

# Carrying Capacity Surveillance: Indicators and Frameworks for Equitable Sustainability



SSHRC  CRSH

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# Background

- Most discussions of carrying capacity reference Thomas Malthus' "An Essay on the Principle of Population" (Malthus 1986).
- This, along with the logistic growth equation (Verhulst 1838, Pearl and Reed 1920), describe how population interacts with limits to growth.

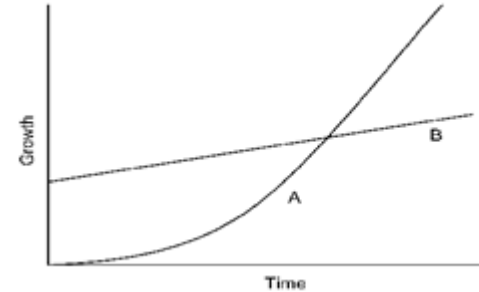


Figure 1.0: Malthus's Model of Exponential Population Growth (A) Versus arithmetic growth of food resources (B)

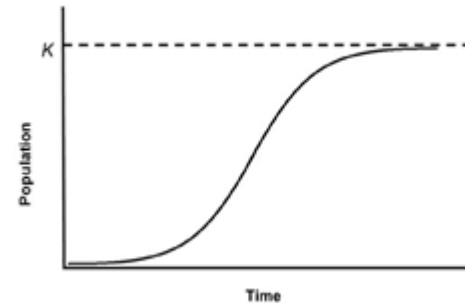


Figure 2.0: Logistic population growth curve

# Background

- Human carrying capacity is more complex than population vs. food supply (Seidl and Tisdell 1999).
- Numerous theories have emerged to account for this (deSherbinin et al. 2007):
  - Neo-Malthusianism,
  - Cultural Boserupianism, and
  - Political ecology.

## Project Objectives

This project:

- Assesses state of knowledge and usage of integrated carrying capacity measurement approaches
- Emphasizes linkages between ecological change, socioeconomic/demographic and health impacts.

# Research Questions

Utilizing a broadly comparative method, this project positioned that inventory and inter-sectoral catalogue against three core research questions:

1. How do contemporary data collection and measurement initiatives select, aggregate and represent key performance measures that link:
  - i. social,
  - ii. ecological,
  - iii. economic, and,
  - iv. population health changes?
  
1. How do such initiatives rise to the integration imperative, and specifically the modeling or representation of change (both positive and negative) within, and across, related sectors?
  
1. How are such initiatives positioned to inform decision-making and action, whether across private, public or third sectors?

# Knowledge Synthesis Objectives

1. Evaluate whether and how relevant indicator frameworks reflect balance or bias in meeting ecological, socioeconomic/demographic and health goals;
2. Assess the factors that facilitate implementation and uptake by policy actors in the Canadian context, with a particular focus upon application at the meso-level;
3. Mobilize knowledge to influence the knowledge, use and refinement/innovation of inter- sectoral carrying capacity indicator frameworks, indices and indicator suites via extant knowledge networks.

# Scoping Review – Methodology (Arksey & O'Malley 2005)

- 109 English language, academic and grey literature studies.
- Urban and regional bias.
- Gaps in study for rural, remote, and Northern communities.

