The Woodland Steward

Promoting the Wise Use of Indiana's Forest Resources

Letter from the Editor

Brian MacGowan

Spring is finally upon us. With its arrival comes a reminder of all the fauna and flora that call our woodlands home. I hope many of you can get out in the woods and enjoy it. Spring is also a season of change. Here at the Woodland Steward, we are no different with a recent change of leadership. With a change of jobs, Dan Shaver stepped down as president of WSI. On behalf of the board, I would like to recognize all of Dan's hard work and dedication over the last 13+ years as our president. We wish him luck in his new position as State Forester with the NRCS in Indiana. We are also pleased to announce that Dan McGuckin will be our new president moving forward. Dan has a broad set of expertise that comes with working as a consulting forester but also working in state and federal assistance for private lands management in Indiana.

In this first issue of our 30th year, we have several stories focused around aspects of climate change. As you may suspect, changes in climate likely involve changes in our forests. How these may or may not impact woodland owners and what we can do about them is really the question. To shed some light on the subject, we have several articles written by top experts in their respective fields. Articles focus on impacts to our forests, ways woodland owners can address some impacts, how environmentally friendly are hardwood products, and climate solutions on farmlands.

As always, we enjoy receiving your feedback on stories and things you would like to see. Be sure and check out the calendar of events in this issue. We all look forward to connecting in person this year as more field days and workshops are now being planned and offered.

Sincerely,

Brian MacGowan, Editor

Indiana's Future Forests

By Melissa Widhalm

Over the next century, rising temperatures and changing precipitation patterns across the Midwest will likely have widespread consequences for Indiana's forests. Expected changes include shifts in the distributions and abundances of trees, understory plants and wildlife, as well as changes in the environmental, economic and cultural benefits these forests provide.

A recent report from the Indiana Climate Change Impacts Assessment examines the direct and indirect impacts that climate change is expected to have on Indiana's forests. The report specifically addresses forest regeneration, forest composition, tree growth and harvest, wildlife habitat and forest products. Presented here are a summary of the report's key findings:

- Predicted changes in climate – warmer, wetter springs followed by hotter, drier summers – may increase habitat suitability for a growing assortment of tree species in Indiana.

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Calendar of Events

May 6
Online webinar: Asian longhorned beetle: Everything you need to know in half an hour
11 AM ET
Registration: *http://www.emeraldashborer.info/eabu.php*

May 26
Tree Identification Hike
3 pm – 6 pm
Southern Indiana Purdue Ag Center, Dubois County
Register at 812-678-5049, *ronr@purdue.edu*

May 12
Online webinar: Thousand cankers disease: Everything you need to know in half an hour
11 AM ET
Registration: *http://www.emeraldashborer.info/eabu.php*

May 13
Online webinar: Hemlock woolly adelgid: Everything you need to know in half an hour
11 AM ET
Registration: *http://www.emeraldashborer.info/eabu.php*

May 20
Ponds 101 online webinar
12:00 pm - 1:00 pm
Register at *http://bit.ly/2Kh9vvP*

August 27-29
Hoosier Hardwood Festival
Marion County Fairgrounds
See *www.hoosierhardwoodfestival.com*

September 11
Invasive Plant Control Training for Landowners
9 am – 4 pm
Southern Indiana Purdue Ag Center, Dubois County
Register at 812-678-5049, *ronr@purdue.edu*

Dates from April – September
Hoosier National Forest Weed Wrangles 2021
learn to identify and control invasive plants More info and registration: *https://www.fs.usda.gov/detail/hoosier/workingtogether/volunteering/?cid=FSEPRD874183*

Ongoing
Upcoming local invasive species management events in your area: See https://www.entm.purdue.edu/iisc/ for times, locations, contact info.

Purdue Forestry & Natural Resources Extension is hosting weekly Facebook Live Ask the Expert series on Thursdays at 3 PM eastern, see https://www.purdue.edu/fnr/extension/join-us-live/ for upcoming programs.

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The opinions expressed by the authors do not necessarily reflect those of the Woodland Steward Institute. The objectives of the newsletter are to provide general and technical natural resource information to woodland owners of Indiana, improve information distribution and build support for responsible forest resource management.

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Indiana's Future Forests *Continued from page 1*

More species' habitats are predicted to expand into the state than retract from the state by century's end. Habitat suitability is expected to increase for 43 to 52 percent of tree species and decrease for 17 to 29 percent of tree species in Indiana.

- A longer growing season and greater concentration of carbon dioxide (CO_2) in the atmosphere may increase forest productivity and carbon uptake in the short term. However, increases in the frequency and intensity of spring flooding and summer drought are likely to reduce or erase these benefits. The wetter springs and more frequent flooding will also promote pathogen-related diseases.
- Many of the tree species (e.g., tulip trees and maples), which are positioned to become dominant due to disturbances and forest aging, are poorly adapted to the warm, drier summer conditions that are predicted by most climate models. Thus, changes in forest composition have the potential to decrease forest productivity and carbon uptake. However, management factors, such as rotation length and harvesting intensity, may influence changes in species composition and growth rates.
- Forest regeneration will be affected by changes in the climate, as well as by changes in the abundance of other species such as herbivores and understory plants. Longer growing seasons could help seedlings establish, but increased spring precipitation and flooding, as well as drier summers, may damage seedlings during sensitive phases of growth.
- Changes in climate will likely have varying effects on the proliferation of invasive plants already in the state. Warmer temperatures may increase the number of new invasive species, as plants such as kudzu and Chinese privet expand their ranges northward in response to an altered climate.
- The number of days with frozen soil is projected to drop by one-half to two-thirds by late century, dramatically shrinking the time window for harvesting trees without environmental disturbance and damage. The risk of soil rutting and erosion from harvest activities on wet soil is likely to increase in Indiana.
- Changes in wildlife population densities will be more strongly influenced by changes in forest composition than by the direct effects of a changing climate. Reforestation and restoration efforts that use climate-adapted tree species may reverse some of the negative consequences of species shifts by providing appropriate habitat for vulnerable wildlife.
- Other forest benefits are also likely to be affected by a shifting climate. For instance, maple syrup season is expected to be earlier and shorter, and some species commonly used as Christmas trees, like white pine, are likely to suffer from the warmer temperatures.

