

How Complexity Science Can Help Us Think Through Complicated Problems

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New Realities

An era of new climates

Changing biotic and abiotic conditions

Unexpected disturbances

Multiple threats to productivity

Economic and social change

- ◆ The notions of homogeneity and stability as a basis for management presents many risks that should no longer be ignored
- ◆ Forests can and will self-organize. Dynamic change and not stable equilibria are the rule.
- ◆ Changes will be neither completely random nor entirely deterministic.

Forestry Can't Be Static

- ◆ More is required than simply modifying traditional tools. Will require new:
 - Viewpoints (need to think differently)
 - Decision criteria (different temporal and spatial scales)
 - Practices (designed to influence adaptive capacity over the long-term, e.g., functional traits, diversity, interactions)
 - Models (uncertainty, non-linear responses)
- ◆ **Silvicultural practices must increase ecosystem adaptability and promote desirable outcomes**

Why Should You Care About Complexity Science?

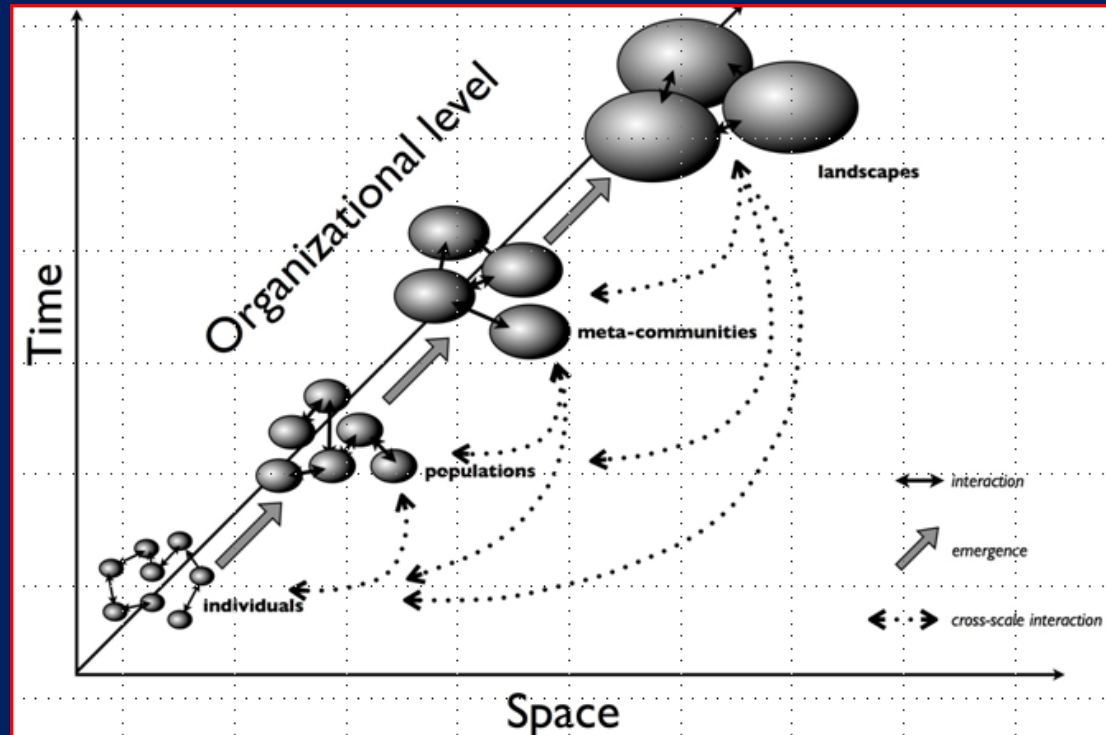
- ◆ Management based on an expectation of order, predictability and the replication of earlier successes is fraught with risk
- ◆ *Peter Reich* – Given that forests cover 1/3 of the terrestrial globe and play critical roles in the earth system, terrestrial biomes and human economy, it is imperative we constantly improve our approach to the science and practice of forest management

Complexity Science

Considering forests as complex adaptive systems

Perplexing, mind bending,
tremendous potential to
improve practice

Provides a formal way of
describing what we know
about forest ecosystems.
That they are systems of
biophysical components and
processes that are intricately
interlinked across scales of
space, time and organization, giving rise to emergent properties
and nonlinear responses



What is Complexity?

- ◆ Diverse, heterogeneous or variable describe the range of elements or components in a system (e.g., tree species, trees size, temperature, precipitation, pathogens), whereas complexity and complex describe the nature and outcomes of interactions among those elements
- ◆ Surprising or emergent phenomena can arise due to interactions among parts of the system
- ◆ They can be positive or negative for the goods and services we manage
 - We are observing negative outcomes from the interactions of climate, tree species, tree size and pathogens in some of our plantations

Moving Forward

- ◆ Viewing forests as complex systems is the logical next step in our changing view of forest dynamics and the evolution of silvicultural practices.
- ◆ **Adaptability** and **self-organization** are good concepts for managing forests as complex systems
 - we want our managed stands to adapt or self-organize after unexpected disturbances or changes and to continue to provide desired goods and services.
- ◆ Adaptability and self-organization can be general criteria for evaluating the success of policy goals and practices

See for details:

Filotas et al. 2014. *Viewing forests through the lens of complex systems science*. Ecosphere, Volume 5(1). Open-access journal.

Messier, Puettmann, Coates 2013 *Managing Forests as Complex Adaptive Systems: Building Resilience to the Challenge of Global Change*. Routledge

Puettmann, Coates & Messier 2009. *A Critique of Silviculture: Managing for Complexity*. Island Press, Washington DC.

