This is to certify that the

thesis entitled

The Conversion of Prime and Good Farmland

To Developed Uses in Southern Michigan

presented by

Steven Carl Bennett

has been accepted towards fulfillment
of the requirements for

M.S. degree in Land Use Planning

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Date 9-10-86

O-7639

THE CONVERSION OF PRIME AND GOOD FARMLAND TO DEVELOPED USES IN SOUTHERN MICHIGAN

By

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Crop and Soil Sciences

1986

ABSTRACT

THE CONVERSION OF PRIME AND GOOD FARMLAND TO DEVELOPED USES IN SOUTHERN MICHIGAN

By

Steven Carl Bennett

Aerial photographs were used to determine the amount of prime and good farmland converted to nonagricultural uses in southern Michigan between 1962-1978. The study area consisted of the 41 southern-most counties in lower Michigan. This area was divided into six regions based on 1980 county populations and general soil characteristics. The greatest amount of development in the study area occurred in Region 3 (containing Detroit, the nation's fifth largest metropolitan area) where 10 percent of the prime soils were developed between 1962-1978. Development totals for the six regions ranged from 0.3 to 10.3 percent on prime soils; 0.6 to 13 percent on good soils; and 0.9 to 6 percent on "other" soils. Overall, 3 percent of the agricultural acreage in the study area was developed between 1962-78.

To my pal Buck, and Dr. John Shickluna.
May they rest in peace

ACKNOWLEDGMENTS

I would like to thank Rod Stocking fom the ASCS office, Sherm Hollander from the Michigan Department of Natural Resources, and the Michigan State University Center for Remote Sensing Staff. Without their cooperation and assistance this study would not have been possible. I would also like to thank Dr. Milton Steinmueller and Dr. Larry Libby for their assistance in the development of this thesis.

A special thank you to Dr. Jim Stapleton who helped develope the sampling techniques; to Dr. Jim Crum for all of his trouble-shooting help and computer instruction; and to Wes Gaddis for his dedication to the research. Wes made the days enjoyable and I am thankful for the friendship that we developed.

I would like to thank my father, Carl Bennett, for his help with statistical problems and assistance in generating many of the ideas used in this study. More importantly, he was the example of a graduate student that I tried to follow.

I can not thank Dr. Del Mokma enough for all of his help and guidance. I learned a great deal from him and he forced me to learn a great deal on my own. Del treated all of his students as equals and provided an example for other major professors to follow.

I am very grateful to my wife, Kristy, who endured both her schooling and mine. Kristy provided a tremendous amount of support, help, and advice; if there was a problem I could always count on her for the right answer.

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INTRODUCTION

Prime Farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, and oilseed crops (Hilner, 1985). It can be cropland, pastureland, rangeland, or forest land, but not built-up land or in a water use. It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops using acceptable farming practices. Prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable pH, acceptable salt and sodium levels, few or no rocks, and good permeability to water and air. Prime farmland is not excessively erodible or saturated with water for extended periods of time. It does not flood frequently and is not protected from flooding.

Good farmland in Michigan is land that has physical and chemical properties capable of producing good yields of food, feed, fiber, forage, and oilseed crops. It has steeper slopes, greater wetness problems, lower available water, and higher production costs than prime farmland (Hilner, 1983). Prime and good farmlands are considered important for crop production at the national and local levels.

In 1976 the Soil Conservation Service (SCS) reported that 3 million acres of agricultural land were being converted annually to nonagricultural uses, an 82 percent increase from the previous decade (Brewer and Boxley, 1982). The annual cropland conversion was 675,000 acres, of which 32 percent was prime farmland (Sampson, 1981; Brewer and Boxley, 1982). The nonagricultural uses included roads, houses, businesses, airports, and water projects. Brewer and Boxley (1982) considered these uses irreversible. The SCS report, coupled with a dramatic increase in foreign export demand and the 1973 OPEC oil embargo, raised doubts about the ability of the United States to meet future demands for food and fiber (Huffman, 1981; Brewer and Boxley, 1982; Crosson, 1982a; Fischel, 1982). These uncertainties prompted the establishment of the National Agricultural Lands Study (NALS).

The National Agricultural Lands Study was conducted by the U.S. Department of Agriculture (USDA) and the Presidents Council on Environmental Quality (CEQ). The objectives were 1) to study the availability of the nation's agricultural lands 2) determine the nature, rate, extent, and causes of agricultural land conversion and 3) evaluate the economic, environmental, and social costs of agricultural land conversion (Sampson, 1981; NALS, 1981). The NALS used data from the SCS, the Census of Agriculture, the U.S. Forest Service, and the Economic and Statistics Service (ESS) to identify changes in major land uses (NALS, 1981).

The Soil Conservation Service collected land use information in the 1958 and 1967 Conservation Needs Inventories (CNI), the 1975 Potential Croplands Study (PCS), and the 1977 and 1982 National Resource Inventories (NRI) (McGill et al., 1981). McGill et al. (1981), Brewer and Boxley (1982), Fischel (1982), Raup (1982), and Frey (Easterbrook,

1986) identified a number of problems with the SCS studies and the NALS. Brewer and Boxley (1982) noted that the individual SCS studies were not comparable or comprehensive because they were tailored for specific SCS programs, the procedures were different, they were conducted at different levels of statistical and geographical reliability (McGill et al., 1981), and the perceptions of land use changed after the 1958 and 1967 CNI's (Raup, 1982; Easterbrook, 1986). Because of these differences, Fischel (1982) believed that the NALS (which relied heavily on SCS data) overstated the conversion of rural land to urban uses by a factor of 2 and probably 3 or 4.

The 1982 NRI (Easterbrook, 1986) concluded that earlier estimates of farmland conversion were "markedly overstated." Proponents of farmland preservation (Misseldine and Riggle, 1985; Reganold, 1986) however, continued to cite the 3 million acre per year figure (Easterbrook, 1986) reported by the SCS and the NALS.

The data base on agricultural land conversion is questionable (Brewer and Boxley, 1982; Fischel, 1982; Easterbrook, 1986). Methods used to collect the data contain many errors and the data reported by different agencies are not comparable. Proponents of farmland preservation, however, frequently cite the inadequate data, hoping to have farmland preservation policies adopted. The data base needs to be updated using highly objective methods designed to measure agricultural land conversion before any policy decisions can be made. The most efficient technique for gathering accurate land use data is by using aerial photography (Fischel, 1982; Easterbrook, 1986). The objectives of this study were 1) to develop an inexpensive, objective technique using aerial photography for measuring the conversion of agricultural land to developed uses, 2) to use this technique to measure the conversion of agricultural land to developed uses in southern Michigan between 1962[1] and 1978, and 3) to determine farmland conversion rates over a 30 year period in three representative counties.

LAND USE INFORMATION

Sources and Problems

Urban and Built Up Land was defined in the National Agricultural Lands Study (1981) as land used for residences, industrial sites, commercial sites, construction sites, railroad yards, parks of fewer than ten acres within urban areas, cemeteries, airports, golf courses, sanitary landfills, sewage treatment plants, water control structures and spillways, reservoirs, highways and roads, shooting ranges, and similar areas. This operational definition is used throughout this review.

The Soil Conservation Service provided land use information in the 1958 and 1967 Conservation Needs Inventories (CNI), the 1975 Potential Croplands Study (PCS), and the 1977 and 1982 National Resource Inventories (NRI). These studies have frequently been used to quantify land use changes over time (McGill et al., 1981).

The 1958 CNI was a two percent sample of nonfederal rural lands. The princicpal objective was to identify areas needing conservation treatment. The study examined 170,000 randomly selected primary

[1] Dates varied between 1958-64 (see Appendix A)

sampling units (PSU's) in the field. The average PSU was 160 acres. The data generated were statistically reliable at the county, state, regional, and national levels. The study excluded from field examination: urban and built up areas of more than ten acres, federal land (except cropland), and bodies of water (McGill et al., 1981; Brewer and Boxley, 1982; Raup, 1982). County records describing incorporated areas, maps, and U.S. Census data were used to obtain and check estimates of urbanized acreages in selected counties (Brewer and Boxley, 1982; Fischel, 1982).

The 1967 CNI was an update of the 1958 estimates. The principal objectives and sampling frame remained the same. The sampling rates, varied between one and eight percent nationally (McGill et al., 1981).

The use of county records (describing incorporated areas) as an enumeration technique may have caused errors in the CNI's (Brewer and Boxley, 1982). This method may have lead to overestimation of urban and built up areas since all land in the incorporated boundaries would be classified as developed, even if they were not. If this procedure were used for an entire state, however, unincorporated - built up areas would not have been included and, therefore, urban and built up areas would have been underestimated. The extent to which these procedures were used in the 1958 and 1967 CNI's is not known, thus both studies contain unspecified errors.

The 1975 Potential Cropland Study (PCS) was a 0.05 percent sample of the nation's nonfederal land. The principal objective was to quantify the potential for new cropland and to identify problems with bringing new land into production. A subsample of data points from the 1967 CNI was used. Five hundred-six counties were randomly selected nationwide, with each state having at least one county selected. There were less than 5,000 PSU's. District conservationists (who conducted the study) paid particular attention to land use changes since 1967, including changes to urban and built up uses (McGill et al., 1981; Brewer and Boxley, 1982; Fischel, 1982; Raup, 1982).

Some assumptions changed between the 1967 CNI and 1975 PCS (Easterbrook, 1986). In 1967 many 10 to 40 acre urban areas were classified as "other rural land", and then in 1975 they were reclassified as urban. This would result in an overestimate of urbanized areas (Fischel, 1982; Easterbrook, 1986). McGill et al. (1981) and Raup (1982) believed that the problem was most pronounced at the urban-rural fringe where there was scattered-lot, low density development. Fischel (1982) also noted that census data were not used to check urban area estimates, as was the case in the 1967 CNI.

