

by Susan M. Brackney Photography by Rodney Margison

rom a lock of baby hair to stacks of old report cards, the detritus of my childhood is well-preserved. My sentimental parents even kept the pint-sized cross-country skis I used as a 6-year-old. Each ski is about as substantial as a county fair yardstick, but they made my mid-1970's winters magical.

Back then, my brother and I skied the gentle slopes of the local golf course with my father. Sometimes, we'd even make a special trip to ski in Brown County State Park. I also recall making lazy loops with my ice skates on frozen ponds as older neighborhood kids played hockey nearby.

In a recent Herald-Times guest column, self-described old-timer Dan Combs likewise waxed nostalgic about colder winters past. "During the winter of 1962-63, there were 13 zero-degree or lower nights," he writes. "In the winter of 1963-64, there were eight below-zero nights in December alone. In the '60s, it was common for Lake Monroe to freeze. Ice fishing was a thing."

These days, those winter activities seem completely out of reach. The culprit is climate change, and its impact on our personal lives reaches well beyond the dearth of good skiing. Whether we realize it or not, climate change has already begun to influence what we eat, how we feel, how we spend our time, and even how long some of us will live.

Indiana's past and future climate

Of course, you don't have to buy into the notion of climate change to recognize that Indiana's seasons aren't quite what they used to be. But, if you hope to understand why we're already seeing wetter springs, hotter summers, less snow in the winter, and more numerous and extreme weather events, maintaining even a grudging openness to the reality of climate change—and our contribution to it—certainly helps.

In late 2018, the Intergovernmental Panel on Climate Change issued a special report stating that human activity has not only caused a 1.8-degree Fahrenheit rise in global temperatures, but, if left unchecked, human activity will continue to boost warming by up to 2.7 degrees Fahrenheit globally between 2030 and 2052. That doesn't mean the planet will warm uniformly; rather, temperatures are likely to increase more over land masses than over bodies of water. "It definitely has gotten warmer in winter [in Indiana]," says Indiana University Department of Geography professor Scott Robeson. "And that's actually happening all over the northern hemisphere."



Robeson also has served on the Indiana Climate Change Impacts Assessment Climate Working Group for the Purdue Climate Change Research Center (PCCRC). In March 2018, the group issued a series of compre-

hensive reports, including "Indiana's Past & Future Climate," which combined realworld weather data with mathematical modeling for medium and high greenhouse gas emissions levels.

Under their "medium" model, we significantly reduce emissions such that they peak in the 2040s and then begin to decline. Under the "high" model, however, our emissions keep increasing until late this century, and, sadly, this happens to be our present trajectory.

"Indiana has already warmed 1.2 degrees Fahrenheit since 1895," the researchers note. And, upon comparing the state's average temperature from 1971 to 2000 to temperatures of the future, they were able to project a 5- to 6-degree Fahrenheit increase for Hoosiers by mid-century, "with significantly more warming by century's end."

"That may not sound like a lot to somebody who thinks, 'Oh, does that mean that instead of it being like 60 degrees it is 65? Or instead of 70 it's 75?" says Indiana University Department of Biology associate professor Rich Phillips. "But what's perhaps most alarming about those predicted changes is that we are likely to have costs

The extra pollen hanging in the air over a longer period of time is expected to aggravate asthma and other lung ailments in children, the elderly, and people with compromised immune systems.

not just in terms of average temperatures but in extreme temperatures."

Among its key takeaways, the "Indiana's Past & Future Climate" report states, "The number of extremely hot days will rise significantly in all areas of the state. In the past, southern Indiana averaged about seven extremely hot days per year, but by mid-century this region is projected to experience 38 to 51 extremely hot days per year." Extremely hot days are those measuring 95 degrees Fahrenheit or higher.

