VIIIth INTERNATIONAL CARTOGRAPHIC CONFERENCE MOSCOW, AUGUST 1976

AN APPROACH TO MAPPING NATURE AND NATURAL RESOURCES FOR ENVIRONMENTAL PROTECTION

"An Examination of Lands Directorate Mapping Projects"

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Resources Mapping Division

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During the past decade Canada, like many other nations, has experienced unprecedented activity in the exploration and exploitation of natural resources. Rich discoveries, together with the tantalizing promise of tremendous potential, have triggered the planning and construction of large-scale projects such as pipelines, transportation corridors and development areas. Much of the exploration and development of mineral resources is occurring in the ecologically sensitive North but there is equal concern regarding proper use and management of land and water resources in Canada's more densely populated southern fringe. The upsurge of public and government interest in environmental quality during the 1960s has matured into serious national and international concern regarding the status and use of natural resources. In some instances, it is no longer a case of concern but of survival.

As the demands for space, land, water, energy fuels and other renewable and non-renewable resources escalate, so do the requirements for an accurate, informative and up-to-date resource information base. A dramatic increase in the publication of thematic resource maps reflects the growing demands for, and utility of, cartographic presentation of resource data.

The Conference theme "Mapping of nature and natural resources for environmental protection" addresses three main areas of interest; mapping, natural resources and environmental protection. This paper focuses on several cartographic projects in the Lands Directorate of Environment Canada. The Department of the Environment, or Environment Canada, is the federal government department assigned the responsibility of providing national leadership in the field of environmental resource management and protection. However,

under the Canadian constitution, the British North America Act, primary responsibility for many resources rests with the provinces. Therefore the role of Environment Canada is one of undertaking detailed research on land, water, forest, air and wildlife resources, using the considerable expertise within the department in order to provide information for federal and provincial agencies for purposes of policy development, resource planning and management, and education.

Within the broad context of this departmental mandate, the Lands Directorate, and specifically the Resources Mapping Division, has worked to develop data collection and publication techniques to assist in meeting these responsibilities. The projects are often map-oriented because maps are a particularly effective method of describing the spatial aspects of resource matters. This paper describes four mapping projects which were developed specifically to suit certain resource problems and issues. The design criteria, cartographic techniques and the subjects vary considerably. Each project is a response to a different need and each has a role to play in environmental protection of resources.

CANADA LAND INVENTORY

Perhaps the best-known and most widely used map series is the Canada Land Inventory (C.L.I.). This national map series was developed in response to a very specific need, a need precipitated by a dramatic population shift. Technological advances, changes in market patterns and a shift in the rural-urban balance after WW II signalled a new trend in Canada. These social and economic changes necessitated changes in farm structure and operation as well as in rural life itself. Marginal farmsteads located on poorer soil were unable to adjust to the new socio-economic climate. Indeed, even more prosperous farms encountered difficulty. The result was that during the 1950s, the number of farms in Canada declined at a rate of 14,218 per year. Widespread rural poverty became a major problem, and land-use planning became a new challenge.

Development of the map series

In the ideal but hypothetical situation, land is allocated to its most appropriate and efficient use based on consideration of society's needs and the land's capability. The most effective allocation of land requires technical and scientific data concerning soil capability. Canada had no such information base. The problem was to devise a comprehensive and reliable base of land

capability data. In 1961 the joint federal-provincial Agricultural Rehabilitation and Development Act was created with the express purpose of assisting in farm consolidation and improvement, as well as providing a basis for rural land-use planning. The goal was to designate the vast portion of soils in Canada's settled region as to physical capability for agriculture, forestry, recreation and wildlife as well as present land use. The means of achieving this goal was an extensive soil survey, land classification and mapping program. So began the Canada Land Inventory, a 12-year, $40,000,000 program to classify 2,589,900 square kilometres of land.

The challenges of preparing a national inventory for a country encompassing a range of climatic, physiographic and vegetative types experienced in few other countries, are many. The map series had to serve two primary functions. First and foremost were the land-use planners and resource managers at the regional, provincial and federal levels who needed the land capability data, and the location and extent of each land class, in a convenient format. The level of accuracy had to be such as to allow the maps to be practical, reliable planning tools. The data had to meet the standards of soil specialists but had to be clearly understood by non-specialists. Land-use planners required large-scale maps. Legend and text material was necessary to adequately explain the classification system and document the limitations affecting soil capability. The classification system had to be consistent across Canada but at the same time had to allow for the phenomenal diversity of soil types and climatic conditions. Finally, it had to be developed, completed and in the hands of the users in a reasonable period of time.

Secondly, the Canada Land Inventory had to have an educational function. The average Canadian in the post-war period was demanding and acquiring goods and services at an ever-increasing rate. Canadian affluence depended partly on the high-technology exploitation of land resources, but conflicts among land uses were intensifying as Canadians increased their demands on the land resource base. Many Canadians were unaware that a nation of 2,589,900 square kilometres and a population density of only 2.3 people per square kilometre could have serious land resource problems. Thus for educational and general information purposes, the data had to be available at a smaller scale, convenient to handle, easy to understand, and attractive as well as informative.

Design and format

In order to meet these requirements, the Canada Land Inventory initiated three map series, each presenting land capability for five uses; agriculture, forestry, recreation, wildlife-ungulates and wildlife-waterfowl. Maps concerning present land use and capability were originally prepared at a scale of 1:50,000 through the use of soil surveys, field checks and air-photo interpretation. These maps are unpublished and serve as working documents for planners and as input into data banks. The soil capability data were then generalized to a 1:250,000 scale, overlaid on the standard topographic base and published in colour with extensive legends. Lastly, a series at 1:1,000,000 illustrating soil capability and critical areas was generalized from the 1:250,000 maps, largely for educational purposes.

A brief description of the soil capability classification scheme for agriculture and the 1:250,000 map for agriculture will illustrate this mapping approach.

The soil capability classification system for agriculture was developed by the National Soil Survey Committee. Mineral soils are grouped into seven classes according to their potential and limitations for agricultural use. The first three classes are considered suitable for sustained production of common cultivated crops, the fourth is marginal for sustained arable agriculture, the fifth is capable of use only for permanent pasture and hay, the sixth is useful only for wild or rough pasture and the seventh is unsuitable for use either as arable land or permanent pasture. These classes then, are the broadest categories. A subclass designation describes the limitation or hazard of each class area. Information concerning adverse climatic factors, erosion damage, stoniness, adverse soil characteristics or topography provides the map user with the data required to assess appropriate management or conservation practices. Additional details concerning the classification systems are available to users through a series of technical reports.

Having briefly described the classification scheme, how is the information portrayed on the maps? The base is a 1:250,000 topographic map containing the usual reference information including place names, transportation routes, legal boundaries, spot elevations and other cultural details. The map is divided into areas representing the soil classes which occur in that location. Within any of the seven soil class areas, represented by seven

colours, a large black arabic numeral also denotes the soil capability class. Letters placed after the class numeral denote the subclass or limitation. In a straightforward example, an area of class 2 soil with undesirable soil structure and excessive water problems resulting from poor drainage would appear in a buff colour with 2^{D}_{W} in bold, black type. A more complex location may contain soils that fall into two or three classes, each with different limitations. For example, a site with some class 3 soil with erosion damage and topographic limitation, as well as some class 4 soil with salinity and stoniness hazards, in the ratio of 7:3, would be shown as $3^{7}_{T}\,4^{3}_{P}$. The colour used to portray such a complex area is determined by the first, and generally dominant, soil class.

Within the map sheet, the 1:250,000 map face appears in the centre, flanked by complete legend material, including full definitions of classes and subclasses in English and French on the margins. In addition, a general description of each map area is printed on the back of the sheet. It describes relevant climatic details, soil characteristics, and vegetation as well as cultural and other geographic features. These notes are prepared by experts familiar with the area.

Application and use

The question which arises is: how do these maps contribute to environmental protection of land? At the 1:50,000 scale, the Canada Land Inventory present land use and capability maps have been used extensively, together with other information sources, as guides to regional and local planners. Consultants, private industry and parks personnel have found this scale to be most convenient and useful in planning recreational areas, highway construction, powerline locations and the like. Agricultural data, for example, are particularly useful in delineating farmlands, identifying submarginal farmland, establishing an equitable assessment base and indicating where urban or industrial growth might be directed without undue interference with or reduction of agricultural productivity.

However, the 15,000 1:50,000 map sheets were not designed for publication but rather for input into a geographical information data base. It is clear that it is impossible to manage or analyze manually the large volume of data

collected and mapped during the C.L.I. program. But no satisfactory computer mapping system existed when the program was initiated. However, investigation showed that a system capable of accepting physical, social and economic data for evaluation of land areas was feasible.

The Canada Geographic Information System (CGIS) has been developed to do this. It is a system designed to accept any geographically specific information, that is area, line or point data. Once entered as input into the CGIS, a map, or other data, may be retrieved, by specific programming, and in the manner desired. Thus, it is possible to obtain area calculations and summaries for a specific area and purpose. Output may be in map or tabular form. This capability of applying the processing and data-handling facilities of large-scale digital computers to the cumbersome tasks of reducing, manipulating, storing, analyzing, tabulating and retrieving C.L.I. data allows much wider application of information for planning purposes.

The 1:250,000 soil capability map series was produced for land-use planners, farm program managers, the interested public and educators. However, it is the 1:1,000,000 series of 47 maps which provides the best perspective of Canada's land capability.[1] Each map sheet portrays a province or group of provinces and provides an overall view of the location and extent of high capability soil for agriculture, forestry, recreation, wildlife, or critical areas. The maps serve to illustrate the scarcity of highly productive land.

The C.L.I. 1:50,000 present land use and soil capability information is available to land-use planners upon request through the Canada Geographic Information System. The 1:250,000 and 1:1,000,000 soil capability maps are distributed free of charge to every Canadian school at the secondary level or above. These maps are also available free of charge to any municipal, regional, provincial or federal government agency upon request. In addition, maps are sold to consultants, private industries and the interested public through the government bookstores and distribution centres. To date, over three-quarters of a million C.L.I. maps have been printed and distributed.

The broad objective of the C.L.I. is to classify lands as to their capabilities for various uses, to obtain a firm estimate of the quantity and location of each land class, to encourage use of the C.L.I. data in planning, and to provide the Canadian population with an appreciation of this finite resource. The C.L.I. with its three map series and computerized data bank

1. The 1:1,000,000 Soil Capability map for Manitoba (appendix) illustrates the land classification system and map design used in the C.L.I. program.

does not provide all the answers. Rather, it is designed to assist planners by filling a gap in land resource information and complementing other data. It is one of the earliest and most comprehensive biophysical inventories of its type in the world. It has certainly contributed to Canadian appreciation of the limited amount of valuable land, the need to manage it properly and the means of achieving such planning.