The sample size in the PCS was too small and the statistical confidence limits too narrow for detecting urban uses and then expanding them to regional and national levels (Raup, 1982; Fischel, 1982). There were 41,000 sample points from 1967 revisited, but they were selected in such a way that there were nine sample points to each plot of land. The plots averaged 160 acres. The urban land recorded was 1.17 percent of the total area examined. This is 480 (.0117 x 41,000) urban or built up points. But most urban development typically takes up an entire plot (all nine points) so the true number of urban observations was closer to 1/9 of 480, or 53 (Fischel, 1982).

The 1977 National Resources Inventory was a one percent sample of all nonfederal land - both urban and rural. A wide range of concerns were addressed, including wetland availability, soil erosion, and potential wildlife habitat. The principal objective was to obtain data for long - range soil and water conservation planning and programming. There were 70,000 PSU's (ranging from 40-640 acres) randomly selected from every county in 48 states. The average PSU was 160 acres. Three points were selected as subsamples within each PSU (only two points were used in PSU's of 40 acres). A three percent subsample, or 210,000 points, was selected for on-site investigations. The investigations identified physical characteristics and changes in land and water area since 1970. The data were statistically reliable at the state, farm production region, and national levels (McGill et al., 1981; Sampson, 1981; Brewer and Boxley, 1982). Urban, built up, and incorporated areas of more than 40 acres were derived from recent USGS, highway, or planning commission maps of the respective counties. Aerial estimates of these uses of less than 40 acres were obtained from the PSU's (Sampson, 1981; Brewer and Boxley, 1982; Fischel, 1982). Bureau of the Census data were not used because they often excluded developments of less than 40 acres. The minimum population for a census Urban Place is 2500, and the area is seldom less than 600 acres (Fischel, 1982).

Fischel (1982) believed that the 1977 NRI procedures were biased and allowed overestimates of the rate of urbanization when compared to 1967 CNI procedures. (It should be noted, however, that the NRI did not calculate changes in agricultural land use since 1967; this was done in the National Agricultural Lands Study, which is discussed below). In

1967 the District Conservationists referred to U.S. Census data to check estimates of urban areas. Also, in 1967 all urban acreages were obtained from USGS, highway, or planning commission maps. In the NRI only urban areas of greater than 40 acres were measured from maps. A final source of overestimation occured where farmland was adjacent to urban areas (Fischel, 1982). In 1967 this land was excluded from the urban total. In 1977, this land was included in determining urban areas.

The 1982 National Resources Inventory was the most extensive study of natural resources on non-federal lands ever conducted by the SCS. It contained facts on 22 natural resource components, including wind and water erosion, the amount of prime farmland, the amount of potential cropland, and land use. There were 350,000 PSU's nationally. The average PSU was 160 acres with three subsamples taken from each. The information was statistically reliable down to the substate (multi-county) level (U.S.D.A., 1984).

Quantifying land use changes over time requires comparable measures of use at two points. The SCS studies are commonly used for this even though the data were not always comparable or comprehensive. The individual studies were tailored for specific SCS programs (Brewer and Boxley, 1982), the procedures were different (Brewer and Boxley, 1982; Fischel, 1982; Fischel, 1982), the studies were conducted at different levels of statistical and geographical reliability (McGill et al., 1981), and the perceptions of land use were different after the 1958 and 1967 CNI's (Raup, 1982). Fischel (1982) believed that measuring increments between the 1967 CNI and the 1975 and 1977 studies was inappropriate because of these differences, and large overestimates occurred. SCS personnel agreed that the data collecting procedures were different, but they did not believe that large overestimates resulted. McGill et al. (1981) noted that all data were collected under conditions of limited funding and personnel, but within those constraints SCS provided the most reliable sampling frame possible.

The National Agricultural Lands Study was conducted in 1979 by the U.S. Department of Agriculture (USDA) and the Presidents Council on Environmental Quality (CEQ). The objectives were: 1) to study the availability of the nation's agricultural lands; 2) determine the nature, rate, extent, and causes of agricultural land conversion; 3) evaluate the economic, environmental, and social costs of agricultural land conversion; and 4) recommend administrative and legislative actions, if necessary, to reduce the problem (Sampson, 1981; NALS, 1981). The NALS used data from different federal agencies to identify changes in major land uses. The sources included SCS, the Census of Agriculture, the U.S. Forest Service, and the Economic and Statistics Service (ESS) (NALS, 1981). Fischel (1982), however, believed the NALS relied exclusively on SCS data for reporting the conversion of rural land and the size of the agricultural land base.

The information in the NALS was fragmentary and, in some cases, inconsistent because the purposes, methods, and timespans of the data differed (McGill et al., 1981; Brewer, 1981). Fischel (1982) believed that the differences in procedures and objectives between the SCS studies should have precluded their heavy use in the NALS. He contended that the NALS overstated the conversion of rural land to urban uses by at least a factor of two and probably three or four. Fischel (1982) also believed that much of what the NALS called rural population increase was most likely located in high density suburban areas and unincorporated towns, which are truly urban even though unincorporated. Despite these shortcomings, the NALS was indicative of the land use problems in Illinois (Dovring et al., 1982), and Wheeler and Harper (1983) believed that no one had offered any data more reliable than the NALS estimates of farmland conversion.

The Economic and Statistics Service (ESS) assembled land use data in its Major Land Use Series (1949, 1954, 1959, 1964, 1969, 1974). The ESS did not generate its own data, however. It relied on data from agencies such as the Soil Conservation Service, the Bureau of the Census, the Forest Service, U.S. Geological Survey, the Bureau of Land Management, the Census of Agriculture, and the Crop Reporting Board (which is in the ESS) (McGill et al., 1981). The classification intervals coincide with the Census of Agriculture. The primary objectives were to interpret and reconcile current data generated by different agencies, relate the new estimates to earlier estimates, and produce a time series.

Problems with the ESS data include: 1) the acreage estimates were derived from reports made by the respective agencies and thus reflected the agencies' determination of land use; 2) the study was primarily an economic survey, not a physical one; 3) because Bureau of the Census data were used, communities with a population under 2500 outside of urbanized areas were not included (Boxley, 1981); 4) since estimates were based on a variety of sources, an overall statement of statistical reliabilty was not possible (McGill et al., 1981); and 5) inconsistencies in land use definitions occurred (McGill et al., 1981).

The Census of Agriculture was taken at five year intervals (1949, 1954, 1959, 1964, 1969, 1974, 1978) to provide a continual source of data on farmland characteristics (McGill et al., 1981). Some of the characteristics included the number of farms, total cropland, and total cropland harvested. These characteristics provided ecomomic and social information related to agricultural activities. Until 1969, data were obtained by personal interviews of land users. The current procedure is to send questionnaires to occupiers of land (McGill et al., 1981; Dovring et al., 1982).

The problem with the Census of Agriculture is that total land area is derived from deeds and leases (Dovring et al., 1982). The information in deeds and leases was based on measurements made at the time of the original rectangular survey. In Illinois this occurred between 1813 and 1849. These measurements contained many errors and were placed in platbooks. In Illinois the 1978 Census overcounted farmland by five percent in about two - thirds of the counties.

<u>Land Use Data</u>

The Potential Cropland Study determined that between 1967 and 1975 23.3 million acres of agricultural land were converted to nonagricultural uses, with an annual conversion rate of 3 million acres (NALS, 1981; Sampson, 1981; Brewer and Boxley, 1982) (Table 1). Approximately 16.7 million acres (70 %) were converted to urban and built-up uses, and 6.7 million acres (30 %) were converted to water projects. The total cropland loss was 5.4 million acres or 675,000 acres per year (Table 1). Sixty percent of the cropland was in SCS Classes I - III and 32 percent was prime farmland. During the same period, 48.7 million acres were converted to cropland. These figures represent an 82 percent increase in the conversion rate of agricultural land compared to the period 1958-67 (Brewer and Boxley, 1982).

Table 1 Agricultural Land Conversion Rates

SOURCE	DATES	TOTAL AG.LAND	ANNUAL AG.LAND	TOTAL CROPLAND	ANNUAL CROPLAND	HARVESTED CROPLAND	ANNUAL FARMLAND
----------------------Million acres---------------------							
SCS[1]	1958-67		1.9				
	1967-75	23.3	3.0	5.4	675,000 (thousand)		
	1967-77	25.0	2.5				
NALS[2]	1915-55					345	
	1956-72					289	
	1972-80					353	
CENS.[3]	1974-78			+18.2	+4.55		- 8.65
OF	1969-74			-17.1	-3.42		-10.70
AG.	1969-78			+ 1.1	+0.12		- 9.79

1 NALS, 1981; Sampson, 1981; Brewer and Boxley, 1982; U.S.D.A., 1982.
2 NALS, 1981.
3 McGill et al., 1981; Healy, 1982.

Publication of the SCS data was not governed by any established protocol to assure a clear statement of the results and their limitations (Brewer, 1981; Caughlin, 1981; McGill et al., 1981) According to Clark (1979), the United States lost 35,000 acres of its agricultural land base each week, land sufficient enough to feed 100,000

Latin Americans, Africans, or Asians for a year. Jeffords (1979) stated that if the decline in agricultural land continued, within 10 or 20 years the U.S. would lose its ability to feed the world and even its own citizens. Most of these statements assumed that 3 million acres of cropland were being paved over each year (Raup, 1982), not 675,000 acres, which was only 0.17 percent of the total cropland reported in the 1977 NRI (Brewer and Boxley, 1982).

