Using Ecosystem Conceptual Models to Measure and communicate Park Ecological Integrity

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Abstract

Conceptual ecosystem models are useful tools in the design of ecological monitoring programs and as communication devices that clearly articulate key drivers of ecosystem structure and functioning. The paper describes conceptual ecosystem models in general and their application to the development of Parks Canada's ecological integrity monitoring programs.

Introduction

A central perspective of the approach of Parks Canada's ecological integrity (EI) monitoring and reporting program is that, to be comprehensive and feasible, park EI monitoring needs to be designed and organized within a series of interrelated and hierarchical conceptual ecosystem models. Ecosystem conceptual models and sub-models should identify, for the main park ecological systems (e.g., forests, tundra, grasslands, wetlands, lakes, streams, near-shore marine), key ecosystem components (e.g., biodiversity, ecosystem processes/functions, social factors, and stressors; see Figures 1 and 2) at a range of scales, and identify the principal drivers and linkages among the components.

The rationale for investing considerable time and energy in conceptual ecological models as a foundation for park EI monitoring and reporting programs include the following:

1. Capturing long-term ecological vision.
The *Canada National Parks Act* (Government of Canada, 1998) is clear that all park management plans require a *"long-term ecological vision"* to guide management activities and determine management objectives. The principal purpose of the park EI monitoring program is to measure and report our achievement in meeting these objectives. Parks are composed of a variety of terrestrial, aquatic and marine ecosystems that interact internally and externally in complex ways across and outside of park landscapes. To provide comprehensive and achievable EI monitoring and reporting it is imperative that we reduce this complexity to a manageable number of fundamental ecosystem components and processes that capture the most important and relevant ecosystem qualities of the long-term ecological vision.

2. An ecological framework for identifying EI measures.
Another important challenge for redesigning park monitoring and reporting programs is to select a small group of measures that will provide maximum information about changes in park ecosystems. By reducing ecosystem complexity to its most important components, processes, and stressors, conceptual models will provide an ecological framework to identify gaps in present

monitoring programs and help guide selection of the most parsimonious suite of EI measures.

Figure 1. Conceptual ecosystem model showing local forest ecosystem (stand-level) components, processes and stressors, with a proposed suite of inter-related forest measures to be co-located in a replicated series of long-term EI monitoring plots.

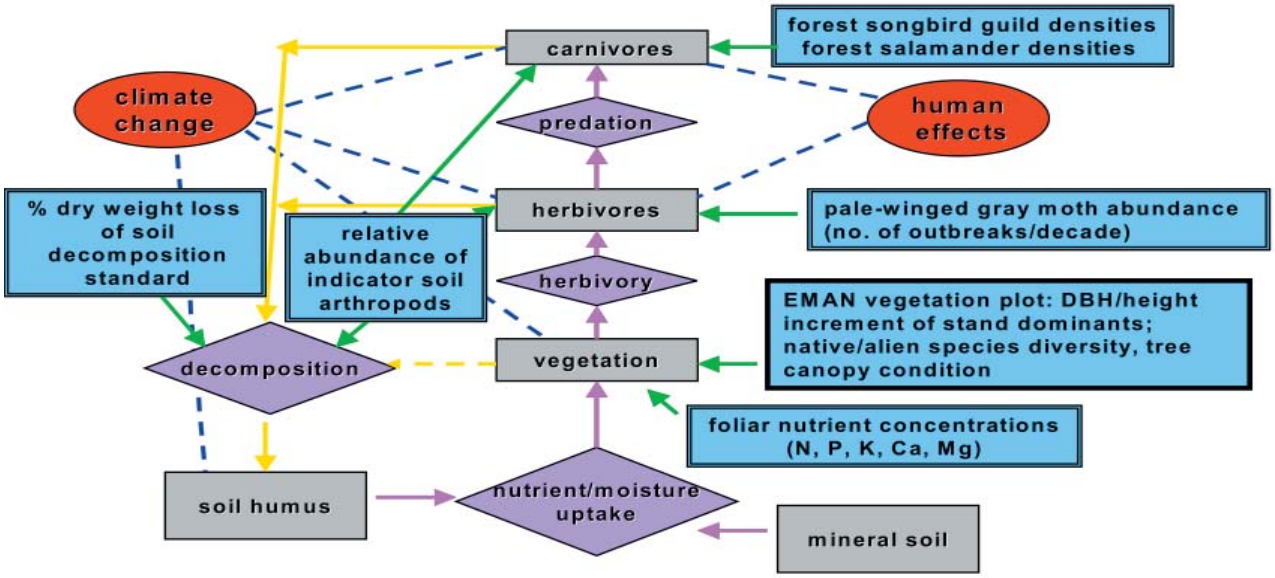
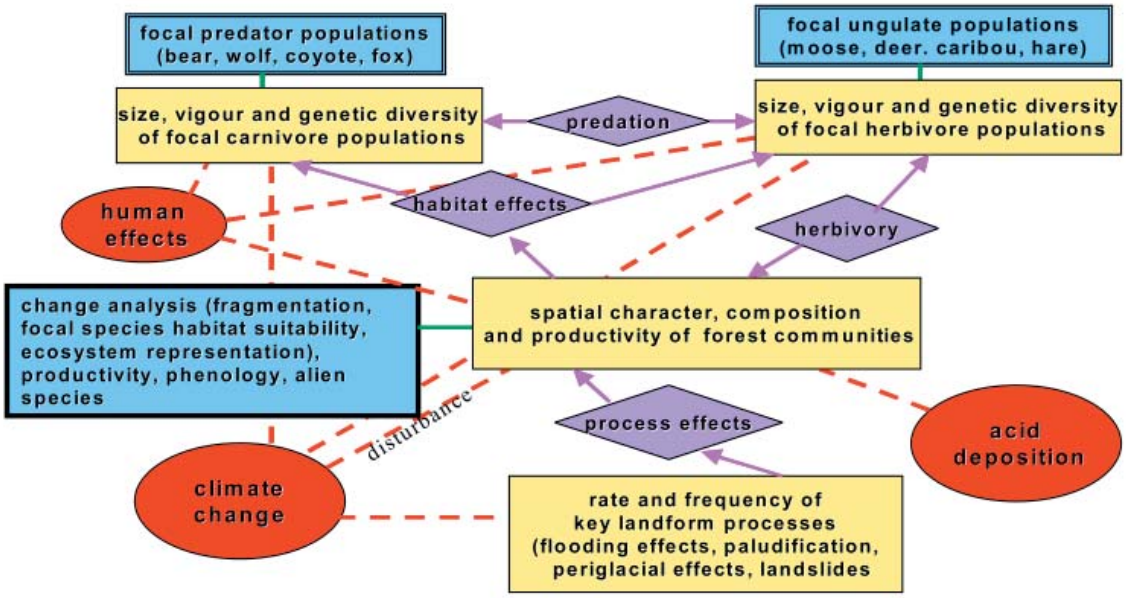


