table XI

SUMMARY OF CONFIDENCE BAND AND CONFIDENCE LIMIT VALUES

FOR VARIOUS PERCENTAGES OF CONFIDENCE FOR ESTIMATING I_c FROM I_a

Desired Percent of Confidence (P)	Confidence Bands	Confidence Limits	
	Ordinate from Regression Line to Edge of P Confidence Band (I_c units)	Ordinate from Regression Line to Line Below Which P% of Tracts Fall (I_c units)	Ordinate from Regression Line to Line Above Which P% of Tracts Fall (I_c units)
50%	± .162	0	0
60	± .202	+ .061	- .061
70	± .248	+ .125	- .125
75	± .276	+ .161	- .161
80	± .307	+ .202	- .202
90	± .397	+ .307	- .307
95	± .470	+ .394	- .394

APPENDIX F

TABULATIONS OF STATISTICAL DATA BY CENSUS TRACTS

1. Alphabetical List of Tracts and Rank of Each Tract in Terms of I_a, $I_{a'}$, I_c, and Rate of Deterioration

The following table has been compiled from Tables XIII, XIV, and XV so that the ranks of the different indexes used in this study for each tract may be compared.

The rank orders of the tracts have been arranged so that a low rank in I_a or $I_{a'}$ means a low average age of dwellings in comparison with other tracts, a low rank of I_c means a lesser degree of deterioration of housing than most other tracts, and a low rank in rate of deterioration means that a tract has deteriorated comparatively little for its age.

In the case of the columns for I_a, $I_{a'}$ and I_c, the rank of each tract was found by carrying out the calculations of Appendix D to a sufficient number of places that each tract had a different index value. (For most of the tracts, four significant figures were sufficient for this purpose, but a few had to be carried to five.) The rate of deterioration indexes, on the other hand, were calculated to only three significant figures. For this reason, and because the values had a small range, a single value of the rate index often applied to several tracts, and it was necessary to assign the same rank to all tracts in such a group. If four tracts had a similar rate index which covered ranks 52 through 55, for example, each tract in the group was assigned the mid-rank of 53.5. In

order to assign tracts to the proper group for the geographical analysis shown in Figure 9, however, the rate index values were recalculated where necessary and carried out to one or two additional places.

It is intended that Table XII may be used not only for finding the rank of individual tracts in each index, but may also serve as a means by which the values of these indexes for each tract may be located in the rank order lists found in Tables XIII, XIV, and XV.

Table XII

ALPHABETICAL LIST OF TRACTS AND RANK OF EACH TRACT IN TERMS OF I_a, $I_{a'}$, I_c, AND RATE OF DETERIORATION

Census Tract	Rank				
	Age Index		Condition Index	Rate of Deterioration	
	I_a	$I_{a'}$	I_c	Based on I_a and I_c	Based on $I_{a'}$ and I_c
A-1	30	27	23	51	49.5
A-2	86	78	85	72.5	96.5
A-3	103	99	109	79	91.5
A-4	130	122	105	33	49.5
A-5	134	144	122	53.5	33.5
A-6	116	102	101	37.5	60
B-1	97	96	120	107	115.5
B-2	122	134	147	143.5	138.5
B-3	104	113	136	132	135.5
B-4	106	131	138	129	117.5
B-5A	23	23	62	132	131.5
B-5B	110	110	100	46	49.5
C-1	154	141	88	6	11.5
C-2	143	151	143	117	91.5
C-3	149	155	124	42	7
D-1	150	154	141	109.5	57
D-2	145	150	140	103.5	68.5
D-3	144	153	117	33	11.5
D-4	141	149	131	72.5	49.5

Table XII (Continued)

Census Tract	Rank				
	Age Index		Condition Index	Rate of Deterioration	
	I_a	$I_{a'}$	I_c	Based on I_a and I_c	Based on $I_{a'}$ and I_c
E-1	136	152	127	72.5	25
E-2	142	145	114	33	44
F-1	90	94	128	139.5	134
F-2	66	67	75	100	100.5
F-3	83	84	97	103.5	103.5
F-4	78	109	107	123.5	63.5
F-5	81	85	74	57	49.5
F-6	28	75	1	3	1
G-1	147	142	155	155	155
G-2	140	148	150	148	142.5
G-3	125	135	94	26	18
G-4	127	123	146	142	145
H-1	70	87	70	86	37
H-2	73	70	151	154	154
H-3	62	58	52	64.5	68.5
H-4	69	105	106	132	63.5
I-1	117	118	148	147	148
I-2	96	91	145	149	150
I-3	153	138	149	145.5	147
I-4	148	130	134	79	111
J-1	146	136	119	33	49.5
J-2	128	107	130	97.5	123.5
J-3	95	90	67	20	33.5
J-4	100	93	55	13	18
J-5	42	37	27	42	44
K-1	63	89	98	127	96.5
K-2	91	147	37	10.5	3
K-3	94	86	9	1	2
K-4A	37	39	11	8	8.5
K-4B	8	7	14	68	63.5
K-5	75	71	8	2	4
L-1	155	137	115	14	40
L-2	126	115	91	16.5	28
L-3	129	124	125	68	86.5
L-4	133	133	99	20	22
L-5	138	140	61	4	5
L-6	152	129	81	6	14

Table XII (Continued)