The NALS reported an annual cropland conversion rate of 675,000 acres (Table 1) from a cropland base of 413 million acres (Table 2). The study identified approximately 500 million acres of federally owned agricultural land containing about 466,000 acres of cropland, and 1.36 billion acres of nonfederally owned agricultural land (NALS, 1981). One hundred twenty - seven million acres were identified as potential cropland. Thirty-six million acres had "high" potential and 91 million acres had "medium potential". Land with "high potential" had physical characteristics conducive to production, and similar lands in the area must have been brought into production within three years prior to 1975. Land with "medium potential" had favorable physical characteristics but higher erosion potential and conversion costs.

Table 2 **National Land Use Data**

Source	Dates	Harvested Cropland	Total Cropland	Urban & Built-up & Transportation
		----------------Million acres---------------		
SCS[1]	1958		448	51
	1967		438	61
	1975		400	78
	1977		413	90
	1982		421	47
NALS[2]	1955	345		
	1972	289		
	1977		413	
	1980	353		65
ESS[3]	1949	352	409	38
	1954	338	-	
	1959	317	399	50
	1964	291	-	
	1969	286	384	60
	1974	322	382	64
CENSUS OF AG.[4]	1949	345	478	
	1954	333	460	
	1959	311	448	
	1964	287	434	
	1969	273	459	
	1974	303	440	
	1978		462	
CROP REPORTING BOARD[5]	1949	352		
	1954	338		
	1959	317		
	1964	291		
	1969	284		
	1974	320		

1 McGill et al., 1981; Brewer and Boxley, 1982; U.S.D.A., 1982; Easterbrook, 1986.
2 NALS, 1981; Easterbrook, 1986.
3 McGill et al., 1981.
4 McGill et al., 1981; NALS, 1981.
5 McGill et al., 1981.

The NALS (1981) reported that acreages of harvested cropland remained stable between 1915 and 1955 at approximately 345 million acres. In 1956 these acreages began a seventeen year decline, falling to 289 million in 1972. Between 1972 and 1980 foreign export demand increased, and harvested cropland increased to 353 million acres (Table 2). These results, however, are not consistent with other data.

The Soil Conservation Service reported cropland acreage steadily decreasing from 448 million acres in the 1958 CNI to 400 million acres in the 1975 PCS (Table 2), with an annual conversion rate of 2.8 million acres (Table 1). Between 1975 and the 1977 NRI, the SCS showed cropland increasing to 413 million acres (Table 2) (McGill et al., 1981).

The Economic and Statistics Service reported a sharp decline in cropland from 478 million acres in 1949 to 465 million in 1974, with an increase in the late 1970's (Table 2) (McGill et al., 1981). Eighty percent of the decline occurred between 1949 and 1964.

The U.S. Bureau of the Census reported that from 1969 to 1974 the amount of land converted to nonagricultural uses grew at almost exactly the same yearly rate as it did from 1959 to 1969 (Table 2) (Healy, 1982). The annual conversion rate was about 1 million acres (Table 1) (McGill et al., 1981).

The Census of Agriculture indicated that between 1969 and 1978 over 35 million acres of cropland shifted out of and back into cropland, with about a one million acre net gain (Table 1) (NALS, 1981). Census of Agriculture data are often cited to dispute the NALS (Dovring et al., 1982).

The 1978 Census of Agriculture has 1.05 billion acres of "land in farms" with 460 million acres of cropland (Table 2) (NALS, 1981). The ESS reports 464 million acres of cultivated cropland in 1974 with 37 million acres of urban and built-up land (Table 2). The 1977 NRI indicates 413 million acres of cultivated cropland with 63 million acres of urban and built-up land (Table 2). These discrepancies were explained by differences in the definition and classification of data elements, differences in the geographic areas and land uses inventoried, and differences in the time periods covered (Brewer, 1981; McGill et al., 1981; NALS, 1981).

The 1982 NRI concluded that earlier estimates of farmland development were "markedly overstated." It reported an urban land total of 47 million acres and a continuation of the 1967 to 1977 cropland increase of 395 million and 413 million acres, respectively to 421 million acres (Table 2) (Easterbrook, 1986).

Zeimetz et al. (1976) conducted a study of the 53 fastest growing counties in the U.S. to identify land use changes. The study compared Agricultural Stabilization and Conservation Service (ASCS) 1:20,000 scale aerial photographs from 1961 and 1970. The selected counties accounted for 20 percent of the 1960 to 1970 population increase. The study found urban development occupied 16.4 percent of the land area in 1970, a 3 percent increase from 1961. Of the developed land, 35 percent was cropland; however, there were regional variations between 6 and 70 percent nationwide. The ten year increase in urbanization was 23 percent (3/13). The NALS estimated a 47 percent increase in urban area for the entire U.S. from 1967 to 1977. If all of the U.S.

population increases in the 1960's occurred at identical rates as the 53 counties in the Zeimetz et al. study, 427,800 acres would have been converted each year (Fischel, 1982). The NALS was aware of the Zeimetz et al. study, and Fischel wondered why the NALS failed to spend part of its 2.2 million dollar budget on updating the data.

The U.S. Geological Survey (USGS) is classifying the land area of the U.S. using high altitude (not satelite) photo mapping (McGill et al., 1981; Fischel, 1982). The study began in 1975, and in August 1980, four states were completed. County development patterns and state totals for urban areas of greater than 10 acres were compared with raw data from the 1977 NRI. The comparison indicated that the NRI estimates exceeded the USGS data by 29 percent in Pennsylvania, 41 percent in West Virginia, and 74 percent in Florida. In Kansas the NRI data were approximately the same as the USGS estimates. However, Kansas was classified by the SCS as having negative conversion of agricultural land between 1967 and 1977 (Fischel, 1982). The major discrepancies occurred in a few counties. Urban development, however, was concentrated in only a few counties. Therefore, a few overestimates in these counties could cause a significant overestimate for the state.

Michigan Data

Large regional variations in the urbanization of agricultural land were reported in the NALS Final Report (1981). Brewer and Boxley (1982) stated that the problems associated with cropland conversion occurred locally and regionally as well as nationally, and local and regional data were needed. They believed that national figures tended to mask more extreme situations at local and regional levels.

Land use data for Michigan were available from the 1958 and 1967 SCS Conservation Needs Inventories, the 1977 and 1982 SCS National Resources Inventories, the Census of Agriculture, and the Michigan Department of Agriculture (MDA). The MDA assembled land use data annually in its Michigan Agricultural Statistics which provide economic and production statistics for Michigan agricultural products. A summary of the data from these sources is found in Table 3. Misseldine and Riggle (1985) reported farmland conversion using Census of Agriculture and 1982 NRI data. They documented an annual prime farmland conversion rate of 120,000 acres between 1977 and 1982 (Table 3).

Table 3 **Michigan Land Use Data**

Source	Dates	Land in Farms	Urban Areas	Total Cropland
		------------Million Acres------------		
Mich. Ag. Stats.[1]	1958	16.0		
	1959		819 (thousand)	10.8
	1960	15.4		
	1965	14.1		
	1967	13.6		
	1975	11.8		
	1977	11.6		
	1978	11.4		
Census of Ag.[2]	1935	18.5		
	1945	18.4		
	1950	17.3		11.0
	1959	14.8		10.0
	1964	13.6		9.5
	1969	12.0		8.6
	1978	11.5		8.4
	1982	10.9		8.5
SCS[3]	1958		2.0	10.5
	1967		2.6	11.3
	1977		3.8	9.5
	1982		2.0	9.4

1 Mich. Dept. of Ag., 1959; Wright, 1974; M.D.A., 1976; M.D.A., 1978.
2 Wright and Caul, 1967; Wright, 1974; Wright, 1984; Misseldine and Riggle, 1985.
3 U.S.D.A., 1968; U.S.D.A., 1982; U.S.D.A., 1984.

CAUSES OF RURAL LAND CONVERSION

Population demographics contributed significantly to the conversion of rural lands (Brown and Beale, 1981; Brewer and Boxley, 1982). Between 1970-79, the population around urban centers grew at an average annual rate of 1.6 percent, while the annual population growth rate of inner cities was less than one percent. Between 1970 and 1978 nonmetropolitan areas averaged 10.2 percent growth compared to 6.1

percent growth for metropolitan areas (Sampson, 1981). Rural areas also experienced a significant growth rate, averaging 9.6 percent. From 1970 to 1976 2.3 million more people moved to nonmetropolitan counties than moved out of them. This trend was reversed from the 1960's when 3 million people moved out of nonmetropolitan areas (Brewer and Boxley, 1982).

Forty - three percent of the housing starts from 1970 to 1977 were in rural areas, and two - thirds were located on lots with septic systems. Lots with septic systems typically require more land than lots with central sewer systems (Brewer, 1981; NALS, 1981; Brewer and Boxley, 1982). The average size of a sewered lot was roughly 0.25 acres; the average size of an unsewered lot was roughly 2 acres (Brown and Beale, 1981).

There was a 22 percent increase in the number of households between 1970 and 1979 (NALS, 1981) and an increase in scattered - site rural development (Brown and Beale, 1981). Fischel (1982) did not believe that scattered-site rural development was a significant cause of rural land conversion. He stated "can one seriously argue that a single - family home on a multi-acre lot causes the entire area to be 'paved over or built up?'" Fischel (1982) failed to consider that efficient agricultural production requires large land units (Whiteside and Schaner, 1972).

