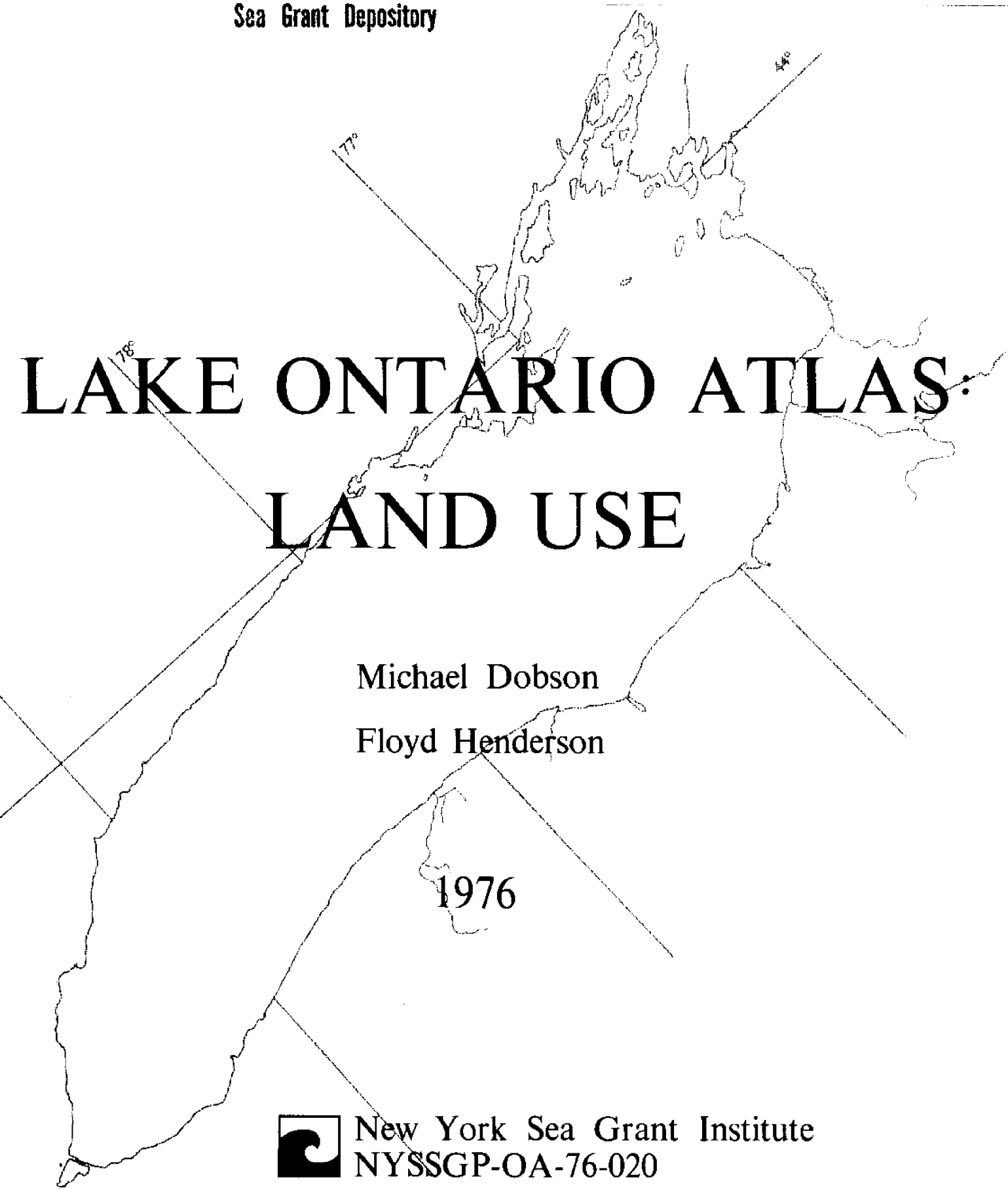

LAKE ONTARIO ATLAS

LAND USE

Michael Dobson

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1976

New York Sea Grant Institute
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LAKE ONTARIO ATLAS: Land Use

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LAKE ONTARIO LAND USE INFORMATION SYSTEM (LOLUIS): A Flexible Data Base for Inventory and Analysis of Land Activity Along the Lake Ontario Shoreline

Introduction

Inventory and conservation of our natural resources are assuming ever-larger roles as scientists attempt to allocate and plan for the future needs of an expanding population. Not only is it essential that we know what we once had but also what environmental assets we have currently and will possess in the years to come. Given the demands of a complex society this task is no mean feat. The challenge of acquiring current useable data about our environment, resources, and its myriad components is mind-boggling. Increasingly huge quantities of information must be gleaned from even larger expanses of raw data in an attempt to provide comprehensive data bases for land use--environmental planning.

While each area of the world has common problems and assets, they likewise differ in that every region also possesses unique resources at its disposal requiring particular attention and wise careful management. In New York State one such unique resource is Lake Ontario, or more specifically in this case the Lake Ontario shoreline. One of the most fertile agricultural areas of the state this area also provides tremendous land use potential for recreation, industry, electrical power generation, as well as the maze of urban land uses and functions. With such related, yet conflicting, demands on the land it is easy to understand the importance of the region and the need to have up-to-date, uniform information on what exists at present to wisely plan for the future. In short we must know how the land is presently being used in order to determine how it will and should be used. However, before we begin this analysis it is perhaps worth a brief pause to describe how this area developed into such a prominent position and view its physical attributes.

Physical Setting, Physiographic Development, Background

The land adjacent to Lake Ontario is the larger of the two physiographic regions that make up the Erie-Ontario Plains Province. Extending northward from the Heldeberg escarpment the province slopes gradually towards the shores of Lake Ontario. The Plain, although typified by low relief is noted for the presence of numerous drumlins that are scattered predominately between Rochester and Syracuse. On the east the Mohawk Valley Province and then the Tug Hill Province merge with the Ontario Plain.

The lake basin acts as a sink for a relatively large drainage basin. In this sense the rivers in the western portion of the plain flow north-northeast, northward in the middle plain, and west to northwest in the eastern portion. Three major rivers are of importance: the Genesee flows northward across the Ontario Plain from Pennsylvania; the Oswego flows towards the middle of the drainage basin (indirectly), the Finger Lakes, Oneida Lake, and part of the Tug Hill Province; the Black River draws the extreme east and portions of the Adirondacks.

Over 500 million years ago this area was covered by the waters of pre-historic seas. Sediments washed down from highlands deposited layer after layer of mud, silt, and sand on the sea bed. Over the following millenia of time climates gradually changed until some 50,000 to 100,000 years ago the seas were no longer. Instead the glaciers of the Ice Age advanced south into New York State. As the glaciers moved forward the ice dug into a preglacial valley of soft shales and sandstone that lay beneath present day Lake Ontario and carried the material along on its southward march. When the glaciers receded the western part of the scoured Ontario basin filled with ice melt to form Glacial Lake Iroquois. Waters from the lake flowed from the lake eastward along the Mohawk Valley. With a second advance of the glaciers this lake system disappeared, but a modified version re-emerged when the ice began to melt and retreat a second time. Still unable to drain down the ice-blocked St. Lawrence River the swelling waters created an enlarged Lake Ontario. Consequently, the Ontario Basin and the Champlain lowland were both inundated by the rising waters forming what was known as the Champlain Sea. Eventually, with further melting the receding ice allowed passage of the impounded waters down the St. Lawrence Basin to the sea and Lake Ontario began to assume its present size and shape.

As the glaciers melted, huge deltas and sand plains and beaches were left behind covering and replacing the outwash features previously found on the surface. It is these lacustrine sands that provide much of the rich soils covering much of the Lake Ontario shoreline today.

The underlying rock formations of the shoreline can be divided into three broad groups. Most of the area, from the western border of the state to the area near Oswego is underlaid by sandstones which show the usual tilt towards the south. At this point a shale and sandstone combination is found extending from the southeast corner of the lake to the area north of Pulaski. From Pulaski north to Cape Vincent and the junction with the St. Lawrence River limestones are the basic underlying formation and these show a slight westward tilt. On the surface the deposition and erosion processes have created diverse land form conditions along the shoreline (Thompson, 1966). The western half of the lake shore is dominated by lacustrine deposits manifested as a low-relief area. Slopes are generally less than two percent on these level plains. East of the area around Sodus Point to the area near Texas the land evidences more diversity. Moderate slopes of 9-18 percent are common and the local relief experiences changes in hundreds of feet. Around Oswego the land is characterized by poorly drained and swampy conditions. Near Pulaski one again finds rolling plains of low local relief and gentle slopes of 2 to 9 percent while the eastern shore of the lake is dominated by glacial drift and sand dunes at spots. In short, while some rolling relief is found the vast majority of the shoreline is similar to the western portion--level plains virtually absent of local relief.

Climatically the Lake Ontario shoreline can be divided into two dominant zones. North of Pulaski the eastern shore is typified by very cold winters and sunny summers. The winter mean temperature is less than -7°C (20°F) and the July mean temperature hovers around 21°C (69°F). Muddy wet springs are followed by a frost free period of 135-155 days. The south shore of the lake experiences warm, dry summers and cold snowy winters. As the prevailing winds come from the north and northwest this area commonly receives over 203 cm of snow (80 inches). The mean January temperature of -4°C (25°F) is contrasted by a summer mean of 22°C (71°F). From 150 to 180 frost free days are available for crop production. The role of these physical features in relation to man's settlement and use of the land is the subject of the following paragraphs.

Cultural Heritage

The first visitors to the Lake Ontario shoreline were undoubtedly the Indians. However, there is little evidence they found the area desirable. Only one or two settlements are known to have existed and those were at river mouths. Traces of small settlements near Rochester and around Henderson Bay and a relatively large cluster at the branches of the Sandy Creek near Ellisburg seem to comprise the extent of occupance by this cultural group. In settling New York the Dutch did not penetrate the area but confined their efforts to the Hudson Valley. Not until Fort Oswego was established in 1727 by the British was any permanent western settlement made. Much of the area was disputed in ownership by colonial state governments (the area from Sodus Bay west was once owned by Massachusetts). This fact, combined with the pioneer opinion of the shoreline as too swampy and gravelly to be productive, retarded settlement. People by-passed it and headed west along the more accessible and familiar Mohawk River Valley for much of the 18th century. A few serious settlement efforts did begin in the 1790's but virtually all communities along the shoreline were founded after 1800. Then, settlement of the Genesee Valley quickly resulted in the rise of the city of Rochester in the 1820's.

Even then political unrest with the British precluded any serious efforts to settle the area. An opinion somewhat justified when one recalls that Sackett's Harbor was the scene of a major battle in the War of 1812. Moreover, owing to the absence of adequate transportation routes to U.S. markets communities depended upon Montreal as a commercial outlet--a definite unsettling factor in those times.

Perhaps it was the Erie Canal that acted as the first true catalyst to population growth for the area. The non-swampy portions of land and those soils absent of large gravel content first were found to be productive wheat-growing areas. Settlers arriving after 1800 relied on this crop and began to look for a milling center to process and market their grain. The cities of Rochester and Oswego grew in response to this demand aided by canal construction, the latter city constructing a feeder route to the Erie Canal. As a result the south shore became a major wheat producing region through the 1840's and 1850's. However, the canal, along with the western settlement movement also provided impetus to the

rise of Buffalo, so much so that by 1855 the Ontario region was considered an old wheat region. The more fertile soils of Ohio and Indiana were producing more wheat and shipping it to Buffalo for milling. Rochester lost its position as a regional producer when transportation economics precipitated the rise of the more market accessible centers of Buffalo, Oswego, and Fulton.

With the decline of wheat as a cash crop farmers of the area began to look to other crops for income. It was not long before the climatic advantages provided by the lake were realized in the production of fruit. The 1850's and 1860's saw the emergence of the Niagara-Ontario fruit belt. The well-drained soils were found to be ideal for peaches, cherries, plums, pears, and apples. The problem of adequate transportation to market was solved with the construction of the Lake Ontario Shore Railroad. Oswego, Rochester, and Sodus Point became termini for railroad traffic from southern New York and Pennsylvania mining areas to Canada. Now the farmers could rapidly ship their produce to the expanding urban markets to the south and east. However, improved access and continued western expansion saw the wane of Oswego as a flour center. Fortunately at the same time a rise in a need for dairy products came from the eastern cities. Recognizing the advantages and limitations of soils and climate along the eastern lakeshore farmers north of Oswego turned to dairying for their livelihood.

Today, these agricultural positions have been maintained and strengthened to such a degree that the shore area can be characterized as parts of three major agricultural regions in the state. From the mouth of the Niagara River east to the area around Oswego a vegetable and fruit agricultural economy has evolved. The intensive land use involved in the production of these crops negates the need and practicality of large acreages. Farms average in the neighborhood of 44.5 hectares (110 acres). Breezes coming off the lake play a critical role, by retarding premature budding of the fruit trees in spring until the danger of a late frost is past. In the fall the warm breezes act to prolong the growing season. In the area from Oswego north to Sacketts Harbor a mixed farming economy exists. The growing season is shorter than the previous region, and snowfalls of 254 cm (100 inches) annually, in combination with soil characteristics, have led to drainage problems in some areas. Dairying is the primary activity here with some fruits and vegetables being grown where soils permit. The remainder of the lake shoreline north to the conflux with the St. Lawrence River is part of a region devoted almost exclusively to dairying. Forage crops of grass, hay, and permanent pastures support this effort. Farms are somewhat larger than previous areas (75 hectares - 185 acres) as the land is used much more extensively. Distance and access to markets as well as climatic and soil factors seem to preclude other types of farming. No foresting of import exists along the shore but some tree farms are being established in Jefferson and Oswego counties.

In contrast to the agricultural importance of this area some mention should also be made of the effects of urbanization. The lake cities of Rochester and Oswego are the two major concentrations located on the shore, but the proximity of Watertown and the Buffalo metropolitan area has certainly been felt. No heavy industry is found in the two lake cities, but light manufacturing and services are large employers of people and space. Expanding needs for housing have and are occupying increasing amounts of land. In addition the lake is seen as an ideal location for power generation sites, particularly nuclear facilities. The concentration around Nine-Mile Point is probably one of the heaviest in the world. Last, the amenities and potential of the lake for recreation is being seen as ever more desireable. Thirteen state parks can be found along its shores, and second home/recreation cottages are being built and purchased by many seeking respite from city life, at least for a short period in the summer.

From this brief characterization it can be readily seen that the Lake Ontario shoreline has had a significant impact on the economy and peoples of New York State. Moreover, its importance will only continue to increase in the future. But as its role increases so does the diversity of demands on this finite area of land. Agriculturalists seek to maintain existing acreages in production and perhaps even expand in order to compete in the economic market and satisfy a rising demand for their product. Urbanized areas constantly seek room to expand for business as well as homes. As they seek to supply demands for heat and electricity, power companies view the lakeshore as potential sites for the power generators. Recreationists probe the coast for new sites to "get away from it all" in the great outdoors. Within each of these group's ranks, as well as external to them, another special interest group can be found--those who are heedful of the physical alterations of the shoreline occurring as a result of man's activities. Conservationists and environmentalists are concerned that the fragile eco-system of the lake shore may be adversely altered unless wise planning is practiced and allowance made to preserve at least some of the area in its natural pristine existence.

In order to meet any or all of these interests and needs the first element needed is an accurate analysis of what types of activities the land is currently being used for. Only then can rational valid assessments be made of how the land is changing and how it should be used in the future. It is the purpose of this study to provide at least part of this critical data base by inventorying the land use along the Lake Ontario shoreline. More importantly, its purpose is to record these data in such a manner that it can be updated and adapted to the needs of the myriad decision-makers involved in the shoreline's future. The remainder of this paper is devoted to the methodology employed, the results compiled, and the development of a land use information system for the area.

Study Area

Exactly what area constitutes the shoreline or coastal zone of a water body has been the subject of great debate. In short it appears the definition depends on the proposed use and type of data desired. For those users concerned primarily with beach erosion processes and wave motion the litoral zone seems to be preferred. On the other hand, those researchers concerned with the broader aspects of water pollution and stream flow have suggested that the entire watershed(s) draining into the lake be considered as the proper areal unit. For this study the Lake Ontario shoreline was defined as the area extending six kilometers inland from the lake. This area is probably the most susceptible to the diverse pressures exerted by developers, recreationists, and expanding urbanized places seeking lakeshore properties. Although narrower or broader limits could be equally justified six kilometers was selected as a workable compromise. Thus the study area encompassed land uses from the Niagara River on the west (the New York State border) to Cape Vincent on the northeast (the point where Lake Ontario abuts the St. Lawrence River) and extended from the lakeshore six kilometers inland (see Figure 1).

Land Use Categories

The land use categories were defined after considering: (1) the nature and types of information sought at a regional or county wide level, (2) the scale and resolution limitations of the imagery, (3) previous work and recommendations of authors of earlier works (Nunnally & Witmer, 1970; Kodak, 1974; Anderson, 1971), and, (4) the desire to incorporate any data into an automated land use information system. Based on these factors the following fourteen land use categories were created as a modified version of Level I and Level II categories appearing in USGS Circular 671 by J. Anderson, et al., 1972.

Code	Type
11	RESIDENTIAL--Residential land uses range from high density (e.g., multiple-unit structures) to low density housing. Linear residential developments along transportation lines extending outward from urban areas are also included. These strips usually have a uniform size and structure spacing with linear drives and lawn areas. Housing on military bases and colleges and universities are not included.
12	COMMERCIAL, INDUSTRIAL, AND STRIP--Commercial areas are used primarily for sale of products and services. Principal components include central business districts, shopping centers, commercial strip developments along roadways. Commercial areas may include some non-commercial uses too small to be delineated. Industrial areas include light manufacturing, heavy manufacturing, and industrial parks. Strip development is found along transportation routes, and in smaller villages, cities, and built-up areas where separate land uses are indistinguishable. Residential,

commercial, industrial, and institutional uses may be included. Farmsteads intermixed with strip development are also incorporated into the class.