INDIANA: Tree Habitat Suitability in 2100

Northern Moraine

Decrease	No change	Increase	New Habitat
Black cherry	American beech	American elm	Black hickory
	Flowering dogwood	Black oak	Blackjack oak
	Red maple	Black walnut	Pecan
	Sassafras	Eastern redcedar	Sweetgum
	Shagbark hickory	Hackberry	
	Sugar maple	Northern red oak	
	Sycamore	Pignut hickory	
		Silver maple	
		White ash*	
		White oak	
		Yellow-poplar	

Central Till Plains

Decrease	No change	Increase	New Habitat
American beech	Black cherry	American elm	Black hickory
Sugar maple	Black walnut	Black oak	Blackjack oak
Yellow-poplar	Red maple	Eastern redcedar	Cedar elm
	Sassafras	Flowering dogwood	Cherrybark oak
	White ash*	Hackberry	Loblolly pine
		Northern red oak	Pecan
		Pignut hickory	Water oak
		Shagbark hickory	
		Silver maple	
		Sweetgum	
		Sycamore	
		White oak	

Southern Hills

Decrease	No change	Increase	New Habitat
American beech	Black cherry	American elm	Black hickory
Red maple	Black walnut	Black oak	Blackjack oak
Sassafras	Northern red oak	Cherrybark oak	Cedar elm
Sugar maple	Pignut hickory	Eastern redcedar	Loblolly pine
Yellow-poplar	Shagbark hickory	Flowering dogwood	Water oak
	White ash*	Hackberry	Willow oak
	White oak	Pecan	
		Silver maple	
		Sweetgum	
		Sycamore	

* declining due to emerald ash borer

Shown above are the projected changes in tree habitat suitability for three physiographic regions in Indiana (regions based on Indiana Geological Survey special report 81). Projections are based on the average future climate in the year 2100 from three climate models using a medium-emissions scenario. A projected species decline of >20% is classified as **Decrease**. A projected species increase of >20% is classified as **Increase**. Species with projected changes (increase or decrease) of < 20% are classified as **No Change**. Species are classified as **New Habitat** if not currently found in Indiana.

Source: Prasad et al. (2014) and Phillips et al. (2020)

You can read the full report, titled *Indiana's Future Forests: A Report from the Indiana Climate Change Impacts Assessment,* online at *www.IndianaClimate.org*.

Melissa Widhalm is an Operations Manager for the Purdue Climate Change Research Center and the coordinator for the Indiana Climate Change Impacts Assessment.

Indiana's Opportunity to Become a Leader with Agriculture, Forestry as Natural Climate Solutions

By Sean Mobley

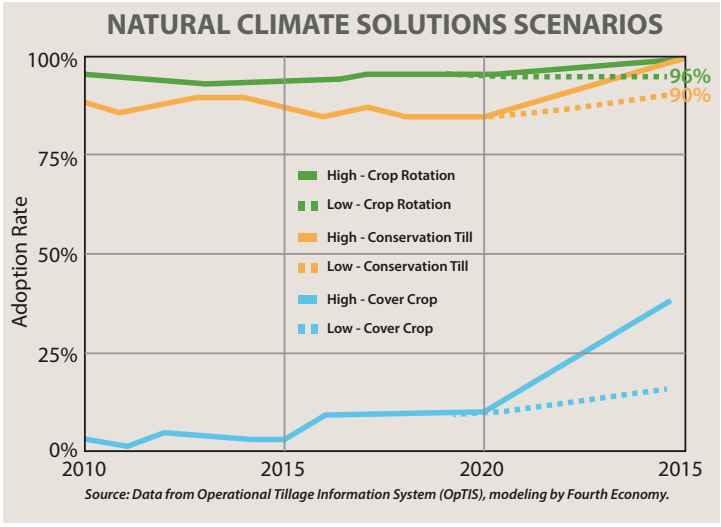
Spring has arrived. With each new year, farmers and agricultural landowners begin thinking about how the next couple of months will affect their ability to sow and reap their harvests. A major part of that calculation is the weather, and how rain – or the lack thereof – can affect agricultural operations. Extreme weather – such as flooding and drought – is the physical manifestation of a changing climate that directly impacts the economies of rural America year after year.

According to the National Flood Insurance Program, "Flooding is one of the most common natural disasters that occur in the United States, and Indiana experienced 230 flooding or heavy rain events in 2019 alone." With an estimated 16% increase in spring rainfall predicted by Purdue University to occur within the next 30 years, flooding will continue to be a persistent problem for Hoosier farmers.

Indiana farmers will not only be impacted by changes in climatic conditions in the state but also changes in agricultural economics. Changes in the growing seasons may result in higher yields, but those gains may be offset by more favorable conditions for pests, insects, and weeds – including new types, which could require increased use of agrochemicals. The increase and variability in precipitation and extreme temperatures could lead to plant diseases, increased risk of flooding, difficulty in the timing of planting, increased demand for irrigation, as well as heat and cold stress on crops and livestock.

Tree species are expected to shift to higher latitudes and elevations for suitable habitat. Tree mortality rates are expected to rise, and regeneration is expected to decline. Rising temperatures have increased the frequency and destructiveness of pest outbreaks and introduced new pests into our ecosystem. Changes in growing seasons, temperatures, and rainfall, as well as changes in carbon dioxide and nitrogen levels, will increase growth rates for some species but increase mortality for others, generating a potential shift in the forests of Indiana and the ecosystems and economy they support.

The state of Indiana is approaching a crossroads of a changing climate, more extreme or unpredictable weather patterns, and a fluctuating global economy that makes long-term planning more and more difficult. But there is a solution that can help Indiana mitigate and adapt to these challenges—the rapid implementation of soil health practices as natural climate solutions.



Source: Data from Operational Tillage Information System (OpTIS), modeling by Fourth Economy.

Natural climate solutions are conservation, restoration, and improved land management actions that increase carbon storage or avoid greenhouse gas emissions in landscapes. Farming practices such as cover crops, conservation tillage, and crop rotation can reduce carbon emissions, protect against nutrient loss and erosion, and improve water quality. There is an immense opportunity to use these practices in Indiana, as nearly two-thirds of Indiana's 23 million acres are farmland and Indiana is home to more than 56,000 farms.