Census Tract	Rank				
	Age Index		Condition Index	Rate of Deterioration	
	I_a	$I_{a'}$	I_c	Based on I_a and I_c	Based on $I_{a'}$ and I_c
M-1	151	132	112	24	40
M-2	131	128	113	48.5	54.5
M-3	132	121	129	86	111
M-4	139	143	153	150	149
N-1	114	117	123	95	96.5
N-2	109	98	79	16.5	33.5
N-3	88	79	63	37.5	44
N-4	124	108	72	10.5	16
O-1	113	103	84	20	30.5
O-2	112	104	110	60.5	79
O-3	120	146	93	24	11.5
O-4	118	106	108	48.5	68.5
P-1A	135	127	132	92.5	111
P-1B	76	68	121	136.5	142.5
P-1C	79	72	80	86	100.5
P-2	77	74	87	100	106.5
P-3	80	81	58	37.5	37
P-4	84	76	78	57	79
P-5	92	92	116	117	121
P-6	82	77	53	29.5	40
Q-1	98	120	137	136.5	131.5
Q-2	123	126	144	139.5	140
Q-3	101	111	126	117	115.5
Q-4	121	114	118	60.5	79
Q-5	107	95	95	42	63.5
R-1	137	139	154	153	153
R-2	119	125	139	125.5	130
R-3	108	116	142	139.5	138.5
S-1	36	40	34	57	60
S-2	111	112	152	151	151
S-3	115	119	135	120.5	126
S-4	61	55	66	97.5	111
S-5	34	32	35	64.5	74
S-6	89	82	76	51	60

Table XII (Continued)

Census Tract	Rank				
	Age Index		Condition Index	Rate of Deterioration	
	I_a	$I_{a'}$	I_c	Based on I_a and I_c	Based on $I_{a'}$ and I_c
T-1	64	65	103	134	135.5
T-2	60	56	104	139.5	141
T-3A	51	51	45	79	79
T-3B	54	53	50	90.5	83
T-4A	59	60	47	60.5	57
T-4B	44	38	44	86	91.5
T-5A	58	59	83	125.5	121
T-5B	52	48	65	111	119
T-6	43	36	133	152	152
T-7A	21	21	46	129	133
T-7B	32	29	90	145.5	146
T-8A	29	26	82	143.5	144
T-8B	55	52	49	86	91.5
T-9	57	50	73	114	126
T-10	53	47	16	12	13
U-1	87	80	69	46	54.5
U-2	102	97	77	20	26
U-3	99	101	102	68	74
U-4	85	83	86	86	86.5
U-5	40	35	42	90.5	91.5
U-6A	47	43	13	9	10
U-6B	3	3	4	27	20.5
V-1	65	62	92	122	128.5
V-2	105	100	111	79	96.5
V-3	93	88	96	72.5	91.5
V-4A	31	33	15	15	15
V-4B	49	45	51	95	103.5
V-5	67	64	38	28	28
V-6	72	69	68	72.5	83
W-1A	24	30	20	42	28
W-1B	19	20	17	53.5	53
W-2	39	42	64	119	121
W-3A	18	18	32	109.5	111
W-3B	48	54	33	51	37
W-4A	35	41	40	86	79
W-4B	13	11	29	114	117.5

Table XII (Continued)

Census Tract	Rank				
	Age Index		Condition Index	Rate of Deterioration	
	I_a	$I_{a'}$	I_c	Based on I_a and I_c	Based on $I_{a'}$ and I_c
W-5	22	22	22	64.5	57
W-6A	1	1	5	46	30.5
W-6B	4	6	12	60.5	44
W-6C	7	8	7	33	23.5
W-6D	10	13	36	129	128.5
X-1	56	57	48	79	68.5
X-2	45	49	43	79	74
X-3A	12	12	24	107	100.5
X-3B	25	28	30	72.5	68.5
X-4A	38	34	28	42	44
X-4B	16	16	10	20	20.5
X-5A	26	24	39	100	103.5
X-5B	20	19	56	135	137
X-5C	33	31	60	120.5	126
X-6A	6	4	21	112	111
X-6B	9	10	31	123.5	123.5
X-6C	41	63	59	114	74
Y-1	74	73	89	107	111
Y-2	50	46	41	64.5	74
Y-3A	15	15	2	6	6
Y-3B	27	25	18	37.5	33.5
Y-4	17	17	25	95	86.5
Y-5A	11	9	19	92.5	83
Y-5B	5	5	6	29.5	23.5
Y-5C	2	2	3	24	18
Z-1A	14	14	26	103.5	100.5
Z-1B	71	66	71	79	86.5
Z-1C	68	61	57	55	68.5
Z-2	46	44	54	103.5	106.5

2. Tabulation of Tracts by Rank and Value of Age Indexes

Table XIII lists the values of the age index for each tract in terms of I_a and $I_{a'}$. The 155 index values for I_a and $I_{a'}$ have been divided into five equal groups of 31 each, the groups of I_a being used to plot Figure 5.

