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Robert E. Mitchell

Antebellum Farm-Settlement Patterns: A Three-Level Approach to Assessing the Effects of Soils

Based on standard census reports and the Integrated Public Use Microdata Series, Hall and Ruggles concluded that (1) the first half of the nineteenth century was a high point of U.S. inter-state migration, characterized by long-distance moves westward from east-coast states to the north-central region, (2) nine out of ten white migrants moved to rural areas (that is, they were primarily farmers or farm laborers), and (3) these new farmers were motivated by the desire to improve their economic well-being (an assumption not documented). The analysis to follow shows that not all states or the counties within them provided farmers with equal economic opportunities. For example, rural areas differed in their soils, supported crops, possible harvest yields, and economic potential. Given this concern and others, Kuhn asked, "Why was the restless pioneer [who bypassed Michigan in the second decade of the nineteenth century] so reluctant to settle there?" With regard to those who did settle in Michigan, Kuhn asked, "Would they then be as well off as Ohio or Kentucky farmers?"[1]

If an area's endowment of fertile soils affected a farmer's economic well-being, and if migrants were attracted to areas offering better economic prospects, antebellum settlement patterns would likely have been influenced by the distribution of soils differing in their fertility. Establishing linkages between soils, their economic benefits, and settlement patterns would support Hall and Ruggles' claim about the motivation of migrants. Moreover, if these con-

Robert E. Mitchell retired from the United States Agency for International Development in 1995. He is currently an independent scholar and an active participant in Harvard University's Institute for Learning in Retirement, residing in Brookline, Massachusetts. He is the author of *Velvet Colonialism's Legacy to Hong Kong: 1967 and 1997* (Hong Kong, 1998); *Family Life in Urban Hong Kong* (Taipei, 1972).

1 Patricia Kelly Hall and Steven Ruggles, "'Restless in the Midst of Their Prosperity': New Evidence on the Internal Migration of Americans, 1860–2000," *Journal of American History,* XCI (2004), 829–843. Madison Kuhn, "Tiffin, Morse, and the Reluctant Pioneer," *Michigan History,* L (1966), 111, 113, does not attempt to answer his questions but instead covers the views and information that the public had about the Michigan Territory.

nections existed in antebellum time, Kuhn's questions can be answered as well.

Michigan was not devoid of fertile soils, and counties within the state differed in their soil endowments, as did sections within a single county. These differences suggest that intra-state and intra-county settlement patterns should follow the same overlap of soils and settlement patterns found at the inter-state soil level.

This article has three objectives. The first is to test Hall and Ruggles' thesis by examining the overlap of soils, farms, settlement patterns, and economic well-being at three geographical levels—the five states of the Old Northwest (Michigan, Ohio, Indiana, Illinois, and Wisconsin), the sixty-eight counties in Michigan's Lower Peninsula, and a small number of farmers enumerated in the federal agricultural census of 1860 for Michigan's Midland County located in the sixth tier of counties north of the state's southern border. Were antebellum farmers more likely to be drawn to locations that had high-quality agricultural soils? The second objective is to assess what, if any, economic benefits were associated with farming different soil classes. The third objective is methodological in intent—to determine the feasibility of using different data sets to explore the first two objectives.

In pursuit of these goals, data were aggregated at the state and county-levels, whereas the individual farmer is the unit of analysis for the exploration of overlapping patterns within Midland County. State and county-level data are subject to the ecological fallacy, but individual farm data avoid this problem. At this level, we can verify and build on the relationship between soils, farmers' economic performance (economic welfare), and settlement patterns.[2]

The present analysis is not the first to explore how soils affected early American migration patterns, nor is it the first to link soils with economic welfare. In "Soil and Southern History," Helms argued that soils (for example, "base-rich soils with titled alfisols") affected the movement of early migrants from the east coast. Helms recognized that researchers cannot assume that "soils of broad geographical regions are unvarying" or, in other words, that all migrant farmers made wise decisions about the soils that they cultivated. Helms saw that using digital and other soil maps

2 For the classic statement on this fallacy, see William S. Robinson, "Ecological Correlations and the Behavior of Individuals," *American Sociological Review,* XV (1950), 351–357.

would allow historians to identify patterns of land use better, although Helms' own research did not explore this possibility in depth. The third section in the present article takes up Helms' challenge at the level of a single Michigan county.[3]

Several other researchers have explored the links between the welfare of farms and the soils that they cultivated. Atack and Bakeman, for example, suggested that a farm's profitability was "influenced by soil type, which affected yields and influenced what crops the farmer could best grow." These authors, however, warned that their results, which were based on eleven soil types, "should not command much attention" because purely local factors, besides soil, might have influenced measures of profitability. Other authors explored how culture affected farmers' agricultural practices, the links between farming practices and soil depletion, and an array of other farming-related topics.[4]

The research for this article draws from three different soil classifications, one for each geographical level analyzed. The history of soil science and soil surveys is beyond the scope of the present article. Antebellum farmers did not benefit from the contributions of soil scientists; they relied on various rules of thumb relating to the feel and color of soil as well as to the vegetation that grew on it. Although certain researchers have addressed the importance of soils for farming in antebellum America and thereafter, social scientists have not yet systematically made the same

3 Douglas Helms, "Soil and Southern History," *Agricultural History,* LXXIV (2000), 732, 736, 741–742.

4 Jeremy Atack and Fred Bateman, *To Their Own Soil, Agriculture in the Antebellum North* (Ames, Iowa, 1987), 259–260, 175–179. This study is based on information taken from the individual agricultural and population schedules within a sample of townships enumerated in the 1860 census. Soil scientists today validate their own classifications by using crop-yield information obtained from farmers and field tests. For a study of German settlers in America that found soil to be more important than culture in influencing agricultural systems, see Walter Martin Kollmorgen, *The German-Swiss in Franklin County Tennessee: A Study of the Significance of Cultural Considerations in Farming Enterprises* (Washington, D.C., 1940), 106–107. Steven Stoll, *Larding the Lean Earth, Soil and Society in Nineteenth-Century America* (New York, 2002) and Archer Hulbert, *Soil: Its Influence on the History of the United States* (New York, 1930) cover similar territory. See also Franklin Thomas, *The Environmental Basis of Society* (New York, 1925), 120–153; Michael Conzen, "The Historical Impulse in Geographical Writing about the United States, 1850–1990," in *idem,* Thomas Rumney, and Graeme Wynn (eds.), *A Scholar's Guide to Geographical Writing on the American and Canadian Past* (Chicago, 1993), 3–90; Helms, "Soil and Southern History," 723–758. The classic source on the privatizing of public lands is Paul W. Gates, *History of Public Land Law Development* (Washington, D.C., 1968).

macro- and micro-level socioeconomic links explored in the present article.[5]

Soils were certainly not the only influence on the locational decisions that migrants made; culture and kinship undoubtedly mattered as well. However, only anecdotal information is available to explore these possibilities. The present article largely ignores the extent to which various physical influences besides soils—drainage (wetlands), health conditions (malaria), climate (rainfall and growing season), and transportation facilities—had on migration decisions. Nor are federal and state laws concerning the privatization of public lands referenced. Although all of these features influenced the availability and cultivation of land, the analysis in this article is limited to the effect that soils and their associated economic well-being had on the settlement decisions of migrants in different parts of the Old Northwest before 1860. The overlap of soils, farms, and farmer performance by no means proves causality. It demonstrates, however, that these settlement decisions had significant economic implications for farmers, their families, and their communities. The economic implications are measured by crops cultivated, crop yields, land values, financial rates of return, income from garden sales, and the ability of farmers to work their farms for ten years, until 1870 (according to the decennial census).[6]

SOILS AND SETTLEMENT IN THE FIVE STATES OF THE OLD NORTHWEST

From 1785 to 1880, approximately 3,500 laws guided the privat-

5 The rules of thumb are seen in the notes that one speculator made during his travels through lower-tier counties looking for land to buy in 1836. He found that some soils had "too large a dose of sand" and others contained more lime or were "as black, as light & mellow, as an old asparagus bed." This speculator used the feel criterion to estimate "the quantity of vegetable matter & ashes . . . and a due proportion of Silex and clay . . . a deep & rich loam which will grease your finger, and feels in the hand like a finely granulated sugar." See Douglas Gordon and George May (eds.), "Michigan Journal, 1836, John M. Gordon," *Michigan History,* XLIII (1959) 258–259, 268–269. Even today, farmers and soil scientists estimate the amount of sand in a soil by rubbing a sample of the soil between their fingers, but laboratory analysis is needed for an accurate classification. See Guy Smith and Andrew Aandahl, "Soil Classification and Surveys," in *The Yearbook of Agriculture 1957, Soil* (Washington, D.C., 1957), 396. Also see Hulbert, *Soil,* 70.