Highways covered approximately 21.4 million acres of rural land in 1977, an increase of 458,000 acres from 1964 (Brewer and Boxley, 1982). Since most growth was prior to 1970, Brewer and Boxley (1982) did not believe that highway construction was a significant cause of the increased rate of rural land conversion reported by the NALS.

In 1979, about 1.5 million acres of land were disturbed by the surface mining of coal (Brown and Beale, 1981). Brewer and Boxley (1982), however, did not believe that surface mining of coal, or rights of way for energy use significantly contributed to the increased conversion of rural land.

INTERPRETING THE DATA

The problem with land use data is that the net effects of agricultural land conversion on total agricultural production are overlooked (Sampson, 1981). The data must be interpreted as a factor of 1) growth in demand for food, fiber, and land, 2) increases in crop yields, 3) quality and quantity of land in reserve, and 4) the cost of bringing that land into production (NALS, 1981; Sampson, 1981; Crosson, 1982b). There are many interpretations of these 4 factors.

Export Projections

Exports are the driving force behind expanding agricultural production and seem to determine the future demands for agricultural land (Huffman 1981). The NALS Final Report (1981) predicted the large agricultural export demand experienced in the 1970's to increase to 2000 and place most of the nation's 540 million acres of cropland into cultivation. These projections were made using the USDA - CARD model. In terms of volume, the NALS predicted that export demand could triple between 1980 and 2000. With little change in total cropland acreage, however, production in 1981 reached 92.5 percent of the NALS volume projections for wheat and 94.2 percent for feed grains. And in

1981/82 the percentages of production used for exports exceeded the 2000 projections for wheat and feed grains (Raup, 1982).

Export demand is dependent upon developments in exporting countries. Some countries, including Russia and the Peoples Republic of China, want to increase domestic food production and rely on imports only when domestic production is low (Crosson, 1982a). Heady (1982) reported projections from the National Research Council indicating that food production could double in developing countries by 2000; and in high income countries, grain production could be increased beyond current U.S. production, thus reducing foriegn demands upon the U.S. agricultural land base.

Yield Trends And Projections

Crop yield trends are viewed in many different ways. Some people believe yield growth curves are beginnig to flatten; others believe the curves are still increasing but at a rate paralleling the 1935 to 1955 period. Yield trends depend upon the time span viewed. In general, the shorter the timespan the more pessimistic the view (Heady, 1982). Yield trends based on observations made up to the mid - 1970's were the most pessimistic; observations made through 1981 were more optimistic. Healy (1982) saw no convincing evidence indicating yields have plateaued because yields and total productivity in the 1970's were drastically affected by fluctations in the weather. Crosson (1982b) indicated yield trends since 1972 decreased relative to the pre - 1972 period, but this did not mean that yield increasing technologies or production potentials were being achieved. Yields did not increase as rapidly partly because high energy technologies developed after 1972 were too expensive to use. Crosson (1982b) also noted that the increase in cropland acreage after 1972 was on poorer quality soils, so the flattening of the curves could be due to farmers switching from intensive to extensive management practices. Heady (1982) believed the differences betweeen average yields and record yields indicate that production potentials have not been achieved.

Crosson (1982a) pedicted yields of grain and soybeans to increase 1.2 percent from 1979 to 2005. He also believed that if yields continue to grow at the same rates, projected output could be met without increases in cropland acreage. Abel (1982), however did not expect any major technological breakthroughs in crop production in the near future; therefore, yields would not increase with rising export demand and more acreage would be needed (NALS, 1981). Boxley (1981) noted the U.S. will have adequate land resources to meet domestic needs for food, fiber, timber, and housing but foriegn demand must be considered.

There is uncertainty about the role of technology in increasing yields because of rising real prices for fertilizers and energy, and lack of unutilized water supplies for irrigation (NALS, 1981). The use of irrigation peaked in the 1970's and further - large productivity gains were not to be expected (Heady, 1982). Pump - irrigation use is slowing and is expected to decrease across the Great Plains as energy prices increase and water supplies decrease (Heady, 1982). The High Plains Study (Supalla et al., 1982), however, estimated that irrigated acreage in the Ogallala region will increase to 2000 and production of all major crops will increase by at least 50 percent. The study reported technology will increase crop yields and irrigation efficiencyallowing productivity increases at lower costs, despite declines in available water sources.

Real prices of energy and fertilizer are expected to increase production costs (Crosson, 1982b). The High Plains Study (Supalla et al., 1982) projected energy costs to increase from 1977 to 2020 by 137 percent for diesel fuel, 309 percent for natural gas, 112 percent for propane, and 94 percent for electricity. The cost of nitrogen is expected to increase by 66 percent of the increase in natural gas prices. Herbicide costs are expected to decrease by ten percent (in real terms) through 1990 and remain constant thereafter (Supalla et al., 1982). According to Heady (1982), agricultural demand for energy is very inelastic, except for pump - irrigated crops. So, in general, rising energy prices do not effect yields directly.

Other Demands For Agricultural Land

If energy prices skyrocket, the use of agricultural land for energy production could be extensive, such as the use of corn for ethanol production (Heady, 1982; Abel, 1982). The NALS Final Report (1981) predicted ethanol production to increase from 2.6 to 5.7 billion gallons between 1985 and 2000. Ethanol production became less optimistic in 1981, however, due to a decrease in petroleum consumption, the prospects of converting cellulose to ethanol, and the increasing use of methane from coal gasification (Abel, 1982).

The NALS Final Report (1981) predicted 12 million new households to be added to nonmetropolitan areas between 1977 and 1995, with a 62 to 75 percent increase in the suburban population by 2000. Brown and Beale (1981) predicted a sharp decline in the rate of household growth after

1985, with 2.5 million fewer households in 1995 than if the 1960 and 1970 rates persisted. Heady (1982) stated that if past trends in nonfarm uses of land continue to 2000, urban areas will occupy about 2 percent of the total U.S. land area - compared with 1.5 percent in 1969.

Many people assumed that the 1967-75 annual conversion rate of 2.9 million acres would continue to 2005 and take 80 million acres out of agriculture (Crosson, 1982a). But household formation is expected to decrease after 1985 (compared to the 1967 to 1975 rate) because adults from the post World War II baby boom will be getting out of household formation age (Brown and Beale, 1981; Fischel, 1982; Brewer and Boxley, 1982; Dovring et al., 1982; Heady, 1982). Also, the construction of roads, highways, and airports has slowed and Brown and Beale (1981) did not anticipate any significant expansions through 2000. Dovring et al. (1982) noted that low interest rates in the 1970's encouraged construction of homes, and in Illinois most of the urbanization was due to rising affluence rather than population growth. The high interest rates in the 1980's however, dampened construction of new homes. Heady (1982) believed that the increasing use of multi-unit buildings, slower population growth, and higher energy prices will dampen urban, transportation, and recreational demands for land.

CONCLUSION

Urbanization has affected farmland for decades. However, the loss of farmland did not become an issue until the USDA showed an increase in the number of acres harvested and, at the same time, the Soil

Conservation Service reported an increase in the conversion rates of agricultural land (Healy, 1982). This may suggest that the agricultural land retention issue depends heavily on the data base used those who collect and interpret the data may determine whether an issue develops. Some people obstensibly concerned about decreased food production, however, may primarily be concerned with the loss of amenity values - such as open spaces, and the preservation of rural life styles. Brewer (Easterbrook, 1986) noted that "when the false arguments about food production and urbanization are peeled away, what people are really saying is that they like to live in a rural setting and they don't want other people coming in." Concerns over the ability to feed a hungry world were voiced because they would draw political responses (Crosson, 1982a; Healy, 1982).

Land use data have primarily been examined from an agricultural point of view, with other land uses considered only as they infringe upon agriculture. There are different perceptions of land use between city planners and agricultural experts, especially at the urban - rural fringe. An agriculturist would probably call this area "urban". Conversely, a city planner divides urban land uses into many categories- with all residual areas being "rural" (Clawson, 1982).

The significance of farmland conversion depends on many complex factors, such as the quality and quantity of land in reserve, the cost of converting this land into production, possible new yield-increasing technologies, future demands for land and food, and the actual conversion rates (Sampson, 1981). Crosson (1982a) contended that the ability to produce food and fiber was not constrained by physical limits of the land because production can be increased at some cost. Therefore, the focus should be on products, not just acres (Healy, 1982).

The conversion of agricultural land as a resource problem is not a present day "crisis" (NALS, 1981), but it does pose some serious long - term risks to the resource base and food production. The NALS (1981) report stated that a resource problem was developing, but immediate incentives for conserving the resource were weak. Fischel (1982) believed that the NALS painted a pessimistic picture - - one that should be qualified; the problem is in the future (allowing ample time to correct it), data showing agricultural land conversion were not reliable, and factors that caused population decentralization were weakening.

Proponents of land preservation frequently cited the 3 million acres per year figure reported by the SCS "because it was impressive, ominous, and nicely rounded" (Easterbrook, 1986). The NALS assumed that this value was correct before work began and it was designed to support the premise that the United States was running out of land (Easterbrook, 1986). Economists Julian Simon, Michael Brewer, Robert Boxley, and William Fischel disputed the statistical claims of the NALS. They want more and better data before enumerating policies (Wheeler and Harper, 1983). Furthermore, many farmers suffering from low commodity prices conclude there is too much, not too little, farmland (Wheeler and Harper 1983). Even Associate Secretary of Agriculture John Crowell was doubtful (Little, 1984). Crowell saw no need to protect farmland because of present crop surpluses and the promise of new technologies to improve yields. Wheeler and Harper (1983) believed there was too much blind faith in technology. They conluded that the issue of agricultural land conversion was plagued with uncertainty. The only way to overcome this uncertainty is with good data on the conversion of agricultural lands.