Table XIII

BOSTON CENSUS TRACTS BY RANK AND VALUE OF AGE INDEXES I_a AND $I_{a'}$

Rank	I_a		$I_{a'}$	
	Index Value (Years)	Census Tract	Index Value (Years)	Census Tract
(Group I)				
1	11.8	W-6A	12.5	W-6A
2	13.6	Y-5C	13.7	Y-5C
3	14.8	U-6B	15.2	U-6B
4	15.7	W-6B	16.5	X-6A
5	16.0	Y-5B	16.6	Y-5B
6	16.4	X-6A	17.5	W-6B
7	17.1	W-6C	18.2	K-4B
8	18.0	K-4B	"	W-6C
9	18.8	X-6B	19.2	Y-5A
10	"	W-6D	19.4	X-6B
11	18.9	Y-5A	19.5	W-4B
12	19.3	X-3A	20.4	X-3A
13	19.5	W-4B	20.6	W-6D
14	20.7	Z-1A	20.9	Z-1A
15	21.0	Y-3A	21.2	Y-3A
16	21.3	X-4B	21.4	X-4B
17	21.6	Y-4	22.1	Y-4
18	22.2	W-3A	22.8	W-3A
19	23.0	W-1B	23.1	X-5B
20	23.1	X-5B	23.3	W-1B
21	"	T-7A	23.6	T-7A
22	23.5	W-5	24.6	W-5
23	25.9	B-5A	25.9	B-5A
24	26.2	W-1A	26.4	X-5A
25	"	X-3B	26.8	Y-3B

Table XIII (Continued)

Rank	I_a Index Value (Years)	I_a Census Tract	$I_{a'}$ Index Value (Years)	$I_{a'}$ Census Tract
26	26.4	X-5A	27.1	T-8A
27	"	Y-3B	27.3	A-1
28	26.6	F-6	27.4	X-3B
29	26.9	T-8A	28.3	T-7B
30	27.3	A-1	29.2	W-1B
31	28.1	V-4A	29.3	X-5C
(Group II)				
32	28.3	T-7B	30.0	S-5
33	28.8	X-5C	30.2	V-4A
34	29.6	S-5	"	X-4A
35	29.7	W-4A	30.4	U-5
36	29.9	S-1	"	T-6
37	30.0	K-4A	30.5	J-5
38	"	X-4A	30.8	T-4B
39	"	W-2	31.0	K-4A
40	30.1	U-5	31.2	S-1
41	30.2	X-6C	31.3	W-4A
42	"	J-5	31.7	W-2
43	30.4	T-6	32.0	U-6A
44	30.6	T-4B	32.1	Z-2
45	30.8	X-2	32.2	V-4B
46	31.1	Z-2	32.5	Y-2
47	31.5	U-6A	32.7	T-10
48	31.6	W-3B	"	T-5B
49	31.8	V-4B	33.1	X-2
50	31.9	Y-2	33.6	T-9
51	32.1	T-3A	33.9	T-3A
52	32.3	T-5B	"	T-8B
53	32.5	T-10	35.1	T-3B
54	33.0	T-3B	35.7	W-3B
55	33.3	T-8B	35.8	S-4
56	"	X-1	36.0	T-2
57	33.5	T-9	36.6	X-1
58	33.6	T-5A	37.0	H-3
59	35.1	T-4A	38.4	T-5A
60	35.3	T-2	38.5	T-4A
61	"	S-4	38.6	Z-1C
62	35.4	H-3	38.9	V-1

Table XIII (Continued)

Rank	I_a Index Value (Years)	I_a Census Tract	$I_{a'}$ Index Value (Years)	$I_{a'}$ Census Tract
(Group III)				
63	36.7	K-1	38.9	X-6C
64	"	T-1	39.1	V-5
65	36.8	V-1	39.2	T-1
66	36.9	F-2	39.5	Z-1B
67	37.0	V-5	"	F-2
68	37.4	Z-1C	39.9	P-1B
69	37.8	H-4	"	V-6
70	"	H-1	40.4	H-2
71	38.0	Z-1B	40.7	K-5
72	38.7	V-6	41.7	P-1C
73	39.3	H-2	42.0	Y-1
74	39.5	Y-1	42.1	P-2
75	39.6	K-5	42.2	F-6
76	39.9	P-1B	42.5	P-4
77	"	P-2	42.6	P-6
78	40.6	F-4	43.1	A-2
79	41.1	P-1C	44.4	N-3
80	41.3	P-3	44.5	U-1
81	41.5	F-5	44.6	P-3
82	42.1	P-6	44.9	S-6
83	42.2	F-3	"	U-4
84	42.4	P-4	45.9	F-3
85	42.6	U-4	46.4	F-5
86	42.8	A-2	47.0	K-3
87	"	U-1	47.6	H-1
88	42.9	N-3	47.8	V-3
89	43.4	S-6	48.0	K-1
90	43.5	F-1	48.1	J-3
91	43.6	K-2	48.4	I-2
92	45.0	P-5	48.8	P-5
93	46.4	V-3	"	J-4
(Group IV)				
94	46.8	K-3	49.8	F-1
95	47.4	J-3	51.6	Q-5
96	47.6	I-2	51.9	B-1
97	48.3	B-1	52.1	U-2
98	48.5	Q-1	52.2	N-2
99	48.6	U-3	52.4	A-3
100	48.8	J-4	52.7	V-2

Table XIII (Continued)