OTHER THEMATIC RESOURCE MAPS

Although the C.L.I. is certainly the largest of the Lands Directorate's mapping endeavours, it is not the only program. Considerable time and energy have been devoted to the development of thematic wall maps. One of our first thematic wall maps, entitled Atlantic Provinces: Resources and Economic Activity, was produced by the Geographical Branch of Energy, Mines and Resources, a forerunner of the Lands Directorate. It marked, for us, a new approach to the cartographic presentation of resource data. An advantage of the wall map is its ability to provide, at a glance, a visual correlation of the basic elements or components of a subject and thereby encourage appreciation of their interrelationships. Wall maps can be used to present two layers of information: 1) overall patterns or spatial distributions apparent from several feet away, and 2) specific information found in finer cartographic details and accompanying notes, visible from a normal reading distance. When composed of a number of insets to highlight various topics, the wall map becomes a "one-page atlas". By providing immediate and simultaneous access to all the information, wall maps actually force the viewer to establish the links or relationships among the components. Such a format is particularly well suited for users in certain situations. High school and university teachers, as well as some resource researchers, seem to prefer the "one-page atlas" approach. In recent years, the Lands Directorate has produced a number of wall maps including: the Great Lakes Water Use map, Strait of Georgia Water and Generalized Land Use maps, the Georgia Strait Urban Region and The Windsor-Québec Axis. A brief description of one wall map, The Windsor-Québec Axis, will illustrate that large thematic wall maps also have an important educational role to play in the protection and management of natural resources.

Development of the Windsor-Québec Axis map

As recently as 50 years ago, more than half of Canadians still lived in rural areas, and the nation had a largely agricultural/rural perspective. By 1971, three of every four Canadians were residing in cities or towns. If present trends continue, ninety per cent of Canadians will live in urban areas, by the year 2000. Within 50 years Canada has evolved into a highly industrialized urban-oriented nation. What has transpired over centuries in other countries has been accomplished within the lifetime of one generation. Canadians are rapidly congregating in the urban southern fringe of the country. When combined with population increases and rising standards of living, this process of hurried urbanization is creating tremendous pressure on land for housing, industry, recreation, transportation and related facilities. Since most cities are located in prime agricultural areas, the land most readily available and most easily developed is the best agricultural land in the country. Less than one-half of one per cent of Canada's land is considered to be class 1 farmland. More than one-half of that prime agricultural land is in southern Ontario, precisely where population density, urban expansion and land demands are greatest.

Serious losses of arable land to competing uses, particularly urban and industrial development and related interurban infra-structures, are occurring continuously but at an accelerated rate. Moreover, many of the irretrievable losses are happening on land with unique capabilities for producing specialized crops such as peaches, grapes, pears and other sensitive fruits. Loss of this farmland reduces Canada's self-sufficiency and increases her dependence on foreign sources.

Although cities occupy a small percentage of the country's land area, these urban agglomerations, with their activities and demands, drastically affect land use in their immediate shadows, as well as throughout the country. Urban areas have an almost insidious influence on land use almost everywhere in Canada. For example, as urban dwellers benefit from increased leisure time and disposable income, they generate strong demands for public and private recreational space, preferably within a short distance of the city. Inevitably they influence the land-use patterns and rural life styles as they surge through the countryside in search of shoreline property for vacation homes, marina facilities, hunting and fishing areas, skiing areas and ski-do trails.

Traditionally, the market system has provided the principal mechanism for allocating land among competing uses. However, the intervention of the public sector through planning controls implicitly illustrates that certain land uses are unable to compete successfully in the market.

So we have a paradox: the land as a commodity to be owned and used as determined by the free market, and the land as a resource of society to be managed and protected by government. The absence of broad public interest in, and support for, the planning process in the past has undoubtedly contributed to the conflicts over land use. A well-informed public helps to ensure that society's expectations from the land are being met. But for a population only a generation from the farm, the issue of land is an intensely emotional one.

Map Design and content

The resource in question is the basic resource, LAND. The particular issue of concern is the interaction of conflicting land uses and the repercussions of uncontrolled land development. Few topics are more complex or larger in scope. Few are more essential to the understanding of the need for rational land-use planning and management. The problem: how to attract and inform as many people as possible, and simplify a complex resource issue.

The objectives to be met in developing the presentation were:

1) to attract an audience by means of a strong visual impact, something more appropriate for display than for storage on a shelf,
2) to reach a maximum number of Canadians who are affected daily by increasingly acute land-use conflicts,
3) to present two levels of information; first, a general overview of land-use inter-relationships, and second, detailed information in the form of specific examples,
4) to portray the elements in such a manner as to encourage the user to think about the relationships, conflicts and consequences,
5) to allow the material to be used by a wide variety of users including teachers, land-use planners and resource researchers,

6) to design a format that could accommodate English and French texts in two separate editions, and

7) to utilize a reasonable number of colours in portraying the information.

Our response was to produce a thematic wall map that would inform people about the general land-use issues by focusing on one specific example "the impact of urbanization on land". In order to provide sufficient detail within this general theme, a regional study area was selected. The Windsor-Québec area contains a potential audience of 12 million people, nearly 60 per cent of all Canadians living on 2 per cent of the land. An ideal study area.

The one-page atlas or "monster map" measures 47 by 66½ inches. Within this 119 by 169 centimetre frame, 11 insets were designed at various scales to illustrate a number of topics. At the wall map level, a number of bright colours such as orange, yellow and magenta are used sparingly to attract attention. At the finer level of detail, the dominant colour is a relaxing pale green. Detailed texts accompany each inset. Instead of employing heavy borders to block off the individual insets, the map presentations are made more cohesive by the use of a clean, white background. The viewer's eye is therefore encouraged to travel around the wall map establishing links among the components.[2]

The central and largest map is the dominant one. The objective of this 1:1,000,000 map of the Windsor-Québec study area is to stimulate the user to concentrate on the relationships among the three elements illustrated, namely population density, geographical distribution of prime agricultural land and the percentage loss or gain of improved farmland over a 20-year period. The solution to portraying the three spatial components was a matrix legend. The general pattern of loss or gain of land in improved farm use was calculated over the period 1951-1971. The calculations were done at the township or census subdivision level and because there are approximately 1,100 townships in the study area, the data provide a detailed pattern of change in farmland acreage. This change in farmland acreage is the first level of data and the design of the map reflects this. Loss or gain of farmland is represented by green or brown line patterns respectively. The angle of the line pattern denotes the extent of the change, according to four categories; 0-25 per cent, 25-50 per cent, 50-75 per cent and 75-100 per cent.

2. The design of The Windsor-Québec Axis (appendix) illustrates the general format of large wall maps.

The second set of information is population density and an isoline map was prepared by use of census data and a General Purpose Contouring computer program. Isolines are used to emphasize certain critical levels of population density which ranges from 0 to more than 7,957 people per square kilometre. The five classes are indicated spatially by five different line widths in green and brown. The third set of information, location of land of class 1 or 2 capability for agriculture, is illustrated by use of a dot pattern. The map user is encouraged to study the legend matrix and to consider the possible relationships and patterns among these three components.

The 10 remaining insets illustrate related issues of varying importance. The size, scale, position and colour schemes of each help to reflect their importance. I will briefly mention a few of their themes to indicate the number of topics dealt with by this wall map.

One inset illustrates the opportunity for outdoor recreational activities on extra-urban sites owned by federal or provincial governments. A quotient was designed to reflect the supply of recreation facilities as well as the pressure for use placed on those sites. The inequities of opportunity for the region's 10 million urban dwellers are immediately evident. At present there does not appear to be sufficient recreational land to meet the demand.

A companion inset to the recreation map is the road traffic map which illustrates the volume of daily traffic on main and secondary roads. This traffic density pattern, which utilizes line widths that vary in proportion to traffic volumes, is superimposed on a highway isochrone pattern showing travel time in hours by road from the two major metropolitan centres, Montréal and Toronto. This serves to underline the recreational locations that are within a one-to six-hour drive of millions of urbanites.

The automobile is an increasingly important part of life in North America. It is estimated that as much as 40 per cent of space in urban areas is devoted to automobiles' demands, seen in terms of streets, parking lots and garages. For the future, however, much concern is directed toward the rural and urban fringe areas which are in many cases undergoing rapid change. Transportation links with urban centres have often been considered a key factor in determining the degree of urban influence. Significant alterations in traffic patterns and volumes occur as rural areas become more urban-oriented, and as access to these rural areas, for housing, industry and re-creation purposes, generates additional pressures. However, the exact

nature of the role played by transportation networks in the process of land-use and social changes is not clearly understood.

To underscore the fact that the urban fringe is an arena for dramatic land-use changes, two very interesting insets focus on a portion of Toronto's rural-urban fringe. In this area, land is almost exclusively class 1 soil for agriculture, but the use of this irreplaceable farmland for urban development is a well-established phenomenon. At a scale of 1:50,000 the first inset illustrates five aspects of the dynamics of the land market for all land parcels affected by land sale transaction between 1968 and 1972. Each parcel of land is designated as to private or corporate ownership. Not surprisingly, corporate ownership stands out clearly as an important factor, especially within the largest parcel size class. Examination of the map also reveals widespread non-resident ownership. Thirdly, the unit price of land is one of the most significant indicators of urbanization pressures. Professional land appraisers agree that good agricultural land in south central Ontario can command a price of approximately $1730 per hectare. Land prices in excess of this figure suggest higher uses associated with urbanization, uses which may reflect society's need for recreational, industrial or residential space. A relatively small number of parcels sold for a reasonable agricultural value of less than $2470 per hectare during the 1968 to 1972 period. Prices for larger parcels tend to reflect an expectation of imminent development and thus some of the highest unit prices are found near the towns. The top prices were in excess of $37,065 per hectare, hardly land bought by full-time farmers for agricultural purposes! Fourthly, the map also illustrates the spatial distribution of changes in land prices for multiple-sale parcels within the same period, January 1968 to December 1972. Change in the unit price of land from the first sale to the last is quite varied, sometimes reaching a 400 per cent increase. The fifth factor portrayed is the spatial distribution of the frequency of land transactions. Before 1967, there was very little land sale activity within the study area. In the following four years, land market activity increased as land for residential development within Metropolitan Toronto became relatively scarce and expensive. This area, as any other undergoing strong urbanization pressures, is susceptible to considerable sales activity, partly the result

of multiple sales of individual parcels. The role of speculation in multiple sales cannot be regarded as insignificant. In the study area, some land parcels changed hands twice within a period of weeks, with sale price increases of as much as 100 per cent. The five aspects of land dynamics are illustrated by means of circles divided into five segments. Circle size reflects parcel size and specific colours within the pie segments indicate the detailed information.

