Did Segregation Increase as the City Expanded?

The Case of Montreal, 1881–1901

Montreal in 1881 was highly segregated along four distinct social dimensions: language, religion, socioeconomic status, and sector of employment. By 1901 the population had doubled, and we examine changes in residential distributions over the two decades. Despite the increased integration of certain groups, segregation remains high, and multiple dimensions are still discernible. In addition to long-established communities of French Canadians, Irish Catholics, and Anglo-Protestants, we see new streams of immigrants occupying their own patches in the urban fabric. To make meaningful observations of sociospatial changes over two decades, we used a geographic information system (GIS) to situate individual census households with spatial precision on 1 of 12,000 lots in 1881 and 30,000 in 1901, so that we could reaggregate them into meaningful districts of different scales and districts with identical boundaries for both years of observation, thereby overcoming the major methodological problems hindering previous comparative analyses. Coupling well-established statistical indexes of segregation and diversity in a GIS framework lends new analytic power to grasp the scale of phenomena and inquire into behavioral choices of nineteenth-century households. The empirical evidence shows how both concentration and diversity were built into the urban fabric. This study also offers methodological cues for comparative studies in other places and periods.
When a city “mushrooms” in size and extends its radius, we might expect to see changes in the spatial expression of social difference. Historians generally contend that rapid industrialization and urbanization of North American cities in the nineteenth century was associated with increased segregation of their expanding populations; however, few studies adequately compare segregation over time (Zunz 1982). For such a study, late nineteenth-century Montreal makes a convenient laboratory. By 1880 it was the largest city in Canada, with 175,000 residents, comparable in size to the US cities Boston and Baltimore. As the nation’s powerhouse of industrial development, Montreal exhibited enormous differences in wealth. Among North American cities, it offers a rare example of a strong Catholic majority (76 percent), an unusual linguistic split—63 percent French-speaking and 37 percent English-speaking—and an exceptional upward mobility among second-generation Irish Catholics (Gilliland and Olson 1998; Olson and Thornton 2002). (For relative status, see figure 1.) Between 1881 and 1901 its population increased by at least two-thirds, and property values doubled. Electrified mass transit was introduced during this period (1892). Cheaper, more effi-

Figure 1  Occupational status of men over 15 years in three ethnic groups, Montreal, 1881
Source: Montreal 1881 tax roll (100 percent).
Note: Protestant concentration is observed in high-status (top-rung) occupations, French Canadian in semi-skilled labor, and Irish Catholic in unskilled labor.
icient, and accessible to a large proportion of wage earners, the electric tram allowed workers to seek employment farther from their domestic environments (Lewis 2000). Despite its rapid growth from 1881 to 1901, Montreal in many respects retained the same high levels of residential segregation along the lines of ethnicity and socioeconomic status.

In this article we examine how social differences were reproduced in the urban landscape of Montreal and attempt to unravel some of the processes that generated and maintained both segregation and diversity at multiple scales. To tackle the difficult task of exploring the comparative segregation over different periods in time and city growth, we take advantage of the functionality of a geographic information system (GIS) for managing, analyzing, and visualizing large amounts of spatially referenced data on the city’s different populations and habitats at multiple scales. The use of GIS allows us to experiment with combining different samples of individuals from the same census and to scrutinize the effects of varying sample sizes, depths, and spatial densities. By using GIS we can reaggregate sample individuals to any areal unit to reveal spatial patterns of ethnic concentration or diversity at different geographic scales and thereby to overcome the problems that have plagued previous attempts at comparative analyses of segregation over time: incommensurability in terms of scale and boundaries. We designed our statistical tests to yield two well-established measures of social differentiation (segregation and diversity) for comparison at two geographic levels of meaningful everyday experience, two periods 20 years apart, and four dimensions of social difference: ethnicity, age, socioeconomic status, and occupational sector of the household head. The quasi-experimental approach to overcoming some of the challenges of observing change in such a laboratory offers cues for comparative studies among other places and decades.

Historians characterize most early industrial cities in North America and England as heterogeneous and commonly assert that the industrial revolution intensified segregation (Dennis 1984; Goheen 1970; Greenberg 1981; Ward 1980; Warner 1968). Indeed, Sam Bass Warner Jr. describes 1860s Philadelphia as a “jumble of occupations, classes, shops, homes, immigrants and native(s)” (Warner 1968: 50); and Stephanie Greenberg (1981) claims that by 1880 Philadelphia still did not have any significant spatial concentrations of ethnic groups other than blacks. On the other hand, Olivier Zunz (1982) reports that Detroit was already strongly segregated along ethnic lines in 1880 and, as auto manufacture transformed the city, ethnic segregation
gave way to income and class segregation in the first decades of the twentieth century. While large Victorian cities such as Liverpool already exhibited significant residential segregation by midcentury (Carter and Wheatley 1980; Lawton and Pooley 1976), most English cities were characterized by a residential mixing of ethnic groups and classes until the end of the nineteenth century (Dennis 1984; Ward 1975, 1980). The specific mechanisms producing vastly different levels of segregation in these cities are largely unidentified; however, higher levels of segregation appear to have been associated with cities at more advanced stages in their industrial histories.

Unfortunately, we have few historical comparisons of segregation levels in different cities at the same time period or in the same city at different time periods. Comparative analyses have been hindered by critical issues of incommensurability due to the lack of common scale and boundaries. Studies of the historical (and contemporary) social structure of cities have tended to rely on sample data aggregated to administrative wards or census tracts, and therefore researchers must be careful when making comparisons between cities or between censuses taken at different times with modified administrative boundaries. Donald A. DeBats and Mark Lethbridge (2005) offer a rare historical exception, using data on individual households from underused nominal data sources (e.g., tax records) to compare spatial patterns of political behavior and ethnic residence in two small (approximately 14,000 inhabitants) preindustrial cities: Alexandria, Virginia, in 1859 and Newport, Kentucky, in 1874 (see also DeBats 2008). Their use of individual-level data in a GIS allows them to circumvent the problems associated with data aggregation and incommensurable boundaries, as we do in this article.

To observe the spatial expression of social differences in Montreal over time, we rely primarily on two sets of digital data from the census of Canada, 1881 and 1901, integrated in a multilayered historical GIS known as MAP. The 1881 data are complete, but for 1901 we are confined to several samples, and we must therefore address problems of their size, depth, and spatial density. A second methodological problem arises from the incongruity of census districting at the two dates. The classic index we (and most others) use—the traditional O. B. Duncan and D. Duncan (1955) segregation index (SI)—is sensitive to the area of the spatial unit. To control effects of scale and boundaries on its reliability, we have to maneuver around the problem by using precise addresses for individual households, available in our historical GIS. The high degree of spatial precision in the GIS allows us to locate and map indi-
individual households (17,000 in 1881) into their respective lots and to reaggregate individual households within alternate boundaries at any desired scale (e.g., block, street segment, census division, district, ward). Besides advancing methodological breakthroughs with respect to the traditional problems of sampling and commensuration in social-historical research, the functionality of the GIS has also fostered two valuable empirical insights in this study: first, the display of “diversity” within a given spatial unit as a complement to concentration and, second, evidence for the ways both concentration and diversity were built into the urban fabric.