Rank	I_a Index Value (Years)	I_a Census Tract	$I_{a'}$ Index Value (Years)	$I_{a'}$ Census Tract
101	49.2	Q-3	53.0	U-3
102	49.3	U-2	53.4	A-6
103	"	A-3	54.1	O-1
104	49.7	B-3	54.4	O-2
105	50.4	V-2	54.6	H-4
106	51.0	B-4	54.7	O-4
107	"	Q-5	"	J-2
108	51.4	R-3	"	N-4
109	"	N-2	55.0	F-4
110	51.6	B-5B	55.5	B-5B
111	51.7	S-2	55.7	Q-3
112	"	O-2	55.8	S-2
113	"	O-1	55.9	B-3
114	52.1	N-1	56.3	Q-4
115	"	S-3	56.5	L-2
116	52.7	A-6	"	R-3
117	"	I-1	56.6	N-1
118	"	O-4	56.8	I-1
119	52.9	R-2	"	S-3
120	53.1	O-3	"	Q-1
121	53.4	Q-4	57.2	M-3
122	53.8	B-2	57.4	A-4
123	53.9	Q-2	58.1	G-4
124	54.0	N-4	"	L-3
(Group V)				
125	54.1	G-3	58.6	R-2
126	54.2	L-2	58.8	Q-2
127	54.5	G-4	59.2	P-1A
128	"	J-2	59.4	M-2
129	55.2	L-3	60.1	L-6
130	"	A-4	60.6	I-4
131	55.3	M-2	61.2	B-4
132	55.5	M-3	61.6	M-1
133	56.0	L-4	"	L-4
134	56.1	A-5	61.7	B-2
135	56.5	P-1A	"	G-3

Table XIII (Continued)

Rank	I_a		$I_{a'}$	
	Index Value (Years)	Census Tract	Index Value (Years)	Census Tract
136	56.7	E-1	61.9	J-1
137	56.8	R-1	62.1	L-1
138	56.9	L-5	62.7	I-3
139	57.5	M-4	63.2	R-1
140	57.8	G-2	63.6	L-5
141	57.9	D-4	64.1	C-1
142	58.2	E-2	64.3	G-1
143	58.5	C-2	65.5	M-4
144	58.6	D-3	65.6	A-5
145	58.8	D-2	66.7	E-2
146	58.9	J-1	67.0	O-3
147	"	G-1	67.1	K-2
148	59.0	I-4	67.8	G-2
149	59.3	C-3	68.1	D-4
150	59.4	D-1	69.8	D-2
151	"	M-1	70.0	C-2
152	59.6	L-6	71.4	E-1
153	59.9	I-3	73.7	D-3
154	60.9	C-1	74.2	D-1
155	61.7	L-1	80.1	C-3
Index Value for City as a Whole:				
	47.86		--	
Mean Value of all Tract Indexes:				
	40.36		43.76	

3. Tabulation of Tracts by Rank and Value of Condition Index, with Percentage Distribution of Dwelling Units in Condition Categories

In the following table the census tracts of Boston are arranged in order of the values of their condition index, starting with those tracts having the best average condition of dwelling units. This list is also subdivided into the five groups that are mapped in Figure 6.

In the four right-hand columns of this table are listed the percentages of dwelling units in each tract in each of the four condition categories used in the original survey. It is from these percentages that the condition index for each tract was calculated. Although these percentages were carried out by the author to two or three decimal places for use in calculating I_c, they should not be considered significant to more than one decimal place--and for most uses they should be rounded off to this extent.

Table XIV

BOSTON CENSUS TRACTS BY RANK AND VALUE OF CONDITION INDEX, I_c, WITH PERCENTAGE DISTRIBUTION OF DWELLING UNITS BY CONDITION CATEGORIES

Rank	Index Value (I_c units)	Census Tract	Percentage of Dwelling Units in Condition Categories			
			Good Condition	Needing Minor Repairs	Needing Major Repairs	Unfit for Habitation
(Group I)						
1	1.06	F-6	94.19	5.81	0	0
2	1.08	Y-3A	91.99	7.51	0.51	0
3	1.12	Y-5C	88.10	11.57	0.32	0.03
4	1.15	U-6B	85.26	14.48	0.25	0
5	1.17	W-6A	83.87	15.22	0.92	0
6	1.20	Y-5B	81.01	18.17	0.70	0.11
7	1.23	W-6C	78.45	20.52	0.89	0.15
8	1.24	K-5	76.80	22.65	0.54	0

Table XIV (Continued)

