Scientia Canadensis
Canadian Journal of the History of Science, Technology and Medicine
Revue canadienne d'histoire des sciences, des techniques et de la médecine

Tools for Rational Development: The Canada Land Inventory and the Canada Geographic Information System in Mid-twentieth century Canada

Shannon Stunden Bower

Volume 40, Number 1, 2018

URI: https://id.erudit.org/iderudit/1048925ar
DOI: https://doi.org/10.7202/1048925ar

See table of contents

Publisher(s)

CSTHA/AHSTC

ISSN

1918-7750 (digital)

Explore this journal

Cite this article

Stunden Bower, S. (2018). Tools for Rational Development: The Canada Land Inventory and the Canada Geographic Information System in Mid-twentieth century Canada. *Scientia Canadensis*, *40*(1), 44–75. https://doi.org/10.7202/1048925ar

Article abstract

From the 1960s through the 1980s, Canadian scientists, resource managers, and computer experts collaborated on two linked undertakings: the Canada Land Inventory (CLI) and the Canada Geographic Information System. CLI was an extensive project that assessed the state of key resources across much of the country, while CGIS was a pioneering effort at computerizing CLI data to support decision-making about resource use. Fundamental components of the Agricultural Rehabilitation and Development Act, CLI and CGIS reflect Canadian innovation in new information-management tools designed to facilitate state goals. This paper examines the production and affordances of CLI and CGIS, and considers the renewed optimism and collaborative relationships that emerged from them. It also examines historical concerns over the limitations of these technologies and explores how CLI and CGIS were oriented to change over space, not time. Ultimately, these technological innovations served to naturalize patterns of inequality and normalize urban-industrial modernity.

Tools for Rational Development: The Canada Land Inventory and the Canada Geographic Information System in Mid-twentieth century Canada

Shannon Stunden Bower

Abstract: *From the 1960s through the 1980s, Canadian scientists, resource managers, and computer experts collaborated on two linked undertakings: the Canada Land Inventory (CLI) and the Canada Geographic Information System. CLI was an extensive project that assessed the state of key resources across much of the country, while CGIS was a pioneering effort at computerizing CLI data to support decision-making about resource use. Fundamental components of the Agricultural Rehabilitation and Development Act, CLI and CGIS reflect Canadian innovation in new information-management tools designed to facilitate state goals. This paper examines the production and affordances of CLI and CGIS, and considers the renewed optimism and collaborative relationships that emerged from them. It also examines historical concerns over the limitations of these technologies and explores how CLI and CGIS were oriented to change over space, not time. Ultimately, these technological innovations served to naturalize patterns of inequality and normalize urban-industrial modernity.*

Résumé : *Des années 1960 aux années 1980, des scientifiques canadiens, des gestionnaires de ressources et des experts en informatique ont collaboré à deux entreprises liées: l'Inventaire des terres du Canada (ITC) et le Système d'information géographique du Canada. L'ICA était un vaste projet qui évaluait l'état des ressources clés dans une grande partie du pays, tandis que le SCIG était un pionnier dans l'informatisation des données de l'ICA pour appuyer la prise de décisions concernant l'utilisation des ressources. Éléments fondamentaux de la Loi sur la réhabilitation et le développement de l'agriculture, CLI et CGIS reflètent l'innovation canadienne dans les nouveaux outils de gestion de l'information pour faciliter les objectifs de l'État. Cet article examine la production et les potentialités de CLI et CGIS, et considère l'optimisme renouvelé et les relations de collaboration qui ont émergé de ces deux organisations. Il examine également les préoccupations historiques sur les limites de ces technologies et explore comment CLI et CGIS étaient orientés vers le changement dans l'espace, et non dans le temps. En fin de compte, ces innovations technologiques ont servi à naturaliser les schémas d'inégalité et à normaliser la modernité urbaine-industrielle.*

Keywords: Canada Land Inventory, GIS, ARDA, rational management, modernity

IN 1954, GEOGRAPHER F. KENNETH HARE PUBLISHED in *The Canadian Geographer* a call for what he termed a "re-exploration" of Canada. Made necessary by the inadequacy of available information about Canada's substantial landmass, the re-exploration envisioned by Hare would ideally take the form of a "national inventory of land and resources." As he saw it, the inventory should encompass multiple facets, accommodating varied environmental features in one coherent effort. Hare also emphasized the importance of geographical expertise in leading this effort.[1]

Shannon Stunden Bower, "Tools for Rational Development: The Canada Land Inventory and the Canada Geographic Information System in mid-20th century Canada," *Scientia Canadensis* 40, 1 (2018): 44-75.

A decade later, Canadian scientists and resources managers, together with representatives of Canada's emerging computer industry, were at work at the problem Hare diagnosed. From the 1960s through to the early 1980s, the federal and provincial governments collaborated in two linked undertakings understood as fundamental to the future prosperity of the Canadian nation and its peoples. The Canada Land Inventory (CLI) was an extensive project to assess the state of key natural resources across much of the country. The Canada Geographic Information System (CGIS) was an innovative effort to develop new means of using CLI data to make better decisions about resource use. Together, these inter-related efforts seemed poised to accomplish much of what Hare had proposed undertaking. This was made possible by the use of computers. My analysis explores how resources management and regional inequality, longstanding themes in Canadian history, intersected with mid-twentieth century efforts by the Canadian state to explore the utility and potential of emerging computing technologies.

Both CLI and CGIS were fundamental components of the *Agricultural Rehabilitation and Development Act*, federal-government legislation that, when passed in 1961, was designed to help stabilize agriculture and resource industries as Canada made what policy-makers saw as "a relatively abrupt transition from a primarily agricultural economy to a primarily urban-industrial economy."[2] ARDA operated as umbrella legislation designed to facilitate programs jointly-funded with the provinces addressing a diverse array of agriculture or resource-related challenges, chief among them unproductive farms and inefficient or inappropriate land use. The legislation was conceived amid interest on the part of governments, both federal and provincial, in reducing inequalities between regions and across economic sectors.[3] ARDA's broad scope was underlined when a 1966 amendment renamed it the *Agricultural and Rural Development Act*, making explicit its relevance to non-farming rural areas.[4] In both original and revised forms, ARDA reflected the federal government's conviction that problems of rural development and regional inequality could be addressed by managing natural resources more effectively, in a manner frequently described as rational.

CLI and CGIS were among the few aspects of the ARDA program that remained directly under federal auspices.[5] Most ARDA initiatives derived from efforts by provinces and agencies to seek federal money in support of suitable programs. This helps explain the multivalent nature of the development imperative as it operated in mid-twentieth century Canada, at least until Ottawa's 1969 creation of the Department of Regional Economic Expansion, which promised to bring greater coherence to development efforts.[6] Also, ARDA operated alongside and in relation to government-led, 1960s-era community development programs aimed specifically at Indigenous peoples living in territory claimed by the Canadian state.[7] Historians of Canada have engaged with development in various ways, with some presenting it as a factor within ongoing historical processes and some taking one of its various forms as a focus of analysis.[8] More

research is necessary before we will adequately understand how development, as an ideology and a practice, emerged and operated in Canada. This research should probe the links between manifestations of development within Canada and their international analogs, contextualizing domestic processes in relation to imperatives of global significance in the period after the Second World War.[9] As reflected in the federal government's approach to ARDA, development involved deliberate, government-led efforts to change human behavior, and especially behavior related to natural-resources use, thought by proponents to lead to improved outcomes in line with urban-industrial modernity.[10] Importantly, this conception of modernity, development's implied endpoint, was narrow. The development imperative animating mid-twentieth century federal-government policy was fueled by the presumption that the lifestyles believed to characterize prosperous urbanized and industrialized areas were good for everyone and desired by most, and that those who did not seek them needed assistance in adjusting their aspirations.

While it was F. Kenneth Hare's 1954 call that most clearly anticipated CLI and CGIS, both these and the ARDA legislation that enabled them had other important antecedents. In scope and ambition, one of ARDA's key forerunners was the Commission of Conservation, a federal-government body operating between 1909 and 1921 that aimed to increase support and capacity for what was seen as efficient administration and use of natural resources.[11] In the CLI's orientation to inventory, important antecedents are found in earlier efforts to classify soils and, more broadly, lands according to their most suitable uses.[12] In setting the stage for CLI and CGIS, the Resources for Tomorrow Conference of 1961 was particularly significant because it demonstrated broad support for federal-government leadership in enhancing the availability, quality, and accessibility of environmental information.[13] At least since the 1959 publication of Samuel Hays' *Conservation and the Gospel of Efficiency*, an influential analysis of the American progressive conservation movement, historians and allied scholars on both sides of the Canadian-American border have analyzed the various ways governments have sought to improve their management of natural resources.[14] My analysis builds on this existing work by exploring the relation between natural-resources management and mid-twentieth century advances in computer technology, an intersection that has not received much scholarly attention.[15]

Examining the Canadian government's efforts to develop CLI and CGIS offers an opportunity to consider resources management as a dynamic process with consequences for both natural resources and the state. James C. Scott's *Seeing Like a State* has influenced many historians of Canada, with numerous scholars drawing on Scott's notion of high modernism in explaining the ideology behind massive state-led projects of human and environmental change.[16] Scholars invoking high modernism often attend in some way to a process Scott termed the production of legibility, the construction of forms of knowledge facilitating state administrative functions. As Scott explains, much of his thinking around

techniques of legibility drew on earlier work by Benedict Anderson. Anderson's *Imagined Communities* focused on the rise of nationalism and the nation-state as historical phenomena, with the management of territory and population a key means through which nations consolidated their authority.[17] Because of differences in analytic purpose, these two important scholars focused on different aspects of the techniques of legibility they both considered. Scott was more concerned with what the state could do with these techniques, while Anderson was more interested in how these techniques helped consolidate the state. In my analysis of CLI and CGIS, I address both angles, considering how these technologies, in prospect and in realization, had consequences for natural-resources management and for the state doing the managing.

Legibility was at the core of a recent piece by Canadian historian Tina Loo arguing for the value of seeing synoptically, of sacrificing detail and complexity to highlight a particular scale of analysis. As Loo sees it, this way of seeing is often dismissed as "imperial, encompassing, reductive vision" without due consideration of its advantages and perhaps its inevitability, at least when confronting large quantities of information.[18] Scholars who both write and read abstracts of academic articles (otherwise known as synopses) possess some familiarity with the advantages and disadvantages of the synoptic. Rather than either condemning or defending the synoptic, in this paper I consider the production and affordances of a particular synoptic perspective, one conceptualized as a key part of mid-twentieth century efforts to achieve rationality in resource management. Insofar as I attend not just to technological aspects but also to broader cultural contexts, my work is in line with what historian William Rankin has recently termed geo-epistemology: the study of the production and use of knowledge about the earth or parts of it.[19]

In the past few decades, scholars from various disciplines, including history, have made use of GIS as a means to display and analyze spatial information. While historians have used GIS to generate new insights on the past, as of yet few have turned their analytic gaze on the history of GIS itself or of its antecedents. It has been primarily within the discipline of geography that the development, evolution, and effects of GIS have been considered.[20] My analysis offers a historical perspective on the emergence of a GIS antecedent from within Canadian resource-management efforts. It resonates with the critical perspective on GIS evident in the work of scholars such as Matthew W. Wilson.[21] My analysis also contributes to a small body of recent scholarship probing the relations between geographical knowledge and the Canadian state.[22]

My paper develops as follows. I begin by exploring how the conceptual and technological innovations of CLI and CGIS inspired a new optimism among resource managers. I situate this optimism in relation to emergent trends within the social sciences, and especially within the discipline of geography. Then I consider how CLI fostered collaborative innovation that helped build relationships among people from a range of professional perspectives, particularly federal and provincial administrators and technical experts,

and scholars from the academic world. I also note historical concerns over the limitations of the synoptic perspective offered by the CLI. Finally, I explore efforts to develop CGIS as a robust technology that could store and manipulate information from the CLI and other sources to support rational resource management. I also explain how the challenges of developing CGIS served to temper initial optimism and complicate collaborative working relationships. Drawing on the historian's emphasis on change over time, I identify a key limitation of both CLI and CGIS in their privileging space over time. Ultimately, my most important argument relates to this limitation: CLI and CGIS, innovative tools intended to arm decision-makers with essential geographic information, registered neither the historical factors that created intractable resource-management problems nor the prospect that people living in Canada might maintain diverse ambitions for their futures. As a result, these new technologies worked to naturalize patterns of inequality and normalize urban-industrial modernity.

