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WPSA Presentation

**The Measurement Challenge for Environmental Policy:
The Discursive Framing, Development and Usages of “Data for Sustainability”¹**

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1.0 Introduction

While the scope, volume and availability of data to assess the Earth's carrying capacity has increased significantly, there are a number of barriers to the use of such data, and their linkage to public policy. Barriers include (but are not limited to) a focus on sector-specific considerations and localized case studies, the growing complexity of data provision, and jurisdictional obstacles. These present significant challenges for understanding, modeling, and using environmental, community, economic and health data, and linking public policy, decision-making and practitioner perspectives with such empirical evidence. Despite the challenges, the role, nature and usage of such evidence are often considered within public policy, and particularly within public health and environmental policy. This paper is interested in understanding the state of sustainability data and integrated measurement approaches to sustainable development (in Canada in particular, but also globally), while delving deeper into the underlying premise of "evidence-informed public policy" to consider the discursive framing, and implications of, the "measurement challenge" raised by the Anthropocene. Recognizing the growing attention being paid to the (usually negative) impacts of human activity upon environment, society, and economy, this paper considers both the rhetorical and applied dimensions of "data for sustainability."

Focused specifically on the application of the paired concepts of carrying capacity and sustainability, this paper asks: How have measurement and subsequent data-driven activities, (ostensibly) intended to underpin public policy and action driven by the relationships between humans and their environment, emerged? What is the "landscape" and etymology of such data? How is the landscape derived from the policy and political contexts framing sustainability, sustainable development, and the severity of anthropogenic ecological change? Drawing from the results of a national (Canadian) scoping review and broader global assessment of the data, frameworks, literatures, and application of measuring "progress" within the Sustainable Development Goals, this paper argues that despite support for systems-based approaches to measurement, few models or examples of such approaches exist. Rather than being constructed or applied to support broader systemic change through political institutions and agencies, the indicators assessed ($n = 418$) and their usage are largely driven by political pragmatism, academic interest, localized priorities, and both policy and institutional inertia. We conclude that, particularly within the Canadian case, these results are: (1) ill-suited to the complexities of sustainability as a policy domain in the 21st Century; (2) consistent with the green-lite² and green-washing theses put forward by Doern, Auld and Stoney (2015); and, (3) consistent with an economic and political agenda that prioritizes the colonial and resource dependent agendas of both provincial and federal government.

After providing an overview of carrying capacity and sustainable development/sustainability, we outline the scoping review methodology and data analysis used

² Doern, Auld and Stoney (2015, 4) describe the state of federal environmental policies and influence in Canada as *green-lite*. The term "reflects the sub-optimal nature of federal stewardship from an environmental perspective and the tendency for other levels of government and the private and not-for-profit sectors to assume greater responsibility for environmental policy in the absence of strong and sustained federal leadership. It is also in part a reflection of the gap between federal and environmental discourse and rhetoric on the environment and the influence and impact of federal policies".

for this project. Next, the collected Canadian studies (n=46) are analyzed and common themes, biases and trends present throughout the literature are discussed. Lastly, an in-depth analysis of the 418 indicators identified from the 46 studies is provided. We assessed these results in light of Canada's policy history, environmental history and economic development priorities and distortional immobility. After a discussion of the findings is presented, the conclusion addresses the green-lite and green-washing theses put forward by Doern, Auld and Stoney (2015). The conclusion speaks directly to the main thesis of the paper, that the state of sustainability measurement and carrying capacity in Canada, is resonant with the green-lite theses about environmental policy in Canada. Specifically, the data are consistent with a policy context/design wherein federal and provincial governments continue to prioritize resource development and extraction, strong political leadership and integrative mandates are lacking, and environmental policy is disparate and weakly enforced. These characteristics reinforce the low probability of policy and institutional change including the low likelihood of additional uptake and reporting on sustainable development reporting since doing so is not in the interest of institutional priorities.

2.0 The Concepts: Carrying Capacity and Sustainability

The concepts of carrying capacity and sustainable development or sustainability are used interchangeably throughout this paper. These concepts, while having different origins, have been conflated in the literature and measurement approaches since the late 1990s. An extensive review of the terms "carrying capacity and sustainable development" and "carrying capacity and sustainability" was published in 2021 (Gao, Fang, and Cui 2021). A collection of 897 records from 1985-2020 demonstrated that the number of publications and citations that merge these two concepts has significantly increased over time, experiencing an explosion of interest in 2009-10 and reaching a historic high in 2020 (Gao, Fang, and Cui 2021, 3). Below, the origins, uses, and common definitions of carrying capacity and sustainable development or sustainability are provided.

Most discussions and conceptions of carrying capacity originate from *An Essay on the Principle of Population* (Malthus 1986). Malthus argued that while human population growth is exponential, food production is limited to arithmetic growth. Food supply presents a simple yet fundamental limit to population growth (Manning 2007). Following the growth of both environmental social consciousness, as well as different environmental movements and scholarship through the 1960s and 70s (Dryzek 2013; Meadows et al. 1972; Ehrlich 1969), Malthus' ideas about limits to growth became foundational to environmental management, as did increasing awareness of ecological degradation, economic growth, and rapidly expanding populations (Seidl and Tisdell 1999). Over the past four decades, understandings of carrying capacity have evolved and it became more widely accepted that the concept is a normative and value-laden idea that is mediated by social, institutional and cultural issues (Manning 2007). Today, "the term carrying capacity is applied extensively, but imprecisely" across disciplines and subjects, "from humans, to wildlife populations, to ecosystems and even to the whole Earth" (Monte-Luna et al. 2004, 486).

