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Land Use *Tracker*

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Electric Vehicles: A Good Idea for Wisconsin?

By Lynn Markham, Center for Land Use Education

Gas pumps still rule the roadways, but electric-vehicle chargers are moving up fast. According to the U.S. Department of Energy, California is home to 1,840 public electric-vehicle charging stations, while Texas ranks second with 599.[1] Electric vehicles (EVs) can help increase energy security, lower fuel costs, and reduce air pollution.[2]

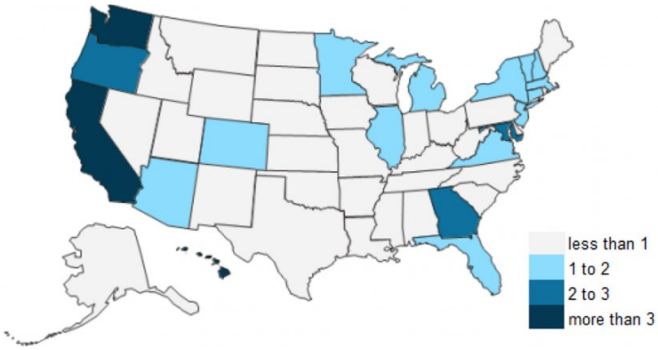
This article takes a closer look at electric vehicles, including costs of ownership, impacts on Wisconsin energy security, benefits to electric utilities, and impacts on air pollution and human health. The article also describes EV infrastructure needs and planning and policy options for community planners, public works directors, local government officials, utilities, and residents with an interest in EVs.

Electric Vehicles on the Road Today

The number of EVs on the road is rapidly increasing. In September 2014, over 600,000 plug-in electric passenger cars and utility vans had been sold in the world. The United States leads the way with a stock of about 260,000 highway-capable plug-in electric vehicles. Japan is second with more than 95,000 EVs, followed closely by China with over 77,000 EVs.[3]

The location of EVs is concentrated in certain parts of the United States. As shown in Figure 1 on page 2, California, Washington and Hawaii lead the nation in the adoption of electric vehicles.[4] Wisconsin has less than one EV per 1,000 registered vehicles, lower than Minnesota, Illinois and Michigan.[5] Data from the Wisconsin Department of Transportation shows that there were 379 registered EVs in Wisconsin in 2014, up from 73 EVs in 2012.[6]

Figure 1. Electric Vehicles by State (per 1,000 Registered Vehicles)



Source: U.S. Energy Information Administration, based on Federal Highway Administration data and R.L. Polk & Company

Electric Vehicle (EV): A vehicle that utilizes a battery to store the electric energy that powers the motor. EV batteries are charged by plugging the vehicle into an electric power source. Also known as a Battery Electric Vehicle (BEV).

Plug-in Hybrid Electric Vehicle (PHEV): A vehicle powered by an internal combustion engine that can run on conventional or alternative fuel and an electric motor that uses energy stored in a battery. The vehicle can be plugged into an electric power source to charge the battery.

Source: U.S. Department of Energy, Alternative Fuels Data Center

Cost of Electric vs. Conventional Vehicles

In January 2015 when Wisconsin gasoline prices were at $2.42 per gallon, the U.S. Department of Energy estimated that it cost $1.44, on average, to drive an EV as far as a conventional car travels on one gallon of gasoline in Wisconsin.[7]

The U.S. Department of Energy has a useful calculator that compares vehicles in terms of purchase price, fuel economy, annual fuel costs, and cumulative costs of ownership over ten years. Figure 2 provides a comparison for seven vehicles. Cumulative costs are based on taking out a five-year loan with 10% down, 6% interest rate, driving 11,926 miles per year, and paying typical maintenance, insurance and other costs. Gasoline is calculated at $2.50 and $4.00 per gallon.

