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Background Paper**



**A Changing Great Lakes Economy:
Economic and Environmental Linkages**

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Background Paper

A CHANGING GREAT LAKES ECONOMY: ECONOMIC AND ENVIRONMENTAL LINKAGES

**David R. Allardice
Federal Reserve Bank of Chicago
Chicago, Illinois**

**Steve Thorp
Great Lakes Commission
Ann Arbor, Michigan**

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Linda Aguilar, Federal Reserve Bank of Chicago (FRBC)

Bill Testa, FRBC

Eric Hartman, Northeast-Midwest Institute

Ted Cowan, Environment Canada

Angela Zeiler, Environment Canada

Tom Muir, Environment Canada

Sally Lerner, University of Waterloo

NOTICE TO READER

These Background Papers are intended to provide a concise overview of the status of conditions in the Great Lakes. The information they present has been selected as representative of the much greater volume of data. They therefore do not present all research or monitoring information available. The Papers were prepared with input from many individuals representing diverse sectors of society.

The Background Papers were first released as Working Papers to provide the basis for discussions at the first State of the Lakes Ecosystem Conference (SOLEC) in October, 1994. Information provided by SOLEC discussants was incorporated into these final SOLEC background papers. SOLEC was intended to provide key information required by managers to make better environmental decisions.

EXECUTIVE SUMMARY

The Great Lakes Basin, containing the world's largest system of fresh water, is the resource centerpiece of a major industrial and agricultural region of North America. Although the region straddles an international border which separates distinct political traditions and national cultures, an integrated resource base and manufacturing complex has developed. This binational regional economy with its historical ties to the Great Lakes and its manufacturing sector strengths is continuing to evolve. Increased competition within the domestic and global economies, a maturing industrial and supporting infrastructure, continued urbanization and the environmental impacts of economic and social activity have placed the region at a strategic and historic crossroads. A new development path is inevitable.

In the development of the Great Lakes region, water was not just important; it was the most important factor guiding settlement and establishing the economy. The natural water routes and canal links channeled territorial expansion, and with it came the underpinnings for economic development, including water-dependent transportation and industrial operations. From this water genesis, an agricultural-industrial complex was created, and it continued to expand abetted by a productive labor force and an entrepreneurial business class. Technological innovation was the rule-of-the-day as new manufacturing methods were pioneered, resulting in a profusion of products. Standardization of goods and mass production combined with relatively high wages created a consumer society. The region with its concentration of steel and iron production and metal fabricating naturally spawned a large cluster of durable goods manufacturing operations. Machinery, transportation and other equipment, appliances, motor vehicles and construction materials became manufacturing mainstays. Through this production bonanza, the region helped build the rest of Canada and America.

Within the Great Lakes region, the Canadian and U.S. economies reveal strong present-day linkages and many similarities to one another. They are not, though, mirror reflections, but portray significant differences in economic performance and structure. For example, as the greater regional economy becomes more diversified and less concentrated in the manufacturing sector, Ontario and parts of the western Great Lakes region continue to industrialize. Nevertheless, the flow of resources, merchandise and information between Ontario and the Great Lakes states inextricably binds the two sides of the regional economy together and makes it an economic force in the global arena.

The Great Lakes Basin represents nearly 11% of total employment and 15% of manufacturing employment for the two nations. Total Basin employment increased between 1970 and 1990 but it should be noted that on the U.S. side of the border the growth rate of total employment in the Basin was less than half the growth rate for total employment in the U.S. (25% vs. 53%). Similarly, while total employment in Canada during this period grew at a 15% rate, total

employment in the Canadian counties in the Basin grew by only 6%.

The most dramatic employment change that has occurred in the region is the redistribution of jobs among industries as is demonstrated by the decline in manufacturing jobs. Nearly 21% of the Basin's manufacturing jobs were lost between 1970 to 1990, with the greatest number of jobs being lost in the manufacturing industries within the Lake Michigan basin. In contrast, while hardly robust, total manufacturing jobs in the U.S. actually increased by only .3%, whereas in Canada, they grew strongly by 22%.

The transboundary integration of the regional economy has had much to do with making U.S.-Canada trade the largest such bilateral relationship in the world. The United States and Canada are each other's most important trading partners in terms of value. U.S. exports to Canada comprise more than one-fifth of total U.S. exports, and Canada's exports to the U.S. make up more than two-thirds of its total exports. Trade between Canada and the eight Great Lakes states in 1992 was valued at \$106 billion, or 56.2% of the U.S.-Canada total. Much of this trade volume and value has an Ontario connection with nearly three-fifths of that amount concentrated in autos, automotive parts and engines. Commodity movement via land crossings predominate in total transits and merchandise value, all of which is focused on only 27 highway crossings, 11 rail crossings and 6 ferry crossings.

People, as well as goods, cross the international border in great numbers. The purpose of such trips is quite varied, including job commuting, retail shopping and a wide range of leisure travel. As for U.S.-Canada travel, the Great Lakes states generated 20.4 million person trips to Canada in 1992, or 63% of all such U.S. trips. Great Lakes state travelers accounted for 4.7 million overnight visits to Ontario, which represented about 75% of all such visits to the province. On the other hand, nearly half of Canadian visitors to the United States report a "presence" in the region, but such travel is dominated by day-only stays and pass-through travel. Ontario travelers account for about three-quarters of all Canadian visits to the Great Lakes states.

A region's economy and employment characteristics have a connection to demographic patterns. Great Lakes Basin population figures vary because of different methodologies used to sort out metropolitan and urban county populations that overlap the hydrologic boundary. A reasonable estimate for 1991 is 33.4 million people for the combined Canadian and U.S. Basin populations, including that portion of northeastern Illinois within the original watershed prior to that created with the inter-basin diversion at Chicago. The most populous individual Lake basin is Lake Michigan's, with more than 10 million people, or nearly a third of the total Great Lakes Basin population.

In recent years, compared with its earlier heyday, the Great Lakes Basin population has seen very little growth relative to the rest of the U.S. and Canada. While the combined population of the U.S. and Canada grew by 22% from 1970 to 1990, rising from 225 million to 275 million, the binational population of the Great Lakes Basin grew by less than 1%. Much of the region's population is concentrated in metropolitan areas and most of the Basin metropolitan areas have coastal locations. On the Canadian side, only six metropolitan areas, ranging in size from

Oshawa to Toronto represented 75% of the 1991 Canadian Basin population. The eleven largest U.S. metro areas located completely or partially in the Basin accounted for 81% of the 1990 U.S. Basin population. These 17 Basin metropolitan areas represent nearly 26 million residents.

The Great Lakes' coastal population and areas of concentration reflect the Basin's historical connection to its shorelands. However, the U.S. Great Lakes coastal population overall has not been growing in recent decades. As a percent of the eight-state population, the coastal population dropped a percentage point in each of the last two decades and the total number of residents in these counties has also declined since 1960. This pattern of decline masks a dispersal from the large urban counties to suburban shore counties where "coastal amenities" and growing employment opportunities have combined to increase these county populations. Nevertheless, building activity in Great Lakes coastal counties has been relatively light compared to other coastal regions. According to the U.S. National Oceanic and Atmospheric Administration, the Great Lakes counties, between 1970 and 1989, ranked last in residential, retail and office construction and accounted for only 17% of industrial building during that period. In the region, as elsewhere, industry and service business development have been decentralizing from built-up city locales to suburban—exurban fringe areas and connecting corridors between metropolitan areas. Land and water availability, lower wage scales, transportation access, proximity to new residential markets and other cost/service factors are propelling this kind of sprawl.

The most significant population and related development issue in the Great Lakes Basin and surrounding region is the continuing growth of major metropolitan areas and the virtually uncontrolled sprawl of lower density residential areas and other development. The detrimental consequences of these trends are well-known. Increased water and air pollution generation, higher transportation and residential energy use, increasing encroachment on agricultural lands and natural areas, higher housing costs, disinvestment in older communities and related social disruption and burdensome physical infrastructure requirements portend a more difficult, if not unsustainable, future for the Great Lakes Basin ecosystem. However, the escalating cost of extending utilities and other basic urban services to these lower density regions may ultimately slow the process and stimulate a more sustainable pattern. This new land stewardship ethic would rely more on intensification of development within prescribed boundaries and existing infrastructure capacity.

The Great Lakes Basin, with more than 100,000 square miles of navigable water and 10,579 miles of Great Lakes and connecting channels shoreline anchors an important and growing marine and coastal recreation industry. On the U.S. side of the Basin, of the 178 state parks, 110 have coastal locations. On both sides of the border, coastal parks represent a disproportionate large amount of park system visits. The natural beauty of the Great Lakes shore with large tracts of relatively undeveloped land, coupled with good highway access and proximity of population centers have promoted recreation and tourism-related travel. The recreational boating industry in the Great Lakes is represented by boat manufacturers and retailers, marina operators, marine business suppliers as well as the millions of recreational boaters and anglers. For the Great Lakes alone, it is estimated that between 900,000 and 1 million U.S. and Canadian boats operate each year with a direct spending impact of more than \$2 billion. With a strong

connection to boating, the Great Lakes sport fishery is a major part of regional fishing activity. U.S. federal surveys projected 2.55 million U.S. anglers fished the Great Lakes in 1991 and had total trip-related and equipment expenditures of \$1.33 billion. Expenditures per angler were figured at about \$500 for the year. These examples of coastal and marine recreation activity illustrate the key role the Great Lakes play in the regional economy.

The Great Lakes Basin and surrounding region faces a future filled with opportunities as well as uncertainties. Contending with its historical economic and environmental legacy, the region's next development path can be one that both supports the economy and preserves the environment. This "sustainable development" course will require new measures to enhance economic growth as well as institutional mechanisms among the public and private sectors designed to foster cooperation and coordination in environmental protection.

1.0 The Greater Regional Economy - Historical Development

The province of Ontario and the eight Great Lakes states comprise a major industrial and agricultural region of North America. Although the region straddles an international border which separates distinct political traditions and national cultures, an integrated resource base and manufacturing complex has developed. The substantial economic activity nurtured in the Great Lakes region has had much to do with making U.S.-Canada trade the largest such bilateral relationship in the world.

Economic development created the modern Great Lakes region. Employment opportunities paved the way for a relatively high standard of living and associated quality of life. But with these good times of ever-increasing prosperity, came the seeds of future challenges. The industrial and supporting infrastructure matured and competition within a developing global economy sharpened. Hundreds of thousands of high-paying jobs disappeared resulting in severe economic dislocation for some communities and families.

Environmental degradation was another outcome of the pell-mell industrial era. The binational region's bountiful natural resources which helped sustain economic growth also were depleted, in some cases recklessly. The Great Lakes, the region's resource centerpiece and the world's largest system of freshwater, was damaged by Basin development and is still threatened.

In the development of the Great Lakes region, water was not just important; it was the most important factor for guiding settlement and establishing the economy. A growing seaboard population and the 19th-century influx of immigrants spurred westward movement toward the Great Lakes. The natural water routes and canal links channeled territorial expansion and with it came the underpinnings of economic development. The passenger and freight network distributed people and goods throughout the waterway system. Localized services for shore communities gradually expanded to support larger markets and hinterlands. The first major "gateway" cities in the region began as ports, such as Montreal, Cincinnati, Toronto, Pittsburgh, Buffalo, Cleveland, Detroit, Chicago, Milwaukee, and Minneapolis-St. Paul. When the railroads came, they connected the cities of the water-based urban system.

An early dependence on water characterized these developing cities of the North American interior. The major settlement period of the Great Lakes region coincided with the rapid development of industrial technologies and processes. Proximity to productive agricultural land and access to important raw materials, coupled with a growing labor force, gave the region an unparalleled advantage in domestic and overseas markets. Direct application of water power had a more limited role in the Great Lakes cities compared with places inland; rather, water transportation was the foundation of shore-based manufacturing and related activities. Water-intensive industrial operations, whether located on the waterfront or nearby, were a natural result

of water availability. In many cases, the waterborne shipment option for raw material delivery and movement of finished goods was a major location determinant.

One of the first major water-connected industries to make use of the Great Lakes was logging and sawmilling, with gigantic log rafts moved around the system as the extensive white pine forests surrounding the upper Lakes were logged. Coal made its way overland to the eastern Great Lakes ports and from there was distributed by vessel for heating and, later, steelmaking and electricity generation. Massive movements of iron ore from northern Minnesota and Michigan to lower Lakes steel mills and grain flows to eastern flour mills made the Great Lakes transportation system the busiest in the world for many years. This shipping "backbone" of Great Lakes commercial navigation was made possible with the construction of a ship canal and lock system, opened in 1855 at Sault Ste. Marie, Michigan and upgraded several times over the years. The iron ore and coal movements coupled with grain flows to eastern flour mills made the Great Lakes transportation system the busiest in the world for many years. These commodity movements materialized in response to the developing continental industrial base that was concentrated in the Great Lakes region.

This agricultural-industrial complex continued to expand, abetted by a productive labor force and an entrepreneurial business class. Technological innovation was the rule-of-the-day, as new manufacturing methods were pioneered resulting in a profusion of products. Standardization of goods and mass production combined with relatively high wages created a consumer society. The region with its concentration of steel and iron production and metal fabricating naturally spawned a large cluster of durable goods manufacturing operations. Machinery, transportation and other equipment, appliances, motor vehicles and construction materials became manufacturing mainstays. Through this production bonanza, the region helped build the rest of Canada and America.

Within the Great Lakes region the Canadian and U.S. economies reveal strong present-day linkages and many similarities to one another. However, both sides of the border are not mirror reflections, but portray significant differences in economic performance and structure. For example, as the greater regional economy becomes more diversified and less concentrated in the manufacturing sector, Ontario and parts of the western Great Lakes region continue to industrialize. Nevertheless, the flow of resources, merchandise and information between Ontario and the Great Lakes states inextricably binds the two sides of the regional economy together and makes it an economic force in the global arena.

2.0 The Great Lakes Basin - Population and Employment

2.1 Population

The Great Lakes Basin is the principal geographical feature of the binational region. See Figure 1. Encompassing nearly 300,000 square miles, including 95,000 square miles in the Great Lakes and connecting waters themselves, the Basin forms the central core of the region with more than a third of the area's population and a substantial portion of its industrial activity. The magnificent water resources of the Basin, which make up 20% of the surface freshwater on earth, have had a key role in supporting the Basin population and area industrial development.

Great Lakes Basin population figures vary because of different methodologies used to sort out metropolitan and urban county populations that overlap the hydrologic boundary. A reasonable estimate for 1991 is 33.4 million people for the combined Canadian and U.S. Basin populations. Table 1 and Figure 2 show the population for the individual Great Lakes basins.