Attempting to balance economic development, environmental protection, and social equity, sustainable development or sustainability is commonly defined as "the ability to meet

current needs and aspirations without compromising future needs” (WCED 1987; Gao, Fang, and Cui 2021, 1).³ This definition comes from the Brundtland report published by the United Nations in 1978 (WCED 1987). Since then, this “vague and imprecise” definition has been applied widely and scholars contend that the “exact meaning of sustainable development remains unclear” (Ross 2009, 34; Parris and Kate 2003). The vagueness and malleability of sustainable development as a concept contributed to its success as a policy tool which, without any central or agreed upon meaning, can be applied to any context without much consequence (Ross 2009, 34). Waas et al. (2011, 1656) expand, stating that sustainable development “continues to be misunderstood and interpreted somewhat randomly amongst individuals, organizations and governments, often in favor of one’s own agenda and interests. This is arguably one of the reasons that little progress has been made in the practical implementation of its original meaning, and why in many cases social and environmental situations have deteriorated.”

Over time, carrying capacity was added into the mix of concepts aligned with sustainable development and evolved as an “operational tool for sustainable development” (Gao, Fang, and Cui 2021, 3). The concepts of sustainability and carrying capacity, which continue to be used widely and indiscriminately, became conflated. This is despite the fact that many interpretations of sustainable development “address neither the limits to the earth’s resilience nor our failure to curb consumption.” (Ross 2009, 32). For the purposes of this paper, which focuses on understanding how the complex relationship between the environment and Canadian society is (or is not) being measured, and the policy response to data measurement, the terms carrying capacity and sustainability or sustainable development are used interchangeably, as is consistent with the use of these terms across disciplines, research, policy, and practice.

3.0 Methods

This project utilized a scoping review method to assess the state of knowledge and usage of integrated carrying capacity measurement approaches primarily within Canada, but also globally, with a particular emphasis upon the linkages between ecological change, socioeconomic, demographic and health impacts. This included an articulation of the strengths and gaps in the carrying capacity assessment and frameworks literatures, and the identification of better practices in support of improved data, measurement, the state, scope and biases of how carrying capacity is measured, and policy uptake and performance at local, regional and provincial levels in Canada. Synthesizing the scope and methods of such initiatives, this project sought to understand how sustainability and/or carrying capacity is being measured in Canada, and connect the findings regarding what is being measured, how, and by whom, to questions of

³ This project is consistent with other scholarship that uses the terms sustainable development and sustainability interchangeably, as “there is no universal conceptual difference between sustainable development and sustainability” (Gao, Fang, and Cui 2021, 1; see also Waas et al. 2011).

how, and why, those assessment frameworks might support (or not support): (a) evidence-informed policy and decisions; and (b) performance change within public policy itself.

The scoping review was based on the framework outlined by Arksey and O'Malley (2005) and involved six stages: (1) Identifying the research question; (2) Identifying relevant studies; (3) Study selection; (4) Categorizing the studies; (5) Summarizing and reporting findings; and (6) Consulting. This review took a comprehensive approach to environment, community and health data, indicator and similar framework-based strategies by searching for relevant materials in Google, Google Scholar, JSTOR, and databases such as Web of Science and Scopus that are available through the University of Alberta and University of Lethbridge. Quantitative and qualitative studies were considered, from peer-reviewed academic journals, dissertations, and conference papers, to government documents, organizational reports, and handbooks. The review was limited to English language materials that were published in the last 10 years. Particular attention was paid to articles and studies describing integration across multiple themes of carrying capacity or sustainability such as ecological, health, socio-demographic, and/or economic themes. In an effort to conduct a broad search of the literature, a number of search terms were used in varying sequences, including, but not limited to: Earth's human carrying capacity; measuring carrying capacity; global health and carrying capacity; ecological and health carrying capacity frameworks; carrying capacity in Canadian cities; sustainable development in Canada; social carrying capacity; ecological footprint analysis; social sustainability framework; Canadian health index; population health in the Anthropocene; measuring social determinants of health; and, cultural carrying capacity.

Once an initial database was established in the referencing software Endnote, duplicate studies were removed, resulting in the final inclusion of 46 Canadian studies,⁴ 18 (39.1%) of which were non-academic (grey literature, non-peer-reviewed) studies and 28 (60.9%) were academic (peer-reviewed) articles. The studies were categorized in an Excel spreadsheet by source and catalogued by year published, authors, scale of analysis (local, regional, national, or global) and geographic focus, to provide ease of storage and citation of the studies. Each study was further assessed according to the themes addressed within the text (whether ecological, health, socio-demographic, and/or economic themes, or some combination of these four) and the focus/intention provided for the research (if the literature addressed general theoretical or methodological knowledge of carrying capacity measurements, and/or carrying capacity modelling, frameworks, metrics, indicators, data collection, or a combination). The inventory and analyses also included the parameters for the data and data sets being used or referenced, including the source of the data. For studies where data was utilized and could be accessed, the sectoral themes (whether ecological, health, socio-demographic, and/or economic themes, or some combination of these 4) of the data used was charted.