The Nissan Leaf EV and Kia Soul EV currently qualify for a $7,500 federal tax credit. This credit will gradually phase out after 200,000 EVs are sold by each manufacturer in the United States. At the end of 2014, cumulative domestic sales for the Leaf were 72,294. Sales for the Soul were not provided.[8]

Of the seven vehicles compared, the Nissan Leaf EV has the lowest cumulative cost over ten years with the existing federal tax credit. If the tax credit were to end, the Nissan Leaf would have the lowest cumulative cost if gas was $4.00 per gallon, while the Honda Civic would have the lowest cost if gas was $2.50 per gallon. Results are likely to change with 2016 models.[9] You can visit the calculator at: www.afdc.energy.gov/calc

Figure 2. Cost Comparison for Electric, Hybrid and Gas Vehicles

Vehicle (2015 models)	Purchase Price	Fuel Economy (city/hwy)	Annual Fuel Cost ($0.13/kWh)[a]	Annual Fuel Cost ($2.50/gal)[b]	Annual Fuel Cost ($4.00/gal)[b]	Cost of Ownership Over 10 Years ($2.50/gal)	Cost of Ownership Over 10 Years ($4.00/gal)
Nissan Leaf EV	$29,010	-	$455	-	-	$47,500[c]	$47,500[c]
Kia Soul EV	$33,700	-	$493	-	-	$53,500[c]	$53,500[c]
Toyota Prius Hybrid 4 cyl 1.8L	$24,200	51/48 mpg	-	$605	$968	$53,000	$56,000
Honda Civic 4 cyl 1.8L	$19,090	30/39 mpg	-	$866	$1,386	$50,000	$55,000
Subaru Impreza 4 cyl 2.0L	$19,195	28/37 mpg	-	$921	$1,473	$51,000	$56,000
Ford Fusion 4 cyl 1.5L	$22,400	25/37 mpg	-	$978	$1,564	$55,000	$60,000
Ford Taurus 4 cyl 2.0l	$26,790	22/32 mpg	-	$1,120	$1,792	$61,000	$67,000

Source: U.S. Department of Energy, Alternative Fuels Data Center (www.afdc.energy.gov/calc). [a] Electricity escalation rate over 10-year period assumed to be -0.3% per year. [b] Gasoline escalation rate over 10-year period assumed to be 1.8% per year. [c] Includes $7,500 federal tax credit. Must have $7,500 tax liability in year of purchase to claim full tax credit.

Wisconsin Energy Security

Wisconsin has no sources of fossil fuels including petroleum. All petroleum used in Wisconsin is imported from other states and countries. As shown in Figure 3, money leaving Wisconsin for petroleum for transportation nearly quadrupled from 1970 to 2012, adjusted for inflation. In 2012, $12 billion left the state to pay for gasoline and diesel for transportation. This equates to approximately $5,200 per household each year. In total, transportation accounted for 76% of out-of-state expenditures for energy in 2012.[10]

While all energy prices fluctuate over time, data from the 2013 Wisconsin Energy Statistics Report clearly shows that gasoline and diesel had greater price variation and dramatically larger price increases than electricity from 1970 to 2012[11] (see Figure 4). Because electricity prices are more stable than oil prices, increasing the use of electricity for transportation could make costs more predictable. It could also help reduce the amount of money leaving the state in the form of transportation energy expenditures.

Electric Vehicles and Utilities

In 2012 Wisconsin used 2% less electricity than in 2007.[12] Nationwide, demand is expected to grow by less than 1% a year between now and 2040. What does this mean for Wisconsin utilities? Homes that own a PHEV typically consume 58% more electricity than homes without one. The Edison Electric Institute, a power-industry trade body, recently issued a report that calls PHEVs a "quadruple win" for utility companies. PHEVs could help the industry increase demand, meet environmental goals, get closer to customers, and cut costs by electrifying its own vehicle fleets.[13]

In Wisconsin, many electric utilities provide information about EVs and PHEVs on their websites. Madison Gas and Electric and WPPI Energy go farther. WPPI Energy, a regional power company serving 51 consumer-owned electric utilities, has two PHEVs charged by 100% renewable energy as part of their own fleet. They have also provided funds to help 15 member utilities offset the cost of purchasing neighborhood electric vehicles (EVs that go up to 25 mph).[14] Madison Gas and Electric has installed a network of 27 public charging stations in the Madison area that are powered by 100% wind power.[15]

