HURON MOUNTAIN WILDLIFE
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Newsletter

Exercise in Cleverness: Seed Production in White Spruce

By Jill Riddell

A few years after the apple trees we planted in our yard in Chicago started to bear fruit, I couldn't understand why some summers the trees didn't make any apples. One year we'd have so many we'd pour bucket after bucket of apples into a cider press, trying to keep up, and the next, we'd harvest no fruits at all. Was it pollinators? Weather?

An artist friend who had put her studio in an orchard in Michigan clued me in that fruit production in many varieties of apple trees is biennial. "Making tons of apples one year, then none, and then lots again the following year," she said, "That's completely normal."

Mystery solved. But then I started noticing something new: the oak trees in our yard followed a similar cycle, where some years they produced acorns and other years zero.

This phenomenon of how seed production fluctuates from year to year in trees is the subject studied by Huron Mountain Wildlife Foundation researcher Jalene LaMontagne, an assistant professor at DePaul University in Chicago. "It's actually a reasonably common pattern in the plant world," LaMontagne says. "Some plants have patterns of seed production where they take a year off, or a few years off, between seed production. It occurs all over the world. It happens in pines, snow tussock plants in New Zealand, bamboo in Asia."

Jalene LaMontagne returned studies seed production dynamics in white spruce near the southern edge of the tree's range. These studies allow assessment of effects of climate on an important food source for birds and small mammals.

The proper term for this process is "mast seeding." "Mast" is the term farmers used to use for the acorns and beechnuts that fell into fields where pigs were kept. A "mast year" was one when those nut trees produced a lot of mast—a prodigious crop of seeds. If it was a mast year, pigs were well fed and the food was free of charge. Farmers observed this cycle and later tracked seed production cycles to predict when mast years might occur. It was important information because those were years when more pigs could be raised.

White spruce seed dynamics

This summer, LaMontagne completed her sixth year of field study in the Huron Mountains on seed production in white spruce trees. It is one of three field sites where she conducts this research. (One of the other two is near Duluth and the other is in northern Wisconsin.)

"At the Huron Mountains, 2013 was a mast year with lots of cones. This summer, 2017, was another year with lots of cones," says LaMontagne. "We seem to be seeing four to six years between big mast years in white spruce in our study sites."

"Does weather have an affect on whether it's a mast year?"

"There's a cue linked to weather but not entirely controlled by it. The summer the year *before* cones are produced is when the tree has to decide whether it's going to invest its resources in greater growth and growing more needles or whether it's going to use that tissue to make seed-producing cones.," LaMontagne says. "After a summer when it's been hot and dry, it's possible that next year you're going to get more reproductive cones."

To gain the energy a tree needs to grow, it photosynthesizes, turning sunlight into energy it uses to fuel either growth or reproduction. "Trees can't produce cones from nothing. They have to make a choice," says LaMontagne. "If they're going to have a cone-making year, that comes at the expense of their growth."

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Left: A student from DePaul University records data on cone production of white spruce at the Huron Mountains. Understanding fluctuations in plant reproductive investment is a key challenge in ecology, conservation, and management. Right: A cone holds a conifer tree's reproductive structures. The large, familiar woody cone is the female cone; these are the cones that contain the seeds. Here, female white spruce cones are just getting started growing. Male cones are much smaller and don't survive for very long. After releasing pollen, male cones quickly deteriorate. *Photos by Jalene LaMontagne*

Advantages of Mast Seeding as a Strategy for Plants

Mystery remains about why some perennial plants mast seed rather than making a smaller amount of seed at a steady pace, year in and year out. "One theory is called 'seed predator satiation,' and the idea is that it's advantageous in most years to produce low amounts of seed so you're not steadily feeding the predators that eat your seed," says LaMontagne. "The predator population stays low and then when the predators don't expect it, the trees suddenly produce large pulses of seeds."