This project also analyzed six of the studies that demonstrated an attempt to measure the relationship between Canadian society and the environment. They were identified as attempting to measure integrated carrying capacity across the five pillars of sustainability, which include social, environmental, health, community, and policy dynamics. These six studies

⁴ While this study was primarily focused on Canada, it also had an international component. In addition to the 46 Canadian studies identified, 63 international studies were also collected and analyzed, and are discussed in other reports.

were chosen for a number of reasons. Within the Canadian literature, only some studies included data, indicators, and/or measurements of any kind (n=25). The remaining studies were instead focussed on designing carrying capacity models or frameworks (n=21). While 18 studies were identified as focussed on the measurement of indicators, 12 were excluded because of their narrow scope or because they did not actually measure the indicators under investigation. These studies either proposed indicators for future study or talked about the process of measuring certain indicators, but did not actually conduct or include any data measurements. The remaining six studies are focussed on indicators, measure change within at least one of the five pillars of sustainability (environment, health, community, economy, and policy), and analyzed the indicators they discussed in the report. It is important to note that these six studies do not represent a complete inventory of indicators from the scoping review, but rather are examples of the measurement of integrated carrying capacity and sustainability in Canada.

These six studies provide an inventory of 418 indicators, the majority of which are unique to each study. Every indicator was assessed in terms of if indicators were single or aggregated measures, how indicators were being calculated and measured, the level of data collection and temporal unit used, and integration of each indicator across environment, health, community, economic, and policy themes. Aggregated indices were separated into their individual parts. For example, measurements of “greenhouse gases” were separated into the specific gases that were included, such as methane and carbon dioxide. Additional data documented for each indicator include the geographical level of data collection (was data collected at the national, regional, or local level?), the temporal unit of collection (was the data cross-sectional, longitudinal, etc.?), and finally whether or not the indicator fit into more than one sector (primary and secondary sectors were considered here). Among the five sectors, there were 37 indicator groups ranging from community-focussed themes like “education” and “infrastructure,” to environmentally-focussed data like “climate and temperature” and “household impacts.” A full list of the indicator groupings is available by request. This analysis was done to determine and analyze what indicators of carrying capacity and/or sustainability are being measured in Canada, how, by whom, and if these sustainability measures are being used in policy.

4.0 Analysis

This project found that while many different indicators are being measured within and across sectors in Canada, they are not necessarily that useful when considered as a collective. This is largely due to the lack of uniformity of, and patterns of differentiation between, the indicators being used. Below, an overview of the literature collected is provided, with an in-depth analysis of the 418 indicators following.

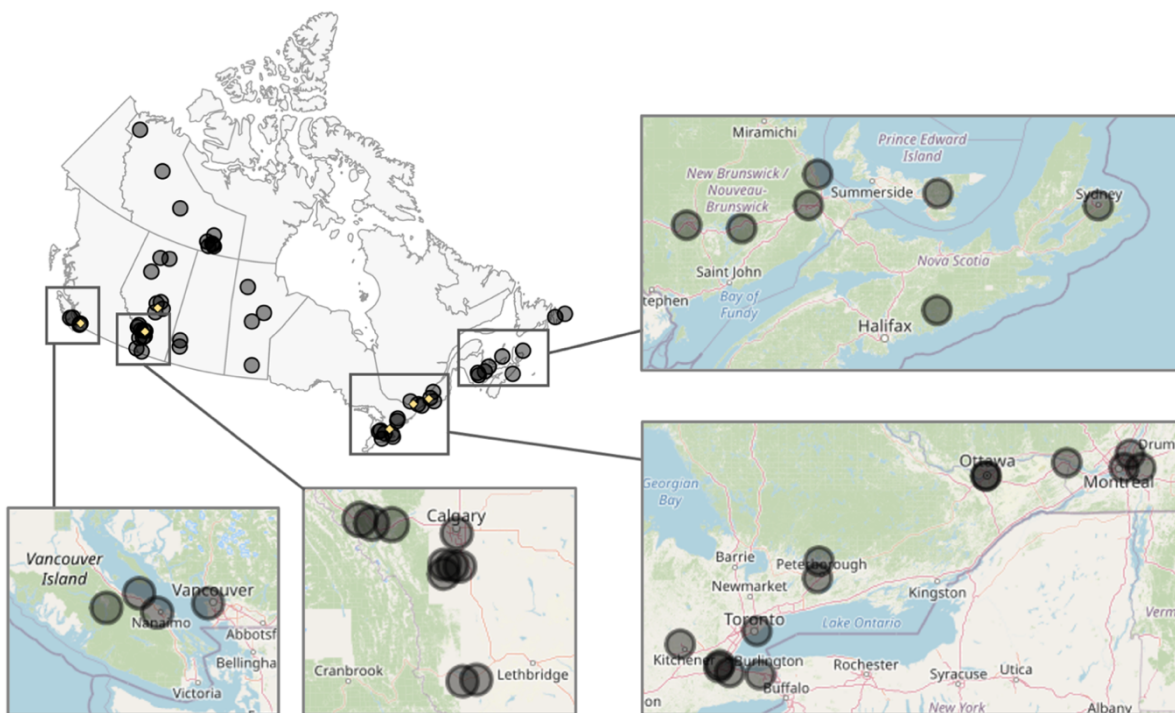
4.1 Canadian Literature

The 46 studies collected through this scoping review cover a broad range of topics, subject matter and study type. Thematically, the majority of the Canadian studies address ecology in some way (n=33), fewer are socio-demographic in theme (n=31), and health (n=23) and economics (n=16) are represented the least. The focus of these studies ranges widely within