STUDY AREA AND METHODS

The study area included the 40 southern-most counties in Michigan (Figure 1). This area contained 86.4 percent of the state's cropland acreage, 90.3 percent of the prime farmland acreage in cropland and pasture (U.S.D.A., 1984), and 91 percent of the state's population (U.S. Dept. of Commerce, 1982).

The study area was divided into six regions (Figure 1) based on population distribution and soil parent materials. Population distribution was the most important consideration because of its influence on the sampling rate (Figure 2). Population characteristics were obtained from the 1980 Census of the Population (U.S. Dept. of Commerce, 1982). Region 1 consisted of small towns with less than 5,000 people on lake plain soils with some moraines and till plains. The soils were primarily loamy. Region 2 contained the state's second most populated counties, with cities ranging from 2,000 to 80,000 people. The soils were loams and loams over sand and gravel. The landforms consisted of outwash plains, till plains, moraines, and lake plains. Region 3 contained the state's most populated counties and largest metropolitan areas. The soils were mainly loams or loams over sand and gravel. The landforms were lake plains, moraines, outwash plains, and till plains. Region 4 consisted of cities of less than 5,000 people, with each county containing a city of 6,000 to 10,000

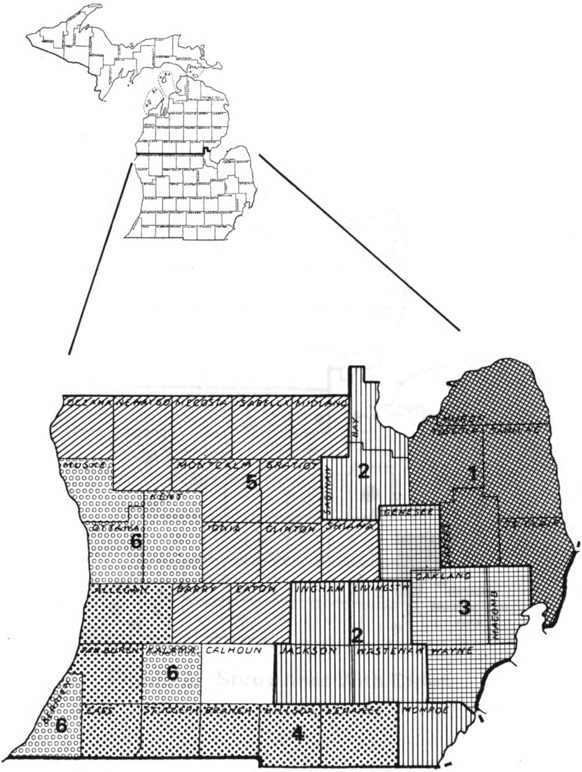

Figure 1. Study Area

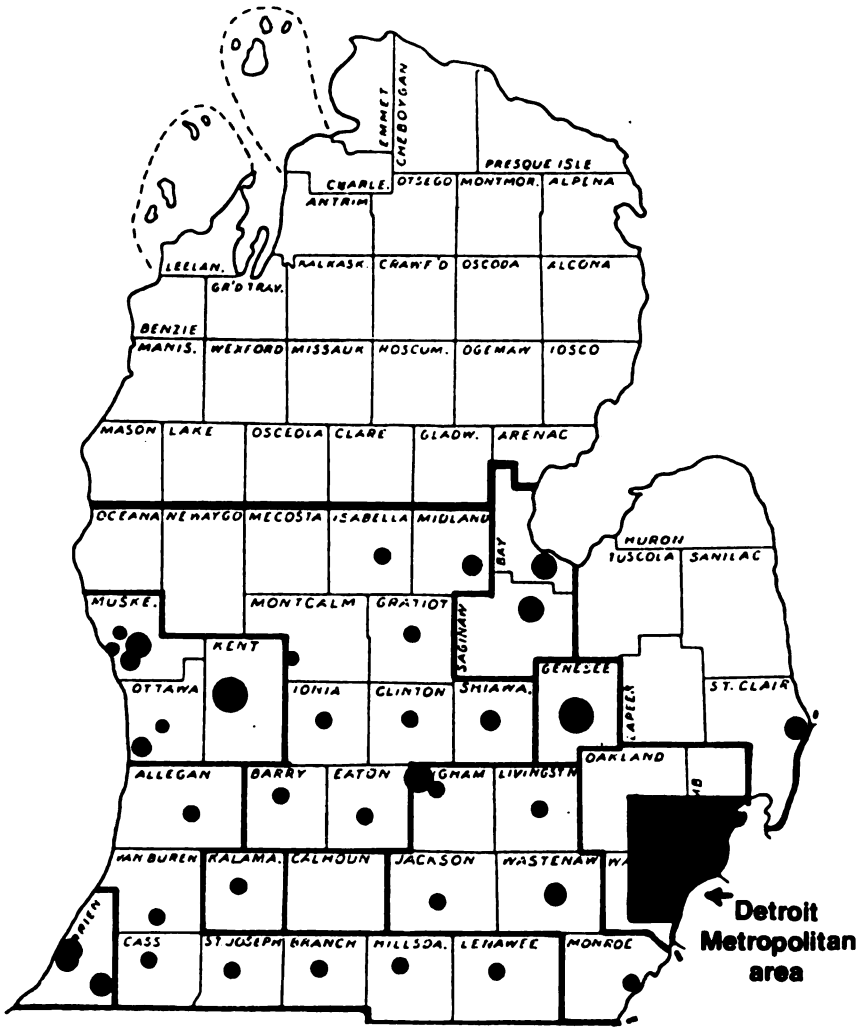

Figure 2. Study Area With Cities

people. The soils were loams and loams underlain by sand and gravel. The landforms were till plains, outwash plains, and moraines. Region 5 had the same population characteristics as Region 4. The soils in the northern and western portions of the region were sandy, and the soils in the southern and eastern portions were loamy. The landforms were primarily outwash plains, till plains, lake plains, and moraines. Region 6 had population characteristics similar to Regions 4 and 5, but each county contained a metropolitan area with 50,000 to 180,000 people. The soils were much sandier than those in Region 2, with some loams underlain by sand and gravel. The landforms consisted of moraines, outwash plains, and sand dunes.

Sampling

A stratified random sampling technique (Cochran, 1963; Kish, 1965) was employed using a section of land (640 acres) as the sampling unit. Stratification helped reduce the sample size (for a given level of error) by reducing the variability between samples. Each county was subdivided into strata using 1980 Census of the Population data (U.S. Dept. of Commerce. 1982). The strata consisted of:

Stratum 1: Cities $<$ 5,000 inhabitants
Stratum 2: Cities $\geq$ 5,000 inhabitants
Stratum 3: Townships $<$ 10,000 inhabitants
Stratum 4: Townships $\geq$ 10,000 inhabitants

with cities always being stratified first.

Cities and townships identified in the 1980 census were delineated on soil survey "index to map sheets" for each county (this made it easier to stratify and select samples). Stratum 1 consisted of sections containing town boundaries. Stratum 2 consisted of all sections within and adjacent to the city boundaries. Stratum 3 consisted of townships with less than 10,000 people. Stratum 4 consisted of 1) highly populated townships, 2) sections outside of large cities that were influenced by the city but not enough to be included in that stratum, and 3) large developments ($\geq$ 30 acres) such as highways, gravel pits, and land fills in rural areas.

Samples were selected in two steps. The first step was to consecutively number all strata in a region and randomly select a representative number of samples. The second step was to randomly select a section from each sample chosen previously. If a city or township was selected more than once during the first step, then the appropriate number of sections were selected in step two. Large lakes of $\geq$ 160 acres, and inner city areas were excluded from the sampling frame (areas that did not contain any agricultural uses in 1962).

Developed areas in 1962[1] were identified using Agricultural Stabilization and Conservation Service (ASCS) 1:20,000 or 1:15,840 scale black and white photographs. These areas were delineated on a soil survey map sheet. Michigan Department of Natural Resources (MDNR) 1978 color infrared (CIR) photographs were used to identify developments since 1962 . These areas were also delineated on the soil survey map sheet. The CIR photographs made it easier to detect land uses and thus 1 served as a check for 1962[1] interpretations. An attempt was made to use 1962 imagery for each county in a region, and every region, (except Region 5 and Wayne County in Region 3) had imagery dates within + or - 1 year (see Appendix A).

[1] Dates varied between 1958 and 1964 (see Appendix A)

Developed uses consisted of buildings (houses, businesses, factories, etc.), highways, mines, gravel pits, borrow pits, water bodies produced by digging (not flooding), parks, oil refineries, cut and filled areas, airport runways and buildings, trailor parks, golf course buildings, and other types of development that either paved over and compacted the soil, or left materials in the ground, thus making it too costly to convert to cropland. Water bodies produced by flooding were not included as developed areas because they could be drained. Parks were included as developed areas because they usually contained water lines, sewer lines, and electrical hook-ups.

Developed areas were delineated using square or rectangular boundaries unless a distinct curvilinear boundary was present. Yards were included with homes; highway right-of-ways were included with highways; and disturbed areas adjacent to new structures were included with the structures. Some assumptions were made in identifying developed uses, they included:

1. When sampling around cities, open spaces were considered to be developed uses unless agriculture was clearly the predominant use. To be concidered an agricultural use, open spaces could not be bordered on all sides by developed uses, or they had to show evidence of an agricultural use, and adjacent areas had to be in an agricultural use.
2. When sampling rural areas, all open spaces were given agricultural priority.
3. Only current land uses were identified, not intended uses.
4. Land uses were identified as "developed" or "open." Land use classifications were not made.