Figure 3.0: Canadian Study Locations

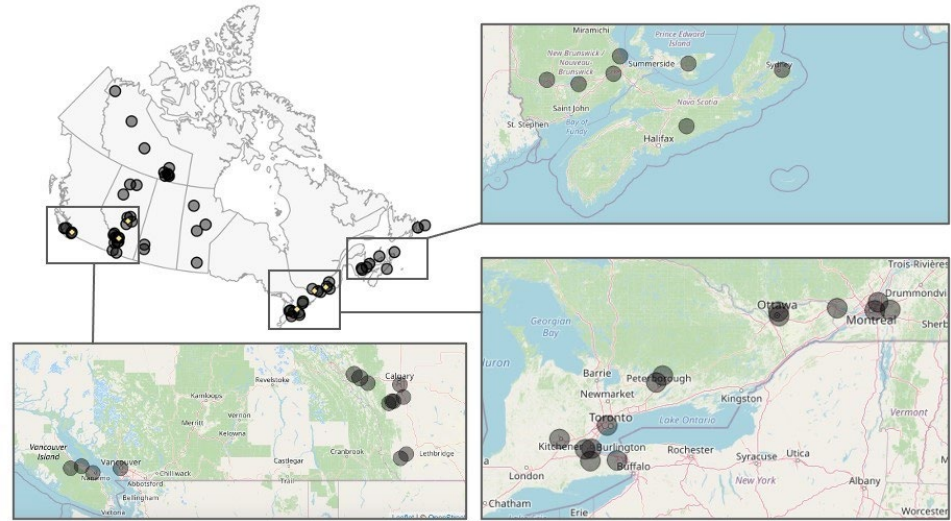


Table 1.0: Carrying Capacity Literature by Subject and Location

	Canadian Studies	Relative Comparator Studies	International Studies
Peer-Reviewed Academic Studies	28 (60.9%)	6 (85.7%)	49 (87.5%)
Non-Academic Studies	18 (39.1%)	1 (14.3%)	7 (12.5%)
<b>Total</b>	<b>46</b>	<b>7</b>	<b>56</b>

# Citation Network Analysis

Figure 2.0: Papers Cited-By Canadian Articles

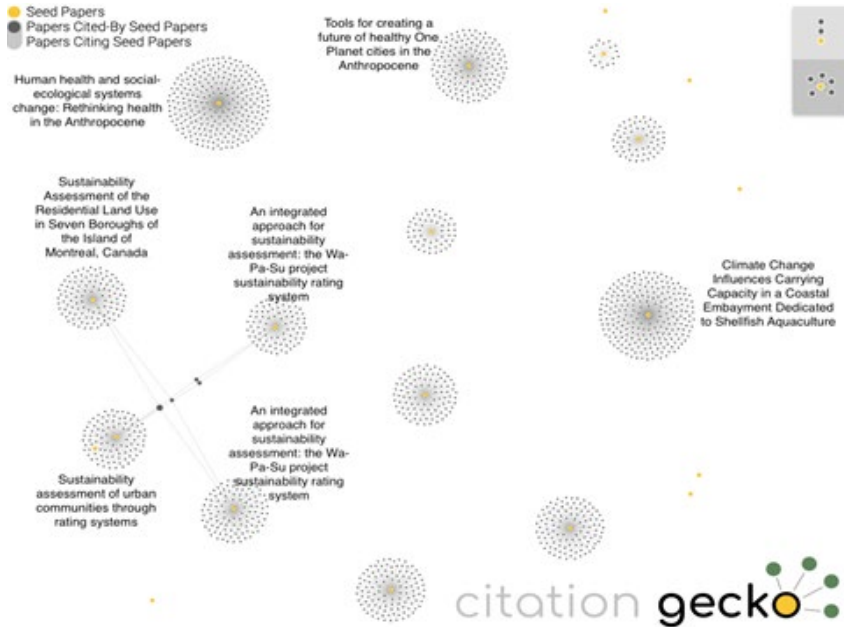
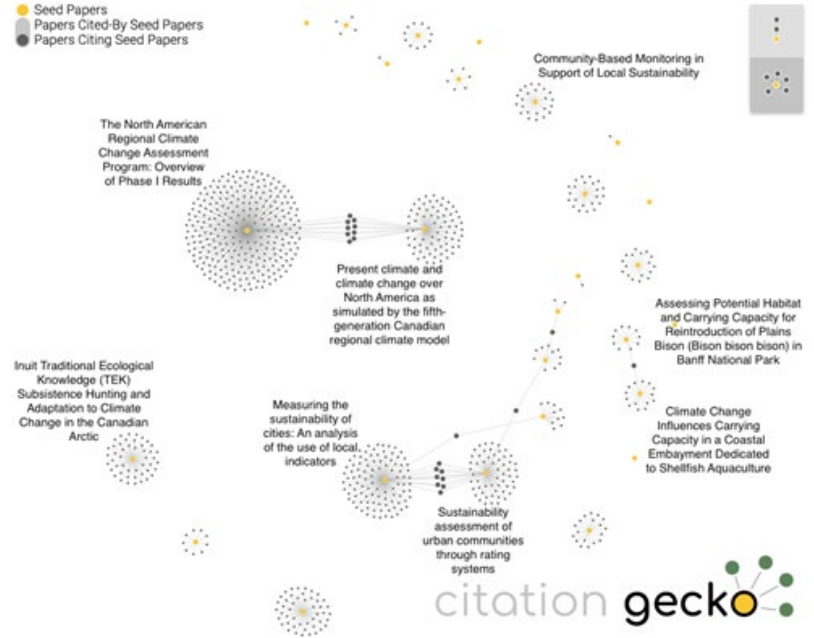


Figure 3.0 : Papers Citing Canadian Articles





# The literature as a whole...

- The majority (n=36) of Canadian literature can be classified as derived from political ecology.
  - Neo-Malthusian (n=3)
  - Cultural Boserupianism (n=7)
- Academic literature:
  - Focused on local areas/species.
  - Emphasis upon disciplinary factors rather than Anthropogenic effects.
- Grey literature:
  - Seeks a more integrated approach to carrying capacity.
  - Often uses the UN Sustainable Development Goals as a framework.
- Both have a strong ecological bias.