In addition to observing environmental, health, and social benefits, adopting natural climate solutions could carry large economic benefits for Indiana farmers. A voluntary, market-based carbon-credit system could create a new revenue stream that pays farmers for adopting climate-friendly practices.

Helping Indiana farmers adopt natural climate solutions is widely supported. Polling conducted by TNC in 2020 found that 90% of Hoosier voters support providing incentives to farmers to adopt agricultural practices that capture carbon in the soil, prevent soil erosion, and improve water quality.

Utilizing voluntary carbon markets as economic incentives that encourage more farmers to optimize traditional farming

practices or transition to a more regenerative model. Carbon markets are a popular tool among policymakers as well.

The Growing Climate Solutions Act, introduced by a bipartisan group and spearheaded by U.S. Senator Mike Braun (R-IN), "will break down barriers for farmers and foresters interested in participating in carbon markets so they can be rewarded for climate-smart practices." The legislation will serve as a clearinghouse for companies and other organizations seeking to offset their carbon emissions and landowners willing to alter their farming, conservation, or forestry practices that result in monitored and verified carbon sequestration.

Similar legislation is currently being considered by the Indiana General Assembly during the 2021 legislative session. Senate Bill 373, authored by State Senator Sue Glick (R-LaGrange) was approved by the full Senate by a vote of 33-16 and was supported in committee testimony by The Nature Conservancy, Indiana Farm Bureau, Hoosier Environmental Council, Indiana Hardwood Lumberman's Association, Indiana Corn Growers Association, Indiana Soybean Alliance, and the Agribusiness Council of Indiana, among others.

These legislative proposals would not only connect buyers and sellers of carbon offset credits, but they would also provide more resources to the federal and state agencies that would be charged with providing enrollment, verification, and technical assistance services to agricultural and forested landowners.

While challenges remain, it cannot be understated the economic, social, and environmental returns that could become realized if these programs supported the implementation of climate-smart practices to scale. The Nature Conservancy in Indiana conducted research that examined two scenarios. Across both scenarios, the most recent data were used as a starting point: among row crops, cover crop has 9.9% adoption; conservation tillage has 85.1%; and crop rotation, 96%.

In the scenario modeled where aggressive adoption targets were set at 40% for cover crops and 100% for conservation tillage and crop rotation, the benefits are large and impressive.

At the sequestration rates laid out in the reThink Soil research by The Nature Conservancy, and with a price of $36 per ton of CO2, Indiana farmers could realize a net earning potential of $333-388 million through carbon credit sales.

Nutrient loss through nitrogen leaching costs Indiana farmers $1.9 billion annually. Adoption of natural climate solutions could cut this cost by up to half, saving Indiana farmers $950 million.

The use of additional cover crops and crop rotation could save $413 to $541 million annually from costs associated with erosion and land degradation.

Insurers pay out an estimated $570 million annually for insurance-related costs of flooding and drought in Indiana. Indemnity insurance payments could be lowered by $311-357 million annually if soils could better hold water and allow for less surface runoff.

Increased adoption of natural climate solutions within agriculture can help sequester a portion of the state's 18.4 million metric tons of CO2 emissions. Aggressive measures could sequester up to 2 million metric tons of CO2 annually.

While the climate change solution will always have to start by reducing emissions from their source, the answer to how we remove emissions already in the atmosphere is beneath our feet and all around us. Utilizing nature and harnessing the power that agriculture as a natural climate solution is an opportunity for the agricultural sector and rural Indiana.

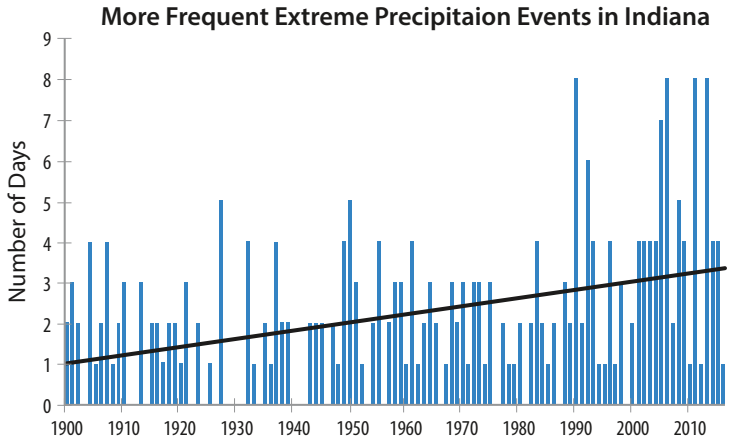
Climate change solutions have a face in Indiana. It is the face of our public colleges and universities, our cities and towns, and the utilities, manufacturers, and agricultural producers that make our economy work. Since 2005, the state of Indiana has reduced carbon emissions by 25 percent while growing the economy by 13 percent. All over the state, investments are being made to tap into the potential of climate solutions that can also grow the economy. Thanks to the leadership from Hoosiers around the state, the agricultural and forestry sectors will soon have a leading role to play.

Sean Mobley is a Senior Policy Associate for the Indiana Chapter of The Nature Conservancy. For more information on the research referenced in this article, visit nature.org/IndianaClimate.

Climate Change Challenges for Forest Land Management

By Chad Menke

Land management practices have been increasingly difficult to implement due to the effects of climate change. Since 1895, average annual precipitation in Indiana has increased by about 15%, or about 5.6 inches, based on a linear trend. This trend is projected to continue, though the type of precipitation and when it falls are changing and will continue to do so.



The number of days with precipitation events that exceed the 1900 to 2016 period's 99th percentile for Indiana (statewide average). The black line represents the trend line (0.2 days/decade) for the 1900 to 2016 period. Source: Midwestern Regional Climate Center.

Increased precipitation makes it even more difficult to manage the land for forestry needs. Any time land activities that require heavy equipment occur, such as: timber harvests, building/maintaining roads, constructing and maintaining ponds, building and maintaining stream crossing structures, building/maintaining trails, etc., soil and water resources are at risk from these disturbances. Work still needs to be performed on the land even though these precipitation events are happening more frequently. The challenge is to manage land with minimal disturbance between rain events as efficiently possible to reduce sedimentation and soil erosion loss and maintain soil productivity. This requires visual pre-monitoring and post-monitoring, proper implementation of project design and best management practices implemented during and after land disturbances.

