Kemp's Point

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News from the University of Wisconsin-Madison's Kemp Natural Resources Station

OAKy.....Which nitrogen TREEment works best?

By Dr. Nick Balster, UW-Madison Department of Soil Science & Forest and Wildlife Ecology

Millions of tree seedlings leave the care of forest nurseries each year to be planted into the "real world," especially in the forests of northern Wisconsin. However, very little is known about how these tiny, young trees do out there on their own. Do they succeed? What is their vigor? Knowing this information would help forest managers modify traditional silvicultural practices to maximize survival and sustain productive growth within the ecological complexity of an ever-changing world. And as a consequence the diversity and health of our forests would increase.

Before (right) and after (above) a subsample of 17-year-old red oaks were collected. Undergraduate, Devin Mulrooney, is shown with the newly thinned study plot.

Intrigued with the question of nursery seedling success, my Ph.D. student, Ryosuke Fujinuma, and I decided to set up an experiment to examine the long-term growth, biomass allocation, and physiological response of out-planted Northern red oak seedlings, which just happens to be my favorite tree. In 2003, we hand planted 720 seedlings divided between two locations -- one in southern Wisconsin near Madison and another at Kemp Natural Resources Station. Knowing that nitrogen is a key macronutrient in plant-soil relationships, often providing the competitive edge for survival and growth, we specifically selected seedlings reared under six different nitrogen fertilization regimes, including a treatment of zero nitrogen supplements, at the Boscobel State Forest Nursery in Boscobel, Wisconsin. And that's where the fun began.

Knowing that critters love to dine on fresh seedlings, especially with higher amounts of nitrogen in their tissue (I swear deer and rabbits can smell this nitrogen), both sites were fenced during planting. But no dice! After the first growing season, Ryo and I were quite perplexed when nary a tree could be found at the southern location the following spring despite the carefully constructed fencing. Upon closer investigation, we discovered that ground squirrels had tunneled under the fence and ate each and every one of the seedlings – 360 trees in the bellies of some happy rodents! Fortunately not all was lost, as the northern site at Kemp had

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OAKy..... *(Continued from Page 1)*

not experienced such predation. Although, there was one incident, when Ryo and I luckily stumbled onto a hare and two deer that had made their way into the enclosure, where a tree outside the plot had fallen and breached the fence. It was quite the experience to chase a snowshoe hare and two deer from an enclosed area with only one outlet! But after these initial surprises, we forged ahead with the experiment at Kemp. And it is here where we especially need to thank the crew at Kemp, especially Gary Kellner, for all their help in maintaining the site over the years.

Above & Right: Members of the Balster Lab process the harvested trees into smaller pieces for transport to campus. Below: Dr. Nick Balster stands in the dry lab at Kemp Station with tree parts for later transport to campus.

Although Ryo, now a full professor at The International Christian University in Mitaka-Shi, Japan, has had to watch from afar as these seedlings have become 30-foot-plus-tall trees, the experiment he helped establish has and continues to yield so many worthwhile dividends. Over the past 17 years, the project has supported eight undergraduate research projects as the trees have been repeatedly measured and sampled. It has provided data that has gone into classroom exercises and lecture example. It has provided a large deer exclosure for others to measure rare plants and bird utilization. And now it is providing the research study for Devin Mulrooney, an undergraduate majoring in Environmental Sciences who won a Holstrom Award in 2020 to support this research, one of four given out each year! Devin is overseeing the "final curtain" to this research that entails harvesting a subsample of the trees and measuring how biomass has been allocated over the years and if differences exist between the fertilization treatments when they were mere seedlings in the nursery.

To accomplish this herculean task, Devin and I, along with the help of the two additional undergraduate researchers, Cole Koffron (Environmental Sciences) and Jaya Suneja (Biological Systems Engineering), and one masters, James Winkelman (M.S. Soil Science), all from my lab, spent time at Kemp this summer measuring the trees. After measuring the diameter and height of every tree at the site, we randomly harvested 36 trees for the additional analysis. It was difficult work as we had to somehow get the total biomass (leaves, stems, branches) of all these trees cut up into bags and transferred back to Madison where they could be further analyzed. In addition, Devin extracted disks (cookies) from the bole of each tree, one at the base and another at breast-height to assess relative growth and vitality. Needless to say, we had our work cut out (pun intended) for us and especially for Devin, as he continues to oversee the entire process from the initial proposal to his goal of publishing the results in a peer-reviewed journal.

The lines between his undergraduate experience

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Kemp Profile: Emma Keele

Hometown: Hastings, Nebraska

Educational background and current area of study: I received a Bachelor's in Wildlife Biology from University of Nebraska-Kearney. Now I am a Master's student at Indiana University of Pennsylvania.