Innovation and optimism

CLI and CGIS emerged out of the belief of federal-government administrators involved in ARDA that rational resource use depended on the availability of what they considered relevant and usable data. The problem was, at the time ARDA was passed, such information was not readily accessible to decision-makers. This was a particular type of information problem, one defined not by a dearth of information, but by an overwhelming abundance of ill-coordinated data-points. In any particular situation, how could decision-makers ever hope to have at hand the most appropriate bits? And even if they did, how could they efficiently integrate data pertaining to distinct geographic areas, expressed through different units of measurement, or contained on separate maps? In light of this information management problem, Canada remained to mid-1960s policy-makers an "unknown country"—one that was "unknown not only in the distant Arctic Archipelago, but even in the places where millions of Canadians make their homes and their livings." Without reliable means for policy-makers to access relevant and usable information, decisions about resources use continued to be made, but, as ARDA administrators worried, there were few means of determining if these decisions reflected "the best things to do with our resources."[23] Rational decision-making about natural-resources management simply was not possible.

The CLI was a key aspect of efforts to address this information problem. As a federally-led effort involving substantial participation from the provinces, the CLI was to standardize basic information about natural resources both across the nation and across resource sectors. The CLI was primarily an exercise in information consolidation, not information collection. Though fieldwork was required to verify accuracy and deal with data-thin areas, the major tasks were identifying existing data sources and extracting relevant information. This information was then used to create resource-specific maps—for instance, maps

of soils, wildlife, or forestry—indicating variation in resource quality across space. The result was a series of jigsaw-puzzle-like maps delineating more and less valuable areas of the particular natural resource under consideration.

This new inventory was promising, but ARDA officials worried that producing more information—even in a usefully standardized format—might actually serve to compound the existing information management problem. Computer technology seemed like one potential solution. Computers might expedite the work of manipulating information that was simply too time-consuming and labour-intensive to tackle manually. As noted in a mid-1960s report, there was at that date no suitable computer system yet in existence that could manage land-use information, but ARDA officials were optimistic the necessary technology could be developed.[24] And so an essential second aspect of this new effort at data processing was the CGIS, designed by computer experts purpose-hired by the federal civil service. At inception, CGIS represented an effort to harness computer technology to the CLI in a way that would permit easy retrieval of information and rapid integration of multiple maps and data sets, including those from non-CLI sources such as the Canadian census.[25]

By the early 1960s, Canada was, as John Vardalas has shown, among those nations scrambling to develop domestic civilian capacity for computer design and manufacturing.[26] Emphasizing the innovative character of Canada's mid-twentieth century computer industry, Vardalas positions his rendering as a counterpoint to those of economic nationalists, who have bolstered their critique of Canada's branch plant economy by underplaying domestic innovation. CGIS is an over-looked example that extends Vardalas' argument; moreover, it shows how the Canadian government sought to make legible Canada's landmass and natural resources through the development of new and innovative computerized data-management tools.[27]

If the prospect of cutting-edge technology was important in federal-government administrators' ambitions for CLI and CGIS, so were particular conceptions of the past and the present. Administrators framed the need for improved use of information in relation to a settlement period that was considered to have passed.[28] As those who worked on CLI and CGIS saw it, many of the problems confronting Canadians and policy-makers alike could be linked to how, during the settlement period, colonizers did not have or use accurate environmental information in making decisions about where and how to establish themselves. In the absence of a more historically-robust understanding of why colonization played out as it did, administrators asserted it was luck as much as anything else that was a key determinant of immediate and longer-term success in settlement. As federal administrators saw it, the situation was compounded over decades by government's "laissez faire" or "hands off" approach to resource management.[29] Those involved in the development of CGIS and CLI saw themselves as working to ensure that logic, not luck, underlay resource management across Canada and to position governments to take a more "hands-on" approach.[30] Such an effort was built

on the interventionist orientation of the Canadian federal government, fundamental to the development imperative that cohered in the aftermath of the Second World War.[31]

Government efforts to achieve rational resource management were in tune with concurrent developments in the academic realm. Canadian historians have noted shifts in scholarly inquiry from the late-nineteenth through the mid-twentieth centuries, with increased emphasis on "scientific principles and rigorous research."[32] Scholars Roger E. Backhouse and Philippe Fontaine have argued that the period after the Second World War saw a significant reconfiguration of social-sciences inquiry, one characterized by increased emphasis on models and quantification by scholars keen to establish their "scientific credentials."[33] For Canadian natural-resources managers concerned with the challenges of administering Canada's vast landmass, among the most relevant of such reconfigurations took place in the academic discipline of geography. As R. C. Hodges, chief of the federal-government division responsible for ARDA, wrote in *The Cartographer*, the resource-management challenges of the Canadian state were defined by "spatial characteristics" as much as by "physical, economic, and social aspects."[34] It was not just effective use of data but effective use of spatial data—the special province of geographers—that seemed poised to bring rational resource management into the realm of the achievable.

In 1962, F. Kenneth Hare organized a session on quantitative methods at the annual meeting of the Canadian Association of Geographers. One of the speakers was University of Toronto geographer Ian Burton, who would later rework his paper for publication in *The Canadian Geographer*. In this published paper Burton dubbed the reconfiguration within his discipline the quantitative revolution.[35] For some scholars swept up in the quantitative revolution or parallel transformations, emphasis on quantification and models was significant because it positioned academics to engage more effectively in the world of policy-making. According to Brian J. L. Berry, who was immersed in this disciplinary transformation, the quantitative revolution focused on "the application of the scientific method to geographic research and of geographic research to important issues of public policy."[36] At the same moment when some geographers were looking to deploy new disciplinary approaches in service to the public, Canadian civil servants were grappling with a resources-management challenge they perceived as spatial in character. The alignment of interests between academic geography and state resource managers was inflected by how, as Trevor Barnes has shown, academic geography was still establishing itself in Canada in the years following the Second World War.[37] Indeed, the Canadian state's interest in natural-resource development represented an opportunity for academic geographers to demonstrate the value of their skills, as Hare recognized in the episode that opened this article.[38]

In the immediate aftermath of the passing of the Agricultural Rehabilitation and Development Act in June 1961, work on the CLI began. A series of meetings

involving federal and provincial civil servants as well as representatives from universities and industry resulted in the establishment of some basic parameters.[39] In November 1962, a seminar on the proposed inventory took place in Ottawa. Participants representing various perspectives and from all regions of the country confirmed the need for a project of this sort. The participants also worked to finalize the range of environmental and cultural features the inventory would include: soil capability for agriculture, land capability for forestry, wildlife, recreation, present land use, socio-economic characteristics, and climatological considerations. The CLI was to address the areas of Canada perceived by organizers to be the most economically productive portion of the nation: "the southern, settled portions of Canada", consisting of 260 million hectares, about 25% of the country.[40] In October 1963, the federal government formally confirmed it would move ahead with the CLI. Shortly after that, the Canadian Council of Resource Ministers, a recently-created body that brought together federal and provincial representatives, approved the plan.[41]

The CLI was understood as fundamental to ARDA's goals. In the absence of such an initiative, it was feared a lack of basic information would mean that "programs of land adjustment and regional economic development" would be "fallible and costly."[42] But moving ahead with the CLI presented its own difficulties. Publishing spatial information related to 260 million hectares of Canadian land at a useful scale would require many thousands of sheet maps. Parsing this information to support rational decision-making around resource use would more than redouble the task. For example, it was estimated that the data management and analysis necessary to determine how Canada's dairy and beef industries could best be managed would take about 550 people working for three years and would cost about $8,000,000.[43] And even if the time and money were available to support this work, Canada did not have appropriately skilled analysts in sufficient numbers. More challenging still were situations in which managers wanted to determine how best to use any particular parcel of land – whether for raising cattle, or growing trees, or developing parks, for instance. ARDA's ambitious goals appeared achievable only because of the prospect of computer-supported analysis, "whereby quantities of data from both maps and statistical tables can be stored in a form which is amenable to analysis by electronic computers."[44] Using CGIS, it was estimated that the required 1,650 person-year analysis of the Canadian dairy and beef industry could be accomplished in mere days.[45]

Together, CLI and CGIS represented federal government efforts at conceptual and technological innovation that, when linked, substantiated the transformative ambition envisioned by civil servants at the core of the ARDA program. As it was put in a 1966 document aimed at potential users, the goal of these two linked innovations was to "develop an information system an administrator could do everything with."[46] Fundamental to these innovations was the role of "the high-speed electronic computer" in supporting decision-makers.[47] Just as railway technology was fundamental to the anticipated success

of Ottawa's National Policy of the late nineteenth century—a project that sought to establish the west as a resource hinterland and consumer market in service to the east's manufacturing industry—so was the computer essential for the realization of ARDA's goals around natural-resource management: "what the steam engine did for muscles, the electronic computer is beginning to do for brains."[48] In both instances, from the perspective of those at work on CGIS, technology was fundamental to overcoming the challenges posed by Canada's vast geography.

CLI and CGIS emerged as innovative tools promising to rationalize the use of natural resources. The potential success of ARDA was seen to hinge on the development of synoptic-scale datasets summarizing key information from across the nation, as well as new methods of manipulating these datasets to make them useful in answering any number of resource-management questions. Civil servants involved in work on the CLI and CGIS perceived these linked undertakings as "essential for the most effective implementation of the ARDA program."[49] Those working on CLI and CGIS were building on past government efforts at resource management and aligning their activities with trends in the social sciences in general and the discipline of geography in particular. Over a period of years, state-driven efforts at innovation resulted not only in the production of new maps and new technologies, but also in the renewal of optimism about the potential for rational management of Canada's natural resources.

The work of inventory

Resource management in mid-twentieth century Canada was riven by at least two major fractures: the jurisdictional divisions between Ottawa and the provinces characteristic of Canadian federalism and the siloed administration typical of that era in natural-resources management, which saw different bureaucracies administering different resources. The work of the CLI involved a reconfiguration of these divisions sufficient to allow the inventory to proceed. The effort of producing a national inventory—a synopsis of Canadian resources—brought together civil servants who previously had little formal professional connection to each other. But modifying bureaucratic structures and relationships did not alter the magnitude of the task at hand. The work of producing a useful synopsis of Canadian natural resources foundered on the diverse environmental conditions of the vast mass of land under consideration. Further, some provincial civil servants were concerned about the CLI's failure to provide information on topics and at scales they perceived as necessary. Ultimately, even as the CLI emerged from a collaborative process, these provincial officials recognized the geo-epistemology embodied in the CLI reflected the perspectives and purposes of the Canadian federal government.