these themes. For example, while some articles address carrying capacity in health systems and through social determinants of health at local, provincial and national levels (Wilson et al. 2009; Chateau et al. 2012; Lavergne and Kephart 2012; Gillingham, Halseth et al. 2016), others consider the sustainability of built infrastructure and land-use, particularly in cities (Berardi 2013; Mahmoud, Zayed, and Fahmy 2019; Vega-Azamar et al. 2016). However, despite the variety, there are a number of clusters and patterns that emerge regarding themes, integration, study topics, and sectoral focus.

Figure 1.0 provides the geographic distribution of the included Canadian studies (a full list of the reports by study location are available on request). The map demonstrates broader patterns of potential data or sampling bias, and identifies the areas where gaps in, and across, carrying capacity studies are present. For example, there are clusters of studies in key areas of ecological importance such as Banff in Alberta, Vancouver Island in BC, and the St. Lawrence Seaway in Ontario. The map is indicative of a strong urban bias, as well as a lack of study locations in the north, rural areas, and Indigenous communities across the country.

Figure 1.0: Canadian Study Locations



The academic literature (n=28) in Canada tends to focus at the micro and/or meso level, is very ecological and biodiversity-focused in subject matter and data, and is largely driven by disciplinary inquiry rather than broader concerns about anthropogenic effects. Environmental and ecological issues range in subject matter from studies at the cellular level, for example the effects of temperature on population rates in a phytoplankton species (Bernhardt, Sunday, and O'Connor 2017), to air quality, such as the contrasts in nitrogen dioxide and mortality in Canadian cities (Crouse et al. 2015), to animal species, for example the re-introduction of plains bison in Banff National Park (Steenweg et al. 2016). Coastal areas and sea life are particularly

common in this literature through studies of shellfish aquaculture (Guyondet et al. 2015) and the Fisheries Research Network (Mussells and Stephenson 2020). In these cases, the focus is almost solely on the interactions of non-human species with their environment. Orientated toward both the micro-level and unit of analysis, these studies do not generally consider the human-environment relationship. The research within these studies is often geographically restricted, based on a single and specific species within a specific ecosystem or sub-system, and is often focused on understanding variables that directly affect species populations.

Despite this focus on ecology within the academic literature, there are a few studies that assert that humankind is operating within the age of the Anthropocene, meaning that humans are drastically and permanently impacting the Earth's carrying capacity, which is limited. For example, the authors of *Health in the Anthropocene* (2020, p6) are:

“concerned with how humanity can learn to live well within the ecological constraints of a finite planet. [The authors] propose that this will not occur without fundamentally disrupting dominant feedback loops within our social-ecological systems; it is a process that can only be accomplished by radically reorienting our political economies, our cultures, and our communities.”

The studies in this group start from the assumption that humans must learn to live within the constraints of the Anthropocene. For example, Hancock, Desai and Patrick (2020, 184) discuss a framework for “one planet living” which combines ecological footprint analysis (“which relates consumption of resources to the amount of productive land and sea on the planet”) with the number of planets it might take to support different lifestyles. Other studies consider human psychological health in the Anthropocene (Bernard 2019) and health equity and planetary health through Indigenous knowledge systems (Ratima et al. 2019). One article argues that humans need to rethink their approach to the determinants of health in the Anthropocene, as the current focus on population health has largely become “ecologically blind” (Hancock 2015). Hancock (2015, 252) contends that “we need to rebalance population health promotion to provide a much greater focus on the ecological determinants of health, and on the eco-social interaction.”

The grey literature (n=18) is less defined by discipline or subject matter, and instead seeks a more holistic approach to sustainability or carrying capacity. Often, the studies are premised upon interpretations of sustainable development and utilize the United Nations Sustainable Development Goals (SDGs) as a model or framework. Defined in the literature as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs,” sustainable development assumes that humans can push the limits of carrying capacity (Tanguay et al. 2010, p407). Sustainable development asserts that because humans can use problem solving to push the limits of carrying capacity, often through improving equity, the economy can continue to grow, and consumption can continue to increase (Tanguay et al. 2010). A number of included studies consider the implementation and adoption of the SDGs within particular cities, such as Calgary (Keough 2020) and Winnipeg (PEG 2019), across particular populations, such as Indigenous peoples (NCCA 2018), or within the Canadian population as whole (Waterloo 2016). Other non-academic studies provide outlines or models that Canadian communities can adopt to progress national SDG implementation, such as “Generating SDG” (Ho and Runnalls 2018), “Progressing

National SDG Implementation” (Kindornay and Gendron 2020), and “Policy and Data Gap Assessments to Inform 2030 Agenda Implementation in Canada” (BCCIC 2019).