And as conditions in Indiana continue to heat up, the snows we used to see between November and March increasingly will be replaced with rain—and potentially lots of it. "In southern Indiana, there will be little snowfall at all by late century under both [medium and high] emission scenarios,"

the researchers continue. In just more than 60 years, snowfall of more than two inches in southern Indiana will be rare. The number of cold and frost days are also expected to decline sharply.



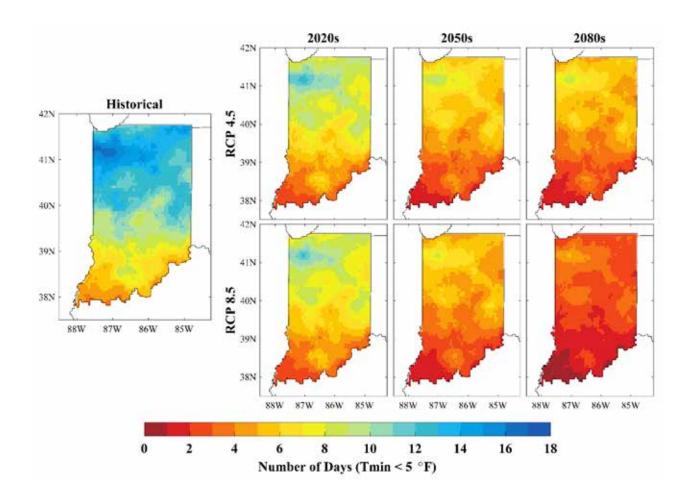
Dangers to our health

With the increase in temperature, heavy rainfall will likely become our new normal. "Essentially, where we might only have gotten one of these events every five or 10 years in the past, we'll get two or three of those a year," Robeson says. "That's consistent with what we would expect, because, as it gets warmer, the atmosphere can hold more water vapor." Put another way, imagine the atmosphere is a giant sponge. When temperatures are high, the sponge can hold a lot more water than it can when temperatures are low.

Like Robeson, Phillips also has worked with the Purdue Climate Change Research Center (PCCRC). He was lead author for the group's report "Indiana's Future Forests." Regarding the amounts and timing of precipitation we can expect in the coming years, Phillips explains, "A lot of that rain is going to come in the winter and a lot of it's going to come in the early spring. That has consequences—one of the most important being that it's not going to come at a time when plants can use that water."

Further, water-logged soils and some significant flooding early each year, coupled with warmer temperatures can make conditions just right for mosquitoes that carry tropical diseases including malaria, dengue fever, and Zika.

According to another PCCRC report, "Hoosiers' Health in a Changing Climate," molds and fungi, which can develop after flooding events, also can threaten human health. So can dangerous algae blooms, which blanket the surface of bodies of water during very hot weather. The algae creates toxins which can sicken humans. "These can be ingested through fish caught in the water, by drinking or touching infected water, and even breathing air near the water," the researchers explain. "Depending on the type of algae, the toxins can cause vomiting, diarrhea, confusion, seizures, liver damage, or even paralysis and death."



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Hardships for farmers —and more dangers

The growing season, too, can be affected. Despite fewer days of frost, gardeners and farmers likely won't be able to get their crops in the ground any sooner than usual, due to heavy spring rains. And once crops are planted, they'll have to struggle through hotter temperatures and drought conditions.

Even warmer nighttime temperatures can affect a farmer's bottom line. According to PCCRC agricultural research, "Observations show that Indiana corn yields are reduced by about 2 percent for every 1-degree Fahrenheit increase in overnight temperatures during July."