Considering ARDA's emphasis on agriculture and previous national soil survey work, it is unsurprising early progress on the CLI was most rapid with respect to soils. By spring 1963, even before the federal government's confirmation

of its intention to move ahead with the CLI, a system was developed for the classification of soil according to agricultural potential.[50] The classification system, developed in partnership with the federal-provincial Canada Soil Survey Committee, divided mineral soils into seven classes, with Class One being the most valuable for agricultural purposes and Class Seven being subject to the most severe limitations.[51] In general terms, classes one through three reflected soils of significant value for agricultural purposes (Figure 1). Thirteen sub-classes were developed to reflect the particular nature of the limitations to which some soils were subject, including for example salinity (indicated with an S), topography (T), and low fertility (F).[52] Using this system, a mid-quality soil subject to erosion might be indicated as 3E. By 1964, pilot efforts to create CLI maps were underway using this classification system.[53]

The soil classification system reflected elements that would be incorporated into other components of the CLI project. With respect to wildlife, recreation, and forestry, land would be divided into discrete units according to suitability for each particular purpose. These units would be irregularly shaped, reflecting the variability of the landscape. The result was the creation of a new set of maps, one that expressed not the geo-political borders characterizing the Canadian state, nor the private-property lines reflecting the imperatives of liberal capitalism, but rather a view of the landscape derived from the intersection between ecological characteristics on one hand and a specific method of resource use on the other. These new maps were highly useful for a variety of users; for the Canadian Wildlife Service, for example, the newly-available data "constituted a coherent body of information on wildlife habitat that far exceeded anything hitherto available in Canada."[54]

The CLI addressed human as well as natural resources. It did so by incorporating census data such as income and educational attainment by geographical area. Analyzing this data at the national scale implied there should be some sort of relative equivalence in life experiences across the 25% of Canada's landmass under consideration. From this perspective, it became noteworthy, for instance, that educational attainment in Manitoba was the lowest among the prairie provinces, on par with that of the maritime provinces.[55] In building a body of knowledge about its citizenry that was oriented to nation-wide comparison, the federal government was conceptualizing as problems instances of deviation from apparent norms. Such problems could then be targeted through programs developed under the auspices of ARDA or complementary legislation.

Committees made up of representatives from federal and provincial governments, the academic sphere, and industry governed the CLI work. That the committees straddled federal and provincial governments was particularly significant within Canada's federal system, in which jurisdiction over natural resources was a complicated and contentious matter.[56] Within the resources included in the CLI, migratory birds were a federal responsibility, for example, while agriculture was shared, and the provinces held jurisdiction over the rest.

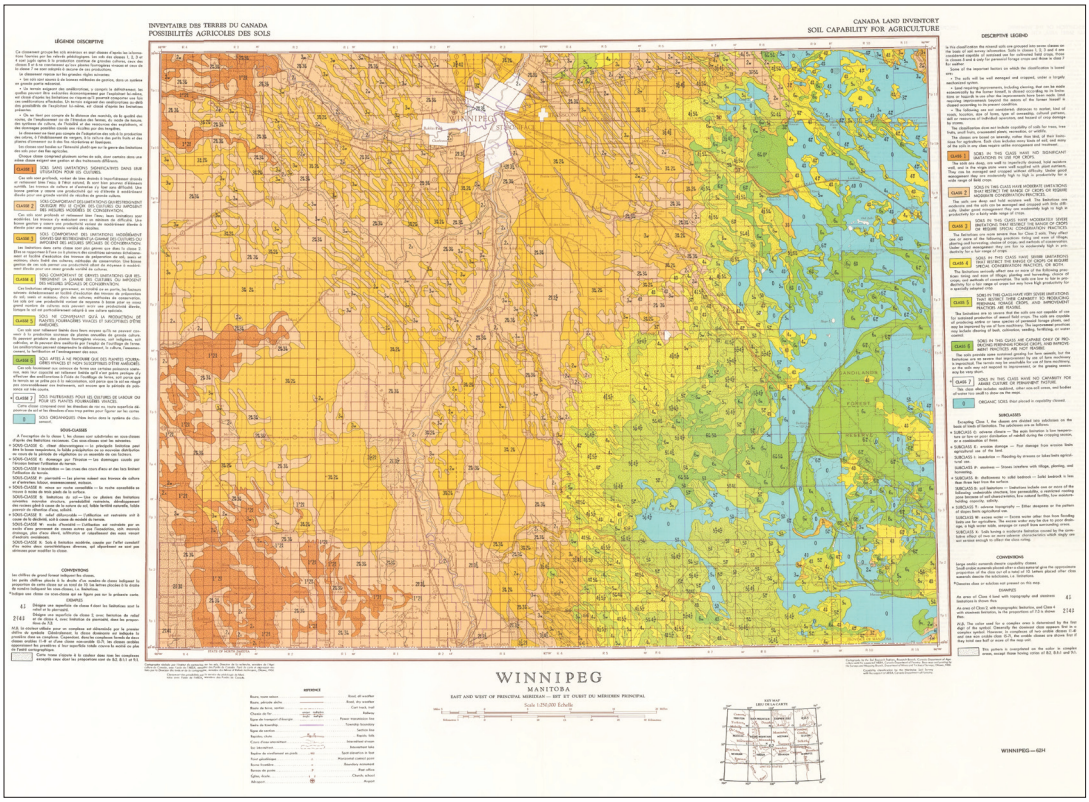

Figure 1: *This CLI map displays soil capability for agriculture for an area of southern Manitoba that includes the city of Winnipeg. In a manner typical of CLI soil maps, irregular parcels of land are labeled with numbers indicating agricultural potential and letters specifying particular limitations. Credit: "Canada Land Inventory (CLI): 1:250,000 and 1:125,000", Agriculture and Agri-Food Canada, accessed 15 November 2017, http://sis.agr.gc.ca/cansis/publications/maps/cli/250k/agr/index.html*

In this uneven jurisdictional terrain, the CLI represented a means through which the federal government could encourage improved resource management without treading on provincial toes. The arrangement was that the federal government paid for the inventory and the provincial governments conducted it for areas within their borders using categories developed nationally.[57] The assembled information would then be provided to the federal government, which was responsible for compiling and publishing it. During the five most intensive years of work on the CLI—from 1963 to 1968—over $15 million was spent (amounting to slightly more than 5% of the ARDA budget for the years in question), with over $11 million handed directly to the provinces.[58] Federal money and logistical support helped ensure the inventory moved ahead despite challenges derived from what one analyst called the "rather inelegant structuring of the Canadian federal system."[59]

The CLI depended on the bridging of divides not only between Ottawa and the provinces, but also between bureaucracies oriented to the management of distinct natural resources. In the mid-twentieth century, the federal government included 18 different institutions with responsibilities for an environmental

feature considered to be a natural resource, with each institution operating independently of the others.[60] This division of responsibility meant natural resources were managed largely in isolation from each other, without any formal means for inter-agency coordination or collaboration. With provincial institutions brought into the picture, the challenges were magnified. Expanding on the basic parameters established during early meetings on the CLI required the formation of committees involving experts drawn from each of the key sectors to be surveyed, including, for example, soils, forestry, and wildlife.[61] As of 1965, representatives from 100 government agencies were involved in these committees, along with members from universities and private industry.[62] The bridging of divisions of various sorts became a fundamental aspect of the CLI effort. In fact, the integrative aspects of CLI work were so compelling they led to the development of a further inventory effort oriented to the "biological and physical" features of the environment "without reference to any particular land use." What became known as the biophysical land classification system was in part an effort to shed the trappings of resource-specific efforts at environmental management, with recognition of the need for such a system emerging partly out of collaborative work on the CLI.[63]

The bridges that spanned jurisdictional and sectoral divides were made possible by the federal government's financial support, but the bridges themselves were built out of professional relationships. Historian Perrin Selcer has recently explored the relationships developed during the mid-twentieth century international effort to produce a global soil map, arguing that these came to represent in themselves a resource of significance.[64] The situation was similar in Canada. The perceived value of the professional relationships that developed during CLI was reflected in how it prompted a federal effort to determine the viability of using "the federal-provincial relationships established under the Canada Land Inventory as a basis for co-operative programs in areas in which there is an environmental concern and to encourage good land use practices."[65] This effort followed up on the resolution passed by the Canadian Council on Resource Ministers some two years earlier, commending the co-operative approach taken with the CLI.[66]

But while professional relationships bridged jurisdictional and sectoral divides, the sheer scale of Canada's geographic variation strained the CLI's national framework, even despite the exclusion of the distinct landscapes of the north. With respect to forested lands, none of the prairie provinces had any areas that qualified as Class 1 or 2, and Quebec and the maritime provinces lacked any Class 1. In this context, Class 3 forested lands assumed a regional importance on the prairies they would not have had elsewhere in the country, reflecting how technically-correct national classifications could fail to capture local significance.[67] Manitoba ended up re-scaling the forestry classification for that province's pilot land-use planning project.[68] With respect to soils, it was clear early on that even soils within a single class varied substantially in terms of productivity. Barley yields on CLI Class 2 land from Alberta provide an example

of this. In the central region of the province, such land would produce only 72% of what it would produce in the south; in the northern region, it would produce only 62% of this.[69] As the CLI soil survey developed, it became clear the survey would offer less an assessment oriented to the scale of the nation-state and more an analysis of "the comparative capability of lands in local areas for agriculture of the types adapted to the districts concerned."[70] By 1976, it was recognized that the CLI's classifications, though "standardized nationally", amounted to "a comparable series of regional ratings."[71] All of this reflected an enduring tension between the large geographic area being addressed and the classification system being deployed. Even in an effort aimed at a national inventory, the geographic diversity entailed in Canada's vast expanse made it hard to avoid a regional framework.

While ARDA staff found in CLI and CGIS reason for optimism in resource management, this optimism proved at times hard to maintain. In November 1964, L. E. Pratt, Chief of the Canada Land Inventory, opened meetings of provincial representatives by noting the federal government was "very gratified by the provincial response" to early CLI work.[72] Indeed, the written record of the discussions that took place at the 1964 meetings confirm that provincial views were generally positive at this early stage. By May 1970, when R. J. McCormack, a successor of Pratt's in the role of CLI Chief, authored a report on progress, more nuance was apparent. In a section titled "comments on inadequacies of CLI," commentators voiced their complaints. Some were of the sort that could be relatively easily addressed: greater effort to generate public awareness and adoption of more effective map colour schemes, for instance. But a commentator from British Columbia offered a more penetrating observation. As they saw it, a "major inadequacy is the scale and detail of the inventory for many uses," with the implication that more detail would make for a more useful tool. In responding to this critique, McCormack echoed further comments from the critic suggesting such inadequacy could perhaps be excused as an acceptable sacrifice given the national scope of the inventory. McCormack concluded by acknowledging that, acceptable or not, such inadequacies "should not be overlooked in the use of the data and should be pointed out."[73]

It was precisely the issue of understanding and working within the limitations of the data that concerned E. A. Poyser, Manitoba's ARDA co-ordinator who had additional responsibilities related to Indigenous peoples in that province. Confronted with the 1966 suggestion that civil servants and Indigenous leaders work together to ensure effective application of the CLI to reserve lands, Poyser pushed back. He felt quite clearly that the CLI would offer very little to support Indigenous peoples or government officials in "making any decisions about the development of Indian lands." As Poyser saw it, the sort of information necessary for improved policy-making (which, as Poyser saw it, included data pertaining to "markets, financial requirements, management requirements, labour availability" as well as information about "the preferences and likings of the Indian people") would not be captured in the synopses generated through

the CLI. Considering what he perceived as the limitations of CLI data in terms of both type and scale, Poyser worried that enthusiasm for the CLI might result in "well intentioned, but useless delay" in "the matter of improvement of wellbeing of Indian-Metis."[74] Unlike McCormack, Poyser did not see missing information as an acceptable sacrifice, but one with real potential for harm. Poyser's misgivings bear out what Hugh Shewell has characterized as conflicts within governments erupting around mid-1960s efforts to bring development programs to bear on Indigenous peoples.[75]

From a contemporary perspective, it seems clear how, under the guise of an objective inventory, the CLI served to privilege the perspectives of the colonial state. The summary report for the recreation inventory noted the abundance of historic sites of potential tourist interest in eastern Canada and the comparative paucity of such sites in the west.[76] In the absence of any recognition of the cultural landscapes produced by Indigenous peoples, the nation's western expanse seemed to lack historical depth. While the soils inventory came to be recognized as a set of rankings that had to make local sense, the assumption persisted that historical value could be assessed on a national basis and by agents of the colonial state. The CLI also failed to accommodate resource uses that operated in terms of subsistence needs, rather than market exchanges or recreational opportunities. Consistent with earlier state practices, the inventories pertaining to wildlife and waterfowl addressed these as significant for the leisure opportunities they presented, not the subsistence needs they fulfilled.[77] Ultimately, as most evident in its inventories of recreational, wildlife, and waterfowl resources, the CLI operated not only in descriptive but also in prescriptive terms, privileging colonial landscapes and market-based ways of interacting with natural resources.