14 EXTRACTIVE--Extractive land encompasses surface mining operations such as sand and gravel operations and stone quarries, surface equipment, storage and loading facilities, and spoil material.

15 TRANSPORTATION, COMMUNICATION, UTILITIES--Highways include areas used for interchanges, limited access right-of-way, and terminal facilities. Rail operations include stations, parking lots, roundhouses, repair, and switching yards. Airports include runways, terminals, parking lots, fuel and equipment storage, and a buffer zone. Communications and utilities involve the generation and transport of water, gas, oil, and electrical power. Transmission and transportation lines are generally excluded unless of extensive width.

16 INSTITUTIONAL--Education, religious, health, correctional, and military facilities are classified by this category. All buildings, grounds, and parking lots that compose the facility are considered part of the unit. Small institutional units (e.g., some schools and churches) failing to meet minimum area requirements are incorporated into residential or commercial categories.

17 OPEN SPACE AND RECREATION--This category consists of golf courses, some parks, cemeteries, and undeveloped land within an urban setting.

21 CROPLAND AND PASTURE--Activities in this land use designation are harvested and cultivated cropland, summer fallow, idle cropland, land in grasses and legumes, plowed fields, and all forms of pasture. With single flight coverage it is extremely difficult to identify the types of cropland or separate cropland from pasture.

22 ORCHARDS, GROVES, VINEYARDS, AND HORTICULTURAL AREAS--These areas produce the various fruit and berry crops found in the study region.

23 SPECIALIZED AGRICULTURE--Feedlot farming operations and nurseries compose this category. Feedlots are defined as large livestock production, poultry farms, and fur-bearing animal farms. Feeding operations in conjunction with other farm operations are not included. Nurseries consist of large floricultural areas, seeded shrubs and garden plants, and greenhouse operations.

24 FOREST SCRUB--This land is not in productive use and is characterized by the presence of brush, regrowth or volunteer vegetation, and abandoned, overgrown orchards.

30 FOREST AND WOODLAND--These are lands that are at least ten percent stocked by mature trees capable of producing timber or other wood products. Included are areas of coniferous, deciduous, and mixed forest in the form of woodlots, isolated stands, and riparian vegetation.

50 WATER--All areas predominantly and perennially water covered embody this category. Included are streams and rivers, lakes, reservoirs, and bays. Sewage treatment and water supply facilities for urban areas are excluded.

60 WETLANDS--Seasonally flooded basins and flats, marshes, swamps, and bogs embrace wetlands. These are usually areas of standing water and associated low vegetation on level areas. Owing to the seasonality of this phenomena some areas may be omitted when only single imagery coverage is employed.

72 BEACHES--Beaches are smooth sloping accumulations of sand and gravel along the shoreline. The beach category is not employed if another more dominant category is visible (e.g., vegetation or recreation).

Methodology

The first step in creating a comprehensive land use information system is the design of a uniform data base. Typical of many areas of the country land use information of the Lake Ontario shoreline does exist in assorted forms and levels of complexity, but no overall inventory is available of the entire area except as part of the New York State's 1968 Land Use Natural Resource Inventory (LUNR) program (New York 1972). Land use data for LUNR were collected on a parcel basis, but individual fields were not delineated. Rather, contiguous fields of the same land use were given a single border bounding the entire area. One square kilometer cells were then employed as the basic information unit to compile and record these data. Although adequate for state-wide inventory purposes the level of generalization is too gross for analysis of smaller areas. County governments and regional planning commissions also possess some land use information but the exact form varies in detail from tax maps to LUNR inventory sheets. Given these conditions the decision was made to provide an information packet based on the incorporation of a uniform data base at a scale and level of complexity on which future change and monitoring of land use could be assessed.

To provide such a base two options were available: a comprehensive ground survey, or the implementation of remote sensing imagery. As the first approach would have required excessive amounts of time and manpower the end product would have been not only dated but prohibitively expensive.

The only feasible option was the implementation of remote sensing techniques.

Study Area Imagery

A search of available imagery resulted in three sets that traversed the entire or a major portion of the shoreline at one point in time. The first set consisted of LANDSAT (ERTS) imagery. Although this imagery was certainly uniform in quality, current, and accessible, the scale (1:1,000,000) was too small and of insufficient resolution for detailed land use mapping unless expensive automated processing and image enhancement techniques were employed. The remaining imagery sets were hyper-altitude flights (scale approximately 1:121,000) by U-2 aircraft recording color infrared photography. The most recent coverage of this type was obtained in June 1973. Unfortunately, an error in filter assignment to the camera resulted in inferior photography. Attempts were made to adapt this imagery as a data base but proved impossible. The remaining flight, flown in July 1970, was employed as the initial data base. Although somewhat dated, the photography was of good quality and did meet the necessity of providing a uniform data base for the majority of the study area (from the Niagara River to Pulaski). Only the eastern portion of the lake shore from Pulaski to Cape Vincent was omitted by this overflight. Coverage for this section of the lake shore was provided from 1:24,000 and 1:48,000 black-and-white aerial photography flown in April 1974.

Interpretation Procedures

To provide potential users with a familiar data base at a useful scale the color infrared photographs were enlarged to a scale of 1:24,000 and the land use mapped from the photos on a parcel basis using a Bausch and Lomb Zoom Transfer Scope. This scale proved to be optimum in extracting the maximum amount of data from the photography as well as providing the desired scale of the data base. Further magnification of the photograph was attempted but resulted in an image of degraded interpretability. A base map was created by mapping each parcel of land use according to the aforementioned categories. Since individual fields were delineated, a more precise reference data base was obtained than that utilized by the LUNR program. Specifically, locations and amount of change in land use can be identified and recorded in future attempts to update the Lake Ontario Land Use Information System (LOLUIS) or sub-areas thereof.

Field Checking and Observations

After the parcel maps of land use were completed field checking was begun to determine the accuracy of interpretation and assess temporal land use changes that had occurred since the overflight. Department of Transportation base maps at a scale of 1:24,000 were compared with the parcel maps to determine an optimum traverse route through the study area. This route was subsequently traveled by automobile using the base maps and parcel maps for field reference. Approximately thirty percent of the entire study area was field checked by this method. As smaller fields and more intensive

land use existed in the western and central portions of the study area than along the eastern shoreline the former areas were more extensively traversed to document interpretation decisions.

The overall fidelity of the parcel maps was found to be better than ninety percent for the entire study area. Errors that did exist were found to be of two types. First, as might be expected, there were temporal changes in areas of unstable land use. Specifically, areas adjacent to urban agglomerations had been developed for housing and some vacation homes had been constructed along the shoreline peripheral to these settlements. The other temporal change involved the practice of clearing old, unproductive orchards and replacing them with new plantings in the same or different fields. While these changes obviously constitute an inaccuracy the amount of land involved in relation to the total land area encompassed by the study was minimal.

The second type of error was one of category confusion. At times it was difficult to distinguish between the forest (30) and forest scrub (24) categories. This was partially a result of interpretative error but more often the cause was one of perspective. The distinction between the two categories is subjective as there is inherently no sharp break between them. As forest scrub matures it will evolve into forest and the exact point of change is an arbitrary decision. Moreover, the view one obtains from aerial photography is different than the one presented by ground observation. It is believed the change in perspective in viewing these two categories is largely responsible for the disagreement found in comparing ground with aerial interpretation. In short, aside from minor temporal changes in land use the inventory as discussed in the following sections is of relatively uniform and acceptable accuracy.

Gridding and Data Processing

After the entire study area had been mapped the next step was to transfer the data into a format compatible to automated data storage and processing. This was accomplished by placing a gridded transparency over the parcel land use map and recording the dominant land use in each cell. The dominant land use in a cell is that activity occupying the majority of the area in the cell. Thus, if a cell contained two, three, or more types of land use the entire cell was given the land use designation of the largest portion of the cell. A cell size of five hectares was selected for the mapping grid. Five hectares was adopted as it was believed to be the smallest unit from which meaningful data could be recorded expeditiously from the parcel map, thus extracting the maximum data as input for the land use information system. Obviously, the size of the grid cell acts as a mesh through which the parcel data are filtered. A larger cell size, although easier to enumerate and classify, would have prejudiced the results in favor of more extensive land use types.

In encoding the cells two modifications were implemented to increase the overall land use accuracy. First, those cells that encompassed the shore as well as the lake water itself were designated on the basis of

the portion of the cell occupied by the dominant land use. This step permitted a more accurate calculation of land use and presented a more realistic picture of the shoreline shape than would be possible if the entire cell had been recorded as either water or land. Second, those cells with wetlands were so noted. In many cases the wetlands category was not the dominant land use but would obviously play an integral role in any assessment of present land use for future planning. For these reasons the dominant land use of the cell was recorded along with the presence of observed wetlands where applicable. Upon completion of the encoding step the data were entered into a computer for tabulation of land use and analysis. For purposes of the present report land use types were tabulated by type for the entire study area to establish regional trends and also by type for the individual counties in order to examine local land use blends.[1]

Land Use Analysis

In discussing land use we must deal with two types of trends; those of a regional nature; and those related to localities within this larger area. On one hand it is reasonable to assume that the study area is affected by proximity to the lake and thus there will be a subset of land uses common to the entire region. Although these activities and economies will undoubtedly vary spatially it is suggested that there is a phenomenological auto correlation among the uses of the land and that specific categories will predominant regionally. Other categories, of course, will reflect local variations unique to the regional setting. In order to adequately focus on these two types of variability land use will be discussed in two sections: one dealing with predominant land uses in the entire LOLUIS study area and the second dealing with land use variation for all 14 categories within each of the 7 counties encompassing the region.

An Area Wide View of Land Use

Land use in the study area falls predominately into six of the fourteen categories that were used for purposes of inventory and these land categories account for 92.98% of the land cover (Table A and Figures 2-7). The remaining land uses (8 categories) although sometimes spatially concentrated and therefore locally important are not of a size significant enough to affect the regional land use blend (Table A and Figures 8-15).

Agricultural Oriented Land Use

It is obvious that areas utilized for crops and pasture are the most dominant land use in the LOLUIS region (Figure 2). Although the amount of land in this category varies highly from locality to locality (see Figure 2a) crop and pasture is the most important areal component on the

[1]The actual land use inventory and field check resulted from a relatively complicated set of procedures and practices. In order to provide the reader with a feeling for the scope of the data bank and the type of information contained in it a site specific example of the LOLUIS process is presented in Appendix 1.

TABLE A

Proportion of Land in Land Use Categories, Lake Ontario Study Area

Category	Percent	Rank
Residential	5.12	5*
Commercial, Industrial, Strip and Clustered Settlement	0.99	9
Extractive	0.06	13
Transportation	0.52	11
Institutional	0.55	10
Open Space and Recreation	1.72	8
Cropland and Pasture	51.59	1*
Orchards	5.10	6*
Specialized Agriculture	0.24	12
Forest Scrub	9.35	3*
Forest and Woodland	14.99	2*
Water	2.86	7
Wetlands	6.83	4*
Beach	0.08	14

*Each land use category was originally mapped on 58 three to four mile wide sections that covered the study area. By examining each section a relatively detailed measure of trends and rates of land use change across the study area was elicited. The six categories marked with asterisks account for approximately 93 percent of the land use in the region and for this reason are graphed by county as well as these 58 divisions. The remaining land use categories which account for 7 percent of the land cover, are graphed only by county.

regional mix. The fluctuations in occurrence are clearly related to the appearance of urbanized areas, impending urban penetration, more lucrative agricultural operations (orcharding in Wayne County) and prohibitive climatic conditions (Jefferson County).

Process vegetables (snap beans, cabbage, cauliflower, cucumbers, sweet corn, tomatoes) account for the majority of products grown on the crop land. In the Rochester area many of the vegetables are cultured for fresh market produce. Towards the east (a transition zone starts on the Oneida plain in the area of the Cayuga-Oswego County border) crops associated with dairy farming (grains, grass and hay) become dominant. In this section pasture also becomes more common increasing in frequency towards the northern border of the study area.

1. Orchard. Groves, Vineyards and Horticultural Areas: (Figures 3, 3a)

The influence of the lake in moderating temperatures on the Erie-Ontario Plain has produced a fruit growing region that extends through Niagara County, Orleans County, and Monroe County and reaches its maximum density and approximate terminus in Wayne County where the coastline begins to turn sharply northward. Orchards in Niagara County produce many of the tender tree fruits while Wayne County is outstanding in apple production. Vineyards although common account for minor amounts of acreage in this category.

There is again the obvious relationship with the urban influence. Buffalo and Rochester provide local markets, transportation to larger markets, and processing facilities. On the other extreme urban-suburban residential penetration linked with the aesthetic considerations related to the value of lake property have caused substantial speculation resulting in much land fragmentation or abandonment particularly in Monroe and Niagara counties.

Specialized agriculture such as large feeding operations or nurseries are extremely rare in the study area (Figure 4). Large feeding operations are prohibited primarily by competitive bidding by other agricultural land uses while nurseries are usually located closer to urban areas due to transport considerations.

2. Forest Woodland and Forest Scrub Oriented Land Use

Large stands of timber are relatively absent in the western portion of the study area (Figures 5 and 5a). Substantial acreage in forest and woodlands begins in Wayne County and reaches its greatest concentration in Oswego County. Towards the north the stands are more fragmented and occur with diminishing frequency. It is quite obvious that agricultural activities were responsible for the removal of forest woodland in the study area. The presence of this category in the areas where climate prohibits fruit and vegetable agriculture represents the climax status of the shore area before large scale settlement began.

Today there appears to be little reforestation taking place. In some areas (particularly where urban penetration of rural areas is occurring), many agricultural plots and orchard areas are being allowed to return to their natural state. These derelict or land speculation areas are generally covered with a sequent regrowth vegetation that is categorized forest-scrub. Clear examples of this are portrayed in Figures 6 and 6a as the amount of land in scrub increases dramatically in Eastern Monroe and Western Wayne Counties where speculation assumedly is taking place. To the east and north (Oswego and Jefferson Counties) there is some urban penetration from Oswego and also second home consideration from Syracuse and other areas. These factors coupled with the trend for reduced size of dairy herds and high capital input to increase dairy efficiency have led many farmers to abandon their land for substantial profit at a time when land prices are rising.

3. Urban Settlement and Recreation Oriented Land Use

Approximately 5 percent of the land in the study area is used for residential purposes (Figures 7 and 7a). Although there are only a limited number of areas in which settlement is the dominant land use residential use is a frequent occurrence within the entire study area. It should be noted that there is a distinct clustering of settlements (that are away from the urban nodes) along the lake shore itself. The density drops off rapidly from the coastal zone. In Jefferson County particularly, the lake shore residences are of a second home nature and seem to have increased in numbers in the last few years as evidenced by the number of modern residences viewed during a field check of the area.

Included in this group of land use are institutional (religious, health and military facilities) users (Figure 8) and open space and recreational facilities (Figure 9). The lake shore is well populated with existing state and local recreational facilities some of which are currently being renovated. During the peak recreation seasons, however, the parks are overcrowded (especially the Rochester-Buffalo coastal corridor). Coupled with a limited amount of open space for expansion the LOLUIS study area may experience a shortage of recreation areas since outdoor vacationing is increasing in popularity.

4. Industrial and Commercial Oriented Land Use (Including extractive and transport) (Figures 10, 11, 12)

Although only a small part of the study area (0.99%) is allocated to industrial-commercial activities, these economies are extremely important to the region. Specific activities are mainly clustered around the major urban nodes although numerous small retailing service centers exist throughout the study area. Only two urban nodes directly effected the compilation for the study area (Rochester and Oswego). Buffalo, Syracuse, and Watertown, however, also provide retail services and are responsible to some degree for the lack of services in the study area since these places assume a central function in the region's economy although they are physically exogenous to the area. Higher order services (manufacturing)

are found only in the Rochester and Oswego areas. The other retailing centers within the study provide lower order goods and other tertiary services. These centers act primarily as farm supply and vacation-recreation supply areas.

Extractive land uses (0.06% of total) are locally oriented and usually of a sand and gravel nature. No extremely large operations were observed within the study area. Several quarries are in operation in the Rochester and Oswego urban zones but they are clearly beyond the borders of the LOLUIS region.

Land use devoted to transportation always represents a minor amount of the total land cover in a given area and the LOLUIS region is no exception to this rule. The general circulation capability in the area is strong and currently provides easy access to most points adjacent to the Ontario shoreline.

5. Water Oriented Land Use (Includes water, wetlands and beach)

Wetlands (seasonably flooded basins and flats) constitute 6.8% of the study area. The greatest concentration of wetlands is in eastern Wayne, Cayuga, and western Oswego counties (Figures 13 and 13a). Wetlands are normal, to some degree, along much of the Ontario coast. In many areas, however, they have been drained or controlled to such an extent that they are used for agricultural or residential purposes. Many of the still existent areas are now supervised by the Department of Environmental Conservation as protected wetland and wildlife refuges and will remain as such for the foreseeable future.

Water (lakes, reservoirs, rivers, etc.) occupies 2.9% of the near shoreline land use. Most of the region has some standing or moving water. Only in a few cases was the land covered large enough to register dominance in the 5 hectare cell. From Wayne through Oswego Counties the water categories registers its greatest areal extent (Figure 14).

Beach, (0.08%) of the total land use, is apparent throughout most of the region along the lake shore. The beaches are relatively narrow and in the majority of the cases did not constitute the dominant use within any cell (Figure 15).

Land Use by County

In the previous section land use in the Lake Ontario study area was examined from a synoptic perspective. General trends and fluctuations were noted and discussed for the entire shoreline. This approach is vital to parties interested in the area as a total entity and provides useful data in the format most useful to national, state or macro-region (e.g., Great Lakes) analysts. In many instances it is probably even the optimum scale for sub-state region and county level officials when a first-cut or overview of land use in their area is desired. However, the need for a

more detailed assessment of land use to complement this overview cannot be dismissed.