In the case of white spruce cones, one of the predators are red squirrels. If the grove of white spruce trees near Flat Rock, for example, produced the same number of cones each year, the population of red squirrels would increase to a level where the number of squirrels was precisely the right amount to consume every seed the white spruce make. By not producing seed for several years, the white spruce trees keep the population of squirrels lower. In a mast year, there aren't enough squirrels present to devour every last seed. Some seeds survive.

"Then there's the 'pollination efficiency hypothesis,'" says LaMontagne. "White spruce are wind pollinated, so it pays for them to put lots of pollen in the air and to have lots of female cones growing all at the same time, on every tree. There are much better odds for cross-pollination than if only some individuals are reproducing."

Discoveries in the Huron Mountains

LaMontagne looks at cone production synchrony by comparing individual trees, by comparing trees across different locations within each study site—like what the white spruce by Conway Bay are doing compared with those by Ives Lake—and by comparing what's happening in the Huron Mountains with what she's observed at study sites in Minnesota and Wisconsin. She and her assistants don't just track cones; they also collect data on each tree's trunk diameter, height and needle volume. They also utilize weather stations to track temperatures at their locations every two hours throughout the entire year.

"At the Huron Mountains, I've tagged almost every white spruce there is in my sites," she says. "I've tagged almost four hundred trees. We track them all."

In an article in DePaul University's science publication, LaMontagne said, "'One of the most striking findings so far is that there can be two trees that are fairly close to one another and yet they are doing different things in terms of cone production. This suggests that it's more than just the weather controlling the patterns of synchrony.' Since seeds form the base of the food chain, LaMontagne's research offers biologists greater insight not only into these Midwestern boreal forests, but also into the insects, birds and mammals who rely on seeds for survival." (*Scientia,* Spring 2016.)

Future of the Work

"One challenge is the number of years it takes to gather data. Sometimes a science experiment takes a month. But a field project like this takes many years," LaMontagne says. "Usually, scientists have to generalize—they have to answer the question: 'What is the average tree doing?' The advantage of our long-term study is we can ask: 'What's the *individual* tree doing?'"

In any given year, there will be some small number of trees producing lots of cones, LaMontagne has discovered. About twenty percent of trees don't seem to follow the group. She's curious to know more about what the consequences are for the aberrant trees that don't produce their biggest quantities of seed in the same year as the majority. "Two trees right beside each other, one might have lots of cones and the other has few or none."

LaMontagne has received National Science Foundation funding for two more years of research. "This project has made me think of how variable the world is," LaMontagne says. "It's more complex and variable than we tend to realize."

Lake Superior shoreline. *Photo by Pamela McClelland*

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Notes From Annual Meeting

By Kerry Woods

The Foundation's annual meeting is typically a double feature, offering a talk by a researcher supported by the Foundation and the presentation of an award. The annual meeting this summer combined both in one double-barreled program, with the researcher who presented also receiving the Award.

This year was the fourteenth year of our offering the William and Anne Manierre Award to recognize the publication of research based on work conducted at the Huron Mountains. It was given to the authors of a paper on Rush Lake's distinctive lake trout published in the *Journal of the Linnaean Society.* The paper describes ecological, physiological, and genetic studies of the two distinct forms of lake trout (or "lake charr") that coexist in the lake. The paper has ten authors who collaborated on the work from eight institutions in the U.S. and Canada. The Manierre Award was presented at the meeting to two of these authors: Dr. Louise Chavarie, of Michigan State University, who was the lead author and drew various parts of the study together, and to Dr. Mara Zimmerman of the Washington State Department of Fish and Wildlife who initiated the study over ten years ago while at the Great Lakes Fishery Commission in Ann Arbor.