By the 1970s, the CLI was being used extensively by both public and private agencies in a variety of manners. W. A. Benson, co-ordinating chair of the CLI in BC, noted that "asking how Canada Land Inventory information will be used is parallel to asking the originator of the wheel, the screw and the inclined plane what effects their invention would have."[78] From a historical perspective, the significance of the CLI derived not just from its finished form, but also from the process of its development. Through the work of developing the inventory, professional networks proliferated nationally, spanning divides related to jurisdiction and sector that often served to complicate natural-resources management in Canada. By 1981, roughly five years after its completion, CLI data was being used by 79% of provincial land management entities.[79] But even as these usage rates suggest a successful undertaking, there were concerns that CLI's synoptic national vision foundered on the diversity of the Canadian landmass. Some provincial representatives worried about the information that went uncaptured at the CLI's scale of operation. And others felt that time and resources devoted to the CLI might detract from more meaningful efforts to help communities, with such concerns suggesting how the federal state's national goals ultimately trumped local needs in the CLI's design.

The prospect of the digital

CLI's ambitious vision gained traction when it became the incubator for a critical piece of technological infrastructure: the Canada Geographic Information System (CGIS). For those working within ARDA, CGIS made rationality in resource management seem not just desirable, but also achievable. CGIS was the result of a chance meeting in 1962 between Roger Tomlinson and L. E. Pratt, who had recently become the head of CLI.[80] Tomlinson (1933-2014), the key architect of CGIS, had trained as a geographer in Britain and Canada before taking up a position with Spartan Air Services in Ottawa. Spartan was a Canadian commercial-aviation firm established in 1946 that conducted air-survey work on contract for the federal and provincial governments.[81] As Tomlinson tells it, frustration within Spartan at inconsistencies among provinces in the classification of forest resources prompted the firm to investigate the possibility of mapping individual tree species and then using an overlay technique to generate species groupings as needed. Using traditional technologies, the costs were prohibitively high.[82] But Tomlinson and his team wondered if a digital approach might change the economics by solving a key problem with paper maps: the difficulties of combining and recombining large quantities of detailed information.

In his role as CLI head, Pratt recognized the difficulties of managing the large quantity of spatial information that CLI was to generate and was keen to learn about Spartan Air Services' efforts to address this challenge. Soon after they connected, Pratt invited Tomlinson to make a presentation to CLI developers that argued for the use of digital techniques in managing CLI data.[83] In his presentation, Tomlinson made the case for investigating "the extent to which computer mapping is applicable to the problems of the Agricultural Rehabilitation and Development Administration."[84] The presentation was well received: Tomlinson was hired on by the federal government and work on CGIS began in earnest.

Those involved in the early years of CGIS conceptualized the technology as consisting of three key components. The first was the system of input and editing, which enabled the incorporation of data. The second involved data manipulation, which involved data management and processing so as to ensure any set of data could be brought into relationship with another. The third system pertained to data output and display. It was to ensure necessary data could be retrieved rapidly and in a useful form. Each system presented its own challenges. Efforts to meet these challenges involved collaboration between the public and private sectors. Spartan Air Services, Tomlinson's former employer, continued working on related contracts through 1967.[85] Tomlinson also built a fruitful relationship with International Business Machines (IBM). The CGIS system was originally designed to work on an IBM S/360 model 50, with 512K bytes of storage.[86] The 360 series was IBM's first offering of computers that ran standard software across varied model sizes, and represented a powerful effort to dominate the computer market.[87] IBM's track-record of innovation

Figure 2: *This scanner was developed by International Business Machines (IBM) for the Canada Land Inventory. It converted graphic information to digital format, an essential step in relation to the Canada Geographic Information System. The scanner is now part of the Ingenium (Canada's Museums of Science and Innovation) collection. IBM Scanner, 1963, Artifact No. 1986.0821*

was also evident in relation to the CGIS project. An early assessment of the technological feasibility of CGIS warned there was not "any existing instrument suitable for directly reading map data into computer storage."[88] In the mid-1960s, IBM designed a digital map scanner for the CGIS project, based in part on work they had already been doing on similar issues.[89] The scanner, the first ever to be made and used, was operational from 1967 to the early 1980s, and is now preserved in the Canada Science and Technology Museum's computing collection (Figure 2).[90]

CGIS harnessed these new digital technologies to transform static maps into dynamic ones that allowed users to ask new questions of data and more easily derive meaningful answers. The most renowned capacity of CGIS was the layering of information. This digital operation was equivalent to the analog process of "placing several maps transcribed on transparent material one on top of the other on a light table."[91] Layering separate maps would allow users to readily generate useful information. For example, combining data from maps documenting agricultural capability and current land use would make it possible to easily locate "the high capability agricultural land that is not in agricultural use."[92] The product of layering has been termed a layer cake, a

phrasing that, though facetious, expresses how the end product was intended to represent something greater than the sum of each component overlay.[93]

Other key capabilities of CGIS included connecting small maps to encompass a larger area (termed linkage by developers because of how it involved linking maps together) and combining distinct areas within maps to permit new types of analysis using simplified data (termed dissolve because of how it involved dissolving borders to facilitate aggregate analysis).[94] Together, these two functions allowed for the creation of a region-wide, province-wide, or nation-wide database that could be analyzed in a variety of ways. The utility of this database was heightened through the use of an analytical function described by developers as a cookie cutter, an analogy that conveyed the system's capacity to introduce new units of analysis.[95] The cookie cutter could be shaped in a variety of ways: in reflection of, for instance, the borders of a national park, the radius around a city, or the extent of acid rain deposition. Neither layering, nor linking, nor dissolving were new functions; they had long been possible through laborious hand methods. But the sheer time and expense of such analyses limited the extent to which they were undertaken.

If CGIS emerged in part out of federal-government collaboration with the private sector, connections to academic geography were also significant. In the mid 1960s, the Canadian federal government tapped geographer Brian J. L. Berry, then a professor at the University of Chicago and a key figure in geography's quantitative revolution, to assess the proposed Canada Geographic Information System. As he put it in his laudatory assessment (underlining in original):

> It is not so much a question of whether the proposed system is better than the alternatives considered, or is the best available. It is the only system which will enable the Canada Land Inventory to achieve its objectives satisfactorily![96]

Berry's assessment must have been read by Canadian officials as a rousing academic endorsement. To the extent that CGIS aligned with the concerns of professional geographers, the effort gained legitimacy and prestige from its parallels in the academic world. This buttressed the optimism of state resource managers. Berry was similarly emphatic when commenting on the project's academic significance, arguing that CGIS "can only have a healthy impact on the development and nature of Geography as a science, not only in Canada, but also throughout the world." [97]

Between 1963 and 1968, 30% of federal spending on CLI was dedicated to CGIS, amounting to approximately $1,180,000.[98] By 1968, the initial phase of developing CGIS was completed.[99] That year also saw the first use of the term 'GIS' in published material.[100] Heralding these milestones was an effort to build awareness and understanding about CGIS. These efforts included seminars that introduced the system to potential users and a 1968 National Film Board offering titled "Data for Decision".[101] This film demonstrated visually the challenges in information management that led to CGIS's development. The narrator earnestly described how CGIS functioned, contextualizing it in relation

to the federal government's efforts to address rural development challenges. One extended sequence featured a resource manager parsing a tricky land-management conundrum through collaboration with a CGIS expert who was able to rapidly produce the necessary data. In the end, the problem is better understood, and the manager is positioned to develop an innovative solution (Figure 3).

In retrospect, such outreach efforts were premature. CGIS was not yet able to service the demand that proponents were working so hard to generate. From 1968 through the early 1970s, CGIS experienced what some have termed serious teething problems.[102] A key difficulty stemmed from the simple reality that a system that was functional did not amount to one that was ready to use: even as developers celebrated their achievement, the time-consuming process of entering CLI data was far from complete. By the early 1970s, provincial officials associated with the CLI were expressing dismay at how long it was taking to come up with a usable tool.[103] Even once the system was partially operational, users were not always pleased with what they found. While the original plan had been to include data at the 1:50,000 scale, CLI managers adopted the less detailed 1:250,000 scale because of time and cost concerns,[104] despite demands from provincial civil servants for detailed maps that could support local environmental management.[105] While perhaps sensible from the perspective of the federal government, with its interest in broad long-term resource strategy and its responsibility for project finances, the adoption of the less detailed approach demonstrated how collaboration in resource management remained bounded by time and money.