5. Areas classified in the soil survey as "made land," or "fill" were classified as developed.

6. The study considered prime soils rather than prime farmland. By definition, prime farmland must be in an agricultural or forestry use.

After delineating the developed areas, they were measured using a Lasico Polar Compensating Planimeter. Developed areas in 1962[1] and 1978 were recorded along with development on prime soils, good soils, and "other" soils. Any farmsteads destroyed since 1962[1] that had yards annexed to a field were subtracted from development totals. Prime and good soils were identified from lists provided by the Soil Conservation Service (Hilner, 1983; Hilner, 1985), and drainage was assumed for prime soils with a drainage requirement.

Total development since 1962[1] along with total development on prime, good, and other soils was determined using stratified random sampling statistical techniques (Cochran, 1963; Kish, 1965) and the computer program STRTRAN (Barrett and Nutt, 1975). The sample size was determined using optimum allocation (Kish, 1965; Barrett and Nutt, 1975) and the computer program STRTSIZE (Barrett and Nutt, 1975).

Determination of the sampling error was based on the amount of development between 1962[1] and 1978. An acceptable sampling error was 10-15 percent with 95 percent confidence. The sampling error was calculated by

$$2[s(yw)]/yw * 100$$

where

s(yw) is the total sample standard error of the mean

yw is the total sample mean

Three counties were selected to determine the rates of development between 1950 and 1978. Bay, Berrien, and Huron Counties were selected because imagery was available and they were considered to represent all regions. Huron County represented region 1; Berrien County represented Regions 4, 5, and 6; and Bay County represented region 2, and region 3 (but on a smaller scale).

[1] Dates varied between 1958 and 1960 (see Appendix A)

RESULTS AND DISCUSSION

Regional totals of agricultural land conversion within the study area varied from 10,614 acres in region 1 to 187,282 acres in region 3 (Table 4). These values were determined at 95 percent confidence with a sampling error of 10-15 percent, and show a direct relationship between the amount of development and the population of the regions.

Table 4 Total Conversion Of Agricultural Land Between 1962[1] - 1978

	-------------------Acres-----------------			
Region	*Total Area	Development	Confidence Limits	Population
1	2,463,144	10,614	8,591-12,637	343,049
2	2,772,205	95,890	83,003-108,777	1,274,651
3	1,388,726	187,282	158,530-216,053	4,494,733
4	2,789,664	30,074	25,500-34,648	426,158
5	4,531,223	64,352	54,763-73,942	622,537
6	1,912,744	98,770	85,006-112,533	1,142,923

In predominately rural areas (regions 1, 4, and 5) the largest source of farmland conversion was from cities of $\geq$ 5,000 people. These areas accounted for 41 percent of the conversion in region 1, 37 percent in region 4, and 44 percent in region 5. The second largest source of farmland conversion in these regions was due to low density housing on

[1] Dates vary between 1958-1964 (see Appendix A).

* Total area only included land areas mapped by SCS; therefore, lakes, urban areas, and pits are not included.

unsewered lots in areas away from towns (townships with less than 10,000 people). This type of development accounted for 37 percent of the conversion in region 1, 35 percent in region 4, and 41 percent in region 5. These results are consistent with those reported by Rossol (1982).

Table 5 Farmland Conversion By Population Distribution (Acres)

	Population			
Region	Cities < 5,000	Cities ≥ 5,000	Townships < 10,000	Townships ≥ 10,000
1	1,435	4,275	3,970	934
2	5,731	44,123	16,417	29,619
3	5,450	136,535	8,033	37,274
4	5,753	10,998	10,486	2,837
5	5,602	28,566	26,342	3,842
6	8,507	59,520	14,895	15,848

Conversion of prime farmland varied from 4,572 acres in region 1 to 81,847 acres in region 3 (Table 6). The conversion of good and other farmland varied from 3,909 and 2,133 (respectively) in region 1 to 63,091 to 42,254 acres (respectively) in region 3. These values indicate a direct relationship between the amount of development on prime, good, and other soils and the population of the regions. Between 1962[1] and 1978, approximately 231,500 acres of prime soils, 133,700 acres of good soils, and 121,900 acres of other soils were converted to non-agricultural uses in the study area. The sampling error for development on prime, good, and other soils varied more than for total development (as indicated by the confidence limits in Table 6) because the sampling rate was based on <u>total</u> development since 1962[1]. The 1982

[1] Dates varied between 1964 and 1958 (see Appendix A)

NRI (Misseldine and Riggle, 1985) reported a loss of 600,000 acres of prime farmland between 1977 and 1982. This value is much higher than 231,500 acres converted between 1962[1] and 1978 in the study area. The NRI estimate was for the whole state of Michigan, but the sample area in this study contained 91 percent of the state's population (U.S. Dept. of Commerce, 1982) and 90.3 percent of the state's prime farmland acreage used for cropland and pasture (U.S.D.A., 1984).

Table 6 TOTAL LAND CONVERSION BY SOILS BETWEEN 1962 - 1978

	ACRES		
Region	Prime	Good	Other
1	4,572	3,909	2,133
2	54,025	25,217	16,648
3	81,947	63,091	42,254
4	16,786	4,520	8,768
5	37,840	13,345	13,307
6	36,318	23,621	38,803

	Confidence Limits		
Region	Prime	Good	Other
1	2,929 - 6,222	2,639 - 5,180	1,178 - 3,095
2	42,834 - 65,216	14,948 - 36,199	8,738 - 25,272
3	53,450 - 109,687	39,615 - 85,809	17,232 - 59,276
4	13,477 - 20,096	2,306 - 6,377	5,425 - 12,111
5	30,062 - 45,619	8,136 - 18,504	6,826 - 19,697
6	25,911 - 46,725	14,309 - 32,948	25,510 - 52,108

Prime soils were developed more often than good and other soils (Tables 6 and 7). This was partly due to a greater proportion of prime soils to good and other soils (Table 8). In regions 2, 4, and 6 conversion was proportionate to the extent of the three groups of soils (Tables 7 and 8).

[1] Dates varied between 1958-64 (see Appendix A)

Table 7 Percentage Of Development By Soils

Region	% Prime	% Good	% Other
1	43	37	20
2	56	26	17
3	44	34	23
4	56	15	29
5	59	21	21
6	37	24	39

Table 8 Distribution Of Prime, Good, and Other Soils In Each Region

Region	% Prime	% Good	% Other
1	62	29	9
2	57	31	12
3	58	35	7
4	60	22	18
5	41	25	34
6	39	27	34

Less than 3.5 percent of the prime soils in regions 1, 2, 4, and 5 were developed during the twenty six - year period (Table 9). Approximately 5 percent of the prime soils in region 6 and 10 percent of the prime soils in region 3 were developed during this period. The percentage for region 3 was lower than expected considering the region contained 54 percent of the population in the study area and the fifth largest metropolitan area in the nation, Detroit (4,361,000 people) (Morss, 1986). The conversion of good soils to developed uses was the highest in region 3 (13 percent) and the lowest in region 1 (0.6 percent). Good soils in region 6 experienced approximately the same amount of development as prime soils in the region (Table 9). "Other" soils in regions 2 and 6 experienced more development than prime and good soils in the respective regions. In regions 1, 3, 4, and 5 development on other soils was less than 2 percent (Table 9).

Table 9 Percentage Of Prime, Good, and Other Soils Developed

Region	% Prime	% Good	% Other
1	0.3	0.6	0.9
2	3.4	3.0	5.1
3	10.3	13.0	0.4
4	1.0	0.8	1.7
5	2.0	1.1	0.9
6	4.8	4.6	6.0

Rates of farmland conversion in the study area were measured over different time intervals in three representative counties (Huron, Berrien, and Bay) (Figures 3, 4, 5 and 6). All three counties had a dramatic increase in development during the 1960's, and two of the counties (Huron and Berrien) showed a decrease in the annual rate of development in the 1970's (Figure 6). This trend is similar to that reported by the Census of Agriculture, ESS, NALS, and SCS (see Table 2). Imagery was not available for Bay County in the early 1970's; therefore, any decrease in the early 1970's has been averaged in with the increase in the 1960's. Conversion rates in region 1 are expected to be similar to those in Huron County. Conversion rates in regions 4, 5, and 6 are expected to be similar to those in Berrien County. Conversion rates in regions 2 and 3 are expected to be similar to those in Bay County, but conversion in region 3 would be of greater magnitude. Much of the increase in conversion during the 1960's was due to construction of the interstate highway system. By the fall of 1986, however, the interstate highway system will be completed in Michigan (Adams and Bailey, 1986).