How is your research funded?
Through the USDA Natural Resources Conservation Service (NRCS)

What question does your field research answer?
Do young forests and shrublands that are managed for the declining golden-winged warbler also benefit monarch butterflies and other butterflies and bumblebees?

Describe a typical day of fieldwork:
In the morning we would drive to our first study site (usually 1-1.5 hour drive) and arrive by 10 am, the earliest our surveys could begin. Once parked and we had our supplies ready (most importantly prepared for ticks), we would hike about 0.5 - 1 mile to the study site location. First, one person would conduct the pollinator survey. The individual had to slowly walk the perimeter of a 500-meter monitoring plot in 25 minutes and record any monarchs, other butterflies, and bumblebees, along with its distance from transect, behavior, and any plants the pollinators might have been nectaring on. Additionally, if milkweed was spotted, we would record it and search the plant for monarch eggs and larvae. While this was happening, the other two individuals would conduct a flowering plant survey. This involved placing one-square-meter subplots every 5 meters along 500 meters of transect (100 subplots per monitoring plot). Within each subplot we identified all flowering plants and counted the number of flowers for each species. It would take us about 1.5 - 2 hours to finish all our surveys at one study site. After the first site we would eat our lunch in the field. Next, we would travel to the 2nd and 3rd study sites of the day and complete the same surveys. We typically returned around 6-7 pm (depending on driving time).

What challenges did you face working on this project?
During the first week we were setting up the monitoring plots. To do this we marked out our transects with brightly colored flagging tape on vegetation about every 5 - 10 meters, so that during each visit we could just follow the flags during the survey. During the first day of setting up our monitoring plots, we were using bright yellow/green flagging tape, which I thought would be easily visible. Unfortunately, it was basically the same color as the aspen leaves, which meant the next time we visited the site we could not see the flagging tape we had used to mark the transects! We had to retape those sites that were setup on the first day, about an hour of repeated work.

Other challenges included: having to juggle/move around field days based on the weather (we could not do the surveys in rain), purchasing unexpected supplies, figuring out how to best hike to the study site, and maintaining a positive attitude while walking through rough vegetation (thorns, dense shrubs, waist deep mud/water).

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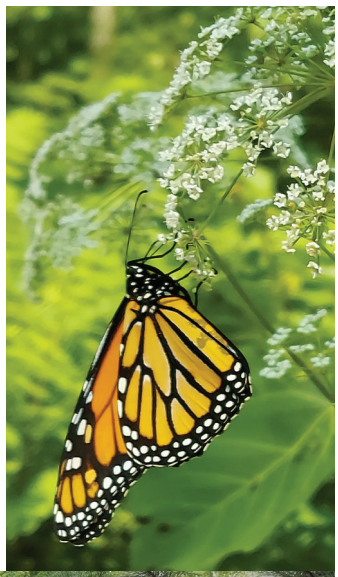
Kemp Profile *(Continued from Page 3)*

What have you enjoyed most working on this project?

We visited the same study site three times throughout the summer (once in June, July, and August). I really enjoyed observing the vegetation change throughout the summer. We saw a lot of spring ephemerals (trillium, jack in the pulpit) in June and in August there was an explosion of goldenrod and other asters. During our surveys we also saw a lot of other exciting creatures like other caterpillars, bird nests, birds, deer, bear, porcupines, toads, and lots of other insects. My co-workers and I commonly said every day brought something new and exciting or unexpected!



Emma, far right, with field technicians Eric Bastidas, left, and Claire Ratcliff, center.

Outreach Returns

Kemp Station was pleased to hold two outdoor outreach sessions late in the season after more than a year off due to COVID-19 restrictions. First up was Dr. Glen Stanosz who gave an informative and beneficial presentation about hazard trees (*right*). Attendees learned about the ways arborists assess trees and determine risk.

Next was the return of Kemp's annual Fungi Fest. The weather cooperated and the morning foray resulted in a large table filled with fungi collected from the forest (*below*). After a discussion about the finds led by Dan Lindner and Anne Small, participants visited a number of outdoor learning stations where various fungi related topics were presented.

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and the responsibilities of a graduate student have blurred for the better!

There are no preliminary results to report thus far except that every tree that received zero nitrogen supplements in the nursery had died by year two of the experiment, i.e., 100% mortality in the control group. Beyond that, Devin is hard at work this semester processing the data, working through the statistical analysis, and writing, writing, writing. We are anxious and excited to see the results of this 17-year study in large part because, harkening back to the beginning of this article, this research marks a unique contribution to an understudied area of forest science that couples both applied and basic science. We will be sure to let the Kemp community know what we discover. Stay tuned!