TABLE 1
POPULATION OF THE GREAT LAKES BASINS

| STATES | Lake Superior | Lake Huron | Lake Michigan | Lake Erie | Lake Ontario | Basin Totals for Jurisdictions |
|-------------------------|---------------|------------|----------------|------------|--------------|--------------------------------|
| Indiana | | | 1,087,494 | 339,264 | | 1,426,758 |
| Illinois | | | 3,494,115 | | | 3,494,115 |
| Michigan | 142,606 | 1,502,687 | 3,007,954 | 4,646,843 | | 9,300,090 |
| Minnesota | 212,796 | | | | | 212,796 |
| New York | | | | 765,537 | 2,702,065 | 3,467,602 |
| Ohio | | | | 4,023,625 | | 4,023,625 |
| Pennsylvania | | | | 242,261 | 2,219 | 244,480 |
| Wisconsin | 70,146 | | 2,467,463 | | | 2,537,609 |
| U.S. TOTAL* | 425,548 | 1,502,687 | 10,057,026 | 10,017,530 | 2,704,284 | 24,707,075 |
| Canada TOTAL** | 181,573 | 1,191,467 | Not applicable | 1,664,639 | 5,446,611 | 8,487,210 |
| Great Lakes Basin TOTAL | 607,121 | 2,694,151 | 10,057,026 | 11,682,169 | 8,150,895 | 33,384,157 |

* U.S. total is based on 1990 census data

** Canada total is based on 1991 census data

Source: Great Lakes Commission and Environment Canada

One area of the Great Lakes Basin that presents special problems for determining Basin population is in the Chicago metropolitan area where substantial alteration of the natural hydrologic basin and direction of water flow has occurred. As a water quality measure, Lake Michigan water is diverted through the Illinois waterway at a long-term average rate of 3,200 cubic feet per second. This diversion, which has been in effect since 1989 along with a more recent one affecting the Calumet River, has converted 673 square miles of original Lake Michigan watershed into part of the Illinois River-Mississippi River drainage basin. By using the original Lake Michigan basin boundary rather than the present "man-made" one which demarks a drainage area only 11 percent of its former size, the population of the Lake Michigan basin is increased by nearly 3 million persons, almost all residing in Cook county.

In recent years, compared with its earlier heyday, the Basin population has seen very little growth relative to the rest of the U.S. and Canada. For example, while the combined population of the U.S. and Canada grew by 22% from 1970 to 1990, rising from 225 million to 275 million, the binational population of the Great Lakes Basin grew by less than 1%. This disparity in population growth rates indicates a redistribution in regional economic activity with older, industrialized regions, such as the Basin, losing population in favor of newer, expanding regions. In the U.S. this has taken the form of people relocating to the South and Southwest as the rapid growth of these economies has become a magnet for migration. Climate-influenced retirement moves have added to the outbound numbers.

Both sides of the border reflect similar and divergent population trends. Ontario, with more than a third of Canada's population, has been gaining population nearly twice as fast as the Great Lakes states but its rate of growth is also slowing. By 1990, the Great Lakes States' population increased by only 1.7% since 1970 whereas Ontario's 1991 population increased by nearly a third or 31% from 1971. Both Canada and the United States are experiencing similar age structure changes as the post-war baby boom bulge advances. A new baby boom is likely to kick in by the end of the 21st century's first decade when births are expected to increase steadily. Fertility patterns by race and ethnicity are expected to remain varied.

Household structure is another major demographic factor that is affecting society and the economy. American household size has declined to record low levels (2.6 persons in 1990). Fewer children, more one-person households and one-parent families have contributed to the decline. A major socio-economic problem is the increase in one-parent households and its effect on family income—these families represent three-fifths of all families living below the poverty level. A "cycle of poverty" among these households has contributed to increasingly violent and dysfunctional urban environments, particularly in the large U.S. cities including those in the Great Lakes region. Another ominous portent for the region linked to the increase in relatively poor single-parent households as well as the general aging of the population, is the dampening of demand for durable goods and its consequent effect on one of the region's strengths, manufacturing employment.

Much of the region's population is concentrated in metropolitan areas. With the exclusion of

New York and Pennsylvania, two-fifths of the binational region's population is concentrated in just seven urban areas: Chicago, Cleveland, Detroit, Indianapolis, Milwaukee, Minneapolis-St. Paul and Toronto. Within the Great Lakes Basin, the urban dominance is even more pronounced. On the Canadian side only six metropolitan areas, ranging in size from Oshawa to Toronto, represented about 67% of the 1991 Canadian Basin population. The 11 largest U.S. metro areas located completely or partially in the Basin accounted for 81% of the 1990 U.S. Basin population. These 17 Basin metropolitan areas represent nearly 26 million residents. Table 2 shows population and labor force data for selected Basin metropolitan areas.

TABLE 2
POPULATION, TOTAL BASIN EMPLOYMENT AND LEADING ECONOMIC SECTORS
FOR SELECTED METROPOLITAN AREAS*

| UNITED STATES | POPULATION | LABOR FORCE | RETAIL/ WHOLESALE TRADE | MANUFACTURING | COMMUNITY SERVICES ² |
|---------------|------------|-------------|-------------------------------|---------------|------------------------------------|
| Chicago | 6,069,974 | 3,176,270 | 634,884 | 552,686 | 672,938 |
| Detroit | 4,665,236 | 2,326,077 | 459,629 | 517,267 | 500,172 |
| Cleveland | 2,102,248 | 1,359,901 | 276,344 | 292,728 | 309,772 |
| Milwaukee | 1,432,149 | 742,474 | 150,153 | 168,746 | 166,568 |
| Buffalo | 1,189,288 | 584,658 | 124,118 | 101,947 | 148,058 |
| Rochester | 1,002,410 | 519,059 | 92,289 | 132,954 | 128,640 |
| CANADA | POPULATION | LABOR FORCE | RETAIL/ WHOLESALE TRADE | MANUFACTURING | COMMUNITY SERVICES |
| Toronto | 3,893,046 | 2,229,090 | 389,555 | 384,815 | 451,835 |
| Hamilton | 599,760 | 322,875 | 58,290 | 70,330 | 74,645 |
| London | 381,522 | 211,690 | 37,965 | 33,425 | 55,900 |
| Kitchener | 356,421 | 200,715 | 35,600 | 51,830 | 41,755 |
| Windsor | 262,421 | 133,445 | 21,820 | 36,580 | 29,915 |
| Oshawa | 240,104 | 131,990 | 21,296 | 31,605 | 25,595 |

- * U.S. data is from 1990 census.
Canada data is from 1991 census
- ¹ Listed city is the principal city for metropolitan statistical area which may have a multiple city designation
- ² Community services includes such occupations as health, education, religion etc.

Coastal Development

Most of the Basin metropolitan areas have coastal locations. Other coastal areas represent a sizable portion of the remainder Basin population. The 85 coastal counties in the Great Lakes states have about 19 million residents, which represents about 17% of the U.S. coastal population. With only 25% of the total Great Lakes states' population located in coastal counties, this attribute is not a hallmark of the region compared to other coastal areas, but it is particularly significant for several states. Michigan and Illinois have about half of their states' populations residing in coastal counties and Wisconsin has more than a third. Nevertheless, the coastal county population is spread quite unevenly. For example, coastal population density ranges from a paltry 22 people per square mile in Minnesota to 4,040 in Illinois but averages 275 persons throughout the region compared to 183 persons per square mile for the entire eight state area. Another measure of coastal population entails a calculation based on shoreline mile and on this basis the Great Lakes county shorelines in 1988 had the highest average number of persons per mile (3,835) for a major coastal area in the U.S. Illinois' two coastal counties lead the nation with more than 91,000 persons per mile of shoreline and Indiana's three counties with nearly 16,000 persons per shoreline mile is second highest in the region. If Indiana's Lake Michigan basin population is used which represents only parts of the three coastal counties, then the population per shoreline mile is more than 24,000.

The Great Lakes' coastal population and areas of concentration reflect the Basin's historical connection to its shorelands. However, the overall U.S. Great Lakes coastal population has not been growing in recent decades. As a portion of the eight-state population, the coastal population dropped a percentage point in each of the last two decades, and the total number of residents in these counties has also declined since 1960. This pattern of decline masks a dispersal from the large urban counties to suburban shore counties where "coastal amenities" and growing employment opportunities have combined to increase these county populations.

As for outlying counties, the heyday for second-home development appeared to peak in the 1960s, and the National Oceanic and Atmospheric Administration (NOAA) projects relative slow population growth for most of these counties from 1988 to 2010, with a few exceptions. In the binational Great Lakes region, the tens of thousands of inland lakes within the Basin and nearby have acted to "deflect", to a certain extent, interest in residing on a Great Lakes shore. This factor combined with already extensive second-home development and retirement living within the coastal zone have probably blunted Great Lakes development pressure from what might have occurred had the inland resort areas not been available. According to NOAA, between 1970 and 1989 building activity in Great Lakes coastal counties was particularly light compared with other coastal areas. As reflected in the number of building permits issued, the Great Lakes counties ranked last in residential, retail and office construction and accounted for only 17% of industrial building during that twenty-year period. In the region as elsewhere, industry and service business development have been decentralizing from built-up city locales to suburban—exurban fringe areas and connecting corridors between metropolitan areas. Land and water availability, lower wage scales, transportation access, proximity to new residential markets and other cost/service factors are propelling this kind of sprawl.

Immigration

A population issue that is receiving increasing attention in the region is the level of immigration and related pattern of settlement and lifestyles. Ontario is presently a destination for more than 50% of immigrants to Canada, and two thirds of these new residents, or about 100,000 a year, have been locating in the Greater Toronto Area. For the Great Lakes states, immigration is also concentrated geographically but less so within the Basin. The U.S. Bureau of Census projects that between 1995 and 2000 net immigration to the Great Lakes states will total to 898,000 with more than half of this amount entering through New York City. Illinois, the other leading region state for immigration, is expected to have 178,000 new arrivals with most of these people residing in the Chicago metro region. Some major metropolitan areas receive particular attention by one or more ethnic or racial groups. For example, the Chicago metropolitan area is attractive to persons of Hispanic origin whereas the Detroit area has the largest Middle Eastern contingent in the United States. Asian and Pacific Islander immigration to both Canadian and U.S. places in the Great Lakes Basin is reasonably strong.

In the U.S. an emerging political issue concerns the estimated 3.85 million illegal immigrants in the country and the associated cost of social welfare programs. Several southern states have sued the federal government seeking reimbursement for some of these costs. In Canada, public debate about the government's immigration policy concerns the level and impact on the national economy. During recent recession periods, sensitivity about these issues increased with concern expressed particularly about the number of non-working persons admitted under the family reunification category. Recent studies of immigrant households in the U.S., may assuage some of these concerns—that average household income of legal immigrants surpasses that of natives over time. Immigrants present new challenges and opportunities for their communities and the Great Lakes Basin. Immigrants infuse spirit in their new locales with distinct cultural traditions and entrepreneurial propensities. However, they also add to the total population pressures on the environment and can strain health, welfare and education systems. Lifestyles of immigrants though, may resist ready incorporation of "western" resource consumption habits and associated environmental impacts but relentless acculturation processes usually narrow the gap over time.

Urban Sprawl

The most significant population issue in the Great Lakes Basin and surrounding region is the continuing growth of major metropolitan areas and the virtually uncontrolled sprawl of lower density residential areas. The negative consequences of these trends are well known. Population-related pollution generation, higher transportation and residential energy use, increasing encroachment on agricultural lands and natural areas and burdensome physical infrastructure requirements portend an unsustainable future.

The northern shore of western Lake Ontario exemplifies these current population growth and distribution pressures within the Basin. Anchored by the Greater Toronto Area (GTA), the area has experienced a 50% population increase since 1970 and contains 10 of Canada's 25 largest municipalities. Urban sprawl has spread more than 100 kilometers from central Toronto making surrounding counties the fastest growing in the province. This settlement pattern in the GTA has resulted in a substantial cumulative loss of productive agricultural land, now estimated at 5,000 hectares per year. From 1981 to 1986 urban development in the GTA consumed nearly 21,000 hectares.

Development is impacting all elements of the region's ecosystem from degraded water and air

quality to increased costs for managing the urban services infrastructure. The provision of adequate transportation services is particularly stressed by increasing urban sprawl. Traffic volume in the GTA is expected to increase about 6% per year straining the area's transportation system with increasing road congestion, pollution and longer commuting times and distance. By 2011, commuter trips for Metro Toronto, based on current trends, could nearly double to around 500,000 each day but this level may be impossible to achieve unless transit use is dramatically increased. The GTA already has a high level of transit use by commuters for a major metropolitan area at 25%, but much of this is concentrated in the City of Toronto where the population density is 6000 people per square kilometer (15,540 per square mile). Beyond the city boundary, population densities are less than half this figure—not enough to support a viable transit system.

Another area of the Western Lake Ontario region that is confronting particular land use issues is the City of Hamilton and its harbor area which supports the largest concentration of heavy industry in Canada. The bulk of Canada's steel manufacturing, with two large integrated mills, is based on the south shore of the harbor. Of the 45 kilometers of harbor shoreline, more than half are occupied by industrial facilities. Residential use is 11% and only 2% is public open space, mostly marinas and parks. Public access to the waterfront has become a major concern for the residents of the Hamilton metropolitan area. Hamilton harbor water quality is also a public concern and certainly has broad land use implications. The area of the harbor itself represents only 4% of its watershed and water conditions in the harbor are significantly affected by natural runoff and agricultural land use practices (two-thirds of the watershed is agricultural). Pollutants also enter the harbor from combined sewer overflows, atmospheric deposition and loadings from harbor sediments. A Remedial Action Plan process is underway for Hamilton Harbor to address water quality problems and restore beneficial uses.

Northwestern Indiana, northeastern Illinois and southeastern Wisconsin are part of the greater Lower Lake Michigan Megalopolis, the third largest greater metropolitan area in the United States after the Northeast Corridor and Southern California. Lake Michigan is this metropolitan region's defining natural resource, serving as a principal source of drinking water and industrial water supply and shaping transportation routes and population settlement as well as having a major influence on the natural environment. Population growth for all these geographic components has stabilized but distribution characteristics reflect the decentralizing trend in evidence throughout the Basin.

In Northwest Indiana, the three-county population actually decreased about 4% from 1970 to 1990 but all of the loss was in the most urban and industrialized county. In northeastern Illinois, the overall population of the six-county area increased only 4.1% from 1970 to 1990 but residential land consumption increased by an estimated 46%. One hundred and sixty-five municipalities, mostly in outlying areas gained more than 1 million residents while 90 municipalities nearer to the region's center had a net loss of 771,000. A disturbing consequence of this decentralization pattern is the impact on the tax base for those communities not part of the growth picture and associated impact on the provision of basic infrastructure and social services.