There was a direct relationship between the amount of development and the population of the regions. In predominately rural

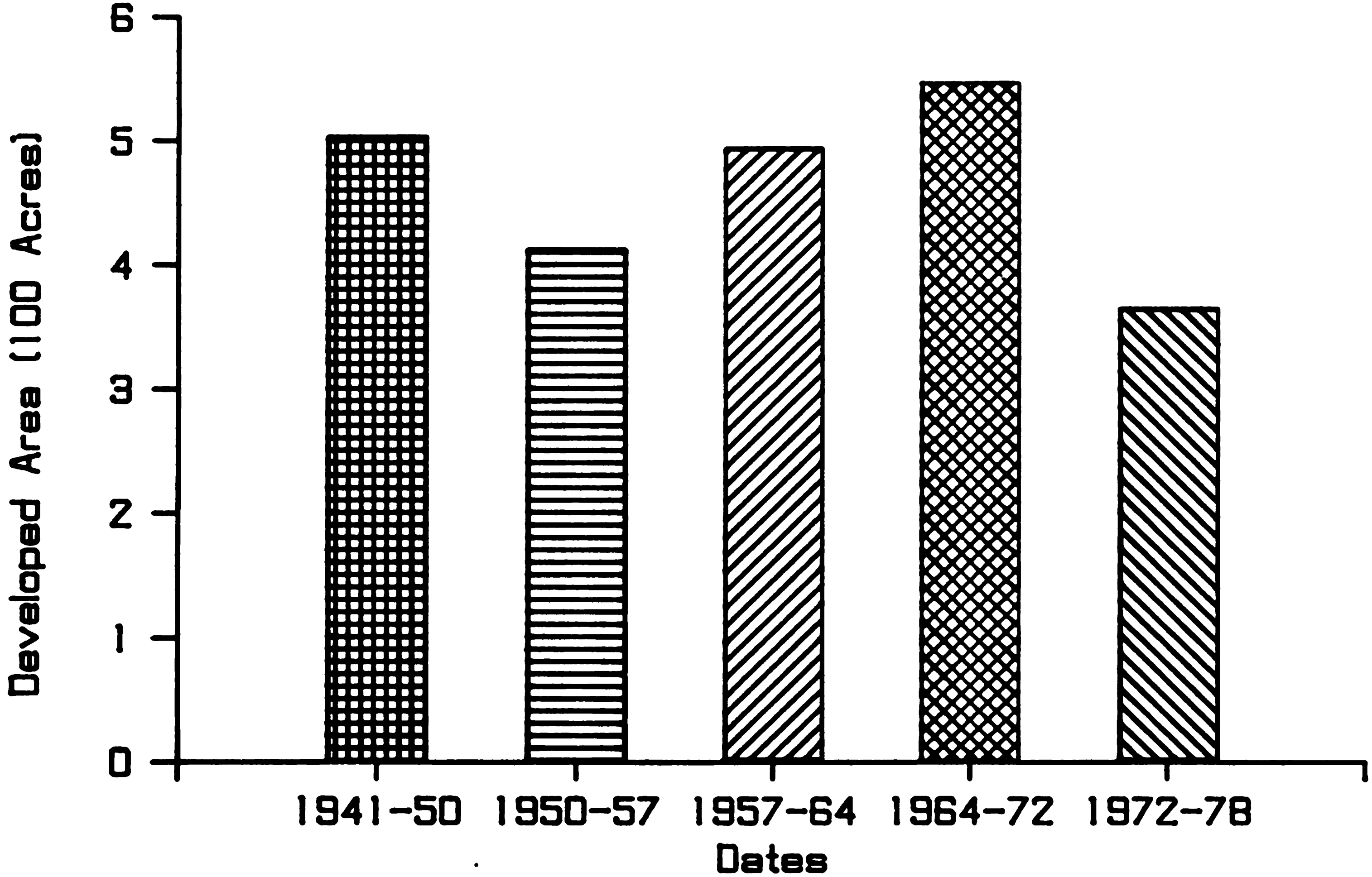

Figure 3. Farmland Conversion in Huron County

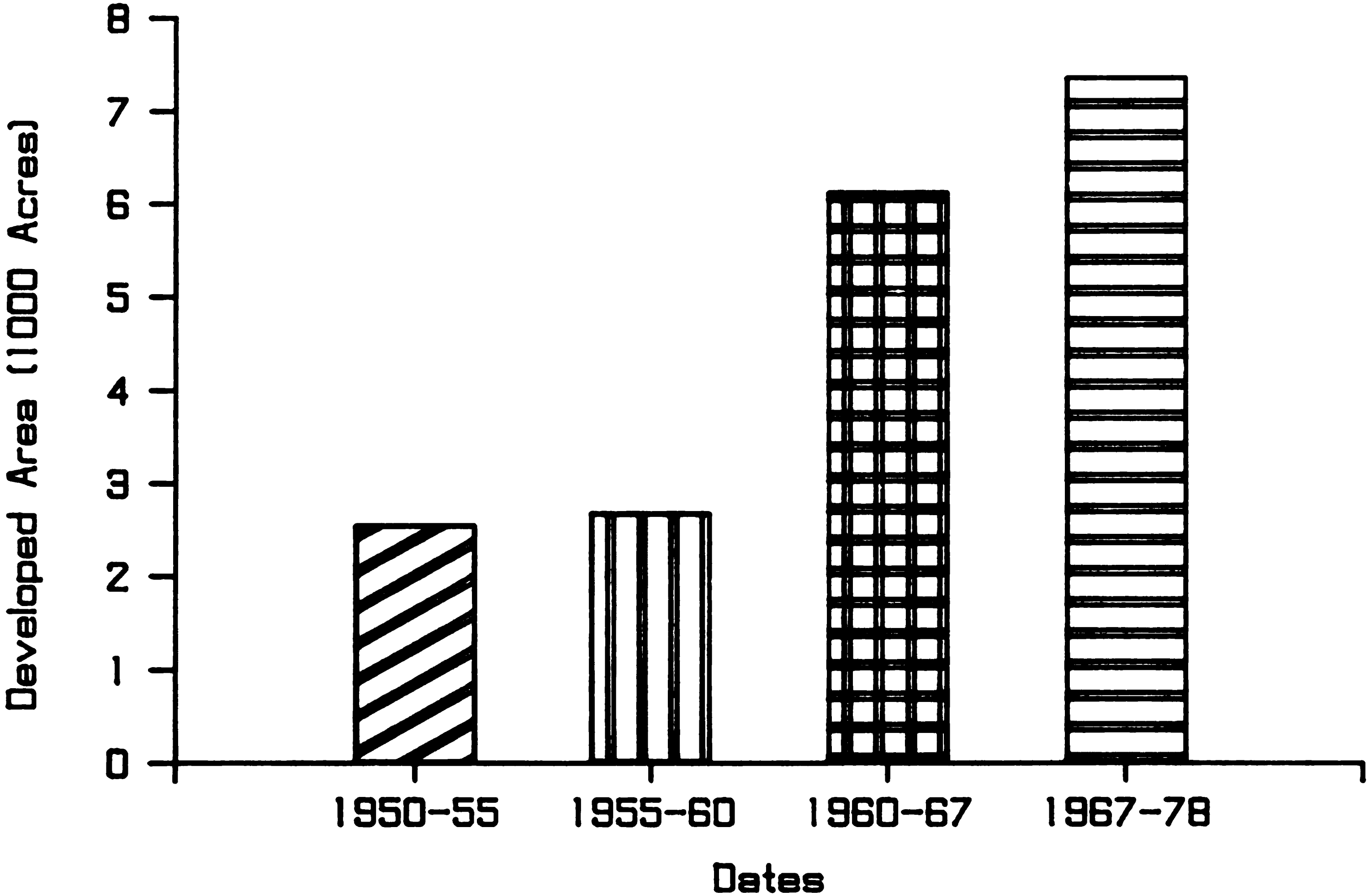

Figure 4. Farmland Conversion in Berrien County

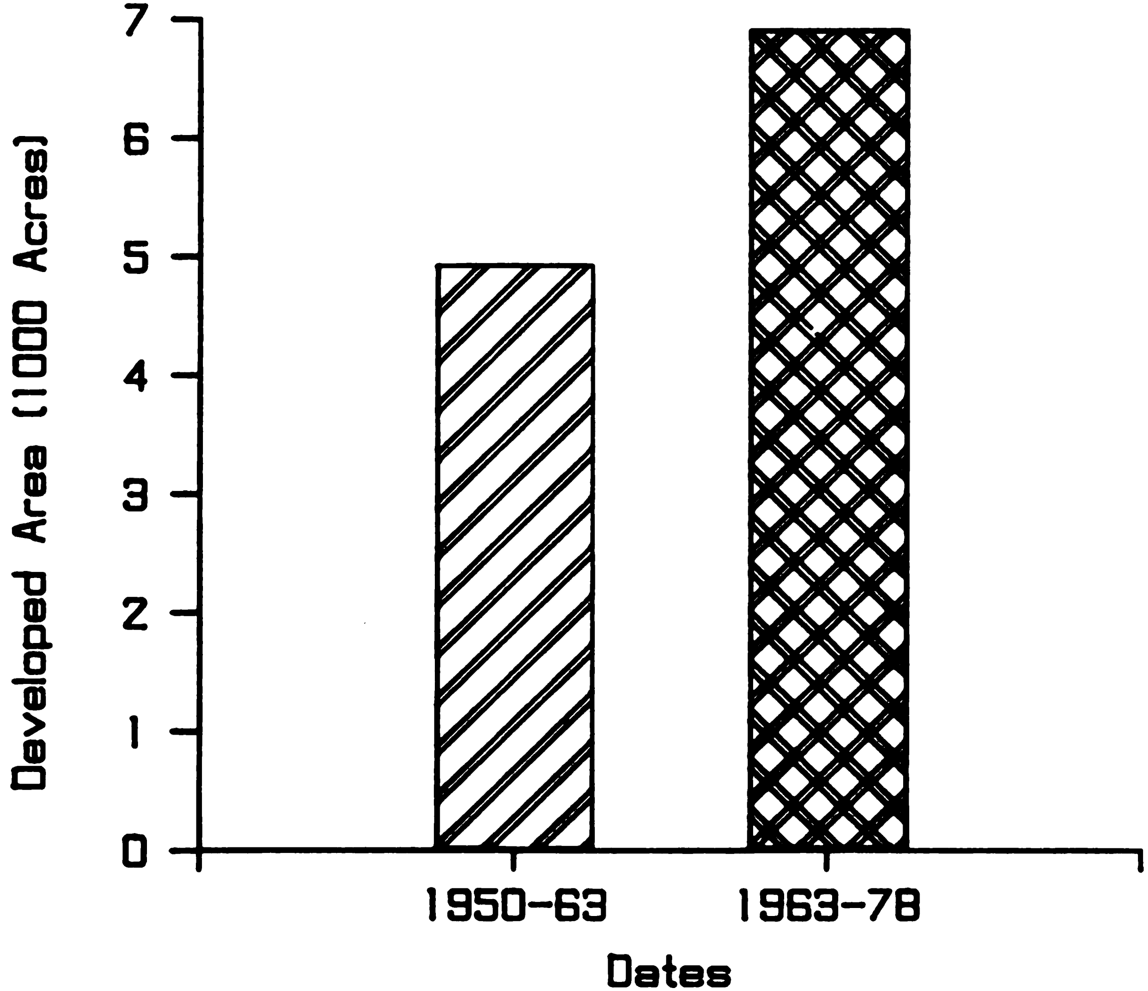

Figure 5. Farmland Conversion in Bay County

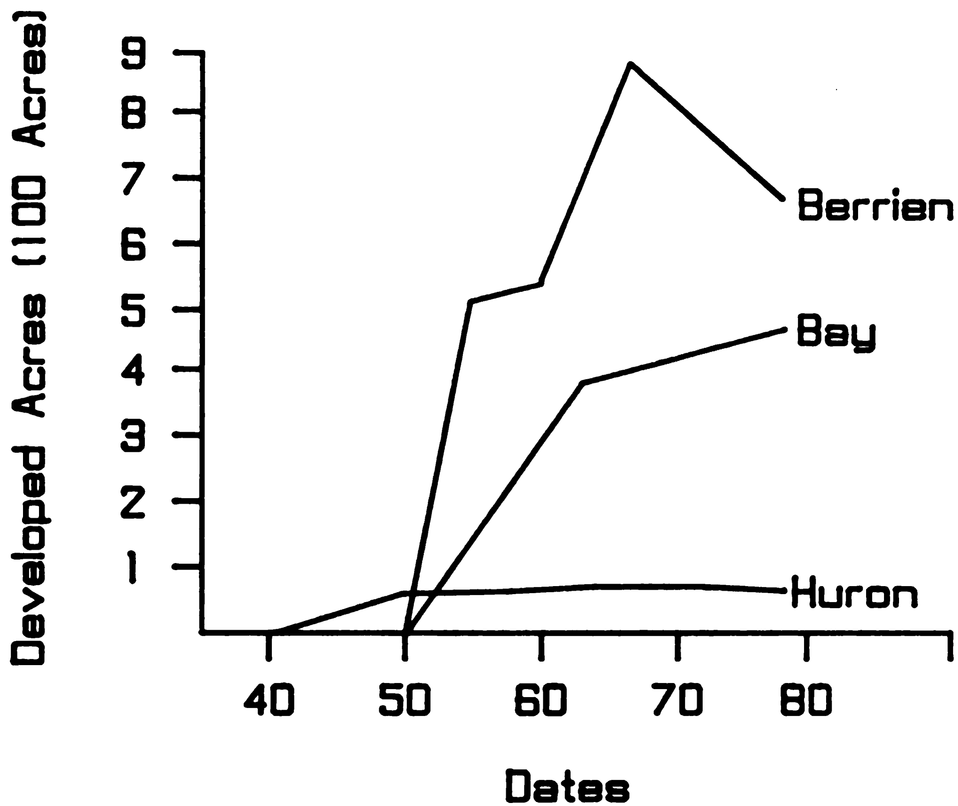

Figure 6. Annual Farmland Conversion Rates in Huron, Berrien, and Bay Counties

areas (regions 1, 4, and 5) however, 35 to 41 percent of the farmland conversion came from low density housing on unsewered lots away from cities. Ten percent of the prime soils and 13 percent of the good soils in Region 3 (containing Flint and metropolitan Detroit) were developed since 1962[1], the highest in the study area. With low amounts of prime and good soil development, the greatest amount of prime soil development adjacent to cities, a downward trend in the conversion rates of agricultural land, and 12,136,452 acres of prime and good soils undeveloped in the study area, it would be impractical to pass legislation protecting all prime soils, especially with 91 percent of the state's population (U.S. Dept. of Commerce, 1982) interspersed with 90.3 percent (U.S.D.A., 1982) of the state's prime soils used for cropland and pasture. If prime soils are to be protected, the focus should be upon low density housing on unsewered lots remote from towns. It should be noted, however, that even though the emphasis is on prime and good soils, other soils are used for crop production.

[1] Dates varied between 1964 and 1958 (see Appendix A)

CONCLUSION

It is possible to objectively and inexpensively collect and update data on farmland conversion using aerial photograph interpretation. This technique can be used at the local, regional, or state level. About 487,000 acres of farmland were converted to nonagricultural uses between 1962 and 1978, significantly less than earlier estimates. This is only 3 percent of the prime, and 3 percent of the good soils in the study area. Prime soils experienced more development than good and other soils. This was partly due to a predominance of prime soils. With large acreages of prime and good soils in the study area, coupled with a large population, slowing conversion rates, and small percentages of prime and good soil development, it would not be advisable to adopt legislation preserving farmland. Rural regions within the study area experienced large conversion amounts from low density housing on unsewered lots, remote from any towns. If farmlands are to be protected, however, this is where policy decisions should be targeted.

FUTURE RESEARCH RECOMMENDATIONS

There are three areas where additions could be made to the research. First, obtain the most recent imagery available to detect any changes in the amount and rate of agricultural land conversion. The sample size could be reduced by treating the study area as one population rather than six. To do this, imagery within a four year period would be needed for each county in the area.