Monitoring requires looking at how much rain fell and soil moisture conditions before planned management disturbances and observing conditions after management practices have been implemented and completed. When monitoring, landowners should ask:

- Has rutting or compaction changed natural surface run-off patterns? These changes can force water to move in different directions causing unwanted erosion in the form of rill, sheet, or head-cut erosion.
- Are loose excavated soils confined and secured from erosive waterways with vegetation, silt fences, etc.?

Erosion is a problem for two main reasons. First, it impacts water quality and aquatic habitat due to sedimentation. Second, it causes soil loss which impacts land productivity and stability for land use and vegetation growth. How productive are the soils after disturbance? Soils take nearly a century to develop and soil erosion happens at a much faster rate so soil conservation is extremely important.

One may ask, "What BMP's can I employ to conserve soils and improve water quality during land management activities?" There are different practices utilized depending on the land management uses. All BMP's are focused on minimizing human-induced erosion and sedimentation rates and maintaining soil productivity during and after land management disturbances.

The Forest Service utilizes a number of BMPs during timber harvesting to mitigate precipitation events. Compaction and rutting are reduced by prohibiting heavy equipment use when the soils are in a saturated condition, thereby reducing surface runoff, soil erosion and loss of soil nutrients. Rutting can reroute or block surface water drainage patterns causing issues with unexpected erosion in the long run. Compaction can also cause unforeseen long-term run-off erosion issues and loss of soil productivity. Some erosion control measures

Landing subsoiled and planted with pollinator habitat on Hoosier National Forest.

Undersized stream crossing in Orange County, Indiana.

are: water bars and slash on slopes, subsoiling compacted soils, and establishing vegetation by seeding and mulching landings and skid trails after harvest.

Skid trails and haul roads all should be planned to reduce soil erosion and minimize surface water drainage impedance. Landings should try to be placed on flat ground with well drained soils. Soil types and topography should dictate the amount and intensity of disturbances to be allowed during harvests. Riparian buffers (stream vegetation) should be maintained. Vegetative buffers along streams hold stream banks in place, limiting erosion, and provide aquatic communities good water quality required to exist. The number of stream crossings should be limited to skid timber out. Try to leave floodplains and wetlands undisturbed, keep ditches and drainage structures clear of debris. Leaving floodplains undisturbed helps store overflows and excessive sediment and reduces channel incision of streams. Channel incision is a deep channel-cutting process which undermines channel banks due to concentrated flows without floodplain storage overflow. Channel incision will undercut dry useful land even though there are riparian buffers in place.

Road and trail construction also cause impairments to soils and water resources. Design of roads and trails should be done in consideration of natural topography and water drainage. Roads and trails need to be hardened based on traffic needs. Roads should be crowned and trails should be designed with dips to shed water. Designation of roads and trails should limit run-off impedance while not creating too many new waterway routes to form and erode. Stream crossings need to be large enough to allow bank full flows. If smaller structures are used, rapid bank erosion will occur

Continued on page 14

Beaver proof drainage structure at Roland Wetland, Hoosier National Forest

Environmental Performance of Wood and Wood Products

By Eva Haviarova

One of the best bodies of scientific information on the topic of the environmental performance of wood and wood products in the U.S. is research generated by the CORRIM - The Consortium for Research on Renewable Industrial Materials – the go to place for wood-related Life Cycle Assessments. CORRIM has prepared a document, *"Integrating Wood into the Circular Economy"* for Congressional Committees to defend the environmental performance of wood products. As a CORRIM's scientific group member, I decided to highlight a few sections of this document and share them with the Woodland Steward readers. The full document and related resources on the environmental performance of wood products could be found on the CORRIM website: *www.corrim.org*.

CORRIM team are scientists with expertise in forest carbon, wood products, engineering, and architecture that recognize forest management and wood use as an integral component of a coordinated climate mitigation strategy. Nearly 25 years ago, scientists from 20 university forestry research institutions (Purdue among them) formed CORRIM as a scientific research consortium that conducted a rigorous scientific analysis of the environmental performance of wood products using internationally accepted methods, standards, and tools.

CORRIM member institutions and their partners have collectively generated hundreds of peer-reviewed publications and spoken both nationally and internationally on the benefits of using wood as a carbon-negative technology. Federally funded research on the environmental performance of wood products makes a compelling case for the carbon mitigation benefits of using wood in place of more energy-intensive materials and fossil fuels. Together in partnership with the USFS Forest Products Lab, the USFS Pacific Northwest (PNW) Research Station, the U.S. Department of Energy, and other federal labs, CORRIM created a large body of work using data-driven life cycle analysis to quantify and characterize the environmental performance of wood products, including biofuels. Our research has found that wood and wood products, when appropriately deployed, can reduce U.S. greenhouse gas emissions in the built environment, transportation, and manufacturing sectors, with significant co-benefits of sustaining rural economic development and maintaining forests as forests. There is wide variability in the carbon mitigation benefits of wood depending on how and where it is used. Wood demonstrates the most significant climate mitigation potential where it can substitute for more energy-intensive materials like steel and concrete in the built environment, with greater benefits shown in multi-story construction due to lower fossil fuel use in manufacturing and construction with the added benefit of carbon storage in the building itself.

Forests and Wood Products Store Atmospheric Carbon. Wood is about 50% carbon by dry weight, so 1 ton of wood holds 1,000 pounds of carbon, which is equal to 3,667 pounds of carbon dioxide that have been removed from the air. The wood harvested from the forest is used in a wide variety of products, from wooden boards to rayon fabric, paper, food, and more. The harvest residues left in the forest after harvest support biological activity in the next generation of planted or self regenerated trees and contribute to above and below ground soil carbon. Complex supply chains for solid wood, engineered products like fiberboard, paper, and energy, use more than 99% of every harvested log. This nearly zero waste manufacturing sector does produce Green House Gas (GHG) emissions, but over 70% of those emissions come from renewable biomass energy rather than fossil fuels. Taken together, U.S. forests and wood products remove enough carbon dioxide from the air yearly to offset about 11-15% of U.S. fossil fuel combustion emissions. Of that total, about 56% is stored in stable soil carbon, and 5% is held in harvested wood products. When considering only the actively cycling parts of the system – i.e., the trees and harvested wood products – 11% is in harvested wood

products. USFS inventory data show that over the past 30 years, carbon stored in forests (live and dead biomass) has increased by 22% and carbon in wood products (in use and in solid waste disposal sites) by 24%, resulting in over 5 billion metric tons of additional carbon stored in the forest sector as a whole since 1990.

