Natural Resources Canada | Ressources naturelles Canada

Bulletin 57

FRONTLINE EXPRESS

Canadian Forest Service – Great Lakes Forestry Centre

From seed size to ecosystem health: the plant trait approach

INTRODUCTION

Measuring and understanding ecosystem response to disturbance is a good determinant of forest health and sustainability. A new, innovative way to assess ecosystem response to human-induced changes is to use the functional trait approach, which classifies vegetation according to the plant characteristics that matter for ecosystem function and processes, such as seed size and life cycle. This method, an alternative to taxonomic classification, allows for comparisons between ecosystems even if they do not share the same species. Such comparisons can be useful in improving our understanding of ecosystem processes and response to disturbances such as logging, biomass removal and forecasting the effects of invasive species, at both the national and international level. This approach also has potential to be useful in land restoration projects, monitoring ecosystem response to climate change and measuring losses in biodiversity. Canada is currently one of nine countries that have contributed data to an international analysis of global ecosystem response to land use intensification. Overall trends indicate a reduction in plant community functional diversity with increased land-use intensity. This international sharing and analysis of data allows researchers to search for global patterns.

GREAT LAKES FORESTRY CENTRE (GLFC) RESEARCH

Functional Trait approach

In a plant trait approach, species with a similar set of characteristics are grouped together, thus reducing diversity in species to diversity of function and allowing comparisons between ecosystems. Plant characteristics used include morphological aspects (such as growth form or height), mechanisms of regeneration (such as mode of seed dispersal or sprouting ability), and uptake of resources (including light, water and nutrients).

GLFC ecologist Isabelle Aubin previously compared understory species assemblages in sugar-maple dominated stands in Québec using the functional trait approach to study the effects of human disturbance. This study found the understory vegetation assemblage to be relatively stable, but there were two groups of species with a set of characteristics specifically associated with unmanaged old growth forests, indicating that species possessing these characteristics may be sensitive to human disturbances. One group was native spring flowering perennials with large seeds and limited capacity for seed dispersal, such as trillium species (*Trillium* spp). The second group was saprophytic species (parasitic plants without chlorophyll that live off large tree roots or dead woody debris), such as Indian pipe (*Monotropa* spp).

Canadian Plant Trait database

The use of the functional trait approach requires a standardized classification of plant characteristics that can be used by ecologists so that meaningful comparisons can be made. An important component of this type of study is the consolidation of this information into one source, which was done by Aubin through the recently developed national network of plant trait databases: The Traits of Plants in Canada (TOPIC). More than 700 species from Québec and Ontario have been documented so far. More than just a database, this initiative is a human network where scientists who generate data about plants (for example, leaf and root characteristics from ecophysiology research) will be linked to the users of the information, such as community ecologists who are studying the impacts of climate change. Using international standards, the network standardizes, integrates and stores data. The project is a collaborative effort between the Canadian Forest Service, Ontario and Québec ministries of Natural Resources, various universities and industrial partners. The information generated will allow data exchange and increased collaboration between researchers and will facilitate large-scale studies on critical issues related to bioenergy, biodiversity, climate change and forest productivity.

International Study

Data from twenty sites in Québec, ranging in disturbance intensity from pasture to old growth forest, were used as part of an international study that examined plant community response to a range of land use disturbances, covering five biomes. The study compared plant traits using 18 datasets from a total of 9 countries, including, Portugal, China, Laos, Australia, New Zealand, Nicaragua, USA and Costa Rica. A total of 3000 plant species were synthesized into 120 groups based on similar traits.

A fundamental question that was at the core of this study was: how do human-induced changes in biodiversity alter the capacity of ecosystems to cope with future disturbances? Overall results indicated that land use intensification reduced functional redundancy, defined as the number of species that contribute similarly to ecosystem function. Response diversity, which is the variability of response to an environmental change of the species in the same group, was also reduced with an increase in land use intensity. These results suggest that intensified management of forest ecosystems may lead to a global loss of resilience and increase the vulnerability of ecosystems to future disturbances.

Future Work

The Traits of Plants in Canada Network will provide the foundation for numerous collaborative studies, many in association with universities. Some planned studies include the assessment of the impact

of some forest management practices, such as biomass harvesting and silvicultural practices, on ecosystem sustainability. The plant trait approach will also be used in an evaluation of peatland restoration activities. Other studies designed to increase our understanding of the impact of various stressors on forest biodiversity include the effects of emerald ash borer on Ontario's landscape and the impact of the deer population on vegetation diversity on Anticosti Island. Aubin is also working with L. Venier, GLFC researcher and M. Moretti, a Swiss researcher, on the development of an ecosystem level assessment that will integrate key trophic group (categories of organisms based on their method of feeding) responses and their interactions, such as the response of birds, plants, spiders and ground beetles to successional change after harvesting.

CONCLUSION

Ecosystem functions are the results of multiple interactions between plant traits and environmental variables. Data gathered from these studies will provide a new way of assessing ecosystem response to human disturbances, an essential tool in our efforts to maintain ecological integrity. In addition, the use of the trait approach and plant traits database will allow inter-regional and international comparisons and facilitate networking among the scientific community and resource managers. Overall, it will lead to well informed science-based decisions by policy makers to help ensure sustainable development practices.

PRINCIPAL COLLABORATORS

- Université du Québec à Montréal
- Université Laval
- IMEP, France
- Ontario Ministry of Natural Resources
- Ministère des Ressources Naturelles et de la Faune du Québec
- University of Guelph
- Genivar

SUGGESTED READING

Laliberté et al. 2010. Land-use intensification reduces functional redundancy and response diversity in plant communities. Ecology Letters 13:76-86

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ISSN 1496-7847