Problems also ensued from the awkward intersection between CLI and CGIS, two innovations that had been conceptualized in relation to each other but developed through distinct processes. CGIS had the unintended effect of exposing flaws in the CLI data. As Canadian-government administrators recognized, work on the CLI was "a combination of art and science."[106] The CGIS function of linkage, which joined small maps, exposed inconsistencies in CLI data by showing how a single geographical area divided between two mapping efforts could be assessed differently. Such inconsistences were attributed to the CLI's reliance on student labour and diverse sources of data.[107] Even disregarding worries about the quality of CLI data, the intersection between CLI and CGIS was still a cause of concern. The precisely located lines that characterized CGIS outputs were inconsistent with the gradual transitions that marked changes in the natural resources assessed through CLI. As William Warren argued in his study of the matter, CGIS represented a too-precise locating of the rough-cut data generated by CLI.[108]

These various concerns, though perhaps only to be expected considering the groundbreaking nature of both CLI and CGIS, made it more difficult for civil servants to maintain the optimistic belief that these innovations would make rational resource management readily achievable. Indeed, some viewed CGIS as "the greatest disappointment" of the entire suite of activities associated with

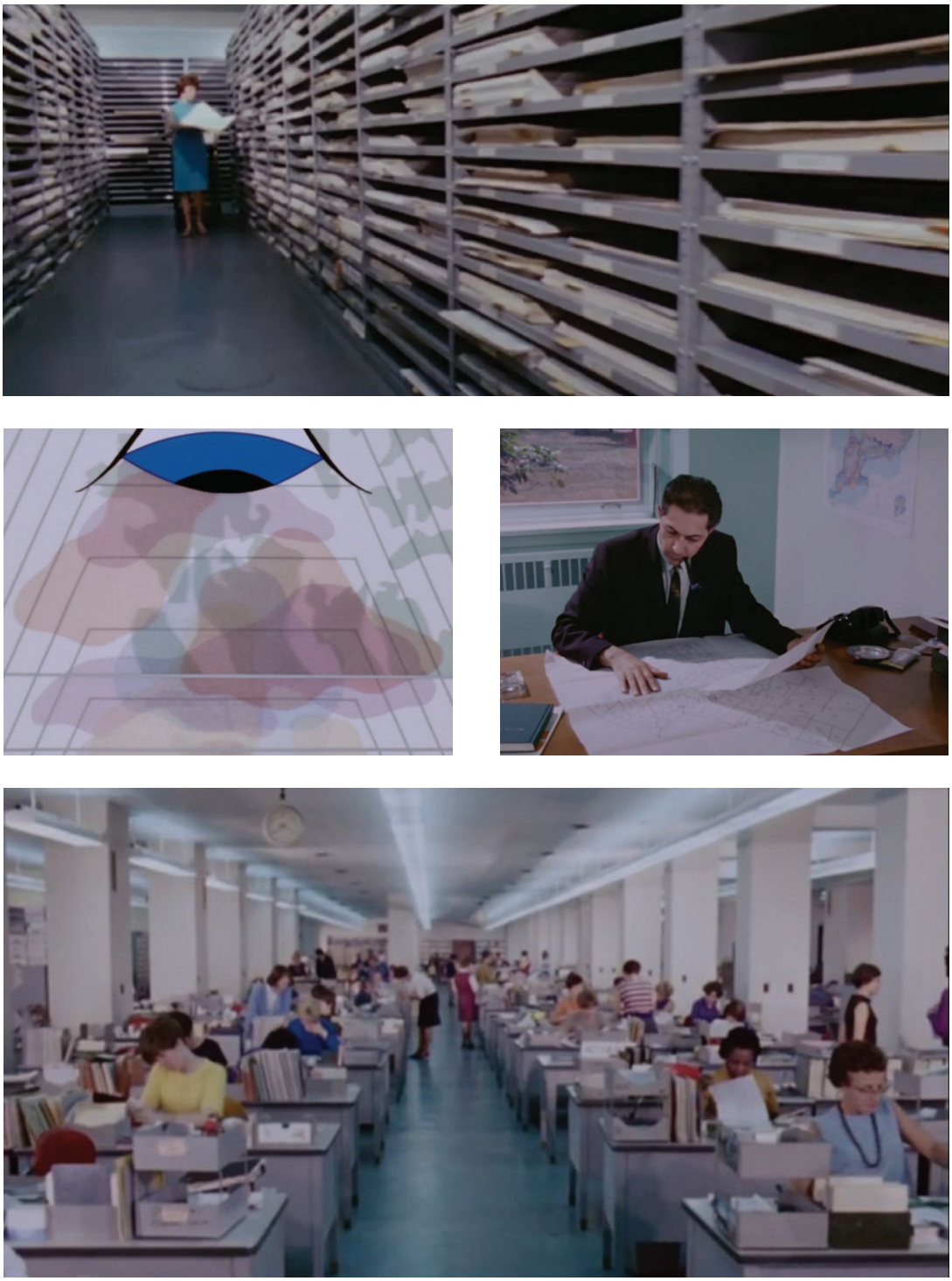

Figure 3: *These images are stills from the 1968 film about the Canada Geographic Information System [CGIS] titled "Data for Decision." The top and bottom images illustrate the challenges with storing and analyzing available data pertaining to natural and human resources. The middle image on the left shows a stylized human eye at the top and a series of transparent maps below, dramatizes the layering function of CGIS. The middle image on the right shows a manager consulting CGIS-generated data in developing an innovative solution to a resource-management problem. The film can be viewed online via the National Film Board website: https://www.nfb.ca/film/data_for_decision/ Credit: Data for Decision ©1968 National Film Board of Canada. All rights reserved.*

ARDA, a remarkable perspective given that CGIS is now widely considered a notable technological innovation.[109] In retrospect, disappointment was perhaps inevitable given how proponents vested CGIS with the overreaching ambition embedded within ARDA: that rational management would solve perceived problems of rural development and regional inequality. The potential for disappointment was heightened by how, in their efforts to gain support for their innovative undertakings, advocates of CGIS constructed a direct link between their work and better decisions. They framed intractable problems of resource management as easily resolvable through use of CGIS's efficient and effective techniques of data management. That framing is evident in 'Data for Decision-Makers,' a 1967 document that claimed CGIS would "give to those who make decisions affecting our nation's resources, an information system with which they could achieve almost anything."[110] As the ambition embedded in the ARDA programme was linked to CLI and CGIS, so these innovations were sometimes taken as promised solutions to the problems ARDA was to address. Those directly involved in developing CGIS, however, were clearer about their work; they recognized they sought to produce better information to support—not replace—the decision-making process, that "[w]here computation finishes, interpretation and evaluation begins."[111] But for those who had been sold on CGIS as the solution to complex resource-management problems, the limitations of CGIS were less clear. In this context, even when it functioned as designed, CGIS could seem like a failure because of the persistence of the resource-management problems that spurred its development.

Ultimately, CLI and CGIS were unlikely to position decision-makers to effectively address the problems of rural inequality and resource degradation targeted by ARDA because neither accounted for the historical processes through which inequality and degradation operated. As political scientist Janine Brodie has made clear, inequality is produced through processes that accumulate over time.[112] Drawing on scholars like Harold Innis and Vernon Fowke who explain regional inequality as a product of political and economic decision-making, Brodie emphasized the necessity of considering history as well as geography in making sense of the uneven nature of outcomes across Canada. Regional inequality was a spatial problem, as ARDA chief R. C. Hodges wrote in 1965. But it was also a temporal problem, one with historical dimensions that required consideration. While historians, historical geographers, and scholars in allied fields have in recent years used GIS as a tool to analyze change over both time and space, in inception both CLI and CGIS privileged space over time.[113] The failure to reckon with the consequences for Indigenous peoples of historical and ongoing processes of settler colonialism was a particularly egregious omission, but as Janine Brodie's work makes clear, patterns of disadvantage evident across places like the Maritimes and the Prairies have their own histories that bear consideration. The very innovations fueling the optimism of ARDA proponents were designed to illuminate spatial variation, but not to shed light on the historical circumstances contributing to differential outcomes.

What contemporary historians might see as a shortcoming of CLI and CGIS reflected parallels between the perspective of those involved in developing CLI and CGIS and those of scholars in the field of quantitative geography. Geographer Trevor J. Barnes has argued that geographers associated with the quantitative revolution deployed a "God's-eye view", not perceiving, as have many later geographers, that "who you are and have been affects what you know and tell others."[114] When deployed by Canada's federal government in the 1960s and 1970s, the "God's-eye view" failed not only to encompass the historical processes that created patterns of inequality, but also to accommodate the perspectives of those with different ambitions for the future. Modernity as conceptualized within ARDA was narrowly defined in a manner that reflected urban-industrial needs and lifestyles. Recognizing this, it is possible to more fully comprehend the concerns of Manitoba ARDA co-ordinator E. A. Poyser, who worried about how CLI might affect efforts to support Indigenous peoples. As Poyser explained to CLI proponents in 1966, it was difficult to imagine how CLI could effectively engage with "the preferences and likings of the Indian people" without considering their community histories or their ambitions for the future, dimensions that the CLI neither reflected nor measured.

As umbrella legislation intended to facilitate jointly funded and provincially-led rural development programs, ARDA's influence was felt across Canada. From fisheries modernization in Newfoundland and ski development in Quebec to water management in Saskatchewan, ARDA funds flowed in diverse avenues through the 1960s across a broad swath of the Canadian nation.[115] Further research is necessary to understand the historical significance of these efforts, individually or in sum. Considering that CLI and CGIS were fundamental to the ARDA program, understanding how these two innovations privileged space over time positions us to better appreciate aspects of the mid-twentieth century development imperative reflected in ARDA. This was rural development oriented to eliminating—not to understanding or accommodating—modernity's unevenness.

Challenges and limitations aside, by 1971 so-called teething problems had resolved sufficiently to permit the declaration that CGIS was the world's first fully operational GIS. It is at this point that the system entered full-scale operation, serving clients within and beyond government.[116] That same year saw a major reconfiguration of the federal bureaucracy that managed CLI and CGIS. In May 1971, responsibility for CLI moved from the Department of Regional Economic Expansion to the Department of Fisheries and Forestry, in advance of the anticipated creation of a Department of the Environment. Amid shifting bureaucratic structures, the federal government sought to alter funding for any successor initiatives. New programs would be distinguished by at least one key factor: they would be cost-shared between the federal government and the provinces.[117] Through the late 1970s, CGIS projects depended increasingly on the user-pay principle, reflecting growing fiscal restraint by the federal government.[118] By this point, the optimism that had surrounded the CGIS effort had largely dissipated. In the early 1980s, privatization and cost-

cutting ultimately led to the shuttering of the CGIS project within the federal government.

By this point, Roger Tomlinson had left the federal government, in part to pursue his ambition of developing "a globally consistent logical schema for the organization of earth data from many areas in a form viable for nearly all users."[119] In 1980, the Province of Saskatchewan hired him to investigate the value of computer systems such as CGIS in relation to the province's particular resource-management needs. In the end, Tomlinson determined that none of the existing systems were yet sufficiently advanced to be of real benefit to the province.[120] Just a few years earlier, advocates had declared that CGIS was "the largest and most technically sophisticated system for handling land data in existence today."[121] But by the early 1980s, CGIS occupied an ambiguous position: even as it was recognized internationally as a notable innovation, it was inadequately supported by the government that funded it and deemed insufficiently advanced by the man most directly responsible for its creation.

Conclusion

In *Imagined Communities*, Benedict Anderson considers how nation-states established their sovereignty, whether in territorial or cultural terms. Among the tactics Anderson examines is map-making, which he understands as part of the state's "totalizing classificatory grid." For Anderson, this grid functioned not just as a tool to facilitate administration but also as a technique of political legitimization, something that "could be applied with endless flexibility to anything under the state's real or contemplated control."[122] CLI and CGIS embellished and extended Canada's "classificatory grid": together, they generated a series of jigsaw-puzzle-like overlays describing particular environmental features and uses, with these overlays made manipulable through new computer technology. And just as traditional maps spoke to legitimacy, so did CLI and CGIS. If a grid map functioned as a tool of political power, CLI and CGIS legitimized this power in environmental and technological terms, terms that were increasingly resonant in the mid-twentieth century.