As the specific area of concern becomes smaller the necessity of more discriminatory data quickly becomes apparent to even the casual observer. County government and sub-state planning commissions, among others, are more immediately concerned with what patterns exist specifically in their area of jurisdiction once a general impression is known. In an attempt to address this issue the LOLUIS land use categories were compiled and tabulated for those portions of each of the seven counties comprising the study area. Admittedly, using man-made boundaries does impose artificial break points in the data. Shifts in county percentages and area occupied by each land use category do not automatically imply a black-white change between counties. In most cases the transition in land use is a gradual one and the fluctuation is due in part simply to the location of the county boundary. If a border were shifted, the figures for the county would obviously change. Yet, it must also be remembered that land uses can in fact change markedly at a political border owing to differences in zoning and similar land related ordinances. Reflect for a moment on the variation in land use one experiences in crossing the United States - Canada, United States - Mexico, Texas - New Mexico, and similar political boundaries owing to divergent enacted legislation and governmental systems. Thus, for better or worse, artificial borders are a fact of life and a pivotal unit in monitoring, inventorying, and planning land use.

By focusing on each of the counties, we are afforded the opportunity of examining land use in more detail than was possible in considering the study area as a single entity, as well as in a format more relevant to sub-state needs. In the following paragraphs the fourteen land use categories of LOLUIS are discussed for those portions of the seven counties embracing the study area.

1. Niagara County

Niagara County is the western-most county in the study area. Located north of the Buffalo metropolitan area it includes Niagara Falls and abuts the Canadian border. As such, the county experiences pressures from many sources. Prime agricultural land is sought for urban uses such as industry, housing, and recreation. While the study area portion of the county has undoubtedly felt the influence of these forces, it is apparent from Figure 16 that it still remains essentially agriculturally oriented. Over sixty-four percent of the area is occupied by cropland and pasture (21) with 7.5 percent devoted to orchards (22), and 7 percent to specialized agriculture (23). Forest, the second most dominant land use, contains slightly more than 9 percent of the total. Only 3.2 percent is classified as residential (11) and urban activities as a whole (categories 11, 12, 15, 16, and 19) comprises less than 10 percent of the total land area. In short, the fertile lake plain is still most useful for the production of foodstuffs and retains its role as a supplier of such to the cities.

2. Orleans County

Situated midway between the Buffalo and Rochester urban clusters, Orleans County has remained relatively unaffected by the immediate pressures of urbanization. As can be seen in Figure 17 the study area portion of the county is dominated by the production of agricultural commodities. Fresh vegetables such as tomatoes, cucumbers, and cabbage comprise the majority of the 73.3 percent of the land used for cropland and pasture (21). Scrub forest (24), with slightly over 6 percent of the land, is the next most important land use while urban associated land uses are found only in marginal amounts. Perhaps even more than the preceding area agriculture is the monoculture of the land.

3. Monroe County

The effects of urbanization are quite apparent in the study area segment of Monroe County. While cropland and pasture (21) remains the major activity less than half of the total area is found to be so oriented (Figure 18). Residential land use (11) is found on almost 20 percent of the area and open space on over 5 percent. Undoubtedly what was once farmland has now become first and second homes by the lake, suburban developments, and golf courses. Moreover, much of the scrub forest (24) and forest (30), are probably idle and abandoned agricultural lands awaiting further expansion of the Rochester urban area. Although the exact rate is unknown it is believed this portion of the study area is undergoing the most rapid as well as the most drastic change in land use.

4. Wayne County

As can be seen in Figure 19 this area has experienced few if any direct changes in land use as a result of Rochester's growth. Instead, cropland and pasture (21) is complemented by orchard activity (22)--30.5 percent and 17.5 percent respectively. This is fruit country and land that is not in production for either fruits or vegetables is generally either aged, worn-out orchards or land too wet or wooded to be considered economically productive. Note, for example, that over 20 percent of the area is forest (30), while wetlands (60) and scrub forest (24)--much of the latter being overgrown aged fruit trees, each occupy over 10 percent. In short this county's area is almost evenly divided between crops and orchards on one hand and wetlands and forests on the other.

5. Cayuga County

Only a small portion of Cayuga County is found in the LOLUIS study area, but it marks a transition in land use patterns. Previous counties have exhibited a marked dominance of agricultural land use owing to advantageous climate and fertile soils. However, in moving east along the lakeshore the land becomes less well-drained and the soil becomes hilly, more dissected, and rocky. This trend is apparent by examining Figure 20 and comparing it with Figures 16-19. Although cropland and

pasture (21) comprise slightly more than 41 percent of the land, most of it is devoted to pasture or crops useable as livestock feed rather than fresh vegetables. The large percentages devoted to forest (30) and wetland (60) uses readily illustrate the less fertile field conditions extant in the area. The lack of urban related uses and orchard activity also point to a rural area beset by rising operating costs and declining productivity on less than optimum land.

6. Oswego County

The trends and conditions discussed in the above paragraph are even more marked in the Oswego County segment of the study area. Note that while cropland and pasture (21) remains the single most dominant activity the combined area occupied by forest (30), wetland (60), and scrub forest (24) totals over 40 percent (Figure 21). Too, there is virtually no land involved in the production of orchard crops (22) or specialized agriculture (23). The small percentages devoted to urban uses (11, 16, 19) mirror the role of the city of Oswego as a regional trade and service center. In general it could be said that this segment of the study area is chiefly one of dairy, idle land, and recreation uses.

7. Jefferson County

The last county containing portions of the LOLUIS study extends along much of the eastern lake shore with the study area itself terminating at the conflux of Lake Ontario and the St. Lawrence River. A quick glance at Figure 22 shows the dominance of cropland and pasture (21) and the monoculture characteristics of the area. Almost no orchards (22) are found and little urban activity. In sharp contrast to western segments of the study area this land is primarily dairy country with cropland devoted almost exclusively to the production of livestock feed. Rocky soils too wet or infertile for cultivation remain as scrub forest (24), forest (30), or wetland (60). In addition, conditions in much of the area comprising these latter three categories can be attributed to the numerous islands, peninsulas, and inlets extant along the eastern lakeshore. Although sharing many of the characteristics found in Oswego and Cayuga counties this segment of the shoreline, in contrast, appears to retain a viable agricultural community supplemented with recreation opportunities afforded by woods, water, wetlands, and indented coastline.

8. Summary

It must be remembered that the percentages of land use concentration reported in the above paragraphs are, to a large degree, a function of the five hectare cell size employed in the inventory and analysis. While the decisions and rationale for the use of this measure have been discussed previously, it cannot be denied that some selected small differences in figures could be expected if larger or smaller cells were used as a base. For example, if smaller cells were used one could expect urban areas (e.g., residential land, institutional, transportation), beach areas, and small wetlands to assume a more significant role. Larger cells would

tend to magnify the importance of cropland and pasture and forest categories since they normally occupy larger contiguous surface areas. In that case, they would be the dominant land use in the cell. Yet, regardless of these minor disclaimers several general trends can be assessed from the data on a county basis.

Overall, the data compiled in this analysis support the discussion of the history and development of the Lake Ontario shoreline found in the introductory portions of this report. The western counties are the most fertile and productive agricultural lands--a fact lent credence by the concentration of orchards and cropland and pasture and the relative absence of wetlands and forest areas. The importance and impact of the Rochester metropolitan area is evidenced by the data compiled for Monroe County. That Cayuga County and Oswego County suffer from poorly drained soils and a rocky terrain can be seen by examining the figures for scrub forest, forest, and wetland. The role of Jefferson County as an agricultural agent significant but divergent from the western counties can be seen by the comparison of cropland and pasture, forest and wetland categories as well as the presence or absence of orchard activity.

By employing the LOLUIS data, changes and rates of change for each of the sub-county areas can be monitored quickly and easily and compared with desired or planned land use. This is no mean capability given the fact the lakeshore is simultaneously one of the most fragile ecosystems and one most subject to divergent land use interests and designs in the future. The final section of this report is devoted to a brief discussion of the potential uses, applications, and recommendations for further analysis of the Lake Ontario Land Use Information System.

Summary and Conclusions

The areas adjacent to Lake Ontario examined during the land use inventory and analysis are predominately used for agricultural purposes. During the next 15 years, however, it is estimated that suburban growth in Buffalo, Rochester, and the Oswego-Syracuse corridor will increase 18 to 37 percent above today's population totals (New York State, 1971). If current trends continue new housing will be constructed on large areas of productive farmland and open space. Analogously, commercial, industrial, and institutional activities will spread away from the urban setting.

The impact of these out-migrations will be especially critical in the immediate vicinity of the city of Rochester and to a lesser extent Buffalo. In these areas the use of rural land parcels for residential subdivision and minor commercial activity has accelerated dramatically (Genesee/Finger Lakes Regional Planning Board, 1972). To a considerable extent residential use of land precludes many of the particular agricultural practices related to fruit and vegetable culture. Additionally the fragmentation of land holdings also restricts various agricultural economies of scale gained by farming larger fields. In these senses it is obvious that it will require a monumental effort to manage the rural-urban fringe in a manner to best plan for the future of the region.

There are also other effects of these changing land use patterns. Planned increases in power generation capacity will add 4 new power plants to the shoreline which will bring the 1990 total to 10, including 4 nuclear facilities.[1] This will lead to increased thermal discharges. Additionally, the rise in population will necessitate new sewage treatment facilities. (In the Rochester area there are now 42 facilities and 18 new operations are in the planning stage.) Similarly the decrease in farmland will provoke a need to increase yield, and the associated inputs of fertilizers will add to the other environmental problems associated with urban expansion.

Given these conditions both prevailing and anticipated, a thorough knowledge of land use patterns and activity is essential if sound planning and wise management of resources are to be implemented. The Lake Ontario Land Use Information System (LOLUIS) is an attempt to supply at least part of this needed data base. The entire shoreline of Lake Ontario inland for six kilometers was mapped from hyper-altitude aerial photography using fourteen land use categories. Land use activity in the study area was first recorded on a parcel basis. To facilitate data retrieval, storage, and updating five hectare cells were then employed to record the dominant land use by cell. From the cell data land use by category was tabulated for the study area as a whole and for those portions of each of the seven counties comprising the study area.

By utilization of the above procedures in the initial analysis the following data may be obtained from LOLUIS:

1) A map of land use by parcel for the entire study area or any sub-area.

2) A land use map of the entire study area or any sub-area showing the dominant land use by five hectare cells.

3) The amount of land devoted to each of fourteen land use categories for any part of all of the study area (based on dominant land use and five hectare cells).

4) Schematic maps and data of each of the fourteen categories showing trends and patterns for the entire study area or any sub-portion.

5) A record of the land use by cell in computer-compatible form.

It is realized the data provided by LOLUIS are not a panacea to the multifarious needs of decision-makers desiring land use information. There is no perfect land classification system. However, it is believed that LOLUIS is a significant first step or benchmark from which a comprehensive data base can be created. As a building block LOLUIS does provide sufficient data for many regional needs. Moreover, the parcel data and

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[1] Personal communication, Power Authority of the State of New York.

cell data do supply input to surrogate studies such as power-site location, recreation development, preservation of open space and ecologically sensitive areas, and urban development. Obviously, correlation of LOLUIS data will soil types, vegetation, drainage and hydrologic data, and topographic data (to name but a few) quickly magnifies the breadth and scope of the system and its potential usefulness.

A discussion of hypothetical applications of LOLUIS is undoubtedly superfluous at this point. The authors firmly believe the system is a significant step in land use planning. It was purposely designed to be simplistic in order that it can be customized to specific problems. For example, by using the parcel data land use can be re-inventoried with virtually any cell-size and made computer-compatible. It is hoped both persons in direct as well as indirect need of land use information will give serious consideration to LOLUIS and what it can provide.

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FIGURE CAPTIONS

Figure 1 LOLUIS Study Area. The inventory and analysis detailed in the following pages is based on land use data collected from the area adjacent to the Lake Ontario shoreline that is symbolized in grey.

Figure 2 Land Use by County--Code 21 (Cropland and Pasture)

Figure 2a Land Use by 58 Divisions--Code 21 (Cropland and Pasture)

Figure 3 Land Use by County--Code 22 (Orchards, Groves, Vineyards, and Horticultural Areas)

Figure 3a Land Use by 58 Divisions--Code 22 (Orchards, Groves, Vineyards, and Horticultural Areas)

Figure 4 Land Use by County--Code 23 (Specialized Agriculture)

Figure 5 Land Use by County--Code 30 (Forest and Woodland)

Figure 5a Land Use by 58 Divisions--Code 30 (Forest and Woodland)

Figure 6 Land Use by County--Code 24 (Forest Scrub)

Figure 6a Land Use by 58 Divisions--Code 24 (Forest Scrub)

Figure 7 Land Use by County--Code 11 (Residential)

Figure 7a Land Use by 58 Divisions--Code 11 (Residential)

Figure 8 Land Use by County--Code 16 (Institutional)

Figure 9 Land Use by County--Code 19 (Open Space and Recreation)

Figure 10 Land Use by County--Code 12 (Commercial, Industrial and Strip)

Figure 11 Land Use by County--Code 14 (Extractive)

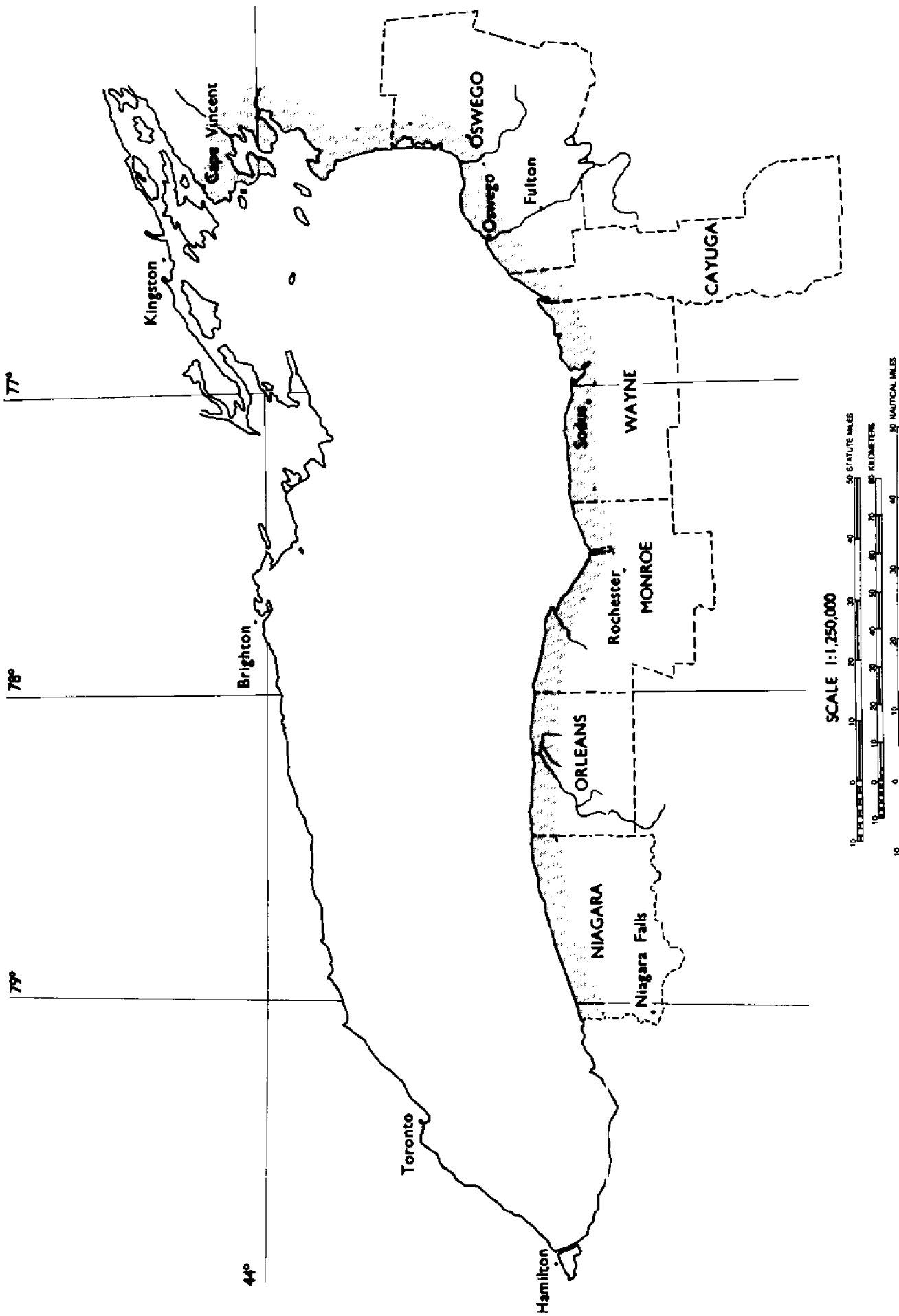
Figure 12 Land Use by County--Code 15 (Transportation, Communication, Utilities)

Figure 13 Land Use by County--Code 60 (Wetlands)

Figure 13a Land Use by 58 Divisions--Code 60 (Wetlands)

Figure 14 Land Use by County--Code 50 (Water)

Figure 15 Land Use by County--Code 72 (Beaches)