The Manierre Award went to researchers studying lake trout. Dr. Mara Zimmerman (award winner); Bill Manierre, Anne Sheret, Dr. Louise Chavarie (award winner); Kerry Woods. The award was presented in August at the annual meeting. *Photo by Buffie Finkel*

The morning after the annual meeting, the two biologists who won the Manierre Award led a field trip out to Rush Lake to seine for small fish. *Photo by Jill Riddell*

Dr. Chavarie delivered the keynote, placing this study in the larger context of her group's work on the occurrence of multiple lake trout forms (or "morphs") in a number of very large lakes across northern North America, including Lake Superior. The researchers wanted to know how such forms might have evolved, how genetically distinct populations could have developed within the same lakes, and what the ecological relationships are that permit their continued coexistence. The presence of distinct forms in Rush Lake was particularly interesting, Dr. Chavarie said, because Rush Lake is so small compared to other lakes that have multiple morphs. The surface area of Rush Lake was less than one-thousandth the size of any of the other lakes studied.

The presence of a small, deep-water form in Rush Lake had been known since the 1920s, but this project was the first to document the ecological and genetic relationships between it and the larger, typical lake trout. The authors of the paper hypothesize that the recent establishment of rainbow smelt in Rush Lake (first documented, in fact, during the team's initial studies in 2006), as abundant prey for the deep-water "huronicus" form, may change ecological relationship with the potential of disrupting the existing balance between the two forms.

The paper is called "Challenge to the Model of Lake Charr Evolution: Shallow-and Deep-Water Morphs Exist Within a Small Postglacial Lake." *Link to the paper at www.hmwf.org on the Manierre Award winners page under the "News" tab.*

Photo by Jim Harwood

RESEARCH PROGRAM PRODUCTS

Research sponsored by the Huron Mt. Wildlife Foundation continues to bear fruit in the form of both peer-reviewed publications and conference publications. Here is a list of such products we've learned about since the last listing. The collection of conference presentations is particularly rich; since these are typically early versions of papers in preparation for journal submission, this bodes well for ongoing productivity of the Foundation's program.

PEER-REVIEWED PUBLICATIONS

Costello, D. M., E. J. Rosi-Marshall, L. E. Shaw, M. R. Grace, and J. J. Kelly. 2016. A novel method to assess effects of chemical stressors on natural biofilm structure and function. Freshwater Biology 61:2129–2140.

Waller, D. M., S. E. Johnson, and J. C. Witt. 2017. A new rapid and efficient method to estimate browse impacts from twig age. Forest Ecology and Management 404:361–369.

Werner, T. and J. Jaenike. 2017. Drophilids of the Midwest and Northeast. https://humanities.lib.rochester.edu/drosophilaguide/

CONFERENCE PRESENTATIONS

Chavarie, L., et al. 2016. Challenge to the model for lake charr evolution: Co-existence of shallow- and deep-water morphs in a small postglacial lake. Canadian Conference for Fisheries Research, St. John's, Newfoundland.

Chavarie, L., et al. 2015. Co-existence of Lake Trout morphs in a small post-glacial lake challenges the prevailing model of Lake Trout diversification. American Fisheries Society, OR.

Dye, A., M.R. Alexander, N. Pederson, and A. Hessl. 2017. Large trees are primarily driving stand biomass accumulation. Association of American Geographers Annual Meeting, Boston, MA.

Leeper, A.C. & J.M. LaMontagne. 2017. Reproductive trade-offs in a mast seeding species. Poster presented at the Canadian Society for Ecology & Evolution Meeting. Victoria, British Columbia, Canada.

Leeper, A.C. & J.M. LaMontagne. 2017. Reproductive Trade-Offs in a Mast Seeding Species. Presented at the Midwest Ecology and Evolution Conference, University of Illinois, Urbana-Champaign, IL.

Marcarelli A., Kohler A., Ebel J., Collins S., Baxter C., Huckins C. 2017. Ecosystem science bolsters fisheries management: lessons from stream restoration projects in Michigan and Idaho. Michigan Chapter of the American Fisheries Society Annual Meeting, Mackinaw City, MI.