In the seven-county Wisconsin area, which includes the Milwaukee metropolitan area, population

increased by less than 1% from 1970 to 1980 and by about 3% from 1980 to 1990. Although only a quarter of this area has an urban land use classification, the rate of urbanization is accelerating. From 1970 to 1985 urban land uses increased by 20% totaling an additional 100 square miles. Much of this land consumption has been at the expense of prime agricultural land which is now the focus of targeted preservation programs.

2.2 Employment

Employment trends in the Great Lakes Basin are influenced by demographic factors and many sector-specific issues. The Basin represents nearly 11% of total employment in the U.S. and Canada.

As Figure 3 shows, total employment has increased, but it should be noted that on the U.S. side of the border the growth rate in the Basin was less than half that of the U.S. (25% vs 53%). Similarly, while total employment in Canada during this period grew at a 15% rate, total employment in the Canadian counties in the Basin grew by only 6%.

The Basin represents 15% of manufacturing employment for the two nations. The most dramatic change that has occurred in the region is the distribution of jobs among industries. It is the economic core of the Basin that has been hardest hit over this period as is demonstrated by the decline in manufacturing jobs (see Figure 4). Domestic and global competitive pressures have led to significant employment decline and a heavy emphasis on enhanced productivity. While the Basin's manufacturers have been able to make great strides to enhance their competitive position through important gains in productivity, the manufacturing employment base has been significantly altered. Nearly 21% of the manufacturing jobs from 1970 to 1990 have been lost, with the greatest number of jobs being lost in the manufacturing industries within the Lake Michigan drainage basin. In contrast, while hardly robust, total manufacturing jobs in the U.S. actually increased by .3%. In Canada they grew by 22%.

Growth in service-sector employment has been dramatic. Since 1970, more than 2 million "service" jobs were added in the Basin, with a growth rate slightly greater than 100% (see Figure 5). However, these jobs have often been lower paying than those in manufacturing that they are replacing. Furthermore, even this impressive rate of growth is behind the combined national growth rates for service jobs from 1970-1990. Given this, it is not surprising to find that as the number of manufacturing jobs declined, personal income growth also slowed. From 1970 to 1980 personal income in the Basin grew by 140%, while from 1980 to 1990 the growth rate fell to 83%.

This restructuring of the Great Lakes Basin economy has been a painful process as jobs have been lost and key industries have seen their economic significance dissipate. However, this difficult and continuing process is producing more efficient competitors who are succeeding in meeting global competition. However, it is this very competition which will provide the ongoing challenge to the region. Current economic research has shown that in economic regions, industries are found to be arranged in clusters, where the productivity of many of the region's firms both big and small, service and manufacturing, reinforce the competitive position of the area economy. An important finding of this research is that regions, not nations or individual

states, will compete for jobs and economic growth in the 1990s. The Great Lakes Basin possesses economic and geographic/resource advantages that are enviable. The Basin, despite considerable economic change, still represents a personal income total of more than \$520 billion, nearly 11% of total employment and 15% of manufacturing employment for the two nations. These strengths give the region a base from which to launch its future.

3.0 U.S. - Canada Trade

The United States and Canada maintain the largest bilateral trade relationship in the world, and are each other's most important trading partners. U.S. exports to Canada comprise more than one-fifth of total U.S. exports and Canada's exports to the U.S. make up more than two-thirds of its total exports. Trade between Ontario and the Great Lakes states accounts for more than half of this binational trade, with three-fifths of the amount concentrated in autos, automotive parts and engines.

The eight Great Lakes states in 1992 exported \$45.191 billion in goods and services to Canada, and imported \$61.036 billion from Canada. The states' \$15.845 billion deficit is nearly twice as big as the overall U.S. deficit of roughly \$8 billion with Canada. Table 3 shows the state-by-state trade totals for 1992.

TABLE 3
CANADA - GREAT LAKES STATE TRADE FOR 1992

| STATE | CANADA IMPORTS | CANADA EXPORTS |
|---------------|-----------------|-----------------|
| Illinois | \$5.789 billion | \$5.234 billion |
| Indiana | 2.157 | 2.903 |
| Michigan | 25.707 | 15.100 |
| Minnesota | 2.252 | 1.775 |
| New York | 14.817 | 6.955 |
| Ohio | 4.819 | 7.638 |
| Pennsylvania | 3.524 | 3.536 |
| Wisconsin | 1.971 | 2.050 |
| TOTALS | 61.036 | 45.091 |

U.S.-Canada trade policy has evolved over many years. One significant development along the way was the 1965 Auto Pact, which ended certain Canadian export subsidies and imposed performance requirements on U.S. auto producers in exchange for the privilege of selling autos in Canada. These requirements led American manufacturers to establish a large assembly base north of the border. More recently, the U.S.-Canada Free Trade Agreement (FTA), which took effect on January 1, 1989, was designed to ratchet down all bilateral tariffs to zero by 1998, with provisions to further enhance trade liberalization including a dispute settlement process.

Because of the FTA's phase-in process and the fact that the great majority of U.S.-Canada goods trade already crossed the border duty free, a quick and substantial trade stimulus was not expected. Although FTA implementation coincided with economic slowdowns in both countries, bilateral trade has increased since 1989, and Canada's significant trade surplus with the U.S. increased. Despite these developments, public opinion, particularly in Canada, reveals a deep reservoir of skepticism about the FTA's benefits. The agreement has been widely blamed for plant shutdowns and significant job losses in manufacturing that have occurred in Canada since 1989. Public concern on both sides of the border has also transferred to the North American Free Trade Agreement (NAFTA), which took effect on January 1, 1994 and seeks to fully incorporate Mexico in continental trade liberalization.

Canada's economic woes since the FTA took effect were caused far less by the FTA than by high interest rates and a recession that hit Canada hard, with gross domestic product falling 0.5% in 1990 and 1.7% in 1991. The FTA actually helped to keep merchandise exports to the United States strong even during that recession, rising 19% from 1988 to 1991. By 1992, the U.S. market absorbed Canadian merchandise exports worth \$98.5 billion, out of total Canadian exports of \$125 billion. The C.D. Howe Institute of Canada found in a 1992 study that Canada's export gains to the United States were especially rapid in those sectors where trade rules were liberalized by the FTA. In the category of office, telecommunications and precision equipment, for example, exports to the United States rose by 74% from 1988 to 1991, at a time when Canada's exports of these goods to the rest of the world fell by 5.5%. To be sure, some Canadian industries have faced far keener competition as the FTA opened up the Canadian market to more U.S. goods. U.S. bilateral export gains, like Canada's, have been rapid in many sectors affected by the FTA, with increases of 100% or more recorded between 1988 and 1992 in categories such as furniture, chemical products, plastics, paper products, apparel, and electric machinery.

One of the FTA's most recognized achievements is in the area of dispute settlement. For the first time, binational panels were given the power to make binding rulings on each nation's use of laws against below-cost "dumping" and unfair subsidization of exports. Canada has prevailed in most of the cases heard by such panels. The issue of subsidization has become the focal point of concern about the FTA and even NAFTA. Critics argue that the scope of binational reviews is too narrow. In a challenge to a U.S. anti-subsidy ruling, for example, the tribunal can decide only if U.S. law was correctly applied, not whether the law's definition of unfair subsidy was sound. Others also argue that dispute resolution takes too long and is too inconclusive, as cases are repeatedly remanded to each nation's trade agencies for reconsideration. Hence, agreement on a common definition of trade-distorting subsidies and dumping is at the top of the agenda as North American trade policy develops and the NAFTA process sorts itself out.

4.0 Selected Economic Sector Profiles

4.1 Manufacturing

The eight Great Lakes states comprise more than one-third of the national manufacturing output while the province of Ontario accounts for more than 50% of Canada's manufacturing activity. The manufacturing sector's share of total employment in both the province and the states is similar at more than 20%. For 1990, 6,770,000 Great Lakes state residents were employed in manufacturing enterprises, and 966,000 Canadians were so employed in Ontario. The binational region's manufacturing share of employment significantly exceeds that of their respective nations. The region's manufacturing sector also illustrates the interconnected nature of industries on both sides of the border. For example, in the mid-1980s, U.S. corporate affiliates in Ontario comprised more than a third of the province's manufacturing employment and an even higher share of related value-added. Canadian direct investment in the Great Lakes states is less pronounced but still accounted for 55,000 more jobs in 1987 than in 1977.

Among individual manufacturing industries, the two parts of the binational regional economy have similar concentrations of jobs in such "metal bending" activities as primary metals production, metal fabrication and transportation equipment. For example, the Great Lakes states account for more than 70% of U.S. steel production, and Canada's four large integrated mills are all in Ontario. In vehicle and related parts production the region also stars, with the Great Lakes states producing 6 out of every 10 automobiles made in the U.S., and more than half of the national truck and bus total. Ontario has more than four-fifths of Canada's vehicle assembly work.

Ontario and the Great Lakes states differ, though, with respect to other major industry groupings. Ontario firms are more concentrated in labor-intensive and resource-intensive industries such as paper, lumber, furniture, textiles and apparel than are firms on the U.S. side of the border. The U.S. region tends to have greater representation in industries where capital and technology intensity characterize the production processes, as in pharmaceuticals, machinery, instruments and electronics.

Substantial changes are occurring in Ontario's and the Great Lakes states' manufacturing sectors. Ontario's share of Canada's manufacturing output has been growing slowly over the longer term — up around 4% since the 1970s. On the other hand, the U.S. Great Lakes region compared with the nation, has suffered a decline over the same period. Since 1970, manufacturing employment has declined significantly, with the Great Lakes states experiencing approximately a 15 to 20% sector job loss. American manufacturing is decentralizing throughout the U.S. in response to such cost factors as wages, energy and land prices. In Canada, industry is continuing to expand in Ontario, building on such advantages as access to population centers and markets and Toronto's burgeoning financial center status.

The Great Lakes region's abundant water supply is an important resource connection for industry. Water use in manufacturing operations is concentrated in five major sectors: steel production,

food processing, petroleum refining, chemicals/allied products and paper—all of which are well-represented in the regional economy. This intensity of water use is illustrated by the fact that the Great Lakes states account for 40% of U.S. industrial water use, and much of this demand is based in the Basin. Great Lakes water satisfies more than three-quarters of total industrial demand in the Basin. In Ontario, the degree of dependency is even more pronounced at nearly 85%. Indiana and Michigan are the top states for industrial water use in the Great Lakes Basin, while Ontario, at 2,058 million gallons per day, leads all jurisdictions.

On both sides of the border, the region's manufacturing sector has been pruning inefficient operations and investing in new technology. These aggressive modernization programs have not been launched across-the-board, but key industries have benefitted, resulting in significant productivity improvements. One key factor in the region's continuing strong manufacturing performance is the implementation of so-called lean or agile manufacturing techniques, which emphasizes quality and speedy response to market conditions based on technologically advanced equipment and a flexible production process. Teamwork and participatory management are also important to lean manufacturing.

The manufacturing workplace is gradually transforming itself from one of mass production with its traditional hierarchical management and stress on total output to one of customized production and employee empowerment. This process of "re-engineering" a company's way of doing business also has the potential for new collaborative industry arrangements. Temporary alliances among businesses where each company may specialize in design, manufacturing or marketing with respect to a particular product are possibilities spawned from the Great Lakes region's cluster of durable goods manufacturing enterprises.

Along with industrial restructuring has come the loss of high-paying jobs and disruption of family and community life in the region, particularly, in areas where major industrial operations were concentrated. One such area, stretching from southeast Chicago into northwest Indiana (Calumet Crescent Corridor) has become an incubator of ideas and demonstration projects designed to both revitalize the local economy and aggressively address environmental problems by relying on inherent community strengths and opportunities. For example, a major regional project, the Environmental Technology Network, has been proposed by two organizations, City Innovation (based in Minnesota) and the Employment Research and Development Institute of Wilmette, Illinois. Four major outcomes are projected:

- Create a sense of ownership in the future of what the Calumet region is now and can become.
- A collaborative regional vision that helps grassroots leaders relate community interests to the larger interests of industries, workers, residents and investors throughout the Corridor.
- Development of entrepreneurial skills and small business opportunities in environmental cleanup technology for a profit to help establish international leadership for the Corridor in this industry.
- Community-led strategies for attracting and mobilizing resources to the advantage of communities throughout the Corridor.

The Calumet Crescent Corridor project offers a unique opportunity to fuse the technical capabilities of existing businesses with the availability of skilled workers to tackle, among other problems, the issue of remediating polluted inactive industrial sites. The Great Lakes Basin contains thousands of such sites or "brownfields" where once thriving industrial operations have now become, not only blighted areas of neglect, but in many cases, sources of continuing pollution. For example, Cuyahoga County in Ohio has between 10 and 14% of its land area or roughly 40,000 acres categorized as brownfield. For the three Lake Michigan-adjacent counties in Indiana, polluted groundwater and contaminated soils and sediments at manufacturing locations have resulted in the designation of 8 Superfund cleanup sites, one Area of Concern designated by the International Joint Commission and more than 200 toxic waste sites warranting some level of cleanup. These problem places particularly in the central urban areas within the Great Lakes Basin, have handicapped efforts at redevelopment. New development is deferred because of cleanup costs and lingering uncertainty over liability issues thus encouraging such development to migrate to outlying areas or undeveloped "greenfields." Legislation and other remedies have been proposed to address the issue through targeted and expedited cleanups as well as new business recruitment strategies that wisely match sites with appropriate uses.

4.2 Transportation

Transportation was a pivotal factor in the development of the Great Lakes-St. Lawrence region. The combination of a natural water transport infrastructure and a strong resource base promoted settlement, agricultural development and a manufacturing economy.

As a trade route among native peoples and a corridor of discovery and commerce for the Europeans, the Great Lakes-St. Lawrence River system, along with other rivers, formed an established transport system long before the United States and Canada became nations. Over time, an extensive rail, road and pipeline grid was laid out and eventually a high-capacity air transportation network was built.

Today, the region's strong multi-modal transportation system compares favorably with any in the world. Much of modern transportation technology was either invented or first implemented on an efficient scale in this region. Freight movements in the binational region serve both domestic markets and international trade.

Among the principal vehicle freight modes, a competitive and yet complementary relationship has evolved. The region's relatively high freight generation level is attributable, in part, to the system's transport efficiencies. Particular modal patterns are evident in commodity movement and route structure. Historically, east-west freight routes have had more capacity and volume compared to north-south links. However, in recent years, cross-border "north-south" commodity flows have been increasing and the infrastructure to support this trend is receiving more attention.