To try to better contend with longer, drier summers, some farmers could choose to install large (and expensive) irrigation systems. Naturally, all or part of that cost will be passed along to consumers. With

Urban Center	# Historical	# 2020s RCP 8.5	# 2050s RCP 8.5	# 2080s RCP 8
	Hot Days	Hot Days	Hot Days	Hot Days
Gary	4.9	14.0	30.6	61.7
South Bend	3.0	11.0	27.9	58.6
Fort Wayne	2.5	11.8	30.4	63.5
Indianapolis	4.0	16.3	38.8	75.2
Muncie	3.0	14.6	36.9	73.0
Brownstown	6.2	26.2	52.2	89.9
Evansville	10.5	34.3	61.4	98.2
Bloomington	6.3	24.4	49.8	87.7
Terre Haute	7.5	21.5	44.2	80.5
Lafayette	4.9	16.3	37.6	72.3
New Albany	8.2	31.0	58.1	96.4

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fewer frosty days, they may also have to face heavier insect pest loads and more weeds as well. Nuisance plants like poison ivy and ragweed could thrive particularly well within this new climate paradigm.

And, because ragweed and other allergen producers will enjoy longer growing seasons in the coming years, allergy season will be longer, too. The extra pollen hanging in the air over a longer period of time is expected to aggravate asthma and other lung ailments in children, the elderly, and people with compromised immune systems.

Perhaps most alarming, the PCCRC "Hoosiers' Health in a Changing Climate" report states, "By late century, the number of extreme heat days is projected to rise to dangerously high levels, with southern Indiana expecting nearly 100 days per year with extreme heat under the high-emissions scenario. Overall, the annual number of temperature-related deaths in Indiana is expected to increase, and potentially even double, by mid-century."

To deal with more extreme heat days, some Indiana residents increasingly will remain indoors and crank up the air conditioning—a move which, although understandable, further exacerbates our emissions problem. "In terms of increased energy consumption, at least in the summertime, that's a local impact," Robeson says. "But atmospheric CO2 gets around pretty well, and emissions that we make in Indiana also contribute to global averages."

If we fail to modify our current emissions path by 2050, the PCCRC researchers maintain, extreme heat will cost the U.S. about \$40 billion in lost wages. They add, "In Indiana, most locations are projected to see about a 1.4 percent to 1.8 percent decline in available outdoor labor hours by 2050."

Marcia Veldman, program/facility coordinator for the City of Bloomington Parks and Recreation Department, has seen first-hand how extreme heat affects the Bloomington Community Farmers' Market.



"In 2012, we had a really hot summer," she recalls. "There were days where customer attendance plummeted because it was over 100 degrees, and it was really kind of hard to witness, because you knew under what diffi-

cult circumstances the farmers had worked to bring that product to market."

Adding insult to injury? "One of the impacts of this is increase in pests, weeds, and also in disease vectors," Veldman says. "We have had, I'm thinking, like six farmers who in recent years have contracted Lyme disease. That previously was just not heard of or was just very, very rare."

When left untreated, Lyme disease can cause severe headaches, joint pain and swelling, and even short-term memory loss.

According to the Centers for Disease Control and Prevention, an estimated 300,000 people

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may contract Lyme disease annually in the U.S. The Indiana State Department of Health reports the state's Lyme disease incidence rate was 2.14 cases per 100,000 people in 2017.

"The scary thing about global climate change is that what we call natural enemies—those could be pathogens or those could be, for instance, predators—might allow the vectors of disease to move more quickly than normal into areas where they don't have natural enemies," says Marc Lame, clinical associate professor at the IU Paul H. O'Neill School of Public and Environmental Affairs. "Any slight change to the food chain or to the ecosystem is going to cause some havoc."

Lame thinks global climate change already has affected the range of certain

tick species. "The Lone Star tick, for instance, was not prevalent in Indiana 20 years ago, but it is now," he says. "And, of course the diseases that go along with the Lone Star are there as well. Ehrlichiosis would be one that we're see-



ing more of." Some symptoms of the bacterial disease include fever, fatigue, nausea, and vomiting, and, according to the Indiana State Department of Health, the number of these cases more than doubled from 2016 to 2017.

To be fair, climate change isn't likely the sole cause for the Lonestar's move to Indiana. We've also gotten better at recognizing and diagnosing tick-borne illnesses. The density of deer populations in Bloomington and Monroe County is another critical factor. But climate change impacts deer populations, too.