Rank	Index Value (I_c units)	Census Tract	Percentage of Dwelling Units in Condition Categories			
			Good Condition	Needing Minor Repairs	Needing Major Repairs	Unfit for Habitation
9	1.25	K-3	74.87	25.13	0	0
10	1.27	X-4B	73.75	25.63	0.62	0
11	1.30	K-4A	71.15	27.86	0.99	0
12	1.31	W-6B	70.79	27.72	1.49	0
13	1.34	U-6A	68.78	28.34	2.88	0
14	1.38	K-4B	61.86	38.16	0	0
15	1.39	V-4A	63.39	34.66	1.93	0
16	"	T-10	62.63	35.89	1.48	0
17	1.43	W-1B	57.67	41.82	0.52	0
18	1.44	Y-3B	60.61	34.96	4.35	0.09
19	1.45	Y-5A	60.54	33.88	5.58	0
20	1.46	W-1A	56.57	40.62	2.81	0
21	1.47	X-6A	54.42	44.02	1.57	0
22	1.48	W-5	52.63	46.57	0.76	0.04
23	1.49	A-1	54.53	42.54	2.64	0.29
24	1.51	X-3A	53.36	42.64	3.53	0.26
25	"	Y-4	51.49	45.77	2.68	0.05
26	1.52	Z-1A	50.39	47.65	1.41	0.55
27	1.54	J-5	47.45	51.53	1.03	0
28	"	X-4A	47.81	50.72	1.02	0.46
29	1.55	W-4B	45.65	53.29	1.06	0
30	1.56	X-3B	48.95	45.79	5.07	0.19
31	1.58	X-6B	47.30	47.24	5.47	0
(Group II)						
32	"	W-3A	47.93	46.26	5.32	0.49
33	1.60	W-3B	47.55	46.46	4.89	1.09
34	"	S-1	53.97	35.35	7.24	3.44
35	1.61	S-5	46.67	45.72	7.59	0
36	1.62	W-6D	42.42	53.69	3.89	0
37	"	K-2	39.19	59.30	1.51	0
38	1.63	V-5	45.74	46.99	5.93	1.33
39	"	X-5A	38.32	60.25	1.43	0
40	1.65	W-4A	38.17	58.31	3.53	0
41	1.66	Y-2	47.25	40.74	11.13	0.87
42	1.67	U-5	38.11	56.95	4.66	0.27
43	"	X-2	37.72	57.34	4.85	0.08
44	"	T-4B	33.72	65.21	0.98	0.09
45	1.70	T-3A	37.74	55.35	6.62	0.29

Table XIV (Continued)

Rank	Index Value (I_c units)	Census Tract	Percentage of Dwelling Units in Condition Categories			
			Good Condition	Needing Minor Repairs	Needing Major Repairs	Unfit for Habitation
46	1.72	T-7A	38.85	50.11	11.03	0
47	"	T-4A	38.38	52.55	7.56	1.51
48	"	X-1	37.19	53.32	9.40	0.09
49	1.73	T-8B	31.65	63.98	4.38	0
50	"	T-3B	33.48	60.16	6.34	0
51	"	V-4B	28.51	70.00	1.29	0
52	"	H-3	44.26	39.16	15.48	1.09
53	1.74	P-6	28.18	70.07	1.38	0.37
54	"	Z-2	32.43	61.22	6.31	0.05
55	1.75	J-4	31.72	62.84	4.51	0.94
56	"	X-5B	27.32	70.47	2.13	0.08
57	"	Z-1C	34.55	56.00	8.93	0.51
58	1.76	P-3	27.34	69.97	2.43	0.27
59	1.77	X-6C	31.39	60.84	7.44	0.32
60	"	X-5C	27.67	67.79	4.53	0
61	1.78	L-5	24.68	73.02	2.31	0
62	"	B-5A	22.99	76.29	0.72	0
(Group III)						
63	1.79	N-3	26.21	68.55	5.14	0.11
64	"	W-2	32.92	55.71	10.49	0.87
65	1.80	T-5B	20.90	78.66	0.29	0.15
66	1.81	S-4	32.96	53.67	12.62	0.75
67	1.82	J-3	19.88	78.75	1.38	0
68	"	V-6	28.11	62.80	8.55	0.55
69	"	U-1	24.72	68.72	6.42	0.13
70	"	H-1	40.60	38.99	18.15	2.28
71	"	Z-1B	27.76	63.11	8.14	0.99
72	1.83	N-4	21.03	75.42	3.20	0.34
73	1.84	T-9	17.33	81.77	0.79	0.11
74	"	F-5	26.40	64.87	7.07	1.66
75	1.85	F-2	18.09	79.01	2.90	0
76	"	S-6	23.81	68.48	6.39	1.32
77	1.86	U-2	23.49	68.29	7.34	0.89
78	"	P-4	18.35	77.42	4.23	0
79	1.89	N-2	17.70	75.98	6.25	0.08
80	"	P-1C	13.57	84.01	2.42	0

Table XIV (Continued)

Rank	Index Value (I_c units)	Census Tract	Percentage of Dwelling Units in Condition Categories			
			Good Condition	Needing Minor Repairs	Needing Major Repairs	Unfit for Habitation
81	1.89	L-6	12.45	86.37	1.04	0.15
82	"	T-8A	15.69	79.65	4.65	0
83	1.91	T-5A	11.68	85.97	2.35	0
84	"	O-1	18.51	73.64	6.45	1.42
85	"	A-2	20.26	68.79	10.69	0.26
86	1.92	U-4	20.01	68.42	11.45	0.12
87	"	P-2	13.55	81.95	3.02	1.48
88	"	C-1	16.50	74.95	8.15	0.40
89	1.93	Y-1	21.90	65.70	10.29	2.11
90	1.94	T-7B	17.12	71.91	10.69	0.29
91	1.95	L-2	12.81	79.92	7.27	0
92	"	V-1	32.21	46.25	16.17	5.37
93	"	O-3	18.90	68.87	10.25	1.99
(Group IV)						
94	1.98	G-3	2.75	96.33	0.92	0
95	"	Q-5	15.81	71.50	11.25	1.44
96	"	V-3	10.59	81.03	7.83	0.55
97	"	F-3	4.88	91.87	3.25	0
98	1.99	K-1	19.00	66.62	10.82	3.57
99	2.00	L-4	13.93	75.28	8.09	2.70
100	"	B-5B	19.93	61.53	17.45	1.10
101	"	A-6	7.12	86.25	6.23	0.40
102	2.02	U-3	16.93	65.74	16.25	1.09
103	"	T-1	16.15	66.51	16.78	0.56
104	2.03	T-2	15.12	67.20	17.68	0
105	"	A-4	5.70	85.45	8.78	0.08
106	"	H-4	18.79	60.19	19.83	1.19
107	2.04	F-4	8.41	80.43	9.69	1.47
108	"	O-4	1.40	93.22	4.91	0.47
109	2.06	A-3	11.09	72.26	16.01	0.65
110	2.07	O-2	7.60	79.03	12.36	1.01
111	2.08	V-2	5.76	80.98	13.11	0.14
112	"	M-1	1.97	89.65	6.40	1.97
113	2.09	M-2	4.18	84.07	10.53	1.22
114	"	E-2	22.43	51.65	20.37	5.56
115	"	L-1	6.47	77.61	15.92	0