Our analysis is opportunistic—what Claude Bernard (1952 [1865]), the pioneer of experimental medicine, called a “found experiment.” Between 1985 and 2000 five Canadian research teams had drawn samples from the census of 1901 for unrelated purposes, and the attempt to rescue these databases, integrate them, and geocode the data made it opportune—indeed necessary—to explore the impacts of alternate sampling schemes. As a by-product, we can address a problem that will arise in comparative use of the digital databases released in 2010 by the Canadian Century Research Infrastructure (CCRI) for the decennial censuses of Canada 1911–51 and in other national-scale, historical GIS projects currently in progress (e.g., in the United States and Great Britain). CCRI objectives are not only to create an overall portrait of the Canadian population but to facilitate comparative work between places and between decades. These massive national GIS efforts are impressive in their historical depth and geographic breadth, but small samples for any one city have limited their utility for studying the changing social ecology of individual cities, particularly how different communities are partitioned in certain streets or neighborhoods.

To observe the expression of social difference across space and time presents particular challenges. Can samples as small as 5 percent be employed in the highly differentiated and high-turnover spaces of the metropolis? Will such samples provide meaningful results for small minorities? What are the effects of alternative sampling strategies? What are the problems of spatial bias? What are the legacy effects of the changes in scale and districting imposed in the original census-taking operations? The CCRI team, recognizing problems encountered by the Minnesota project, Integrated Public Use Microdata Series, initiated a more explicit and thorough consideration of the issues of spatial sampling, addressing problems of representativity and confidence limits and the compromises (or satisficing) that are required
(Ngan and Moldofsky 2002). Here we confine ourselves to a discussion of some practical problems of estimating the classic SI for a late nineteenth-century context. In addition to the technical issues, the time span and location of our case study provide useful reminders of ambiguities in the variables we employ and shifts in the meaning of terms like *ethnicity*, *poverty*, *wealth*, *neighborhood*, even *occupation* and *household composition*. All of these considerations affect the potential of the SI—and related measures—for interpreting the social processes that generate the varieties of residential mixing or isolation.4

The remainder of the article is organized in four parts. In the first section we present the methodological problem of performance of the classic SI under various sampling frames. We move in the second section to details of the conduct of the experiments and in the third to the empirical results. The final section, more speculative, is an interpretation of the persistence of patterns of residential segregation: we show how social difference was built—hardwired—into the fabric of the city.

The Methodological Problem of Assessing Segregation in Varying Samples

The Duncan and Duncan SI, also known as the index of dissimilarity, is calculated in the following way:

\[
SI = \frac{1}{2} \sum_{i=1}^{n} \left| \frac{e_i}{E_T} - \frac{f_i}{F_T} \right|
\]

where \(n\) is the number of districts, \(e_i\) is, for example, the English-speaking population of district \(i\), \(f_i\) is the French-speaking population of district \(i\), \(E_T\) is the total English-speaking population of the city, and \(F_T\) is the total French-speaking population (adapted from Duncan and Duncan 1955). Numerous alternatives have been proposed (reviewed by Iceland et al. 2002; Massey and Denton 1988), and of increasing interest are entropy measures and the truly spatial indexes (Wong 2004, 2005). In practice, however, several research teams have found that alternative algorithms yielded results with the same rank order (Apparicio et al. 2007; White et al. 2005). For the present purpose, the classic measure is retained in the form that has, for half a century, nourished debate over housing, schooling, and social welfare policies in North American metropolitan areas (Clottfelter 1999). Furthermore, our
choice to focus on this popular index increases the likelihood of future comparative studies.

Sensitivity of the SI to the area of the spatial unit is a recognized limitation (Duncan and Duncan 1955; Walks and Bourne 2006). For 1881 Montreal, values we generated from finer-grained districting were substantially higher than those from coarser districting, and, since we were working with information for an unbiased 70 percent of the population, we were confident that the observations reflected the extent of spatial concentration at a chosen scale of observation. Table 1 demonstrates that over a range of six scales of analysis, SI values increased inversely with the median area of the spatial unit, and at each scale an array of arbitrary “data bins” (hexagons) of comparable size yielded values similar to those for the original administrative units (see Carr et al. 1992). In other words, scale mattered, but modification of boundaries did not. Both ethnic differences and differences in status were sharpest at the fine grain of block or street segment.

Meaningful comparison of two periods, 1881 and 1901, therefore requires that we standardize the spatial units for generating our two sets of measurements, but—the nub of the problem—Canadian census-taking machinery did not provide standard divisions. Continuity has never been the strong suit of the agency. Every 10 years administrators designed a new set of tracts as an instrument of data collection; they provided no tabulations at this level before 1941, retained no maps of their boundaries, and made no effort to re-create the same tracts for the next census. As a result, it is uncertain whether districting is comparable between two Canadian cities at the same date; there is no foundation for comparing Montreal with US cities.

<table>
<thead>
<tr>
<th>Spatial unit</th>
<th>Units (n)</th>
<th>Area (000 m²)</th>
<th>SI between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>FC-IC IC-PR FC-PR</td>
</tr>
<tr>
<td>City block</td>
<td>942</td>
<td>11</td>
<td>69 55 73</td>
</tr>
<tr>
<td>Street segment</td>
<td>370</td>
<td>34</td>
<td>66 52 70</td>
</tr>
<tr>
<td>Census division</td>
<td>67</td>
<td>208</td>
<td>58 43 63</td>
</tr>
<tr>
<td>Hexagon⁴</td>
<td>60</td>
<td>208</td>
<td>56 42 62</td>
</tr>
<tr>
<td>District</td>
<td>40</td>
<td>488</td>
<td>49 38 56</td>
</tr>
<tr>
<td>Ward</td>
<td>9</td>
<td>1,645</td>
<td>51 30 53</td>
</tr>
</tbody>
</table>

⁴Arbitrary grid sized to match mean of census divisions.

Table 1  Outcome of SI tests 1881: Segregation among ethnic groups (French Canadian [FC], Irish Catholic [IC], Anglo-Protestant [PR]) as a function of unit area
Montreal itself, the 1881 and 1901 divisions are incommensurate (74 vs. 489 divisions, as shown in table 2), and their boundaries do not allow straightforward reaggregation below the level of the 14 municipal wards. The legacy effect of changing scale and districting between censuses is that historians must work with individual-level data for proper comparative analyses.