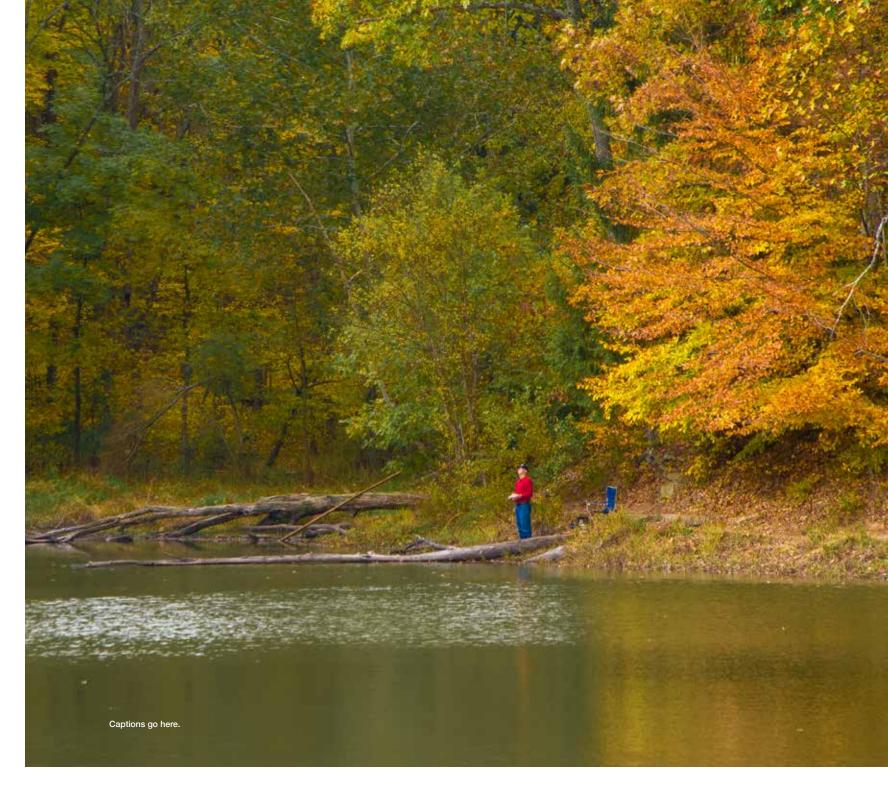
"Deer population sizes often are reduced in winter when there are really cold winters," Phillips says. "But we're expecting more mild winters with climate change, so you won't have some of this natural death that you might expect with extremely cold conditions."

Winners and losers

As our climate shifts, so will some of the plant and animal species that call Indiana home. About four years ago, for example, Lame confirmed a Shelbyville resident's sighting of a southern bark scorpion in the wild. "I found it in their backyard," he says. "They're coming from down south in Alabama and Georgia, but I was surprised to see them up here. Although the creatures are small, their stings are mighty, producing pain that can last for several hours to a day or more.

"Now, there are reports of them being in Kentucky and southern Indiana more," Lame continues. "We are going to see animals and diseases that were typically confined to the tropics and the subtropics moving up into areas that we haven't seen them in before."

Lame suspects Indiana will also host fire ants within a decade or so. "They're considered medically important, because they sting and their sting can send people into shock," he says. "And they can cause secondary infections. They definitely are a nuisance both to agriculture and to humans."



IU Department of Biology associate professor Phillips says, "Who will be the winners and losers of climate change is always really a challenging question, and that's the important, take-home message of all of this. Not every species will be negatively affected." To come up with an educated guess about the habitat changes for different species, researchers map species' preferences along with predictive climate models. "Then, we sort of map those two things onto one another, and we can

see where everything could move," Phillips says. "If the climate goes this direction, it gets hotter and there's less rain and there's this temperature increase. How will that affect distribution of species just within their preferences?"