Table XIV (Continued)

Rank	Index Value (I_c units)	Census Tract	Percentage of Dwelling Units in Condition Categories			
			Good Condition	Needing Minor Repairs	Needing Major Repairs	Unfit for Habitation
116	2.10	P-5	4.76	81.22	13.48	0.54
117	"	D-3	10.06	75.58	8.83	5.52
118	"	Q-4	20.16	52.79	23.71	3.34
119	2.11	J-1	7.76	75.22	15.30	1.72
120	"	B-1	8.31	73.20	17.62	0.87
121	"	P-1B	0	88.57	11.43	0
122	2.13	A-5	6.93	76.01	14.72	2.35
123	2.15	N-1	7.27	72.33	18.53	1.87
124	2.16	C-3	19.51	50.89	24.04	5.56
(Group V)						
125	"	L-3	11.84	60.68	27.38	0.14
126	2.18	Q-3	11.68	60.30	26.05	1.97
127	2.20	E-1	13.60	57.47	24.53	4.40
128	"	F-1	3.23	76.06	18.42	2.29
129	"	M-3	2.49	78.40	15.58	3.53
130	2.21	J-2	1.85	79.03	15.77	3.36
131	2.23	D-4	9.93	61.46	24.78	3.82
132	2.24	P-1A	0.56	77.08	19.96	2.40
133	2.26	T-6	6.55	61.19	32.25	0
134	"	I-4	5.89	67.21	21.92	4.98
135	"	S-3	7.83	60.79	28.67	2.71
136	2.28	B-3	11.45	52.77	31.66	4.12
137	2.29	Q-1	11.11	54.50	28.57	5.82
138	2.30	B-4	8.12	56.33	32.81	2.74
139	2.31	R-2	3.82	64.76	24.31	7.12
140	2.32	D-2	2.32	68.06	24.54	5.09
141	2.36	D-1	4.03	64.92	22.38	8.67
142	2.37	R-3	4.42	61.83	26.12	7.63
143	2.38	C-2	0.41	69.46	21.48	8.64
144	2.42	Q-2	2.43	55.37	39.94	2.25
145	2.45	I-2	1.81	54.47	41.02	2.69
146	2.46	G-4	0.50	59.41	34.16	5.94
147	"	B-2	3.37	53.85	35.83	6.96
148	2.55	I-1	2.88	45.03	46.34	5.76
149	2.61	I-3	3.57	47.45	33.30	15.70
150	"	G-2	2.63	43.76	43.23	10.38

Table XIV (Continued)

Rank	Index Value (I_c units)	Census Tract	Percentage of Dwelling Units in Condition Categories			
			Good Condition	Needing Minor Repairs	Needing Major Repairs	Unfit for Habitation
151	2.63	H-2	8.59	35.87	39.35	16.20
152	2.65	S-2	2.94	32.66	60.62	3.78
153	2.72	M-4	2.90	40.58	38.04	18.48
154	2.85	R-1	0.62	40.30	32.19	26.90
155	3.22	G-1	0	9.18	59.49	31.33
Dwelling Units in City as a Whole:						
	1.8075		32.90	55.20	10.19	1.72
Mean Value of all Tract Indexes:						
	1.8798					

4. Tabulation of Tracts by Average Rate of Deterioration

In this table the census tracts of Boston are arranged in rank order of their average rate of deterioration, those tracts showing the least deterioration for their age appearing first in the list. The value listed in the table is the amount in I_c units by which each tract deviates from the age-condition regression line, which represents the average rate of deterioration of all tracts in the City. For an explanation of the sign convention used in this table, see page 24. The list is subdivided into the five groups which were used in mapping this data in Figure 9.

Table XV

BOSTON CENSUS TRACTS BY RANK AND VALUE OF

VERTICAL DEVIATION FROM AGE-CONDITION REGRESSION LINE

dI_c Based on I_a and I_c			dI_c Based on $I_{a'}$ and I_c		
Rank	Value of Deviation (I_c units)	Census Tract	Rank	Value of Deviation (I_c units)	Census Tract
(Group I)					
1	-0.75	K-3	1	-0.79	F-6
2	-0.61	K-5	2	-0.69	K-3
3	-0.52	F-6	3	-0.68	K-2
4	-0.43	L-5	4	-0.58	K-5
6	-0.38	C-1	5	-0.45	L-5
"	"	L-6	6	-0.39	Y-3A
"	"	Y-3A	7	-0.37	C-3
8	-0.35	K-4A	8.5	-0.35	K-4A
9	-0.34	U-6A	"	"	O-3
10.5	-0.32	K-2	10	-0.33	U-6A
"	"	N-4	11.5	-0.32	C-1
12	-0.31	T-10	"	"	D-3
13	-0.29	J-4	13	-0.29	T-10
14	-0.23	L-1	14	-0.28	L-6
15	-0.22	V-4A	15	-0.25	V-4A