The second, and companion inset to the map described above, illustrates the actual changes in land use that occurred in the same portion of Toronto's urban fringe, between 1961 and 1971. By means of a bold, black letter designating the land use in 1961 and the standard land-use colour scheme representing the land use in 1971, a clear pattern of land-use change is visible. The pressure of Toronto, to the south of the study area, is evidenced by the fact that in 10 years, low-and medium-density residential acreage doubled. In addition, other urban-oriented uses such as industry, quarrying and outdoor recreation also exhibited sizeable increases in area. However, the most dramatic fluctuations in the land-use system of the study area involved the cropland/pasture combination. Cropland sustained the largest decrease in acreage with a reduction of nearly two-thirds. While cropland and pasture were converted to all other use categories, especially large quantities were lost to residential and mineral extractive uses as well as rough pasture, woodland and rough woodland. These exchanges, or losses and gains, among land uses may be viewed within the context provided by the companion inset. Together they indicate that the direction of land conversion is cause for considerable concern, especially when prime agricultural land is affected.

Other background information is presented on the Windsor-Québec map in graphs, pyramids, three-dimensional graphics and small maps. This supplementary information including population structure, trends in farmland acreage, number of farms, farm population, rural non-farm as well as urban population, provides details about past trends and offers clues as to possible future directions. The research presented on this wall map supports the hypothesis that urban pressures are impairing the viability of agriculture in certain areas, and conflicting with other land uses. There is reason to believe that the land-use changes occurring in the Windsor-Québec region are characteristic of events in other urban areas across Canada.

In evaluating the effectiveness of The Windsor-Québec Axis map, it is clear that each format has certain disadvantages as well as advantages. This map is not easy to handle. It is difficult for a map user to concentrate on the finer cartographic details and small-type text while craning his or her neck over the 2 square metres of wall map surface. The size of the map sheet posed enormous problems at the design, layout, scribe and registration stages of production. Questions and uncertainties regarding colour consistency and registration during printing were always present. Mailing of the maps requires sturdy 122 cm. map tubes and much patience in carefully preparing the maps for distribution. Storage of flat copies requires unusually large map shelves. These are only a few of the inconveniences involved in producing a map of this size.

Nonetheless, The Windsor-Québec Axis and its counterparts have been well received, particularly by resource geographers, geography teachers and cartography instructors. In attempting to make this resource information available to a wide audience, the Lands Directorate distributed copies of the Windsor-Québec map to every high school not only in the study area but also throughout the provinces of Ontario and Québec. As a matter of standard practice, copies of maps are also sent to university geography departments, map libraries and cartography departments. Judging from user reaction, The Windsor-Québec Axis, Strait of Georgia Urban Region and other recent maps have generated considerable appreciation of the need to manage land and water resources more efficiently with a view to optimizing the use of these finite commodities.

THE LAND USE INFORMATION SERIES

Over vast regions of the country, resource management concerns focus on other resources such as forests, wildlife, fish, water and minerals. Careful management of these resources has become increasingly important in our resource hungry yet environmentally conscious society. In recent decades frontier areas, for the most part in the North, have been subject to unprecedented activity in the search for natural resources. Experience has shown that uncontrolled development in the North can lead to undesirable and perhaps irreversable environmental damage. In addition, large-scale programs

designed to develop the non-renewable resource base are sometimes incompatible with efforts to develop full utilization of renewable resources by indigenous peoples who, increasingly, are demanding effective control of resource development in the land where they live. There has been a growing concern in government and public circles that we simply did not possess the tools required to undertake a comprehensive land management program in the Canadian North.

Government response to the concern, in part, took the form of the Territorial Land Use Regulations (1971) and the Northern Inland Waters Act (1972), designed to provide a control and monitoring framework for land management in the Yukon and Northwest Territories. At the same time, legislators were aware of the need for a comprehensive information base with which administrators could make well-informed decisions. It was physically impossible for active planners and administrators to research and assimilate quickly the vast numbers of reports and studies available on the North. An additional problem was the vast area of the North, and the need to be able to quickly relate resource information to specific geographic locations. In the spring of 1971, a group of administrators and geographers from Environment Canada and the Department of Indian Affairs and Northern Development met to discuss ways of dealing with the problem. In the months that followed, the Land Use Information map series was developed as a solution.

Such tasks are never easy. A number of conditions had to be met. The format had to include both maps and text since neither approach alone was sufficient. Because of the normal business pressures of users, the reference method had to be convenient and concise. It must meet the needs of the specialist, yet be clear enough to inform the non-specialist. It had to present as much information as possible, yet not lose effectiveness by presenting too much. And finally, the format had to be flexible enough to meet the challenge of considerable variation in the physical, social and economic parameters of various northern regions.

Development of the Map Series

As originally conceived, the series was to be primarily an exercise to gather existing data, compile it into a convenient format and make it available to administrators and planners in published map form. Researchers for the project would simply have to review the available information, visit

and interview northern scientists and residents, and summarize the results. The first season of data collection revealed an important shortcoming in this approach. The problem was, simply, a lack of significant regional baseline data, since much scientific research tends to be site and/or problem specific.

The initial intent of the project was to investigate the Mackenzie River Valley and publish a type of regional atlas. However, once the project was initiated it became obvious that the same approach was desperately needed elsewhere in the North. In 1972 the series was extended westward to the Yukon Territory. As a result of the data collection difficulties experienced in the first season, the research was broadened to include field surveys of fish and wildlife resources and other topics.

The Mackenzie Valley project resulted in 44 map sheets at a scale of 1:250,000. Since that time another 64 sheets have been published, and work has begun on another 60. The 108 sheets now available cover approximately one-half million (506,617) square miles (1,312,138 square kilometres), or one-third of the two northern territories, and nearly one-seventh of Canada. The project continues to be jointly funded by Environment Canada and the Department of Indian Affairs and Northern Development, at an annual cost of $300,000.

Format and Content

A basic aim of the map series has been to strive for a broad data base; one which describes, as accurately as possible, the resources and management concerns of a given region. All data are presented in association with a topographic base, so that spatial aspects are portrayed clearly. Extensive textual notes found on the margins of each map summarize, concisely and conveniently, the resource information collected for the area covered by that particular map sheet.[3] The marginal notes and the information presented on the map face are keyed together through a system of quick-reference symbols. The symbols enable a regular user to interpret the maps quickly and efficiently.

The information base for the series can be grouped into four main categories: wildlife; fisheries; hunting and trapping; supplementary topics.

[3] The Yellowknife sheet (appendix) illustrates the design of this map series.

Information on areas critical or important to wildlife is developed by a Canadian Wildlife Service biologist working year-round. Following library research and reference to aerial photography and satellite imagery, a program of survey flights is developed. Although it is impossible to locate all animal activity within any given area, it is possible, with an adequate biophysical background and a well-planned survey program, to determine the areas likely to be critical or important to the survival or health of major wildlife species. These areas are indicated on the map by a solid red line boundary enclosing a pattern of red dots. In recent map sets some of the background biophysical information has been presented as wildlife zones, indicated on the map by a broken red line.

Each area outlined on the map face is keyed to explanatory notes found on the margin of the map. The symbols themselves are a 'shorthand' method of describing the importance of each area. Each symbol consists of: one or two large letters which indicate the species involved, a smaller letter which indicates habitat function, and another small letter which indicates the season of use. With a little practice it becomes very easy to interpret the information portrayed on the map using these symbols. The number with each symbol indicates the relevant reference note to be found in the legend. These notes provide a concise summary of the reasons why each area is considered to be important or critical. They also provide an opportunity for comment on measures which might be taken in conjunction with a land-use operation to protect wildlife habitat or populations.

Data on fish resources, and domestic as well as commercial fishing, are developed by the Fisheries and Marine Service of Environment Canada. Research begins in early spring with a thorough literature search to identify areas or river systems which lack comprehensive baseline data. Summer field research includes interviews with local residents and lodge operators as well as test-netting surveys in rivers and lakes. Fisheries information is presented on the map in blue, as a letter or numeral within a circle. All information is classified into the following categories: fish migration route, existing or potential fish spawning area, commercial fishing, important area for domestic fishing, and other general comments. The marginal notes include further comment on species, season of activity, and other important aspects of fisheries management.

The description of hunting and trapping activities is based on information provided, under contract, by native organizations. Their data in turn have been derived from the extensive interview programs conducted for various land-use and occupancy studies. The information received is supplemented by interviews with territorial game management officers and then summarized for presentation on the maps. The areas of significant activity are outlined on the map in light blue. The symbols on the map face indicate the settlement base of the hunter or trapper and the number of the legend reference note. The notes include references to the number of people utilizing a given area, why it is important to them, the seasons of use, the mode of travel, and the resource utilized.

There are a number of other topics which receive less emphasis. Areas and sites of recreation-tourism interest are indicated on the maps. Sites are identified through extensive air-photo interpretation, supported by field reconnaissance surveys. Recreational capabilities are indicated by a system of letter symbols, derived from the Canada Land Inventory. Notes describing areas or facilities of recreational interest are keyed to symbols on the map face and usually describe activities of local residents, from whom much of the information is gathered. This section also includes a short description of the physiography followed by a summary of the recreation potential of the area.

A number of topics are handled primarily in the legend. When climatic data are available for a settlement, the records are summarized and presented in graph form. This is accompanied, where possible, by a table of known break-up and freeze-up dates. Also included is a short paragraph describing any communities in the area. These descriptions are condensed from published material, with the aid of personal experience. Boundaries of local development control zoning are indicated on the map face in black. The marginal text also includes a section of historical notes. In general these notes refer to locations (shown on the map face) where uncontrolled land-use activities might damage structures with historical value, or destroy burial or similar sacred sites. Information concerning historical sites is developed by project researchers through library research, with assistance from northern residents, the territorial governments and native organizations. The boundaries of sites proposed as reserves for scientific study under the International

Biological Programme (IBP) are also shown. A short legend note provided by the IBP describes the significant features of each site.