The Great Lakes-St. Lawrence transportation system, stretching more than 3,700 kilometers, is a unique deep-draft navigation route unlike any other in the world. Recent studies of the system's economic impact indicate that more than 60,000 Canadian and U.S. jobs are dependent on the cargo movements and these activities generate more than \$3 billion in business revenue

and personal income.

Great Lakes and St. Lawrence River commodity movements are dominated by relatively low value bulk commodities. Total annual U.S. and Canadian tonnage (shipments and receipts) for the 145 ports and terminals in the system has averaged around 200 million tons (181 million metric tons) in recent years. Grain flows have been quite variable as the world grain market is continually adjusting in terms of supply and demand. North American steel production and related raw materials movement have been affected by recession periods and fluctuating levels of imported steel. Coal shipments, particularly those to electricity generating stations are more stable but utility decisions on fuel contracts have dramatically altered some supply patterns. Salt, which is used primarily for road de-icing, represents 5 to 8% of Canadian Great Lakes tonnage. Petroleum products movement is significant for St. Lawrence River ports and Sarnia, Ontario, a major Great Lakes refinery center. Movement of general cargoes (higher value containerized, palletized and other processed or manufactured goods) is declining on the Great Lakes and such traffic now constitutes only a small percentage of St. Lawrence Seaway tonnage.

Since 1959, the modern Seaway with its seven river locks coupled with the older Welland Canal has transitted more than 1.4 billion metric tons with an estimated value of \$200 billion. With few exceptions, annual tonnage for the Montreal-Lake Ontario Seaway section increased until the peak year of 1977, when over 57.4 million metric tons were reported. While there have been year-to-year fluctuations since the late 1970s, the 31.9 million metric tons recorded in 1993 indicate a substantial overall decline in average Seaway tonnage.

Rail and motor carrier freight transportation complement waterborne commerce in the Great Lakes-St. Lawrence region but both maintain well-established service profiles while engaging in intermodal operations and head-to-head competition in some instances. Although annual truck and rail freight fluctuate in response to business cycles, two trends are significant. The combined modes account respectively for three-fifths and two-thirds of Canadian and U.S. intercity tonnage, but highway use, particularly for the movement of manufactured goods, is expanding rapidly. For example, U.S. highways carried a third more total tonnage in 1990 than in 1980, whereas U.S. rail movement of manufactured goods declined by about 15% during the decade. Intermodal operations (rail haul of truck trailers and containers) have also been increasing in both countries as shippers and carriers emphasize coordination in an effort to create a "seamless" transportation system.

As the hallmark of the region's manufacturing economy, the personal motor vehicle also dominates passenger transportation. A relatively dense road network, encompassing around one million miles of right-of-way, represents a mobility asset, though also a tremendous maintenance and land use burden. Rail passenger transportation plays a commuter role for several cities in the region. Although the region accounts for nearly 75% of U.S. and Canada station activity (arrivals and departures), intercity rail travel is not growing. On the other hand, air travel has been expanding its mode share. The region, because of its concentration of corporate headquarters, generates a higher amount of business-related air travel.

Within the Great Lakes Basin, commodities move across the international border by all modes (air, water, rail and highway) but land crossings predominate in total transits and merchandise

trade value. Minnesota, Michigan and New York, the three Great Lakes states with Canada border crossings, accounted for 82% of 1992 U.S.-Canada trade value associated with the land crossings or \$123.2 billion. Table 4 indicates these shipments were handled through 27 highway crossings, 11 rail crossings and 6 ferry crossings (3 vehicular and 3 railroad). A growing integration of the region's binational transportation system is evident. For rail operations this is indicated by the substantial amount of Canadian carrier-owned line located in the Great Lakes states and the fact that half of Canadian rail revenues derived from movements between Canada and the U.S. has an Ontario or Quebec connection. Such transborder rail traffic is growing, now accounting for 18% of total Canada-U.S. merchandise trade value and representing 23% of total Canadian rail tonnage. Scheduled improvements to Michigan-Ontario rail crossings, including a new tunnel at Port Huron-Sarnia, will enhance this trend. Cross-border truck movements have kept pace with increasing trade flows and for Ontario, one-quarter of its trucking industry revenues are tied to such movements.

TABLE 4
GREAT LAKES STATE AND PROVINCE BORDER CROSSINGS

| STATE - PROVINCE | HWY | RAIL | FERRY | TOTAL |
|---------------------|-----|------|-------|-------|
| Michigan - Ontario | 4 | 3 | 6 | 13 |
| Minnesota - Ontario | 8 | 4 | 0 | 12 |
| New York - Quebec | 8 | 1 | 0 | 9 |
| New York - Ontario | 7 | 3 | 0 | 10 |
| Total | 27 | 11 | 6 | 44 |

Source: Michigan Department of Transportation

Each of the transportation modes faces a unique set of challenges that will guide its future development and use. The region's overall transportation system is a dynamic network continuing to change in response to new challenges as well as opportunities. Even though the private marketplace is the main arena for transportation decision-making, public policy, as expressed through regulations, taxation and land use policies, has played a major role in the movement of people and goods. The region's commodity movement patterns have developed not only in response to geography and the orientation of population settlement but also from government policy. National goals for transportation sufficiency and economic development have fostered regulatory regimes and subsidy programs for various commodities and the transport modes themselves. This welter of rules and practices has undeniably shaped the flow of goods throughout the region.

For the region's deep-draft maritime sector, several issues pose serious problems. A nine-month navigation season for through traffic, vessel size limits, Canadian Seaway tolls and the cumulative impact of pilotage costs for long-distance system movements have all combined to dampen growth prospects for Seaway general cargo shipping. Bulk cargo, prone to much annual variability, also faces long-term threats from increasing tolls, various government cost recovery initiatives, dredging problems, rail competition and changes in supply sources.

The dredging issue illustrates the complexity of maritime sector challenges. Periodic dredging to maintain authorized project depths is essential for Great Lakes commercial navigation. For example, for a 1,000-foot bulk carrier, the loss of one inch of vessel draft translates into a loss of 270 tons of cargo carrying capacity. Siltation levels are high for many ports, especially those at the outlets of rivers where the drainage basin is characterized by heavy agricultural activity. Most of the 119 U.S. commercial harbors in the Great lakes are maintained by the Army Corps of Engineers, with the others under private control. In recent years, an average of 3 to 5 million cubic yards of material have been dredged each year at a cost of up to \$33 million. Some of this dredged material is polluted, particularly that from industrialized harbors and must be disposed of in confinement facilities. In the United States, of the 26 such sites built since the 1970s, a few are completely filled and all but two will be full or at design capacity by the year 2006. The difficulty in finding suitable sites for new disposal facilities coupled with a need to remediate existing sites and the lack of adequate future financing for this aspect of the Great Lakes dredging program are critical issues to be addressed for not only commercial maritime interests but also for governments at all levels.

Another significant issue relates to border crossings. Vehicular traffic at border crossings in the Great Lakes region exhibits a wide range in volume from a few thousand vehicles to more than 8 million autos, trucks and busses annually for a particular crossing. For example, in 1992 only four border crossings—2 bridges and a tunnel in eastern Michigan and a bridge in western New York—accounted for nearly 30 million vehicle crossings, or 50% of the total crossings in the region. These facilities also handled about three-quarters of all truck crossings on the region's international border. The fact that most of the region's international border is comprised of the Great Lakes and connecting channels, the St. Lawrence River and other smaller rivers and lakes, tunnel and bridge border crossings are more limited, which tends to concentrate traffic and creates particular congestion, inspection/processing and physical infrastructure investment challenges. Unimpeded flow of cross-border traffic, whether it relates to personal travel or goods movements especially with growing trade volumes and development of just-in-time delivery and inventory systems, is vital to the region's economy.

Other important issues for the region's transportation system are pollution generation potential, energy use and land use impacts. These issues were not high priority concerns during the system's intensive development period. Since the 1970s, with the periodic energy crises and advent of concerted environmental regulation, these issues have become more salient, both for government and private business. Pollution elimination and reduction policies coupled with energy conservation measures are beginning to drive transportation activities, but land use planning as a means to control transportation impacts has not progressed very far. Awareness of the problems and the need for comprehensive transportation planning is growing. As this new transportation policy direction takes hold, society is challenged to devise effective and practical means to institutionalize this aspect of ecosystem management and sustainable development.

4.3 Agriculture

The Great Lakes region encompasses a significant portion of the United States' and Canada's farm sector and is a major part of the overall economy of the two nations and the region. As

part of the greater region, Great lakes Basin agriculture is also diverse and productive, even though it represents only 5.3% of total agriculture employment for both Canada and the U.S.

With respect to value and volume, dairy, cash grain and livestock sales are the region's mainstays. Unique climatic-production niches have also contributed to a wealth of specialty crops. The high level of agricultural productivity is partly a function of geography. The part of the region located between 39° and 45° latitude has a combined soil and climate regime that makes it a prime agriculture area. With the exclusion of the podzolic soils of the Canadian Shield, the northern tier states, and mountain districts in New York and Pennsylvania, most of the region is suitable for large-scale farming. Average annual precipitation within the prime area ranges between 24 and 42 inches. Along with an average 145-day growing season, the prime area has moderate levels of potential evapotranspiration and solar radiation. These characteristics make the region suitable for production of eight of the ten top food crops in the world.

Estimates for 1990 show the Great Lakes states contain about 136 million acres of farmland, representing a seventh of all land in farms in the United States and more than half the nonfederal total land area of the states. U.S. Basin cropland and pasture area is estimated at about 28 million acres. With almost 600,000 farms in the eight states (a quarter of the national total), the size of the average farmstead is less than half of that for farms elsewhere. From an income perspective, farmers in the region received more than \$36 billion in cash receipts from farm commodity sales with several billion dollars more in direct government farm program payments in 1989, or about 23% of the nationwide total. Eighty percent of farm sales are tied to five commodities: milk, corn, soybeans, cattle and calves and hogs.

With less than 10% of Canada's farmland, Ontario accounts for more than a quarter of the total value of Canadian agricultural sales. The 1991 Census of Agriculture found 68,633 Ontario farms, a 6% decrease since 1986. Total farmland amounted to 13.5 million acres, a decrease of 4% over five years. At 62% of total Ontario farmland, land devoted to crop production decreased only slightly from the previous census, but it represents a substantially smaller relative share of land use compared with that in the Great Lakes states. Much of Canada's corn and soybean production is based in the province which also grows about half of the nation's vegetables. Significant production niches in Southern Ontario exist for grapes, tobacco, tree fruits and nursery products.

Great Lakes Basin agricultural productivity and the quality of its forestry resources could be in jeopardy if significant climate change occurs. More so than for most occupations, farming entails gambling on the vagaries of weather and climate. Prolonged dry spells and seasonal droughts have occurred throughout the Great Lakes region and disrupt agriculture and harm forests on a periodic basis. But the possible threat posed to area agriculture by CO₂-driven global warming and ozone depletion caused by man-made gasses is serious. There is evidence that over the last 100 years the average surface temperature in the Northern Hemisphere has increased 1° F and the rate of warming is accelerating. Another degree or two of increase may result in significant climate change. Interior continental areas could experience longer, more persistent droughts, rainfall patterns may change precipitously, and on a positive note, the growing season could increase north of the 45th parallel. For the Great Lakes region, a lengthened growing season might be offset by more instability in rainfall amounts and planting/harvesting dates. The possible depletion of the ozone layer could compound the impact on agricultural productivity if

it parallels the "greenhouse effect." An increase in ultraviolet radiation may cause some food and non-food plants to lose their tolerance to sunlight with disastrous consequences for the environment.

A major agriculture-related problem for the Great Lakes Basin is soil erosion and related sedimentation. Exacerbated by inefficient and conflicting land management practices and policies, runoff and wind erosion result in substantial economic costs and environmental harm. Agricultural productivity is reduced, resulting in lower yields and/or greater fertilizer use. Sediment transport and deposition degrades water quality, limits uses of water resources and incurs significant infrastructure costs, including harbor dredging. According to the 1987 National Resources Inventory conducted by the U.S. Department of Agriculture, more than 63 million tons of soil erode annually in the U.S. portion of the Great Lakes Basin. Much of this erosion comes from the more than 20 million acres of Basin cropland. In recent years more responsible land-use practices in agricultural areas have gained only modest ground, but future prospects are brighter as more demonstration programs and assistance are directed to the problem. The Conservation Reserve Program and Great Lakes Basin Program in the U.S. and Ontario's Conservation and Environment Protection Assistance Program, along with an array of other measures such as contour plowing, conservation tillage, vegetative and woodland cover in erosion-prone areas, filter strips, and sediment detention ponds, have proved that progress is possible.

Agricultural chemical use in the Great Lakes Region is a difficult issue with both economic and environmental consequences. From row and field crop monoculture to specialty crops vulnerable to disease and infestation, many North American and Basin farmers are hooked on chemical pesticides, herbicides and fertilizers as a means to enhance yields and maintain product quality. Agricultural chemicals are ubiquitous in the rural landscape but are also linked to urban areas: the producing plants, the transportation system, at distribution points and in the human food chain. Toxic contamination of food and water supplies and personal exposure to such hazardous substances are fast becoming major issues in agricultural policy. Even though modern monoculture is dependent on chemicals, alternatives do exist. Reducing chemical concentrations may affect yield but can also reduce input costs. Mechanical weed control that concentrates on emergent weeds is an option. Time release and faster degradation formulations for chemicals can reduce some risk to the environment. Integrated pest management strategies and biotechnologies that rely on natural control mechanisms such as enhancing predator/prey dynamics, sterilization of breeding populations, hormone control meshed with natural growth cycles and development of disease and pest resistant crops and livestock are receiving increased research attention and are gradually being introduced in day-to-day agricultural practice.

Over the last two decades, the farms in the region have become more specialized, with domestic production for export increasingly tied to larger-size farms. Also, farm receipts from crop sales have increased in response to export market growth. The vagaries of export demand, though, have challenged producers. When farm income declines, rural areas and part of the nonfarm economy also suffer because a large share of the farm sales are recycled as a result of farmers' purchases of manufactured inputs, labor and services. Although the marketplace is the principal arbiter of agricultural production, government policy relating to trade, commodity production/price supports, soil conservation, habitat preservation, and rural development will play a critical role in the future prosperity of the Great Lakes region's agriculture sector.