CLI and CGIS projected a vision of natural-resources management in Canada. In prospect and realization, they also affected the Canadian state. At the outset of ARDA, CLI and CGIS helped sustain the belief that rationality in resource management was eminently achievable, despite the recognized magnitude of the task. Optimism was bolstered by alignment between the resource-management efforts of the Canadian government and shifts in the academic world, particularly in the discipline of geography. Establishing better data and better technology was believed to hold transformative potential among Canadian resource managers as among academic geographers. CLI and CGIS were built through new professional relationships that extended across governments both federal and provincial, private industry, and the academic world. These relationships also bridged differences of perspective related to jurisdictional divisions and resource sectors. To those involved in CLI's development, the structure of Canadian federalism and the siloed nature

of natural-resources management made the project "a daring and formidable task!"[123] To those focused on CGIS, the challenges were different but no less daunting at a time when it was still commonplace for Canadians to wonder if computers could be trusted.[124]

Despite various twists and turns, both CLI and CGIS outlived ARDA, the legislation that prompted their development. By the 1970s, the CLI had found a community of users among resource-management professionals. A decade later, CGIS successor efforts were shuttered by the federal government, even as CGIS itself gained renown as a notable technological innovation. Today, scholars and practitioners of various disciplinary or professional persuasions regularly employ GIS in analyses that account for both space and time, and also engage in lively debates over the opportunities and challenges of GIS-driven work.[125] Further, some Indigenous peoples and communities have adopted GIS technologies as a means of recording their historical and contemporary patterns of engagement with lands and resources.[126]

Over a period of decades, both CLI and CGIS have taken on significance beyond the parameters of Canadian rural development and resource management. It is these contexts, however, that explain the origins of these innovations. In turn, the affordances of CLI and CGIS—what was included in and left out of the synoptic perspective they offered—speak to rural development in Canada under the auspices of ARDA. As part of a rural development program oriented to rational resource management, CLI and CGIS were to help expose what federal-government policy-makers saw as failures of development, insofar as these occurred within the southerly landscapes that CLI included. In part through the creation of CLI and CGIS, failures of development were recast as problems that could be solved by the state, through policies and practices that were to help lagging rural areas catch up with urban-industrial modernity.

Tina Loo's recent argument for a reconsideration of the synoptic scale is constructed in relation to successes in the field of wildlife conservation made possible, at least in part, by "seeing synoptically." [127] Using the synoptic scale responsibly, as Loo clearly favours, demands that we reckon with the ways antecedents of contemporary synoptic tools incorporated the purposes of their producers. Or, to incorporate William Rankin's terminology, that we seek to understand the particular geo-epistemology at play. CLI and CGIS offered perspectives locked on their moment of creation, making it possible to detect deviation from a national standard but failing to incorporate explanations of different pasts or to accommodate the prospect of local ambitions inconsistent with the urban-industrial ideal—or to elaborate on the role of state policies and practices in producing patterns of inequality. CLI and CGIS were transformative accomplishments with respect to resource management and computer technology. At the same time, CLI and CGIS contributed to naturalizing patterns of inequality the state had participated in creating and normalizing urban-industrial modernity as the goal to which all regions and communities should aspire.

Shannon Stunden Bower is an Assistant Professor in the Department of History and Classics at the University of Alberta. Previously, she was the Research Director at the University of Alberta's Parkland Institute. In 2011, she published Wet Prairie: People, Land, and Water in Agricultural Manitoba. She has also published articles in journals, including Urban History Review, Environmental History and the Journal of Historical Geography.

Endnotes

1 F. Kenneth Hare, "The Re-Exploration of Canada," *The Canadian Geographer* 1, no. 4 (January 1954): 85-88. For more on Hare's thinking, see: Matt Dyce, "Canada Between the Photograph and the Map: Aerial Photography, Geographical Vision and the State," *Journal of Historical Geography* 39 (January 2013): 69-84.

2 Department of Forestry, "The Canada Land Inventory: Objectives, Scope, Organization," no. 1 (Department of Forestry Publication no. 1088, 1965), 3.

3 P. E. Bryden, "'Pooling our resources': Equalization and the origins of regional universality, 1937-1957," *Canadian Public Administration/ Administration Publique du Canada* 57, no. 3 (September 2014): 401–418; James N. McCrorie, *ARDA: An Experiment in Development Planning* (Ottawa: Canadian Council on Rural Development, Special Study #2, 1969), 9.

4 McCrorie, *ARDA*, 10; Helen Buckley and Eva Tihanyi, *Canadian Policies for Rural Adjustment: A Study of the Economic Impact of ARDA, PFRA, and MMRA* Economic Council of Canada Special Study No. 7 (Ottawa: Queen's Printer, 1967), 101.

5 McCrorie, *ARDA*, 34.

6 Donald J. Savoie, *Regional Economic Development: Canada's Search for Solutions*, 2nd ed. (Toronto: University of Toronto Press, 1992 [1986]); Antony John Lloyd, *Community Development in Canada* (Ottawa: St Paul University, Canadian Research Centre for Anthropology, 1967); Clyde Weaver and Thomas I. Gunton, "From Drought Assistance to Megaprojects: Fifty Years of Regional Theory and Policy in Canada," *The Canadian Journal of Regional Science/La Revue Canadienne des Sciences Régionales* V, no. 1 (1982): 5-37; R. Harley McGee, *Getting it Right: Regional Development in Canada* (Montreal: McGill-Queen's University Press, 1992); P. E. Bryden, "The Limits of National Policy: Integrating Regional Development into the National Agenda," *American Review of Canadian Studies* 37, no. 4 (Winter 2007): 475-491; Peter Aucoin and Herman Bakvis, "Organizational Differentiation and Integration: The Case of Regional Economic Development Policy in Canada," *Canadian Public Administration* 27, no. 3 (Autumn 1984): 348-371;

7 Hugh Shewell, "'Bitterness behind Every Smiling Face': Community Development and Canada's First Nations, 1954-1968." *Canadian Historical Review* 83, no. 1 (March 2002): 58-84; Will Langford, "Jean Lagassé, Community Development, and the "Indian and Métis Problem" in Manitoba in the 1950s-60s" *Canadian Historical Review* 97, no. 3 (September 2016): 346-376. David Quiring, ''From the Bush to the Village in Northern Saskatchewan: Contrasting CCF Community Development Projects,'' *Journal of the Canadian Historical Association* 17, no. 1 (2006): 151–78.

8 Raymond B. Blake, *Lions or Jellyfish: Newfoundland-Ottawa Relations since 1957* (Toronto: University of Toronto Press, 2015); Miriam Wright, *A Fishery for Modern times: The State and the Industrialization of the Newfoundland Fishery, 1934-1968* (Don Mills: Oxford University Press, 2001); Hugh Shewell, "'Bitterness behind Every Smiling Face,'" 58-84; Will Langford, "Jean Lagassé, Community Development, and the "Indian and Métis Problem" in Manitoba in the 1950s-60s," 346-376; Anthony G. S. Careless, *Initiative and Response: The Adaptation of Canadian Federalism to Regional Economic Development* (Montreal: McGill-Queen's University Press, 1977); David Quiring, ''From the Bush to the Village in Northern Saskatchewan," 151–78; P. E. Bryden, "The Limits of National Policy," 475-491; James L. Kenny, "A New Dependency: State, Local Capital, and the Development of New Brunswick's Base Metal Industry, 1960-1970," *The Canadian Historical Review* 78, no. 1 (March 1997): 1-39; David M. Quiring, *CCF Colonialism in Northern Saskatchewan: Battling Parish Priests, Bootleggers, and Fur Sharks* (Vancouver: UBC Press, 2004); T. Stephen Henderson, *Angus L. Macdonald: A Provincial Liberal* (Toronto: University of Toronto Press, 2007).

9 A suggestive early effort in this vein by non-historians is Benjamin Higgins and Donald J. Savoie. "Canadian Regional Development at Home and Abroad: A Comparative Perspective," *Canadian Journal of Development Studies/Revue canadienne d'études du développement* 8, no. 2 (1987): 227-250. See also: Benjamin Higgins and Donald Savoie, *Les canadiens et le développement régional au pays et dans le Tiers-Monde/Canadians and regional development at home and in the Third World* (Moncton: Institut canadien de recherche sur le développement régional, 1988).

10 This working definition is informed by a number of sources and scholars, but particular acknowledgement is due to Tina Loo, "Missed Connections," 622-627. Scholarship by Canadian historians considering modernity in relation to resources management and development includes: Tina Loo, "People in the Way: Modernity, Environment, and Society on the Arrow Lakes," *BC Studies* no. 142/143 (Summer/Autumn 2004): 161-191; James L. Kenny and Andrew G. Secord, "Engineering Modernity: Hydroelectric Development in New Brunswick, 1945-1970 *Acadiensis* Vol. XXXIX, no. 1 (Winter/Spring 2010): 3-26. The focus on hydroelectric development in these two pieces can be usefully broadened in relation to other state-driven efforts of the era, such as ARDA.

11 Michel F. Girard, *L'Écologisme retrouvé: Essor et déclin de la Commission de la conservation du Canada* (Ottawa: Les Presses De L'Université D'Ottawa, 1994).

12 J. A. McKeague and P. C. Stobbe, *History of Soil Survey in Canada, 1914-1975* (Canada Department of Agriculture, 1978), 6; George Falconer, "Federal, Provincial, and Private Sector Thematic Mapping," *Mapping a Northern Land: The Survey of Canada, 1947-1994* in eds. Gerald McGrath and Louis Sebert (Montreal: McGill-Queen's University Press, 1999), 311.

13 Department of Forestry, "The Canada Land Inventory: Objectives, Scope, Organization," no. 1 (Department of Forestry Publication no. 1088, 1965), 3; Darcy Ingram, "Governments, Governance, and the "Lunatic Fringe": The Resources for Tomorrow Conference and the Evolution of Environmentalism in Canada." *International Journal of Canadian Studies* 51 (2015): 69-96.

14 Samuel P. Hayes, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890-1920* (Cambridge: Harvard University Press, 1959); John Sandlos, "Nature's Nations: The Shared Conservation History of Canada and the United States," *International Journal of Environmental Studies* 70, no. 3 (2013): 358-371.

15 For another example of the importance of this intersection, consider the use of the first computer in Canada, housed at the University of Toronto, to carry out 1950s-era backwater calculations related to the St. Lawrence Seaway and Power Project. The episode is discussed in Zbigniew Stachniak and Scott M. Campbell, *Computing in Canada: Building a Digital Future* (Canadian Science and Technology Museum, Transformation Series 17, 2009), 33. For more on the St. Lawrence Seaway, see Daniel Macfarlane, *Negotiating a River: Canada, the US, and the Creation of the St. Lawrence Seaway* (Vancouver: UBC Press, 2014).

16 James C. Scott, *Seeing Like A State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998; Tina Loo, "High Modernism, Conflict, and the Nature of Change in Canada," *Canadian Historical Review* 97, no. 1 (2016): 34-58. Loo also offers in this piece a useful listing of works invoking high modernism published to that point by historians of Canada.

17 Benedict Anderson, *Imagined Communities: Reflections on the Origins and Spread of Nationalism* Rev. Ed. (London: Verso, 2016).

18 Loo, "High Modernism, Conflict, and the Nature of Change in Canada," 39.

19 William Rankin, *After the Map: Cartography, Navigation, and the Transformation of Territory in the Twentieth Century* (Chicago: University of Chicago Press, 2016), 2

20 Works on GIS's history and role include: Nicholas R. Chrisman, *Charting the Unknown: How computer mapping at Harvard became GIS* (Redlands: *ESRI Press,* 2006); N. Chrisman, "The risks of software innovation: A case study of the Harvard Lab," *The American Cartographer* 15, no. 3 (1988): 291–300; N. Chrisman, "Full-circle: More than just social implications of GIS," *Cartographica* 40, no. 4 (2005): 23–35; N. Schuurman, "Trouble in the heartland: GIS and its critics in the

1990s," *Progress in Human Geography* 24, no. 4 (2000): 569–90; Patrick McHaffie, "Surfaces: tacit knowledge, formal language, and metaphor at the Harvard Lab for Computer Graphics and Spatial Analysis" *International journal of geographical information science* 14, no. 8 (2000): 755-773; Mark Palmer and Robert Rundstrom. "GIS, internal colonialism, and the US Bureau of Indian Affairs." *Annals of the Association of American Geographers* 103, no. 5 (2013): 1142-1159; J. Coppock and D. Rhind, "The history of GIS" In *Geographical information systems: Principles and applications*, ed. D. Maguire, M. Goodchild, and D. Rhind (London: Longman, 1991): 21-43; T. Foresman, ed. *The history of geographic information systems: Perspectives from the pioneers* (Upper Saddle River, NJ: Prentice Hall, 1998); F. Harvey, "The social construction of geographic information systems," *International Journal of Geographic Information Science* 14, no. 8 (2000): 711–13; F. Harvey and N. Chrisman, "Boundary objects and the social construction of GIS technology," *Environment and Planning A* 30, no. 9 (1998): 1683–94. F. Harvey and N. Chrisman, "The imbrication of geography and technology: The social construction of geographic information systems." In *Geography and technology*, ed. S. Brunn, S. Cutter, and J. Harrington, Jr., (Dordrecht, The Netherlands: Kluwer Academic, 2004): 65–80.