Second, a stratification technique that takes into account soil properties could be developed to reduce the variability on the total conversion for each soil. If this is not possible, an area that contains a combination of the three soils should be sampled more heavily than an area dominated by one soil.

Third, analyze the data from both an economic and physical perspective. The economic analysis should focus upon both supply and demand for agricultural land.

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APPENDICES

APPENDIX A

Table 10 County Data Sources

County	Region	Imagery Date	Imagery Source	Number of Samples	1980 Popoulation	Soils Information
Huron	1	1964	P	25	36,459	Survey
Lapeer	1	1964	S	11	70,038	Survey
Sanilac	1	1963	M	12	40,789	Survey
St. Clair	1	1964	P	18	138,802	Survey
Tuscola	1	1963	P	11	56,961	Interim
Bay	2	1963	p	15	119,881	Survey
Ingham	2	1963	M	10	275,520	Survey
Jackson	2	1964	P	13	151,495	Survey
Livingston	2	1963	M	5	100,289	Survey
Monroe	2	1964	P	6	134,659	Survey
Saginaw	2	1963	M	9	228,059	Update
Washtenaw	2	1963	M	7	264,748	Survey
Genesee	3	1964	S	17	450,449	Survey
Macomb	3	1964	P	16	694,600	Survey
Oakland	3	1964	P	24	1,011,793	Survey
Wayne	3	1957	P	9	2,337,891	Survey
Allegan	4	1960	P	9	81,555	Interim
Branch	4	1961	P	9	40,188	Interim
Cass	4	1960	P	5	49,499	*Interim
Hillsdale	4	1963	P	7	42,071	Update
Lenawee	4	1963	M	11	89,948	Survey
St. Joseph	4	1960	P	12	56,083	Survey
Van Buren	4	1960	P	12	66,814	Interim
Barry	5	1962	P	4	45,781	*Interim
Clinton	5	1963	P	7	55,893	Survey
Eaton	5	1960	P	18	88,337	Survey
Gratiot	5	1963	P	9	40,448	Survey
Ionia	5	1960	P	5	51,815	Survey
Isabella	5	1958	P	6	54,110	Survey
Mecosta	5	1958	P	3	36,961	Survey
Midland	5	1958	P	4	73,578	Survey
Montcalm	5	1961	P	7	47,555	Survey
Newaygo	5	1958	P	5	34,917	Update
Oceana	5	1958	P	4	22,002	Update
Shiawassee	5	1963	P	18	71,140	Survey
Berrien	6	1960	P	15	171,276	Survey

Appendix A (cont'd)

Kalamazoo	6	1960	P	14	212,378	Survey
Kent	6	1961	P	14	444,506	Interim
Muskegon	6	1962	P	8	157,589	Survey
Ottawa	6	1962	P	10	157,174	Survey

P Photograph
S Soil Survey
M Photograph Mosaic (Index)
* These counties were partially mapped

Interim Reports refer to advanced soil map sheets for counties being mapped

APPENDIX B

Table 11 Soil Acreages by Region and County

REGION 1

County	Prime	Good	Other
Huron	348,665	84,795	94,140
Lapeer	227,344	154,789	36,347
Sanilac	429,742	160,870	24,061
St. Clair	270,143	179,279	22,099
Tuscola	251,064	128,249	51,557

REGION 2

County	Prime	Good	Other
Bay	194,845	49,875	39,810
Ingham	251,625	94,825	8,560
Jackson	190,870	222,085	38,030
Livingston	135,445	173,409	55,804
Monroe	260,009	55,545	38,260
Saginaw	338,752	71,168	107,328
Washtenaw	225,350	183,490	37,120

REGION 3

County	Prime	Good	Other
Genesee	286,936	82,583	22,453
Macomb	216,401	51,329	25,904
Oakland	199,830	245,280	43,505
Wayne	95,740	106,125	12,640