4.4 Energy

As is characteristic of modern industrial societies, Canada and the U.S. are energy-dependent. In the Great Lakes region, energy sources and consumption by end-use sector reveal particular economic strengths and vulnerabilities. Although all conventional energy resources are found in the region, most of the area's energy is derived from imported fuel sources. For example, petroleum is the principal energy source for the Great Lakes states, representing about a 37% share in the late 1980s, whereas regional production amounted to only 4% of consumption. More than three-fifths of this petroleum use is consumed by the transportation sector, which accounts for nearly one-quarter of all U.S. regional energy use. The sector's almost total dependence on petroleum-based fuels raises serious questions about related pollution and future availability as well as cost. This level of petroleum consumption is likely to grow because of increasing use by the transportation sector, coupled with decreasing use in other sectors.

Coal has the next largest energy share at 30%. It is the dominant energy resource available in the Great Lakes states where nearly 29% of U.S. coal reserves are located. Mining in the region, which has been declining, is 20% of U.S. production, but the area consumes a third of national production. Ontario has no coal mining, but imports low-sulfur Canadian coal and U.S. coal for electricity generation and other industrial production. Coal usage throughout the United States has been undergoing a dramatic change over the last two decades, primarily because of environmental regulation that restricts the use of high-sulfur coal, the dominant coal found in the Great Lakes region. To meet demand, the Great Lakes states must import coal, mainly from the low-sulfur sources in the West.

Natural gas and nuclear power are the other principal energy sources in the region. The Great Lakes states use eleven times more natural gas than they produce. The commercial and residential sectors are more dependent on gas than other sectors, accounting for 49 and 60% respectively of their total energy requirements.

Nuclear power as an energy source has grown dramatically in the region. In the late 1980s, nuclear power represented 8.6% of the Great Lakes states' total energy requirements, an increase from just 0.4% in 1970. With 41 of the nation's 110 operable nuclear generating stations, the Great Lakes states have lessened dependence on fossil fuels for producing electricity. In Illinois, 13 nuclear plants produce about 50 percent of the state's electricity needs, highest for any Great Lakes state. Ontario has 18 of Canada's 20 nuclear power plants. These plants generate more than 50% of the electricity used in the province, and new stations will increase the figure to around 60% during the 1990s. The region's use of nuclear power has eliminated the need for an equivalent amount of electricity derived from other fuel sources—mainly coal and natural gas. The proportionate reduction in sulfur dioxide and to a lesser extent carbon dioxide has had a beneficial effect on the environment, but problems with radioactive waste disposal, particularly for the used nuclear fuel, may offset air quality benefits.

The principal renewable energy source used commercially in the Great Lakes region is hydropower tied to electricity generation. In Ontario, hydropower represented 29% of the province's electricity output in 1992. Among the Great Lakes states, New York ranks first in hydroelectricity production with three large facilities, an 800 megawatt (MW) plant on the St. Lawrence River, a 2400 MW plant on the Niagara River and a 1000 MW pumped storage

facility, all which supply about 10% of the state's power demand. New York, because of electricity imports from Canada, also ranks highest in use of electricity derived from hydro facilities—around 18% of total state use. Michigan is second in production with most of its hydropower output coming from a pumped storage plant at Ludington on Lake Michigan. This facility, opened in 1973, is one of the largest in the world rated at 1872 MW and it complements "baseload" coal fuel and nuclear generation capacity by providing electricity at peak periods. Wisconsin, in contrast, relies on a system of more than 70 hydropower sites to generate about 4% of the state's electrical production. Wisconsin's stake in hydroelectricity is historic; the world's first such central generating station was built there in 1882.

The Great Lakes states' industrial sector is the largest energy-consuming sector, with petroleum, coal and natural gas all supplying between 25 and 30% of basic fuel needs along with electricity at around 17%. Even though the Great Lakes states have a concentration of energy-intensive manufacturing such as steel, petrochemicals and automobiles, its usage in this sector on a per capita basis is less than that for the nation because of large energy efficiency improvements made during the 1980s. Changes in production processes and waste heat utilization have helped region manufacturing operations maintain their competitive position as well as reduce their energy-use impact on the environment.

The transportation sector's almost total dependence on petroleum-based fuels raises serious questions about related pollution and future availability as well as cost. In Canada and the United States, road transport is the dominant mode for fuel use dwarfing all other modes combined (See Table 5).

TABLE 5
TRANSPORTATION ENERGY USE - 1988
(percentage by mode)

| MODE | Canada | U.S.* |
|-----------|--------|-------|
| Air | 8.4 | 8.7 |
| Marine | 5.4 | 5.9 |
| Pipelines | 7.1 | 3.9 |
| Road | 74.5 | 72.5 |
| Rail | 4.6 | 2.3 |

* U.S. figures do not include off-highway use (2.9%) and military use (3.5%)

Sources: Transportation Energy Data Book: Edition 11, Oak Ridge National Laboratory and Martin Marietta Energy Systems, Inc., U.S. Dept. of Energy, 1991, and Energy and Environmental Factors in Freight Transportation, Transport Canada, A.M. Khan, 1991.

Transportation is also a major contributor to air pollution, particularly for certain pollutants. According to the Organization for Economic Cooperation and Development, the transport sector in Canada and the United States accounts for the following portions of total North American emissions: 71% of carbon monoxide; 47% of nitrogen oxides; 39% of hydrocarbons and 14% of particulates. Transportation vehicles contribute only a small percentage of another important

pollutant, sulfur dioxide, and the amount varies greatly depending on the sulfur content of a particular fuel. For the principal air pollutants, gasoline-fueled automobiles are the major sources and urban areas the most heavily affected places. However, freight transportation, dependent on diesel fuel, makes a significant contribution to pollution levels but the impacts vary according to mode and operations.

Fuel efficiency and emission control improvements across all modes are taking place spurred by the relatively high cost of petroleum-based fuels and environmental regulation. Also operational changes such as optimal routings for trucks and trains and better load management resulting in fewer empty running miles have improved energy use and thereby reduced related pollution. Automobile use remains the most difficult transportation energy issue. Principal goals are to continue to increase auto fuel economy, dampen the growth in vehicle miles travelled through increasing vehicle occupancy levels and more mass transit use and the gradual introduction of alternative fuel vehicles with supporting infrastructure.

The region's electric utility industry is adapting to a new environment where the enormous costs of installing new generating capacity have stimulated great interest not only in conventional demand-side management programs but in securing alternate and flexible electricity supplies. Matching generating capacity with demand is fraught with uncertainty as evidenced by the region's recent experience of capacity expansion coupled with periodic economic downturns with less industry electricity use. Regional per capita use though, shows a steady upward trend. In the Great Lakes states, per capita electricity use increased 47.4% between 1970 and 1988 and in Ontario for the period of 1970 to 1992, such use increased 49.9%. Utilities have aggressively developed special rate programs to encourage less peak period electricity use and have undertaken other efforts to support electro-technologies to improve efficiency of electricity use by all types of customers. Arranging for flexible electricity supplies is a widespread effort among utilities through a variety of mechanisms including linkages with nonutility generators, building peak-load response facilities and retail "wheeling" of supplies from outside of service territories. Cross border movement of electricity between Canada and the Great Lakes states is an important part of the region's supply picture. Electricity trade between Canada and the U.S. began in 1901 at Niagara Falls, reached a peak in 1987 and for 1992, Canada's exports constituted 5.2% of total electricity generation. U.S. exports are relatively small. In 1992 the Great Lakes states accounted for 30% of Canadian exports or 7.3 million megawatts.

The region's use of nuclear power has eliminated the need for an equivalent amount of electricity derived from other fuel sources—mainly coal and natural gas. The proportionate reduction in sulfur dioxide and greenhouse gases such as carbon dioxide has had a beneficial effect on the environment but radioactive material disposal, particularly for used nuclear fuel, has created problems. The method of disposal and/or storage of "spent fuel", the highly radioactive material removed from nuclear reactor cores generated during periodic refueling, is a current issue at several Great Lakes Basin nuclear plants. Eventually all plants will need to cope with mounting quantities of spent fuel that have exceeded limited on-site, in-water storage capacity. Because of great uncertainty as to availability of a national storage site, the nuclear power industry has resorted to above ground, dry fuel storage facilities at nuclear generating stations. These facilities are seen as only temporary and as with nuclear power plants themselves there is a risk of radiation release resulting from natural calamities or sabotage as well as during removal and transportation of material. A long-term issue of ensuring safe plant decommissioning with its

complex planning requirements is another serious challenge for the utility industry.

4.5 Travel, Tourism and Outdoor Recreation

The Great Lakes, as a world-class freshwater resource, contribute to the region's global identity and a comparable reputation for outstanding tourism and recreation opportunities. Business and leisure travel along with outdoor recreation make a substantial contribution to the region's economy and quality of life. Although travel and tourism respond to the business cycle and other variables such as weather and gasoline prices, associated employment, personal expenditures and tax revenue have been growing faster than for most other sectors in the region. Such activity has led to the establishment of a wide range of attractions, facilities and services.

The Great Lakes region benefits from a large intraregional travel flow, with nine out of ten non-local trips completed within the province of Ontario or the eight Great Lakes state region for trips originating in their respective jurisdictions. The proximity of the international border and presence of major air transportation gateways also result in significant numbers of international travelers in the region: for example, more than half of Canada's international visitors arrive by way of Ontario. The Great Lakes states account for around 40% of the U.S. foreign visitor total.

As for U.S.-Canada travel, the Great Lakes states generated 20.4 million person-trips to Canada in 1992 or 63% of all such U.S. trips. Great Lakes state travelers accounted for 4.7 million overnight visits to Ontario, which represented about 75% of all such U.S. visits to the province. On the other hand, Statistics Canada data indicate that while nearly half of Canadian visitors to the United States report a "presence" in the region, such travel is dominated by day-only stays and pass-through travel. Ontario travelers account for about three quarters of all Canadian visits to the Great Lakes states.

For residents of the Great Lakes region and visitors to the area, outdoor recreation is more than a quality-of-life issue—it is a way of life. Many natural and cultural assets of the region are preserved and managed through separate state/provincial and national park systems. Of the 637 state parks in the Great Lakes states, 178 are located within the Great Lakes Basin and of these, 110 have coastal locations. On both sides of the border, coastal parks represent a high amount of park system destinations. The natural beauty of the Great Lakes shore, with large tracts of relatively undeveloped land, coupled with good highway access and proximity of population centers, have promoted recreation and tourism-related travel. Through state-provincial cooperation in the establishment of the successful Great Lakes Circle Tour, a 6,500-mile designated scenic road system, and the "North America's Fresh Coast" overseas visitor attraction campaign, governments and businesses have found unique ways to tap into the Great Lakes scenic attributes and coastal recreation potential.

The Great Lakes Basin, with more than 100,000 square miles of navigable water, anchors an important and growing marine recreation industry. The number of registered recreational boats in the Great Lakes states was 3.84 million in 1992, or 34% of the U.S. total. The number of boats has increased by more than 570,000 since 1986. No comprehensive, system-wide data on Great Lakes recreational boating activity is available. However, using the results and methodology of several university studies which addressed state-specific boating activity, it is

estimated that between 900,000 and 1 million U.S. and Canadian registered boats are operated on the Great Lakes each year. Michigan has the largest number of registered recreational boats in the U.S. and surveys indicate that nearly a third of its "boat days" are tied to the Great Lakes, even though less than a fifth of the boats are dedicated to exclusive Great Lakes use. For the Great Lakes alone, it is estimated that recreational boater direct spending is more than \$2 billion per year.

The recreational boating industry in the Great Lakes is represented by boat manufacturers and retailers, marina operators, marine business suppliers as well as the millions of recreational boaters/anglers. Retail boat/trailer, outboard motor, and marine accessories sales for the Great Lakes states amounted to more than \$3 billion in the late 1980s, or more than a third of national spending. In 1993, total sales were \$1.5 billion or only 13.6% of the national total. According to the U.S. Bureau of Labor Statistics, the eight Great Lakes states account for about 6,000 private sector, marina-related jobs and 10,000 boat dealer and supplier jobs. Marina development and related facilities in the Great Lakes have been expanding to keep pace with recreational boat usage. In Michigan, more than 750 marinas had been developed by the late 1980s along its 3,200 miles of Great Lakes shoreline, representing a 20% increase from the late 1970s. Many of the boat facilities are part of residential waterfront developments. For lower Lake Michigan these developments are accounting for around 1,000 new boat slips a year. A survey undertaken by The Center for the Great Lakes indicated that 13,000 new slips were added around the Great Lakes between 1986 and 1991 as part of waterfront projects. Annual boat shows also play an important part in industry promotion and local economic impact.

Another regional boating activity is the significant passenger vessel sector on the Great Lakes and St. Lawrence River. At present, several million people take these day excursions and ferry trips during the navigation season. Overnight cruise passengers visiting Canadian ports on the St. Lawrence River reached a modern-day record of 51,000 in 1991. Passenger capacity for the approximately 150 regularly scheduled U.S. and Canadian operations is nearly 60,000. However, passenger movement by vessel mode is substantially less than what it was when immigrants boarded boats for westward destinations and millions of travelers embarked on trips during the famed "Resort Era" in the early twentieth century. In the wake of current interest in reviving the overnight cruise business, feasibility studies and marketing surveys have been completed indicating substantial demand for multi-day cruise service for the Great Lakes/St. Lawrence System.

With a strong connection to boating, the Great Lakes sport fishery is a major part of regional fishing activity. The 1991 National Survey of Fishing, Hunting and Wildlife-Associated Recreation, conducted by the U.S. Departments of Interior and Commerce, indicated that 2.55 million U.S. anglers fished the Great Lakes that year. Previous U.S. and Ontario fishing surveys indicate that the number of freshwater anglers on the Great Lakes is declining overall but slowly. The aging of the population is a factor. The trend also appears among younger age groups partly attributable to fewer people in this population group. In 1991, Lake Erie had 35% of all Great Lakes anglers followed closely by Lake Michigan at 34%. Great Lakes connecting waters attracted 10% of the anglers. The U.S. survey projected 25.3 million days of fishing or an average of 10 days per angler. Michigan Great Lakes waters accounted for 9.9 million days of fishing or nearly 44% of the Great Lakes total. Two types of fish, walleye and perch, dominated fishing activity together comprising about 70% of the time spent fishing. Great Lakes sport

fishing results in a substantial economic impact, particularly for coastal communities that are near the "hot spots." For 1991, total U.S. Great Lakes fishing expenditures were projected at \$1.33 billion. Trip-related expenditures, including food, lodging, transportation and guide/package fees amounted to \$869 million with equipment-related costs the remainder. Expenditures per angler were figured at about \$500 for the year. It is estimated that about half of Great Lakes sport fishing is done from boats, some of which make up a growing charter fishing industry. Within the last 20 years, roughly paralleling the growth in sport fishing, the number of fishing boats-for-hire increased from 500 to more than 3000.