The sampling problem introduces a further complication. The 1901 data consist of five samples (5–10 percent each) independently drawn by different methods (table 3). The samples have been discussed by their respective creators in Baskerville and Sager 1998, Gauvreau and Gossage 2000, Green and MacKinnon 2001, Sager 2000, and Thornton and Olson 2001. None of the sets of sample points is randomly distributed over the urban space, and none is randomly distributed with respect to population density. Most census takers worked an assigned territory in a systematic way along one street and around the block or up one side and down the other (Lauzon 1990); the order is disturbed by sorties on several days and by the absence of a household requiring a second visit. Geographic order is therefore implicit in the original census-taking operation, and that uncertain degree of spatial clustering is transferred into the page-by-page order of the census document. To the extent that neighboring households share some social properties, spatial clustering is likely to produce fine-grained clusters of social variables. But this is precisely the feature we are trying to assess: Do birds of a feather flock together? From variations in the extent and scale of spatial clustering in the five sampling schemes, we anticipated that, whatever the units and boundaries we adopted, the Mary MacKinnon and Danielle Gauvreau–Peter Gossage samples would be likely to retain the degree of spatial clustering that

Table 2  Spatial units for comparative analysis, 1881 and 1901

<table>
<thead>
<tr>
<th>Units (n)</th>
<th>Area (000 m²)</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Census division 1881</td>
<td>74</td>
<td>208</td>
<td>423</td>
</tr>
<tr>
<td>Census division 1901</td>
<td>489</td>
<td>23</td>
<td>105</td>
</tr>
<tr>
<td>Districts 1881</td>
<td>35</td>
<td>230</td>
<td>650</td>
</tr>
<tr>
<td>Districts 1901</td>
<td>40</td>
<td>390</td>
<td>1,276</td>
</tr>
<tr>
<td>Street segments 1881</td>
<td>406</td>
<td>34</td>
<td>54</td>
</tr>
<tr>
<td>Street segments 1901</td>
<td>578</td>
<td>34</td>
<td>88</td>
</tr>
</tbody>
</table>

Note: The counts in either year cover the city of Montreal as constituted in 1901.

*The five other districts were undeveloped and virtually unpopulated.
<table>
<thead>
<tr>
<th>Sample sizes and properties</th>
<th>Census of 1901</th>
<th>Census of 1881</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of households</td>
<td>2,513</td>
<td>31,312</td>
</tr>
<tr>
<td>Sampling density (%)</td>
<td>4.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Census divisions sampled</td>
<td>455</td>
<td>74</td>
</tr>
<tr>
<td>Ethnic distribution (col. %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>French</td>
<td>61.7</td>
<td>57.1</td>
</tr>
<tr>
<td>Irish Catholic</td>
<td>13.0</td>
<td>17.3</td>
</tr>
<tr>
<td>Anglo-Protestant</td>
<td>22.7</td>
<td>25.1</td>
</tr>
<tr>
<td>Jewish</td>
<td>2.6</td>
<td>28.3</td>
</tr>
<tr>
<td>Occupational status (col. %)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High (A + B), e.g., merchants</td>
<td>28.0</td>
<td>28.6</td>
</tr>
<tr>
<td>Middle (C + D + E), e.g., butchers, carpenters, molders</td>
<td>52.7</td>
<td>52.4</td>
</tr>
<tr>
<td>Low (F), laborers</td>
<td>19.2</td>
<td>19.0</td>
</tr>
<tr>
<td>Households with servant(s) (%)</td>
<td>8.9</td>
<td>10.7</td>
</tr>
</tbody>
</table>

Note: Index covers all census households. All samples includes all households sampled (full information). Xsample excludes the highly clustered MacKinnon and Gauvreau-Gossage samples (high-rent). 3way excludes samples with pronounced bias: B (age), Gauvreau-Gossage (high-status), and Ethnic (three minorities). The counts cover the city limits of 1901, but the tax roll of 1881 excludes three suburbs.
characterized “neighborhoods” and would therefore yield higher SI values than the other samples.

The MacKinnon sample was drawn by selecting 101 census divisions at random and taking in each division a run of 50 dwellings from the property schedule. In most cases these are addresses facing the same street, including upstairs-downstairs flats or the three dwellings in a triplex. In contrast, the Canadian Families Project (CFP) and E. W. Sager samples drew from every division a page (or pages) at random, collecting all of the families referenced on a particular page, ordinarily a batch of 5 to 10 neighboring households. The most highly clustered of all is the Gauvreau-Gossage sample, consisting of the entire population of only 33 census divisions. It was conceived as a supplement to the CFP to expand the number of households in sparse strata (e.g., the wealthy in each ethnic group). This would facilitate analyses stratified on ethnicity and social status but would introduce spatial clustering, since divisions were selected on the basis of concentrations already observed from the 5 percent CFP sample. The Patricia Thornton and Sherry H. Olson sample consists of families with a child less than three years of age and, within that stratum, the subset whose surnames began with the letter B. Although it selected families in the life stage of childbearing, the alphabetical device randomized sample points, accessing every manuscript page of every census division. To diminish the age bias, we have since added to it all B-surname households recovered from the four other sampling schemes.

How sensitive is the SI to the “neighboring” properties of sample design? The initial study for 1881 suggests that difference was rather fine-grained and neighborhoods of identity were highly localized—precisely the scale at which spatial clustering occurs in the records (Gilliland and Olson 2010). Ideally we would like to measure segregation at the scale at which the process operated to generate the phenomenon (the journey to work, for example) or at the scale at which its consequences were felt (as in the segregation of entire schools). For want of full information on process, we must explore the data at more than one scale and consider the spatial range of behaviors and choices that may be pertinent.

**Conduct of the Experiment**

How did the SI measure perform under the five sampling schemes? We report strictly empirical observations for the Montreal case at a particular
date, although theory suggests that variations might be much more radical (cf. Massey and Denton 1988; Wong 2005). To appraise the adequacy of estimates from samples, we conceived two kinds of tests. First, a digital index for the entire population allows us to evaluate sampling density and ground the several samples with respect to a limited number of variables. We treat the 100 percent index file as a “gold standard” (but it is restricted in number of variables). It offers surrogate variables for three important dimensions of social difference. Ethnic origin can be assigned to households from names: French, English (including those of Irish origins, both Catholic and Protestant), Jewish, Chinese, and Italian. Ages are classed into four groups (≤ 14, 15–29, 30–44, ≥ 45). High-income households are defined as those with one or more live-in servants (10.7 percent in 1881, 8.9 percent in 1901). A census street address was found for 92 percent (by page and line cross-reference to the property schedule), and the others could be verified or inferred (from an indication of two families in the same house). With the spatial identifier of street address, data on individual households could be mapped with high precision and aggregated to any desired spatial unit for multiple analyses. On these variables, the measures obtained from a particular sample can be compared with counts from the 100 percent index: Which samples yield closer approximations to the index value?

Second, to assess whether a particular sample captures the heterogeneity of the spatial unit, we bring into play a complementary index of diversity. A value for each spatial unit uncovers departures from the gold standard. Widely employed in species ecology, the Claude Shannon (1948) diversity index (DI) is calculated as follows:

\[ DI = \sum_{i=1}^{n} \frac{1}{p_i^2} \]

where \( p \) is the proportion of households of each type in district \( i \). Estimates from the several samples will diverge from the values derived from the index file.