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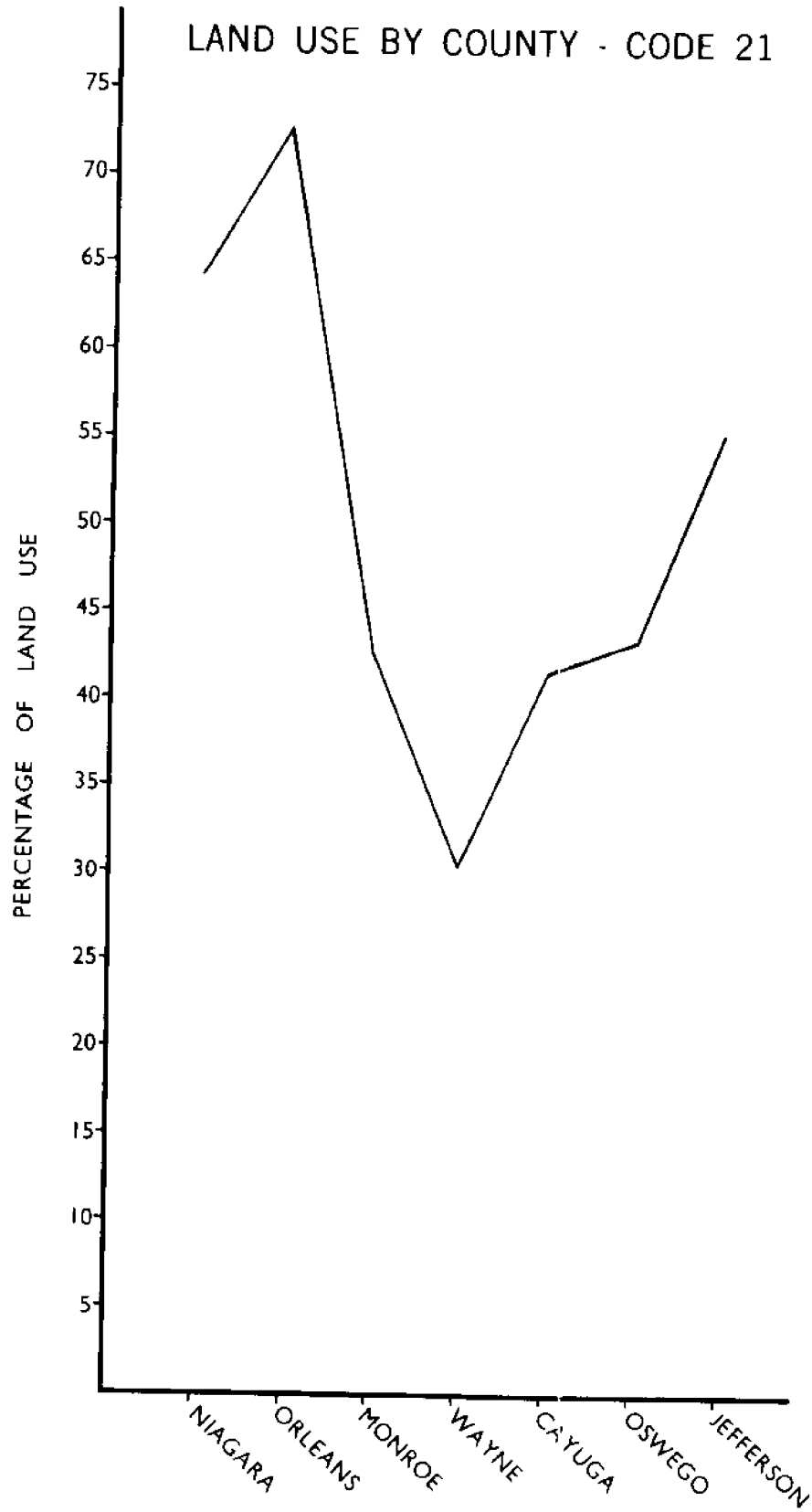

Figure 2 Land Use by County--Code 21 (Cropland and Pasture)

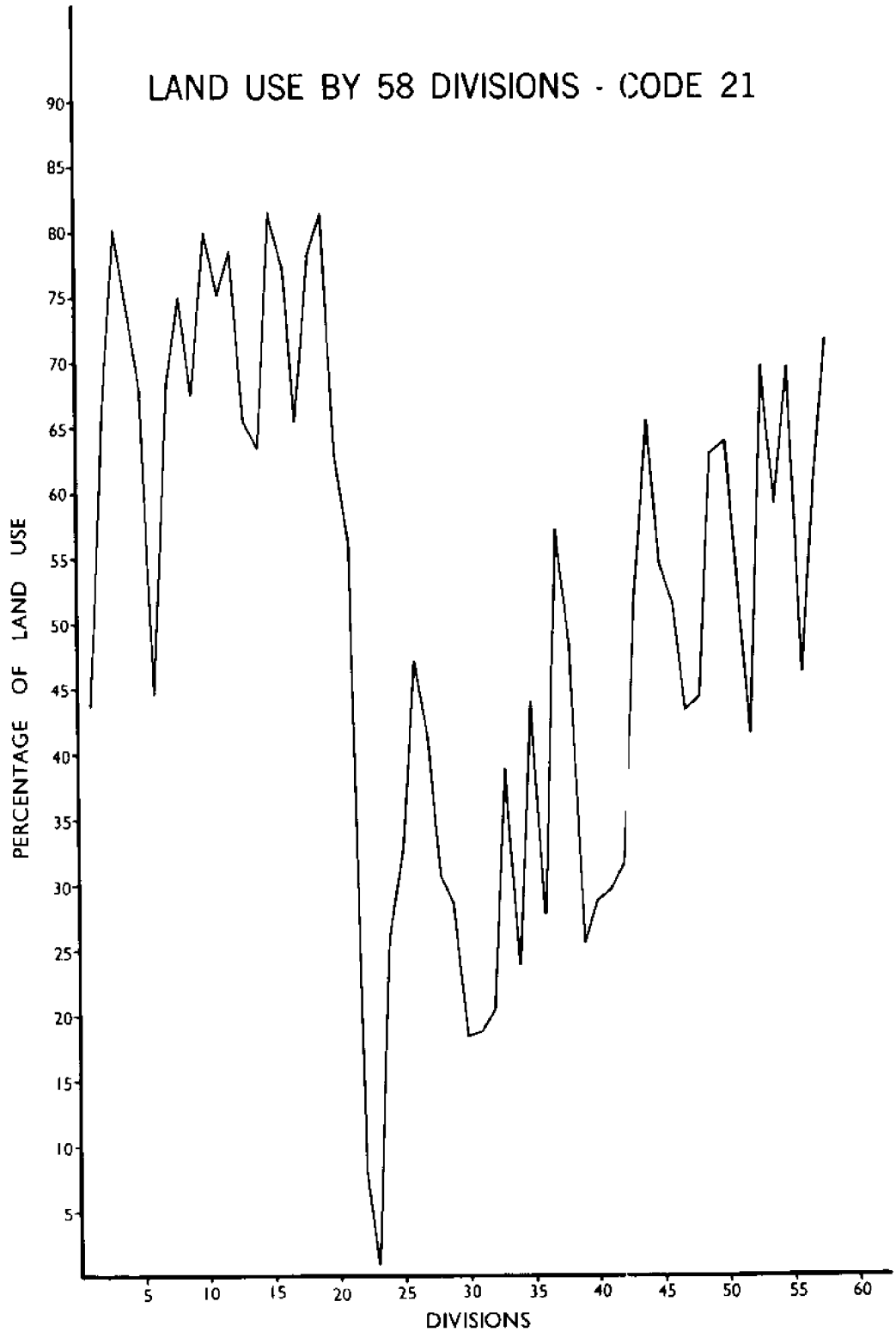

Figure 2a Land Use by 58 Divisions--Code 21 (Cropland and Pasture)

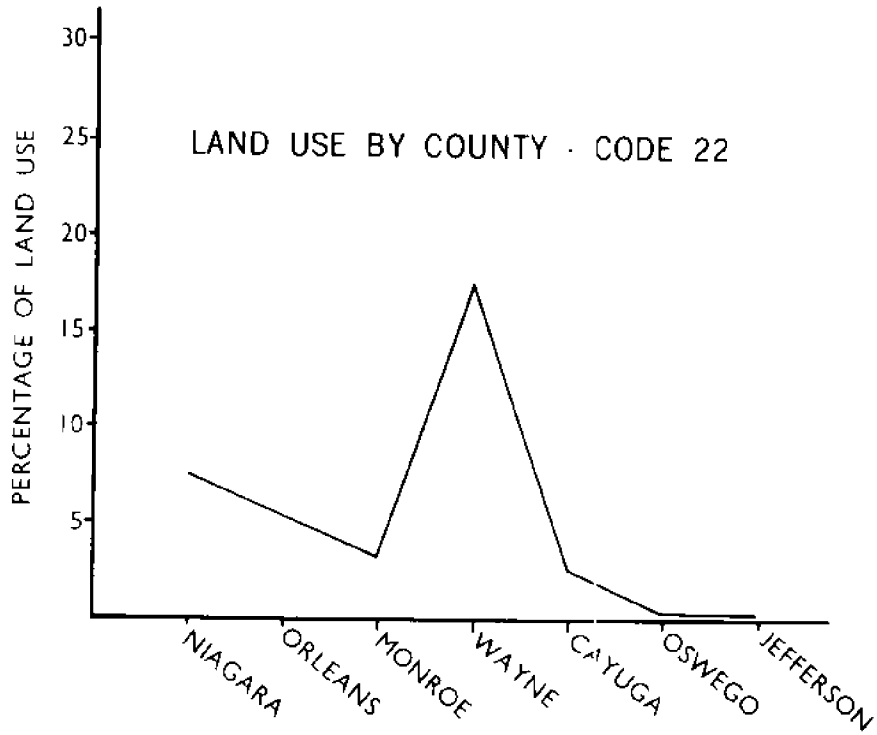

Figure 3 Land Use by County--Code 22 (Orchards, Groves, Vineyards, and Horticultural Areas)

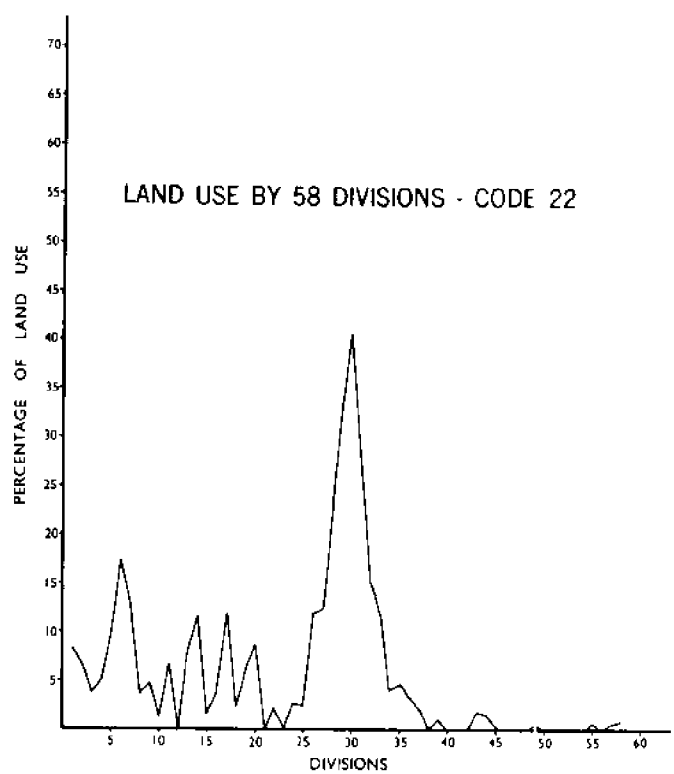

Figure 3a Land Use by 58 Divisions--Code 22 (Orchards, Groves, Vineyards, and Horticultural Areas)

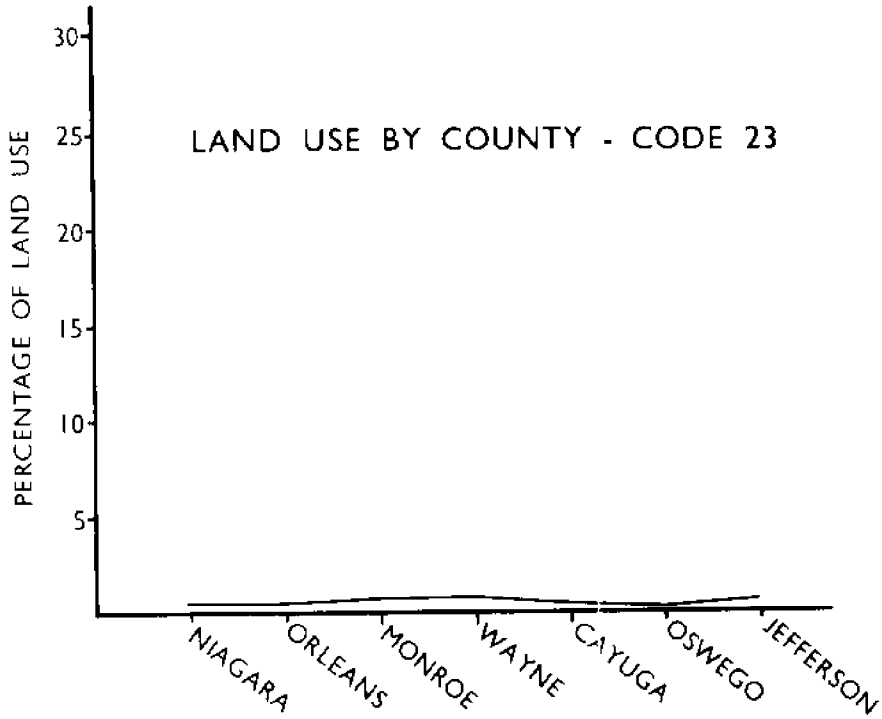

Figure 4 Land Use by County--Code 23 (Specialized Agriculture)

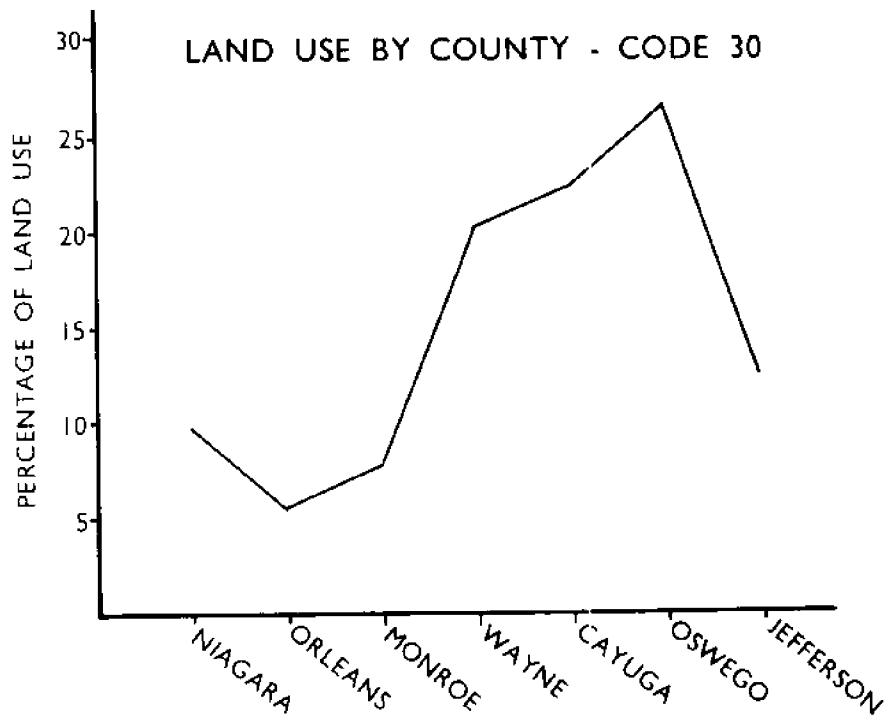

Figure 5 Land Use by County--Code 30 (Forest and Woodland)

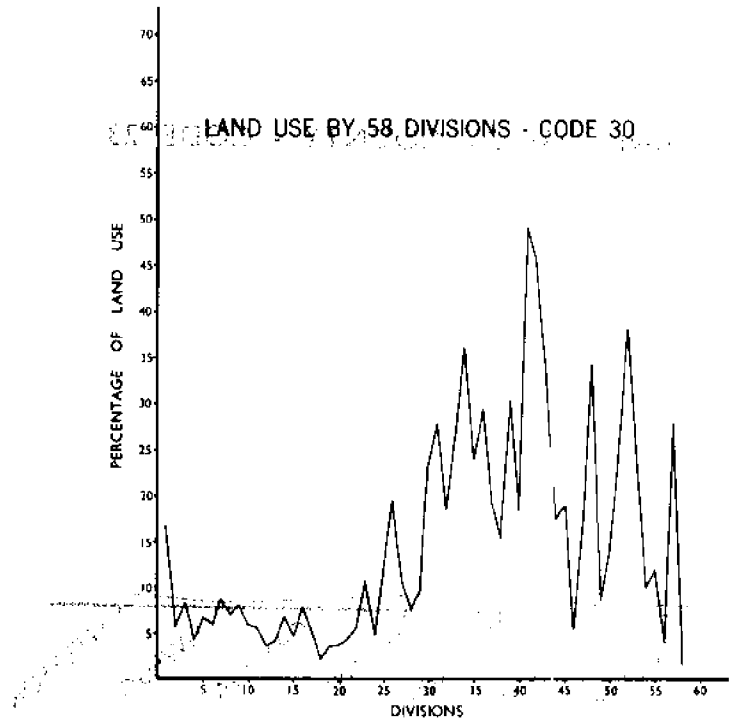

Figure 5a Land Use by 58 Divisions--Code 30 (Forest and Woodland)