Marcarelli A.M., et al. 2017. Of Small Streams and Great Lakes: Carbon and Nutrient Cycling in Linked Terrestrial-Stream-Lake Networks. American Water Resources Association Spring Specialty Conference, Snowbird, UT. (Invited)

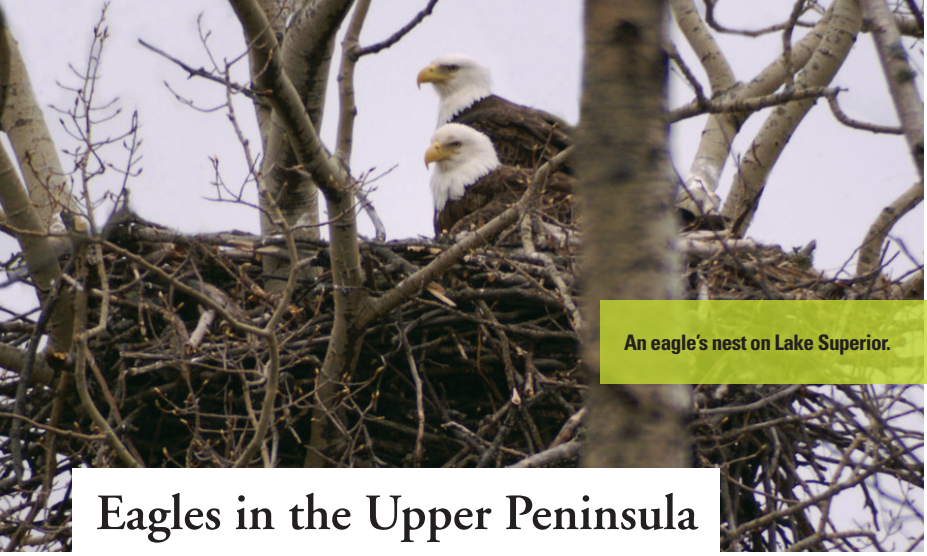
Marcarelli A.M. 2017. Food web and ecosystem connections between forests and streams. The Michigan Society of American Foresters Spring Meeting, Marquette, MI. (Invited)

Murchie, K. et al. 2017. Using citizen science to track Great Lakes fish migrations. State of Lake Michigan Conference, Green Bay, WI.

Muzika, R. and W. Carson 2016. Using boulders to evaluate the effects of overbrowsing in eastern deciduous forests. Northeastern Natural History Conference.

Nevorski, K.C., Marcarelli, A.M., Huckins, C.J., Eggert, S. 2017. Long-term open water metabolism estimates associated with sediment restoration in a low-gradient river. Society for Freshwater Science Annual Meeting, Raleigh, NC.

Woods, K.D., 2017. Cross-continental comparisons of multi-decade tree mortality in old-growth temperate forests show convergent patterns of life-history differentiation and non-equilibrial dynamics. International Association for Vegetation Science Annual Symposium, Palermo, Italy.



An eagle's nest on Lake Superior.

Eagles in the Upper Peninsula

By Declan Spring

There aren't too many things more thrilling than spotting a bald eagle. From their nests, they lord over terrain with awe-inspiring majesty. At the Huron Mountains, eagles can be seen at the West End Beach, the mouth of the Salmon Trout River, swooping over the road to the Ives Lake Science Station, or even at the Narrows between First and Second Pine Lakes.

After almost going extinct, the bald eagle population in the Upper Peninsula of Michigan has increased. Banning DDT in the sixties and passing the Federal and the Michigan Endangered Species Acts in the seventies saved bald eagles. Once down to 1,000 nests nationwide, there are now over 800 in Michigan alone—including, in the past decade, one large nest prominently located along the south end of Salmon Trout Bay.

Photo by Paul Sundberg

About the Huron Mountain Wildlife Foundation:
Since 1955, the Huron Mountain Wildlife Foundation has supported original research in a wide variety of scientific fields. The research takes place in the Upper Peninsula of Michigan. More information on the Foundation can be found at: **www.hmwf.org**

We welcome comments and suggestions on this newsletter. Please send them to:

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