ESA | ECOSYSTEM SERVICES Assessment Project

POLLINATION SERVICES REPORT

OVERVIEW

Ecosystem services are the benefits provided by nature that contribute to our health and wellbeing. Despite the essential role that ecosystem services play in our lives, they're often ignored in decision-making because we don't recognize their value. This project aims to change that by measuring and valuing these services.

The Ecosystem Services Assessment (ESA) project assesses and maps ecosystem services across Alberta. In the first phase of the project (2012-2015), we developed a set of spatially explicit models that can be used to map their supply and economic value, starting with five ecosystem services:

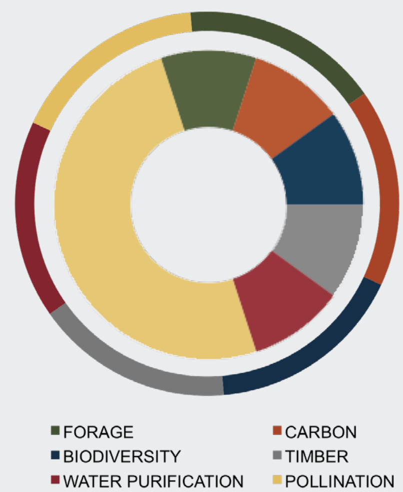
- Water purification
- Timber production
- Forage production
- Pollination
- Carbon storage

We've also mapped the ABMI's Biodiversity Index, drawing from the ABMI's extensive province-wide biodiversity data, to estimate how overall biodiversity responds to varying amounts of human footprint.

We're interested in how these ecosystem services interact with humans: how they are affected by human activities and change with land management, both positively and negatively. The second phase of the project, beginning in 2015, will demonstrate applications of ecosystem service information for use by land managers, and incorporate this knowledge into marked-based instruments for environmental management.

Powered with this information, Albertans can make the best possible decisions about how to manage our landscape and natural resources. Improved knowledge about the provision and value of ecosystem services can support better environmental management through regional planning, market-based approaches, and sustainability reporting.

INTEGRATED PLATFORM



Ecosystem services are linked to one another and do not respond independently to changes in land-use or management practices. Integrating ecosystem service models in a single platform is essential to a comprehensive assessment of ecosystem services – so that the effects of a single management action can be represented for multiple ecosystem services.

> **For example, forest harvesting simultaneously affects carbon storage, water purification, and biodiversity; only by integrating these services in a modelling environment can the inherent trade-offs be understood.**

POLLINATION SERVICES

Canola (*Brassica spp.*) is the most valuable crop in Canada, generating a quarter of all farm cash receipts and providing an average annual contribution of $6.1 billion to Alberta's economy.[1] Pollination by wild pollinators has been shown to increase yield in many economically important crops,[2] and declines in wild pollinators have been associated with low yields for some crops.[3] Varieties of canola can be either self-compatible, meaning they can be fertilized by their own pollen; or self-incompatible, meaning they require pollen from a different plant, which must arrive by animal or wind pollination. Pollination by insects, however, increases seed production even in self-compatible canola, and in fact a lack of pollination can lead to a 30% decrease in canola yield.[4]

Ensuring wild pollinators are available to provide sustainable pollination services to Alberta's canola has huge economic implications. But because they nest in uncultivated lands and fly a limited distance between nesting and feeding habitat, the frequency with which pollinators visit crops depends upon the availability of uncultivated areas.[5] In Alberta, only canola flowers within about 1km of uncultivated land receive the benefit of pollination by wild bees.[6]

To assess the economic value of pollination in Alberta, we developed a spatial model to estimate the proportion of annual canola yield that can be attributed to pollination by wild bees. We used available knowledge of native pollinators of canola[4] and detailed landcover data from the ABMI to delineate the boundaries of crop fields and uncultivated areas, as well as annual crop type maps from Agriculture and Agri-food Canada to determine which fields are actually growing canola. With this information, we created a statistical model predicting bee abundance based on the area of uncultivated land within 800 metres of canola fields. This allows us to estimate canola yield based on the predicted abundance of bees in an area and their associated pollination benefits (Fig 2).

This preliminary model of pollination's value for canola is ready for integration with our other ecosystem service models in a single platform. However, because we don't know enough about the current abundance and distribution of Alberta's native bee populations, the model's predictions are highly uncertain. Researchers from the University of Alberta are addressing this uncertainty by sampling bees throughout the agricultural regions of Alberta (Fig. 1).

Once complete, we will integrate this comprehensive dataset into the canola pollination model to produce more accurate predictions of pollination services to canola yields.

The economic value of canola attributable to pollinators can be estimated by multiplying the improved yield (in kg) by the price of canola. At the 2010 canola seed price of $461.81/tonne,[7] our preliminary estimate of the potential value of wild pollinators to canola production is $500 million a year across the province of Alberta.

Using this model, we can predict changes in crop yields in response to potential pollinator management actions. For example, we can explore the economic impact of planting hedgerows to increase pollinator abundance. Conversely, we can estimate the reduction in canola yield from the clearing of nearby woodlots and other natural habitats that support wild bees.

Importantly, land management actions that affect pollinator-mediated canola yield can also affect other ecosystem services, such as water-borne nutrient retention and carbon storage on agricultural lands. We can better understand the provision of ecosystem services across Alberta and the impact of management actions by integrating individual ecosystem services in a single modelling platform, offering a more holistic picture of the benefits we're receiving from nature.