Overall sample size is a constraint for estimating segregation of small minorities, and we need to consider the probable effects of the density of sample points. The 1901 datasets include three additional samples with small numbers but large proportions: selection of all B surnames reporting Jewish religion and all householders reporting birthplace in China or in Italy. These samples, as well as the 100 percent index, will provide further standards, from which we can expect greater deviations for small population units and
for units sampled at lower density (below 5 percent). Sample size would inevitably have a greater impact on SI estimates for the three small ethnic minorities and for other small groups that might result from cross-tabulation of ethnicity with status.

With those objectives and constraints in mind, we designed our tests to yield SI measures for comparison at two geographic levels, two census dates 20 years apart, and four dimensions of social difference: ethnicity, age, socioeconomic status, and occupational sector of the household head. For 1901 we derived separate measures for the several census samples and the combinations shown in table 3. Every set is based on nominal microdata: households with explicit street addresses. We excluded institutions (households with 30 persons or more), and, in the absence of income or full 1901 data for individual household rents, we adopted a “next best” measure of socioeconomic status based on occupation of the household head.

To appraise SI at two spatial scales, we employed sets of street segments and districts (see Lewis 1991). About the size of a city block, the street segment is a pair of opposite block faces and, in a row house city like Montreal, Baltimore, or Philadelphia, provides a more homogeneous and socially meaningful unit than the block. Although the 1881 census provides no street addresses, 70 percent of census households had already been successfully matched to addresses in a municipal tax roll of occupants. (In each case, matching produces an underrepresentation of the very lowest rents.) A 1903 municipal tax roll of property owners makes possible the same precision by linking addresses to the 30,000 cadastral lots. Each street segment had a minimum of 30 households, and median population sizes are shown in table 2 for the 406 segments in 1881 and the 578 in 1901. For each street segment, we have near–100 percent coverage for one well-tested socioeconomic status indicator (median rent), one measure of ethnicity (percentage French surnames), and age. The street segments are nested within districts designed as compact blocks for maximum homogeneity, and the geographic boundaries of the 40 districts are identical in all analyses. Sample coverage and SI values were, at either date, calculated for an identical territory: Montreal as constituted in 1901. Some comparisons between 1881 and 1901 can also be performed for a “greater Montreal.”

Ethnicity, where we have the full census record, is assigned as a compound variable from language and religion. French Canadians were 99 per-
cent Catholic; Protestant households included as many as 10 percent Catholic members (usually servants) and were of more diverse paternal origins, principally Scottish, English, and Irish. The group of English-speaking Catholics consisted in large part of descendants of Irish Catholic immigrants of the 1840s. In 1881 “other” groups amounted to less than 2 percent, in 1901 to 4 percent. Figure 2 displays the concentrations of the four largest cultural communities in each of the 40 districts in 1901. Using GIS to visualize the distributional patterns of different populations in this way reveals several distinct ethnic districts where a single group represents over 80 percent of the population, such as French Canadians in the northeast or Anglo-Protestants near the slopes of Mont Royal. The smaller Irish and Jewish populations also exhibit spatial clustering; however, their neighborhoods seem to be more mixed (as will be confirmed later).

Choice of a consistent measure for socioeconomic status is more debatable. Ultimately we used the occupation of the head to assign the household to one of six levels of occupational status, based on the median of the rents paid by all male householders in the city of the same occupation. One hundred occupation titles covered 94 percent of workers. Although one-tenth of the pool is excluded because the household is headed by a widow or a retired “gentleman,” we could discover no ethnic bias.

All of the researchers who collected the data were explicitly concerned with sorting out effects of ethnicity and social status on social behavior. Because our 1881 measures of segregation revealed some interdependence, we applied multidimensional scaling (MDS) to consider the compound notion of “ethclass,” and we attempted this again in the 1901 dataset. From a study of infant deaths (Thornton and Olson 2001), we anticipated that the several social dimensions of segregation would persist, with the same high levels for both ethnicity and socioeconomic status. We anticipated that Irish Catholics, experiencing upward mobility, would move into Protestant neighborhoods and that the Protestant poor would continue to live in neighborhoods of greatest ethnic diversity. We anticipated emergence of some new occupational clusters and, as a result of relaxation of the journey-to-work constraint (due to the arrival of the electric tram in 1892), a greater dispersion of household heads in some occupational sectors.
Figure 2  Concentrations of the four largest cultural communities by district, Montreal, 1901
Source: Census of 1901 triple sample.
Note: A different scale is used to visualize the smaller Jewish group.
Empirical Findings

The Duncan and Duncan SI remains a remarkably robust measure. As shown in table 4, every sample at either date shows that Irish Catholics (IC) are closer to Protestants (PR) and French-speaking Catholics (FC) (apparent by lower SI) than those latter two groups are to each other. This is understandable, since Irish Catholics shared a common religious affiliation with French Canadians and shared a common language with Protestants. With about one-third of Protestants, they shared also a common national origin and cultural outlook (on age at marriage, for example). The way people shared the residential spaces of the city provides an effective set of cues to relative social distances between groups, and, over the 20 years of observation, the structure of that social space was remarkably stable.

Relative values are much the same at the two dates, and values are high. In table 4, for instance, we see at the top left for the CFP sample an SI of 49 between occupation groups A (high-rent merchants and lawyers) and F (lowest-rent laborers). On a scale of 0 to 100, this implies that to achieve redistribution over all districts in the same proportions, we would have to displace half of one group or the other. Values are higher still for segregation between Protestants and French Canadians.

Of the 1901 array, the spatially clustered samples (e.g., Gauvreau-Gossage, MacKinnon) depart most from the gold standard of the 100 percent index. As anticipated, our 15 percent combined “Xsample” (excluding Gauvreau-Gossage and MacKinnon) comes closest. Even 5% random samples, like CFP, can affect the SI, and it would be unwise to treat differences of two or three points as evidence of significant change. The highly clustered Gauvreau-Gossage sample is not amenable to estimating segregation citywide, it yields erratic SI measures, and a DI cannot be applied since few census divisions were sampled at 100 percent.18

Application of the Shannon index made it possible to display the zones of greatest diversity in 1901 (figure 3). This is a neglected “mirror image” of the more familiar maps of ethnic concentrations (as seen in figure 2). Any city that shows substantial ethnic segregation will necessarily possess frontier zones of diversity, and in Montreal these zones were much the same for both ethnic diversity and socioeconomic diversity. Geographic distribution of diversity was much the same in 1881 and 1901 (composite levels for diversity of “ethclass” are shown on figure 4). Protestant laborers (the lowest
Table 4  SI values obtained from diverse samples