Kemp Specimens Added to Wisconsin Odonata Survey

An early September visit by Dr. Ken Tennessen, author of The Dragonfly Nymphs of North America: An Identification Guide, and a few of his colleagues resulted in two notable discoveries. While exploring the bog around Kemp Station's Jyme Lake, two new darner species were found. *Aeshna subarctica* (above left), commonly known as Subarctic Darner, is a northern species of bogs and fens. Tennessen comments, "There are very few records in Wisconsin; it's been recorded in only 6 northern counties." Also collected was *Aeshna tuberculifera* (above right), known as the Black-tipped Darner.

Species in the genus, *Aeshna*, are known as "Mosaic Darners" and fly mainly in late summer and fall. Large, fast-flying dragonflies, are colorful with mainly blue, sometimes green, stripes and spots on a brown to black body. The pattern of striping on the thorax is important for identification of the species. Males of these two large dragonflies patrol over the edge of the lake and around the sphagnum edges, looking for females laying eggs down in the vegetation.

In North America 15 species of "Mosaic Darners" are know, with 10 species found in Wisconsin. Prior to these recent discoveries, only 4 of the 10 species were recorded for Oneida County. According to Tennessen, "It is likely that at least 3 other species occur in the county, but more surveys are needed." The two new species are now part of the Oneida County records on the Wisconsin Odonata Survey. Learn more about dragonflies and damselflies and how to report new sitings to the Wisconsin Odonata Survey at https://wiatri.net/inventory/Odonata/.

The Pursuit That Ended Poorly

Every 7-10 days throughout the summer I would swap the collection bottles from the two Malaise traps that were deployed at Kemp Station by Dr. Dan Young of UW-Madison's Department of Entomology. The insects collected in these traps are being added to the Wisconsin Insect Research Collection. The collection bottles contain ethyl alcohol so I would pour some of the contents through a small strainer into a jar. Imagine my surprise when a tree frog landed in the strainer during the pour! "Poor" indeed! This little tree frog made an unfortunate when it pursued its prey and fell into the collection bottle, plunging to its untimely death along with its pursued prey. *-KO*

The *Other* Mistletoe

By Dr. Glen Stanosz, UW-Madison Emeritus Professor of Forest Pathology

Most of us only know of mistletoe as a holiday decoration, greenery with white berries under which sweethearts might exchange a holiday kiss. That plant is "leafy mistletoe," with evergreen leaves like the holly that is often used for holiday decoration. But there is another, less well-known plant that is not valued for decoration (or stimulating romance). This other mistletoe is "dwarf mistletoe" found in our northern Wisconsin forests (including at Kemp Natural Resources Station).

Both leafy and dwarf mistletoes are flowering, seed-producing plants in the family *Santalaceae*. Like other plants, they possess chlorophyll, and use the sun's energy and absorbed CO_2 to produce carbohydrates needed for growth and reproduction. But mistletoes are disease-causing pathogens. Unlike most plants that grow independently in soil, mistletoes grow only in the crowns of trees they parasitize. By leaving the soil, mistletoes have escaped competition with other plants and grazing by ground-dwelling animals.

Just one species of dwarf mistletoe, *Arceuthobium pusillum*, is found in the northeastern USA, and eastern Canada. Black spruce is the typical host in Wisconsin, but other spruces, balsam firs, tamaracks, and some pines can be affected. In areas where black spruce is a commercially managed forest resource, damage can be severe.

Dwarf mistletoe female plants produce berries after fertilization with pollen from separate, male plants. Small white berries are produced, and fill with fluid as they ripen. Mature berries burst with great force, expelling seeds at speeds as much as 60 miles per hour! This unusual mechanism can propel seeds dozens of feet from the diseased tree. A sticky substance called viscin coats the seeds and allows them to adhere when they land in crowns of other trees. Following seed germination on a young spruce shoot, the emerging dwarf mistletoe "root" penetrates directly through the twig surface.

Figure 1.

Following infection, strands of the dwarf mistletoe grow within host tree twigs and branches, absorbing from the tree the water, nutrients, and carbohydrates the mistletoe needs for growth and reproduction. It takes a few years of growth within the infected twig before shoots of the dwarf mistletoe plants emerge. But without the need to produce abundant foliage to produce their own photosynthates, stems are small and bear only tiny, scale-like leaves. Shoots of our Wisconsin native dwarf mistletoe are tiny, and can be hard to see among the tree's needles (*Figure 1*).