Depending on region, legend inset maps are used to describe forest and soil resources. The forestry inset presents a generalized picture of stands of sawtimber and pulp-size softwood. Since 1974, satellite imagery has made it possible for the inset to include the locations of recent forest fires. This information is collected with the co-operation of the federal Forest Management Institute and the advice of local forestry personnel. Maps for the upper Mackenzie Valley region now include, as an inset, a generalized map of soil capability for agriculture, as restricted by climate. The mapping, undertaken by the Soil Research Institute of the Department of Agriculture, follows classification procedures developed under the Canada Land Inventory.

There are also a number of pieces of information added to the face of the map, but for which there are no marginal notes. These symbols, all listed in the legend summary, include: archeological sites, hydrometric and water quality stations, mines, mining prospects, and gas and oil wells. Efforts are also made to update some of the information normally presented on the topographic base map. This includes such items as landing grounds, power-lines, pipelines, parks, new roads or trails. The research personnel who carry out the editing and compiling of all collected information spend several months in each study area. In addition to obtaining data from local sources, researchers make every effort to become familiar with each study area to facilitate a critical analysis of all data prepared for the series.

Map Design and Interpretation

Needless to say, the quantity of information portrayed by the maps creates considerable design problems. However, the use of five colours does ease the task of map design. The five colours are fully utilized to ensure information differentiation on the map face. Red is used for information concerning wildlife. Blue was chosen to present information on fisheries, and 50 per cent blue for data on hunting and trapping. A 15 per cent black screen indicates recreation sites and 100 per cent black is used for other symbols. Green and brown continue to be used to portray forest cover and contours, although a lighter brown ink was chosen to de-emphasize the contours. These two colours are also used for the forestry and soil insets.

The map margins are fully utilized for the presentation of descriptive notes, which are typeset for neatness and to conserve space. The colour symbols used on the map face are also printed in colour with the marginal notes. This greatly facilitates the matching of the map face location and the explanatory note by the map user. Thus, a user looking at the wildlife aspects need concentrate only on red, overlooking other colours.

Despite the use of colour, the map face does appear complicated at times. Every effort is made to position symbols and line boundaries so that they interfere with each other as little as possible. However, some symbols cannot be moved, and some areas, especially close to settlements, do become congested. Nevertheless, with some experience, most users are able to interpret the maps easily and effectively.

It is, of course, important to be aware of the limitations of the series and of the data presented. Mapping at this scale prevents the inclusion of vast amounts of detail. The maps present information only at a reconnaissance level and they are not intended to provide all the answers. They are not adequate for a complete evaluation of the local impact of a development project. When used properly, the maps should highlight critical concerns and suggest the need for, and style of, additional investigation.

Perhaps more important is the fact that certain classes of information should not be interpreted too strictly. For example, animal habits and populations may change significantly from year to year, influenced by climate, natural cycles, vegetational succession, or human activity. The areas outlined on the map face and the legend notes summarize, to the best of a researcher's ability, current knowledge of important and critical wildlife considerations. It is obvious that a statement indicating where certain animals are thought to spend part of the year is no guarantee that they will in fact be there. Thus, certain aspects of the data should be viewed as reliable advice designed to assist resource managers in decision making.

Use of the Maps

The Land Use Information Map Series has generally been well-received. The goal of creating a convenient reference system to assist in the management and administration of land-use activities has been met. The maps are used by the Territorial Land Use Advisory Committees, which regulate most land-use operations, to evaluate land-use applications and to spot, in advance, possible

land-use conflicts. In conjunction with this, many applicants for land-use permits are now required to refer to the maps before making their applications. Thus, oil companies can plan exploration activities to avoid seasonal trapping or hunting activities of local residents. Road construction, and the mining of gravel from river beds can be restricted or timed to avoid fish spawning migrations. Aerial survey programs can be scheduled so as not to disturb calving caribou, or pre-migration concentrations of waterfowl. As a result of their research for the series, the Canadian Wildlife Service and the Fisheries Service now use the maps as one of their working tools when dealing with resource management problems. The maps are also used by the territorial governments for planning in such fields as recreation, game management and local development. For those projects requiring more detailed site or route planning such as pipelines, highways or power dams, the maps are extremely valuable as a regional overview and can be used to identify areas and topics on which to centre more detailed research. The maps are also available to the public and, with increasing awareness of their existence, it is anticipated that their use will increase.

Perhaps one of the most valuable contributions of the map series is educational. The maps present a spatial organization of data that makes patterns of land use relatively easy to grasp. The maps impress upon the user the fact that "undeveloped" regions are not empty, and in fact have many present uses, whether it be for trapping or caribou winter range. Such an awareness is extremely important when considering the impact of any proposed development on land-use patterns, and the possible environmental or social consequences of that change. Land-use mapping illustrates clearly that the social and economic patterns of a region are closely related to the resources found there.

MAP FOLIOS

A New Approach

The Lands Directorate has a flexible program which allows a variety of formats to be utilized. In addition to the designs mentioned above, the Lands Directorate began a map folio series in 1976. It had been apparent for some time that many of the resource issues under investigation by the Lands Directorate were of a very complex nature, and could not always be

adequately presented on a wall map, in a conventional atlas or in the traditional report format. Many of the Directorate's presentations require 1) explicit portrayal of the spatial aspects of Canadian resources, 2) graphs, charts and other graphics to illustrate trends in everything from increasing energy demands to decreasing areas of farmland, 3) photographs, air photos or satellite imagery to effectively illustrate land misuse, competing land uses, resource rehabilitation or other issues, and 4) texts to provide the essential scientific and technical narrative necessary to give the reader a better appreciation of the situation. The decision to create a new publication series was based partly on the warm reception given to an early folio, Gulf of St. Lawrence: Water Uses and Related Activities, published in 1973. It was designed to illustrate some of the many physical, climatic and social factors which influence the supply, demand and use of fresh and salt water within the designated study area.[4] Because of the number of topics involved, and the desire to combine maps and texts in the presentation, a folio format was introduced.

Folios have many advantages. They complement other publications or series without duplicating those design formats. They can be made formal or informal depending on the design and subject matter. They are flexible enough to allow the researcher/cartographer to work with the elements of colour, symbols, organization, text, scale etc. to create a more interesting publication, better suited to a specific topic. A folio is relatively compact but allows single or double pages, plus single or double foldouts to be utilized where appropriate. Texts accompany the map; they may be viewed simultaneously, and may form an equally important contribution to the publication. The folio is an opportunity to combine, in equal or whatever ratio, the cartographic and narrative components. Relevant appendices or expanded introductions can be accommodated easily. The 11½ by 16 inch (29.2 by 40.6 centimetre) size fits conveniently on most bookshelves and students' desks, in briefcases and mailing bags. The folio can make an appealing display in school, libraries or offices. Original and colourful cover designs attract attention. The format is acceptable to a diverse audience, and is well suited to the presentation of data concerning a wide range of topics. The

4. An example of the format used in the Gulf of St. Lawrence is included in the appendix.

themes of three forthcoming folios; rural to urban land conversion in Canada; Canada's critical lands; and the impact of energy development on land resources, reflect the folio format's ability to portray a range of topics.

SUMMARY

Each of the map series published by the Lands Directorate reflects a special response to specific resource management challenges in Canada. The Canada Land Inventory provides the framework for modern, responsible land-use planning. It also serves to document the relative scarcity of high capability land for many uses, particularly for agricultural purposes. The thematic wall map series provides a vehicle for a popular, yet detailed, presentation of land-use conflicts and land-use trends. The northern Land Use Information series has evolved into an effective administrative tool for the management and protection of natural resources in frontier regions. And the new folio series promises to develop into a unique presentation combining cartographic and textual approaches in an flexible, attractive format. The wide variety of resource topics and possible publication styles provides considerable challenge to the Lands Directorate staff of geographers, planners, biophysical and computer scientists, cartographers and drafting personnel. Since effective presentation is crucial in reaching the intended audience, we welcome user reaction to the design and content of our thematic mapping programs. In the future, the Lands Directorate will continue to contribute to thematic cartography, an essential technique for resource management and environmental protection.

APPENDIX

INVENTAIRE DES TERRES DU CANADA
POSSIBILITÉS AGRICOLES DES SOLS

MANITOBA
SOUTH PART – PARTIE SUD

CANADA LAND INVENTORY
SOIL CAPABILITY FOR AGRICULTURE

SCALE 1:1,000,000 ÉCHELLE

Compilation and cartography by the Soil Research Institute, Research Branch, Agriculture Canada, based on maps prepared by the Manitoba Soil Survey, with the support of the Lands Directorate, Environmental Management Service, Environment Canada. Printing by the Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa, 1974

Compilation et cartographie réalisées par l'Institut de recherche sur les sols, Direction de la recherche, Agriculture Canada, d'après les cartes préparées par le Service de pédologie du Manitoba, avec l'aide de la Direction générale des Terres, Gestion de l'Environnement, Environnement Canada. Impression réalisée par la Direction des levés et de la cartographie, ministère de l'Énergie, des Mines et des Ressources, Ottawa, 1974.

LEGEND

The agricultural capability map at 1 1 000 000 scale was compiled from information published or to be published at 1 250 000 or 1 125 000. It summarizes the more detailed information of larger scale maps.

The classes and definitions used on the map are identical to those employed on the larger-scale maps. Major classes only are shown; classes representing 20 percent or less on the larger-scale maps are not included. Not more than two classes are used in each area. When two classes are used, the first class is dominant and represents about 70 percent of the area and the second class is subdominant and represents about 30 percent. A solid line beneath a class number indicates that the rating applies to irrigated land.

Two subclasses may apply to one class either jointly or separately. In the first case, they are shown one above the other. In the second case, they are separated by a horizontal line.

When the same subclasses apply to both the dominant and subdominant classes, they are indicated only after the subdominant class and the two classes are united by a dash.

Mineral soils are grouped into seven classes. Soils in Classes 1, 2, 3 and 4 are considered capable of sustained use for cultivated field crops, those in Classes 5 and 6 only for perennial forage crops, and those in Class 7 for neither. All information is based on soil survey data.

Some of the important factors on which the classification is based are:

- The soils will be well managed and cropped under a largely mechanized system.
- Land requiring improvements, including clearing, that can be made economically by the farmer himself, is classed according to its limitations to use after the improvements have been made.
- Land requiring improvements beyond the means of the farmer himself is classed according to its present condition.
- The following are not considered: distances to markets, kinds of roads, location, size of farms, type of ownership, cultural patterns, skill or resources of individual operators, and risk of crop damage by storms.

The classification does not include capability of soils for trees, tree fruits, small fruits, ornamental plants, recreation, or wildlife.

The classes are based on intensity, rather than kind, of limitations for agriculture.