<table>
<thead>
<tr>
<th>Samples for 1901 (by districts)</th>
<th>1881</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFP B MacK GG X sample 3 way Index districts</td>
<td></td>
</tr>
<tr>
<td>Between Occupation levels A and F</td>
<td>49 58 73 44 42</td>
</tr>
<tr>
<td>Occupation levels A and B</td>
<td>25 27 22 29 24 21</td>
</tr>
<tr>
<td>Ethnicities IC and FC</td>
<td>54 51 60 51 48 54</td>
</tr>
<tr>
<td>Ethnicities IC and PR</td>
<td>41 43 42 51 38 49</td>
</tr>
<tr>
<td>Ethnicities FC and PR</td>
<td>60 57 52 67 58 56</td>
</tr>
<tr>
<td>Ethnicities JW and all other</td>
<td>67 71 56 66 72 61</td>
</tr>
<tr>
<td>Servant(s) and no servant</td>
<td>68 73 69 68 43 62</td>
</tr>
<tr>
<td>Note: All SI is calculated for 40 districts across the city of Montreal as constituted in 1901. Occupations are ranked A (high) to F (low).</td>
<td></td>
</tr>
</tbody>
</table>
Figure 3  Levels of ethnic diversity by district, Montreal, 1901
Source: Census of 1901 triple sample.
Note: Darker shades indicate higher diversity in the district.
status group) persisted, as expected, in the districts of maximum diversity, while high- and middling-status Protestants lived in regions of low diversity (compare figures 2–4). The new concentration of Jewish (JW) immigrants emerged in this belt of social diversity (compare figures 2–4).¹⁹

What cannot be seen in the overall measures are the patterns of segregation for emergent small groups. The “other” populations account for 4 percent of the urban population in 1901, but their presence exceeded 12 percent in several districts, as high as one-quarter or one-third in several street segments. It is apparent from table 5 that a 5–8 percent random sample yields too few cases (< 25 households) for small minorities (Jewish, Chinese, and Italian). Their distribution over 40 districts would be unreliable, and a chi-square test (for example) would not be applicable. For calculation of the SI, sampling density does not need to be the same for two groups. If,
Table 5  Small group constraints in 1901 samples (numbers of households)

<table>
<thead>
<tr>
<th></th>
<th>CFP</th>
<th>Sager</th>
<th>B</th>
<th>MacK</th>
<th>GG</th>
<th>Xsample</th>
<th>3way</th>
<th>Ethnic</th>
<th>Allsamples</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jewish (JW)</td>
<td>64</td>
<td>60</td>
<td>82</td>
<td>142</td>
<td>201</td>
<td>215</td>
<td>356</td>
<td>100</td>
<td>530</td>
<td>1,022</td>
</tr>
<tr>
<td>Italian (IT)</td>
<td>0</td>
<td>23</td>
<td>16</td>
<td>1</td>
<td>20</td>
<td>190</td>
<td>190</td>
<td>214</td>
<td>210</td>
<td>244</td>
</tr>
<tr>
<td>Chinese (CN)</td>
<td>0</td>
<td>18</td>
<td>1</td>
<td>3</td>
<td>12</td>
<td>135</td>
<td>138</td>
<td>150</td>
<td>149</td>
<td>180</td>
</tr>
</tbody>
</table>
for example, we take the 12 percent sample of Jewish households with B sur-
names, rates of segregation relative to the three larger groups approach the
values obtained from the 100 percent index. The problem of small numbers
again rears its ugly head when we introduce more than one dimension of seg-
regation. To explore an “ethclass” array of 18 groups (McNicoll 1993), a 5–8
percent near-random sample is unreliable for the smallest groups (the lowest
tier of Protestants, the highest tier of [English- or French-speaking] Catho-
lics), and the spatial coverage and distribution of sample points have to be
carefully evaluated.

SI values for the “ethclass” array of 18 groups are shown in table 6. They,
too, possess much the same overall structure in 1881 and in 1901. A modest
shift can be visualized from figure 5, showing for each ethnic community the
extent of residential segregation between one level of occupational status and
the next. The “rungs of the ladder” are a little farther apart in 1901 than in
1881, and the effect is greater in the English-speaking communities.

Application of MDS offers another way to visualize the relationship
among the 18 “ethclass” groups (figure 6) (Cox and Cox 1994; Kruskal and
Wish 1978; Stata Release 9 2005). Distance on the horizontal $x$-axis reflects
occupational status, while distance on the vertical $y$-axis captures ethnic dif-
fERENCE. In this abstract “social space,” the gap between language groups was,
at either date, greater than that between religious groups, and the highest-
rent populations—the people with greatest choice—were most isolated.20
The 1901 distribution is more nuanced; within each ethnic community we
see a greater separation in terms of occupational status (also seen in figure 5),
and the six Irish Catholic populations were approaching the Protestant popu-
lations, sandwiched among them and tracking at each rent level. The upward
social mobility of second-generation Irish Catholics has been described else-
where as being linked to high levels of renting and household mobility (Gau-
vreau and Olson 2008; Gilliland 1998; Gilliland and Olson 1998; Olson and
Thornton 2002). Such residential strategies were presumably adopted so
workers could take advantage of opportunities for better employment and/
or accommodations as they became available.

The prime components—ethnicity and economic status—are the
ones observed in factor analyses of mid-twentieth-century cities of North
America and even today in multivariate marketing segmentation systems
like PRIZM.21 The factor missing in the late nineteenth century is life stage
(sometimes called “familism”). The data for Montreal show very low levels of
<table>
<thead>
<tr>
<th></th>
<th>French Canadian populations</th>
<th>Irish Catholic populations</th>
<th>Anglo-Protestant populations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High</td>
<td>Mid</td>
<td>Low</td>
</tr>
<tr>
<td>FA</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>FB</td>
<td>27</td>
<td>0</td>
<td></td>
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<td>FC</td>
<td>30</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
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<td>FE</td>
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<td>IF</td>
<td>55</td>
<td>65</td>
<td>60</td>
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<tr>
<td>PA</td>
<td>66</td>
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<td>55</td>
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<tr>
<td>PD</td>
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<td>58</td>
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</tr>
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<td>PE</td>
<td>58</td>
<td>58</td>
<td>57</td>
</tr>
<tr>
<td>PF</td>
<td>64</td>
<td>59</td>
<td>53</td>
</tr>
</tbody>
</table>

Note: Based on MAP Xsample from the census of 1901. Householders are grouped by ethnicity and occupational status. The Duncan and Duncan SI is displayed for each pair, ranging from 0 (identical distributions across 40 districts) to 100 (no overlap of residences).
Figure 5  Social distances between people of same ethnicity but different occupational status appear farther apart in 1901 than in 1881

Sources: SI measures, census of 1881 and 1901 Xsample.

Note: Occupations are ranked A (high) to F (low). Bold numbers in 1901 highlight a substantial increase in the spread between rungs of occupation, 1881–1901.
Figure 6  Two-dimensional representation of social distances based on spatial segregation by “ethclass,” 1881 and 1901
Source: Households sampled from censuses of 1881 and 1901, MAP matches.
Note: MDS array of SI between groups, 1881 and 1901.
segregation (SI values of 10 or 11) among four age groups. This can be attributed first to the longer span of childbearing and second to the frequency with which members of the older generation resided with their children and grandchildren. While the city received, in every surge of growth, a heavy stream of migrants from a catchment of the Plaine de Montréal on the order of 15–20 percent per decade, or 40 percent of a generational cohort, only in 1901 do we have a census variable that specifies urban or rural birthplace. The distinction, applied to the Canadian-born over 20, yielded a modest SI value, accounted for by the proportion of Catholics of French mother tongue.