Figure 3. Wisconsin Expenditures on Gasoline and Diesel for Transportation (in 2012 dollars)

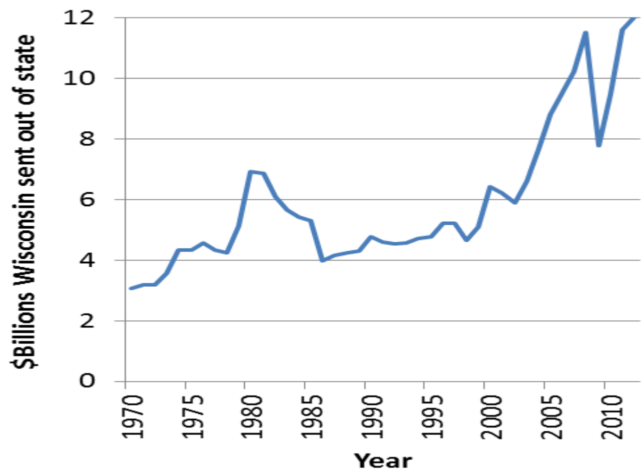


Figure 4. Change in Energy Costs Over Time

Type of energy (unit)	1970 price	2012 price	Percent change
Residential electricity (kWh)	$0.109	$0.132	+20
Commercial electricity (kWh)	$0.118	$0.105	-11
Unleaded gasoline (gallon)	$1.57	$3.62	+131
Diesel (gallon)	$0.88	$3.95	+352

Source: 2013 Wisconsin Energy Statistics.

Air Pollution and Health Impacts

Total emissions from an EV can be significantly lower than those from a conventional internal combustion engine in regions of the country where wind, hydropower, and natural gas make up a greater proportion of energy sources used to generate electricity.[16] This is the case in some parts of the country including the Pacific Northwest, California, New England, and New York.

A 2014 study by researchers at the University of Minnesota evaluated the air-quality human health impacts of ten types of energy for transportation. They estimated life cycle air pollution emissions and resulting human health impacts of air-borne particulates, ozone, and greenhouse gas (GHG) emissions. They found that driving vehicles that use electricity from renewable energy instead of gasoline could reduce the resulting deaths due to air pollution by 70 percent. The study also shows that switching to vehicles powered by electricity generated from natural gas yields large health benefits. Conversely, it shows that vehicles powered by coal-based or national "grid average" electricity (49% coal and 22% natural gas in 2007) are worse for health. Switching from gasoline to those fuels would increase the number of resulting deaths due to air pollution by 80 percent or more.[17] This study is summarized in a two minute video at: http://discover.umn.edu/news/environment/switching-vehicles-powered-electricity-renewables-could-save-lives

Figure 5 shows the percentage of electricity generated from coal in Wisconsin compared to neighboring states and the nation. In the Midwest, Wisconsin uses a higher percentage of coal to produce electricity (51.4%) than Minnesota (43.5%) or Illinois (40.9%). It also uses a higher percentage than the nation as a whole (38.6% for 2012—the most recent year with complete data). This means that Wisconsin utilities produce more air pollution (i.e. air-borne particulates and ozone) and more carbon dioxide[18] per unit of energy than the national "grid average."

Based on the 2014 study from the University of Minnesota, switching vehicles from gasoline to Wisconsin-generated electricity from the grid would actually increase the number of resulting deaths due to air pollution by 80 percent or more. In contrast, switching from gasoline-powered vehicles to renewable energy powered EVs could reduce resulting deaths due to air pollution by 70 percent.[17]

A calculator created by the U.S. Department of Energy uses the 2009 fuel mix for electricity by region to estimate GHG emissions. Figure 6 shows emissions estimates for seven vehicles that drive 11,926 miles per year. The Nissan Leaf EV charged with electricity off the grid in Wisconsin has GHG emissions 20 to 38 percent lower than a Honda Civic, Subaru Impresa, Ford Fusion or Ford Taurus; however, emissions are 15 percent higher than a Toyota Prius Hybrid.[20]

