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Landsat-based Detection of White Spruce Masting in the Kluane Region, Yukon

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Abstract

Mast seeding is the synchronous production of highly variable seed crops over time by a population of perennial plants, and this phenomenon occurs in numerous species around the world. In white spruce (*Picea glauca*), a dominant species in the boreal forest of North America, seed cone production may occur on an annual basis at low intensity but, at intervals of approximately 4 to 7 years, can occur in abundance on individual trees and synchronously across large areas. These abundant “mast events” provide a pulse of food resources to seed predators such as small mammals and birds, often leading to mammal population spikes and avian irruptions in subsequent years. However, surveys of mast seeding have been limited entirely to ground-based observations, with numerous survey sites established across North America, and such surveys remain time-intensive and logistically challenging to implement over broad scales. Remote sensing offers untapped potential for detecting mast events at regional and continental scales. We present results from an investigation into the detection of white spruce mast events using Landsat images over the Kluane region of Yukon, Canada, for the past 20 years. We combine these remote sensing observations with detailed ground surveys to demonstrate that, with proper image timing in the early autumn season when mast seeding becomes most apparent, these events are indeed detectable using satellite-based observations. We have found that certain multispectral band combinations and vegetation indexes derived from the Landsat images clearly indicate an optical signature that can be attributed to seed cone condition following seed release and, potentially, precursor physiological aspects of resource allocation during the mast event. These results can then be extended from individual survey sites to surrounding areas, with the potential for near-real-time detection of mast events and their synchrony over large regions.

Keywords: Landsat, mast seeding, phenology, white spruce