Work on sustainable development within this grey literature relies on discussions of environmental standards and pressures and equity considerations, rather than understanding the Earth’s carrying capacity as a universal constraint or limit. Within this literature, adaptation and resilience play a role in moving the limits to increasing population and consumption (including absorptive capacity) outward. For example, municipal projects such as the State of our City Calgary (2020) and the Peg (2019) in Winnipeg, attempt to explain and measure sustainable development within and across specific Canadian cities. The Peg explicitly explains the focus on equity, stating that “ending poverty goes hand in hand with strategies that build economic growth and address a range of social needs, including education, health, social protection and job opportunities, while tackling climate change and providing environmental protection” (PEG 2019, p3).

These results, particularly the difference between the academic and grey literatures, presents a challenge for systems level understandings of carrying capacity and sustainability in Canada. Academic research (that is peer-reviewed and produced through academic publishing channels such as an academic journal or university press) is not only more methodologically sound and rigorous than grey literature (which is produced outside of traditional, academic publishing channels and is not peer-reviewed by other academics or experts in the field), but the work (and subsequent data management, access, etc.) are often funded by the government at a large scale. Funding systems may be failing to make crucial connections between local and global processes, as one specific challenge for such focused academic researchers is “to understand how changes at the local and national scale relate to global-scale changes and how, in turn, their research can inform policies and programs at these lower scales that will attenuate environmental impacts at all levels” (de Sherbinin et al. 2007, p364).

4.2 Indicator Analysis

In order to assess how integrated measurement approaches were being applied in Canada, the collected studies were analyzed for their effort to measure the integrated and complex relationship between Canadian society and the environment in a holistic manner. Six reports were identified as demonstrating an attempt to measure carrying capacity in Canada across the five pillars of sustainability, which include social, environmental, health, community, and policy dynamics. Table 1.0 below provides an overview of the applied studies identified, including the number of sectors and subsectors considered, and the number of indicators included within, each study. Representing an overview of how the relationship between Canadian society and the environment is being measured, these studies all approach measurement through a sustainable development based framing of the human-environment relationship.

Table 1.0: Canadian Applied Studies

Canadian Study	Author/Date	Sectors	Subsectors	Number of Indicators
Learning From the Census: The Socio-economic Factor Index (SEFI) and Health Outcomes in Manitoba	Chateau et al., 2012	3/5	6/37	11
2019 Our City: A Peg Report on Winnipeg and the Sustainable Development Goals	The Peg, 2019	4/5	16/37	34
Canada 2030: An Agenda for Sustainable Development	Kindornay et al., 2015	5/5	25/37	137
How Are Canadians Really Doing? The 2016 CIW National Report	University of Waterloo, 2016	5/5	25/37	64
Achieving a Sustainable Future: A Federal Sustainable Development Strategy For Canada, 2019 to 2022	Environment Canada, 2019	1/5	9/37	130
2020 State of Our City Report	Keough, 2020	5/5	22/37	42

A number of general patterns were identified across the 418 indicators from the six studies. Overall, the grey literature contributed most to this inventory in terms of sheer number of measures identified and indicators reported. Academic sources contributed less as some reports studied only a small number of indicators. Only a handful of indicators out of the 418 were replicated across data sets. The indicators that were found multiple times throughout the broader group of 418 include:

- 27 indicators were labelled “self-reported” or “self-assessed”. These were usually survey responses to do with the health sector. These were often “self-reported physical/mental health” or another similar measure.
- Indicators assessing aid, such as Official Development Assistance (ODA) and Other Official Flows (OOF), occurred 8 times
- Indicators measuring income (demographic-based low-income measures) occurred 4 times

- Emissions data (CO₂, CH₄, N₂O, NO₂, SO₂) were all present in 4 data sets
- Measurement of body-mass index (BMI) occurred 3 times

In an effort to further assess and distill what is being measured, how, and by whom within these reports, this project examined the sectoral trends, single or aggregated nature, methods of measurement and calculation, scale and location, temporal data trends, and the presence of asset and liability measures across the 418 indicators present in the six studies. This analysis found that environmental indicators are the most common, the majority of the indicators are single measures (as opposed to indices), count data or a ratio are the most common method of indicator measurement utilized, the majority of the indicators are drawn from national surveys, data are most often collected annually, and asset measures (those measuring positive attributes and assessing strengths) are used most often.

Sectoral Trends

In total, environmental indicators are the most common, as they made up 179 of the total number of indicators. This is followed by community data with 106 indicators, then economy, which had 94. After this, there was a steep decline, with the health sector sitting at 28 indicators, and then the policy sector, with 16. In the environment sector, most indicators (44.63%) fall under the subsector of “water/air/land quality and wildlife.” The remaining 55.37% primarily fit into conservation efforts (12.43%), and presence of contaminants (harmful chemicals (14.69%). For the health sector, “overall health,” at 28.57%, was largely measured through self-reported survey-type questions, while the community sector’s most common subsector was “social capital,” at 47.16%. The economic sector was largely focused upon measuring “the broader market,” at 41.49% (which included GDP), while policy was mostly measuring “democratic process,” at 42.86%. See the Appendix for detailed results.

Single and Aggregated Indicators

While the majority of the indicators were single measures (for example, emissions of CO or O₃) a number of indicators were aggregated or calculated indices. The table below shows the number of indicators that were considered single or aggregate.

Table 2.0: Number of Single and Aggregated Indicators

	Frequency	Percent
Single	343	82.1%
Aggregate	75	17.9%
Total	418	100%

Methods of Measurement and Calculation

The majority of the indicators used count data or a ratio of some sort. There were other methods, particularly calculation of means, and, for economic variables, measurements in currency (dollars) or percentage of GDP, however, these were in the minority.