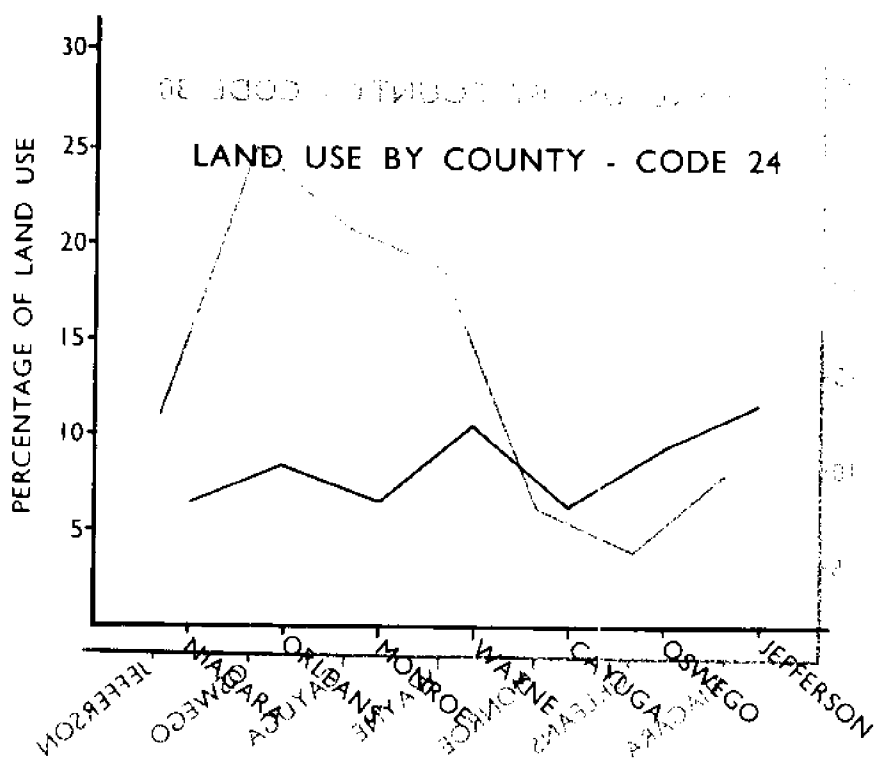

Figure 6 Land Use by County--Code 24 (Forest Scrub)

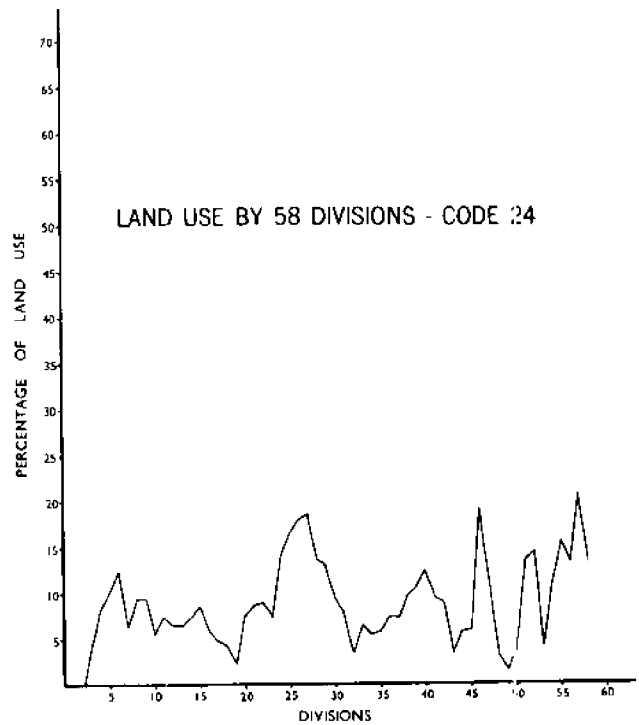

Figure 6a Land Use by 58 Divisions--Code 24 (Forest Scrub)

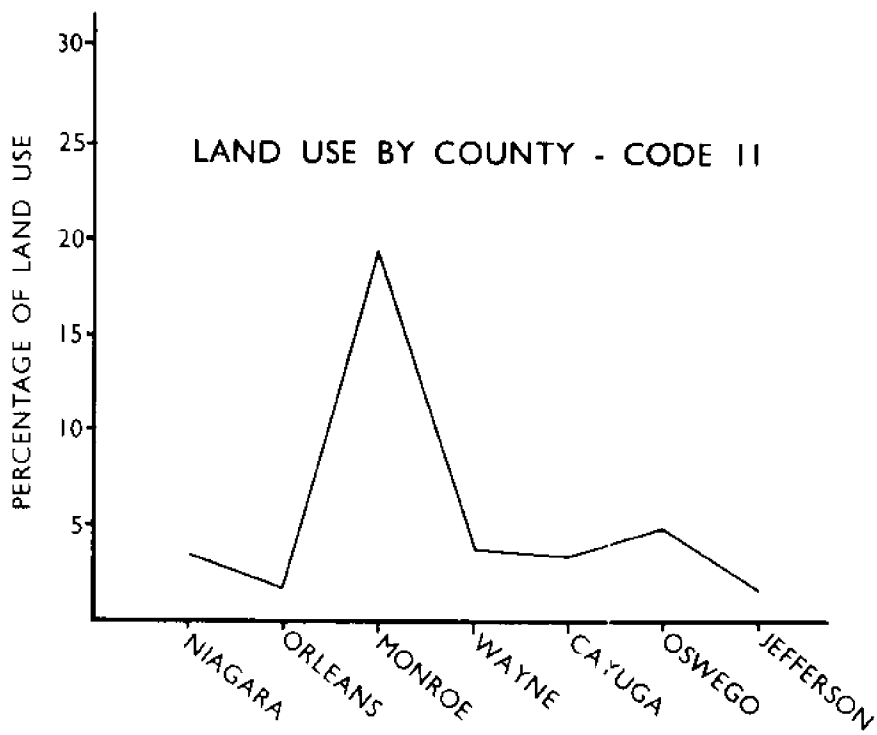

Figure 7 Land Use by County--Code 11 (Residential)

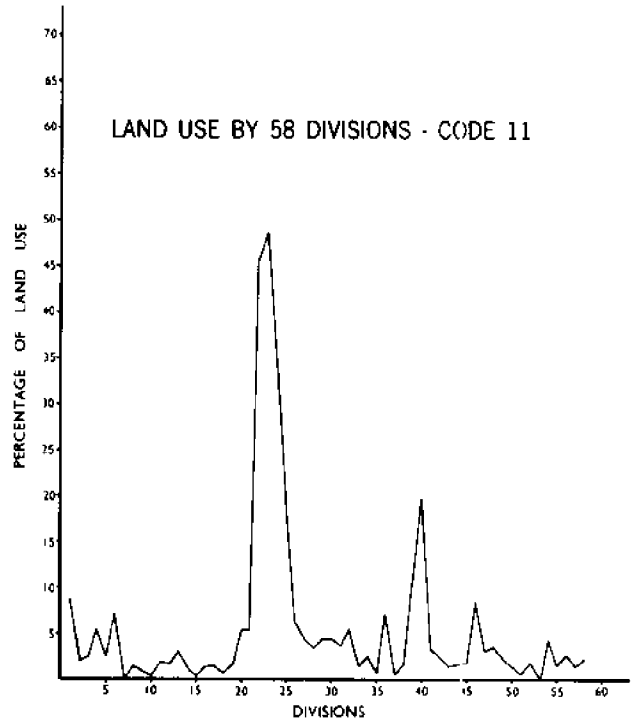

Figure 7a Land Use by 58 Divisions--Code 11 (Residential)

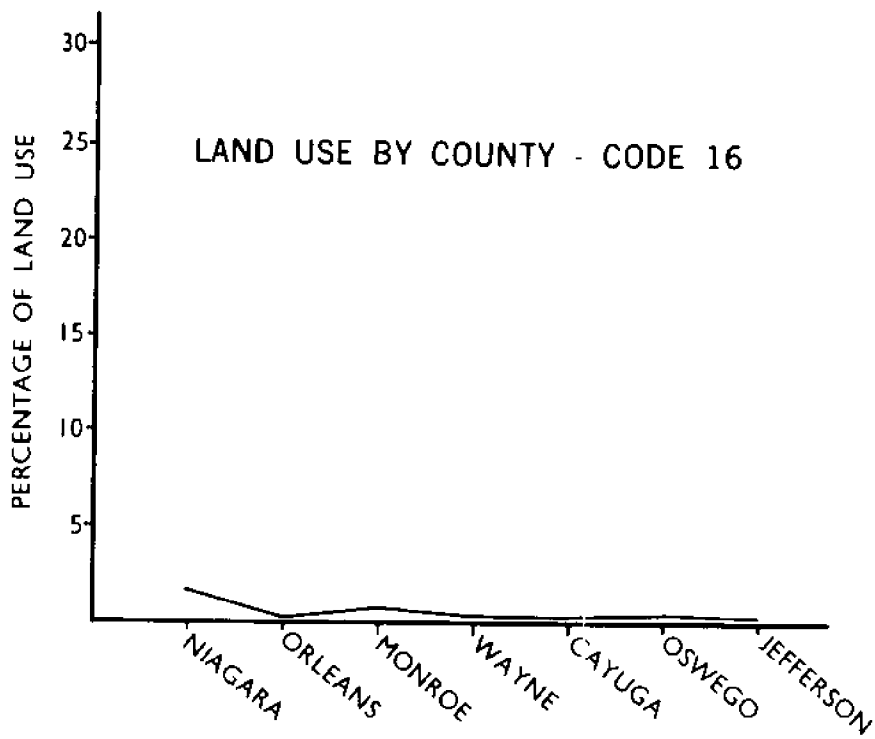

Figure 8 Land Use by County--Code 16 (Institutional)

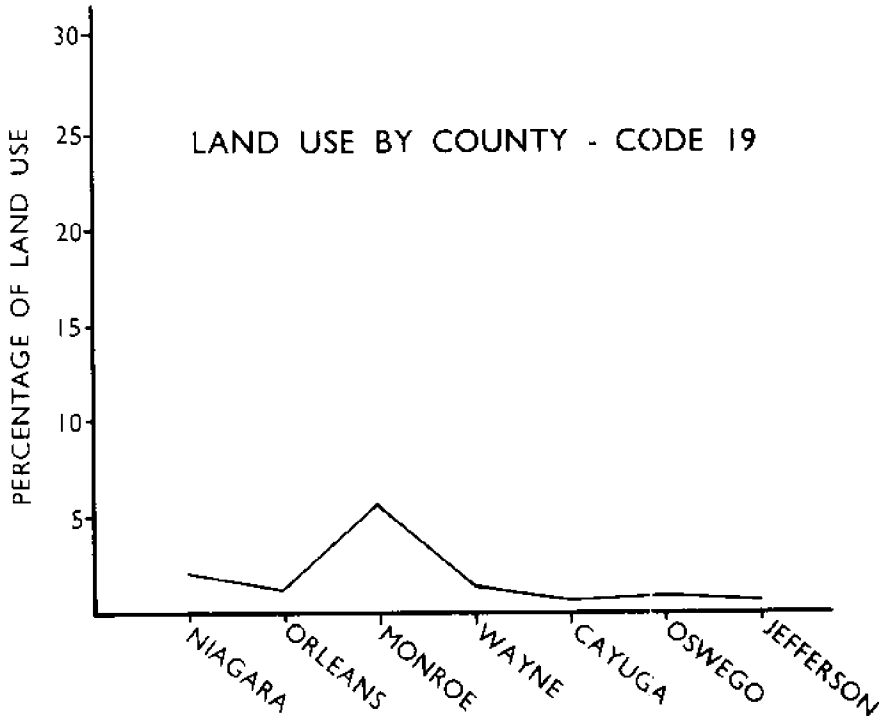

Figure 9 Land Use by County--Code 19 (Open Space and Recreation)

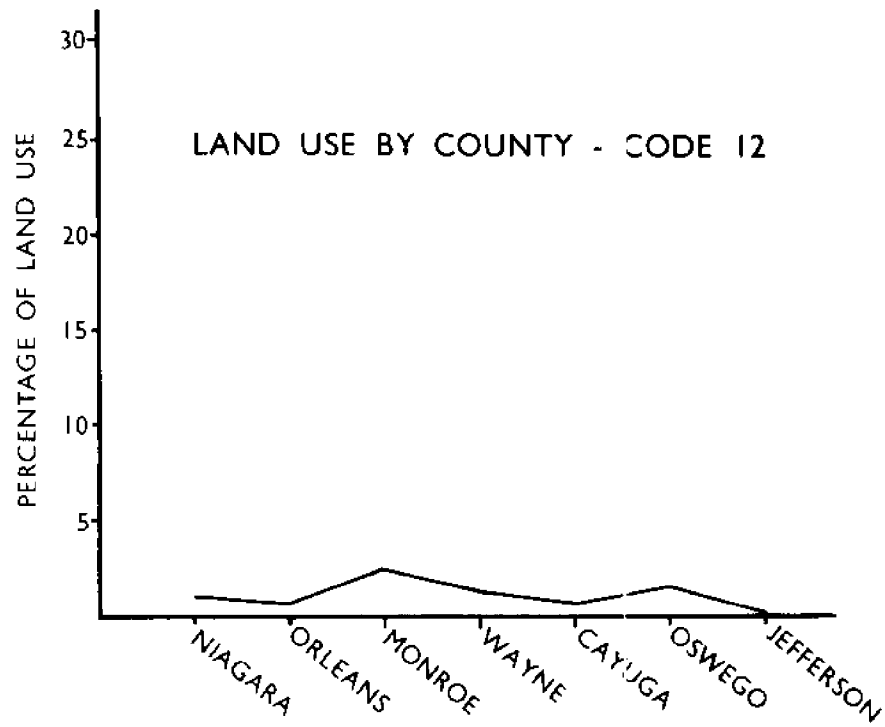

Figure 10 Land Use by County--Code 12 (Commercial, Industrial and Strip)

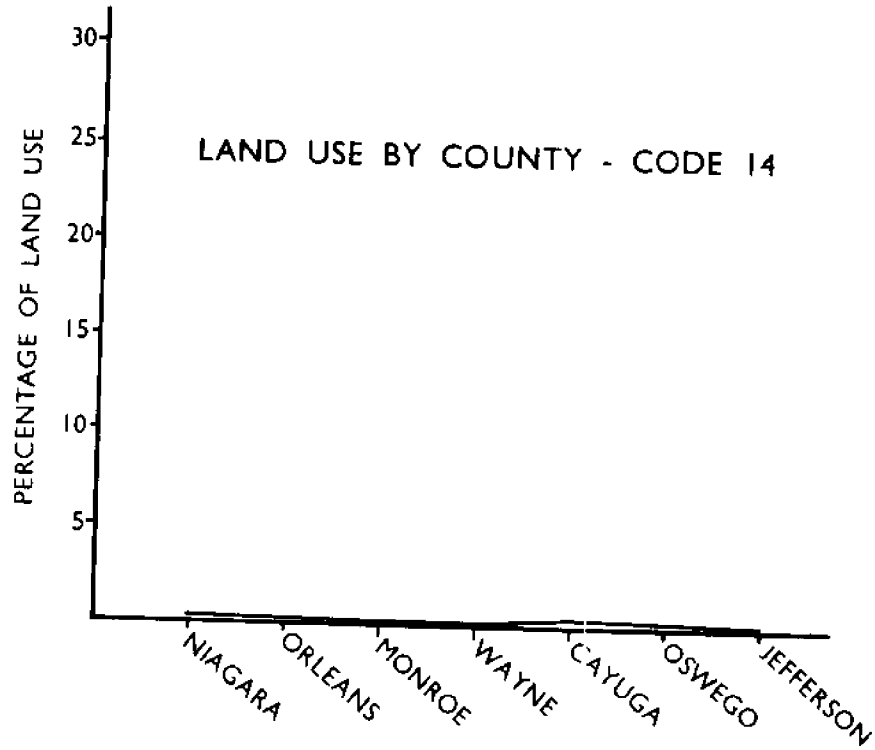

Figure 11 Land Use by County--Code 14 (Extractive)

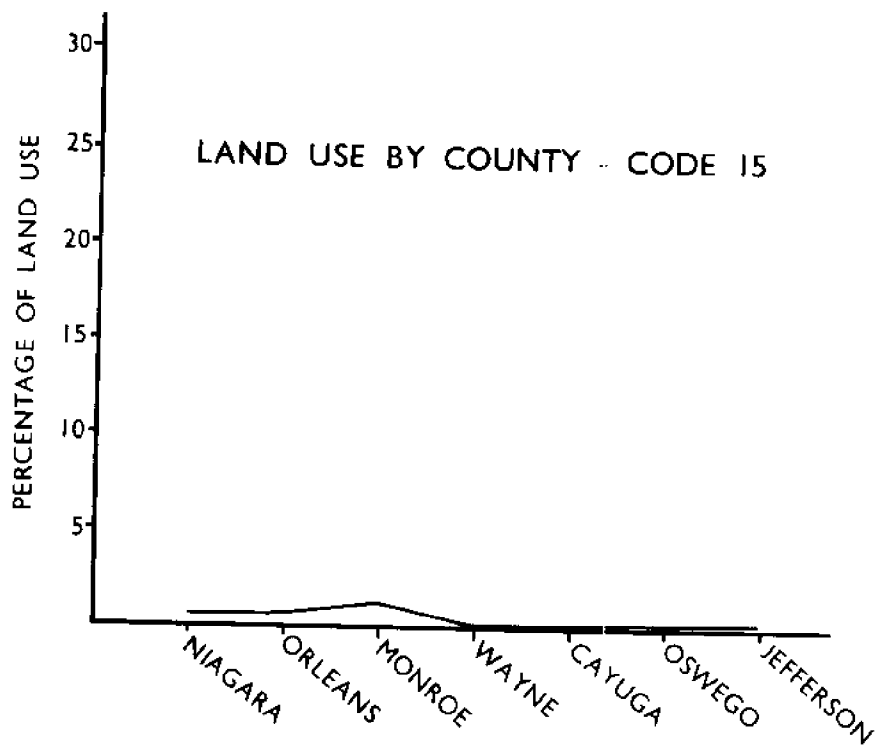

Figure 12 Land Use by County--Code 15 (Transportation, Communication, Utilities)