Unmanaged Forests are Net Sources of Atmospheric CO2. Not only do the carbon, nitrogen, and methane emissions from wildfires reduce forest sector climate mitigation benefits, they reduce forest inventories, sometimes for decades. In the near term, they also create massive health, safety, and economic impacts in affected communities mainly throughout the west (e.g., California, Oregon, Pacific Northwest) and create critical wildlife habitat and water quality degradation. Federal forest inventory statistics show that some states are already net GHG sources due to the impact of fires and insects.

Figure 1. Conversation Plinth - one of the first hardwood Cross Laminated Timber structures temporarily build in Columbus, Indiana. It contained locally sourced hardwood lumber. https://bensonwood.com/portfolio/conversation-plinth/

Facts Support Benefits of Product Substitution. Studies showing that the wood sector offsets 11-15% of the state, regional, or national GHG emissions do not include the carbon mitigation benefit from product substitution. This product substitution benefit is the difference in GHG emissions between alternative product systems that serve the same function. Multiple analyses comparing wood to competing materials (i.e., steel, concrete) show that climate benefits are 0.2-14 times greater when using wood over alternative materials. These differences arise because of the significant differences in manufacturing processes and the GHG emissions associated with them, and the co-benefits of carbon storage in the wood product itself.

Scientific Justification for Considering Wood as a Carbon-negative Technology. While there are no immediate fixes for climate change, there are immediate fixes that can shift society in a direction that reduces GHG emissions. They start with sound forest policies that encourage and support sustainable forest practices by private forest landowners that own 70% of U.S. forests and provide most of the wood products we use – from toilet paper to wooden skyscrapers. It includes a realistic assessment of our building needs and how best to meet them sustainably using American grown products that support rural economies. CORRIM supports and illuminates the scientific connections between healthy, sustainable forests and healthy, sustainable markets for low carbon wood products. In that way, it provides the scientific underpinning for efforts like the Trillion Tree Movement, the US Forest Climate Working Group, and the American Forest Foundation with their direct focus on implementing natural climate solutions that rely on the relationship between a stable forest – economic system.

How does the Indiana Hardwood Industry Contribute to these Efforts? The high-quality hardwood forests of Indiana make significant contributions to the environment and economy. Drawing from their abundant hardwood resources, Indiana has ranked the first nationwide in production of wood office furniture, kitchen cabinets, and hardwood veneer. Logs, lumber, and veneer, Indiana's primary exports of hardwood products, play a dominant role in total hardwood sales, however, they tend to fluctuate with macroeconomic conditions and trade policies. Indiana hardwood market has available wide variety of hardwood species in significant volumes and high quality. Indiana forest products industry is also producing a variety of high-quality, durable hardwood products with a long lifecycle and low environmental footprint. Despite all of that, there is still space to add better value to hardwoods, to find new uses and new markets for this abandoned resource. The Wood Research Laboratory at Purdue University is working on various projects related to value-added hardwoods. Our group is looking for new opportunities to add value to lesser-used wood species, increase production efficiency, implement new technologies, and involve hardwood in the mass timber buildings to develop the Indiana wood product industry further.

Eva Haviarova is a Professor of Wood Products Engineering and Furniture Strength Design in Department of Forestry and Natural Resources at Purdue University. Dr. Haviarova also serves as director of the Wood Research Laboratory (https://www.purdue.edu/woodresearch/). Elaine Oneil, PhD, CORRIM Director of Science and Sustainability, contributed to this document (elaine@corrim.org).

Wood Utilization, Product Development, and their Environmental Impact

By Eva Haviarova

Wood is the most promising sustainable material for the future sustainable society. It is one of few renewable, recyclable, and biodegradable biomaterials. As a wood scientist with expertise in product development and strength design, I promote wood utilization through my research, teaching, and extension activities.

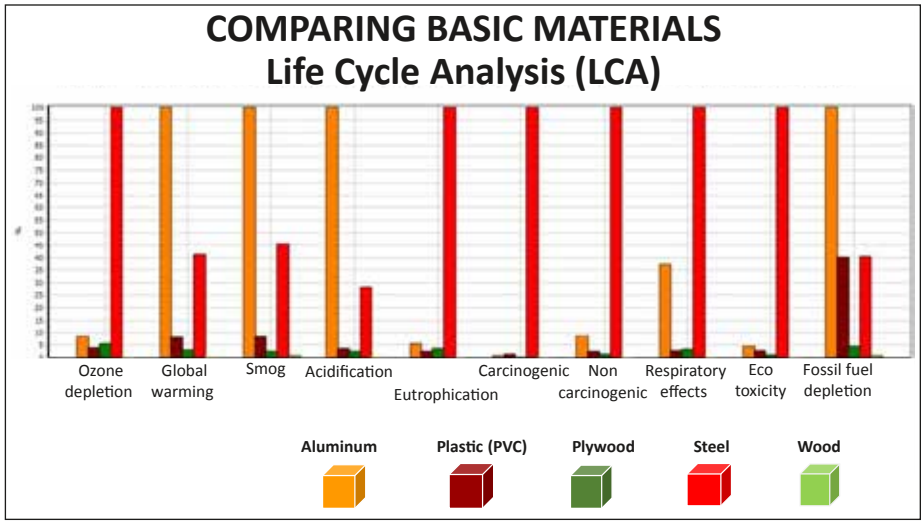


Figure 1: A comparison of LCA on different materials (wood- light green, plywood – dark green, PVC plastic - brown, primary aluminum - orange, and steel-red), developed by Haviarova at Purdue FNR.

Wood is described by many as a green material, which means that durable wood products can store (sequester) carbon for many years. Wood is economical material to use, and most people love to feel its presence (phenomena called biophilia). Wood is easy to work with, and it has technical possibilities unavailable to other materials. It is the world's strongest material relative to mass. Wood is elastic – some wooden houses remain standing during calamities, such as earthquakes, that cause concrete houses to collapse. Wood is often cheaper to build with – wooden houses and bridges are often more economical when energy consumption and CO2 emissions are factored in. Under the right conditions, wood products could last generations, considering selecting the right type of wood species, correct design, and minimizing water exposure. However, wood is also a living biological material that could degrade by the sun, wind, and microorganisms and be dissolved back to nature.

