Landsat-based detection of masting in white spruce (*Picea glauca*) forests

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Submitted to *Remote Sensing of Environment* (Elsevier) on 27 April 2020

Revision 1 submitted on 27 October 2020

Revision 2 submitted on 21 December 2020

ABSTRACT

Mast seeding in conifers is characterized by the spatially synchronous and temporally variable production of seed cone crops. Large mast seeding events (known as "mast years") can be a visually stunning and ecologically important phenomenon, supporting trophic interactions and survival of seed predators as well as forest regeneration. Documenting patterns in mast seeding is generally labor-intensive, requiring repeated visual cone counts at consistent and widespread locations over long periods to quantify the spatiotemporal variability of cone production. Our goal in this work was to evaluate the correspondence of multispectral vegetation indexes (VIs) from Landsat with ground-based observations of mast seeding in white spruce (Picea glauca) forests of the Kluane region, Yukon, Canada. Given the visual characteristics of mast seeding in white spruce, we tested: 1) whether photosynthesis- and color-oriented VIs can identify senescence of spruce cones in late summer and autumn during mast years, and 2) if moisture-oriented VIs can distinguish the significant drying of seed cones from the surrounding spruce canopy vegetation during that senescence and after seeds are released. We hypothesized that the slope of late season decline in VIs in spruce forests would be related to masting (i.e., greater decline in VI during mast years). Using generalized linear mixed-effects modeling (GLMM), we compared more than 100 site-year combinations of mast/non-mast observations to develop VI-based regressions. We found some success identifying mast years with moisture-oriented VIs, while models using the photosynthesis- and color-oriented VIs were not supported, given the data. However, we found that models containing multiple VIs from both categories were more successful than any single-VI model, accurately predicting four of sixteen mast events in site observations. We provide compelling evidence that mast-seeding patterns may be detectable using moisture-oriented Landsat observations over large coniferous forest areas. Additional work is warranted to distinguish the signal for mast events from confounding disturbance-related effects and to differentiate variation in VI signals attributable to masting productivity in contrast to effects of climatological variability on reflectance.