6 Privatization is covered elsewhere in Mitchell, "Towards a History of Privatizing Public Lands in Michigan, 1785–1860," *Michigan Academician,* XXXVIII (2008), 121–148. For a different data-based analysis of the geographical mobility of farmers, See Donald H. Parkerson, *The Agricultural Transition in New York State: Markets and Migration in Mid-Nineteenth-Century America* (Ames, Iowa, 1995). Hall and Ruggles place their research in the context of Frederick Jackson Turner's frontier hypothesis.

ization of public lands nationwide, including the 240,000 square miles in the five states of the Old Northwest. These five areas were settled from east to west as reflected in the dates on which they had sufficient residents to qualify for admission to the Union as states. Ohio was first (1803), followed by Indiana (1816), Illinois (1818), Michigan (1837), and Wisconsin (1848). Privatization—through the issuance of patents processed by the General Land Office (GLO)—was driven by speculators and settlers; the federal government did not adopt an integrated settlement strategy like the one that Canada developed with the construction of "colonization roads," financial guarantees for railroad companies, and specific searches for land with good agricultural potential.[7]

According to one source, Indiana, with 22,662,848 acres, was the smallest of the five new states, followed by Ohio (25,816,933), Wisconsin (35,130,381), Illinois (35,271,513), and Michigan (36,424,662). These five states attracted one-fourth of the nation's population growth from 1790 to 1860. By 1860, the Old Northwest accounted for nearly 29 percent of the nation's farms and 37 percent of all new farms created nationally in the 1850s.[8]

Congress quickly recognized that land in the public domain differed in its suitability for farming. The simple dichotomy of suitable/not suitable was incorporated in the Scrip-Warrant Act of 1812, which awarded "bounty land" to veterans of the war of that year. Only land fit for cultivation, "not otherwise appropriated," was to be selected. More precise classifications came later with the

7 In 1787, the Continental Congress passed the Northwest Ordinance, which set the initial terms for the privatization of public land in what became the five states lying northwest of the Ohio River Valley. Land was not to be auctioned or sold until it had been surveyed. The Land Ordinance of 1785 established a rectangular system of surveys. For a history of public-land laws, see Gates, *History of Public Land Law Development*. For acreage numbers, see Mark S. Joy, *American Expansionism, 1783–1860* (Harlow, 2003), 2. For a review of Canadian settlement policies in the 1840s, see John Laddell, *They Left Their Mark: Surveyors and Their Role in the Settlement of Ontario* (Toronto, 1993), 133–135, 144. American surveyors under contract to the General Land Office were required to assess the agricultural potential of the land that they covered. These observations and the results of the surveyors' field notes were made readily available to the general public.

8 Thanks go to Sharon W. Waltman, Soil Scientist-Soil Geography, USDA-NRCS, Soil Survey Center, Lincoln, Nebr., for the information about acreage. For other estimates, see *Statistical Abstract of the United States, 2000* (Washington, D.C., 2000), 228; "Annual Report of Commissioner of General Land Office," *S.exdoc 1 (33–1)* and *(33–2),* Library of Congress. A sizable minority of the American population growth of 8,251,445 during the decade were the 2,598,000 foreign-born immigrants who arrived from 1851 to 1860. See Conrad and Irene Taeuber, *The Changing Population of the United States* (New York, 1958), 5, 53–57.

development of soil science's attention to different components of soil fertility, soil management, cropping systems, classifications, and the use of soil maps. Today's classifications of soils are founded on two concepts, the capacity of soils to function and their fitness for use. The capacity of soil to function entails such properties of soil formation as climate, topography, vegetation, and parent material. Measures of fitness or quality depend on actual crop production statistics. These figures are assumed "to reflect the inherent properties of soils." Two other concepts, capability and limitations, are introduced below.[9]

Soil surveys use various observations (such as soil horizons) and laboratory analyses to determine soil series that "because of their similar origins, chemical, and physical properties cause the soils to 'behave' similarly for land use purposes." The series are typically named after the town or area where a series was first recognized. Illinois recognizes approximately 800 soil types with about 430 of them grouped in 50 soil associations. A 1955 Wisconsin study reported 22 "major soil associations," and a Michigan soil survey a year later grouped 43 major soil associations into 26 divisions. Ohio and Indiana have analogous, unique classifications.[10]

9 Thirty-eight years after the Scrip-Warrant Act, the same terminology was included in the Swamp Land Act, which granted to states "swamp and overflowed lands unfit for cultivation." *Fit* and *unfit* were subjective terms that focused on land and cultivation (as well as drainage), not soil and its fertility. For a history of land grants to Michigan and the privatization of the state's land, see Mitchell, "Towards a History of Privatizing Public Lands." For an early survey of soil-science history, see *The Yearbook of Agriculture 1957, Soil* (Washington, D.C., 1957). Any number of more recent publications brings this history up to date, including the preparation of digital soil maps. See, for example, http://www.alfredhartemink.nl/history.htm; Philippe Lagacherie, Alex. B. McBratney, and Marc Voltz, *Digital Soil Mapping: An Introductory Perspective* (Oxford, 2007). Soil maps have a long pedigree. State agricultural experiment stations, in cooperation with the USDA, have been making and publishing soil surveys since 1899. The Natural Resources Conservation Service (NRCS) provides an online list of hundreds of county-level surveys for the five states in the Old Northwest. See http://soils.usda.gov/survey/printed_surveys/. The USDA and the United States Geological Survey continue to improve their online access to various kinds of digital maps. As a result, some of the web addresses cited in this article's footnotes may have changed from what they were when the article was originally drafted. Marlow Vesterby et al., *1.3. Land and Soil Quality,* a United States Department of Agriculture online document at http://www.ers.usda.gov/publications/arei/ah712/AH71213a.PDF, 41.

10 The members of the soil series have as many as three common horizons—surface, subsoil, and substratum. See USDA, NRCS, *State Soils,* an online publication at http://soils.usda.gov/gallery/state_soils/, 1. Specific crops differ in their responses to soils. For example, oats are a cool-season crop; corn is better adapted than wheat or oats to poorly drained soils; and forage crops are better suited to well-drained, steep, or easily eroded soils than corn. *Average*

These multiple categories are further divided into subcategories (by, say, sand content). The resulting diversity makes it difficult to devise easily aggregated general classes that can be used to compare the soil endowments of different states, as well as those of different counties within a single state.[11]

Table 1 ranks the five states of the Old Northwest according to the proportion of their soils that are either alfisol or mollisol, the most productive of the twelve. This table also reports the United States Dept. of Agriculture's (USDA) Soil Conservation Service's top two classes in an eight-category classification of soils based on their limitations for crop production. Classes 1 and 2

Crop, Pasture, and Forestry Productivity Ratings for Illinois Soils, Bulletin 810, University of Illinois College of Agricultural, Consumer and Environmental Sciences (Urbana-Champaign, 2000), 4. The management and technical skills of farmers are also important to cropping systems (the kind and sequence of crops grown) and soil-management systems (use of fertilizers and drainage practices along with cropping systems). See W. H. Allaway, "Cropping Systems and Soil," *Yearbook of Agriculture* (Washington, D.C., 1957), 387.