Table 3.0: Methods of Measurement for Indicators

Methods of Measurement	Frequency	Percentage
Count data	160	38.28%
Ratio	156	37.32%
Other (GDP, proprietary indexes, yes/no surveys, etc.)	73	17.46%
USD/CAD/Other currencies	29	6.94%
Total	418	100%

Scale and Location

The majority of the indicators (n=257) are drawn from nation-wide surveys. Two Canadian cities, Calgary and Winnipeg, are represented in every sector due to the city-wide studies conducted in these urban centers (see Keough 2020 and Peg 2019). Local and regional indicators make up a minority of the indicators, and there was no Canadian data focused exclusively on rural areas. Indicators identified as “other” include those measured globally, by industry, or where the locality of the data was not identified.

Table 4.0: Number of Indicators by Sector and Location

Primary Sector	Local	Regional	National	Other	Total
Environmental	18	19	93	45	175
Health	3	4	14	6	27
Community	18	2	81	4	105
Economy	20	0	60	0	80
Policy	0	1	9	3	13
Missing	-	-	-	-	18
Total	59	26	257	58	418

Temporal Data

In addition to questions of content and scale, indicators were also assessed from a temporal standpoint. Specifically, the temporal nature (cross-sectional, longitudinal, time series) and

frequency of collection for each indicator was catalogued. Most reports mentioned that their data was collected in yearly surveys, such as the Census and other national reporting surveys.

Table 5.0: Number of Indicators by Sector and Temporal Measurement

Primary Sector	Hourly	Daily	Monthly	Annually	Every 5 Years	Other	Total
Environment	14	3	4	153	1	0	175
Health	0	0	0	20	4	0	24
Community	0	1	0	99	2	3	105
Economy	0	0	0	80	0	0	80
Policy	0	0	0	9	1	1	11
Missing	-	-	-	-	-	-	23
Total	14	4	4	361	8	4	418

As seen in table 5.0 above, the majority of data, across all sectors, were collected annually, with environmental data also being collected at a more granular level (hourly, daily, monthly). Some indicators (8.61%, n=34) were measured using other units of time, primarily in the environmental sector, where several (n=14) indicators were measured on a continuous basis, noted and reported as hourly. These indicators primarily dealt with the monitoring of certain chemicals in air and water.

Asset and Liability Measures

Many indicators were “asset measures,” meaning they are measuring positive attributes and assessing strengths, like community faith in the democratic process or productive capabilities. As seen below, asset measures were the largest proportion of the economy and policy sectors. Liability measures are indicators that focus on measuring negative or harmful impacts. These were especially common in the environment sector. Some indicators fit in neither category, and were primarily survey response questions meant to assess the landscape or prevalence of a measure, such as self-rated health or life expectancy. These were the largest proportion of the health sector.

Table 6.0: Asset vs Liability Indicators by Sector

Primary Sector	Asset	Liability	Neither	Total
Environment	45	116	15	176
Health	9	9	10	28
Community	70	16	20	106
Economy	54	26	14	94
Policy	13	1	0	14
Total	191	168	59	418

4.3 SDG Audit

In an effort to further understand sustainability measurement in Canada, an audit of Canada’s reporting on the Sustainable Development Goals (SDGs) was undertaken. The SDGs are a set of 17 goals set with the intention of “provid[ing] a shar[ed] blueprint for peace and prosperity for the people and the planet, now and into the future” (United Nations 2022). The SDGs were compiled in order to help the UN reach goals outlined in the 2030 Agenda for Sustainable Development. Each goal has a number of targets, which help to track progress, and each target has a number of indicators which in turn track target progress. The complete list of indicators can be found on the UN’s webpage dedicated to the 2030 Agenda and the SDG goals, and is also available for the most part on a website dedicated to compiling the reporting data for the SDG indicators. The latter was used to conduct an investigation on Canada’s reporting practices to the UN regarding data collected for the SDG indicators.

There are 245 SDG indicators, many of which have a count data component and a ratio or percentage component, bringing the total number of reported indicators on the UN data tracking site to 488. Of note, several targets and their corresponding indicators are missing from the Canadian data collection. As well, in several spots data was shown as being reported, but no number was available⁵. These were counted as a year reporting, but noted as being unavailable.

*Table 7.0: Data Reporting?
Almost half of all indicators are not being reported to the UN by Canada.*

Reporting?	Count	Percentage
Yes (1)	260	53.3%
No (0)	228	46.7%

228 of 488 indicators show “no data to report”. There was at least one indicator with no data to report on every single goal, but most goals had several entire targets that were unavailable due to lack of data.

Most indicators were reported in just one year, providing only snapshot data about an indicator (see table 8.0 below). The year range was anywhere from 2000 to 2021, and many indicators with multiple years reporting were not reported in regular intervals. As well, certain multi-part indicators were not reporting each part of the indicator during every single year of reporting. These data issues contribute to an incomplete picture of Canada’s progress toward the SDGs. Where data on the SDG indicators is unavailable, it must be collected, and where available, it should be reported to the United Nations to provide a more complete data set.

⁵ N/A showing under the applicable year, meaning “non-relevant” and “data not available”. This is distinct from simply having no data to report, where a dash is shown in place of a number or letter code.

Table 8.0: Years Reporting?