Clean Power Plan

On June 2, 2014, the United States Environmental Protection Agency proposed the Clean Power Plan to cut carbon pollution from power plants. Nationwide, the Clean Power Plan will help cut carbon pollution from the power sector by 30 percent from 2005 levels. It will also reduce pollutants that contribute to the soot and smog that make people sick by over 25 percent. States will decide how to cut carbon pollution. The proposed timeline is for EPA to issue final rules on the Clean Power Plan in the summer of 2015, and for states to submit initial or complete compliance plans to EPA by the summer of 2016.[19]

Figure 5. Electric Power Industry Generation by Primary Energy Source, 2012

	U.S.	WI	MN	IL	IA
coal	38.6%	51.4%	43.5%	40.9%	62.3%
natural gas	29.1%	18.1%	13.6%	5.7%	3.4%
nuclear	19.8%	22.4%	22.9%	48.8%	7.7%
hydroelectric	7.0%	2.4%	1.1%	0.1%	1.4%
wind	3.6%	2.4%	14.6%	3.9%	24.8%
petroleum	0.5%	0.5%	0.1%	0.0%	0.2%
biomass	0.4%	0.8%	1.9%	0.3%	0.3%
wood	0.3%	1.8%	1.6%	0.0%	0.0%
solar	0.1%	0.0%	0.0%	0.0%	0.0%
other	0.0%	0.1%	0.8%	0.2%	0.0%

Source: U.S. Energy Information Administration.

Figure 6. Emissions Estimates for Wisconsin

Vehicle (2015 models)	Fuel Economy (city/hwy)	Annual Emissions (lbs CO_2)
Nissan Leaf EV	27/33 kWh/100m	6,882
Kia Soul EV	28/37 kWh/100m	7,463
Toyota Prius Hybrid	51/48 mpg	5,991
Honda Civic	30/39 mpg	8,581
Subaru Impreza	28/37 mpg	9,121
Ford Fusion 1.5L	25/37 mpg	9,683
Ford Taurus	22/32 mpg	11,092

Source: Source: U.S. DOE, Alternative Fuels Data Center.

Electric Vehicle Infrastructure

Charging stations in homes, workplaces and along travel routes are necessary to support electric vehicles. According to their manufacturers, the Nissan Leaf can travel an average of 84 miles per charge,[21] while the Tesla Model S can go from 244 miles (with a 60 kWh battery) to 306 miles (with an 85 kWh battery).[22] The time necessary to charge a vehicle's battery depends on the vehicle, battery type, and type of charger. Figure 6 shows typical charging rates for a light-duty vehicle and how many locations in Wisconsin offer each type of charging. A full list of Wisconsin charging stations by type can be found at: www.afdc.energy.gov/locator/stations/#results?ev_legacy=true&location=WI&fuel=ELEC

DC fast charging stations, which are the most useful for long-distance travel, are located in Milwaukee, New Berlin and Madison. Tesla can only use stations in Eau Claire, Onalaska, Pleasant Prairie and Madison. Based on the location and number of existing charging stations in the state, driving an EV is a viable option when driving distances between charges do not exceed the range provided by a charged battery. Currently, longer distance driving is supported only in the Milwaukee and Madison areas.

Planning and Zoning for Electric Vehicles

Community planning can be used to determine where and how electric vehicle charging infrastructure is allowed or encouraged. An update to the zoning ordinance is often a necessary first step to define, allow, incentivize, or require EV infrastructure. Other tools such as parking ordinances can also be used.