In addition to robbing their hosts, dwarf mistletoes cause trees to proliferate shoots on the diseased branches. These clusters of shoots form dense "brooms" that deform tree crowns. while producing even more photosynthates to benefit the dwarf mistletoe. Brooms can occur throughout tree crowns, and brooms can grow from one to three or more feet in diameter (*Figure 2*). Brooms may be used as shelter for a myriad of small animals and as bird nesting sites. But brooms also serve as "fire ladders" to carry flames from ground fires upward to result in rapidly spreading and dangerous crown fires.

Being obligate parasites that depend on living host trees for their own survival, effects of dwarf mistletoes accumulate slowly. But years of parasitism can dramatically reduce growth and eventually lead to tree death, when of course the dwarf mistletoe plants also die. In areas where black spruce is a com-

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Figure 2.

mercial forest crop, management of dwarf mistletoe to prevent tree growth loss and mortality can be necessary. Seeds launched from mistletoe brooms spread the pathogen within tree crowns and to neighboring trees. Infestations tend to grow to many acres, only interrupted when non-host trees are encountered.

Wildfire was the way nature "managed" this disease. By killing all trees in an area, the mistletoe was eradicated. Forest managers emulate nature's method by clearcutting or burning mistletoe-infested stands to eliminate diseased trees. But this effort must be thorough, because even one diseased tree can be the source of mistletoe seed to result in reinfestation of the subsequently produced black spruce stand. Alternatively, because our black spruce mistletoe is host-specific, another tree species might be favored if site conditions permit.

So when you hike the Northwoods, take a moment to follow the bog trail (or visit Jyme Lake at Kemp Natural Resources Station). Risk getting your feet wet to take a closer look at the black spruce. Perhaps there are brooms. And with an even closer look, you just might see the *other* mistletoe.

Study of Young Walleye

Left: Ana Sara and field technician Eric Naas remove larval fish from gill nets. Below: Age-0 walleye.

AnaSara Gillem, a graduate student at UW-Stevens Point, spent a lot of time on boats this summer on northern Wisconsin lakes where walleye are facing recruitment challenges. She explains that "...'recruitment' refers to the number of fish that survive to a certain age or size, and for my study it is indexed at age 0." From her samples, she will look at the diets of larval walleye to determine the relative importance of zooplankton and larval fish as prey items. She is also examining young-of-year yellow perch from spring to fall to see if there are any differences in abundance between lakes with sustaining versus declining natural walleye recruitment. "Recent research has suggested that walleye and yellow perch recruitment are influenced by similar factors, so that's why I'm looking at age-0 perch abundances between the two different walleye recruitment histories." Zooplankton samples were also collected to determine if the density and spatial and temporal distribution of zooplankton prey differs between lakes with sustaining and declining natural walleye recruitment. AnaSara will continue her study next summer.

University of Wisconsin
Kemp Natural Resources Station
9161 Kemp Road
Woodruff, WI 54568

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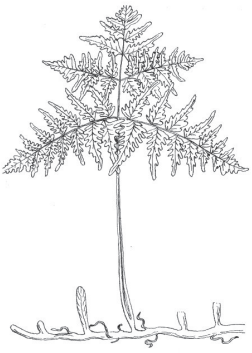

Bracken Fern (*Pteridium aquilinum*)

Travel anywhere in northern Wisconsin and you will see bracken fern. It is common throughout the state, and North America, in forest clearings, pastures, and along roadsides. It is prolific -- "In number of fronds produced it is probably the most numerous fern in Wisconsin," according to the UW-Green Bay's herbarium listing. Bracken fern can survive a forest fire because the main rhizome system is far enough below the surface at 3.5-12 inches. Fire actually helps this fern by removing all of its competitors, creating an alkaline soil surface that supports good spore germination, and greater spore production occurs on the young plants in the post-fire, sun drenched habitat. Over time, bracken promotes fire because of the thick layer of dead fronds that accumulate each fall. From a competition perspective, this same frond layer will smother other plants, provided they did not already fail to thrive in the shade of the fronds during the summer. Bracken fern produces and releases allelopathic chemicals into the soil which can also prevent other vegetation from growing nearby. It is known to be poisonous to livestock, but is commonly used as a food for humans, with the young fiddleheads being a popular wild edible in the spring. Bracken has been determined to contain carcinogenic properties, and is being looked at as a source of insecticide development. Historically, the fern has served humans well, as thatch for roofs, fuel for fire, and during the Middle Ages was a valuable commodity that was used to pay rent. The complexities of this plant have evolved over 55 million years, during the "Age of Mammals," when mammals were also evolving, making its toxicity to livestock an interesting fact.

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Karla Ortman, Editor
Kemp Natural Resources Station
9161 Kemp Road
Woodruff, WI 54568
(715) 358-5667
kemp@cals.wisc.edu

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