How many years of reporting?	Count	Percentage
1	56	11.5
2	26	5.3
3	15	3.1
4	11	2.3
5	13	2.7
6	3	0.6
7	8	1.6
8	10	2.0
9	5	1.0
10	10	2.0
11	6	1.2
12	7	1.4
13	2	0.4
14	7	1.4
15	9	1.8
16	1	0.2
17	5	1.0
18	11	2.3
19	20	4.1
20	29	5.9
21	3	0.6
22	3	0.6

5.0 Findings

The literature, indicator, and data analysis above demonstrates that there is no comprehensive perspective on what an integrated understanding of carrying capacity and/or sustainability is in Canada, or how it can be measured and subsequently used to inform policy. Individuals, groups and governments across Canada appear to be measuring different aspects of the Earth's carrying capacity and/or sustainability inconsistently and within separate academic or disciplinary silos. Integrative approaches to measurement are encouraged in theory, but not carried out in practice or outlined in policy or legislation. Overall, the Canadian literature is largely focused on niche, nonhuman ecosystems. The majority of human-focused research is centred on understanding the specific and less the holistic realities of the human-planet relationship. The few projects that integrate ecological, economic, socio-demographic, and health impacts of carrying capacity, are largely community-based efforts that have not been peer-reviewed.

Despite widespread conceptual support for integrated approaches to carrying capacity, few practical solutions exist. Only 6 Canadian studies were identified as having the potential to measure the complex relationship between Canadian society and the environment in a holistic manner. An analysis of these studies and their 418 indicators finds that the bias in sheer number of indicators is clearly toward the environmental sector. Out of the six projects selected for detailed analysis of indicators, almost all authors had a majority of their indicators measuring the environmental sector, and two of the six focused exclusively on environmental variables. In total, environmental indicators made up 179 out of the total (n=418). 106 indicators are measuring issues related to community well-being and 94 indicators are measuring aspects of the economy. Only 28 and 16 indicators are measuring issues of health and policy (respectively). Further, the majority (82.03%) of the indicators are single indicators, focused on collecting data on one specific thing, and are not aggregated indices.

The evidence presented suggests that despite increased theoretical and methodological calls for improved integration within and across indicators, data sets, and measurement frameworks addressing human carrying capacity and sustainability, the mechanisms, and political support, to put this into practice are severely lacking. While many Canadian organizations and government initiatives are tracking and measuring change related to sustainable development, these efforts are largely disparate and uncoordinated, resulting in a collection of indicators that are inconsistent (Sanmartin et al. 2021). In addition, significant data gaps remain, regarding missing data for SDG reporting, and missing data from rural and northern communities across all of the frameworks identified. Measurement is inconsistent across the country, making it difficult, if not impossible, to benchmark or compare data. For example, out of the six studies analyzed, only a handful of indicators out of 418 were replicated across data sets.

6.0 Conclusion & Discussion

Inconsistent, non-comparable, and siloed by sector or discipline, sustainability measurement and data in Canada is ill-suited to an in-depth understanding of the complexities of the human-environment relationship/or and measuring sustainability in the 21st Century. The

evidence provided demonstrates that measurement approaches in Canada are driven by niche indicators, a focus on local systems, and a bias towards environmental and ecological data. Across Canada, individuals, groups and governments appear to be measuring what they want, and how they want, with little to no guidance from high-level policy goals. This has resulted in collection of disparate sustainability indicators and data sets that have not been collected in a standardized manner and thus cannot be used for comparison or integrative purposes. These findings are consistent with the green-lite and green-washing these put forward by Doern, Auld and Stoney (2015), and align with a Canadian political agenda that prioritizes resource development and export over other policy goals. This conclusion will examine these theses and provide a deeper understanding of the political discourse surrounding environmental policy in Canada.

Doern, Auld and Stoney (2015, 6) contend that Canada's performance on environmental policy has been "relatively modest and sometimes lagging." While some progress has been made, (for example, see the establishment of Environment Canada, Canadian leadership in early environmental summits and with some assessment processes, national parks, the Great Lakes, and the ozone layer) green-lite "as an empirically grounded concept" implies that in Canada, environmental progress "is still very much a struggle because of complexity in the overall Canadian environmental policy and governance system" (341). These complexities include: (1) Jurisdictional challenges, arguments, and differing opinions between municipal, provincial and federal governments; (2) Canada's reliance on the staples industries and the stakeholders involved, and Canada's resulting position as a resource exporter in the international economy; and (3) The changing and shifting positions of federal governments and ministers over time. Each of these challenges is explored in detail below.

(1) Multiple jurisdictions (municipal, provincial and federal), vast geography, and differing regions make it more difficult to garner consensus and agreement on any policy in Canada, and finding a balance between all relevant parties regarding resource management, promotion and regulation has always been an issue. For example, Environment-Canada was set up as the department with aspirations to be at the centre of environmental policy and progress. However, it's position was challenged from the outset by opposition or non-compliance from other federal departments and agencies, and provincial and local governments – both of which the ministry needs to collaborate with in order to garner compliance and enforce policy. Doern, Auld and Stoney (2015, 337-8) continue, stating that:

"Environment Canada's aspirations as a central agency and player has been shown to be subject to continuous pushback from other ministers and departments as overall agendas changed, including those centred on economic recessions and deficits, global free and fair trade, and Canada-US relations. Power structures, democracy, and governance also affected environmental policy when particular natural resource sectors gained ascendancy in certain periods, including forestry, fisheries, and oceans. However, rarely did these resources trump the consistent base of power of the oil and gas and electricity industries of the massive Alberta-centred oil sands industry."