The Great Lakes Basin's tourism and outdoor recreation sectors are well-established, but face many challenges. Climate change that translated into more seasonal temperature and precipitation variability could have short or long term negative impacts for susceptible activities and places. Other factors such as relatively low wage rates and benefits for many tourism jobs, particularly in the accommodation and restaurant business and long-term and place-specific labor shortages may significantly influence employment opportunity and small business stability. Successful planning by both the public and private sectors will be needed to meet these and other challenges.

One current issue with ramifications for the future concerns local and system-wide water quality conditions and its impact on fishing resources and the perception of marine recreation opportunities. For example, the rapidly improving clarity of Lake Erie water, due, in part, to the zebra mussel infestation, has made swimming, boating and fishing more enticing, but the mussel may threaten the Lake's celebrated fishery. This nonindigenous bivalve mollusc is an efficient filter feeder and is altering levels of plankton and thereby could affect the Lake's food chain. These problems along with the mussel's colonization of hard surfaces, including rocky shoals important for walleye spawning, could create serious future fish resource problems.

The recreational boating sector has experienced long-term growth in the Great Lakes region but particular issues may alter this trend. Cyclical swings in the national economy tend to have pronounced impacts on boat and equipment sales. These impacts reverberate throughout the coastal recreational economy. Fewer trips or ones of shorter duration translate into fewer restaurant meals and overnight lodgings as well as less gas and supplies purchased. The current smaller baby bulge compared with the parents (baby boom) generation may dampen future boating trends and will likely manifest itself in different boating activities. For example, with fewer young people fishing, recreational boating may lose some of its fishing connection and larger boats used for cruising may increase demand for transient slip usage. Also, increasing marina congestion tied to transient boaters and new restrictions on shore home building and marina construction could dampen Great Lakes boating trends.

Other important issues relate to sufficient investment in and proper management of game/wildlife and habitat resources and park lands in order to maintain current levels of hunting and camping activity, each with their significant economic benefits. Many state and provincial parks in the Great Lakes region have inadequate staffing and funding for needed maintenance as well as improvements. Great Lakes-adjacent parks are particularly vulnerable to funding problems because of generally higher visitation levels. For example, in Michigan, coastal parks account for 50% of total system attendance. As for hunting, habitat and game management practices are becoming increasingly important. One forest management/deer habitat issue that generates controversy is old-growth forest versus traditional timber harvest policies. Ecologists are arguing

for retention of more continuous acreage of post-mature forest to create greater environmental diversity. Unfortunately, this type of habitat does not support large deer populations.

The region's travel, tourism and outdoor recreation sectors have many unique challenges but also opportunities for public and private sector cooperation. The region's natural features and cultural heritage provide a solid base from which to develop diverse and quality travel and recreation facilities to serve visitors and residents alike. As the prominent geographic feature and natural resource for the region, the Great Lakes represent an invaluable asset for environmentally-compatible recreation and tourism development.

4.6 Information and Communications

Telecommunications services and facilities have played an important role in the Great Lakes region since their introduction in the early part of this century. Initially limited to voice services, telecommunications vendors today provide an increasing amount of data and video services utilizing digital switching and fiber optic transmission technologies. The growth of telecommunications services and infrastructure in the region has been heavily influenced by both advances in technology and policy, particularly on the U.S. side of the Great Lakes.

The breakup of AT&T created a climate of greatly increased competition in the telecommunications industry beginning in 1984. Canada has seen a similar trend towards deregulation and increased competition, though the pace has been slower. The divestiture of AT&T's local Bell operating companies led to greatly increased competition in long distance services but maintained government-regulated monopolies for local access. At this writing, both Congress and the Clinton administration appear determined to end the local access monopolies and to bring the same level of competition in this area that has been seen in the long distance arena.

The trend towards the use of digital facilities for data and video networking has accelerated rapidly in the past decade and is now the focus of a series of national, state, and provincial initiatives. The most well-known of these, the National Information Infrastructure, introduced by the Clinton administration, is aimed at nothing less than transforming some of the most basic ways in which individuals and organizations access, process, and utilize information. While telecommunications and information initiatives have, in the past, typically centered on the telecommunications industry, the cable television industry is playing an increasingly larger role in this area and is likely to be a strong contributor to the region's networking activities in the future.

The Great Lakes region has been particularly strong in the development of data networking and Internet services. These activities have their roots in a number of academic consortia but today include regional and national telecommunications vendors, cable TV companies, and a growing number of entrepreneurial organizations. Beginning with the Merit Computer Network in Michigan, which became operational in 1972, today every state and province has at least one state-wide data networking organization. This has resulted in the phenomenal growth of sites in the region connected to the Internet from less than 150 in 1990 to almost 1,000 today. Internet services are supported by a combination of customer fees and state, provincial, and federal grants

with total spending exceeding \$30 million.

One notable use of the region's Internet capabilities was the establishment of the Great Lakes Information Network (GLIN) in 1993. GLIN is used to link the region's environmental scientists and policymakers and is operated by the Great Lakes Commission and CICNet under a grant from Ameritech Foundation. Currently, GLIN provides access to data at numerous state and federal agencies, the International Joint Commission, the USEPA's Great Lakes National Program Office, and other organizations. Information housed on GLIN is accessible by anyone on the Internet.

The use of telecommunications technology in support of distance education and curriculum is another important trend that is quickly gaining momentum throughout the region. At the community, provincial, and state level there are numerous projects underway using data and video networks to bring a wide variety of educational resources into schools, businesses, and homes. These activities range from the use of electronic mail for international pen pal programs to access to full-color, real-time weather images for high school science classes, to the offering of entire graduate programs in the workplace.

Telecommunications and computing technology continues to grow in its potential to influence the lives of residents in the Great Lakes region. With this growing potential comes a number of important issues that merit careful attention. Perhaps the most important is the delivery of information to the home. Until now, information and telecommunications vendors have been divided into local and long-distance telephone services and cable TV services. As a result of continued deregulation and technological advances, these divisions are likely to disappear quickly during the last half of this decade leaving the consumer with the advantage of a more competitive marketplace but the disadvantage of a much more confusing set of services and, potentially, less assurance of uniform service offerings in rural areas of the region.

Another issue that is of critical importance is the use of these new telecommunications services in educational activities. Two-way video and access to the global Internet hold the potential for a greatly expanded slate of educational resources for students in both urban and rural settings. At the same time, the region's educators and policymakers need to understand the most cost effective way to deploy these services in order to avoid large expenditures on technological services that do not deliver the necessary educational improvements. Finally, the business community's incorporation of telecommunications technologies as strategic tools that can provide the Great Lakes region with a competitive edge in a wide variety of business sectors is expected. Data networking, in particular, as well as video and voice services, hold the potential to transform the way in which business is conducted.

5.0 Infrastructure Issues

Adequate infrastructure is the foundation that supports and sustains most economic activity. There is widespread recognition of the importance of infrastructure for economic growth, but questions regarding the magnitude of the effect remain. Studies have shown that infrastructure stimulates local development and also acts as an ingredient in the business attraction recipe. The environmental benefits and costs that accrue from infrastructure development underline the important connection between the economy and environment.

Concern about the level of investment in public works infrastructure such as roads, sewers and water supply systems, has become a major public policy issue. An aging infrastructure, coupled with tightening governmental budgets, has produced a widening gap between needs and existing facilities. During the 1980s, several U.S. infrastructure needs studies were completed. The general findings were:

- the nation's vast infrastructure has been maintained unevenly;
- many public facilities have not been maintained adequately and are in such disrepair as to pose risks to public health and safety;
- the problem is widespread, not confined to a few categories, or certain cities or geographic areas; and
- the cost of meeting future demands for public infrastructure will be very high.

All levels of government have a role in providing and maintaining public works projects. The guiding policy for infrastructure investment has been to assure an equitable distribution of services through the efficient use of resources. These "services" not only support economic activity but are an important factor in enhancing the quality of life. Public works expenditure trends over the past two decades indicate that the growth of such investment has slowed due to shifting public expenditure priorities. Today, infrastructure investment as a percent of total public expenditures is less than half of what it was in the mid-1960s. A fall-off in capital spending, coupled with rapidly increasing expenditures for maintenance of the existing capital base, reflects the gradual maturing of the public works capital plant.

Overall infrastructure investment requirements are growing. Although infrastructure needs vary from place to place and according to category, future investment decisions will be constrained by fiscal limits and political considerations concerning environmental and social equity issues. Replacement and rehabilitation costs will account for most of the needed investment. Continuing dispersal of economic activity, abetted by population growth and migration along with new safety and environmental standards, will contribute to escalating investment requirements. For example, a study funded by the Clean Water Council, a lobby organization, estimated that \$167 billion will be needed between 1990 and the year 2000 to achieve U.S. water quality and wastewater treatment standards currently in force, as well as those expected to be adopted over the period. About half of this amount is expected to be available through the usual capital expenditure channels. For the eight Great Lakes states, the total shortfall is \$36.7 billion, or more than 46%

of the national total.

The transportation sector encompasses a major part of the infrastructure picture. Other than the freight rail and pipeline modes, much of the transportation sector's infrastructure is publicly funded and accounts for between two-thirds and three-fourths of the identified U.S. infrastructure investment requirements. Construction and maintenance of the national road system is an immense task not only dollar-wise, but in terms of manpower deployment and materials requirements. Seventy-three percent of all government expenditures for transportation infrastructure are spent on the road system. The Great Lakes states, with 923,000 miles of public roadway, have a relatively dense road network compared with the nation as a whole. Seventy-eight percent of the road miles is concentrated in rural areas, and reflects the influence of the township and range land survey system as well as the historical development of farm-to-market access. The region's road and bridge system has a continuing need for repair including replacement. An estimated one-third of the region's bridges are deficient. Freeze-thaw cycles wreak havoc on road and bridge structures. Damage to vehicles and weight restrictions, particularly for rural farm areas, add up to significant costs for the transportation system.

Transportation services depend on an adequate infrastructure base, one well-suited for its intended purpose. More pavement and roadway mileage has been the traditional means through which this need was met for the highway mode. The relentless growth in vehicle miles traveled and the number of vehicles is creating significant capacity problems. Improved road system efficiency, including more traffic monitoring and control, use of "smart vehicles" and congestion fee policies, has been a major planning tool. Such an efficiency approach can work for all other transportation modes. Multimodal and intermodal operations have become commonplace in freight transportation, recognizing the inherent efficiencies and cost advantages for individual transport options. With transportation as an energy intensive activity, a major generator of pollution and a big consumer of land, the need to seek environmentally friendly movement alternatives is required if the goal of a sustainable society is to be realized.

Technology is transforming the production, consumption and distribution of goods and services. The rapidly changing circumstances of economic activity necessitates a more flexible approach to infrastructure development. Market mechanisms, as they are gradually introduced to the infrastructure decision-making process, show promise in making efficiency a major criterion for infrastructure investment. No longer should political muscle be the chief determinant of the what and where of infrastructure. Building infrastructure to last with a greater emphasis on maintenance and design efficiency will channel and preserve capital flows. Long-term management strategies are needed to preserve system integrity and maintain environmental benefits.

6.0 Sustainable Development

6.1 Public Policy

The abundant natural resources on which the regional economy was founded continue to sustain it, even though resource depletion and degradation have taken their toll. Excessive timber harvest, overfishing in the Great Lakes, extensive cropland development, destruction of wildlife habitat, air pollution, soil and water contamination and other man-induced challenges to nature are all part of the region's history of development. Over the past twenty years, the regional economy has changed considerably, becoming more diversified but less robust in many sectors. During this time, concern about environmental conditions in the Basin came to the fore. Increasing public awareness of environmental issues and aggressive environmental regulation combined to focus attention on environmental - economic linkages and have led some to explore "sustainable development" concepts.

Sustainable development, based on the interdependence of the economy and the environment and aimed at achieving their mutual sustainability, is both a policy and practice. It calls for a way of life that meets the needs of the present without compromising the ability of future generations to meet their own needs. The basic concept was nurtured through countless individual and organizational efforts, but it received full-fledged expression with publication of *Our Common Future*, the 1987 report of the World Commission on Environment and Development. Under the leadership of Norway's Gro Brundtland, the Commission's efforts focused world attention on the reality of accelerated population growth, a limited resource support base, and environmental degradation.

The global implications of "business as usual" were reemphasized at the United Nations Conference on Environment and Development held in Brazil in 1992. Following these efforts, individual countries have identified sustainable development as a goal and are beginning to develop appropriate policies. In the United States, a President-appointed Council has been established with a mandate to recommend federal sustainable development policies by summer 1995. In December 1990, Canada released its environmental action plan or "Green Plan" which expressly identifies sustainable development as a government and society objective. In releasing the Green Plan, the Prime Minister said: "The challenge we now face is to build upon our economic strengths in harmony with our environment, the basis of our health and prosperity. Every Canadian has a role to play in achieving this goal of sustainable development."

6.2 Institutional Arrangements

The evolution of the region's socio-economic status has both shaped and been shaped by an elaborate system of governance that transcended traditional political boundaries to recognize, on a binational basis, shared environmental and economic characteristics. In fact, the Canada-United States boundary within the Great Lakes region has long been the locus for extended experimentation in political, diplomatic and institutional endeavors.

The origin of such experimentation is found in the earliest years of U.S. constitutional history and relations with Great Britain and, for the most part, was motivated by shared interest in economic development. For example, in 1895 the two countries established a Deep Waterways Commission to investigate the feasibility of constructing a seaway to permit transportation access from the Great Lakes to the Atlantic. This entity later developed into the International Joint Waterways Commission (1903)—a precursor of the International Boundary Waters Treaty of 1909 and its implementing agency, the International Joint Commission. More recently, interstate deliberations in the mid-1900s leading to the formation of the Great Lakes Commission were promoted by an emerging sense of regionalism brought about in large part by the impending opening of the St. Lawrence Seaway. The formation of the binational Great Lakes Fishery Commission during that same period was the culmination of a long-standing economic concern: the decline of the commercial fishery. More recently, the formation of the Council of Great Lakes Governors in the early 1980s was fueled in part by the midwest's shared economic recession and recognition of the benefits of collective action.

While resource management and environmental protection issues have been of concern at the binational level for many decades, it is generally agreed that issues of economic development were the principal catalyst for early binational institution-building efforts. Recognition of environmental/economic linkages, in fact, is explicit in the enabling legislation for all of the above mentioned institutions. Thus, it can be argued that the conceptual basis for sustainable development has been established for some time, although its emergence as a pre-eminent guiding principle in Basin governance is a recent phenomenon.