Table XV (Continued)

dI_c Based on I_a and I_c			dI_c Based on I_a, and I_c		
Rank	Value of Deviation (I_c units)	Census Tract	Rank	Value of Deviation (I_c units)	Census Tract
16.5	-0.21	L-2	16	-0.24	N-4
"	"	N-2	18	-0.22	G-3
20	-0.20	J-3	"	"	J-4
"	"	L-4	"	"	Y-5C
"	"	O-1	20.5	-0.21	U-6B
"	"	U-2	"	"	X-4B
"	"	X-4B	22	-0.20	L-4
24	-0.19	M-1	23.5	-0.19	W-6C
"	"	O-3	"	"	Y-5B
"	"	Y-5C	25	-0.18	E-1
26.5	-0.18	G-3	26	-0.17	U-2
"	"	U-6B	28	-0.16	L-2
28	-0.17	V-5	"	"	V-5
29.5	-0.16	P-6	"	"	W-1A
"	"	Y-5B	30.5	-0.15	O-1
33	-0.15	D-3	"	"	W-6A
(Group II)					
33	"	E-2	33.5	-0.14	A-5
"	"	J-1	"	"	J-3
"	"	A-4	"	"	N-2
"	"	W-6C	"	"	Y-3B
37.5	-0.13	A-6	37	-0.13	H-1
"	"	N-3	"	"	P-3
"	"	P-3	"	"	W-3B
"	"	Y-3B	40	-0.12	L-1
42	-0.11	C-3	"	"	M-1
"	"	J-5	"	"	P-6
"	"	Q-5	44	-0.10	E-2
"	"	W-1A	"	"	J-5
"	"	X-4A	"	"	N-3
46	-0.10	B-5B	"	"	W-6B
"	"	U-1	"	"	X-4A
"	"	W-6A	49.5	-0.09	A-1
48.5	-0.09	M-2	"	"	A-4
"	"	O-4	"	"	B-5B
51	-0.08	A-1	"	"	D-4
"	"	S-6	"	"	F-5
"	"	W-3B	"	"	J-1

Table XV (Continued)

dI_c Based on I_a and I_c			$dI_{c'}$ Based on $I_{a'}$ and I_c		
Rank	Value of Deviation (I_c units)	Census Tract	Rank	Value of Deviation (I_c units)	Census Tract
53.5	-0.07	A-5	53	-0.08	W-1B
"	"	W-1B	54.5	-0.07	M-2
55	-0.06	Z-1C	"	"	U-1
57	-0.05	F-5	57	-0.06	D-1
"	"	P-4	"	"	T-4A
"	"	S-1	"	"	W-5
60.5	-0.04	O-2	60	-0.05	A-6
"	"	Q-4	"	"	S-1
"	"	T-4A	"	"	S-6
"	"	W-6B	63.5	-0.04	Q-5
(Group III)					
64.5	-0.03	H-3	"	"	K-4B
"	"	S-5	"	"	F-4
"	"	W-5	"	"	H-4
"	"	Y-2	68.5	-0.03	D-2
68	-0.02	K-4B	"	"	H-3
"	"	L-3	"	"	O-4
"	"	U-3	"	"	X-1
72.5	-0.01	A-2	"	"	X-3B
"	"	D-4	"	"	Z-1C
"	"	E-1	74	-0.02	S-5
"	"	V-3	"	"	U-3
"	"	V-6	"	"	X-2
"	"	X-3B	"	"	X-6C
79	0	A-3	"	"	Y-2
"	"	I-4	79	0	Q-4
"	"	T-3A	"	"	O-2
"	"	V-2	"	"	P-4
"	"	X-1	"	"	T-3A
"	"	X-2	"	"	W-4A
"	"	Z-1B	83	+0.01	T-3B
86	+0.01	H-1	"	"	V-6
"	"	M-3	"	"	Y-5A
"	"	P-1C	86.5	+0.02	L-3
"	"	T-4B	"	"	U-4
"	"	T-8B	"	"	Y-4
"	"	W-4A	"	"	Z-1B
"	"	U-4	91.5	+0.03	T-8B
90.5	+0.02	T-3B	"	"	A-3

Table XV (Continued)