(2) As a major exporter of staple resources (such as oil, food, fish, forest products, etc.), Canada is exposed to new and old forms of international pressure. Canada's role as an exporter of staple resources in the international economy means that "decisions being made through international supply chains by individual companies, collections of companies and multi-

stakeholder private regulatory initiatives are becoming critical venues shaping and sometimes surpassing the importance of Canada's public policy processes at both federal and provincial levels" (Doern, Auld and Stoney 2015, 14). This has resulted in industry-forward and supportive language and government systems. For example, the rhetoric within federal ministries has been about energy resources and resource promotion and use, rather than regulatory systems title with environmental terminology. In addition, environmental policies which seek to regulate industry are ambiguous, lack rigour, and/or go unenforced, international trade agreements put provisions for environmental policies in place, but can often be ignored if they present "a barrier to trade," and sustainable development or environmental considerations must be made, but not necessarily acted upon, by industry stakeholders (Doern, Auld and Stoney 2015, 342-5).

(3) While governments have differed on their appetite for environmental policy adoption and enforcement, overall, the environment has rarely held a prominent policy position within Canadian government. Environmental policy is largely a low-priority within thrown speeches, and there is a high turnover of environment ministers and mandates. Additionally, there is often a diverse and conflicting range of ministerial and government mandates regarding environmental policy across ministries and departments. The growing emergence of anti-science and anti-evidence forces and practices (particularly with the rise of the internet and social media) have also played a part in green-lite, as have governments (such as Prime Minister Harper's) that have muzzled their environmental scientists and mobilized communications to frame the conversation (Doern, Auld and Stoney 2015, 339).

Because of these challenges, in some cases, the Canadian state has become more of an observer and less of an actor in environmental politics. Rather, private networks, NGOs, and civil society have taken the lead and appealed to other governments or international bodies, such as the UN, on matters of environmental policy (Doern, Auld and Stoney 2015, 335-6). This is consistent with the findings on measurement approaches in Canada. As previously discussed, examples of holistic and integrative approaches to sustainability often come from NGOs, civil society and other localized community groups. Often, the studies utilize the United Nations Sustainable Development Goals (SDGs) as a model or framework. For example, a number of the studies consider the implementation and adoption of the SDGs within particular cities, such as Calgary (Keough 2020) and Winnipeg (PEG 2019), across particular populations, such as Indigenous peoples (NCCA 2018), or within the Canadian population as whole (Waterloo 2016). Other non-academic studies provide outlines or models that Canadian communities can adopt to progress national SDG implementation, see for example "Generating SDG: Empowering Canadians through Sustainable Development" (Ho and Runnalls 2018), "Progressing National SDG Implementation" (Kindornay and Gendron 2020), and "Policy and Data Gap Assessments to Inform 2030 Agenda Implementation in Canada" (BCCIC 2019).

In contrast, academic studies and research tends to take place at the micro-meso level and is largely driven by disciplinary factors rather than broader concerns about anthropogenic effects. This may be a result of research funding in Canada and how funding bodies (such as SSHRC/NSERC and CIHR) structure their call for proposals and parameters for successful grant applications. While the non-academic, grey-literature attempts to be more integrated, this does not mean that it is without its flaws. Because non-academic studies may not have access to the same resources, academic expertise, and academic review processes and standards, non-academic studies can face challenges with methodological rigour, analytic capacity, reporting,

and review. Instead of being directed by policy, sustainability measurement and data collection in Canada is driven by funding calls, curiosity, and the mandates of NGOs. This lack of high-level policy direction has significant consequences.

In the absence of any national targets and indicators, clear definitions of human carrying capacity and sustainability, and measurement and data collection standards, existing measurement approaches, indicators, and data sets are so disparate and fragmented that they are largely useless as tools for public policy. There are no high-level policy goals, standardized benchmarks, or integrative frameworks to facilitate an integrated, holistic understanding of the human-environment relationship in Canada. While the underlying environmental problem-solving discourse suggests that evidence and data can and should guide public policy, aiding in the government's response to wicked problems such as climate change, this assumption only works if there is a consistent and comprehensive framework to guide measurement and data collection, which is nonexistent in Canada today (Olive 2019).

This reality is consistent with Canada's profile as an environmental under-performer, that prioritizes resource extraction and production for economic benefit. Doern, Auld and Stoney emphasize the staying power of the staples base of the Canadian economy and Canadian capitalism. They assert that "the staples economy has reasserted itself in ways that have made it politically difficult in Canada to foster alternative energy sources and green industries" as "the resource sectors often provide a path of least resistance to some form of better economic future" (2015, 348). In this political context, while the literature points to gaps in Canadian policy and room for improvement, there is little uptake by government leaders or policy-making and an overall lack of knowledge concerning the issues. Despite the many policy-orientated solutions that have been put forward, economic growth and GDP continues to be the top policy priority for Canada, alongside many other governments across the globe, at the expense of an integrated understanding of carrying capacity which includes environmental, economic, health and socio-demographic data, measurements and indicators (Waterloo 2016).

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