The decade of the 1980s distinguished itself as a turning point for sustainable development at the basin level. A renewed regional consciousness was sparked and sustained by the emergence of complex resource policy and environmental issues (e.g., diversion and consumptive use, toxic contaminants), and a sense of desperation brought on by prolonged economic recession. The latter found the region's leaders as unwitting shareholders in an economy characterized by the decline of the industrial base, high unemployment, and poor future prospects due, in part, to the strength of overseas industrial competition and the competitiveness of the "sun belt" states. These same leaders—most notably the governors and premiers—found in the Great Lakes a hope for the future. A shared resource with unique and under-utilized characteristics, the lakes represented a common bond between the jurisdictions, symbolizing the strength and resiliency of the region as well as its untapped potential. It was recognized that the region could not support a strong economy without a well-managed, high-quality natural resource base. In turn, it was recognized that the region could not afford a well-managed resource without a strong economy and associated tax base.

As Ecosystem management principles and practices have become increasingly important in the Great Lakes Basin, a parallel need for sustainable development has also been identified by a wide range of organizations and groups. For example:

- In late 1992, the Ontario Round Table on Environment and Economy submitted its strategy for sustainable development to the Premier and the people of Ontario. This farsighted plan proposed many innovative ideas on how to develop a more environmentally-responsive economy and emphasizes industrial and governmental accountability as sustainability goals are established and achieved.

In 1993 the Chairman of the Council of Great Lakes Governors, Ohio Governor George Voinovich said in his Annual Chairman's Report: "Over the last decade, the Great Lakes Governors have articulated a vision of the region as a world leader in natural beauty and economic might. It is a vision that recognizes that the restoration and protection of the Great Lakes is dependent upon a world-class economy. A vibrant manufacturing base, utilizing advanced technologies and highly skilled workers, is essential to meet the ultimate environmental objectives of the region. At the same time, the Governors recognize that the health of the Great Lakes is central to the region's economic future. The region's industries will not be competitive in the world economy, unless they are world leaders in clean, sustainable production."

The International Great Lakes St. Lawrence Mayors' Conference adopted a sustainable development resolution at its 1993 Annual Meeting in Montreal. This binational organization urged the regional leadership in the Great Lakes-St. Lawrence Basin "to develop a plan to convert the concept of sustainable development into an agenda for action" and to identify a "regional laboratory" to demonstrate the application of sustainability principles.

In January 1993, the Regional Council of Hamilton-Wentworth, Ontario, adopted the final report of the Chairman's Task Force on Sustainable Development as a basis for all decision making. Entitled, *VISION 2020: The Sustainable Region*, this report was the result of 2-1/2 years of study, involving more than 1,000 citizens. *VISION 2020* is an expression of a desired future for the community and provides everyone, including citizens, elected representatives, business leaders, public servants, and local agencies with a common goal. The report is wide ranging with more than 400 recommendations covering topics such as, natural areas, water and air quality, waste reduction, economic change, transportation, agriculture, and community empowerment.

The Environmental Defense Fund's Great Lakes Pollution Prevention Alliance has targeted its current collaborative efforts toward the fostering of sustainable activities including reducing toxics use, increasing transportation efficiency and promoting social justice and safe employment in livable communities.

The Minnesota Sustainable Development Initiative launched in early 1993 is a broad-based effort with strong state agency support. The goal of the Initiative is to assist the state's Environmental Quality Board as it develops a *Minnesota Strategic Plan for the Environment* and the Department of Trade and Economic Development as it revises its *Economic Blueprint for Minnesota*. Seven Initiative Teams have been designated, each responsible for a specific economic sector. A "Congress" was held in early 1994 where interested individuals and organizations advised the Initiative teams.

Surveys and reports from around the Great Lakes region indicate growing private and public sector interest in sustainable development, particularly at the local level. Neighborhood projects and community-wide activities are experimenting with selected sustainable development practices ranging from waste reduction to zoning changes. Futuristic models and visioning exercises have also become part of these efforts.

- One manifestation of strengthening environmental economic linkages in the region is the emergence of a substantial "environmental industry" sector. Many new firms have been established that specialize in resource conservation, pollution remediation and reduction technology and other goods and services intended to help the economy reduce its negative impact on the physical and social environment. In Ontario alone, these industries are already the third largest employer.

- The Great Lakes Commission, in cooperation with many regional organizations, is coordinating development of an *Ecosystem Charter for the Great Lakes-St. Lawrence Basin*. The charter sets forth a series of principles and commitments to improve and sustain the environmental health and economic viability of the world's greatest freshwater system. Signatories will use the charter as guidance in the development of their work plans and priorities, as a means to enhance communication and cooperation with other stakeholders, and as a benchmark for assessing progress toward a shared vision for the Great Lakes-St. Lawrence Basin Ecosystem.

Recognition of economic/environmental linkages in resource management and protection is increasing within the Great Lakes "institutional ecosystem," and is generally reflected in Remedial Action Plans, Lakewide Management Plans and a host of other initiatives. While such recognition is a necessary condition for sustainable development, it is not a sufficient one. Many agencies and organizations at various levels have embraced the concept of sustainable development, however defined, but have found the leap from concept to application to be a formidable one. Sustainability, as an outcome, can be achieved when environmental protection is fully integrated with economic activity so that a sound basis exists for future development. Wise and efficient use of resources and emphasis on pollution prevention, quality production and effective information dissemination are considered necessary measures if harmony between the economy and environment is to be established.

The relative sophistication of the Great Lakes institutional ecosystem has provided a supportive—albeit sometimes painstaking—vehicle for the gestation of management innovations. Within this arena, principles of sustainable development will be formulated, tested and applied over time. Case studies to date suggest that sustainable development principles are most effectively applied at a local level, either on a small watershed or community basis. Ensuring that an adequate institutional infrastructure exists at these levels is a priority concern.

7.0 RECOMMENDATIONS

Based on informal peer review of this paper and comments received from participants at the SOLEC meeting in October 1994, the authors believe some changes to the paper are warranted if another version is prepared for the next SOLEC meeting. These recommendations are made:

Data

Although this paper takes a broad view of the binational regional economy with an emphasis on descriptive economic data, more information and analysis of demographic trends and land use should be included. Settlement patterns and trends particularly for suburban and urban areas should be discussed in greater detail as this information is pertinent to the overarching trend of urbanization within the Great Lakes Basin. More discussion of trends in agricultural land conversion and loss of open space and natural habitat would be appropriate.

With respect to industry sector profiles, several additions are recommended and more in-depth discussion of particular industry clusters within sectors is needed. Selection criteria should include but not be limited to industry's relative importance to the Great Lakes region in terms of employment, production share, value-added factors, utilization of natural resources inputs and regional environmental impact. Particular industry clusters within the broad sector categories to be considered are: chemicals and petroleum refining, pulp and paper, mining, fisheries and the commonly referred to category "green industries" covering both manufacturing and service companies engaged in pollution prevention/control, remediation, response and resource conservation activities etc. All of these industry groups have a substantial presence in the Great Lakes region and connection to natural resources. Pollution issues and related trends associated with these industries are closely tied to implementation of the binational Great Lakes Water Quality Agreement and deserve more attention in the next SOLEC paper.

Discussion of industrial and municipal water use should to be expanded. Industry water use in the Great Lakes Basin is intensive because of the particular industry mix and availability. Also major changes are occurring in industry water use such as more recycling which have significant implications for Great Lakes water quality. Discussion of municipal water treatment issues including levels of infrastructure investment and treatment concerns should be expanded. For example, some review of Great Lakes water supply for non-industrial purposes would be appropriate. Also, examples such as the cryptosporidium outbreak in Milwaukee in 1993 and zebra mussel infestation of water intakes could be used to illustrate investment requirements related to water supply and treatment.

Native American Authorities/First Nations

Several SOLEC participants indicated that more discussion of tribal economic activities on reservations is needed. Business/industry recruitment efforts and employment levels could be addressed. Gaming and casino development should be addressed. The "information and communications" sector discussion in this paper could be expanded to include a description of the Great Lakes Regional American Indian Network, a current project designed to promote and support Internet connectivity on regional reservations.

Public Policy and Sustainable Development

A more thorough review of activities intended to foster sustainable development that are under way or planned in the Great Lakes Basin would be desirable. These activities would include discussion of major pollution prevention initiatives involving key industry sectors and innovative public-private partnerships. Waste generation, at all levels of society and activities aimed at reducing it, should be discussed. Coverage of federal policy developments on this issue would be appropriate. The President's Council on Sustainable Development policy recommendations scheduled for summer 1995 and related federal agency efforts will provide much additional information of value for the next SOLEC meeting. For example, appropriate economic and environmental data sets by which to measure progress toward sustainable development are being developed as part of this effort. Also, the Department of Commerce's Bureau of Economic Analysis is developing economic and environmental satellite accounts which will consider natural and environmental resources as productive assets, therefore providing a means to measure their contributions to national income, production, consumption and wealth.

The issue of cost effectiveness of environmental regulations relates to sustainable development policies but may need to be addressed in a separate section. A review of the basic arguments for and against cost benefit analysis of such regulations would be appropriate. Perhaps the Great Lakes Water Quality Initiative could be used as a case study example of how this issue could be applied. Also, more discussion of the impact of environmental regulation of key region industries along with its effect on interregional competitiveness would be appropriate.

8.0 CONCLUSION

With all its diversity, strength, and common ground, the Great Lakes region is a remarkable and unique place. This impressive economic region, rich in resources—people, industry, natural resources and institutions—is challenged by the need to maintain its strengths and pursue new opportunities. Throughout the region's notable history, challenges were met and difficulties overcome. Now, the continual quest for economic growth and prosperity reckons with the realities of the international marketplace and environmental protection. Uncertainty, whether it pertains to personal economic circumstances, the welfare of community or the flux of national politics, is ever-present. Faith in the future may be an age-old expression, but for Great Lakes region residents, it is as fresh and forceful as the new day it heralds.