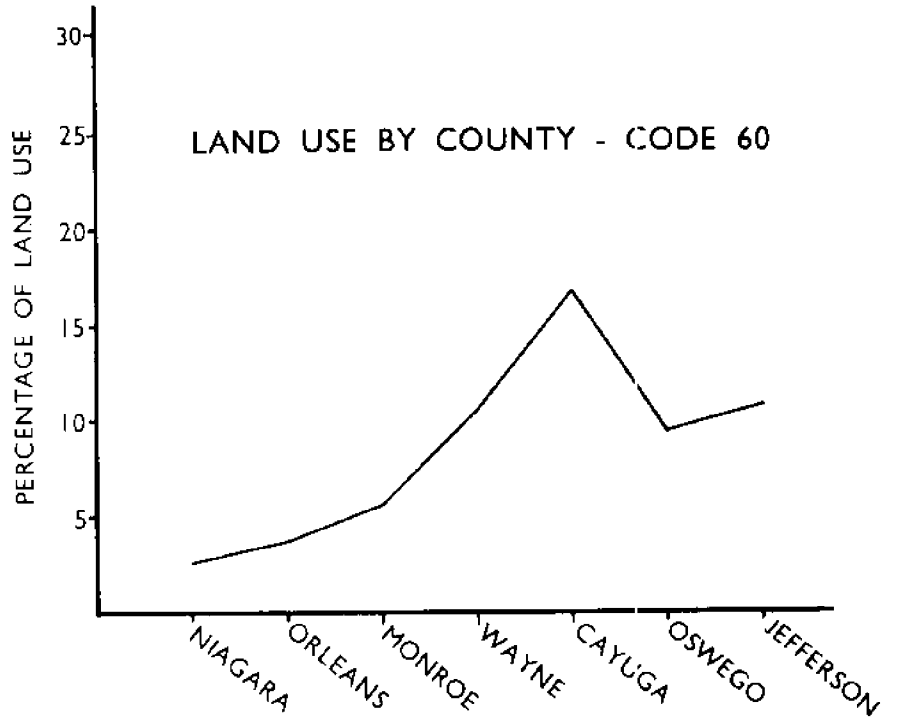

Figure 13 Land Use by County--Code 60 (Wetlands)

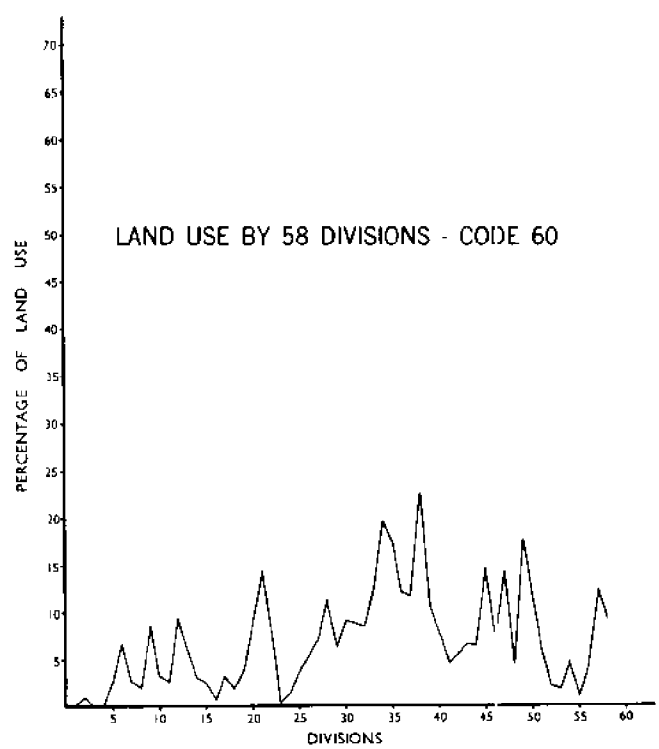

Figure 13a Land Use by 58 Divisions--Code 60 (Wetlands)

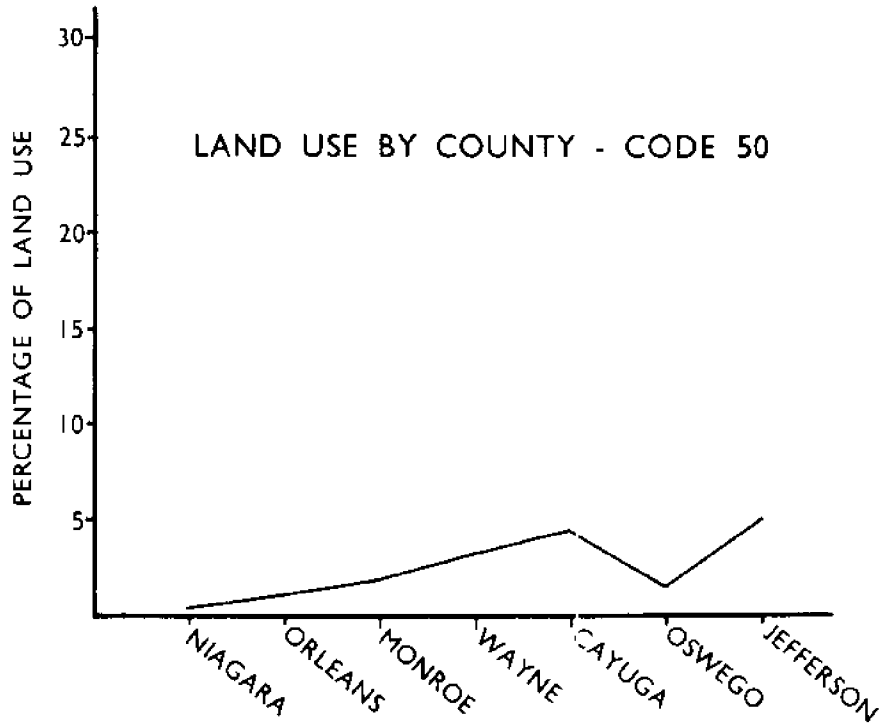

Figure 14 Land Use by County--Code 50 (Water)

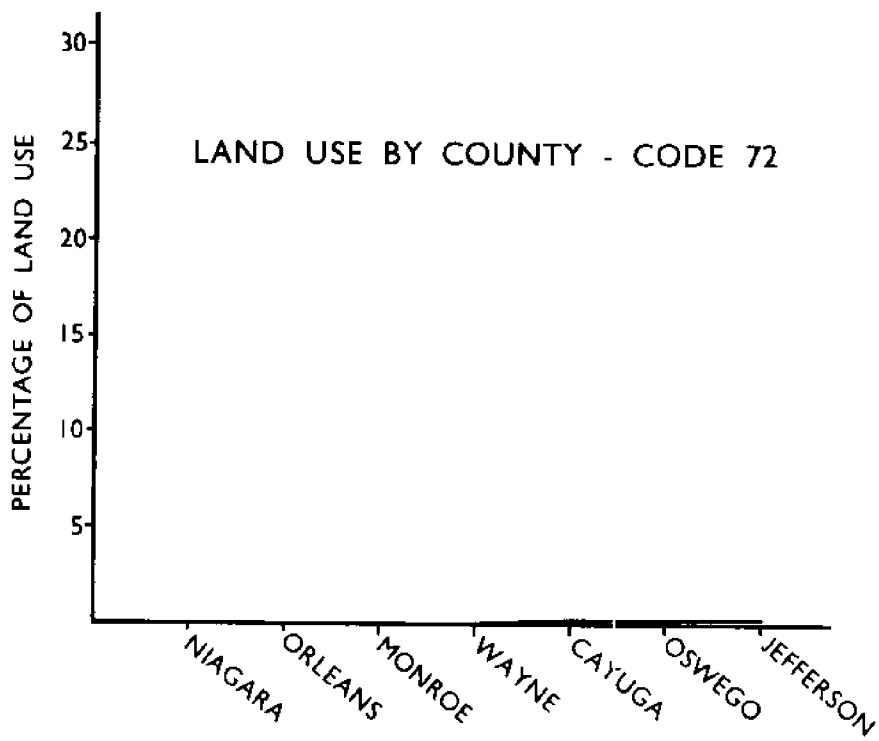

Figure 15 Land Use by County--Code 72 (Beaches)