21 Matthew W. Wilson, "New Lines? Enacting a Social History of GIS," *The Canadian Geographer / Le Géographe Canadien* 59 no. 1 (2014): 29–34; Matthew W. Wilson, *New Lines: Critical GIS and the Trouble of the Map* (Minneapolis: University of Minnesota Press, 2017).

22 Trevor J. Barnes, "The Geographical State: The Development of Canadian Geography," *Journal of Geography in Higher Education* 31, no. 1 (2007): 161-177; Dyce, "Canada between the photograph and the map," 69-84; Gerald McGrath and Louis Sebert, eds. *Mapping a Northern Land: The Survey of Canada, 1947-1994* (Montreal: McGill-Queen's University Press, 1999); John Warkentin and Paul Simpson-Housley, "The Development of Geographical Study in Canada, 1870-2000," in Gary Dunbar, ed. *Geography: Discipline, Profession and Subject since 1870* (Doredrecht: Kluwer Academic Publishers, 2001); Graeme Wynn, "Tracing One Warm Line Through a Land so Wide and Savage. Fifty Years of Historical Geography in Canada," *Historical Geography* 40 (2012): 5-32.

23 Information and Technical Services Division, *The Canada Land Inventory* (Canada Department of Forestry and Rural Development, 1966), 1

24 Department of Forestry, "The Canada Land Inventory: Objectives, Scope, Organization," no. 1 (Department of Forestry Publication no. 1088, 1965), 5.

25 Information and Technical Services Division, *The Canada Land Inventory* (Canada Department of Forestry and Rural Development, 1966), 1.

26 Vardalas, *The Computer Revolution in Canada*, 1.

27 Notably, my assertion is consistent with Vardalas' observation that technological innovation in a Canadian context has often stemmed from the "historically-specific interplay between the practitioners and the government." Vardalas, *The Computer Revolution in Canada*, 295. The historical significance of Canada's size has been explored in a provocative piece by Alan MacEachern. Alan MacEachern, "A Little Essay on Big: Towards a History of Canada's Size," in *Big Country, Big Issues: Canada's Environment, Culture, and History*, eds. Nadine Klopfer and Christof Mauch *RCC Perspectives* no. 4 (Rachel Carson Center, 2011): 6-15.

28 D.F. Symington, "Land Use in Canada: The Canada Land Inventory," (Canada Department of Forestry and Rural Development, 1968), 7-9.

29 R. J. McCormack, *Foothills Resource Allocation Study: A Land Use Planning Case Study* (Canada Land Inventory Program, Agricultural Rehabilitation and Development Act, 1972), 6.; D.F. Symington, "Land Use in Canada: The Canada Land Inventory," (Canada Department of Forestry and Rural Development, 1968), 6.

30 D.F. Symington, "Land Use in Canada: The Canada Land Inventory," (Canada Department of Forestry and Rural Development, 1968), 6.

31 Benjamin Higgins and Donald Savoie, *Regional Development Theories & Their Application* (New Brunswick: Transaction Publishers, 1995), 284.

32 Quotation from Donald Wright, *The Professionalization of History in English Canada* (Toronto: University of Toronto Press, 2005), 5. See also Marlene Shore, *The Science of Social Redemption: McGill, The Chicago School, and the Origins of Social Research in Canada* (Toronto: University of Toronto Press, 1987); Hugh Shewell, "'What Makes the Indian Tick?' The Influence of Social Sciences on Canada's Indian Policy, 1947-1964," *Social History/Histoire Sociale* vol. XXXIV, 67 (May 2001): 133-167; Douglas Owram, *The Government Generation: Canadian Intellectuals and the State* (Toronto: University of Toronto Press, 1986).

33 Roger E. Backhouse and Philippe Fontaine, *The History of the Social Sciences Since 1945* (Cambridge: Cambridge University Press, 2010), 189. See also Carl E. Schorske, "The New Rigorism in the Human Sciences, 1940-1960," *Daedalus* 126, no. 1 (Winter 1997): 289-309.

34 R. C. Hodges, "The Role of Special Maps in the National Economy," *The Cartographer* 2, no. 2 (1965): 73.

35 Ian Burton, "The Quantitative Revolution and Theoretical Geography," *The Canadian Geographer* 7 (1963): 15-18. For additional context on the quantitative revolution in the discipline of geography, see Trevor J. Barnes "Retheorizing economic geography: from the quantitative revolution to the "cultural turn"" *Annals of the Association of American Geographers* 91, no. 3 (2001): 546-565.

36 Brian J. L. Berry, "Geography's Quantitative Revolution: Initial Conditions, 1954-1960. A Personal Memoir," *Urban Geography* 14, no. 5 (1993): 441.

37 Trevor J. Barnes, "The Geographical State," 161-177.

38 Hare, "The Re-Exploration of Canada," 85-88.

39 Department of Forestry, "The Canada Land Inventory: Objectives, Scope, Organization," no. 1 (Department of Forestry Publication no. 1088, 1965), 4

40 Sustainable Development Branch, "Making a Difference: the Canada Land Inventory," Fact Sheet 88-5 (Canadian Wildlife Service, Environment Canada, 1988): 2; Department of Forestry, "The Canada Land Inventory: Objectives, Scope, Organization," no. 1 (Department of Forestry Publication no. 1088, 1965), 3.

41 W. E. Rees, *The Canada Land Inventory in Perspective*, Canada Land Inventory report # 12, March 1977, 3; Kathryn Harrison, *Passing the Buck: Federalism and Canadian Environmental Policy* (Vancouver: UBC Press, 1996), 72.

42 Department of Forestry, "The Canada Land Inventory: Objectives, Scope, Organization," no. 1 (Department of Forestry Publication no. 1088, 1965), 3.

43 D.F. Symington, "Land Use in Canada: The Canada Land Inventory," (Canada Department of Forestry and Rural Development, 1968), 11.

44 Department of Forestry, "The Canada Land Inventory: Objectives, Scope, Organization," no. 1 (Department of Forestry Publication no. 1088, 1965), 3.

45 D.F. Symington, "Land Use in Canada: The Canada Land Inventory," (Canada Department of Forestry and Rural Development, 1968), 11-12.

46 "Geographic Information System of the Canada Land Inventory Users' Manual, Working Outline No. 3, 7 November 1966, p. 3, File e011062662, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC. Underlining in original.

47 Ibid., p. 8-12.

48 Ibid., p. 11.

49 Canada Land Inventory, *Technical Work Meetings, Edmonton, Alberta - Amherst, Nova Scotia: Sector Reports* (Canada, 1964), 4.

50 Department of Regional Economic Expansion, "The Canada Land Inventory: Objectives, Scope, and Organization," no. 1, 2nd ed. (Department of Regional Economic Expansion, 1970), p. 5; George Falconer, "Federal, Provincial, and Private Sector Thematic Mapping," 316.

51 J.A. McKeague and P. C. Stobbe History of Soil Survey in Canada 1914-1975. Historical Series No. 11. Soil Research Institute. Research Branch. Agriculture Canada (Ottawa: Agriculture Canada, 1978), 23.

52 The Canada Land Inventory, *Soil Capability Classification for Agriculture*, no. 2 (Department of the Environment, 1965 [reprinted 1969 and 1972]), 9-10.

53 Canada Land Inventory, *Technical Work Meetings, Edmonton, Alberta - Amherst, Nova Scotia: Sector Reports* (Canada, 1964), 1.

54 J. Alexander Burnett, *A Passion for Wildlife: The History of the Canadian Wildlife Service* (Vancouver: UBC Press, 2003), 153.

55 Land Use Section, Agricultural Rehabilitation and Development Administration, *Economic and Social Disadvantage in Canada* (Canada Department of Forestry, 1964).

56 Scholarship involving direct attention to natural-resources management and jurisdiction includes: Kathryn Harrison, *Passing the Buck*; G. Bruce Doern and Thomas Conway, *The Greening of Canada: Federal Institutions and Decisions* (Toronto: University of Toronto Press, 1994); J. Owen Saunders, ed. *Managing Natural Resources in a Federal State* (Toronto: Carswell, 1986); Shannon Stunden Bower, *Wet Prairie: People, Land, and Water in Agricultural Manitoba* (Vancouver: UBC Press, 2011); Works by historians on mid-twentieth century federalism more generally include: Dimitry Anastakis and P. E. Bryden, eds. *Framing Canadian Federalism* (Toronto: University of Toronto Press, 2009); Barry Ferguson and Robert Wardhaugh, " 'Impossible Conditions of Inequality': John W. Dafoe, the Rowell-Sirois Royal Commission, and the Interpretation of Canadian Federalism," *Canadian Historical Review* 84, 4 (December 2003): 51-584; Raymond Blake, "Politics and the Federal Principle in Canada: Newfoundland Offshore Oil Development and the Quest for Political Stability and Economic Justice," *The Canadian Historical Review* 96, 1 (March 2015): 33-60; Raymond B. Blake, "Canada, Newfoundland, and Term 29: The Failure of Intergovernmentalism," *Acadiensis* XLI, 1 (Winter/Spring 2012): 49-74; Raymond B. Blake, *Lions* or Jellyfish; P. E. Bryden, *"A Justifiable Obsession": Conservative Ontario's Relations with Ottawa, 1943-1985* (Toronto: University of Toronto Press, 2013); P. E. Bryden, "'Pooling our Resources,'" 401- 418; P. E. Bryden, "The Limits of National Policy," 475-491.

57 R. J. McCormack, "Interim Report on Progress and Use: Canada Land Inventory, Department of Regional Economic Expansion," May 1970, File 551-3-0, volume 814, RG 39, LAC.

58 William W. Warren, "The Development and Utilization of the Canada Land Inventory," (Master of Arts thesis, University of Alberta, 1979), 90, 98.

59 W. E. Rees, "The Canada Land Inventory in Perspective," no. 12 (Fisheries and Environment Canada, Lands Directorate, March 1977), 4-5.

60 Canada. National Committee on Forest Land. Sub-committee on Multiple Use. *Toward Integrated Resource Management* (Department of Regional Economic Expansion, 1970), 13.

61 P. J. B. Duffy, "Information Details: Canada Land Inventory", 6 May 1970, File 551-3-0, volume 814, RG 39, LAC.

62 Department of Forestry, "The Canada Land Inventory: Objectives, Scope, Organization," no. 1 (Department of Forestry Publication no. 1088, 1965), 4.

63 W. E. Rees, "The Canada Land Inventory in Perspective," 9-10.

64 Perrin Selcer, "Fabricating Unity: The FAO-UNESCO Soil Map of the World," *Historical Social Research* 40 (2015): 174-201.