Figure 2. Conceptual ecosystem model showing landscape-level forest ecosystem components, processes and stressors, with a proposed suite of inter-related forest measures with information coming primarily from GIS data and satellite monitoring.



3. Facilitating EI reporting across bioregions and nationally.
Parks Canada has a legislated mandate to report every two years on the condition of EI across the national parks network. This requirement can be greatly facilitated in the long run by building program elements into park models through core bioregional components (i.e., model components that are common to major ecosystems across a bioregion can act as core components of park ecosystem models).

4. An interactive frame for assessing EI monitoring results.
Conceptual ecosystem models will describe major ecosystem components, the processes that link them, and the stressors that affect them. Since model components are conceptually inter-related, and if measures are co-located in long-term permanent sample plots, the changes in the measures that represent those components will also be logically inter-related, and this will greatly improve the interpretation of changes in individual EI measures. Because of the logical connection among monitored ecosystem components, monitoring results can be more easily combined into an EI indicator for that park ecosystem component.

5. Communicating monitoring results to external audiences.
Providing a clear and concise picture of park EI and how it is changing is a critical EI monitoring and reporting program component. Complex ecosystems and the factors that affect them are difficult to communicate to non-specialist audiences, and the proposed conceptual ecosystem models will create a clear, shared picture of park ecological systems that can be communicated widely. High-level conceptual diagrams that combine model components with animated interpretative graphics will effectively communicate to non-specialist audiences (Figure 3), while specialists can use the models to navigate through program logic and arrive at the fundamentals of program design and measurement (Figure 4). Low level control models, such as that illustrated in Figure 4, would be appropriate to include in a monitoring protocol for a monitoring measure such as soil decomposition, and would provide a conceptual link from that small program component to all other aspects of the program through the system of hierarchical models.

Figure 3. Conceptual ecosystem diagram — forest nutrient cycling.