That doesn't necessarily mean researchers have a definitive picture for our future ecosystem. "You can't point to a place in the southeastern United States and say, "That's what the ecosystems of Indiana will look like," Phillips says. "It's complicated, and

we don't really have a good sense of how a lot of these things are going to shake out."

That's because there will also be evolutionary pressures at work. Some species will successfully adapt. Others won't. One tree species that just might adapt to Indiana's hotter, more extreme climate is the loblolly pine. "That is a species that's very dominant," Phillips says. "It grows in plantations in the southeastern United States. Conditions that favor loblolly pine will increasingly become more common in

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the southern part of Indiana. That's what our models tell us, based on suitability of habitat related to climate."

One species that ultimately won't fare as well is the sugar maple. "We have noticed some decline in production of maple syrup because it has pretty specific requirements of freezing at night and warming during the day," Veldman says. Our less predictable, less reliable weather patterns have been hard on area maple trees. This, in turn, has decreased the supply and increased prices. "It's just costing more to make less," she adds.

Fruit crops like apples and peaches are already hurting. "Growing peaches in southern Indiana has never been a sure prospect, but it's even becoming less sure," Veldman says. "We had a spring where in February, March, and early April, it was pretty warm. The trees were starting to flower, and then we had a hard frost in late April that just wiped out entire peach and apple crops."

A couple of years back, Veldman had to cancel a special apple-tasting event. "There were really no apples by farmers at the market that year," she remembers. "There was a complete crop failure. And one of the reasons for that challenge is the patterns in weather are less stable and less predictable."

If more volatile weather hadn't directly done in the farmers' fruits, it could still do a number on them indirectly via poor pollination. Adequate rainfall and just-right temperatures affect the amount and quality of nectar and pollen for area honey bees. When these resources are plentiful, bees load up their stores and expand their population numbers.

But during periods of extreme heat and drought, plants die back-meaning sources of much-needed nectar and pollen are lost with them. Beekeepers overseeing managed honeybee colonies under these circumstances may notice poor nectar and pollen stores, increased susceptibility to parasites and disease, low brood numbers, and lower-quality honey. And growers in need of pollination services may see fewer-and weaker—bees in the coming, climate-challenged years.

Economic impacts

Climate change is bad for business in plenty of other ways. Retailers like J.L. Waters Adventure Outfitters, located on Bloomington's downtown Square, long ago had to adapt to southern Indiana's vanishing ski season and the closure of Ski World, Bloomington's nearest ski resort. "We used to have a fully operative ski shop," says Tyree Shelton, the store's hard goods equipment buyer. "Once Ski World closed, we kind of moved out of that."

A perfect storm of unreliable snowfalls, warmer weather, and astronomical insurance costs forced Ski World's owners to replace downhill skiing with snow tubing in 2002.

"Algae creates toxins that can be ingested through fish caught in the water, by drinking or touching infected water, and even breathing air near the water. Depending on the type of algae, the toxins can cause vomiting, diarrhea, confusion. seizures, liver damage, or even paralysis and death."

Established in 1979, Ski World had a long run, but ultimately couldn't recover. A 2003 article in The Herald-Times says the business shut down permanently in November of that year.

"As far as the change in the weather. we've definitely seen a pattern," Shelton adds. "We have less warm clothing being sold in the winter. Like this year and last year, there are days when it's 50 degrees in December or January."

That doesn't mean the store can do without parkas and pullovers completely. "The very random, sporadic weather we have has affected what we've sold and how it has sold," Shelton says. "Like when the polar vortex came through, we made up for that with heavier clothing."

As if cued up solely to confuse the issue of climate change, the January polar vortex whipped Bloomington with a wind chill below minus 30 degrees Fahrenheit that ultimately closed the IU campus and countless other institutions across the state. Meanwhile, President Donald Trump whipped up climate change deniers with this corresponding Tweet: "In the East, it could be the COLDEST New Year's Eve on record. Perhaps we could use a little bit of that good old Global Warming that our Country, but not other countries, was going to pay TRILLIONS OF DOLLARS to protect against. Bundle up!"