Early settlers may have been aware of, and attracted to, locations with fertile soils, but new farmers seem to have been repulsed by wetland areas. For example, northeastern Ohio's Black Swamp south of the Maumee River was regarded as a barrier to movement throughout the year, even after the government pushed a road through it in 1812. See Kenneth E. Lewis, *West to Far Michigan, Settling the Lower Peninsula, 1815–1860* (East Lansing, 2002), 25. Based on his expedition into northern Indiana in 1823, Maj. Stephen Long wrote, "The country is so wet that we scarcely saw an acre of land upon which a settlement could be made." See Hugh Prince, *Wetlands of the American Midwest: A Historical Geography of Changing Attitudes* (Chicago, 1998), 119, who quotes a number of similar negative observations about antebellum Ohio, Indiana, Illinois, and Michigan. Gen. William Henry Harrison wrote in 1812 that the country north of the Bloomington, Indiana, moraine was "almost continued swamp to the Lakes" (*ibid.,* 27). Southern Illinois was called "Egypt," a poor, unhealthy area, a "land of darkness" (Gates, *History of Public Land Law Development,* 182). Congress approved several swampland laws, beginning with the 1849 and 1850 Acts that referred to "swamp and overflowed lands unfit for cultivation," eventually granted to individual states for their disposal to private buyers. Michigan was awarded 7,273,724 swamp acres, more than twice that awarded to Wisconsin and Illinois and five times that awarded to Indiana (*ibid.,* 182).

The 800 figure for soil types comes from *Average Crop, Pasture and Forestry Productivity Ratings for Illinois Soils,* 3. Associations appear to be similar, if not equivalent, to "series." The 430 figure comes from Fehrenbacher, *Soils of Illinois,* 1. *Introduction to the Soils of Wisconsin* (Madison, 1955), 8; E. P. Whiteside, I. F. Schneider, and R. L. Cooke, *Soils of Michigan* (East Lansing, 1956), 32. According to William Bowman, the USDA's state soil scientist for Michigan, "Soils are usually named by any nearby feature where the soil is located. But after a soil is classified it can be used anywhere in any state in the country where those soil characteristics are observed. So the soil is named once where found but can be used in many counties and states" (email to author, December 14, 2009).

11 Published soil surveys for individual counties include summary tables that combine the diversity of soils into more general classes. However, only a minority of these reports (at least for Michigan) have been placed online.

Table 1 State-Level Soil Classifications

	ACRES OF ALIFSOL AND MOLLISOL[a]	SOILS THAT ARE ALIFSOL OR MOLLISOL[b]	ONLY FEW OR SOME LIMITATIONS FOR CULTIVATION[c]
Illinois	31,871,339	90%	63%
Ohio	20,163,024	78%	49%
Wisconsin	19,391,970	55%	35%
Indiana	18,606,198	82%	64%
Michigan	13,954,288	38%	30%
Total	103,986,819		

[a] Information provided by Sharon W. Waltman, National Soil Survey Center, Lincoln, Nebraska.
[b] For base numbers, see Soil Survey Staff, *State Soil Geographic Data for U.S. States and Territory of Puerto Rico* (Lincoln, Nebr., 1994). Digital soil maps and attribute tables—9/94 CD-ROM media. http://soils.usda.gov. Soil Survey Staff, *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys* (Washington, D.C., 1999).
[c] "Land Capability Class, by State, 1997," Map ID: m6175, available online at http://www.nrcs.usda.gov/technical/land/meta/m6175.html.

have few or only moderate limitations that would reduce the choices of plants that (as of 1992) might be grown on these soils.[12]

The data in Table 1 are not perfect indicators of soil productivity and potential profitability. However, the numbers in this table suggest an answer to Kuhn's question on whether farmer-settlers in Michigan would have been at a disadvantage compared to farmers in Ohio. Michigan's apparent drawbacks, however, mask the effects of the state's Upper Peninsula and much of the mid-to-north counties in the Lower Peninsula. Yet, Michigan had approximately 14 million acres of the two top-ranked soils, and every state had large amounts of farm-poor soils. Nonetheless, a farmer migrating to Illinois certainly had a much greater chance of cultivating productive soils than farmer-settlers had in Michigan.[13]

If these soil classifications correctly capture differences in soil fertility, and if most settlers were farming alifsol and mollisol soils that suffered few usage limitations, inter-state differences in corn yields and rates of return on farm investments should follow the ranking of states by the proportion of these good soils. Although

12 Thanks again to Waltman for acreage estimates of twelve different soils in each of the five Old Northwest states. Soils with the two top-capability classes do not necessarily have the highest value of crop production per acre.
13 Vesterby et al., *Land and Soil,* 42.

Table 2 Rate of Return on Farm Investments, 1860

	WITHOUT CAPITAL GAINS[a]	WITH CAPITAL GAINS[a]	MEAN PROFITABILITY OF OWNER–OCCUPIED FARMS[b]
Illinois	10.8	19.1	0.185
Ohio	8.3	13.3	0.120
Wisconsin	6.6	11.4	0.077
Indiana	3.8	10.4	0.061
Michigan	−0.5	5.8	−0.128

[a] Jeremy Atack, Fred Bateman, and William Parker, "The Farm, the Farmer, and the Market," in Stanley Engerman and Robert Gallman (eds.), *The Cambridge Economic History of the United States* (New York, 2000), II, 245–284 (Chapter 6) ; Atack and Bateman, *To Their Own Soil, Agriculture in the Antebellum North* (Ames, Iowa, 1987), 255.
[b] Atack and Bateman, *To Their Own Soil,* 257.

the ranking of states on several productivity and financial criteria is not the same as that in Table 1, Illinois generally has a high ranking whereas Michigan ranks last.

Atack and Bateman's estimates of per-capita income of owner-occupiers and tenants for 1859/60 place Michigan owner-occupiers at the bottom of the five-state ranking at only $85. Illinois owner-occupiers earned twice as much on a per-capita basis ($165), followed by Ohio ($146), Indiana ($113), and Wisconsin ($96). Easterlin's estimates of agricultural income per worker for 1840 gives the highest rank to Ohio ($157), followed by Illinois ($154), Indiana ($137), Wisconsin ($132), and Michigan ($116).[14]

Not only were Michigan farm incomes the lowest in the region; farmers in the state had the lowest rates of capital gains on the investments that they made in their farms. In fact, farmers who did not sell their holdings had a negative rate of return in 1860 (Table 2). These various yield and economic arrays answer Kuhn's question: Antebellum Michigan farmers were not as well-to-do as farmers in Ohio.[15]

14 Michigan tenant farmers had the third-highest per-capita incomes among the five states, although tenants everywhere fared less well than owner-occupiers did (Atack and Bateman, *To Their Own Soil,* 243). Richard Easterlin, "Interregional Differences in Per Capita Income, Population, and Total Income, 1840–1950," in National Bureau of Economic Research, *Trends in the American Economy in the Nineteenth Century* (Princeton, 1960), 98.

15 Other studies that estimate antebellum farmer performance do not provide sufficient information to link soil classes specifically to economic returns. Easterlin's statewide estimates of 1840 farm productivity levels in Michigan and Wisconsin were lower than estimated regional and national levels and not much different from those of older states along the eastern seaboard. He suggested that relatively low productivity and income levels for new states, such as

These statewide aggregated figures in Table 2 do not recognize intra-state differences in the distribution of soils. For example, in Illinois the "areas of highest soil productivity, regardless of management level, are in the east-central and north-central counties." In Wisconsin, both corn and wheat yields per acre from 1996 through 2000 were slightly higher in the state's southern than in its northern counties.[16]

Although antebellum farmers might not have been able to distinguish among different classes of soils, new arrivals might have based their locational choices on information about crop yields according to the spatial distribution of soils. That is, crop yields were surrogate indicators of soil classifications.

