Assessing ecosystem services from Canadian beef: a social-ecological systems approach

Sarah Pogue¹,²,³, Roland Kröbel², H. Henry Janzen², Karen A. Beauchemin², Getahun Legesse⁴, Danielle Maia de Souza⁵, Majid Iravani⁴, Aklilu Alemu², Shannan Little², James Byrne¹, Carrie Selin³, Tim A. McAllister²

¹University of Lethbridge
²Agriculture and Agri-Food Canada
³Alberta Biodiversity Monitoring Institute
⁴Government of Manitoba
⁵University of Alberta
~74.3 million tonnes of protein

FAO (2017)
Canadian beef and global meat demand

- **~10.5 million** beef cattle in Canada in July 2017
- **1.3 Mt** beef leather, medicine, manure, cosmetics...
- **11th** largest producer
- **5th** largest exporter of beef globally
- **$16 billion** to GDP per year (2012-2016 average)
- **1.9% a⁻¹** increase in developing country consumption to 2050
~7.8 million beef cattle in prairies

Intensification of production

High population growth

**Aim:** to construct a conceptual framework for ecosystem service assessment accompanied by a set of indicators to measure the ecological and social performance of the system

Ecoregions, land cover (AAFC, 2016) and beef cow presence (Statistics Canada, 2014) in the Canadian Prairies
Assessing the sustainability of Canadian beef

- Much ES research focused on biophysical capacity or single/few ES
- Less information on the role of humans in the co-production of services
- Less information on service flow and impacts of changes in service flow on human well-being

Social-ecological systems approach to ES assessment for prairie beef systems
The agricultural stages of beef production

Integrated beef-cropping operation

based on typical practices for the prairies: the primary management unit and source of ecosystem services.
Ecosystem service capacity: the potential of the system to produce a service e.g., mass of pollutants retained by the system
Planting of farmyard shelterbelts over 80 years in Saskatchewan sequestered an estimated $>130,000$ t of C in tree biomass and soils of white spruce.
Agritourism sector has expanded in recent decades...
Most agritourism farms and farm-based recreational activities occur in the prairie ecoregions of AB, SK and MB.
Ecosystem service flow: the actual amount of a service used or consumed e.g., mass of pollutants retained upstream of point of use or extraction
Need to **disaggregate** user groups based on: *who* they are, *where* they are, *how* they consume or use a service, *how* changes in service flow affect them.
Climate regulation

Capacity and Flow

Soil C sequestration (t C ha\(^{-1}\) yr\(^{-1}\))
Avoided GHG emissions (t CO\(_2\) eq. yr\(^{-1}\))

Demand

Required increase in climate regulation capacity to offset GHG emissions from the beef operation or to reach GHG emission targets

Human well-being

Society: health benefits/impacts; Social cost of carbon (SCC)
Producer: market value of C credits ($ t C\(^{-1}\)
Anthropogenic pathways: off-farm infrastructure that facilitates movement of people to the farm

Demand, influenced by the location of the user, user values and preferences, cultural identity and disposable income

User group = Producer and Farm visitors

Producer: income

Visitors: positive impacts on health and social well-being

Capacity

No. visitors beef cattle ranch can host per year for different activities
No. of fishing permits available for a stretch of river

Flow

Total visitor-days from current year
No. of people engaged in different activities

Demand

Individual visitation rates from previous year

Human well-being

Visitors: perceived/self-reported improvements in physical and psychological well-being
Producer: income from rural tourism activities ($)

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32% of respondents expect to eat less beef in the next five years

55% of ag producers cited economic pressure as barrier to adopting BMPs
Trade-offs within stages of production

**Cultural services**
- Ranching tradition and rural tourism

**Water quality regulation**
- Low risk of contamination

**Air quality regulation**
- Positive impact on air quality

**Climate regulation**
- Feedlot cattle
  - Air quality regulation
    - 39% - 72% of ingested N emitted as NH$_3$
  - Water quality regulation
    - Runoff greatest risk

**Climate regulation***
- Cattle on pasture
Trade-offs across stages of production

Antimicrobial administration improves disease regulation

Feedlot cattle

Increased NH₃ emissions from stockpiled and composted manure

Manure

Lower NH₃ emissions following land application

Cropland

Antimicrobial administration increases water contamination risk
Next steps

- Going from **general to specific** – combine assessment framework and evidence base and apply to ecoregion-specific beef farms
- **Expand our knowledge** base to health and social sciences
- **Identify knowledge/data gaps** for different ecoregions and propose solutions or strategies
- **Communicate** to interested parties
Expanding Holos

GHG emissions and Soil C changes for ag operations

Capacity to provide other ES

Impacts on ES flows and HWB
Contributing scientists

Aklilu Alemu
Karen Beauchemin
Jim Byrne
Marcos Cordeiro
Dan Farr
Majid Iravani
Henry Janzen

Roland Kroebel
Shannan Little
Danielle Maia de Souza
Tim McAllister
Carrie Selin
Candace Vanin

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Contact information
Sarah Pogue (sarah.pogue@canada.ca)