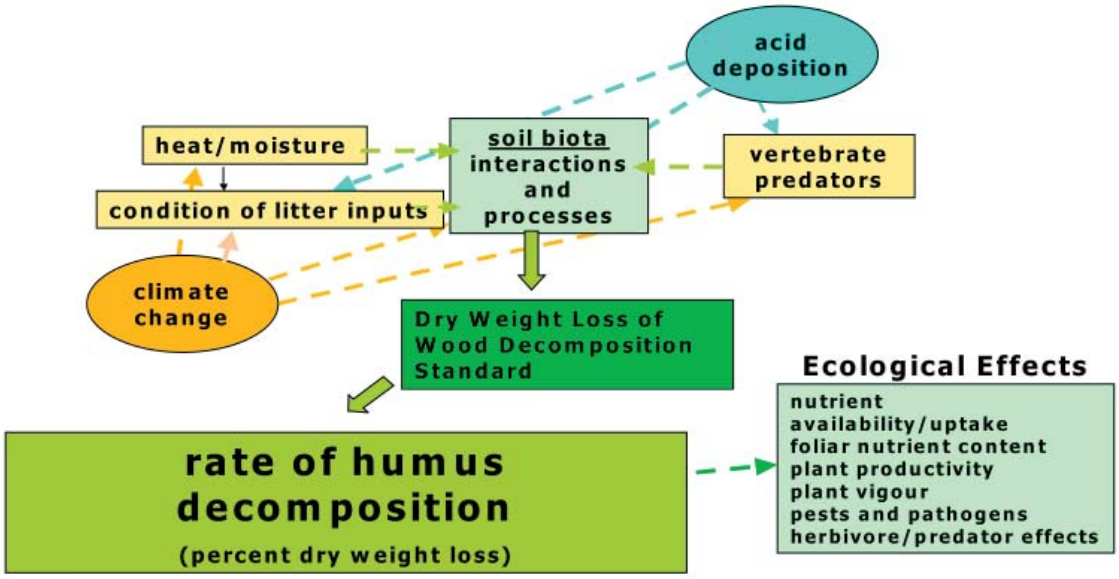
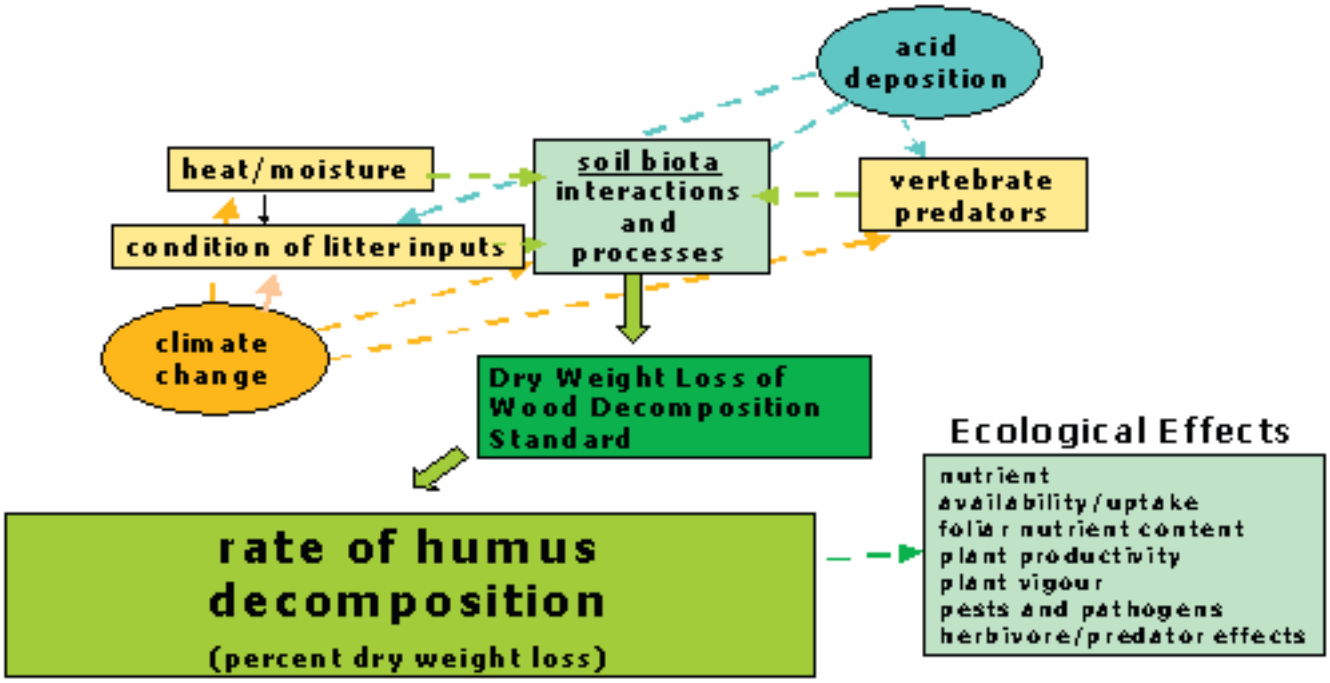


Figure 4. Conceptual ecosystem model showing inter-relationships between a monitoring measure (dry weight loss of wood decomposition) and related ecological components and processes.



6. Communicating internally.
Model development and refinement will take place in park and bioregional workshops, and it is anticipated that this will generate a common and shared understanding of park ecosystems, and EI vision in a park and across a bioregion. The group learning that accompanies the development of the models will lead to an increased mutual appreciation of ecosystem function and complexity, park EI, and monitoring program development. This will in turn provide a common forum for cooperating to develop park programs across a bioregion.

Conclusions

It is anticipated that development of final park conceptual models will take several years and iterations up to 2008. By that date, all park EI monitoring programs should have a hierarchical series of inter-related conceptual models that capture park EI, and provide a useful and well-articulated conceptual foundation for the park EI monitoring and reporting program.

References

Government of Canada. 1998. *Parks Canada Agency Act.* C. 31.