As noted above, an overwhelming proportion of migrants in the early and mid-1800s settled in rural areas. More than 80 percent of each state's 1860 population was classified as rural, but the absolute numbers indicate that Michigan had the smallest rural population in 1860 and that it was second to last in the number of rural residents added during the 1850s. The number of farms and the farm population both increased between 1850 and 1860. The number of Michigan's farms increased by 83 percent from 1850 to 1860, representing an additional 28,330 farms, still the lowest of the five states. For every 1,000 new Michigan farms, the other states added 6,700 new ones. Even though Michigan's farm growth rate was more than three times that of Ohio's, the latter

Michigan, may be partially attributable to the heavy labor investments required in clearing land and in adjusting old farming technologies to new environments. See Easterlin, "Farm Production and Income in Old and New Areas at Mid-Century," in David Klingaman and Richard Vedder (eds.), *Essays in Nineteenth Century Economic History, The Old Northwest* (Athens, 1975), 81, 90–91. American yields per acre were low compared with those in Europe. Atack, Bateman, and William Parker, "The Farm, the Farmer, and the Market," in Stanley Engerman and Robert Gallman (eds.), *The Cambridge Economic History of the United States* (New York, 1966), 260. Other studies report a mixture of medians, means, and ranges that can be interpreted in multiple ways. For example, the low end of the range of corn yields from 1843 to 1856 follow the ranking of states by the percentage of their acres in alifsol and mollisol soils. The high end of the corn yields does not produce the same ranking, nor do the high and low ranges for wheat. See Parker and Judith Klein, "Productivity Growth in Grain Production in the United States, 1840–1860 and 1900–1910," in Dorothy S. Brady (ed.), *Output, Employment, and Productivity in the United States after 1800* (Princeton, 1966), 500 (Table B. 1), as reported in Atack and Bateman *To Their Own Soil,* 164.

16 P. W. Mausel, E. C. A. Runge, and S. G. Carmer, *Soil Productivity Indexes for Illinois Counties and Soil Associations,* University of Illinois, College of Agriculture, Agricultural Experiment Station Bulletin 752 (Champaign, 1975), 2. Thanks go to the Wisconsin Agricultural Statistics Service for *The 2000 Wisconsin Agricultural Statistics,* 19–23.

Table 3 Going Where Others Had Already Gone

	QUALITY LAND (ALFISOL, MOLLISOL) AVAILABLE IN 1850 (IN THOUSANDS OF ACRES)[a]	NEW FARM ACRES ADDED 1850–60[b]	QUALITY LAND TAKEN BY 1860
Ohio	2,166	2,475	114%
Indiana	5,813	3,595	62%
Illinois	19,834	8,875	45%
Michigan	9,570	2,684	28%
Wisconsin	16,415	4,517	28%

[a] The numbers of acres reported in the USDA's soil tables are multiplied by the percentage of each state's alfisol and mollisol soils. There are several different estimates of each state's total acres. For other totals, see the *Statistical Abstract of the United States: 2000* (Washington, D.C., 2000), 228; *Historical Statistics of the United States 339,* Series A195–209, Library of Congress.
[b] Joseph C. G. Kennedy, *Agriculture of the United States in 1860; Compiled from the Original Returns of The Eighth Census* (Washington, D.C., 1864), 222.

added 7,749 more farms. Every other state also added more improved acres—that is, "cleared land used for grazing, grass, or tillage, or which is now fallow."[17]

If we (unreasonably) assume that settlers both before and after 1850 farmed only the most favorable soils, the unclaimed supply of these soils would have dwindled over time, as seen in Table 3. Under this assumption, the new farmer-settlers in Ohio would have started farming relatively lower quality soils by 1860. Moreover, with the assumption that farmers were willing to cultivate only these soils and that the supply of acres with such soils had declined, new soil-savvy migrants in search of farms would increasingly have migrated to states with a larger supply of unfarmed fertile soils. In Ohio, even the existing farmers left the state to begin anew elsewhere, including other states in the Old Northwest. Moreover, large numbers of migrants appear to have leapfrogged Ohio to neighboring states with still-available fertile soils. Ohio, the earliest settled of the five states in the Old Northwest, had more out- than in-migration as early as the decade from 1840 to 1849. The state's natural increase in population more than compensated for these losses in both the 1840s and 1850s (that is, the

17 Population figures for the present discussion are taken from Vedder and Gallaway," Migration and the Old Northwest,"161–165. For rural population statistics, see *Historical Statistics of the United States,* Series A195–209, Library of Congress. See Atack and Bateman, *To Their Own Soil,* 118; *1860 Census Instructions to Marshals* provided by IPUMS at http://www.ipums.umn.edu/usa/voliii/inst1860.html

resident population produced more children than the number of residents who left the state). Indiana, the second state to be more heavily settled, displayed a similar migration pattern during the 1850s. Illinois, Michigan, and Wisconsin had more immigrants than emigrants during this same decade.[18]

The five states of the Old Northwest differed in their endowments of fertile soils. Data aggregated at the state level suggest that states with a high percentage of acreage with the fertile alfisol and mollisol soils (or the surrogate measures of quality—soils with few or some limitations for cultivation) also had high rates of return on farm investments. Despite a lack of perfect agreement among the several state rankings of soils and economic measures, Illinois generally ranked at the top, whereas Michigan always ranked last. Soil endowments affected (predicted) the economic welfare of farmers. Because economic-welfare motivations, according to Hall and Ruggles, drove antebellum farmers' locational decisions, it is not surprising that the availability of good soils seems to have influenced population and settlement patterns.

Although the links between soils, economic welfare, population trends, and settlement patterns seem reasonable, these links are based on aggregated (ecological) data, not on information that refers to specific farmers. However, if the sixty-eight counties in Michigan's Lower Peninsula follow the same general pattern found at the level of the five states, added credence is given to the interpretation proposed above. Yet, aggregating data at the level of either the state or the county is no substitute for an analysis of individual farmers. Before turning to a small number of these farmers, we explore antebellum county-level patterns of soils and settlement in Michigan's Lower Peninsula.

SOILS AND SETTLEMENT IN THE LOWER PENINSULA'S SIXTY-EIGHT COUNTIES Reliable county-level information is not available for crops, crop yields, and economic welfare in antebellum Michigan. What is available can only be considered crude approximations. Although analysis of the sixty-eight counties cannot possibly repli-

18 Helms, "Soil and Southern History," 736, reported that "Migration to the continuously cultivated alfisols of the limestone valleys drove up land prices and made for smaller farms"—for example, in Lancaster County, Pennsylvania. Both Ohio and Indiana had a net outflow of the "native born." These losses were partially offset by a net immigration of foreign-born. See Vedder and Gallaway," Migration and the Old Northwest," in Klingaman and Vedder (eds.), *Essays in Nineteenth Century Economic History,* 162–165.

cate the five-state analysis, some of it parallels the five-state patterns already noted, reinforcing the need for a study based on individual farms and farmers.

Differing in both their sizes and shapes, the Lower Peninsula's counties were stacked south to north in eleven tiers. Twenty-eight of these sixty-eight counties bordered one of the Great Lakes. Only twenty-six of the other forty counties had a box shape. Ten others had straight-line borders but were in irregular patterns. It is not surprising, therefore, that counties differed greatly in size from one another. The largest county had three times more acres than the smallest. Information is provided below for selected counties, but the following analysis takes tiers of counties as the primary unit for an exploratory analysis.[19]

The state's fertile soils would ordinarily have attracted settlement, but poor climate, drainage problems, and unhealthy environments discouraged it. For example, farmers north of a convex line drawn from Saginaw in the east to Muskegon in the west had 60 to 120 frost-free days, whereas farmers south of this line had at least 140 such days. An antebellum farmer settling in Michigan also had to cope with incomplete drainage and malaria, conditions not unique to the state. Settlement was further impaired by an absence of roads both to unsettled lands and to markets for farm products.[20]

Nonetheless, anecdotal information suggests that farmers fac-

19 Lewis, *West to Far Michigan,* adopts an alternative visual approach by presenting a series of differently scaled maps to support his narrative. Inter-county size differences can be addressed by standardizing (where possible) by acres.