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The Great Lakes Basin

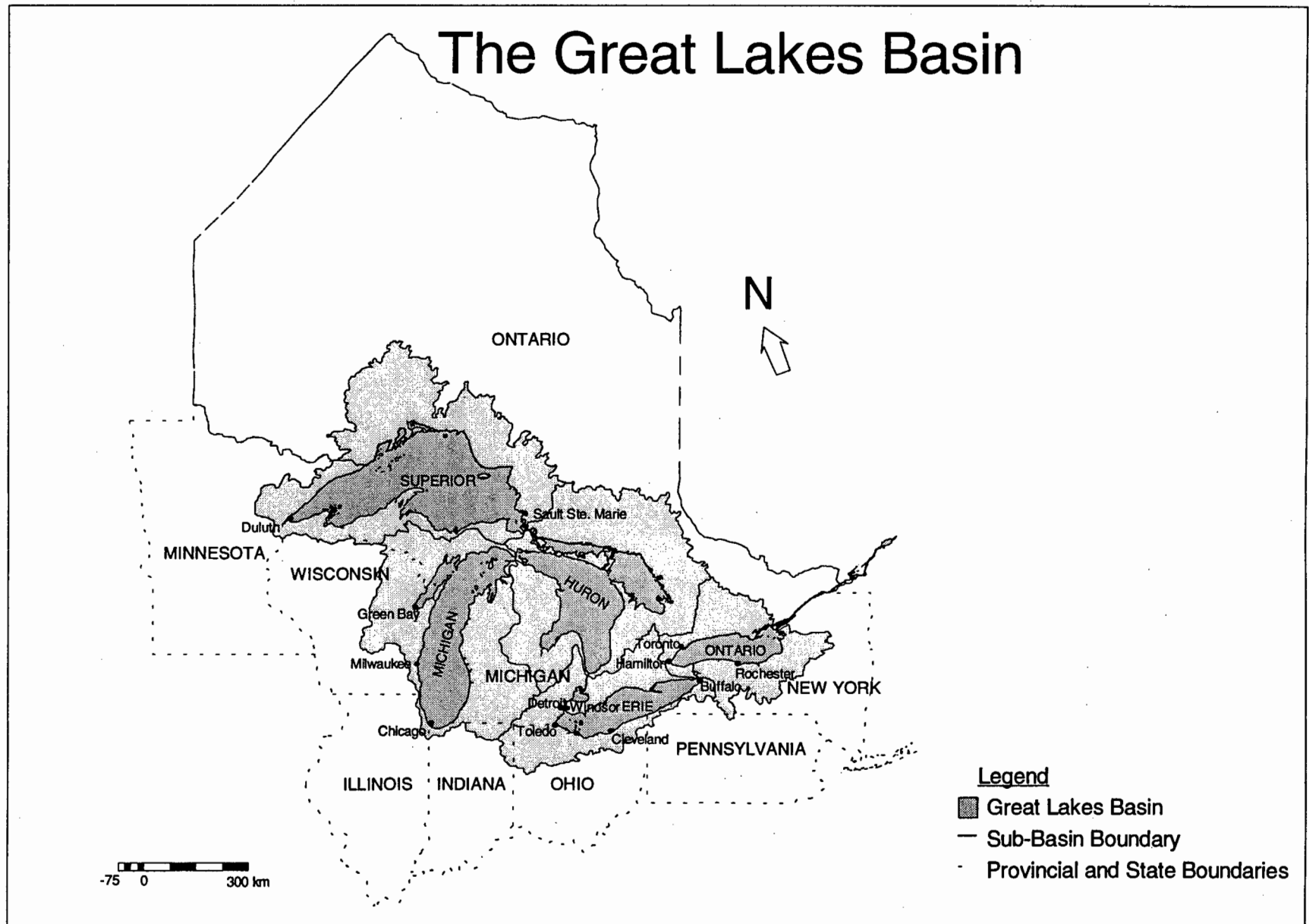


Figure 1. The Great Lakes Basin

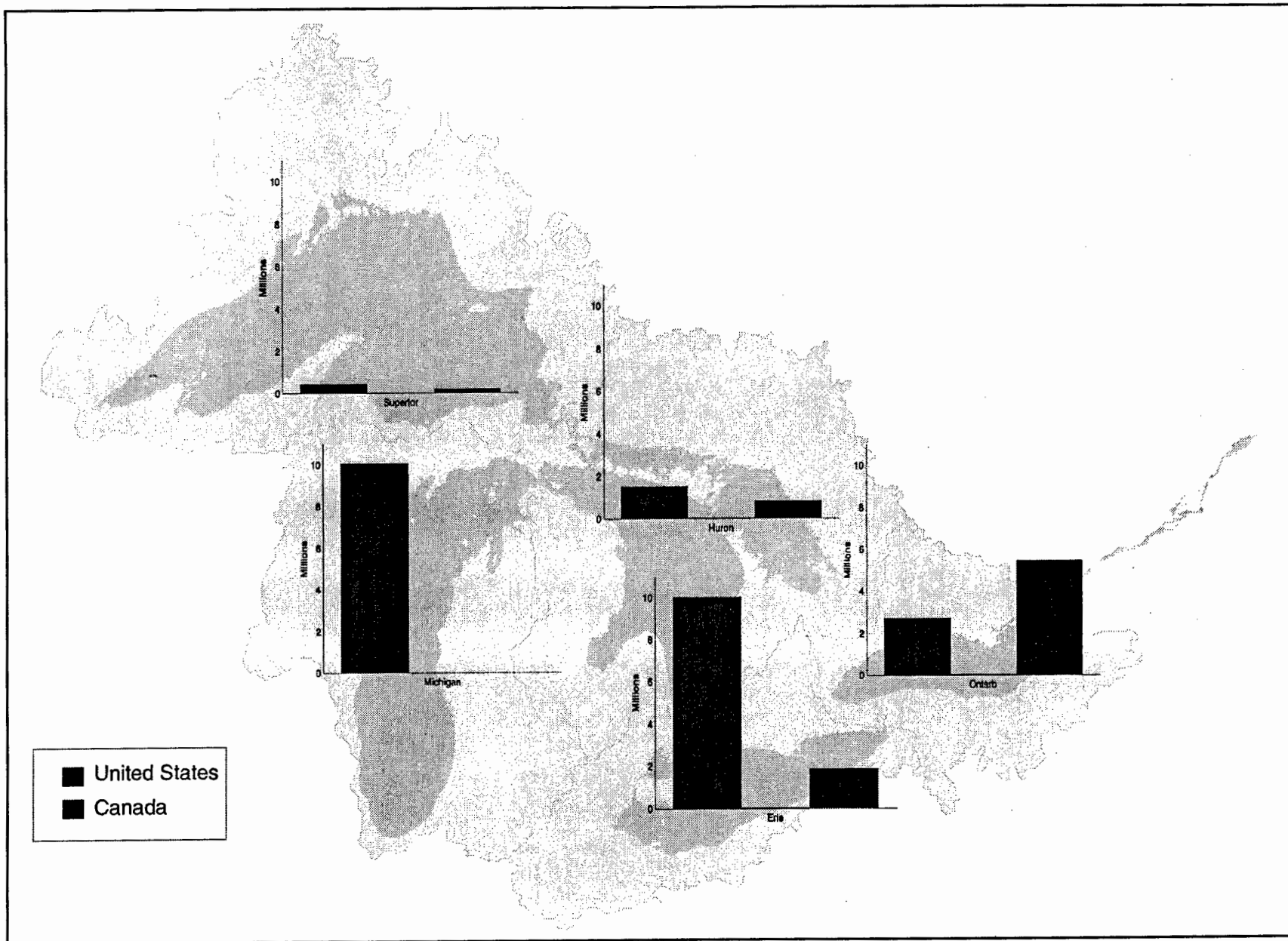


Figure 2. Population of the Great Lakes Basins

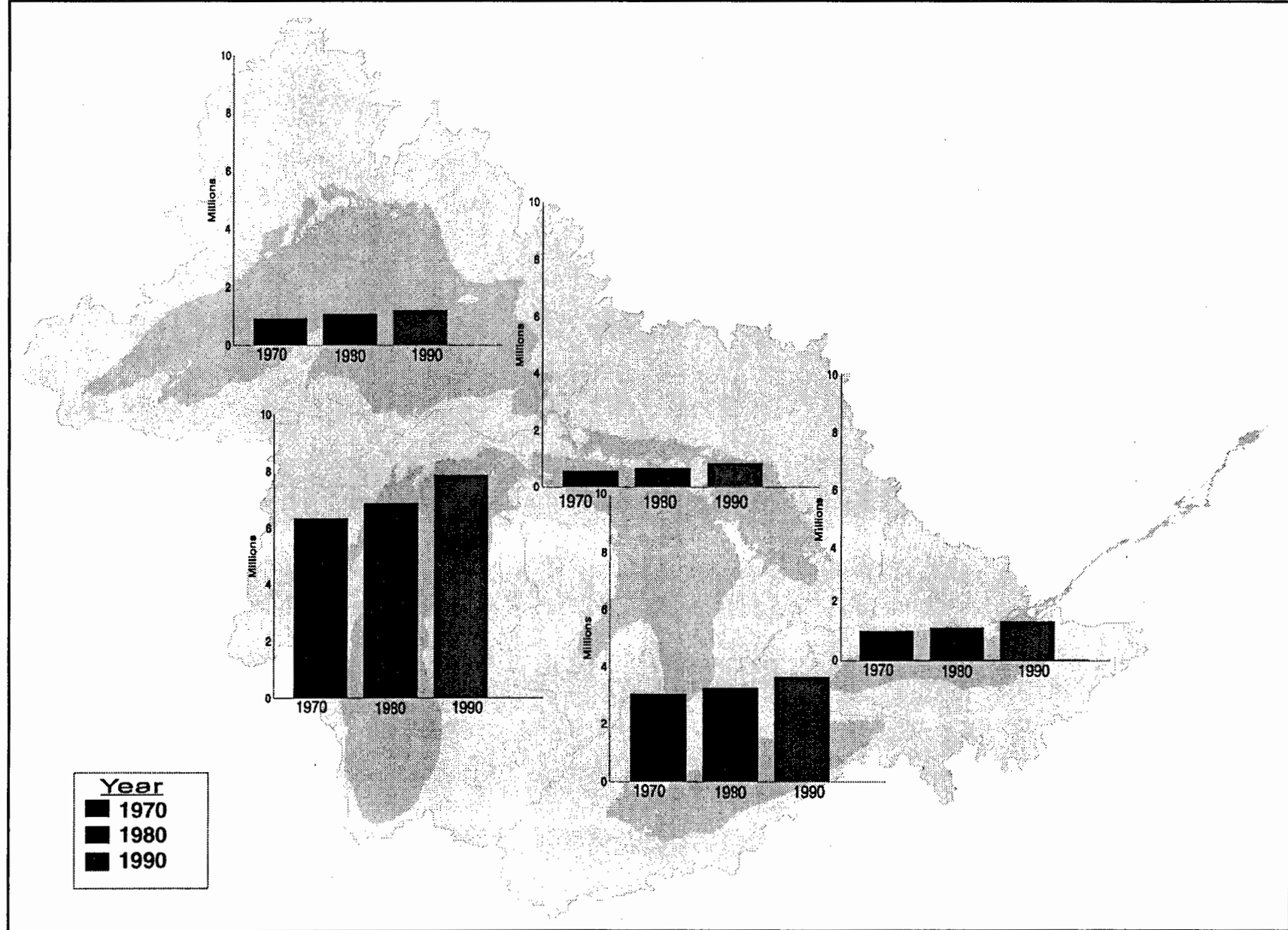


Figure 3. Total Employment by Lake Basin.

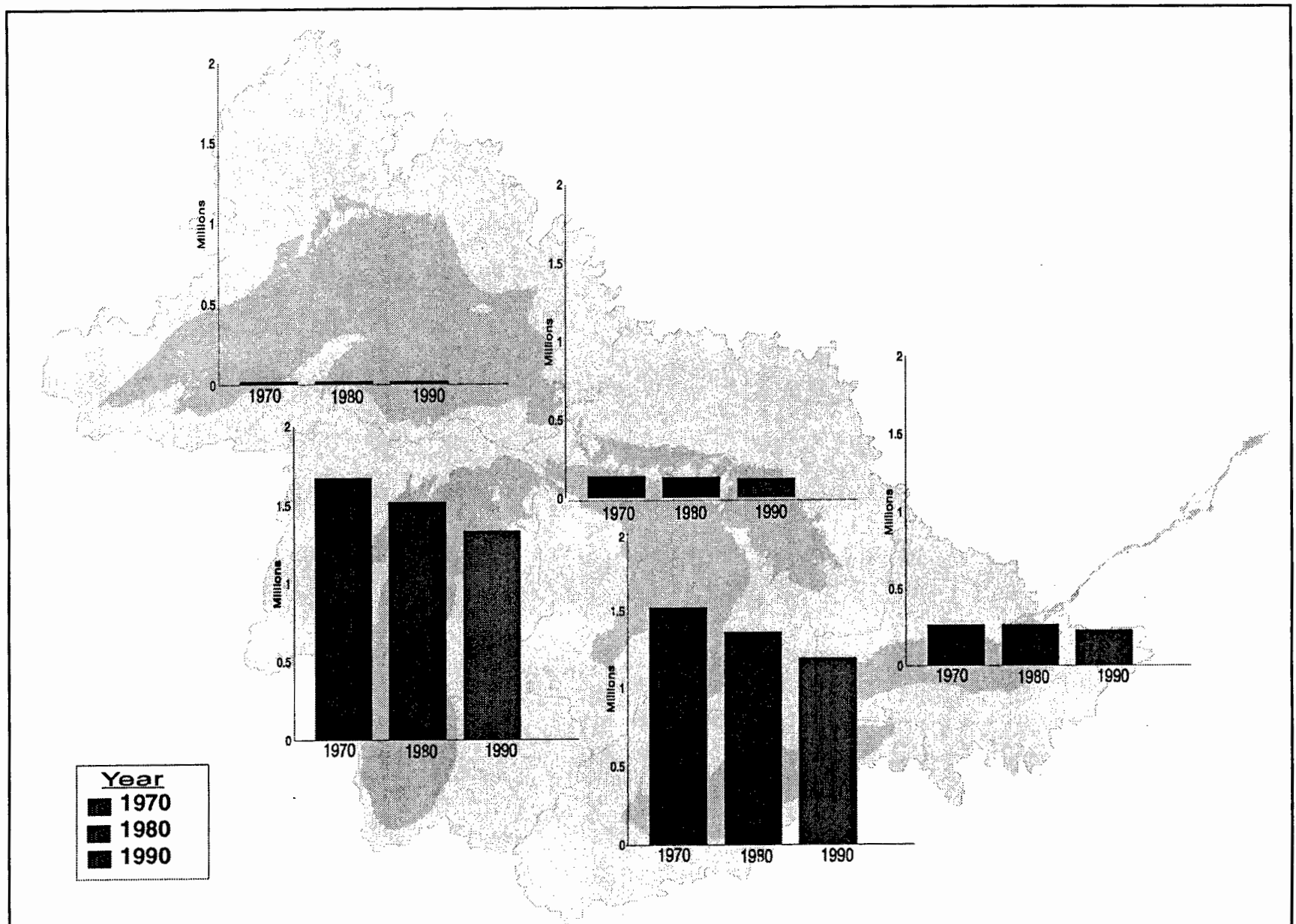


Figure 4. Manufacturing Employment by Lake Basin.

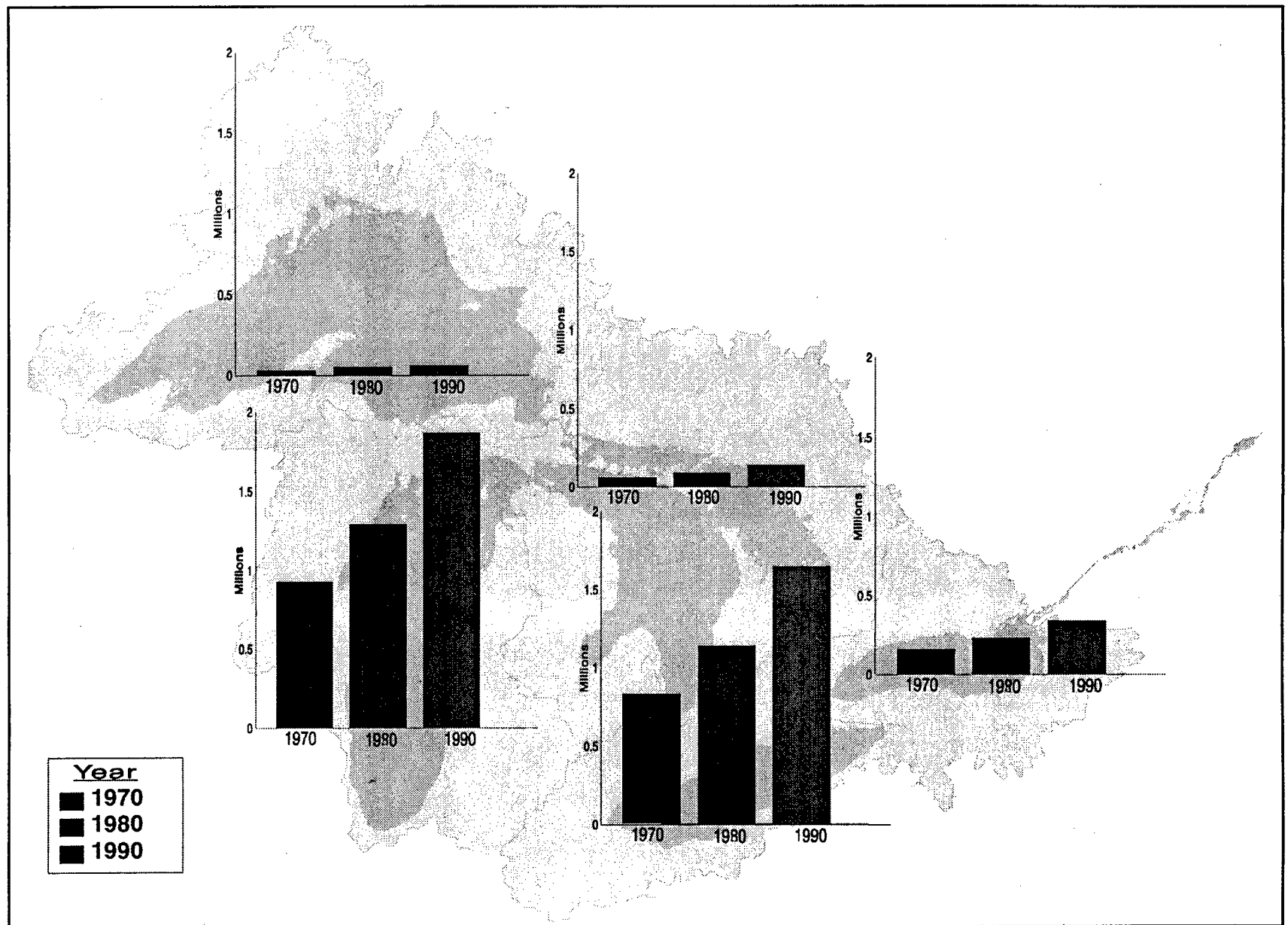


Figure 5. Service Employment by Lake Basin.