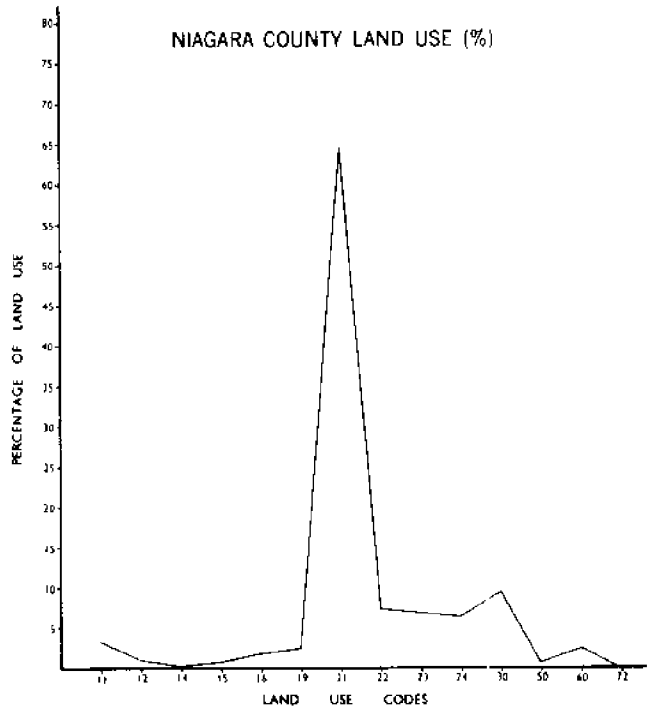

Figure 16 Percentage of Land Use by Category in Niagara County

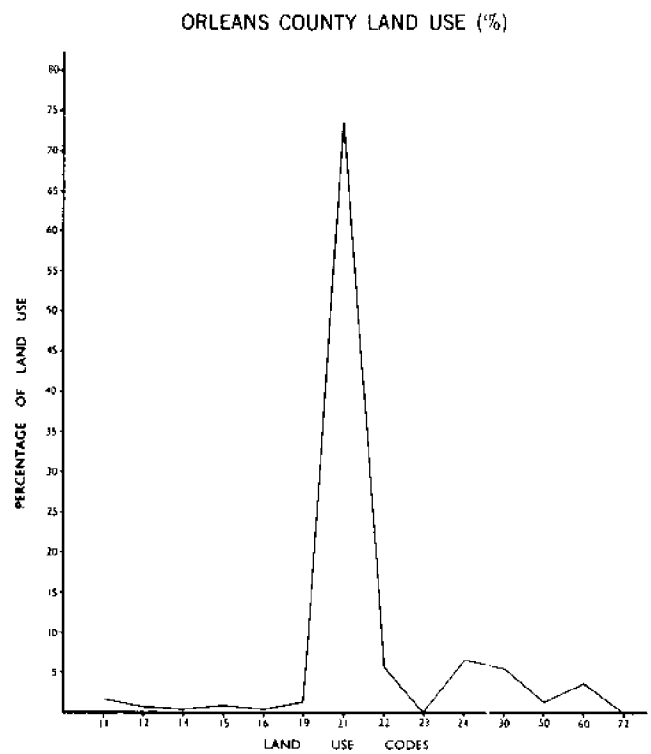

Figure 17 Percentage of Land Use by Category in Orleans County

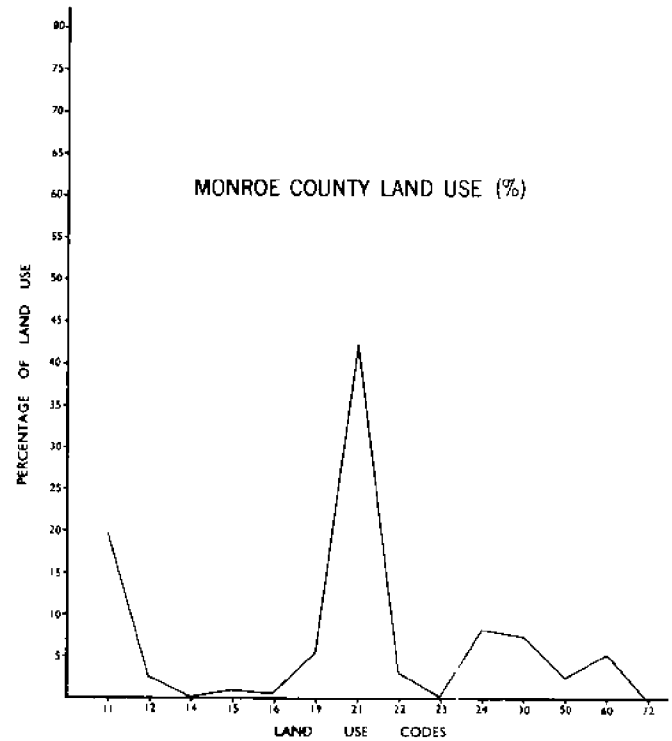

Figure 18 Percentage of Land Use by Category in Monroe County

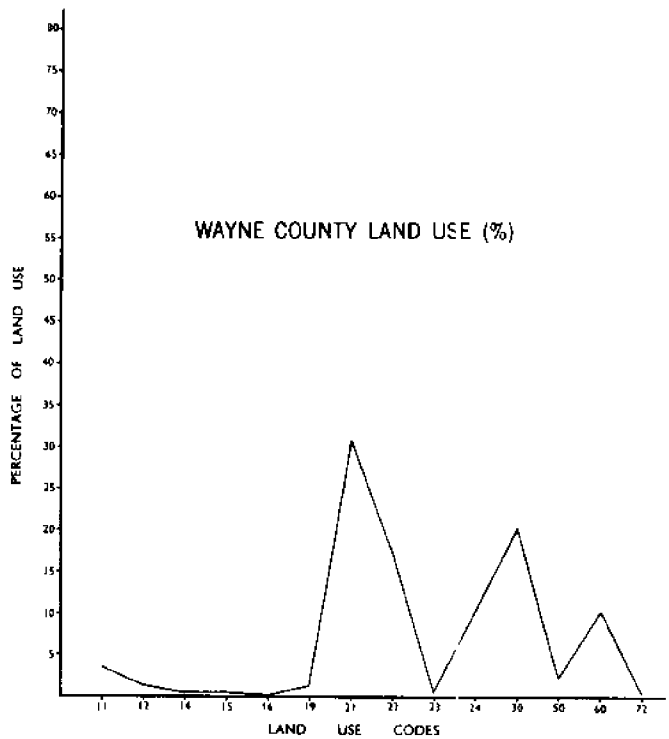

Figure 19 Percentage of Land Use by Category in Wayne County

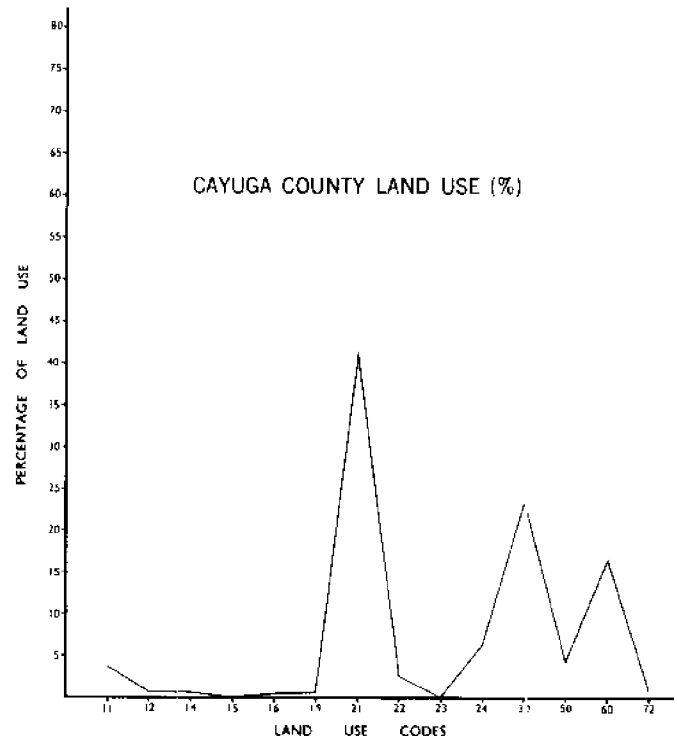

Figure 20 Percentage of Land Use by Category in Cayuga County

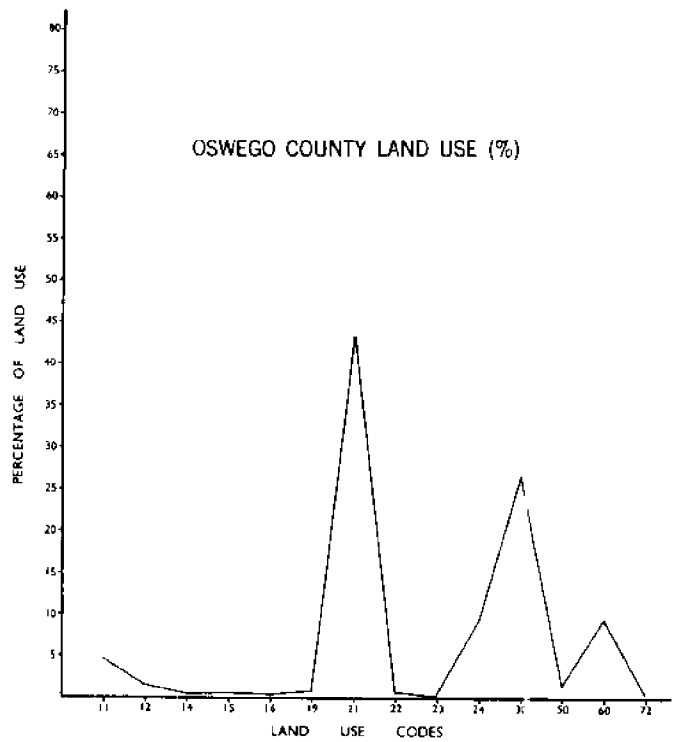

Figure 21 Percentage of Land Use by Category in Oswego County

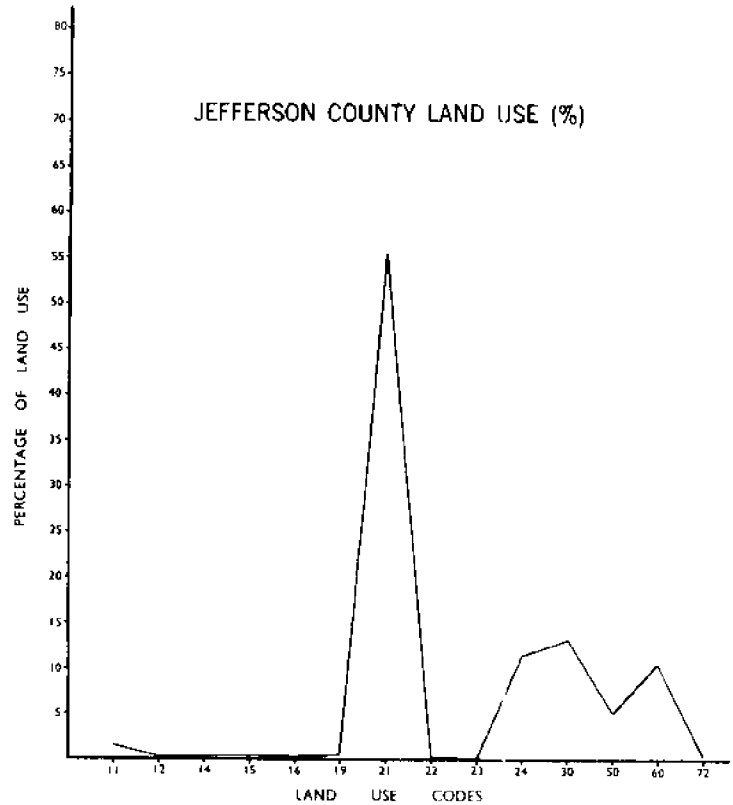

Figure 22 Percentage of Land Use by Category in Jefferson County

APPENDIX 1

The actual procedures involved in acquiring the land use data for the LOLUIS study area were discussed in the text. In reality most of the information existed in graphic or tabular form. Figure 1 portrays the sequence that was executed in order to measure the land use activities described in this study. Once the remotely sensed data were interpreted a parcel map was produced for the region. A partial map is shown in Figure 2. Some patterns on the photographs were not clearly discernible. This coupled with the temporal lag between the date of the photographic mission and the study date necessitated an exhaustive field check of the shoreline. Required annotations were made to the parcel maps (Figure 3) and the data base was then gridded with 5 hectare cells (Figure 4). Dominant land use information was converted to MRF (Machine Readable Format) allowing for computation and computerized mapping (Figures 5-10). These computer maps portray the locations of the 6 top ranked LOLUIS categories for the area shown in Figure 2. Any of the land use categories or combinations of categories can be extracted and mapped in this manner.

The initial data acquisition and mapping was carried out utilizing 58 three to four mile wide data enumeration divisions along the Lake Ontario coast. The types of information described above are available for any location within the study area.

APPENDIX FIGURE CAPTIONS

Figure 1 Sequence of Operations

Figure 2 A Portion of a Parcel Map from the Rochester East Quadrangle

Figure 3 Field Update of Parcel Map

Figure 4 Grid Placement for Analysis and Mapping

Figure 5 Computer Map of Cell Data for Landuse Category 21 (Cropland and Pasture)

Figure 6 Computer Map of Cell Data for Landuse Category 30 (Forest and Woodland)

Figure 7 Computer Map of Cell Data for Landuse Category 24 (Forest Scrub)

Figure 8 Computer Map of Cell Data for Landuse Category 60 (Wetlands)

Figure 9 Computer Map of Cell Data for Landuse Category 11 (Residential)

Figure 10 Computer Map of Cell Data for Landuse Category 22 (Orchards, Groves, Vines, and Horticultural Areas)

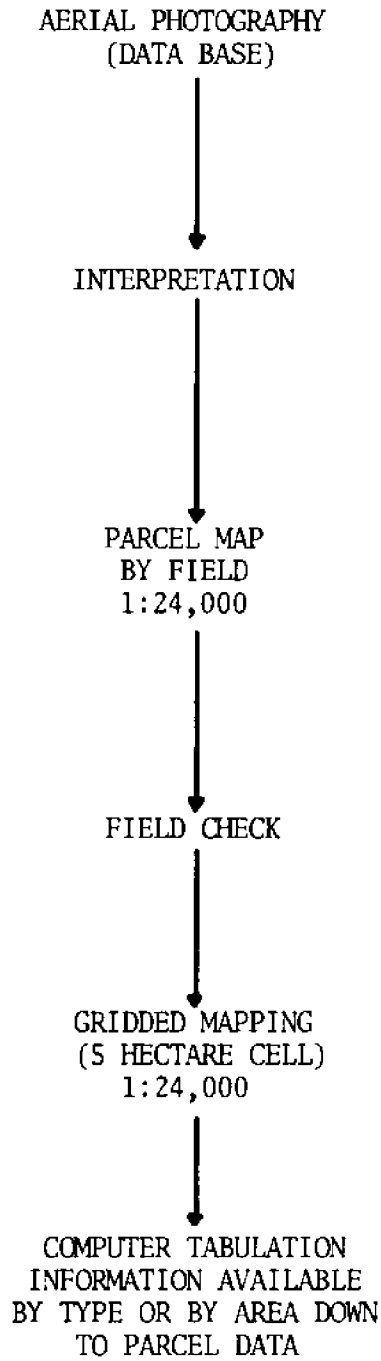

Figure 1. Sequence of Operations

Figure 2. A portion of a parcel map from the Rochester East Quadrangle.

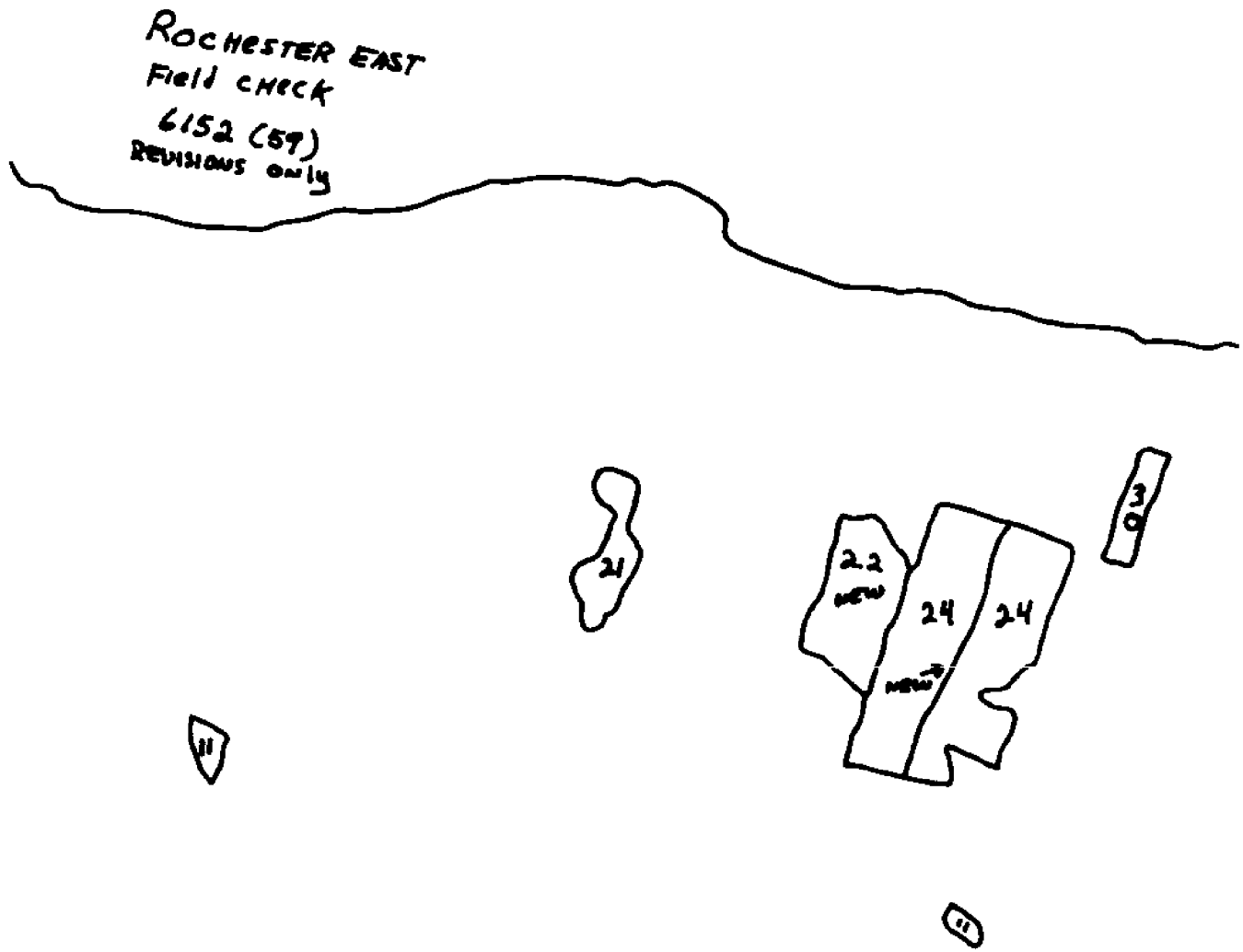

Figure 3. Field update of parcel map.

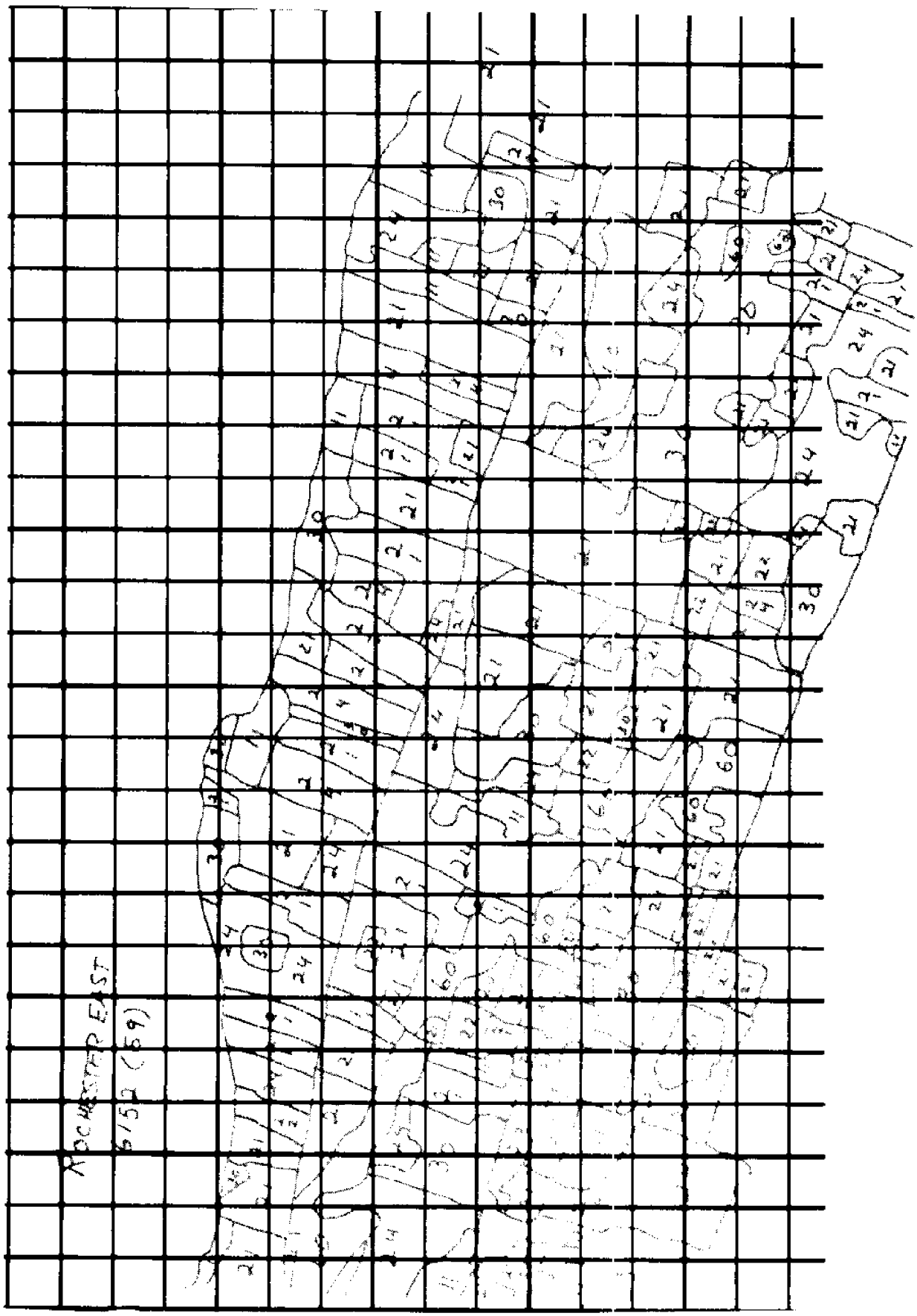

Figure 4. Grid placement for analysis and mapping.

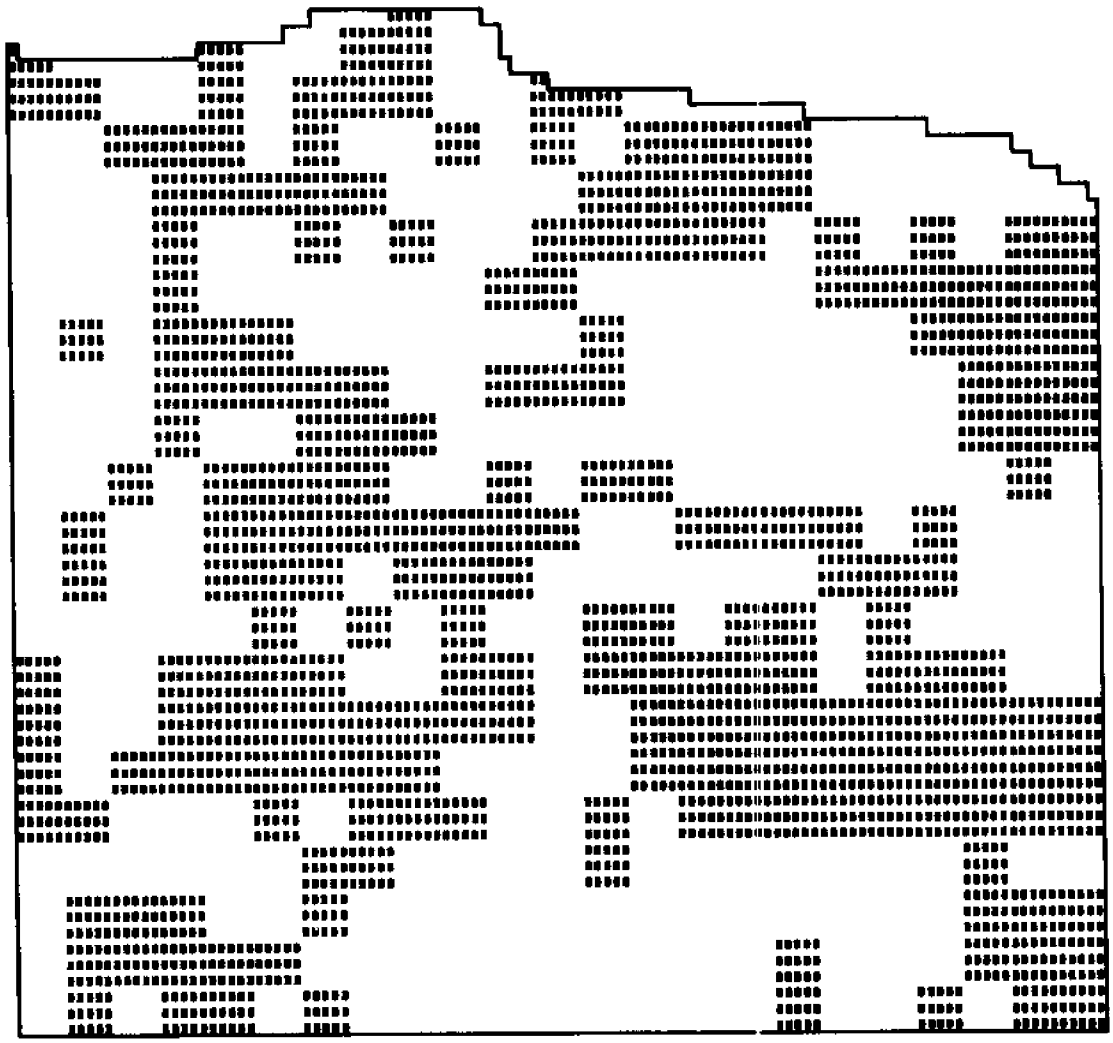

Figure 5. Computer Map of Cell Data for Landuse Category 21.