20 *Ibid.,* 47 (Chapter 3 of Lewis' book is titled "The Environmental Context of Colonization"). Prince, *Wetlands,* noted that "[s]warms of insects are the most profuse and characteristic forms of life in all Midwestern wetlands" (71), and that a survey party in the Michigan swamps in 1821 refused to finish their work because of "the suffering from mosquito bites, both men and horses being weak from loss of blood and want of sleep" (14). Many earlier travelers commented on how unhealthy Michigan was; the state's overflowed lands were a source of the ague (malaria). Gordon on October 7, 1836, referred to the River Rouge in southeast Michigan as a place that "the New England emigrant might enjoy the ague & fever nine months in the year & and the bilious for the other three" ("Michigan Journal, 1836," 257). Farther north, the U.S. Army in 1823 moved its garrison from Saginaw to Detroit because the "pestilential swamps" in the area were a source of "an aggravated form of intermittent fever" that affected those housed in the garrison. At least nine young soldiers died along with members of their families. See Anita Fisk, *The History of Saginaw County Medicine* (Midland, 1986), 1–3. Lewis, *West to Far Michigan,* 285–289, provides maps of antebellum railroads and road networks for the Lower Peninsula. His descriptive research is essential reading that overlaps the present analysis. I have not been able to find statistical ways to measure the overlap of two or more maps that display different physical (for example, classes of soils) and socioeconomic (for example, farms) features. Instead, the present analysis deals with county-level information arrayed spatially as tiers of counties.

tored soils into their settlement decisions. Gray reported that early settlers in Kalamazoo County "passed over" a township (Alamo) in which more than four-fifths of its lands were marginal according to Gray's classification ("fertile but requiring constant improvement for general farming"). Early settlers in the third-tier Macomb County were also "apparently dubious about buying land" in a lake plain, although a more recent soil survey indicated that this area was well suited to farming. Other researchers found settlers who were less astute. Moore reported that homesteaders between 1878 and 1890 attempted to farm Grayling sand outwash plains that were unsuitable for agriculture in the seventh-tier county of Oscoda.[21]

Kuhn reported early negative images of the state as well as many positive ones. Michigan had large amounts of farmable land, but not until Veatch's work in 1941 was the state's supply and location of four different classes of soils estimated. Based on their "inherent productivity," Veatch's first-class soils had the highest value for general farming. Second-class soils included usable land of medium value for general farming; the third- and fourth-class soils had low or no such value.[22]

Veatch's classifications and estimates suffer a few liabilities. First, they are based on only twenty soil samples from each thirty-six-section township. Second, crop yields were used to validate his classification (apparently like many current soil surveys), and, third, they did not use a single statewide standard for distinguishing among his four classes. For all we know, Veatch's first-class soils in northern counties might have been rated second-class in lower-tier ones.

According to Veatch, not all counties and tiers of counties were equally endowed with good farming soils. Twenty-eight of the Lower Peninsula's sixty-eight counties placed three-quarters

21 Susan E. Gray, *The Yankee West, Community Life on the Michigan Frontier* (Chapel Hill, 1996), 37; Marjorie True Dooley, "The Andrews Bailiwick: A Geographic Study of Migration to the Settlement of Northern Macomb County, Michigan, 1810–1850, as Perceived by Selected Participants," unpub. Ph.D. diss. (Michigan State Univ., 1975), xviii; Rose Lockwood Moore, "Of Berry Pickers, Shanty Boys, and the Jack Pine Bird: Patterns of Settlement and Subsistence in Nineteenth Century Oscoda County (Michigan)," unpub. MA. thesis (Western Michigan Univ., 1990), 51.

22 See J. O. Veatch, *Agricultural Land Classification and Land Types in Michigan,* Michigan State College, Agricultural Experiment Station Special Bulletin 231 (East Lansing, 1941), 23–31 (detailed classifications of soils in the Lower Peninsula), 57–58 (description of his fourfold classification); *idem, Soils and Land of Michigan* (East Lansing, 1953).

or more of their land in Veatch's two top classes. Forty (59 percent) had half or more of their land in these two classes. At the other extreme, half or more of the acres in seven counties were fourth-class soils; fourteen counties had 40 percent or more of these acres. More northerly counties had higher proportions of poor soils. Fourth-class soils began to predominate after the fifth tier; higher-quality soils were proportionately more abundant in southern tiers. However, sizable inter-county differences appeared within individual tiers, as seen in Table A of the Appendix.[23]

Table 4 groups these eleven tiers into three broad categories to emphasize the contrasting soil endowments of different regions within the Lower Peninsula. Farmers who settled primarily in counties with a greater proportion of good soils, which would presumably have attracted more settlers, would likely have had higher crop yields and farm values, assuming that they (perhaps by chance) cultivated only land with class 1 and 2 soils. The 1850 and 1860 federal agricultural censuses lend some support to these assumed effects. The dollar value per acre of both improved and total acres dropped after tier 4. In 1860, the per-acre value (based on a farm's total acres) was $20 or higher for tiers 1 through 4 but dropped to $10.20 in tier 5, $8.70 in tier 6, and $0.70 in tiers 7 through 11 (these figures refer only to counties that had farms at the time).[24]

23 Lewis, *West to Far Michigan,* 52, provides a map of the Lower Peninsula showing counties with first- and second-class "land."

24 Overlapping the south-to-north gradient is the length of the previously noted growing season. Crops that did well in some environments did less well in others. Wheat fared better in drier and cooler climates that were relatively free of wheat rust and wheat blast, and corn did so in moderate climates. See Andrew Cayton and Peter Onuf, *The Midwest and the Nation: Rethinking the History of an American Region* (Bloomington, 1990), 39. Corn was also better adapted than wheat to "naturally very poorly drained soils" (http://www.ideals.illinois.edu/handle/2142/1027; originally listed at http://research.nres.uiuc.edu/soilproductivity, 4.). Adequate information is not available to test the several elements of the crop-yield assumption. Information reported by the state's secretary of the Board of Agriculture for the 1863 growing season lists only ranges of corn and crop yields for seven lower-tier counties. See *Third Annual Report of the Secretary of the State Board of Agriculture of the State of Michigan for the Year 1864* (Lansing, 1864). The Michigan secretary of state at the time judged the state census of 1864, which reported on the same 1863 growing season, as suffering from "inaccuracies, or in some cases *an entire failure* to report upon important points suggested" (emphasis in the original). See *Census and Statistics of the State of Michigan, 1864* (Lansing, 1865), iii–v. The state census of 1854 is equally, if not more, incomplete. Some of the differences in value per acre were probably due to the stage of farm making within the tiers. More acres were cleared and fully farmed in the more southerly tiers. The inter-county gaps by tier were $20 (tier 1), $11 (tier 3), $9 (tier 4), $28 (tier 5), $55 (tier 6) and $28 (tiers 7 through 11).

Table 4 Another Perspective on Tiers and Their Soils

TIERS	TOTAL ACRES	ACRES IN CLASSES 1 AND 2	ACRES IN CLASS 4
1–4	43%	56%	12%
5–6	22%	24%	17%
7–11	36%	19%	71%
Total	101%	99%	100%

These tier differences, however, mask sizable intra-tier variations. Most strikingly, in 1860, farmers in Wayne County (with Detroit, the state's largest city) valued their land at $72 per improved acre, $33 more than similar acres in the tier-2 counties of Calhoun and Jackson. There were similar gaps between high- and low-valued counties in other tiers. Clearly, soil fertility was not the only determinant of self-reported farm values. Market access was also important; counties in tiers 1, 2, and 3 that were close to Detroit had relatively high values (more about this point below).

Whether drawn by soils, the yields of existing farms, or ease of access (available roads), new farmers followed a south-to-north settlement trajectory. However, relatively few of these early settlers leapfrogged to tier 5 or higher counties with sizable supplies of unfarmed class 1 and 2 soils. All twenty-eight counties in tiers 1 through 4 had farms in 1850. By 1860, all six counties in tier 5 had farms (ten years earlier, only four counties had farms), and all seven counties in tier 6 were also being farmed in 1860 (three in 1850). No farms were reported in 1850 for tiers 7 through 11. By 1860, six of the twenty-seven counties in these two tiers had attracted pioneer farmers.[25]

Counties within a tier differed in the number of farms and farms added during the decade. These population trends reduced supplies of unfarmed class 1 and 2 soils; some tiers and counties

25 Tiers 1 through 3, which held 83% of all farms in 1850, added 45,870 new farms during the decade—an average of 15,290 farms per tier. Tier 4 counties increased their number of farms by twice the rate as the lower tiers. Starting with few farms in 1850, tiers 5 and 6 had the highest growth rate, although they added only 3,107 farms, 11% of the new starts added during the decade. The twenty-one counties without farms in both 1850 and 1860 (28% of the total acres in the Lower Peninsula), which are excluded from the subsequent analysis, had approximately 2,273,760 acres of class 1 and 2 soils, 14% of the Lower Peninsula's total, but also 61% of the Lower Peninsula's class 4 soils.