Following are some specific suggestions that communities wishing to promote EVs should consider:

- Include relevant goals, objectives and actions in the comprehensive plan to promote EV infrastructure
- Use the future land use map and appropriate zoning districts to allow EV infrastructure in logical locations
- Establish clear definitions for EVs and EV infrastructure
- Incentivize EV infrastructure by providing a density bonus (i.e. additional floor area) for development that includes EV infrastructure
- Require a specific number of EV charging stations for certain types of new construction
- Use a capital improvement plan to budget for municipal charging stations

State Policies and Programs

Many states are working to diversify fuel types by increasing the use of alternative transportation fuels such as electricity, natural gas, hydrogen, and biofuels.[23] Many states are also specifically

Figure 6. Wisconsin Charging Stations

Charging Station	Driving Range	Number in Wisconsin
AC Level 1	2 to 5 miles per hour of charging	80
AC Level 2	10 to 20 miles per hour of charging	91
DC Level 2	60 to 80 miles per 20 minutes of charging	10

Source: U.S. DOE, Alternative Fuels Data Center, May 2015.

promoting the adoption of hybrid or plug-in electric vehicles. At least 37 states and the District of Columbia have incentives that provide high-occupancy vehicle lane exemptions, financial incentives, vehicle and emissions test exemptions, parking incentives, and utility rate reductions. Financial incentives including tax credits and registration fee reductions are particularly popular ways to promote adoption. State rebates and tax credits range from $1,000 in Maryland to $6,000 in Colorado. At least 20 states considered legislation in 2014 to encourage sales and increase use of hybrids and PHEVs.[24] As of January 2015 Wisconsin did not have any policies to encourage or discourage EVs.

Conclusions

So, are EVs a good idea in Wisconsin? The answer is “it depends.” Specifically, it depends on how the electricity to run an EV is generated.

Switching from gasoline-powered vehicles to EVs charged with electricity from wind, hydropower or solar will result in:

- Less money leaving Wisconsin in the form of gasoline and diesel expenditures,
- Less fuel tax collected in Wisconsin,
- Fewer greenhouse gas emissions, and
- Fewer deaths due to air pollution (i.e. ozone and air-borne particulates).

Switching from gasoline-powered vehicles to EVs charged with grid average electricity in Wisconsin will result in:

- Reduced cumulative costs of vehicle ownership,
- Less money leaving Wisconsin for gasoline and diesel,
- Reduced fuel tax collected,

- Reduced greenhouse gases (in most cases),
- Increased deaths due to air pollution (i.e. ozone and air-borne particulates), and
- Increased sales for Wisconsin electric utilities.

To avoid increased deaths due to air pollution from driving EVs charged on Wisconsin grid electricity (51.4% coal), options include:

- Reducing the amount of coal used in generating electricity in Wisconsin,
- Creating more EV charging stations powered by wind, hydropower or solar, and
- Sticking with gasoline and diesel powered vehicles.

Clearly, state and local governments have a lot to consider with EVs. Relevant policies, if crafted thoughtfully can help to capture dollars leaving the state, provide a boost to local electric utilities, produce potentially lower vehicle ownership costs, and reduce air pollution and its associated impacts on human health.

Acknowledgements

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Reading the Wetland Landscape Workshops

The Wisconsin Wetlands Association is delivering a series of field-based workshops to help planning, zoning, and land conservation staff and local officials understand how local development practices and ordinances can be used to preserve wetland condition and functions. Participants will learn how to:

- Gather information that helps them consider the watershed context of site proposals.
- Relate concepts of wetland connectivity and landscape position to water resource management.
- Address linkages between wetland functions and zoning criteria when reviewing specific proposals.

Lincoln County Workshop

June 2, 2015, 9:30am - 5pm
Lincoln County Service Center (Merrill)

Brown County / Duck-Pensaukee Workshop

June 30, 2015, 9:30am - 5pm
Radisson Hotel (Green Bay) & nearby wetlands

Instructors include Tracy Hames, Tom Meier, Tony Kuchma, Mike Grimm, and representatives from WDNR and the Army Corps of Engineers. For more information and to register please contact Kyle Magyera at 920-250-9971 or policy2@wisconsinwetlands.org.