65 Memorandum to the Cabinet: Canada Land Inventory, 9 March 1972, File 4010_03_5, Volume 4952, RG 19-F-2, LAC.

66 Memorandum from D. R. Redmond to Members of the Land Resource Survey Committee, 22 May 1970 and attached resolution, File 551-3-0 [1], volume 814, RG 39, LAC.

67 W. E. Rees, "The Canada Land Inventory in Perspective," 15.

68 Warren, "The Development and Utilization of the Canada Land Inventory," 116-117.

69 C. F. Bentley, *Agricultural Land in Canada: Quality, Quantity and Preservation* (University of Alberta, 1982), 3.

70 C. F. Bentley, *Western Canadian Agriculture – The Land and People Resource Base* (Canada West Foundation, 1980), 2.

71 Canada Land Inventory, "Land Capability for Agriculture: Preliminary Report," no. 10 (Environment Canada, Lands Directorate, 1976, [reprinted 1977 and 1978]), 13.

72 L. E. Pratt, "Opening Remarks," Canada Land Inventory, Technical Work Meetings, Sector Reports, November 1964, 1-2.

73 R. J. McCormack, Canada Land Inventory: Interim Report on Progress and use, Department of Regional Economic Expansion, Ottawa, May 1970, File 551-3-0, volume 814, RG 39, LAC.

74 E. A. Poyser, Provincial ARDA Co-ordinator Manitoba, to R. M. Connelly, Regional Director Indian Affairs Manitoba, 3 June 1966, File 578D22/19-2-9, Economic Development – Canada Land Inventory, 1966-05-01 – 1966-6-30, vol. 01, Box 4, RG 10, Indian and Inuit Affairs, LAC.

75 Hugh Shewell, "'Bitterness behind Every Smiling Face,'" 58-84.

76 Canada Land Inventory, *Land Capability Classification for Outdoor Recreation*, no. 6 (Canada Department of Regional Economic Expansion, 1969), 10-11.

77 Tina Loo, *States of Nature: Conserving Canada's Wildlife in the Twentieth Century* (Vancouver: UBC Press, 2006), 7.

78 W. A. Benson to R. J. McCormack, 12 January 1970, File 551-3-0, volume 814, RG 39, LAC.

79 David M. Gierman, *Survey of User Requirements for Land Use Data: Canada Land Use Monitoring Program*," Working Paper no. 15 (Lands Directorate, Environment Canada, 1981), 4.; J. A. McKeague and P. C. Stobbe, *History of Soil Survey in Canada, 1914-1975* (Canada Department of Agriculture, 1978), 23.

80 Roger Tomlinson, "The Canada Geographic Information System," in Timothy W. Foresman, ed. *The History of Geographic Information Systems: Perspectives from the Pioneers* (Upper Saddle River: Prentice Hall, 1998), 24.

81 Don W. Thomson, *Skyview Canada: A Story of Aerial Photography in Canada*, Energy, Mines and Resources Canada (Ottawa: R. B. W. Canada, 1975), 78, 111-113, 156.

82 Roger Tomlinson, "The Impact of the Transition from Analogue to Digital Cartographic Representation, " *The American Cartographer* vol. 15, no. 3, July 1988, 253, file: e011067385, box: 2001738346, Ian Crain Collection, LAC.

83 Roger F. Tomlinson and Michael A. G. Toomey, "GIS and LIS in Canada" in *Mapping a Northern Land: The Survey of Canada, 1947-1994* in ed. Gerald McGrath and Louis Sebert (Montreal: McGill-Queen's University Press, 1999), 467-468.

84 Roger F. Tomlinson, "An Introduction to the Use of Electronic Computers in the Storage, Compilation and Assessment of Natural and Economic Data for the Evaluation of Marginal Lands," Presented to the National Land Capability Inventory Seminar, 29-30 November 1962, 8, file e011062652, Ian Crain Collection, LAC.

85 R. F. Tomlinson, H. W. Calkins, D. F. Marble, *Computer Handling of Geographical Data: An Examination of Selected Geographic Information Systems* (The UNESCO Press, Natural Resources Research XIII, 1976), 40, 31.

86 "The Canada Geographic Information System," 2, File e011062658, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

87 Vardalas, *The Computer Revolution in Canada*, 168.

88 Spartan Air Services Ltd, "Feasibility Report of Computer Mapping System," 8, file e011062673, box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

89 Spartan Air Services Limited, "ADP Methodologies and Techniques for Processing Military Geographic Intelligence," June 1967, 38, file e011062663, box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC; R. F. Tomlinson, "An Introduction to the Geo-Information System of the Canada Land Inventory," (Canada, Department of Forestry and Rural Development, 1967), 8.

90 Roger Tomlinson, "The Canada Geographic Information System," in Timothy W. Foresman, ed. *The History of Geographic Information Systems: Perspectives from the Pioneers* (Upper Saddle River: Prentice Hall, 1998), 30.

91 Jean Thie, W. A. Switzer, N. Chartrand, "The Canada Land Data System and Its Application to Landscape Planning and Resource Management," Invited paper presented at the International Symposium on Landscape Information Systems, 9-10 March 1982, Germany, 5. File e011062639, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

92 Terry Fisher and Connie MacDonald, "An Overview of the Canada Geographic Information System (CGIS)" in Canada Land Data Systems Selected Papers I, 1979-1980, 4, File E011062636, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

93 Michael F Goodchild, "GIS and Geographic Research," in John Pickles, ed. *Ground Truth: The Social Implications of Geographic Information Systems* (New York: Guilford Press, 1995), 37.

94 Canada Geographic Information System Managerial Overview Appendicies [sic], January 1975, 4-5, file e011062660, box 2001738346, Ian Crain Collection, LAC.

95 W. A. Switzer, "Application of a Geo-Processing System to Handling Ecological Data," in *Proceedings of the Ecological Data Processing and Interpretation* Workshop, November 1980, 55.

96 Brian J. L. Berry, "Data Co-Ordination Methods Proposed for the Canada Land Inventory: An Assessment," 23 August 1964, 14, file e011062653, box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC; See also letter from Brian Berry: Brian J. L. Berry to L. E. Pratt, 23 August 1964, file e011062672, box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC; Also note that at least one of Berry's students briefly joined the project: R. F. Tomlinson, "The Impact of the Transition from Analogue to Digital Cartographic Representation," *The American Cartographer* 13, no. 3 (July 1988): 256, file e011067385, box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

97 Brian J. L. Berry, "Data Co-Ordination Methods Proposed for the Canada Land Inventory: An Assessment," 23 August 1964, 15, file e011062653, box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

98 Warren, "The Development and Utilization of the Canada Land Inventory," 90.

99 Jean Thie, W. A. Switzer, N. Chartrand, "The Canada Land Data System and Its Application to Landscape Planning and Resource Management," Invited paper presented at the International Symposium on Landscape Information Systems, 9-10 March 1982, Germany, 3. File e011062639, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

100 Roger Tomlinson, "A Geographic Information System for Regional Planning," in *Land Evaluation* ed. George Stewart (Melbourne: MacMillan, 1968), 200-210; For earlier usages, see Nick Chrisman, *Charting the Unknown: How Computer Mapping at Harvard Became GIS* (Redlands: ESRI Press, 2006), 17, fn 30.

101 W. Switzer, "The Canada Geographic Information System," 23-24, file e011062677, box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

102 Jean Thie, W. A. Switzer, N. Chartrand, "The Canada Land Data System and Its Application to Landscape Planning and Resource Management," Invited paper presented at the International Symposium on Landscape Information Systems, 9-10 March 1982, Germany, 3. File e011062639, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

103 Department of Regional Economic Expansion, Third Annual Meeting of the Provincial Canada Land Inventory Co-Ordinators, (no date), File 551-3-0, volume 814, RG 39, LAC.

104 Warren, "The Development and Utilization of the Canada Land Inventory," 313.

105 Brian J. L. Berry, "Data Co-ordination Methods Proposed for the Canada Land Inventory: An Assessment," 23 August 1964, 1, file e011062653, Box 2001738346, R-13742-0-2-EBAN, LAC; Alberta, Land Use Forum, *Report and Recommendations*, Sessional Paper 503/76, tabled 8 March 1976, 221.

106 P. J. B. Duffy to N. Sprout, 17 December 1969, File 551-3-0, volume 814, RG 39, LAC.

107 Warren, "The Development and Utilization of the Canada Land Inventory," 126-27.

108 Ibid. 501-02.

109 Ibid. 502.

110 Spartan Air Services, *Data for Decision-Makers: Introduction to the Geo-Information System of the Canada Land Inventory* (Ottawa: May 1967), p. 57. File e011062651, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC. Underlining in original.

111 Ibid., 21.

112 Janine Brodie, *The Political Economy of Canadian Regionalism* (Toronto: Harbourt Brace Jovanovich, 1990); Janine Brodie, "The New Political Economy of Regions," in Wallace Clement, ed. *Understanding Canada: Building on the New Canadian Political Economy* (Montreal: McGill-Queen's University Press, 1996): 240-261.

113 Notably, this circumstance seems to have persisted through at least the early 1990s, when Gail Langram presented a method she claimed would allow geographic information systems to, as she says in her preface, track "changes in an area by storing historic and anticipated geographic data." Gail Langran, *Time in Geographic Information Systems* (New York: Taylor & Francis, 1992).

114 Barnes, Trevor J. "Retheorizing economic geography: from the quantitative revolution to the "cultural turn"." *Annals of the Association of American Geographers* 91, no. 3 (2001): 557.

115 ARDA: Partners in Progress, Ministry of Forestry and Rural Development, Queen's Printer, 1966.

116 W. Switzer, "Canada Geographic Information System," 24, file e011062677, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

117 S. S. Reisman to Minister C. M. Drury, 9 January 1973, File 4010_03_5, Volume 4952, RG 19-F-2, LAC.

118 Jean Thie, W. A. Switzer, N. Chartrand, "The Canada Land Data System and Its Application to Landscape Planning and Resource Management," Invited paper presented at the International Symposium on Landscape Information Systems, 9-10 March 1982, Germany, 13. File e011062639, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

119 Roger F. Tomlinson, "Geographic Information Systems: A New Frontier," *The Operational Geographer/ La géographie appliquée,* no. 5 (1984): 36.

120 Roger F. Tomlinson and A. Raymond Boyle, "The State of Development of Systems for Handling Natural Resources Inventory Data," *Cartographica* 18, no. 4 (1981): 65-95. For more on this, see: Nick Chrisman, *Charting the Unknown: How Computer Mapping at Harvard Became GIS* (Redlands: ESRI Press, 2006), 164.

121 Hugh H. Calkins, "Information system developments in North America," *Proceedings of the Commission on Geographical Data Sensing and Processing*, ed. R. F. Tomlinson (International Geographical Union, 1977), 95.

122 Anderson, *Imagined Communities,* 184.

123 W. E. Rees, "The Canada Land Inventory in Perspective," 6.

124 Spartan Air Services, "Geographic Information System of the Canada Land Inventory Users' Manual," Ottawa, January 1967, 3. File e011062662, Box 2001738346, R-13742-0-2-EBAN, Ian Crain Collection, LAC.

125 For anthologies that offer some sampling from historians, see: Jennifer Bonnell and Marcel Fortin, eds. *Historical GIS Research in Canada* (Calgary: University of Calgary Press, 2014); Anne Kelly Knowles, *Placing History: How Maps, Spatial Data, and GIS Are Changing Historical Scholarship* (Redlands: ESRI Press, 2008).

126 Kenneth G. Brealey, "First (national) space:(Ab) original (re) mappings of British Columbia." PhD diss., University of British Columbia, 2002.

127 Loo, "High Modernism, Conflict, and the Nature of Change in Canada".