Table 5 Using Up Class 1 and 2 Soils (Sixty-Eight Lower-Peninsula Counties)

TIER	CLASS 1 AND 2 SOILS STILL AVAILABLE		CLASS 1 AND 2 SOILS AVAILABLE IN 1850 ADDED TO FARMS BY 1860
	1850	1860	
1	44	16	63
2	27	6	79
3	48	26	46
4	76	53	30
5	99	85	14
6	99.8	93	7
7–11	100	99	1

had tighter supplies than others. Farmers who arrived before 1850 (and every year thereafter) removed their acres from the supply available to new arrivals. By 1850, about 70 percent of the acres in three counties (Oakland, Washtenaw, and Jackson) had farms (both improved and unimproved acres). Nine of the thirty-four counties that had farms in 1850 had half or more of their land reported as farms in that year (there were actually thirty-five counties, but information about Huron County is unavailable). That number jumped to seventeen ten years later. The number of heavily farmed counties (those with 75 percent or more farmed acres) increased fourfold to eight (see Table B in Appendix).[26]

If potential farmers searched exclusively for higher-quality soils, new settlers would have begun farming in counties with relatively more of these soils. Table 5 provides some support for this contention. Assuming that the farmers enumerated in the 1850 agricultural census cultivated only class 1 and 2 soils, tier 2 counties already had 63 percent of their higher-quality soils in farms. Table 5 gives the percentage of class 1 and 2 soils still available in 1850 and 1860. Only 27 percent of the class 1 and 2 soils in tier 2 were still available in 1850. By 1850, Oakland County had already exhausted the supply of its best soils. At the end of the decade, only

26 Oakland County in Tier 3 had 3,559 farms in 1850, the highest number in the state. Even though only 270 farmers had decided to settle in Allegan, also in Tier 3, 1,558 farmers moved into Allegan during the decade, the highest number in the Lower Peninsula. If the incomplete published census figures are approximately correct, Wayne and St. Clair Counties had fewer farm acres in 1860 than in 1850.

6 percent of the class 1 and 2 soils in tier 2 counties were not already farmland. In addition to Oakland County in tier 3, St. Joseph and Cass Counties in tier 1, and Jackson and Washtenaw Counties in tier 2 had more acres in farms (improved and unimproved acres) than these counties had in their class 1 and 2 soils.[27]

Instead of being attracted to more readily available good soils in tiers 3, 4, and higher, a large majority of new arrivals stayed closer to where farmers had already settled. The settlement pattern moved from south to north (as well as from east to west), but existing farm operations seem to have exerted a stronger pull than the attractiveness of a larger supply of good soils in higher tiers. The pull of markets for farm products might have been even more important, explaining the higher land values of Wayne County and population concentrations more generally. In 1860, the correlation at the county level between population and average value per total farm acre was a high 0.89.[28]

The information about the role that soils played in shaping farm-settlement patterns in the Lower Peninsula's sixty-eight counties is not completely consistent. If Hall and Ruggles were correct in attributing settlement decisions to a search for greater economic welfare (aside from climate), farmers would have increasingly settled in higher-tier counties as the supply of affordable class 1 and 2 soils declined in the lower tiers. Although this south-to-north migration gradually occurred from 1850 to 1860, new immigrants seem to have been drawn more to existing concentrations of farms than to counties with more abundant unfarmed good soils. Leapfrogging to these higher-tier counties was not the common migration pattern.

The importance of economic motives in Michigan's settlement history is unclear; no reliable information about crop yields

27 Wayne and St. Clair Counties added new farms during the decade, even though they had fewer acres in farms in 1860 than in 1850. Census errors could help explain some of these differences.

28 Based on information from the flawed 1864 state census, the correlation (using counties as the unit of analysis) between population and yields of corn and wheat is only half or less than the correlation between population and land values (the first correlation was for 1863; the second was for 1860). Some of the increased value of land near concentrations of higher population is explained by the fact that farmers added value by diversifying into animal husbandry, as reflected in their number of milch cows and sheep. Dairy farming (milk more so than butter and cheese) depended on access to larger markets. A farmer who used manure from his cows to fertilize his land could increase crop productivity, which was important for providing feed for livestock.

and economic rates of return are available at the county level. Flows of current income are different from one-time capital gains based on the sale of farm land. Such gains were much higher in southern than in northern tiers of counties. The higher per-acre costs of land in lower tiers would have priced many new settlers out of the market for land there. That is, the high price of land was a "push" force for certain migrants, and the cheaper class 1 and 2 soils in more northerly tiers acted as a "pull" force. These push–pull forces are distinguished as the gravity versus magnet causes of population movements.[29]

The magnet model assumes that individual farmers responded to economic opportunities and the improved economic welfare of their families. This assumption can be tested by analyzing how individual farmers behaved in different socioeconomic and social environments—in this case, a small number of farmers in the sixth-tier county of Midland.

SOILS AND SETTLEMENT AMONG INDIVIDUAL FARMERS IN MIDLAND COUNTY An analysis of individual farmers requires the time-consuming consolidation of data drawn from a county's soil surveys, patent and deed records that identify the survey sections with specific farms, crop and financial information provided in the enumeration sheets of the county's 1860 federal agricultural census, and information from the 1860 and 1870 federal censuses to identify farmers who left a county during the 1860s. This collaboration of diverse data yields information about thirty-one (43 percent) of the seventy-two farms enumerated in Midland County's 1860 agricultural census. The other 57 percent (forty-one farmers) were probably either renters, tenant farmers, farmers buying their land on an installment basis, or farmers who used military scrip to acquire their land.[30]

Midland County has "about 332,800 acres, or 520 square miles" of land. The county is located in a transitional agricultural area just west of Saginaw County. The GLO surveyors working in 1831 and 1832 took notes on the soils and vegetation along the

29 Helms, "Soil and Southern History," 736, noted the effects that soil-based settlement patterns had on the price of land.

30 It was not possible to identify the sections farmed by several individuals with land in two or more survey sections. Names were missing on many patents acquired through the use of military scrip.

lines that they were laying in Midland. Surveyors also gave a general description of each of the county's sixteen townships, noting whether the soils were first-, second-, or third-rate for agricultural purposes. These township-wide assessments were not particularly favorable to Midland; negative comments outnumbered positive ones by about three to one. Soils there were most commonly classified as second- and third-rate, since large areas of certain townships were considered too wet to permit farming.[31]

In contrast with these early negative assessments, later reports expressed a booster's mentality. The *Michigan State Gazetteer and Business Directory for 1863/64* claimed the county's soil to be "unsurpassed for farming purposes, being a rich black loam, which produces wheat, corn, potatoes, etc., in the greatest profusion." Even in 1893, questionable claims were asserted by Michigan's secretary of state: "There are no swamps of any size. . . . The soil of the southern portion of the county is mostly clay; that of the northern part is a clay loam, while the western and eastern portions have a sandy loam. . . . The 'stump lands' of this county have a good soil, and wherever cultivated have produced good crops." Early farmers were making their settlement decisions based on questionable, if not totally erroneous, information.[32]

31 Information about soils and farming in Midland were added to a database originally built to study how men were recruited to serve in Union armies during the Civil War; Midland was not selected to be representative of antebellum farming communities. However, the study of land and soils took on a life of its own, as reflected in two articles—Mitchell,"Towards a History of Privatizing Public Lands in Michigan, 1785–1860"; *idem,* "Antebellum Michigan Farmers and Their Soils: Yes, Choices Had Consequences," *ibid.* (forthcoming). The second of these two articles is an in-depth analysis of thirty-one Midland farmers cultivating different quality soils in 1860. The analysis in this section draws freely from this longer article.