Each class includes many types of soil, and many of the soils in a class may require different management and treatment.

CLASSES

- SOILS IN THIS CLASS HAVE NO SIGNIFICANT LIMITATIONS TO USE FOR CROPS.
- SOILS IN THIS CLASS HAVE MODERATE LIMITATIONS THAT RESTRICT THE RANGE OF CROPS OR REQUIRE MODERATE CONSERVATION PRACTICES.
- SOILS IN THIS CLASS HAVE MODERATELY SEVERE LIMITATIONS THAT RESTRICT THE RANGE OF CROPS OR REQUIRE SPECIAL CONSERVATION PRACTICES.
- SOILS IN THIS CLASS HAVE SEVERE LIMITATIONS THAT RESTRICT THE RANGE OF CROPS OR REQUIRE SPECIAL CONSERVATION PRACTICES, OR BOTH.
- SOILS IN THIS CLASS HAVE VERY SEVERE LIMITATIONS THAT RESTRICT THEIR CAPABILITY TO PRODUCING PERENNIAL FORAGE CROPS, BUT IMPROVEMENT PRACTICES ARE FEASIBLE.
- SOILS IN THIS CLASS ARE CAPABLE OF PRODUCING PERENNIAL CROPS ONLY, AND IMPROVEMENT PRACTICES ARE NOT FEASIBLE.
- SOILS IN THIS CLASS HAVE NO CAPABILITY FOR CROP USE OR PERMANENT PASTURE.
- 0 — ORGANIC SOILS (not placed in capability classes)

SUBCLASSES

A – droughtiness or aridity as a result of climate
D – undesirable soil structure and/or low permeability
E – past damage from erosion
F – low natural fertility
H – adverse climate as a result of cold temperatures
I – periodic inundation by streams and lakes
M – deficient soil moisture
N – salinity
P – stoniness
R – shallowness to bedrock
S – a combination of two or more of the subclasses D, F, M and N
T – adverse relief because of steepness or pattern of slopes
V – a pattern of wet (W) and moisture deficient (M) soils very intimately associated
W – excessive soil moisture
X – an accumulation of two or more adverse characteristics that individually would not affect the class rating.

LÉGENDE

La carte des possibilités agricoles des sols au 1 1 000 000 résume les informations déjà publiées ou devant être publiées à l'échelle de 1 250 000 ou 1 125 000. Elle indique sous une forme condensée les principales informations apparaissant sur les cartes à plus grande échelle.

Les classes utilisées et leur définition sont les mêmes que pour les cartes à plus grande échelle. Seules les principales classes sont indiquées; celles qui ne représentent que 20% ou moins sur les cartes à plus grande échelle sont omises. Au plus deux classes apparaissent pour chaque superficie: la première, dite dominante, en représente environ 70%, la seconde, dite sous-dominante, environ 30% de la superficie. Le souligné d'un numéro de classe indique que le classement s'applique à du terrain irrigué.

Deux sous-classes peuvent s'appliquer à une classe soit conjointement, soit séparément. Dans le premier cas, elles se superposent simplement l'une sur l'autre. Dans le second cas, une ligne horizontale les sépare.

Lorsque les mêmes sous-classes s'appliquent à la fois à la classe dominante et à la sous-dominante, elles ne sont indiquées qu'une fois, après la sous-dominante, et les deux classes sont jointes par un trait d'union.

Les sols minéraux sont groupés en sept classes. D'après les renseignements contenus dans les relevés pédologiques. Les sols des classes 1, 2, 3 et 4 sont considérés aptes à la production continue des récoltes de grande culture, ceux des classes 5 et 6 ne conviennent qu'aux plantes fourragères vivaces et ceux de la classe 7 ne conviennent à aucune de ces productions.

Le classement repose sur les postulats suivants:

- Le travail du sol et les récoltes se font à l'aide de la machinerie moderne.
- Le terrain qui nécessite des améliorations (y compris le défrichement) que l'exploitant peut exécuter lui-même est classé selon les limitations ou les risques que son utilisation pourrait entraîner après ces améliorations.
- Le terrain qui nécessite des améliorations dépassant les capacités de l'exploitant lui-même est classé d'après les limitations actuelles.
- On ne tient pas compte de la distance des marchés, de la qualité des routes, de l'emplacement ou de l'étendue des exploitations, du mode de faire-valoir, des systèmes de culture, de l'habileté ou des ressources des exploitants ni des dommages que des tempêtes pourraient causer aux récoltes.

Le classement ne tient pas compte des aptitudes des sols pour la production d'arbres, l'établissement de vergers, la culture de petits fruits et de plantes d'ornement, la récréation et la faune.

Les classes sont fondées sur l'intensité plutôt que sur le genre des limitations imposées dans l'utilisation des sols pour des fins agricoles.

Chaque classe comprend plusieurs sortes de sols, dont certains dans une même classe, exigent une gestion et des traitements différents.

CLASSES

- SOLS NE COMPORTANT AUCUNE LIMITATION IMPORTANTE DANS LEUR UTILISATION POUR LES CULTURES.
- SOLS COMPORTANT DES LIMITATIONS QUI RESTREIGNENT QUELQUE PEU LE CHOIX DES CULTURES OU IMPOSENT DES PRATIQUES MODÉRÉES DE CONSERVATION.
- SOLS COMPORTANT DES LIMITATIONS MODÉRÉMENT GRAVES QUI RESTREIGNENT LE CHOIX DES CULTURES OU IMPOSENT DES PRATIQUES SPÉCIALES DE CONSERVATION.
- SOLS COMPORTANT DE GRAVES LIMITATIONS QUI RESTREIGNENT LE CHOIX DES CULTURES OU IMPOSENT DES PRATIQUES SPÉCIALES DE CONSERVATION.
- SOLS QUI SONT L'OBJET DE LIMITATIONS TRÈS GRAVES ET NE CONVIENNENT QU'À LA PRODUCTION DE PLANTES FOURRAGÈRES VIVACES, MAIS SUSCEPTIBLES D'AMÉLIORATION.
- SOLS QUI SONT L'OBJET DE LIMITATIONS TRÈS GRAVES; INAPTES À PRODUIRE D'AUTRES PLANTES QUE DES PLANTES FOURRAGÈRES VIVACES ET NON SUSCEPTIBLES D'AMÉLIORATION.
- SOLS INUTILISABLES SOIT POUR LA CULTURE SOIT POUR LES PLANTES FOURRAGÈRES VIVACES.
- 0 — SOLS ORGANIQUES (Non inclus dans le système de classement).

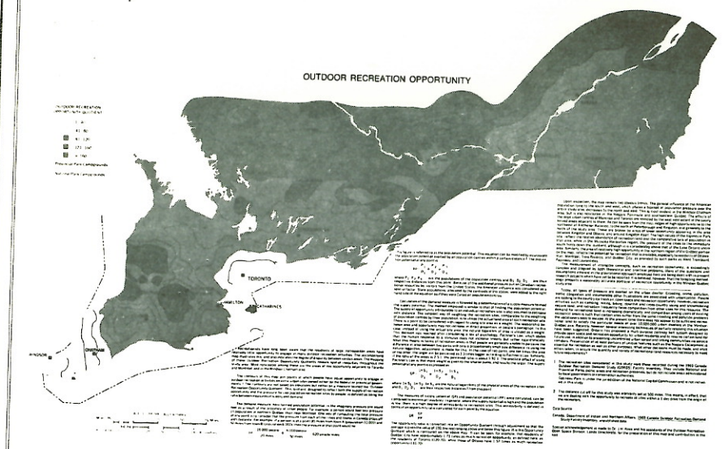
SOUS-CLASSES

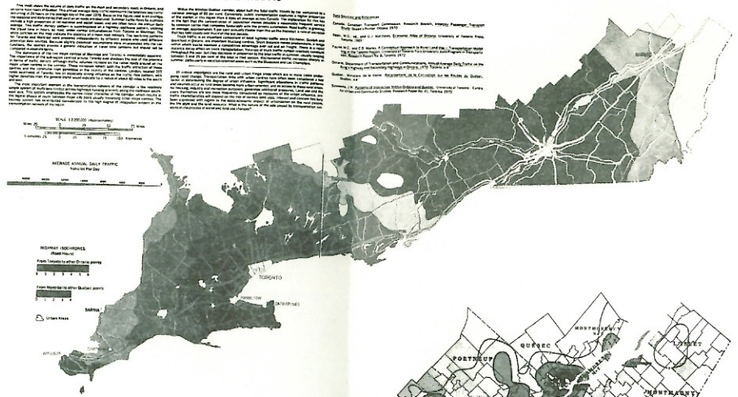
A – sécheresse ou aridité résultant du climat
D – mauvaise structure, perméabilité restreinte, ou les deux à la fois
E – dommages causés antérieurement par l'érosion
F – basse fertilité naturelle
H – climat défavorable dû aux températures froides
I – inondations périodiques dues à la crue des cours d'eau et des lacs
M – déficience en humidité du sol
N – salinité
P – pierrosité
R – sol mince sur roche consolidée
S – présence de deux des sous-classes D, F, M et N ou davantage
T – relief défavorable dû à la déclivité ou au modelé du terrain
V – sols trop humides (W) et trop secs (M) très intimement associés
W – excès d'humidité du sol
X – accumulation de plusieurs caractéristiques défavorables qui prises séparément ne sont pas assez graves pour modifier le classement

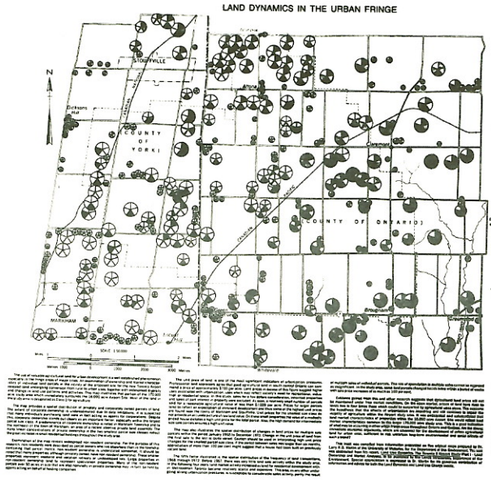
Main highway		Route principale	
Secondary highway		Route secondaire	
Railway		Chemin de fer	
Boundary, provincial		Limite de province	
Boundary, park or reserve		Limite de parc ou de réserve	
Township boundary		Limite de township	
Provincial capital	•	Capital de province	
International airport	⊕	Aéroport international	
Other airfields	+	Autres aérodromes	
Elevation (in metres)	725	Altitude (en mètres)	

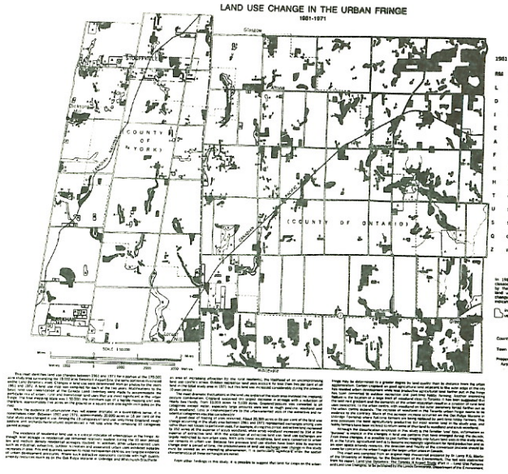
This Soil Capability for Agriculture map for Manitoba illustrates the land classification system and mapping approach used in the Canada Land Inventory 1:1,000,000 series.