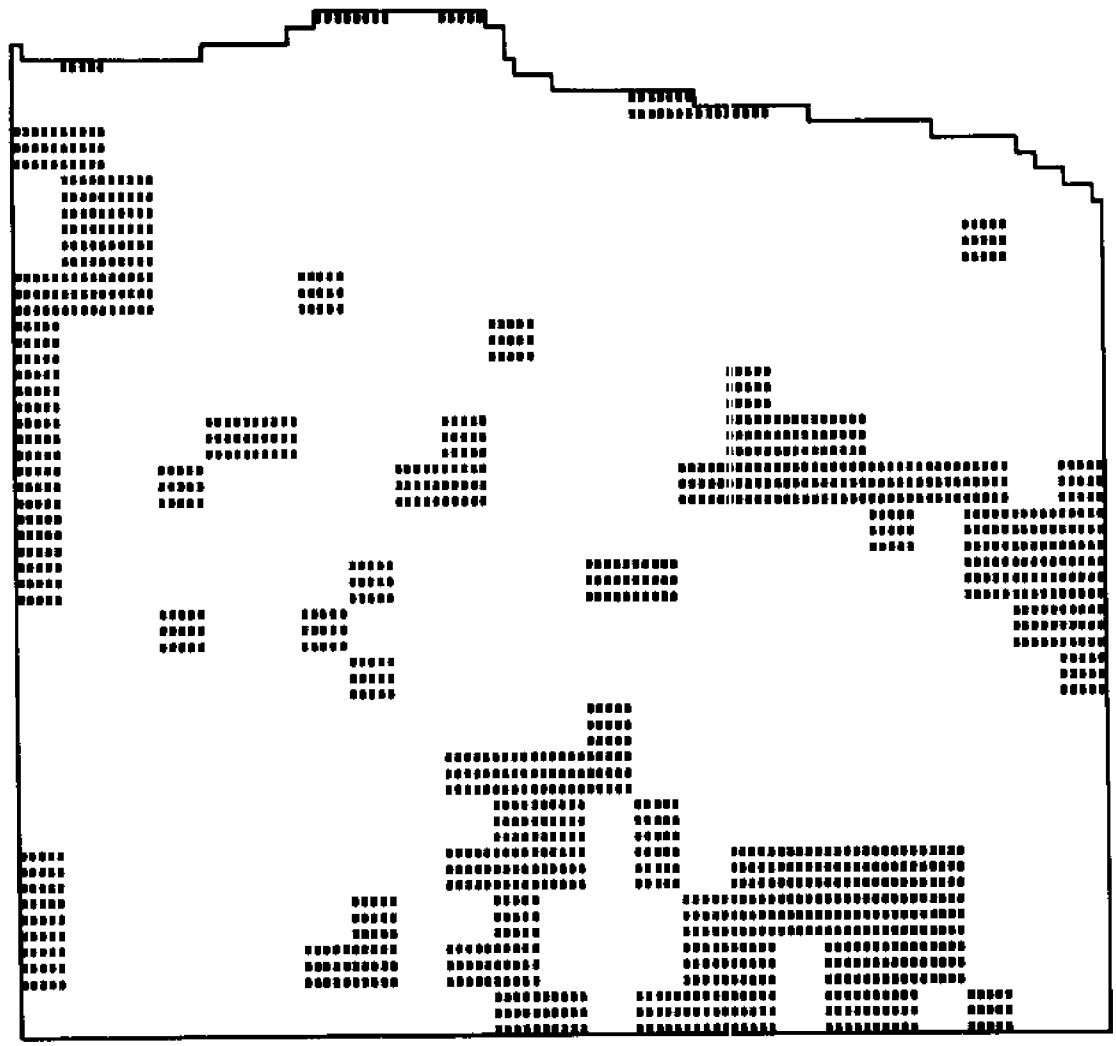

Figure 6. Computer map of cell data for landuse Category 30.

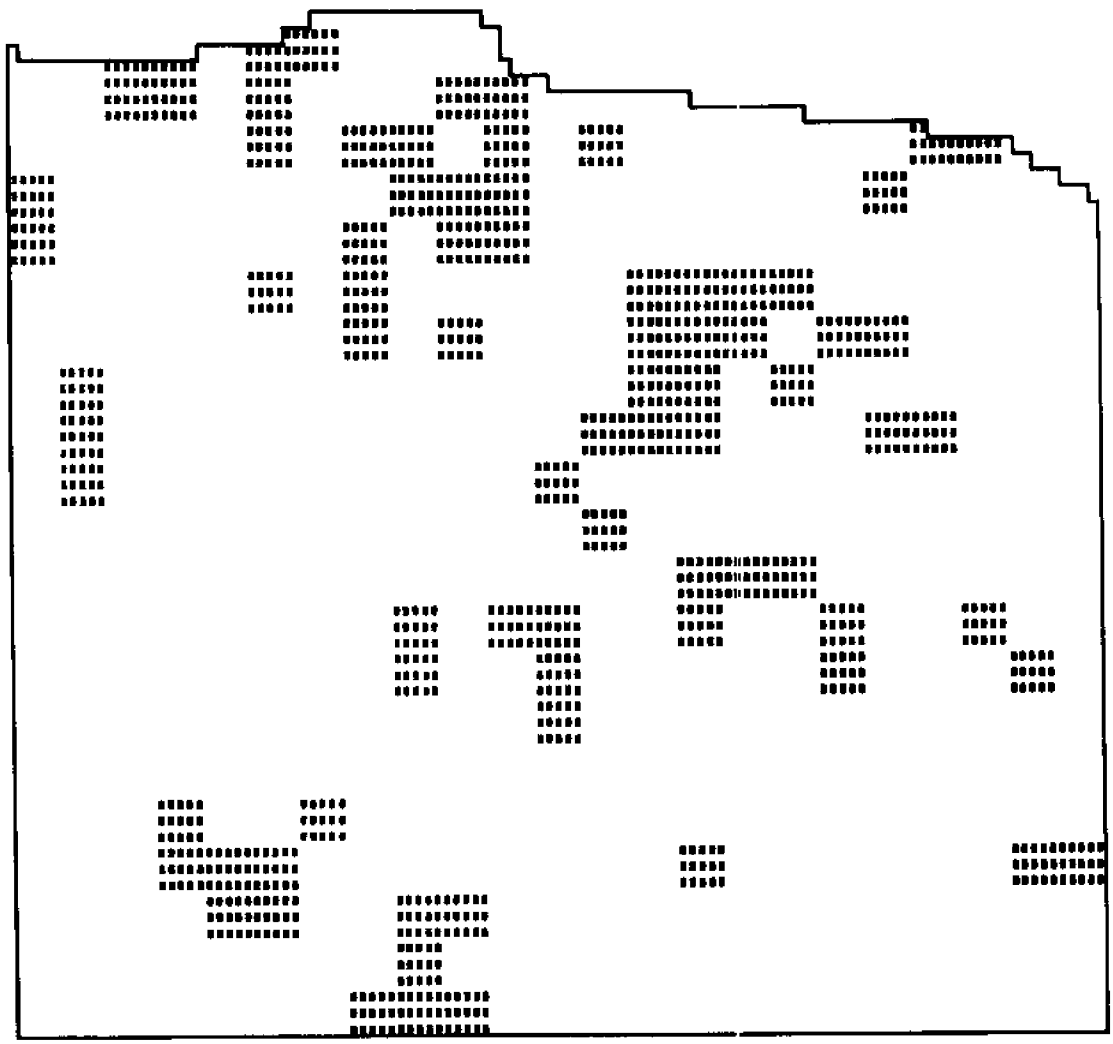

Figure 7. Computer map of cell data for landuse Category 24.

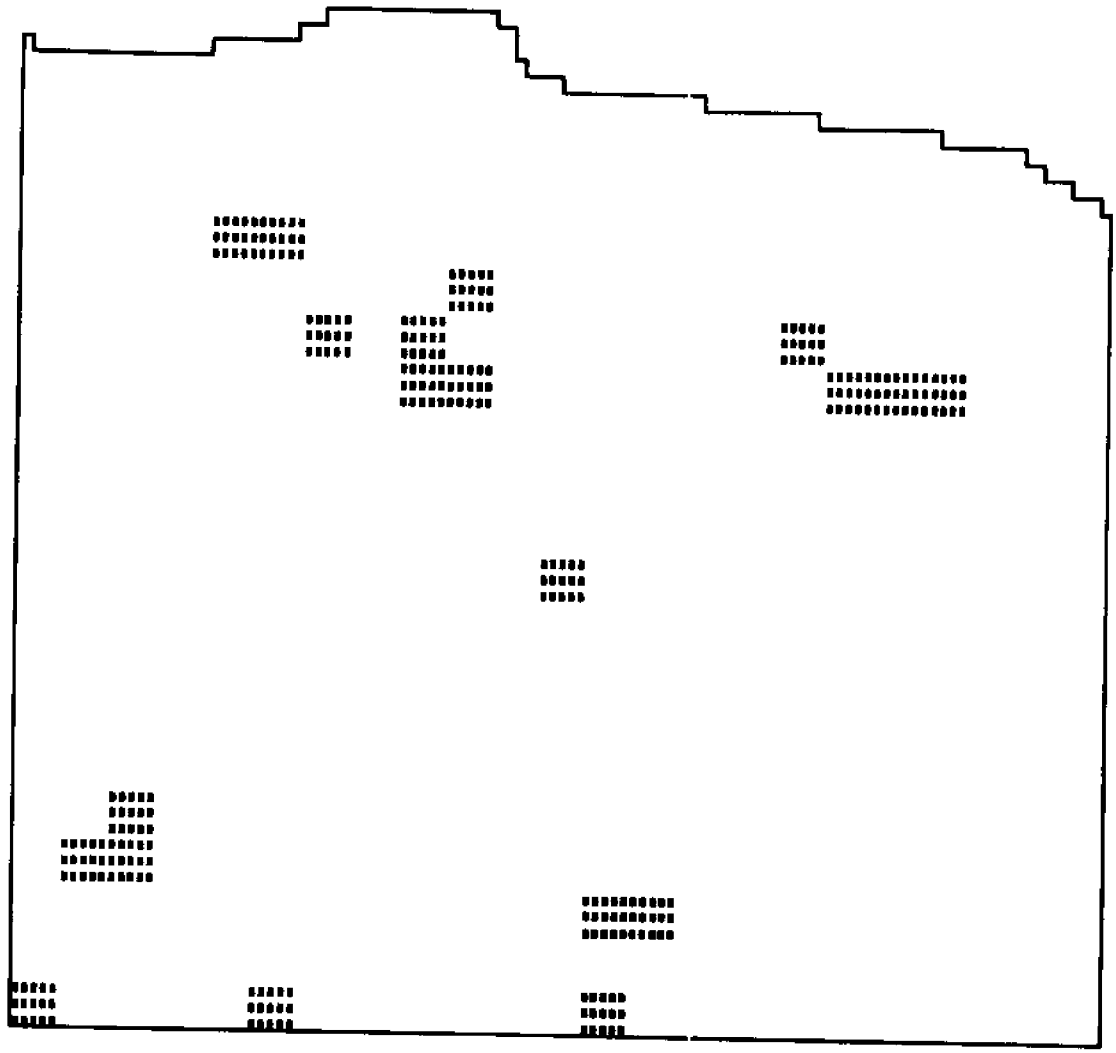

Figure 8. Computer map of cell data for landuse Category 60.

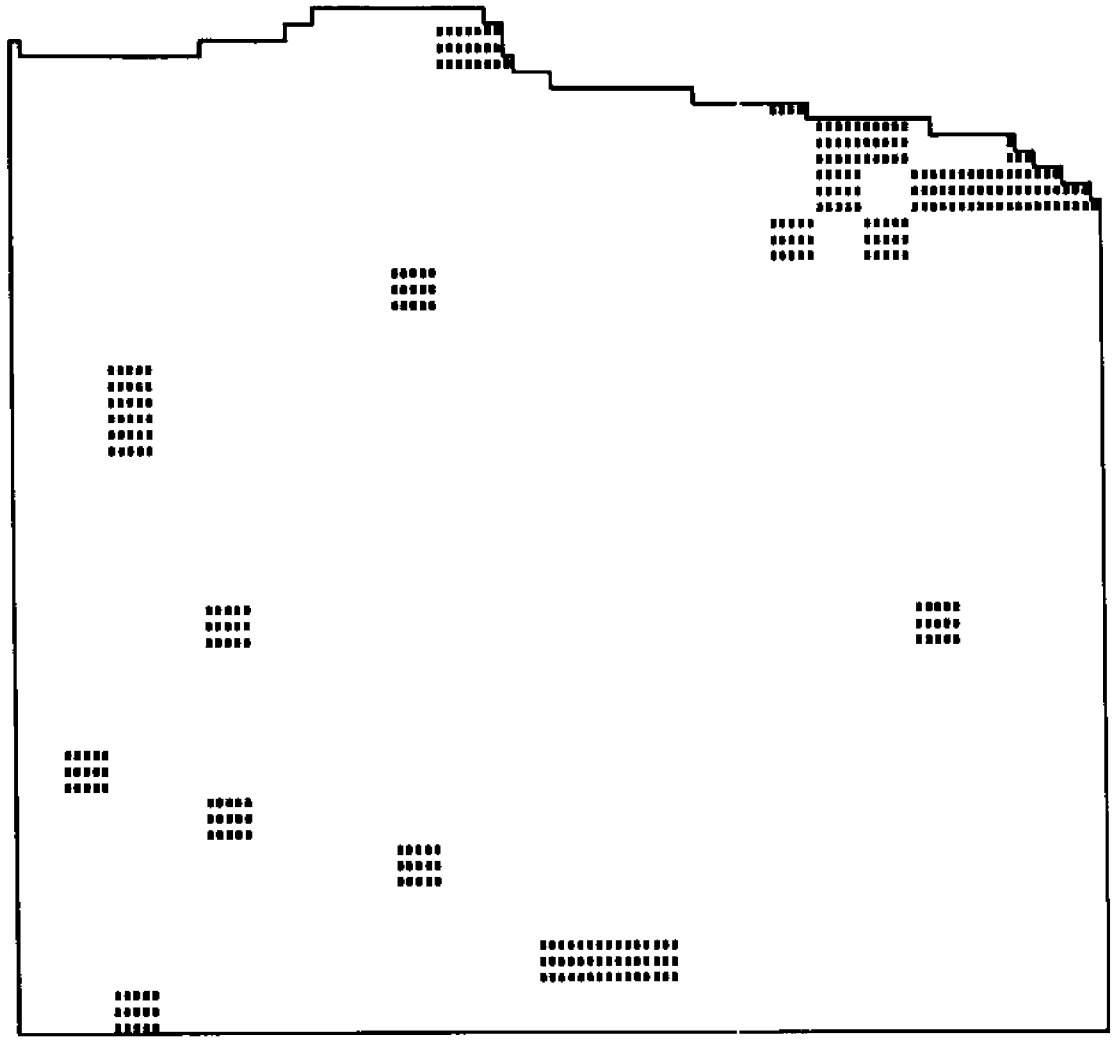

Figure 9. Computer map of cell data for landuse Category 11.

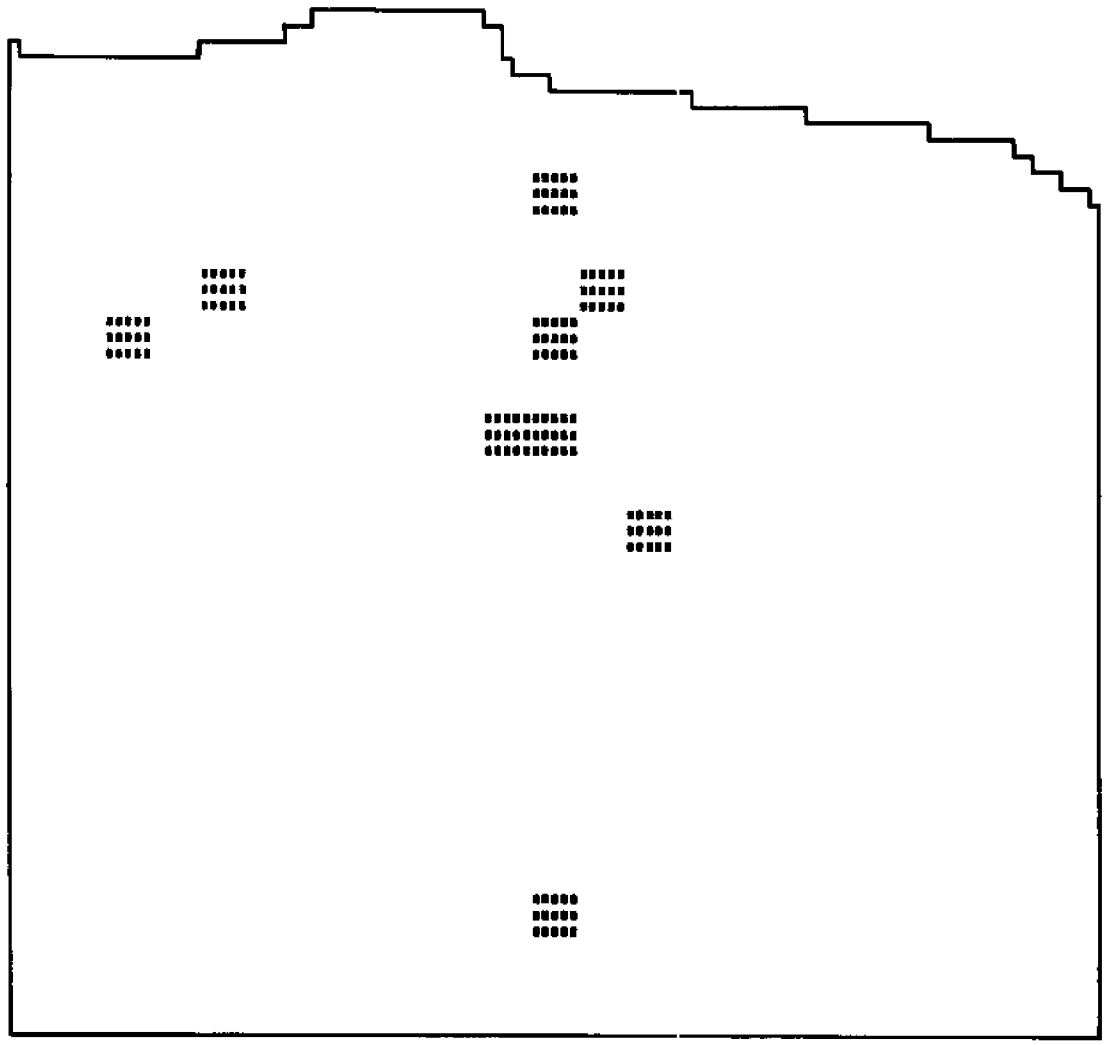

Figure 10. Computer map of cell data for landuse Category 22.