# Results: Thematic analysis of data utilization

- Many studies (n=47) do not explicitly use data.
  - This table only accounts for studies that do use data, and since many of them use more than one sector of data, the total number is higher than 47.
- Most studies measured ecological variables.
- Economic and health data not as well represented.

Table 2.0: Literature and Dataset Themes Present in Canadian Studies

Primary Sector	Number of Studies by Literature Theme	Percentage of Studies by Literature Theme	Number of Studies by Dataset Theme	Percentage of Studies by Dataset Theme	Ratio of Literature Theme to Dataset Theme
Ecological	34	32.7%	20	31.2%	170.00%
Health	23	22.1%	14	21.9%	164.29%
Socio-demographic	31	29.8%	18	28.1%	172.22%
Economic	16	15.4%	12	18.8%	133.33%
Total	104	100.0%	64	100.0%	

# Results: Indicator Analysis

- 418 indicators across 6 Canadian studies measuring integrated carrying capacity.
  - Environment,
  - Health,
  - Community,
  - Economy, and
  - Policy.
- 37 sub-categories, ranging from “democratic processes” to “harmful chemicals present in land, air, sea, and animals”.

Table 3.0: Number of Single and Aggregated Indicators

	Frequency	Proportion
Single	343	82.1%
Aggregate	75	17.9%
Missing	0	0.00%
Total	418	100.0%

# Results: Indicator Analysis

*Table 4.0: Number Sub-sectors and Indicators per Sector*

Sector	Number of Sub-sectors	Number of indicators
Environment	11	176
Health	7	28
Community	8	106
Economy	7	94
Policy	4	14
Total	37	418

# Results: Indicator Analysis

- Most indicators were drawn from data found in national surveys.
- Gaps in regional data.

Table 5.0: Number of indicators by Sector and Location

	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
Total	59	26	257	58	400

# Results: Indicator Analysis

Table 6.0: 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	100.0%

Table 7.0: Asset vs liability indicators by sector

	Asset	Liability	Neither
Environmental	45	116	15
Health	9	9	10
Community	70	16	20
Economy	54	26	14
Policy	13	1	0
Total	191	168	59

# Results: Indicator Analysis

- Frequency of data collection was noted for each indicator.
- Were data cross-sectional, longitudinal, or time series?
- Majority of indicators collected in yearly increments.
  - Dates for collection range from 1990-2018 to 2005-2016

Table 8.0: 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
Total	14	4	4	361	8	4	395

# Assessment

- Across Canada and the globe, individuals, groups and governments appear to be measuring what they want, and how they want. There is inconsistency across the literature and a lack of intersectoral indicators,
- Despite the many policy-orientated solutions that have been put forward, economic growth and GDP continues to be the top policy priority for governments across the globe, at the expense of an integrated understanding of carrying capacity.
- The lack of applied studies means that very little is known about best practices regarding the measurement of the relationship between environmental carrying capacity and society in Canada.



# Recommendations

- Attention needs to be paid to:
  - Carrying capacity conceptualizations,
  - Different understandings of carrying capacity, and
  - Applications of carrying capacity at scale.
- Cross-sectional and longitudinal data must be identified, collected and measured across the country while simultaneously facilitating attention to place-based approaches and measurement.
- Policy-makers and governments must pay attention to explicit linkages and measurements across sectors:
  1. Comparability
  2. Standardization
  3. Recognition of Place
  4. Integration
  5. Liability and Assets

# Direction for Further Research

1. What are the models or theoretical assumptions that might facilitate more integrative perspectives on the relationships between population, resources and consumption?
2. What are the ethical/equity-based considerations that are neglected? What results from their inclusion?
3. How does socio-demographic stratification impact local/regional perspectives and realities of carrying capacity?
4. Does carrying capacity have utility for public policy and practice in Canada as a concept “in practice”?
5. How can Canada overcome the geographic/rural/northern gaps for both data and policy driven intervention?
6. What role can/should/might market instruments play?

# Questions and Discussion