UNDERSTANDING THE IMPORTANCE OF SPATIALLY-EXPLICIT METRICS OF NATURAL DISTURBANCE REGIMES IN RESTORATION OF MIXED-PINE FORESTS

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Red pine (*Pinus resinosa Ait.*) is one of the few fire-resistant tree species in the eastern United States, with a range confined to the North American Northern Forest region and the southern fringe of the North American Boreal Forest region. Periodic surface fires played an important role in red pine regeneration by ensuring open understories for this shade-intolerant species, reducing competing vegetation, and exposing mineral seedbeds. However, many of these forests in the northern Lake States have been altered from their pre-European condition, first by extensive logging, and later by fire suppression policies.

A number of forest management and silvicultural options have been recently proposed to restore mixed-pine forests through the emulation of natural disturbance processes. Little region-specific information, however, is available on the historical and geographic variability of natural disturbance regimes, forest composition, and fuel loadings of mixed-pine forests. We initiated a study to provide a knowledge base for the ecological restoration of mixed-pine forest ecosystems of Upper Michigan and to address the need to reduce loadings and fire hazards in these forests. One of the objectives of this study was to develop a better understanding of the pre-European settlement and post-settlement fire regimes.

We reconstructed fire history of the Seney National Wildlife Refuge (SNWR) since early 1700s using dendrochronological methods. We analysed historical fire return intervals (non-spatial metric) and the fire cycle (spatially-explicit metric) in two landform types represented in the refuge typical of eastern Upper Michigan: the outwash channel and sand ridge types.

Analysis of fire return intervals indicated that during the pre-European settlement time period (prior to 1860), the probability of a site escaping a fire for more than 80 years was approximately 20-30% for both landforms. In the European settlement time period single stands had only a 10% chance of escaping

MANAGEMENT IMPLICATIONS

1) Frequent (once in 25-35 years), low-intensity fires are the main feature of the historic fire regimes in the red pine forest ecosystems across the northern Lake States.

2) Management plans aimed at conserving and restoring red pine-dominated forest ecosystems should include these fire events to promote red pine regeneration and maintain low fuel loadings.

3) Long-term plans should include introducing fire activity at the scale of 100-1,000 hectares.

Want to learn more?

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Drobyshev, I., Goebel, P. C. , Hix, D.M., Corace, R. G. III, and Semko-Duncan, M. E. 2008. Pre- and post-European settlement fire history of red pine-dominated forest ecosystems of Seney National Wildlife Refuge, Upper Michigan. Can. J. For. Res. 38: 2497–2514

fire after 40 years of fire-free period. In the post-SNWR establishment time period, the probability of escaping fire increased to 60% after 80 years of fire-free period.

Fire cycle (FC) is defined as number of years required to burn an area equal to the study area. FC reconstruction revealed more dramatic changes in fire regime. Within both landform types, the fire cycle decreased from the pre-European settlement time period (53 and 91 years, respectively) to the European settlement time period (30 and 22 years), and then dramatically increased in the most recent time period (179 and 1090 years).

Frequent (once in 25-35 years), low-intensity fires are most likely the main feature of the historic fire regimes in the red pine forest ecosystems of SNWR as they are elsewhere across the northern Lake States. Management plans aimed at conserving and restoring red pine-dominated forest ecosystems should therefore include such fire events, which promote red pine regeneration and maintain low fuel loadings.

An important question is whether a conservation- and restoration-oriented management plan should target certain levels of return intervals or be designed with estimates of historical FC in mind. For SNWR, these were about 150 years for the sand ridge landform type embedded within the patterned fens and about 50 years in the outwash channel landform type. We believe that it is the FC estimates that should ultimately serve as long-term guidelines for the conservation burns. The biological rationale for this decision comes from the fact that the amount of area burned appears to be an important factor controlling the long-term dynamics of the amount of different habitat types, e.g. abundance of early successional stages, landscape structural diversity, and dynamics of deadwood, all of which have been shown to be closely connected to the dynamics of many species groups. Also, FC data incorporate our knowledge on spatial extent of fires, a feature of fire regime not represented in the fire interval data.

Using FC reference values as benchmark, however, would imply introducing fire activity at the scale of 100-1,000 ha, which may not be currently feasible because of high fuel loadings in many formerly red pine-dominated forests and high risk associated with escaping prescribed fires. We therefore advocate for the use of fire interval data for the development of interim management targets. Subsequent versions of conservation plans may want to address targets based on FC data, which will inevitably expand the plan's scope and include the management of larger fire events (≥100 ha). High costs associated with prescribed fires of such size may render them currently unfeasible as a tool to achieve the required amount of fire-impacted areas. In this context, a combination of small prescribed fires and less restrictive fire suppression policies leading towards larger fires may prove a viable alternative even given a clearly negative perception of large fires by the general public.

Related information:

Drobyshev I., P. C. Goebel, Y. Bergeron, R.G. Corace, III. 2012. Detecting changes in climate forcing on the fire regime of a North American mixed-pine forest: a case study of Seney National Wildlife Refuge, Upper Michigan. Dendrochronologia 30 (2012) 137–145.

Drobyshev, I., Goebel, P. C. , Hix, D.M., Corace, R. G. III, and Semko-Duncan, M. E., 2008. Interactions among forest composition, structure, fuel loadings and fire history: a case study of red pine-dominated forests of Seney National Wildlife Refuge, Upper Michigan. For. Ecol. Manage. 256 1723–1733.