Wisconsin Wetlands Association to Release County Wetland Fact Sheets During American Wetlands Month

By Erin O'Brien, Wisconsin Wetlands Association

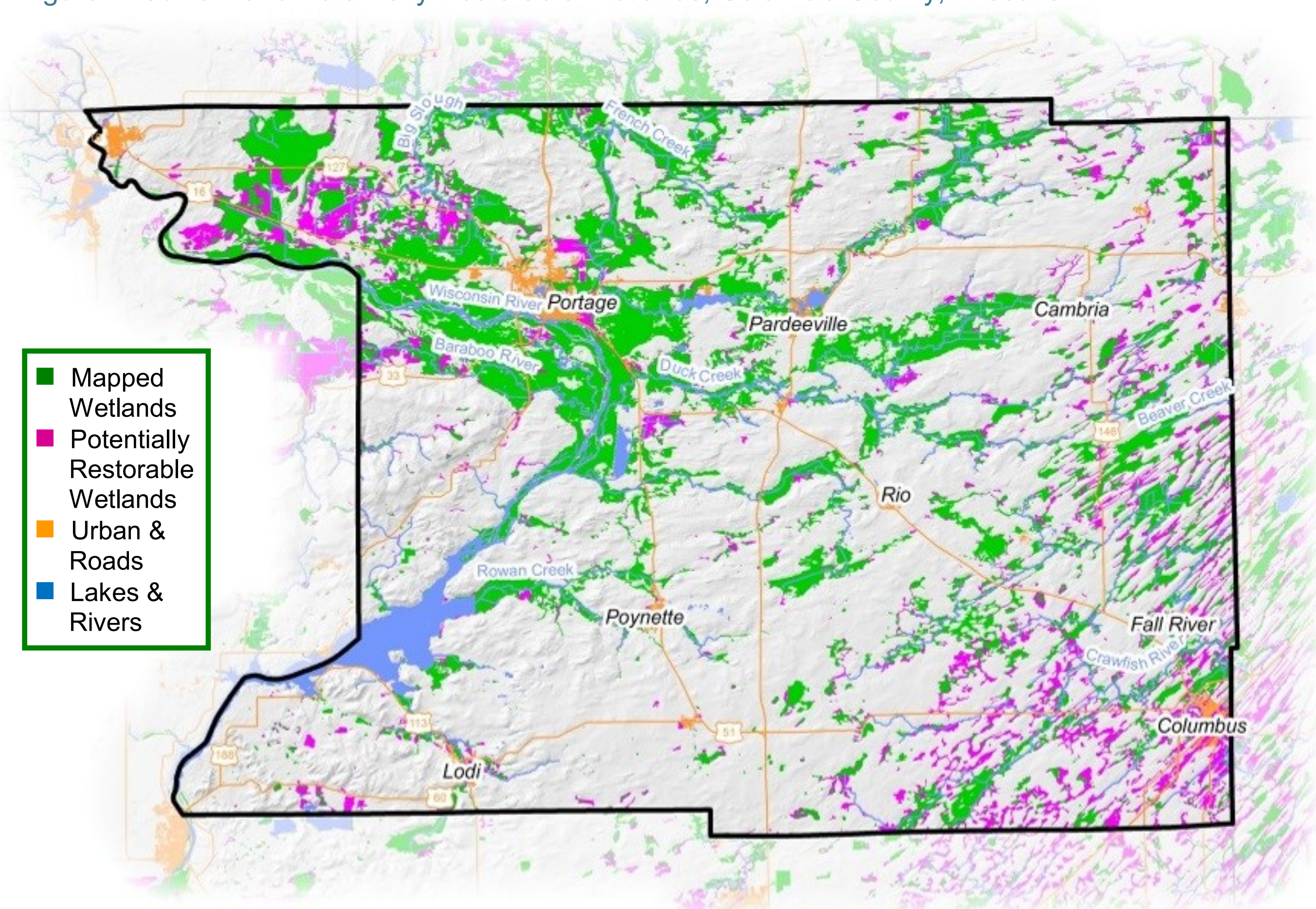
May is American Wetlands Month. To mark the occasion, Wisconsin Wetlands Association (WWA) has launched a month-long social media campaign to help improve wetland understanding and engagement. Their theme is "*Working Wetlands*," so you can expect to see a variety of posts providing new facts and information on the public benefits of wetlands and how people are working to protect them. To follow or catch up on these posts, search for #americanwetlandsmonth on Facebook or Twitter.