Choice of the material is a crucial component of successful sustainable design and one of the most critical tasks for the designer or the product developer. Life Cycle Assessment (LCA) could help designers and producers quantify and evaluate a broad scope of environmental impacts of material and products made from them. This tool could help product developers to select their materials and benchmark the products they are proposing. Life Cycle Assessment is also one way for the wood industry to promote the environmentally-friendly properties of wood with scientific evidence 15. A classic LCA project comprises three stages: defined scopes and goals, a Life Cycle Inventory (LCI), and a Lifecycle Impact Analysis (LCIA). LCA analysis is complex and as good as the information and inventories inputted into the system. Obtaining all information throughout the product life cycle could be challenging, and very often, users rely on existing inventories and databases.

To demonstrate the environmental impact of materials and products made out of them, I selected a simple benchmarking example among basic building materials in Figure 1. Wood is marked in light green and is almost not visible because of its very low environmental impact compared to other materials. The environmental impact

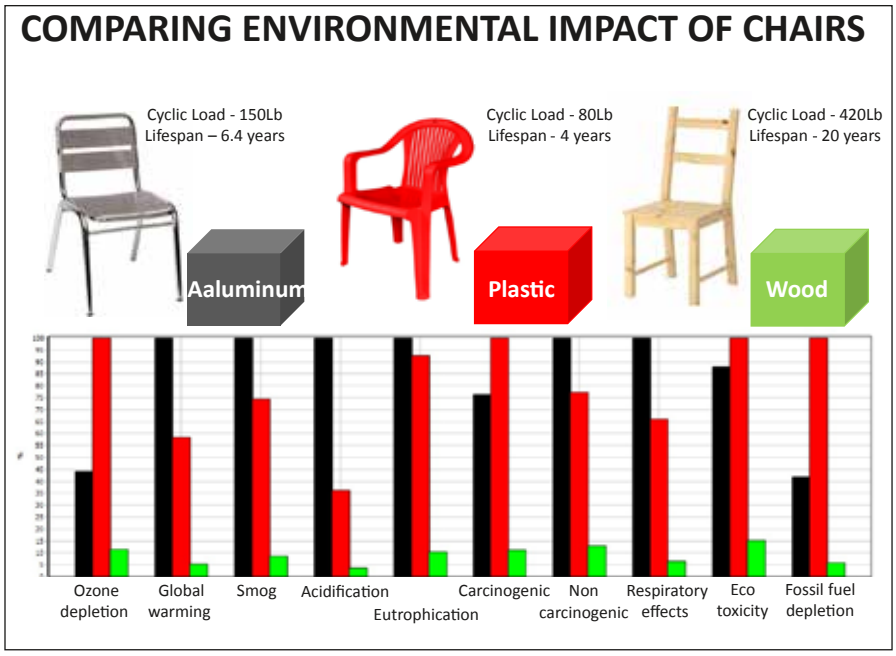


Figure 2: A comparison of LCA on three different chairs made of three different materials, based on TRAIC 2.1. , developed by Haviarova at Purdue FNR.

of plywood is shown as dark green. It is disproportionally lower than other non-renewable materials such as plastic, aluminum, and steel, all displayed in Figure 1. (PVC plastic - brown, primary aluminum - orange, and steel-red). Life Cycle Analysis outputs indicate the superiority of wood in all measured categories (ozone depletion, global warming, smog, acidification, eutrophication, carcinogenic, non-carcinogenic, respiratory effects, eco-toxicity, and fossil fuel depletion) when compared to other non-renewable materials.

To demonstrate the LCA on products, simplified benchmarking among three chairs made of different materials (wood, aluminum, and plastic) is shown in Figure 2. These LCA studies on chairs were also conducted at the Wood Research Lab, Purdue University. The lifespan of chairs and their strength were based on product performance testing. Chairs were subjected to cyclic loading until they failed, and their service life was estimated accordingly. Based on LCA, wooden chairs have the lowest environmental impact in each category. Based on these findings, it is possible to conclude that material selection significantly impacts product sustainability, and it should be taken into consideration by product designers and developers.

Eva Haviarova is a Professor of Wood Products Engineering and Furniture Strength Design in Department of Forestry and Natural Resources at Purdue University. Dr. Haviarova also serves as director of the Wood Research Laboratory (https://www.purdue.edu/woodresearch/).

Register Your Timber or Plantation with Drift Watch

The DriftWatch registry tool is meant to help pesticide applicators and specialty crop growers communicate more effectively to promote awareness and stewardship activities to help prevent and manage drift effects. The boundaries on the map are not property lines, but user-submitted specialty site designations. Furthermore, DriftWatch is not intended to be a registry for homeowners or for sites less than half an acre in size.

This site features a powerful map interface at *https://in.driftwatch.org/map* that clearly shows pesticide applicators the locations of registered specialty sites so they can use the information in their ongoing stewardship activities before they spray.

In addition to user-submitted sensitive crops, the map interface provides other data layers that give further insight into sensitive and protected areas, as well as help identify county/township/section jurisdictions.

Register your timber at *www.in.driftwatch.org* or order "No Drift Zone" signs to help applicators recognize your sensitive crops.

When Smoke Gets in Their Eyes!

By Mike Warner

Every spring beginning in April my phone begins to ring with requests from applicators and from landowners both to help them evaluate impacts from herbicide drift on offsite trees and shrubs. In most cases everyone involved are not happy people. I want to share with you some of my first hand consulting experiences as examples of offsite damages and situations. Second, will provide some tips you might consider doing before work begins this spring to reduce the opportunity of offsite damages and suggestions to help minimize exposure risks.

Impacts to trees and shrubs from exposure to 2,4-D and or dicamba is a situation I run across. Some common symptoms I see are:

- Young seedlings or stressed trees are particularly vulnerable and die off.
- Larger established trees are rarely killed.
- Aborts fruit and nut set.
- New bud set and maturation is interrupted. This can carry over into the next year depending on timing.
- Shortens internodal growth.
- Reduces aesthetic values.
- Contributes to, or accelerates, decline of already stressed trees.
- Reduces annual growth of timber trees?