Soil Survey of Midland County, Michigan (Washington, D.C., 1979), 1. The negative–positive ratio leaves out townships that had both negative and positive comments on their soils. Census enumerators also wrote their assessments of township soils in 1860. Midland's lone census enumerator (a lawyer) wrote that the soil in Midland Township was "of a dark sandy lose & gravel mixture." Ingersoll and Jerome townships had favorable assessments: "This township contains excellent soil for agricultural purposes." These comments appear at the bottom of Schedule 3 titled "Persons who died during the Year ending 1st June, 1860." Midland and Jerome townships had multiple other townships attached to them in 1860. The picture of swamps is consistent with the explanations that surveyors gave for not finishing their work on time. The field notes were made available to potential patentees.

32 *Michigan State Gazetteer and Business Directory for 1863/64* appears online in the Library of Congress' American Memory Series, *Pioneering the Upper Midwest: Books from Michigan, Minnesota, and Wisconsin, c. 1820–1910,* 111. Michigan Department of State, *Michigan and Its Resources* (Lansing, 1893), 259–260. An assessment in 1993 by Michigan's Department of Environmental Quality offered a contrary view, that the poorly drained portion of the county supported large swamps. See State of Michigan, Department of Environmental Quality, Office of the

Although Veatch did not comment specifically on Midland's soils, other soil scientists wrote that Midland's primary soils had "very low value for general farm crops" and that the minority soils consisted of "poorly-drained loam to clay loam" types, drainage being one of the principal requirements for the agricultural use of this land. Midland did not have the same attractions (soils, growing season, drainage, access to markets, etc.) enjoyed by lower-tier counties. However, the relative advantages and disadvantages of the county are not the concern of this study. Instead, the focus is on the relative benefits associated with cultivating different classes of soils.[33]

The USDA's Conservation Services report of 1979, *Soil Survey of Midland County, Michigan,* provided a detailed classification of the county's twenty-eight soil types combined into seven soil complexes. The survey team prepared two types and scales of soil maps, one for "detailed planning" and the other a "general soil map for broad land use planning." Both map types identified the soil complexes found in individual survey sections.[34]

Parallel to the soil classifications reported for the five states of the Old Northwest and for Michigan counties, the criteria used to classify Midland's soils were their potential for farming and their capability—that is, the degree of limitation on their use for agricultural purposes. Limitations were either "few," "modest," or "severe." Midland had only five of the possible eight capability classes; it lacked any soils "that have few limitations that restrict their use" and none of the two lowest-capability categories. Three of the seven soil complexes had "good potential," accounting for 30 percent (99,840 acres) of the county's 332,800 acres. Another two complexes had "fair potential," and the other two complexes had "poor potential."[35]

Great Lakes, *Historical Wetlands of the Saginaw Bay Watershed,* available at http://www.deq.state.mi.us/ogl/sagbay/histwet.htm.

33 Whiteside, Schneider, and Cook, *Soils of Michigan,* 41, 44. See Lawrence M. Sommers, *Atlas of Michigan* (East Lansing, 1977), 38, for the map of "Suitability of Land for General Farming." Although the map does not include boundaries, Midland appears to have nearly equal amounts of "Well Suited" and "Poorly Suited" land.

34 The seventy-three detailed maps of individual sections are at a scale of 1:15,840. The digitized form of this map can identify a soil type down to a three-acre parcel. The color-coded general soil map is at a scale of 1:190,080.

35 There are an estimated 70,395 acres of best soils (those with moderate limitations), all of which require "major management" attention be given to "wetness." The assessment of "potential" is given only for the seven map units used in the general soil map, which provides

The General Soil Map was used to classify each of Midland's 528 sections with regard to their primary and, as relevant, secondary soils, based on the seven categories used in this map. The resulting classification yields a gross categorization. Only the two predominant soil types are recorded. Of Midland's 528 sections, 42 percent had at least some good soils; even more sections (63 percent) had at least some poor ones.[36]

As expected, the good soils surveyed for the 1979 report had higher crop yields per acre, and the associated economic benefits, than did the fair and poor soils. These differences were based on "farm records and [on] field or plot experiments on the same kinds of soil" elsewhere. Other supportive evidence on inter-soil differences in the value of land comes from soil rental rates offered farmers under the Conservation Reserve Program administered by the USDA's Farm Service Agency under the Federal Agricultural Improvement and Reform Act of 1996 (as amended). Rental rates in Midland ranged from a high of $102 per acre to a low of $39 per acre. The rate scale follows the seven-category ranking introduced above (as well as the three general categories of good, fair, and poor).[37]

acreage numbers.The three soil complexes with "good potential" and "moderate limitations" were Lenawee-Bowers-Wixom, Parkhill-Londo, and Intersoll-Pella; the two with "fair potential" and "severe limitations" were Belleville-Wixom and Wixom-Belleville-Pipestone (79,872 acres); and the two with "poor potential" and even worse limitations were Kingsville-Pipestone-Covert and Cohoctah-Sloan (153,088 acres, a small number of which had limitations impossible to remove).

36 This approach still recognizes some variation of soils within sections that are absent in other studies. See, for example, Atack and Bateman, *To Their Own Soil,* 116–117, 175–179, 259–260; Gray, *Yankee West,* 179. However, the current approach is unable to identify what could be heterogeneous soil types within a particular farmer's cultivated acres—even within a single acre.

37 *Soil Survey of Midland,* 22 (Table 5 shows the yields per soil class for seven different crops). Thanks go to William Frederick and Wilbur Sears of the NRCS regional office in Midland who provided the supportive evidence in April 2002. This service also uses nine soil names for Midland's "Prime Farmland." All nine qualify as "prime farmland if drained." This program allows for an "Environmental Benefits Index" to be assigned to particular acres and an "erosion index" to be assigned to "cropped wetland" to yield an "erodibility index" and ultimately rental rates "based on the relative productivity of soils within each county, and the average of the past three years of local dry-land cash rent or the cash rent equivalent." For the procedures used to develop these indexes, see Sandra S. Batie, Mary A. Schulz, and David B. Schweikhardt, *A Continuation of Environmental Conservation Policy: The Conservation Reserve Program,* Staff Paper 97–16, Department of Agricultural Economics, Michigan State University (East Lansing, 1997), available at http://ideas.repec.org/p/ags/midasp/11519.html. Only Lenawee ($83), Bay ($80), Saginaw ($80), Gratiot ($75), and Monroe ($75) had average rates

The soils (classified in the 1979 report) cultivated by farmers in 1860 can be identified through the use of federal patents (the county's tract books) and county deed records, which provide the exact locations of farms according to their section and sub-section. Linking these sections to the soils in them is a straightforward procedure. Another helpful source is the detailed information from the enumeration sheets of the 1860 agricultural and population censuses. Nonetheless, soil information is available for only 43 percent of the county's seventy-two farms recorded in 1860.[38]

Thirty-one of these farms (69 percent) were cultivating "good" soils, which supported different crops and potentially greater income than the soils of their less fortunate neighbors. For example, 84 percent of the farms with "primary good" soils cultivated Indian corn, whereas only 27 percent of the farms without good soil could do so. This same pattern held for wheat—79 percent versus 33 percent. The Irish potato was the only crop grown on all of the farms. These same inter-soil differences appear in the value of market garden sales and the estimated dollar value of farm land. Of the farms with primary good soils, 32 percent had sales of $50 or more, whereas only 9 percent of the farms with no such soils had a similar level of income (the dollar figures refer to the agricultural year preceding June 1, 1860). Analogously, 47 percent of farms with primary-good soils were valued at $50 or more per improved acre; only 27 percent had the same value for farms with no such soil.[39]

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higher than Midland ($70.) The Midland rental rates derive from a table titled *Soil/Payment Rate Table—For CRP Bid Caps, 2000 Approved Dryland Rates,* Document ID EPEB50-R001, dated September 22, 2000. Fieldwork after 1979 found that the "soil delineation and map unit components" used in the *Soil Survey* "were accurate." This follow-up work provided a test of "reliability." The "validity" of the categorization ranking was provided by the yield and rental rate calculations (*Soil Survey Geographic (SSURGO) database* 8, available at http://www.ftw.nrcs.usda.gov/ssurgo/metadata/mi111.html until the NRCS replaced this link with http://www.mi.nrcs.usda.gov/soils.html).