Although such extreme weather events may seem antithetical, they are themselves thought to be triggered by the planet's increasing temperatures. For instance, as warmer Arctic temperatures cause sea ice to melt, jet stream patterns can shift. Rather than remaining neatly contained along the Arctic Circle, the jet stream strays, bringing cold air along with it.



In the East, it could be the COLDEST New Year's Eve on record. Perhaps we could use a little bit of that good old Global Warming that our Country, but not other countries. was going to pay TRILLIONS OF DOLLARS to protect against. Bundle up!

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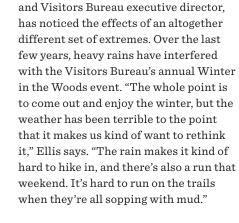












Jane Ellis, Brown County Convention

Historically, leaf peepers also flock to Brown County to eat, shop, and admire the area's fall foliage, but that's also changing. As far as fall leaves' brilliant reds, golds, and oranges, their colors come out with the right combination of cool evening temperatures, shorter day lengths, and a drop in available moisture. As these conditions become rarer, so, too, will the prolonged shows of fall color we've gotten used to.

As it happens, the live, streaming footage available via Ellis' "leaf cam" has already demonstrated this. "The leaves do start changing earlier," she says. "A lot of the yellow starts showing, but those leaves are kind of underneath a canopy of green. And when the leaves change, it seems like it's almost overnight. Almost in a weekend."

Gone, too, are the days of highly concentrated groups of visitors. "Years ago, Brown County, from October 1 to 31, was like a light switch—you could turn it on and turn it off," Ellis says. "Over the years, we've seen that traffic spread out throughout the year. And, this past year, it seems as if it rained every weekend in October, so, that certainly put a damper on our weekend traffic.

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"We measure things like the innkeepers' tax collection, state parks' gate fees, our web traffic, and walk-ins at the visitor center." she concludes. "When you put it together, it seems to even out, but we are seeing the shifting seasons."

The challenge for gardeners



If they haven't already, avid gardeners soon will notice seasonal shifts of another sort, and, when climate change really hits us, succeeding with a simple vegetable garden or bed of ornamentals will require

more thought and planning than ever. Amy Thompson has long coordinated the Monroe County Master Gardener Association and works as extension educator for Agriculture and Natural Resources with Purdue Extension-Monroe County. "It's not necessarily going to be, 'I'm going to stick this in the ground, and it's going to grow," Thompson says. "The predictability has sort of gone out of things."

Moya Andrews sounds downright wistful as she describes the way springtime used to unfold. "You once knew that by March you would have your daffodils and your Forsythia," says Bloom's garden columnist. "And probably by late October, you'd get your first killing frost. But now you can't really be sure."

Also the host of WFIU's "Focus on Flowers" program, Andrews suggests gardeners try to be more exacting when choosing plants and planting sites. "Our plants have to be able to thrive in a huge number of diverse conditions," she says. They also need to be able to survive increasing amounts of change over the long haul. "If we plant a tree now in our Indiana garden, in 20 years it probably won't be able to survive in this climate even if it's a native," Andrews says. What to do instead? It may be time to match a non-native tree to your particular microclimate.

In general, gardeners who've become attached to particular plant varieties eventually may need to bid many of them adieu. "Things that might normally have grown well here, may now grow in southern Michigan well in the future," Thompson says. "Unless there are big changes, things will shift to where their optimal growing conditions are found."

For example, Thompson says, "Maybe even in my lifetime, some apple varieties that we grow here aren't going to be viable in southern Indiana, because they won't have the length of chilling hours they need in order to set fruits." In their place, some new-to-us plants might move in from the south. Horticulturalists are also working to develop varieties which can better tolerate the effects of climate change. "They're working to develop varieties that can tolerate more drought conditions or maybe they have a higher cold tolerance," Thompson says. "Hopefully, the development of those varieties can keep up as our climate does change."