The value of these impacts depends on which side of the fence you are sitting on! Words like fairness, retribution, payback, penalties, apologies, be realistic, and more begin to be bantered about. Most of my calls are related to situations where 2,4-D or dicamba has volatilized (changed from a liquid to a gas) and has moved off site. You can visualize a volatilized herbicide like "Second Hand Smoke!" Volatilized herbicides are:

- Easily Moved By Wind in many directions
- Trapped by inversions (calm winds, Hazy skies, Very red sunsets)
- Follows air drainage patterns
- Can be deflected/directed by obstacles (buffer strips, windbreaks, closed ventilation systems)

Like second hand smoke, many people just do not like the smell or exposure to it. They react! New products on the horizon will mean a more widespread use of dicamba and 2,4-D products further into the growing season. They may mean greater impacts to non-target trees and shrubs and shortened recovery time as well.

There are several things you can do this growing season and future seasons. Like many problems, a little prevention now can save a lot of heartache later. Be proactive and meet with neighbors and discuss what you are doing to minimize exposure risks. Identify high risk crops nearby. Drfitwatch.org is an online registry tool to help pesticide applicators and specialty crop growers communicate more effectively to help prevent and manage drift effects. You can also invest in an anemometer for your spray rig so you can measure wind speed. Plan and install warm season grass buffers adjacent to woodlands and other high risk crops nearby. Lastly, quit smoking and consider other less volatile pest management products.

Mike Warner is a Certified Forester, ACF. He is also the president of ArborTerra Consulting Inc. based in Lizton, Indiana.

Editor's note: This was originally published in the 2015 Woodland Steward newsletter and is reprinted with permission. Dicamba use has increased over the last few years, along with it the risk of drift has increased as well.

Indiana Office of State Chemist announces 2021 Dicamba Restriction

The OISC is the pesticide regulatory agency for Indiana. In 2020, the OISC added an additional label restriction for users of Dicamba that prohibited application after June 20, 2020. This change was due to the rising number of off-target complaints in the previous three seasons. On March 2, 2021, the Indiana Pesticide Review Board voted unanimously to classify all Restricted Use Pesticides containing more than 6.5% dicamba as Highly Volatile Herbicides (HVH). This HVH determination was made to allow for the establishment of a June 20th application cutoff date in Indiana again in 2021. As usual, the use of HVHs must comply with any application timing restrictions listed on the label of the product being used. In addition, HVHs may not be applied during the period June 21st through August 31st. Application of an HVH during that no-spray period is not covered by the terms of the general permit and will constitute a violation of IC 15-16-4-59(5). For more information, visit the OISC Dicamba Herbicde Updates page online at *https://www.oisc.purdue.edu/pesticide/dicamba.html*.

Earl McCleerey Receives Recognition for 50 Years in Forestry

By Tina Ligman

Earl (Mac) McCleerey has deep roots in Indiana. He said his family was in the Indiana territory before Indiana was a state. One of his ancestors was one of the first school teachers in the area. He has a great grandfather buried in Brown County who fought in the Civil War. McCleerey is proud of his Hoosier Heritage and can't think of a better place he'd rather have worked.

McCleerey grew up in the Indianapolis/ Carmel area and went to Purdue University after High School. He majored in Forest Production. He worked in Kentucky briefly before going into the Army. He served in the military for five years, mostly in western Germany in a special weapons unit. After the Army, he returned to the Division of Forestry in Kentucky for a year while watching for a job back home in Indiana.

Earl "Mac" McCleerey at work in the forests of Indiana where he's spent his career.

When a job came open with the Lincoln Hills RC&D in Cannelton, IN; McCleerey took it. McCleerey still has a great fondness for the Lincoln Hills RC&D. He noted it was the first RC&D to form in the United States; 55 years ago. The Lincoln Hills Forestry Committee, which McCleerey co-chairs, is still active in the area. The Lincoln Hills job covered Harrison, Crawford, Perry and Spencer Counties.

He worked with the RC&D for two years before transferring to the Indiana DNR. He was able to stay in the same area and with his new job as District Forest, he covered Perry and Spencer Counties. McCleerey noted the private landowners he worked with treated him well and he enjoyed the work. His counties were 50% forest, so it was a great place to be a forester!

The Lincoln Hills Forestry Committee continues to be active and worked with him to provide workshops, field days, events, and lumber studies which allowed him to keep his landowners informed and build good relationships with the lumber industry. He hopes we can continue those good partnerships into the future, though he said there are many fewer loggers and sawmills than there were in the past. There have been some bad years for loggers, and its dangerous work, but foresters, landowners and the timber industry has always worked well together in his area.

McCleerey did limited consulting work after his retirement and continues to do some today. He enjoys keeping active in the profession. He also co-chairs the Lincoln Hills Forestry Committee which still holds regular workshops and workdays. He's also Vice President of the Purdue Club which is an organization of former Purdue University alum that raise and distribute scholarship money each year to local students.

He and his wife Patricia live in Tell City. They have no biological children but sponsored 32 teenage girls over the years through the International Lions Club. These girls, who came from 15 different countries, came to Perry County for a camp and stayed with the McCleerey's. He said he and his wife thoroughly enjoyed having the girls and as they've traveled, they've visited some of the girls and their families and the girls have come back to see them. It was a wonderful enduring experience for them.

Asked about the future of forestry, McCleerey said he'd like to see more young foresters since it seems that there are never enough graduates to fill the jobs. In the past when he spoke at High School career days he'd emphasize that being a forester was not likely a job you'd get rich at, but it was a life style where you lived and worked in beautiful country, and breathed clean air and saw wildlife and fish and that he had never had any regrets.

The Woodland Steward periodically receives award notifications that we print as space as allows. The Indiana Society of American Foresters bestowed this recognition in 2019. We offer our belated congratulations to Mac on an outstanding career.

Climate Change Challenges for Forest Land Management *Continued from page 7*

due to turbulent flows caused by the crossing constriction. Crossings should also be appropriately armored with rock or vegetation. Undersized crossings also create passageway barriers to aquatic organisms.