FIGURE 1: *Locations of 11 clusters of agricultural sites (three canola and three rangeland sites per cluster) visited in the summer of 2014 to survey the abundance and diversity of native pollinators in Alberta.*

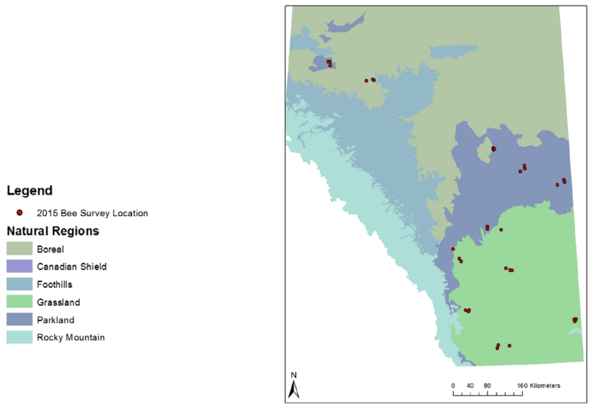


FIGURE 2: *Net present value of wild bees to canola production in Alberta over four years (top; in $/ha) and increase in pollinator value if 12% of agricultural land were converted to uncultivated , potential pollinator nesting habitat (bottom; in $/ha).*

- We successfully assessed and mapped five ecosystem services across Alberta. We're now integrating our five models with a biodiversity model into a single interactive platform – available on our website soon! ecosystemservices.abmi.ca

- We have completed a preliminary assessment of how rangeland forage production and soil carbon storage may be impacted by climate change, and evaluated the potential costs and benefits of specific adaptation strategies to respond to those changes. Once complete, this information can support the evaluation and implementation of community climate change adaptation strategies.[8]

- Our research on biodiversity offset priorities was published in Conservation Biology. The goal of biodiversity offsets is to counter the loss of biodiversity from development by conserving or restoring the same type of biodiversity elsewhere. We evaluated alternative offset policies in northern Alberta as a case study. Our work suggests that flexible offset systems tailored to regional conservation priorities (e.g., caribou habitat), can achieve better conservation outcomes at a lower cost compared to systems focused strictly on offsetting the exact same types of ecosystems and biodiversity that were affected by the development.[9]

- We have contributed to initiatives focused on sustainable beef production, including the Food & Agriculture Organization at the UN and the Canadian Roundtable on Sustainable Beef. Our capacity to assess ecosystem services supports sustainable livestock by providing a complete assessment of the environmental performance of a given piece of land.[10]

APPLICATION – PHASE 2

The goal of the second phase of the project (2015-2017) is to promote environmental innovation and competitiveness in Alberta's leading natural resource industries by demonstrating how to apply the systems developed in Phase 1 for assessing ecosystem services and biodiversity.

Understanding the provision of ecosystem services is an essential first step in developing market approaches to conservation, like offsets, sustainability reporting, and certification. We need a full assessment of the benefits we're receiving from the landscape before we can begin to accurately value these services in the marketplace. The ESA project offers Albertans that potential.

This project is part of a province-wide initiative, the Ecosystem Services Research and Innovation Roadmap, funded and led by Alberta Innovates – Bio Solutions, and also receives funding from the Alberta Livestock and Meat Agency. This project is a collaboration with the University of Alberta, Alberta Innovates – Technology Futures, Silvacom, the University of Guelph, and the Alberta Land Institute.

ALMA Alberta Livestock and Meat Agency Ltd. | Alberta Innovates Bio Solutions | Alberta Innovates Technology Futures | University of Alberta

Visit our project website for the most recent reports, products and updates from the project: www.ecosystemservices.abmi.ca

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[1] *Canola Council of Canada: http://www.canolacouncil.org/market-stats-industry-overview/.*

[2] *Garibaldi, L.A., et al. (2013). Wild pollinators enhance fruit set of crops regardless of honey bee abundance. Science 339 (6127): 1608-1611.*

[3] *Kevan (1977) and Allen-Wardell et al. (1998), cited in Morandin, L.A., and M.L. Winston (2005). Wild bee abundance and seed production in conventional, organic, and genetically modified canola. Ecological Applications 15: 871-881.*

[4] *Morandin and Winston (2005).*

[5] *Ricketts, T.H. et al. (2008). Landscape effects on crop pollination services: are there general patterns?. Ecology Letters 11(5): 499-515.*

[6] *Morandin, L.A. and M.L. Winston (2006). Pollinators provide economic incentive to preserve natural land in agroecosystems. Agriculture, Ecosystems & Environment 116(3): 289-292.*

[7] *Canola Council of Canada: http://www.canolacouncil.org/market-stats/statistics/historic-canola-oil,-meal,-and-seed-prices/*

[8] *Nixon, A.E. et al. (2015). Climate change and the provision of ecosystem services in Alberta. ABMI.*

[9] *Habib, T.J., D.R. Farr, R.R. Schneider, & S. Boutin (2013). Economic and ecological outcomes of flexible biodiversity offset systems. Conservation Biology 27(6): 1313-1323.*

[10] *LEAP FAO Principles for the Assessment of Livestock Impacts on Biodiversity.*

Canadian Roundtable on Sustainable Beef