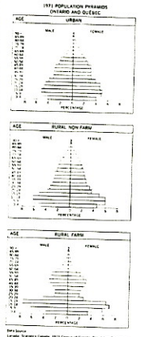
THE WINDSOR–QUÉBEC AXIS

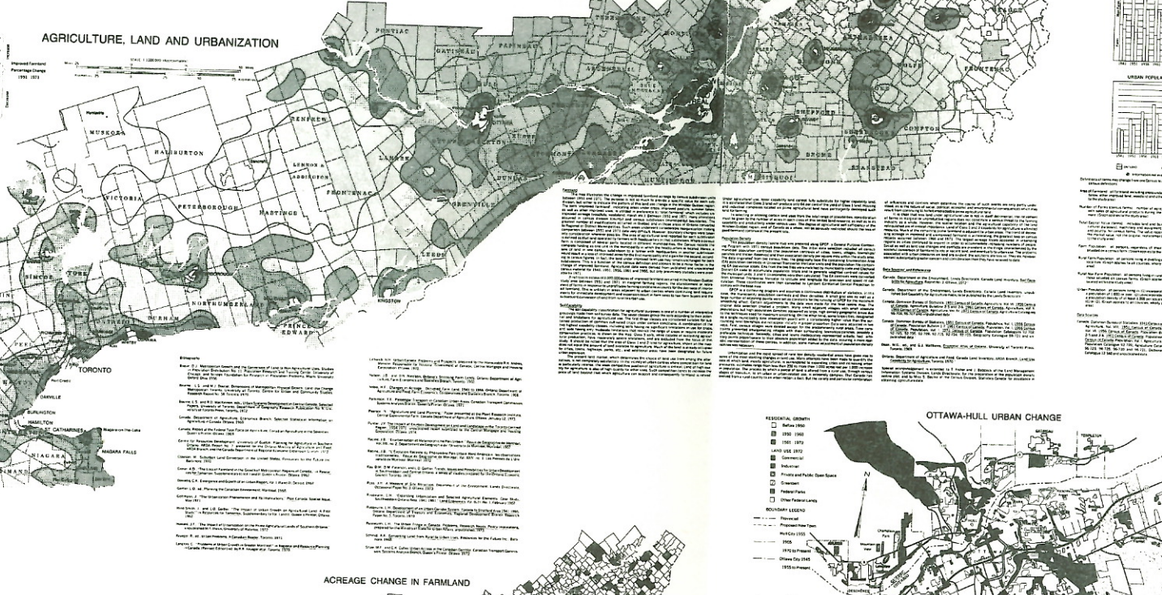


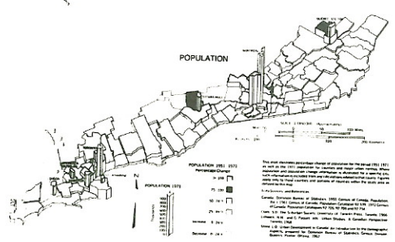


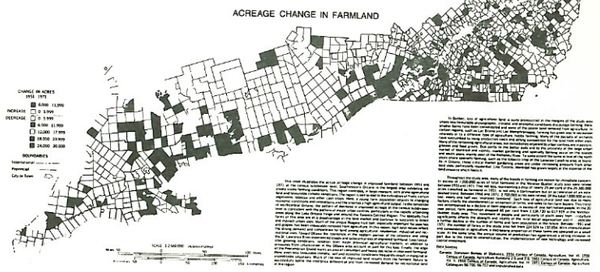


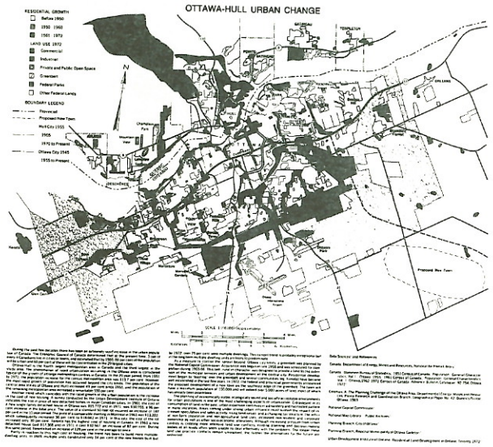




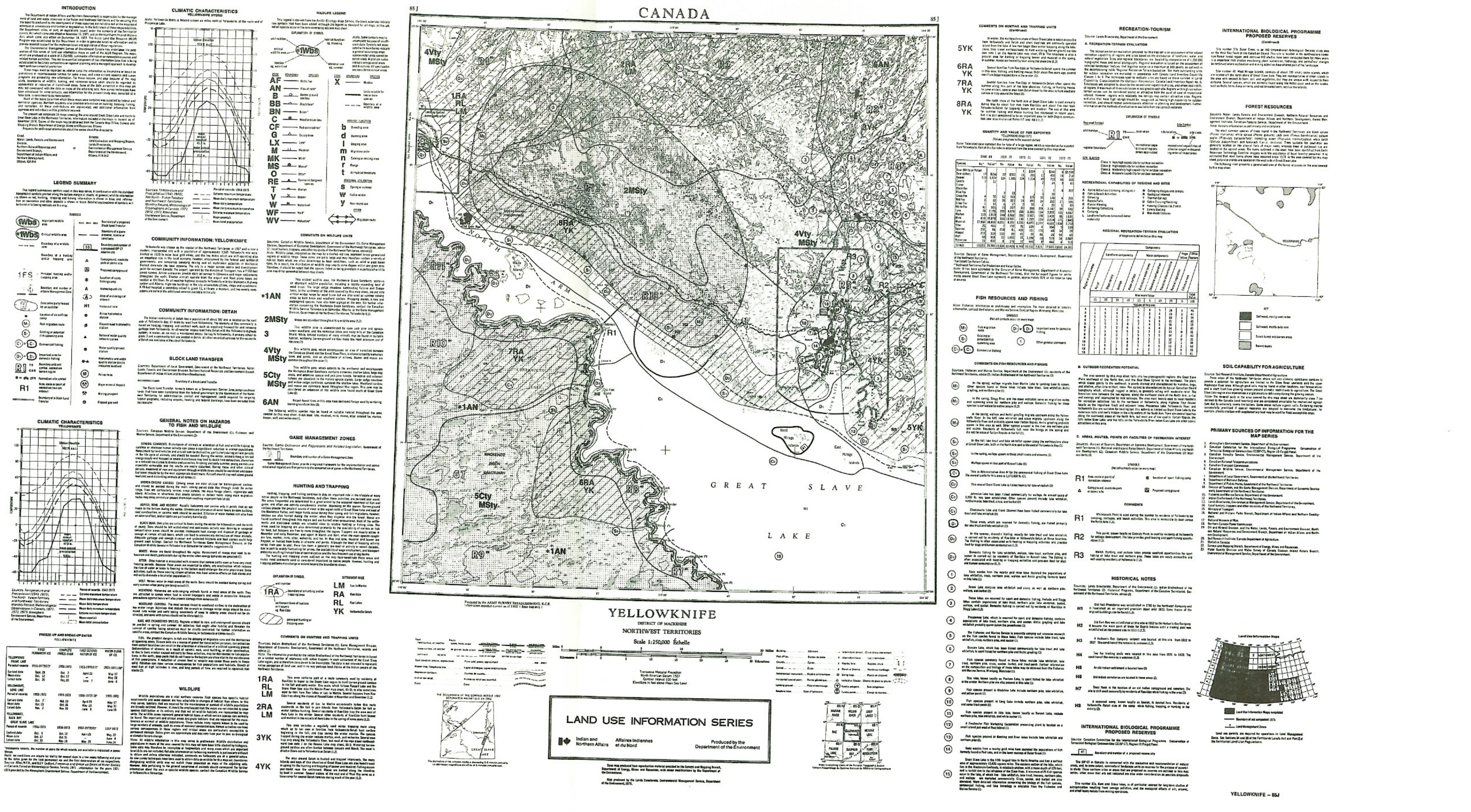








The impact of urbanization on land is the theme of the 'one-page atlas' design of the Windsor-Quebec Axis wall map.



The Land Use Information Series combines a topographic map base and extensive marginal notes to summarize data on renewable resources in Canada's northern territories.

COMMERCIAL FISHING

The nutrient-rich waters of the continental shelf in the Gulf of St. Lawrence and Atlantic sea fisheries contain a varied and valuable selection of marine life. Historically, fish species have supported a profitable fishing industry but overfishing and pollution have recently led to the demise of several fisheries and now threaten the future of fishing operations.

DEPLETION OF STOCKS

The high stock-to-yield ratio of some of the slow-growing and late-maturing fish species in temperate and polar waters means that these species are particularly vulnerable to the overfishing of which today's highly automated and efficient fleets are capable. The fleets of several fishing nations harvesting sizable catches in the Gulf and Atlantic sea fisheries have long been considered a prime cause of Canada's failure to increase significantly its proportion of the total catch taken from coastal waters. Canada's share of the catch from Atlantic banks declined markedly between 1960 and 1970. The total landings have increased, however, owing to intensified fishing effort.

Such intensified effort, however, in conjunction with other factors, has affected fish stocks. Landings of Atlantic salmon by high seas vessels have raised concern over the future of this species, which originates in the streams of the Gulf of St. Lawrence. The harvest of scallops from Georges Bank by Canadian vessels in 1969 fell to one-fifth of the volume taken in 1961. Anxiety has been expressed over the failure of diminishing lobster stocks to regenerate at a rate sufficient to balance the removal of mature lobsters. It is believed that the maximum sustainable yield for cod was passed in 1968, and haddock landings have dropped severely, to only 45 per cent of the catch of a decade ago. Exploitation of marine resources with little regard for the consequences has begun to take its toll.