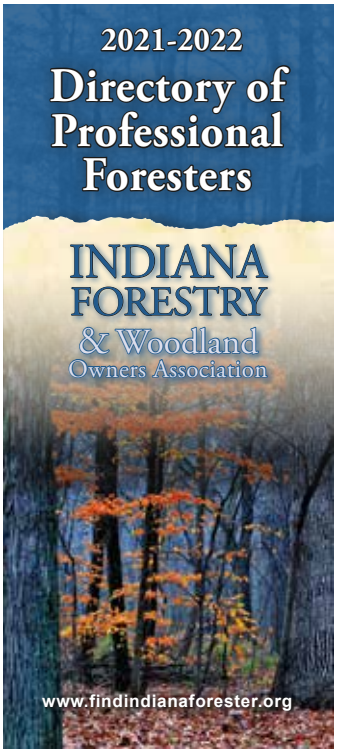
Pond and lake maintenance has now become a yearly observation and maintenance issue. Make sure the control structure is clear of debris to keep pool levels where they are needed and emergency spillways are working only during extreme events. You may need to beaver proof the control structure. Emergency spillways need to be examined for head-cutting and re-hardened with appropriate-sized rock or vegetation or the dam may breach eventually. Keep dams clear of trees by routine mowing or bushhogging. Trees roots will eventually ruin the integrity of the dam.

Keep in mind that emergency temporary mitigations may need to be utilized if design or implemented BMPs fail. Be prepared to install silt fencing or create sediment traps using staked straw bales, check dams made of rock/woody debris. Exposed soils may need to be blanketed with mulch, geotech fabric or staked straw netting. Terrain may have to be re-contoured to conserve soils. Creativity may be your only valuable design tool in an emergency mitigation.

The best laid out design and BMPs will not always guarantee that erosion issues will not occur. Water has a way of seeking the path of least resistance sometimes unseen by the human eye. Always monitor the activity afterwards and plan to mitigate unforeseen issues. As long as landowners are always monitoring and reacting, there will be less negative impacts to soil and water resources. Climate change requires us to never walk away and plan on always implementing adaptive post-mitigations and maintenance as needed.

Chad Menke is a hydrologist for the Hoosier National Forest.

New Foresters Directory Available



A new Directory of Professional Foresters, listing Indiana foresters who provide private woodland services and advice, has been released. Foresters are located throughout the state and provide assistance such as management plans, timber sales, tree planting, invasive species control, and many other services.

The Directory is available via interactive map at *www.findindianaforester.org* to find foresters by county or address or to download. Printed copies of the booklet are available at county Extension offices, county Soil & Water Conservation District (SWCD) or Natural Resources Conservation Service (NRCS) offices, or from a state Division of Forestry district forester.

"Finding the resources to help you meet your woodland management objectives is important and key to successful stewardship of private woodlands," says Lenny Farlee, Purdue Extension Forester. "These foresters can provide the expert advice and assistance needed to meet your property management goals."

Indiana Forestry & Woodland Owners Association (IFWOA) is dedicated to conservation and sustainable management of woodlands in Indiana. IFWOA advocates for scientific best practices for management to achieve objectives of clean water, wildlife habitat, soil protection, native species diversity, timber production, recreation, carbon sequestration and many others. More information about IFWOA and how it is Working for Indiana Woodlands is available at www.ifwoa.org or call 765-409-3272.

Ask the Steward

By Dan Ernst

Question: I have several pawpaw trees in my woods, but I only got 10 pawpaws off of them last year. How can I increase fruiting?

Answer: Did you know that pawpaws are perfect? And, therein lies part of the problem with their low fruit production. If you have pawpaws in your woodlot and have taken a close look at their flowers, I think you'll agree with me that they are quite unique and beautiful. The maroon to purple blossom contains both male and female flower parts and are therefore 'perfect' flowers. However, they are not self-pollinating due to the fact their male and female flower parts mature at different times. To complicate things further, they are generally self-incompatible and require cross pollination with another genetically distinct variety of pawpaw. For woodlots with several clones of pawpaw this may not be the major obstacle to successful pollination and fruit production. However, there's another glitch to the pawpaw way of life. Unlike other flowers of the forest bees rarely, if ever, visit the pawpaw flower. Its' faint fetid odor and deep purplish color are specifically designed to attract various fly and beetle species to do the pollination work. Sounds good, but these insects are not very efficient pollinators. How can you help? In an effort to increase pollination, and boost the attraction of flies and beetles some have hung a roadkill, manure or rotting fruit near the trees during flowering. Or, you might consider planting other varieties of pawpaw near existing groves to insure cross-pollination sources. And, for a little fun and family science lesson, try hand pollinating the flowers using a small, soft artist's brush. Information on this subject is plentiful on the internet. Or, connect with local enthusiasts who are passionate about pawpaw, such as the Indiana Nut and Fruit Growers Association or the Ohio Pawpaw Growers Association.

Troy Evans, Great Smoky Mountains National Park, Bugwood.org

Question: I'm planting trees next spring or fall and with warming temperatures and climate change should I rethink what species I plant?

Answer: The topics of assisted species migration and range expansion are gaining quite a bit of interest as average temps are forecasted to rise several degrees in the decades ahead and season length between killing frosts expected to also increase. Despite this, the top recommendation on tree planting remains 'plant the right tree in the right place'. This means matching tree species to your site considering among other things: soil types, drainage, rooting restrictions, slope and aspect. Once these are fully taken into account then you do have some options on introducing species, or seed sources that are normally from areas farther south, or even east and west of your planting. A good example of this would be Cherry Bark Oak, which is a fairly common red oak species found in Southwest Indiana counties. It is a very good timber tree and has great wildlife value. Helping move this species north by planting on suitable sites in Indiana's more northerly counties, or even farther is certainly feasible. American chestnut, as disease resistant selections become available, may also be worth considering as may other species. When deciding if or what species to help in their migration or range expansion, I recommend looking at selections within 300 miles of your tree planting site, but that varies by species and local ecologic conditions. Further, only include those selections as a portion of your total planting- perhaps 25%. When designing your tree planting do talk with your forester for species that may be suitable for your particular site. They can give you great insights for a successful planting that also considers the potential impacts of climate change.

Dan Ernst is a professional forester and past Assistant State Forester with the Indiana Division of Forestry. He has authored 'Ask the Steward' since 1992 and can be reached at foresterdan@yahoo.com

Days Gone By

Updated photos by Roy C. Brundage

A group of 3 timber buyers from different sawmills estimating the standing timber of a woodlot in the vicinity of Whitley County, Indiana. The 2 men in the rear (left photo) are the owners of the timber and are designating the trees which they desire to sell.

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