38 I might have missed a small number of deeds because of the poor quality of the microfilms at a local Family History Center. The following Midland-specific FHC microfilm numbers in the United States, Canada, and the Caribbean series were reviewed: 0946176 Deed Index A–C, 1855–77; 09466180 Deed Records A–B, 1855–60; 0946179 Deed Records V, 1856–59; 0946184 Deed Records V, G–H, 1858–98; 0946181 Deed Records V. C, 1860–64; 0946173 Mortgage Index A–C, 1856–1902; 0946186, Deed Records K–L, 1852–1935; 0945495 Index to Mortgages, Vol. 1–2, 1836–81; 0946471 Calendar 1850–1900 Probate File # 5, 1873.

39 Estimations of per-acre yields are impossible due to the unavailability of relevant acreage figures. Some of this pattern for corn and wheat, however, could be an artifact of inter-

The effect of these inter-soil differences on economic welfare parallel those found at the state level and, to a lesser extent, the county level. Farmers probably had the same reason for settling in Midland Country as they had for leaving there in relatively large numbers—the failure to support their families on mediocre soils. Of the eleven farmers without any good soil, 73 percent had left Midland farms by 1870; only 42 percent of those whose soils enjoyed a primary-soil classification were absent from the 1870 agricultural census. Although these percentages are based on a small number of farmers, the relationships between soil and residential persistence is the same as that between soil, crops cultivated, and income from market garden sales. Farmers benefited or suffered from their choices of farmland.[40]

These Midland County findings address the extent to which soils attracted farmers and the overlap between soil and settlement patterns. The relatively low economic rewards realized from second-rate soils impelled those who farmed them to seek more promising opportunities elsewhere during the 1860s. Both a push to leave Midland and a pull from other farming areas were in operation. In the absence of new arrivals making unwise selections of soils, the settlement pattern over time would have overlapped the distribution of soils within the county. Notwithstanding the small

township differences not only in soils but also in the weather and ready access to nearby markets. Ingersoll Township in the far southeast of the county was close to Saginaw on the Tittabawassee River, which provided access to markets and services outside Midland County. All thirteen Ingersoll farms cultivated Indian corn and eleven cultivated wheat, whereas only one-third of the eighteen non-Ingersoll farms cultivated corn and just 39% cultivated wheat. All of Ingersoll's thirteen farms benefited from harvesting a crop that they did not plant, maple syrup; 44 percent of the farmers in other townships had this same income-generating resource.

40 Farmers with both large and small farms were likely to leave. Daniel Springstead, who had the largest farm (1,200 acres), left the county. Out-migrants also came from farms with different cash values. No doubt many farmers who left the county set up farms in places thought to have more opportunity for success than Midland. Yet, Midland attracted 154 new farms during the decade. In 1870, the county had 185 farms, 31 of which were also in the agricultural census of 1860. See *Statistics of the State of Michigan Collected for the Ninth Census of the United States, June 1, 1870* (Lansing, 1870), cxvii. Instead of the $100 threshold used for the 1860 agricultural census, a farm had to claim $500 in sold agricultural products to be included in the 1870 agricultural census. See Thomas Pressly and William Scofield, *Farm Real Estate Values in the United States by Counties, 1850–1959* (Seattle, 1965), 6 (Table 1). This pattern of mobility was not unique to Midland County. For example, Margaret Walsh, *The American Frontier Revisited* (Atlantic Highlands, N.J., 1981), reported, "Analyses of early decades of settlement in several parts of the Midwest point to a turnover of some 65 to 75 percent among farm operators" (65).

number of farms comprising this Midland research, soil types, crops sown, crop yields, economic yields from garden sales, the value of farm land, and farmers' staying power from 1860 to 1870 maintained a consistent relationship, revealing how soils shaped early settlement patterns.

If Hall and Ruggles were correct in their assumption that early and mid-nineteenth-century migrants were looking for rewarding economic opportunities, new farmer-settlers would have relocated to places where good unclaimed agricultural soils were plentiful. This assumed link between soils and settlement patterns, however, is based on another assumption—that soils can be classified according to their fertility. From this perspective, soils can serve as a surrogate measure of potential economic well-being. Did antebellum farmers incline toward locations with high-quality soils?

Although analysis at the first geographical level of the five states of the Old Northwest did not show an exact match in the rankings for farmer-settlements, soils, and farmers' economic performance, the top and bottom-ranked states were generally consistent in that regard. The evidence suggests (but does not prove) that the geographical concentrations of farms and good soils overlapped one another.

Despite the lack of reliable data on the economic performance of farms within the sixty-eight counties of Michigan's Lower Peninsula—the second geographical level in this study—evidence tends to support the assumed overlap between the distribution of soils and farm populations within the state. However, other influences, such as existing population concentrations, were also influential in the locational decisions made by antebellum farmers.

The best test of whether good soils attracted farmers requires information at a third geographical level—individual farms. Analysis of a small number of antebellum farms in mid-Michigan's Midland County demonstrates that good soils contributed greater economic benefits than medium or poor soils did. This finding is hardly surprising, but the linkages have seldom been confirmed for antebellum farmers. Although the Midland evidence does not contain information about the soil-selection criteria that new farmers used, farmers who worked the county's best soils had the

best chance of remaining viable from 1860 to 1870. Many of their less fortunate neighbors had to leave in search of more promising economic opportunities elsewhere. Their departure, in theory at least, would have contributed to a closer overlap between the spatial distributions of soils and farms. The ineluctable conclusion is that soils were a significant motivating factor in the locational decisions of antebellum farmers at the state, county, and intra-county levels.

APPENDIX: SOIL QUALITY AND FARM ACREAGE, BY TIER

Table A Breakdown of Soil Classes by Tier

TIER	NUMBER OF ACRES IN CLASSES 1 AND 2	PERCENT OF ACRES IN CLASSES 1 AND 2	PERCENT OF ACRES IN CLASS 4	COUNTY WITH HIGHEST PERCENT IN CLASSES 1 AND 2	COUNTY WITH LOWEST PERCENT IN CLASSES 1 AND 2
1	2,070,014	81	5	Lenawee (96)	Cass (61)
2	1,890,322	76	6	Washtenaw (85)	Van Buren (64)
3	2,238,769	79	7	Eaton (96)	Allegan (63)
4	2,855,876	86	4	Shiawassee (97)	Ottawa (65)
5	2,228,632	78	9	Sanilac (96)	Muskegon (24)
6	1,665,239	60	22	Huron (98)	Newaygo (28)
7	756,996	38	39	Osceola (55)	Lake (12)
8	640,658	29	42	Ogemaw (35)	Roscommon (12)
9	510,106	25	47	Grand Traverse (41)	Crawford (7)
10	632,637	40	32	Antrim (52)	Montmorency (22)
11	572,351	39	31	Charlevoix (46)	Emmet (27)

SOURCE J. O. Veatch, *Agricultural Land Classification and Land Types in Michigan,* Michigan State College, Agricultural Experiment Station Special Bulletin 231 (East Lansing, 1941), 63–65.

Table B Proportion of Farmland in Lower-Tier Counties

	50 PERCENT OR MORE OF THE COUNTIES' ACRES IN FARMS		PERCENTAGE OF TIER ACRES IN FARMS	
TIER	1850	1860	1850	1860
1	2/7	6/7	46	68
2	2/3	5/6	55	71
3	3/7	3/7	41	58
4	0	3/8	20	40
5	0	0	1	12
6	0	0	0	4
7 thru 11	0	0	0	2

NOTE Numerators in columns 2 and 3 refer to the number of counties with 50 percent or more of their acres in farmland. Denominators refer to the number of counties in the tier.