POLLUTION

Pollution is the second major threat to the strength, stability and durability of Canada's Atlantic fisheries. Two conflicting water uses of the Gulf - as a dumping ground for sewage, refuse and other pollutants, and as a source of supply for profitable commercial fishing - are not always compatible; the raise of pollution has recently accelerated at the expense of fishing. Discharged wastes from municipal, industrial, agricultural, engineering, forestry, mining and shipping sources have all contributed to a decline in water quality. Pulp and paper mills and processing establishments, in addition to fish-processing plants, which rely on the productivity of the Gulf, have used rivers, lakes, harbours and the sea as effluent sinks. Inland commercial and sports fishing for trout and salmon has suffered in many rivers. The number of salmon caught by sports fishermen in Maritime rivers dropped nearly 42 per cent between 1970 and 1971 owing to commercial over fishing on the high seas, pollution, environmental changes and normal biological variability. Atlantic herring around Placentia Bay were killed in large numbers by toxic effluents containing elemental phosphorus. Discarded mercury forms methyl mercury, which accumulates in marine life, where it becomes a serious problem. In 1971, fishing for swordfish was banned for this reason. The effects of D.D.T. on the survival of young Atlantic salmon, after the spraying of this pesticide over much of New Brunswick to control the spruce budworm, is well documented. Supertankers and cargo ships now transporting oil and chemicals pose major threats to the marine environment, and the 2,200,000-gallon Bunker C fuel oil spill in Chedabucto Bay from an 18,000-ton vessel forewarns of the potential danger of oil spills from the 200,000-ton vessels now being built. Contamination of water by human wastes has contributed to the closure of shellfish beds in the Maritimes; the number of closures rose from 48 in 1940 to 199 in 1972.

The down-grading of water quality in the important shallow offshore fishing areas is likely to continue, as only a small percentage of the Maritime population is served by public sewers with treatment facilities. Particularly crucial is the subtidal zone, that area from high-tide level on the shore, seaward to a depth of approximately 50 metres. This boundary coincides with the photosynthetic limit beyond which attached plants cannot grow. This zone has an abundance of marine life, both floating and attached, and because of its relatively shallow nature, any marked deterioration of water quality affects its ability to support rich and diversified aquatic life. Such a despoilment of water quality jeopardizes the continued existence and harvest of valuable species while more tolerant but less desirable species thrive.

The degree to which over-exploitation and pollution, in addition to other factors, have altered the fishing industry is evident not only from landing figures given below but from the employment picture. Although the number of persons engaged in fishing varies from one year and from one community to another, as economic opportunities vary, there has been a noticeable exodus from fishing operations in recent years.

Until the late 1960s, Canada permitted virtually unlimited licensed entry into its commercial fisheries. As a result, not only was there severe depletion of fish but Gulf and Atlantic region fishermen suffered economically from over-competition for the diminishing numbers of fish. It would be desirable to attain the maximum sustainable yield from the Gulf and Atlantic fisheries, consistent with replenishment of fish stocks. At present, fishery resources will not provide the large work force now engaged in fishing with sufficient economic return. By the promotion of other industries in these areas and the encouragement and optimization of location for related businesses, such as fish-processing, it is hoped to achieve a smaller, more stable and efficient fishing labour force and to develop a range of alternative means of employment for those ceasing to fish.

To strengthen the domestic fishing economy, several steps have been taken. The 12-mile exclusive fishing zone was established in 1964 to replace the old concept of the three-mile limit. In 1967 straight baselines were drawn from headland to headland and the 12-mile territorial limit was extended beyond these new lines. The fishery-closure lines drawn in 1971 across the Strait of Belle Isle, Cabot Strait and the Bay of Fundy gave Canada exclusive fishing rights within these limits and brought such waters under exclusive Canadian jurisdiction, notably for the purpose of pollution control and marine-resource management. Amendments to the Fisheries Act, the Coastal Fisheries Protection Act and the Territorial Sea and Fishing Zones Act were aimed at managing not only fish species but the entire aquatic environment. The recently tabled Inquiries Landings of Atlantic salmon by high seas vessels have raised concern over the future of this species, which originates in the streams of the Gulf of St. Lawrence. The harvest of scallops from Georges Bank by Canadian vessels in 1969 fell to one-fifth of the volume taken in 1961. Anxiety has been expressed over the failure of diminishing lobster stocks to regenerate at a rate sufficient to balance the removal of mature lobsters. It is believed that the maximum sustainable yield for cod was passed in 1968, and haddock landings have dropped severely, to only 45 per cent of the catch of a decade ago. Exploitation of marine resources with little regard for the consequences has begun to take its toll.

LA PÊCHE COMMERCIALE

Une faune marine variée et précieuse habite les eaux riches en matières nutritives des pêcheries maritimes qui jalonnent le plateau continental dans le Golfe Saint-Laurent et dans l'Atlantique. Ces espèces de poisson approvisionnent depuis plusieurs siècles l'industrie de la pêche, mais la surexploitation et la pollution ont récemment causé la disparition de plusieurs pêcheries et menacent maintenant l'avenir des autres.

ÉPUISEMENT DES STOCKS

Le rapport stock/rendement de certaines espèces de poisson dont la croissance est lente et dont la maturité vient tard dans les eaux tempérées et polaires est élevé, ce qui veut dire que ces espèces sont particulièrement vulnérables à la surexploitation des stocks dont sont aujourd'hui capables les flottes de pêche automatisées et très efficaces. Les flottes de pêche de plusieurs nations maritimes qui font d'importantes récoltes dans les pêcheries du Golfe et de l'Atlantique sont depuis longtemps considérées comme la principale cause de l'impuissance du Canada à augmenter sensiblement sa proportion du total des prises dans les eaux côtières. La part canadienne des prises annuelles sur les bancs de l'Atlantique a même sensiblement diminué de 1960 à 1970. Pourtant, le total des prises s'est accru par suite de l'intensification de la pêche.

Cette intensification, joint à d'autres facteurs, n'est pas sans exercer son effet, cependant, sur les stocks ou peuplements de poissons. Les prises de saumon de l'Atlantique par les navires de haute mer ont fait naître des inquiétudes pour l'avenir de cette espèce, dont les petits naissent dans les cours d'eau qui se jettent dans le Golfe Saint-Laurent. En 1969, les navires canadiens n'ont prélevé sur le banc Georges que le cinquième de la récolte de pétoncles qu'ils avaient eue en 1961. Les stocks de homard diminuent et l'on s'inquiète devant leur impuissance à se reproduire à une cadence suffisante pour équilibrer les prélèvements de homards adultes. On croit que le taux de rendement maximal de la morue a été touché en 1968 et les prises d'aiglefin ont subi une baisse brutale, se situant à 45 p. 100 seulement de ce qu'elles étaient il y a dix ans.

LA POLLUTION

La pollution est le deuxième grand danger qui menace la vigueur, la stabilité et la survivance des pêcheries canadiennes de l'Atlantique. Les eaux du Golfe font l'objet de deux utilisations contraires comme réceptacle des eaux d'égout, de détritus et d'autres matières pollluantes et comme source d'approvisionnement pour l'industrie de la pêche. Ces deux usages ne sont pas toujours compatibles et le taux de croissance de la pollution s'est récemment accéléré aux dépens de la pêche. Les eaux usées et détritus divers qu'y déversent les municipalités, les établissements industriels, l'agriculture, les entreprises de construction, les exploitations forestières, les mines et les navires ont tous contribué à diminuer la qualité de l'eau. Les fabriques de pâtes et papiers, les usines de transformation et les conserveries de poisson qui dépendent pourtant de la productivité du Golfe utilisent les rivières, les lacs, les ports de la mer comme autant de dépotoirs. La pêche commerciale et la pêche sportive de la truite et du saumon en ont souffert dans plusieurs rivières. Le nombre de saumons que prennent les pêcheurs sportifs dans les rivières des Maritimes a baissé de près de 42 p.100 entre 1970 et 1971 à cause de pêches excessives en haute mer, de la pollution, des changements survenus dans le milieu naturel et des aléas biologiques naturels. Autour de la baie de Placentia, le hareng de l'Atlantique a été tué en grand nombre par des effluents toxiques contenant du phosphore élémentaire. Les résidus contenant du mercure forment du mercure méthylé, qui s'accumule dans la faune marine, où sa présence constitue un grave problème. En 1971, la pêche de l'espadon a été interdite pour cette raison. Pour combattre la tordeuse des bourgeons de l'épinette, on avait répandu du DDT sur une grande étendue du Nouveau-Brunswick et les effets produits sur le taux de survivance des jeunes saumons de l'Atlantique sont bien connus. Les pétroliers et cargos géants qui transportent maintenant le pétrole et les produits chimiques constituent un grand danger pour la faune marine. Un navire de 18.000 tonnes a récemment déversé 2.500.000 gallons de mazout dans la baie de Chedabucto, ce qui donne une idée des accidents qui pourront se produire avec les pétroliers de 300.000 tonnes actuellement en construction. La contamination de l'eau par les déchets humains a contribué à l'interdiction de bancs de crustacés dans les Maritimes, le nombre des interdictions semblables est passé de 48 en 1940 à 199 en 1972.

La dégradation de l'eau qui couvre les hauts-fonds où la pêche est si importante va probablement se continuer, car rares sont les municipalités des Maritimes qui sont équipées pour traiter les eaux usées. La situation est particulièrement grave à l'étage infralittoral la zone qui s'étend depuis la ligne atteinte par la marée haute sur le rivage jusqu'à une profondeur d'environ 50 mètres vers le large. C'est précisément la zone de photosynthèse hors de laquelle les plantes fixes ne peuvent pas croître. Cette zone recèle une grande abondance d'organismes vivants, flottants ou fixes, et parce que l'eau est relativement peu profonde toute détérioration sensible de la qualité de l'eau la rend moins capable d'entretenir une vie aquatique riche et diversifiée.

La surexploitation et la pollution, en s'ajoutant à d'autres facteurs, ont infligé à l'industrie de la pêche des pertes dont la preuve est fournie, non seulement par les quantités prises, données ci-dessous, mais aussi par la statistique de l'emploi. Il est vrai que le nombre des personnes employées par l'industrie de la pêche varie d'une année à l'autre et d'une localité à l'autre, suivant les conditions économiques, mais on assiste clairement à un exode de pêcheurs depuis quelques années.