Differentiation occurred among occupation clusters, and, as a result of relaxation of the journey-to-work constraint, there was by 1901 a greater dispersion of household heads in some sectors. Extension of the Canadian Pacific Railway around the rim of the city attracted shop workers, yard workers, and running trades; and the car barns of the street railways created new residential nodes of motormen. Printers, who were the best schooled, best organized, and best paid of the blue-collar occupations, moved into newer housing in the Mile End district. Metal workers, foremen, and inspectors (among them Grand Trunk Railway employees) moved from older habitats near the Lachine Canal to the modest but newly built neighborhoods of Pointe Saint-Charles, and the expanding numbers of traveling salesmen appeared in high-rent streets. These changes did not diminish the levels of segregation by occupational status, nor did they reduce the residential expression of ethnicity.

**Inferring Changes in Spatial Expression of Difference**

Overall, the findings point to stability in the levels of segregation, in the major districts and “axes” of social difference, in the concentrations of both wealth and poverty, and in the geographic patterns of concentration of the three largest ethnic groups. They point also to a neglected but persistent geographic zone of diversity. We can now consider some of the factors that fostered stability and examine some subtle changes in the meaning and expression of social difference.

Spatial concentrations of wealth and poverty are signified by the enormous differences in household purchasing power exhibited on the map of median dwelling rents per street segment (“twinned block faces”) in 1881
The poorest households were concentrated in tiny dwellings in the lowest-rent streets (lightest shades) that permeated industrial districts, proximate to jobs along the canal and rail yards; the wealthy were concentrated in spacious mansions on high-rent street segments (darkest shades) climbing the slopes of Mont Royal—dwelling size was also correlated with elevation. By 1881 the original riverfront site (already nicknamed “Old Montreal”) had lost its elite residential function to high-rent commercial, industrial, and office uses (Gilliland 2004; Hanna and Olson 1983, 1990); with no residential rents, the central business district is represented by the “doughnut hole” in figure 7. By 1901 businesses were hiring a clerk, bartender, night watchman, janitor, hotel clerk, or cook rather than housing their own live-in apprentices and servants. The few remaining resident families were boardinghouse and hotel keepers with a clientele of singles attracted to expanding clerical jobs. Domestic servants were more consistently concentrated in uptown districts of wealth (darker shades). Here, too, once-elegant town houses were converted to boardinghouses for a larger-scale and cosmopolitan clientele. On McGill College Avenue, for example, half of the 12- and 14-room terrace houses built in the 1850s were used as boardinghouses by 1901 (Hanna 1977).

The introduction of electric tramways in 1892 made a powerful difference in the journey to work and in residential search behavior. Employees of the Grand Trunk Railway (the large lot in the extreme south of the map in figure 7) offer an excellent example of the leap—in a decade—in the distance traveled to a workplace (Hoskins 1987). For those unwaged, however, neighborhood became a more confined space. The sheer increase in the radius of the city and the persistence of a short tether placed on children, mothers, unmarried girls, and the elderly (Miller 1982) created a demand for development of institutions at the neighborhood scale: grocers, butchers, bank branches, churches and Sunday schools, and schools (under school administrations structured by religious and linguistic affiliation). These features were in turn “attractors” that reinforced the initial ethnic concentrations.

The Jewish, Italian, and Chinese populations of 1901 were largely new arrivals in the 1890s. Chinese and Italian laborers were brought into Montreal or were transferred there “by the trainload,” and their representation in the census was affected by the early-spring timing. Their “otherness” was widely discussed and contributed to a reconceptualization of Irish Catholics as part of the “majority” and, to some extent, to a reconceptualization
Figure 7  Extreme differences in social status revealed at street segment level
Source: Montreal 1881 tax rolls.
Note: Median rent in 406 street segments.
Segregation in Montreal, 1881–1901

of the split between native- and foreign-born. The census of 1901 was taken at a moment of extreme official racialization, apparent in the gender bias of Chinese exclusion acts and a census question on race (with highly unreliable entries for Montreal). Degrees of residential apartheid of the three newcomer groups are suggestive of the meaning of spatial difference. The Chinese (all males but one) were systematically identified in the census as separate households, even the lone family servant. In a tiny “Chinatown” two blocks square, a few merchants provided ethnic products; supplied gambling, drugs, and entertainment to a more diversified clientele; and housed the crews of Chinese laborers in transit for railway construction sites. (For more on Montreal’s Chinese population during this era, see Aiken 1989.) Yet the SI for the Chinese is fairly low (36): the livelihood of several hundred laundrymen led them to scatter, in households of three or four, along the principle that Harold Hotelling (1929) referred to as the ice cream seller on the beach.

In the fast-developing Italian community, an intermediate level of segregation (SI = 47) also conceals a complex distribution: a concentration of sojourners, boardinghouses, and padrones near the point of arrival (at the foot of Saint-Timothée street); a suburban concentration at the wire mill in Lachine; and a scatter along a suburban perimeter where gardens could be developed (for more on the Italians of Montreal, see Ramirez and Del Balso 1980). For the Jewish community, a higher index of segregation (SI = 61) relative to all other groups is associated with the rapid creation of a complete array of institutions and services. If, among either Italian or Jewish families, we distinguish immigrants by time of arrival, the cohort who arrived before 1890 appears much more integrated, Italians with the French-speaking and Jews with the English-speaking populations (on the early Jewish population in Montreal, see King 2000).

The “ethclass” patterns of segregation (identified in table 6 and the MDS vectors in figure 6) indicate subtle shifts in the “pecking order.” The newly arrived (of either foreign or rural birthplaces) more often occupied the lowest rungs of the ladder and the oldest habitats of the city. In a society with extreme inequality and diversity of origins, residential segregation was certain to emerge, but the issues remain: At what scale would it emerge? How did the economic and ethnic dimensions reinforce each other? By what mechanisms was it extended into newly developed territory?

A source of stability in residential patterns was of course the long-lived nature of the built environment. The modal dwelling unit was a flat of three
to five rooms, and the range of rents in 9 street segments out of 10 would accommodate either single- or two-family occupancy of the same house (Gilliland and Olson 1998). The modal household size was 5 or 6 persons, tailing off to 11 or 12. Only 2 or 3 percent were one-person households. The most common housing type after 1860 was the two-story upstairs-downstairs duplex shown in figure 8, with the triplex (or triple-decker) appearing after 1880 (Dufaux 2000, 2007). The newer working-class flats provided about 50 percent more floor area per person than the older type, and carpenters built many of them in groups of four or six, like the “double duplex” illustrated in figure 8.

In the framework of an annual lease, Montrealers moved often; as many as 20 percent may have moved every year (Gilliland 1998), most of them on about May 1, and the newspapers reported these spectacular operations like the spring return of the swallows. In such a system, residential choices were adjusted at short intervals and might therefore be responsive to many factors, including the journey to work and the demands of kinship. Application of a simple probability model confirmed the additional role of owner bias. Where the owner lived on the same lot, the rate of ethnic match between owner and

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Figure 8  The “double duplex” was the dominant housing typology in Montreal, 1881–1901. Photo: Jordan Kemp
tenant was about double what we would expect from a random process. If we remove from the pool dwellings occupied by their owners, landlords still favored their own groups.