Plantation Management

◆ Traditional approach

- Emphasis on control to achieve optimal productivity
- Presumption of predictability
- Assessed at stand scale at free-growing
- Based on mean response of tree attributes

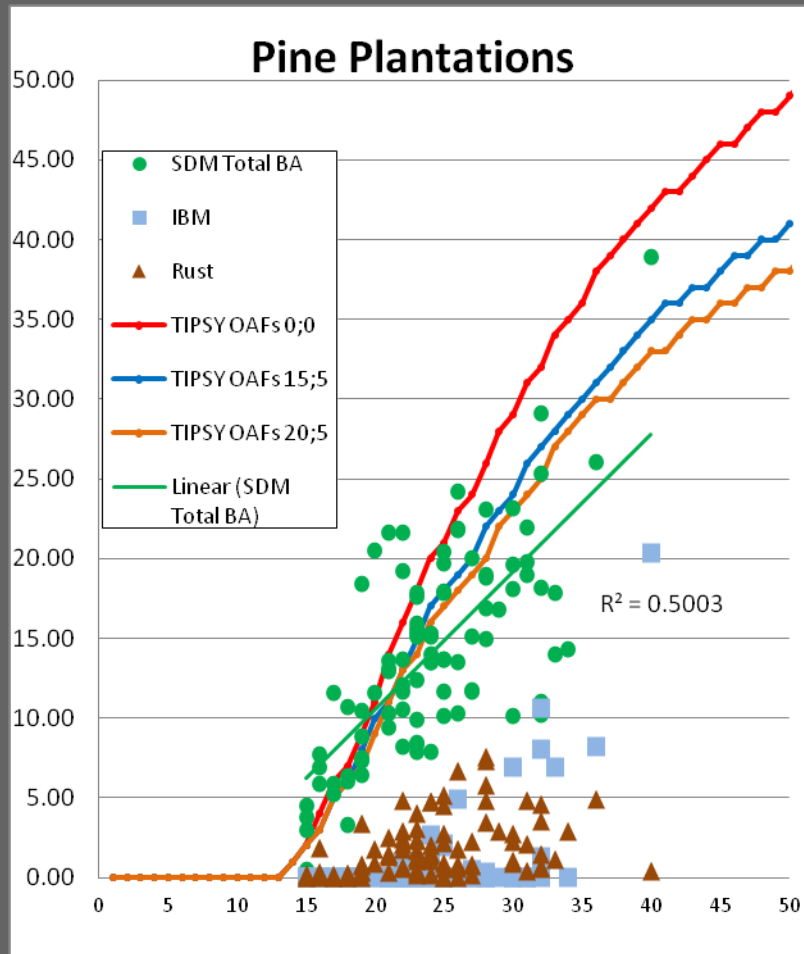
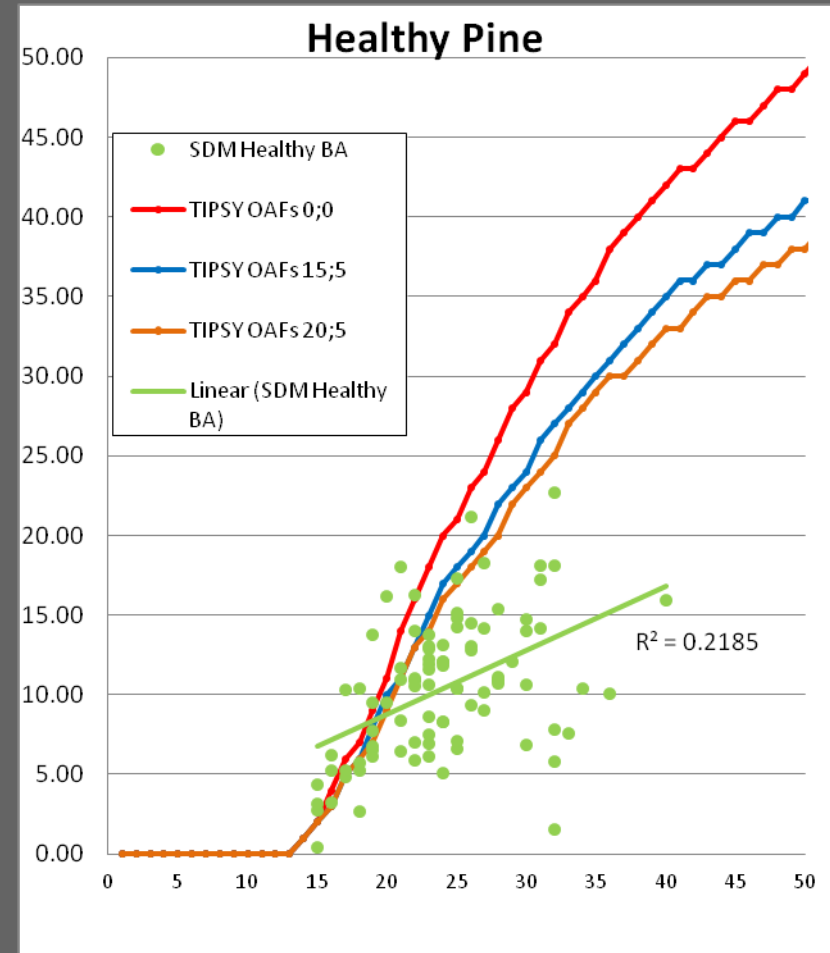


◆ Shifting to a complexity view

- Multi-scale perspective that considers site- stand- and landscape-scale processes and their interactions over time
- Acknowledge variability and uncertainty in environmental, biological, economic and social conditions
- Emphasis on self-organization and adaptability
- Assessed at various spatial and temporal scales
- Adjust based on response of various agents and drivers

The Current Condition of 15-40 Year Old Pine Plantations In Northern BC

Basal Area



Age of Plantation

Thanks to Erin (Havard) Holtzman for these graphs