Jusqu'à la fin des années 1960, le Canada accordait à peu près tous les permis demandés par les étrangers voulant accéder à ses pêcheries commerciales. Il en est résulté une grave diminution des poissons et, de plus, les pêcheurs canadiens du Golfe et de la côte atlantique ont subi des pertes par suite de la concurrence qui s'exagérait pendant que le nombre des poissons baissait. L'idéal serait de limiter les prises au maximum compatible dans le temps avec la normalisation du peuplement de poisson. A l'heure actuelle, les effectifs employés à la pêche sont trop nombreux pour que les pêcheries leur fournissent un revenu suffisant. En stimulant l'établissement d'autres industries dans ces régions et en encourageant l'établissement (et la localisation rationnelle) d'entreprises associées à la pêche, comme les conserveries, on espère que la main d'oeuvre affectée à la pêche deviendra à la fois moins nombreuse, plus stable et plus efficace, et qu'il naîtra en même temps d'autres occupations pour ceux qui auront cessé de pêcher.

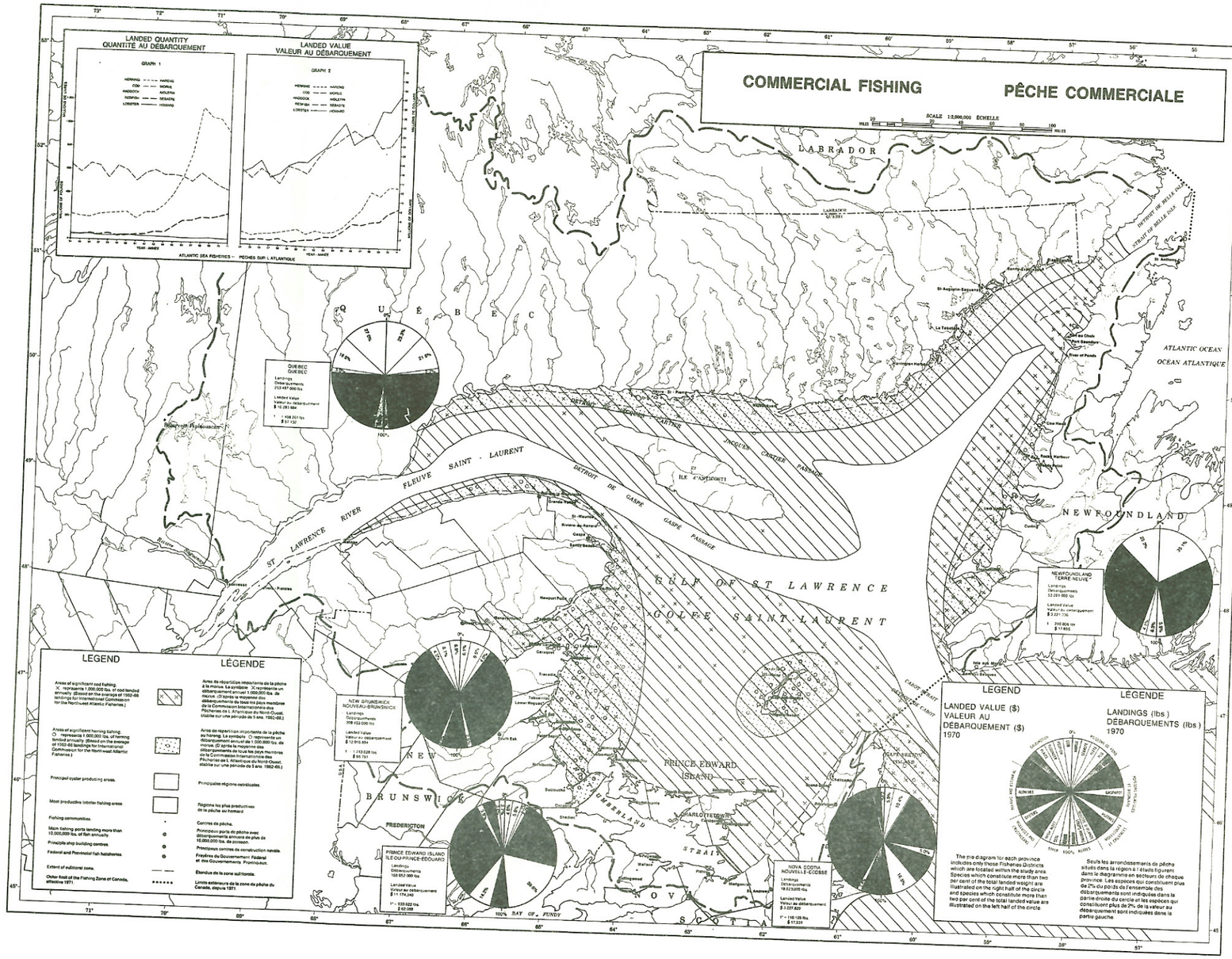
Plusieurs mesures ont été prises pour renforcer l'industrie canadienne de la pêche. En 1964, la zone de pêche exclusive a été portée de trois à 12 milles. En 1967, des lignes droites de base ont été tracées de promontoire en promontoire et la limite territoriale de 12 milles a été située au-delà de ces nouvelles lignes. Les lignes de délimitation des pêcheries tracées en 1971 à travers le détroit de Belle-Isle, le détroit de Cabot et la baie de Fundy ont donné au Canada des droits exclusifs de pêche à l'intérieur de ces limites et ont placé ces eaux sous l'autorité exclusive du Canada, notamment pour combattre la pollution et assurer la gestion des ressources marines. On a modifié la loi sur les pêcheries, la loi sur la protection des pêcheries côtières et la loi sur les eaux territoriales et les zones de pêche en vue d'assurer la gestion, non seulement des espèces de poisson, mais aussi de tout le milieu aquatique. Les nouvelles dispositions introduites dans la loi sur les eaux du Canada constituent un pas de plus dans cette voie. De plus, on a pris des mesures particulières pour préserver le saumon de l'Atlantique. Au début de 1972, la pêche commerciale du saumon a été interdite pour un temps indéfini au Nouveau-Brunswick, dans la région de Port-aux-Basques à Terre-Neuve et dans certaines parties du Québec.

De 1964 à 1969, la consommation des produits de la mer au Canada est passée de 13.5 à 12.1 livres par tête, soit une diminution de 10 p. 100 mais dans l'ensemble le marché canadien est demeuré stable pendant que la demande étrangère augmentait. Deux tiers de la production des pêcheries et conserveries canadiennes de l'Atlantique sont exportés aux États-Unis, où la demande augmente à une cadence qui dépasse 5 p. 100 par année.

Depuis dix ans surtout, on a recours aux progrès de la technique et de la science pour accroître le rendement des pêcheries du Golfe et de l'Atlantique. Il est devenu de plus en plus manifeste que la recherche doit s'appliquer, non seulement à maintenir les peuplements actuels de poisson, mais aussi à leur permettre d'augmenter.

Les Graphiques 1 et 2 donnent les quantités totales et les valeurs de cinq espèces de poisson importantes pour la Nouvelle-Écosse, le Nouveau-Brunswick, l'Île-du-Prince-Édouard, le Québec et Terre-Neuve (les chiffres sont les totaux provinciaux). Depuis 20 ans, l'industrie de la pêche dans ces cinq provinces a subi une transformation remarquable; au lieu de camper surtout sur la morue salée, elle prend et vend maintenant de nombreuses espèces et les offre frais et congelés. Une quarantaine d'espèces de crustacés et de poissons sont maintenant offertes à la consommation canadienne.

La morue avait été pendant longtemps le poisson le plus important de la région, et elle a conservé sa primauté jusqu'en 1966, alors que le volume des prises de hareng a surpassé celui des prises de morue. Au cours des 18 années présentées ci-dessous, les prises de morue ont fluctué considérablement, subissant des écarts allant jusqu'à 119 millions de livres au cours d'une période de deux ans. Ces fluctuations semblent avoir un caractère cyclique, une hausse sensible survenant à tous les trois ans. Plusieurs scientifiques pensent que la diminution des prises de morue est due à la surexploitation des bancs, qui ont peut-être atteint en 1968 le rendement maximum qu'il soit possible de soutenir. L'évolution de la valeur des prises (Graphique 2) révèle que dans l'ensemble les prix ont augmenté jusqu'en 1966, y compris une hausse particulièrement forte de 1961 à 1966. Au cours de cette période, la valeur totale des prises de morue est passée de $15.646.000 à $25.084.000. Ces résultats reflètent l'attrait croissant conféré à ce produit par les nouvelles méthodes de traitement et de vente, et l'éclipse de la morue salée, le produit traditionnel, dont la vogue disparaît. C'est le hareng qui a connu l'augmentation la plus frappante, touchant un sommet inattendu en 1968 après des années de prises stables. Ce fait est particulièrement dû aux captures plus considérables et aux techniques perfectionnées qu'on applique depuis quelques années à la récolte des espèces pélagiques et aux fortes quantités prélevées sur le Banquereau et le banc Georges, récemment découverts. La valeur totale des prises de hareng est passée de $ 2.216.000 en 1964 à $13.247.000 en 1970. L'essor de la pêche du hareng est dû à la forte augmentation de la demande dont fait l'objet cette espèce qui constitue une forte proportion de plusieurs mélanges de nourriture pour bétail. Les prises d'aiglefin ont touché en 1970 leur niveau le plus bas depuis plusieurs décennies, la valeur des prises s'établissant à seulement $5.397.000. Les prises d'aiglefin baissent constamment depuis longtemps et tout indique que les peuplements de cette espèce sont en train de s'épuiser dans plusieurs régions, si bien qu'on a interdit la pêche d'aiglefin sur les bancs Georges et Brown pendant la période de frai. Les prises et les prix du poisson rouge, qui étaient demeurés assez constants jusqu'en 1962, n'ont cessé de monter jusqu'en 1971. Les prises ont atteint un total de 248.625.000 livres en 1961, soit cinq fois le total des prises de 1954. Au cours de la même période, la valeur des prises annuelles a été multipliée par huit, dépassant $8.654.000 en 1971. Les prises de homard sont demeurées constantes de 1954 à 1971, reflétant la difficulté d'augmenter la récolte, et accusant même une légère tendance à la baisse depuis quelques années. Le total actuel des prises est considéré comme fort proche de la récolte maximale compatible avec la conservation des stocks. En 1971, la majoration des prix a eu pour effet d'augmenter considérablement la valeur globale des prises de homard et de la porter à plus de 33 millions de dollars.



This sheet from the Gulf of St Lawrence Folio illustrates the combination of text and cartographic presentation of resource data utilized in the map folio format.