Some street segments, however—about 1 in 10—showed a decidedly higher-than-average diversity in multiple ways, apparent in the larger range of dwelling rents (displayed in figure 9), a wider array of room sizes in dwellings, and also higher values of the DI for ethnicity, occupational status, and occupation title. The remarkable social diversity of these streets reflected the wider variety of units in the stock of buildings and a greater mix of shops and workplaces with dwellings. Because the material structures were built to last, their appeal to heterogeneous markets persisted over many decades. Structural diversity in these streets contributed to social diversity of residence (compare figures 9 and 3), and the durability of the buildings constituted a skeletal framework for neighborhoods where diversity of language, religion, and income would persist.

To grasp the importance and stability of these streets, we need to consider their locations in the overall configuration of the network, consistent with a “space syntax” approach (Hillier 1996; Vaughan and Penn 2006). Jason A. Gilliland’s (2001, 2002) analysis of the street network demonstrates relationships between the street layout or topological configuration of the urban circulation system, intensity of traffic circulation, and patterns of land use. The streets most highly “integrated” in the urban circulation system in 1881 persisted at the top of the line in 1901 (e.g., Saint-Lawrence, Sainte-Catherine). These major axes, with the best access from all the others, were wider, were more likely to be paved, and bore the heaviest traffic flows. What looks in figure 7 like a “middle range” of rents in fact reflects the mix of both high and low rents in these highly integrated street segments, such as Sainte-Catherine, Saint-Antoine, and Saint-Lawrence. These major axes were chosen for the new tram lines and for widening carried out between 1880 and 1901 and were extended as “main streets” into the new suburbs (Gilliland 2001, 2002). Their frontages were more intensely developed, with a mix of commercial and domestic spaces. It is the axial structure of the street network—a long-lived property of the built fabric of the city—that ensured diversity of land use and integration of diverse livelihoods and threaded together the economies of agglomeration that attracted people to the city. Grafted onto these were the secondary streets typical of the row house city, offering more homogeneous material habitats that attracted people from
Figure 9  Street-by-street diversity of rents in 1881
Source: Montreal 1881 tax rolls.
Notes: Diversity of rents for 444 street segments.
specific, narrow ranges of rent-paying capacity and allowed them, in a local streetscape, to assert their identity and respectability in a community of their sisters and their cousins and their aunts.

Conclusion

The results are of three orders: methodological cautions, observations of some neglected dimensions of differentiation of the urban space, and some new evidence that the built form of the city played a role in the expression of social difference.

The exercise for 1901 suggests caution with respect to scale and sampling. Estimates of levels of segregation can be compared between decennial censuses only if care is taken to standardize the districting. The ideal solution is to use GIS to map individual households as points and then reaggregate to identical unit areas. A second-best solution is to search for exact addresses in a small subsample, since, as we learned in this study, a lower density of sampling has less impact on the comparative values than the size of districts. Short of this, it may be reasonable, in interpreting SI measures, to adjust estimates to compensate for the change of scale and to employ complementary measures, such as the DI, or to explore several districts at a finer grain. All of those adaptations are facilitated by adoption of locational precision and GIS for aggregation. Coupling GIS with statistical models like the classic SI and DI lends new power to grasp the scale of phenomena and inquire into behavioral choices of nineteenth-century households.

The comparisons for Montreal in 1881 and 1901 further suggest the need to adjust the scale of analysis to accommodate the sizes of the groups under study and the presence of clustering in the samples. Five percent samples proved large enough to estimate SI at the scale of the city in terms of linguistic difference (two principal languages), religious difference (three principal religions), and rich, middling, and poor (three classes), but smaller populations (several immigrant groups and status subgroups) can be examined only if we employ higher-density samples. Complementary samples not only accommodate small minorities but allow exploration of finer-grained patterns (differentiation at several scales).

In the same way, complementary samples and complementary measures can be used to uncover some of the factors that contribute to the persistence of differences and their extension to newly urbanized territory. In the
Montreal case, for example, we can consider the ethnicity of servants, the correlation between ethnicities of property owners and their tenants, or the impact of kinship on distributions. Since identity is multidimensional (cf. Hale 2004), it is important to consider multiple dimensions of segregation and to bring into play MDS (or some other multivariate technique) for considering the relationships among these social dimensions.

The notion of segregation is inherently spatial, but because it is an outcome of social processes with ongoing, ever-modified outcomes, it should always be perceived and assessed as time-dependent. The Canadian census does not make it easy to do this, as its geographic units were perennially modified, but GIS offers the researcher some choice of unit boundaries for analysis. Observation over time also requires consideration of changes in the perceptions of ethnicity, the various definitions of poverty or wealth, and the variables available as estimators.

Social reproduction can be thought of as a dynamic equilibrium: high levels of segregation persisted in Montreal between 1881 and 1901 along several distinct social dimensions, despite growth of the system. Individuals moved in and out of households and households in and out of dwellings at astonishing rates. At a census date, a third of what seem to be nuclear families were what we would today describe as “reconstituted,” and a sixth of the households lodged unrelated boarders. In a city built for diversity, a well-oiled legal system facilitated the year-to-year decision making of households and the mutual adaptation of extended families to changes in circumstance.

Both segregation and diversity were built into the urban habitat. So long as the material habitat was extended—along the same axes, to roughly the same heights, densities, and lot coverages, with the same building typology and the same potential for neighboring—it reproduced the same patterns of segregation among inhabitants and the same levels of social diversity. Neighboring was expressed at the same scale, and annual turnover ensured reproduction of persistent household preferences along multiple dimensions of personal identity.

Notes

Databases are available from the authors. David Hanna (Université du Québec à Montréal) and Robert Lewis (University of Toronto) were long involved in constructing street segments and tests of rental values. David W. S. Wong (George Mason University) generously provided the segregation extension for ArcView. Robert C. H. Sweeny (Memorial
University of Newfoundland) initiated the test for the effect of property ownership. We are indebted to many other contributors to the MAP project, notably François Dufaux, Kevin Henry, Don Lafreniere, Patricia Thornton, and Rosalyn Trigger. Karen Van Kerkoerle provided cartographic assistance. Geodatabases and financial support for MAP were provided by Ville de Montréal, Bibliothèque National du Québec, Network of Centre of Excellence–GEOIDE, the Centre Interuniversitaire d’Études Québécoises at Laval and Trois-Rivières, the Social Sciences and Humanities Research Council of Canada, the Montreal History Group (McGill University), and the University of Western Ontario Academic Development Fund.

1 For comparative analyses, the published Canadian census is seriously deficient: questions and definitions varied from one census to the next; geographic organization was limited to the level of electoral districts (counties, townships, and municipalities), often modified with each census; and no maps of the smaller divisions used for data collection in the city were retained (see critique in Curtis 2000). For comparative analyses of present-day Canadian cities, see Walks and Bourne 2006.