dI_c Based on I_a and I_c			$dI_{c'}$ Based on $I_{a'}$ and I_c		
Rank	Value of Deviation (I_c units)	Census Tract	Rank	Value of Deviation (I_c units)	Census Tract
90.5	+0.02	U-5	91.5	+0.03	T-4B
92.5	+0.03	P-1A	"	"	V-3
"	"	Y-5A	"	"	U-5
(Group IV)					
95	+0.04	N-1	"	"	C-2
"	"	V-4B	96.5	+0.04	A-2
"	"	Y-4	"	"	K-1
97.5	+0.05	J-2	"	"	N-1
"	"	S-4	"	"	V-2
100	+0.06	F-2	100.5	+0.05	F-2
"	"	P-2	"	"	P-1C
"	"	X-5A	"	"	X-3A
103.5	+0.07	D-2	"	"	Z-1A
"	"	F-3	103.5	+0.06	F-3
"	"	Z-1A	"	"	V-4B
"	"	Z-2	"	"	X-5A
107	+0.08	B-1	106.5	+0.07	P-2
"	"	X-3A	"	"	Z-2
"	"	Y-1	111	+0.08	I-4
109.5	+0.09	D-1	"	"	M-3
"	"	W-3A	"	"	P-1A
111	+0.10	T-5B	"	"	S-4
112	+0.11	X-6A	"	"	W-3A
114	+0.12	T-9	"	"	X-6A
"	"	W-4B	"	"	Y-1
"	"	X-6C	115.5	+0.09	B-1
117	+0.13	C-2	"	"	Q-3
"	"	P-5	117.5	+0.11	B-4
"	"	Q-3	"	"	W-4B
119	+0.14	W-2	119	+0.12	T-5B
120.5	+0.15	S-3	121	+0.13	P-5
"	"	X-5C	"	"	W-2
122	+0.16	V-1	"	"	T-5A
123.5	+0.17	F-4	123.5	+0.14	X-6B
"	"	X-6B	"	"	J-2

Table XV (Continued)

dI_c Based on I_a and I_c			dI_c Based on I_a, and I_c		
Rank	Value of Deviation (I_c units)	Census Tract	Rank	Value of Deviation (I_c units)	Census Tract
(Group V)					
125.5	+0.18	R-2	126	+0.15	T-9
"	"	T-5A	"	"	S-3
127	+0.20	K-1	"	"	X-5C
129	+0.21	B-4	128.5	+0.16	W-6D
"	"	T-7A	"	"	V-1
"	"	W-6D	130	+0.17	R-2
132	+0.22	B-3	131.5	+0.18	B-3
"	"	B-5A	"	"	Q-1
"	"	H-4	133	+0.20	T-7A
134	+0.23	T-1	134	+0.21	F-1
135	+0.24	X-5B	135.5	+0.22	B-5A
136.5	+0.25	P-1B	"	"	T-1
"	"	Q-1	137	+0.24	X-5B
139.5	+0.27	F-1	138.5	+0.26	B-2
"	"	Q-2	"	"	R-3
"	"	R-3	140	+0.27	Q-2
"	"	T-2	141	+0.29	T-2
142	+0.30	G-4	142.5	+0.30	P-1B
143.5	+0.31	B-2	"	"	G-2
"	"	T-8A	144	+0.31	T-8A
145.5	+0.33	I-3	145	+0.32	G-4
"	"	T-7B	146	+0.34	T-7B
147	+0.36	I-1	147	+0.39	I-3
148	+0.38	G-2	148	+0.44	I-1
149	+0.43	I-2	149	+0.45	M-4
150	+0.49	M-4	150	+0.49	I-2
151	+0.54	S-2	151	+0.56	S-2
152	+0.60	T-6	152.5	+0.62	T-6
153	+0.64	R-1	"	"	R-1
154	+0.78	H-2	154	+0.81	H-2
155	+0.97	G-1	155	+0.97	G-1

5. Group Cross-Classifications Between I_a, I_c, and Average Rate of Deterioration

The following three tables show how the tracts in one group with respect to one variable (age, condition, or net rate of deterioration) are distributed among the groups for another of these variables. These tables therefore show numerically what may be observed visually by comparing the maps found on pages 17, 18, and 26 with one another.

Table XVI shows the extent to which those tracts in any of the groups I through V with respect to age of housing also appear in the same groups with respect to condition of housing. For example, by reading down this table, it can be seen that of the 31 tracts in the youngest age group (I_a group I), 24 are also in the best condition group (I_c group I), while 6 are in the second condition group, 1 in the third condition group, and none in the lowest two condition groups. Alternatively, by reading horizontally, it can be seen that of the 31 tracts in the best condition group, 24 are in the youngest age group, 5 in the second youngest, 1 each in the next two age groups, and 0 in the oldest group.

Tables XVII and XVIII show the relationship between age groupings and condition groupings and the net rate of housing deterioration in the census tracts of Boston. These tables should be read in the same way as Table XVI.

Table XVI

CONDITION INDEX VS. AGE INDEX

(by Number of Census Tracts)

I_c Groups	I_a Groups I	II	III	IV	V	Total
I	24	5	1	1	0	31
II	6	18	5	1	1	31
III	1	6	15	6	3	31
IV	0	1	8	11	11	31
V	0	1	2	12	16	31
Total	31	31	31	31	31	155

Table XVII

CONDITION INDEX VS. AVERAGE RATE OF DETERIORATION

(by Number of Census Tracts)

I_c Groups	Rate of Deterioration Groups I	II	III	IV	V	Total
I	12	9	4	6	0	31
II	5	5	11	6	4	31
III	9	5	6	8	3	31
IV	5	12	4	5	5	31
V	0	0	6	6	19	31
Total	31	31	31	31	31	155

Table XVIII

AGE INDEX VS. AVERAGE RATE OF DETERIORATION

(by Number of Census Tracts)

I_a Groups	Rate of Deterioration Groups					Total
	I	II	III	IV	V	
I	7	7	4	8	5	31
II	3	5	11	8	4	31
III	4	7	7	7	6	31
IV	8	6	3	4	10	31
V	9	6	6	4	6	31
Total	31	31	31	31	31	155

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