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Mast seeding patterns in response to climate change

My research background: I am an Assistant Professor in the Department of Biological Sciences at DePaul University. I have been studying patterns of mast seeding for 16 years, and my primary research focus is on conifers, and in particular, white spruce (*Picea glauca*). I have developed methods for assessing cone production on white spruce (LaMontagne et al. 2005), and for identifying the occurrence of mast years within datasets (LaMontagne & Boutin 2009). I study synchrony in mast seeding (LaMontagne & Boutin 2007; Wang et al. 2017), and climatic determinants of mast seeding (Krebs et al. 2012). Since 2012, I have been studying scales of synchrony in mast seeding and drivers of variability and synchrony in white spruce masting across spatial scales including nearly 1000 individual trees across 18 sites in Minnesota, Wisconsin, and Michigan. I am also studying spatial and temporal patterns of mast seeding in conifer species across North America.

Research premise: Mast seeding is the pattern of synchronous production of highly variable seed crops by perennial plant populations. It occurs in numerous species in temperate, tropical, and boreal regions. Bud differentiation into either reproductive structures or vegetative buds is believed to be influenced by temperatures during bud differentiation, with a higher production of reproductive buds in conifers associated with higher temperatures. There are opposing predictions for how reproductive patterns of conifers will respond to a warming climate. For instance, there could be less variability in reproduction over time, with more mast years, because there will be more consistent signals for masting, or no impact on variability in masting patterns because it has been proposed that the difference in temperature between years is what matters and not annual temperatures experienced (Kelly et al. 2013). Black spruce (*Picea mariana*) has relatively low variability in cone production over time, but will still produce cones in abundance on occasion, with peak crops occurring about every 4 years (Viereck & Johnston 1990). Tamarack (*Larix laricina*) has good seed crops at intervals of 3 to 6 years (Johnston 1990). My research will test alternative hypotheses for the influence of climate warming on mast seeding patterns in black spruce and tamarack. Differences in cone structures (i.e., semi-serotiny in black spruce) and the deciduous nature of tamarack could contribute to differential impacts of warming on patterns cone production.

Methods: I will count cones on all black spruce and tamarack trees in each chamber annually during July. The number of visible cones will be counted on trees using binoculars as an index of productivity. I visited the site in July 2017 to test the cone count methodology of LaMontagne et al. (2005) to ensure that the tops of trees were visible within the chambers, and the method works on all trees in the chambers. Cone production will be divided by tree size (dbh) for size-adjusted reproduction. Variability in mast seeding will be measured as the coefficient of variation (CV), which I will calculate in mean reproduction across years (testing the Kelly et al. hypothesis), and across individuals within chambers (I expect a lower CV across individuals at higher temperatures). Mean cone production across trees within years will be compared across temperature treatments. I could also potentially look at collecting pollen or counting pollen cones on trees, allowing comparisons in allocation to male and female reproductive structures with warming.

Relation to other SPRUCE projects: I am interested and open to opportunities to collaborate with others involved with the SPRUCE project. For instance, in a warming environment, cone production could be related to seed production that is being collected in the chambers, temperature influences phenology, and patterns of cone production by individual trees in relation to growth increments could be influenced by the temperature treatments.

Relevant research publications:

Kelly, D., A. Geldenhuis, A. James, et al. 2013. Of mast and mean: differential-temperature cue makes mast seeding insensitive to climate change. Ecology Letters 16: 90-98.

Krebs, C.J., J.M. LaMontagne, A.J. Kenney & S. Boutin. 2012. Climatic determinants of white spruce cone crops in the boreal forest of the southwestern Yukon. Botany 90: 113-119.

LaMontagne, J.M. & S. Boutin. 2007. Local-scale synchrony and variability in mast seed production patterns of *Picea glauca*. Journal of Ecology 95: 991-1000.

LaMontagne , J.M. & S. Boutin. 2009. An evaluation of quantitative methods for defining mast-seeding years across species and studies. Journal of Vegetation Science 20: 745-753.

LaMontagne, J.M., S. Peters, & S. Boutin. 2005. A visual index for estimating cone production for individual white spruce trees. Canadian Journal of Forest Research 35: 3020–3026.

Wang, Y, J. Zhang, J.M. LaMontagne, F. Lin, B. Li, J. Ye, & Z. Hao. 2017. Variation and synchrony of tree species mast seeding in an old-growth temperate forest. Journal of Vegetation Science 28: 413–423.