2 MAP stands for “Montréal, l’avenir du passé.” For more details of the MAP GIS, see Gilliland and Olson 2003 and Sweeny and Olson 2003.

3 See the North Atlantic Population Project at www.nappdata.org; the CCRI at www.canada.uottawa.ca/ccri; the Great Britain Historical GIS (GBHGIS) at www.port.ac.uk/research/gbhgis; and, for the United States, the National Historical Geographic Information System at www.nhgis.org. These interdisciplinary teams benefit from methodological innovations and standards developed for large databases in the United States (www.ipums.umn.edu), the Netherlands, Norway, and Sweden. Peter Baskerville and Eric W. Sager show the potential of comparisons among six Canadian cities (1891–1901) (Baskerville and Sager 1998; Sager and Baskerville 2007); Danielle Gauvreau and Peter Gossage (2000) pursue comparative analyses for 1901 by reusing Gordon Darroch’s 1871 sample (Darroch and Ornstein 1980); and historical demographers in the United States are making creative use of the Integrated Public Use Microdata Series samples from decennial censuses from 1790 to 2000 (e.g., Gullickson 2006; White 2008). For applications and development of the GBHGIS, see Gregory 2008 and Gregory and Ell 2005, 2006, 2007.

4 For a comprehensive treatment of interactions between class and ethnicity in present-day cities, see Walks and Bourne 2006.

5 We recognize the limitations of the classic SI (e.g., its neglect of physical distances); however, it is the most widely used index of social differentiation in the literature, including historical studies, and therefore it promises the greatest likelihood of future comparative studies. Our experiments with David W. S. Wong’s spatial segregation measures (packaged as ArcView 3.x tools) reproduced similarly high levels of segregation for the two periods (see Wong 2002, 2004, 2005). Measures of “exposure” of one group to others could also be calculated using indexes of “interaction” and “isolation” (Apparicio et al. 2007; Massey and Denton 1988); however, these indexes are more sensitive to sample characteristics (size, depth, density) and therefore were deemed inappropriate given the makeup of the 1901 samples.
For full details of the experiments, see Gilliland and Olson 2010.

For 1881 we re-created boundaries by matching property owners to the municipal tax roll that provides a geocodable street address and cadastral lot number. Larry McCann’s team re-created the 1901 divisions for Montreal (Buck et al. 2000).

The CFP sample was developed for a wider range of purposes; the others, earlier and with more modest funding, were influenced by the specific research objectives of the teams: Baskerville and Sager on unemployment rates; Gauvreau and Gossage on fertility; MacKinnon on immigrant earnings; Patricia Thornton and Sherry H. Olson on infant mortality.

The letter B was chosen on three criteria: in handwritten documents it is rarely ambiguous to the eye; it was reliably distinguished by ear, regardless of language and literacy; and we anticipated comparable proportions of the four largest ethnic communities, French Canadian, Irish Catholic, Protestant, and Jewish.

The array of French Canadian surnames is reasonably small, well known, and well studied (see www.genealogie.umontreal.ca). We also used first names to differentiate, for example, the Abraham family of Sarah, Jacob, Ettie, and Pinkas from the family of Napoléon, Bernadette, and Marie Louise.

The 1901 index, transcribed by volunteer genealogists, is accessible at www.automatedgenealogy.com, and the link to images of the nominal records is at www.collectionscanada.gc.ca/archivianet. See also, for Quebec City, databases at www.phsvq.cieq.ulaval.ca.

The Shannon index was calculated with diversity.xla, an Excel function offered at www.reading.ac.uk/ssc/software/diversity/diversity.html. For derivation and uses, see Shannon 1948 and MacArthur 1972. Philippe Apparicio et al. (2007) employ both an SI and a DI for an array of immigrant groups in present-day Montreal.

The restriction accommodates a limitation of the MacKinnon and Sager samples. Compilations for either date include Hochelaga, Saint-Gabriel, and Saint-Jean-Baptiste wards, suburbs annexed in 1886. In 1901 additional suburbs would add 20 percent to the total population and would produce a slight increase in citywide SI values. The most important of those were Saint-Henri and Sainte-Cunégonde (heavily French), Saint-Louis du Mile End, Maisonneuve, and Westmount.

Information is provided for both dates on religion and country of birth. The 1901 data provide more explicit confirmation of mother tongue and national origin in the paternal line; for the Canadian-born, urban or rural birthplace; and for the foreign-born, year of immigration.

Although earnings were reported in 1901, they were not reported in 1881, and even in 1901 information was required only of the “wage earner.” The municipal assessment of rental value of the dwelling (taxe locative) proved a satisfactory variable for 1881 when adjusted for modest inflation of rents. For 1901, however, it was available as a digital database solely for B-surname households. The best indicator of status is median rent of all dwellings in the street segment, but its use would introduce circularity into the analysis. High-rent households can be effectively selected by the presence of one or more servants.
In view of the underreporting of occupations for women, we did not attempt to substitute the occupation of the widow.

See further discussion of MDS in Gilliland and Olson 2010. See also McNicoll 1993 on “ethclass” and Darroch and Marston 1961, 1969, on the multiple dimensions of social class and ethnicity.

This set is nonetheless very valuable. It can be used for stratified analyses as intended, and, if we treat it as an array of 33 separate samples, it provides information about the “real” diversity at the fine grain of the 1901 divisions. Since it contains the full array of census variables, it offers some potential for uncovering unsuspected social dimensions and exploring their interactions.

These are the 1920s settings familiar from Mordecai Richler’s novels (e.g., Richler 1959, 1971).

The two vectors accommodate 97 percent of the variance among the 18 groups in 1881, 87 percent in 1901. SI values for Jewish households in 1901 would appear as a tight clump apart from all others, not shown because we are not satisfied that the classification by occupations adequately captures status differences in an array dominated by the rubrics “trader” and “tailor.”

See www.claritas.com/MyBestSegments/Default.jsp.

For the taxe locative we have verified the near-perfect correlation with floor area (Hanna and Olson 1983), for 1901 a strong correlation with number of rooms (Gilliland and Olson 1998), and, from an array of several thousand leases, its reliability as an estimator of actual rents paid.

For domestic rental values expressed as log10, this occurs at an interquartile range of 0.30.

One- and two-person households did not become a common option in Montreal until the 1950s with the emergence of apartment houses, greater capitalization, indoor plumbing, a wider range of jobs for women, and union achievement of the eight-hour day and pensioned retirements.

As indicators of the mix of land uses, we compiled from the tax roll of rental valuations the ratio of business rents to domestic rents in the street and the percentage of commercial-industrial spaces to all taxable spaces.

High values of global integration showed a correlation coefficient of 0.63 with vehicles per day measured on municipal surveys from 1889 to 1891, 0.72 with street width in 1890, and 0.53 with log of rent/front foot of street in 1890 (Gilliland 2001). For accounts of space syntax, see Hillier 1996 and Vaughan and Penn 2006; and for application to Montreal, see Dufaux 2007 and Gilliland 2001.

References


Segregation in Montreal, 1881–1901