"If we plant a tree now in our Indiana garden, in 20 years it probably won't be able to survive in this climate even if it's a native."

Employing mechanical fixes for some of the issues unique to gardening in the age of climate change also may help. Case in point? Step away from the pesticides and protect your plants with floating row cover instead. You can also install rain barrels to catch some of the water you'll need for later.

"The heat is bad, the cold is bad, the wet springs are bad, and the dry summers are bad," Andrews says. "You've got these extremes, and it is a dim view. But I suppose the thing you have to do is just be prepared to roll with the punches every year."

The long view

"I feel like what we're doing is selfish," IU's Department of Geography professor Robeson admits. "People are just really focused-understandably in some cases-on the short-term. They're focused on their next paycheck or getting through this year.

But, if we start to look at the longer-term picture, this is going to affect our children and our grandchildren, and it's not fair. It's just flat-out not fair."

Considering the very real hardships we and future generations—now face, it may be tempting to give up hope. And, while the volatility of climate change may feel like the only constant we all share, it doesn't have to be. Turns out we also happen to have a healthy contingent of climate change activists quietly working behind-the-scenes to make a real difference.

Robert Meitus leads the South Central Indiana Chapter of Citizens' Climate Lobby, an international nonprofit organization that's focused solely on passing Carbon Fee and Dividend legislation. "We're not so visible all the time, because we're not out marching," Meitus says. "But it's one of the most active environmental organizations in the country, and it's very effective."

"We're calling for a market-based approach to the problem of carbon pollution," explains Citizens' Climate Lobby member David Mann. How exactly does it work? Businesses which remove carbon-releasing coal, oil, gas, or similar agents from the ground are assessed a carbon tax. These taxes are then pooled and paid as dividends to the general public to help offset price increases on gasoline and other carbon-taxed goods. This approach also helps level the playing field for cleaner energy products like solar and wind. (To learn more about Energy

Innovation and Carbon Dividend Act legislation, visit EnergyInnovationAct.org.)

"We think is one of the only things that is big enough to have a



and off of the carbon fix that we're in right now," Meitus says. "This country is not really into regulating everything, so if that's not possible, just put a price on it. Many conservative economists say this makes the most sense."

Captions go here.

The notion also seems to make sense to some of our state legislators. Marcia Veldman serves as state coordinator for the Citizens' Climate Lobby when she's not working at the City of Bloomington Parks and Recreation Department, and she helped



shepherd the bipartisan Energy Innovation and Carbon Dividend Act, which is now in the

"It includes one Republican and multiple Democratic supporters," she says. "It's our hope that by June we'll have bipartisan legislation introduced in the Senate as well that closely mirrors what is currently in the House."

Slowly building goodwill—and political will—the local group has been working toward these legislative goals for five-and-a-half years. In that time, they've made myriad trips to lobby state and national legislators. They also contact members of the media, write letters to the editor, take a table at public events, and present to various organizations.

"This massive, planetary problem of catastrophic climate change makes you feel helpless at the individual level," Mann says. "This is a way to have some direct action and join forces with other like-minded individuals."

"It's a big job," he says. "But you don't have to do it all by yourself." *

Get Involved

Citizens' Climate Lobby

The Citizens' Climate Lobby's South Central Indiana Chapter meets monthly. Visit https://citizensclimatelobby.org/chapters/IN_South_Central_Indiana for details.

Hoosier Environmental Council

The Hoosier Environmental Council continually seeks Environmental Advocates to help educate the public about environmental legislation currently in the Statehouse. Training sessions for new Environmental Advocates are held monthly. Visit www.hecweb.org for details.

Earth Care

A "network of local faith communities concerned with climate change," Earth Care helps congregations and individuals working to shift to renewable energy. Earth Care meets monthly, and new members are welcome. To learn more visit www.earthcareindiana.org.

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