In late May, WWA will release County Wetland Fact Sheets for 33 of Wisconsin's 72 counties. Each fact sheet contains a table and maps showing the extent of current and potentially restorable wetlands by county (see Figure 1). Maps illustrating changes in historic wetland land cover at the county and sub-watershed (HUC 12) scale are also provided (See Figure 2 on page 8).

WWA produced the fact sheets to provide Wisconsin citizens with basic information about the amount and location of wetlands in their community and to show them where wetland loss has occurred. WWA is also using the fact sheets to encourage people to think about wetlands in a watershed context, and how wetlands are connected to other waters.

For many counties, the maps and data paint a powerful picture of the abundance of local wetlands—as well as how substantially we have altered the wetland landscape over time.

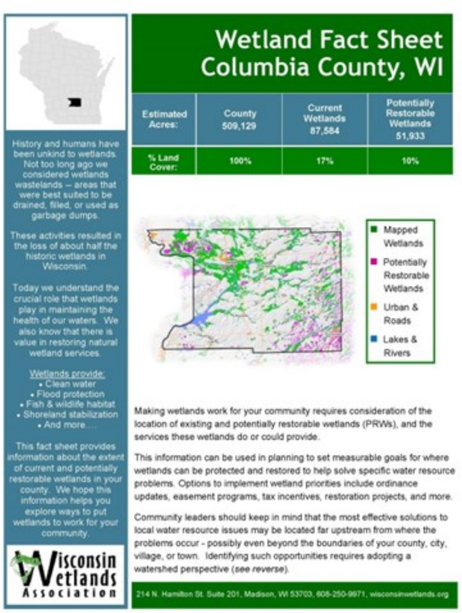
Figure 1. Current and Potentially Restorable Wetlands, Columbia County, Wisconsin



The presentation of both current and historic wetland data provides the reader with a visual opportunity to consider whether or how wetland loss has contributed to present-day water resource management problems. While the maps are not detailed enough to answer questions about the relationship between wetlands and flooding, or wetlands and water quality at specific locations, they can improve the reader's understanding of the potential connections. The data used to create the maps can also be used by planners and conservation professionals to identify areas where wetland protection and restoration could have the greatest positive impact on watershed health.

The fact sheets were created with assistance from a UW-Madison graduate student seminar, using potentially restorable wetlands data produced by the Wisconsin Department of Natural Resources, Water Quality Bureau. WWA is encouraging communities to make use of this data in local land use planning and policy development.

Fact sheets for 33 of Wisconsin's 72 Counties will be posted at www.wisconsinwetlands.org/countyfactsheets.htm by the end of May. Fact sheets for the remaining counties will be released as updates are made to the Wisconsin Wetlands Inventory and potentially restorable wetland data layer.



Wetland Fact Sheet
Columbia County, WI

Estimated Acres:	County 509,129	Current Wetlands 87,584	Potentially Restorable Wetlands 51,933
% Land Cover:	100%	17%	10%

History and humans have been unkind to wetlands. Not too long ago we considered wetlands wastelands – areas that were best suited to be drained, filled, or used as garbage dumps.

These activities resulted in the loss of about half the historic wetlands in Wisconsin.

Today we understand the crucial role that wetlands play in maintaining the health of our waters. We also know that there is value in restoring natural wetland services.

Wetlands provide:
- Clean water
- Flood protection
- Fish & wildlife habitat
- Shoreland stabilization
- And more….

This fact sheet provides information about the extent of current and potentially restorable wetlands in your county. We hope this information helps you explore ways to put wetlands to work for your community.

Mapped Wetlands
Potentially Restorable Wetlands
Urban & Roads
Lakes & Rivers

Making wetlands work for your community requires consideration of the location of existing and potentially restorable wetlands (PRWs), and the services these wetlands do or could provide.

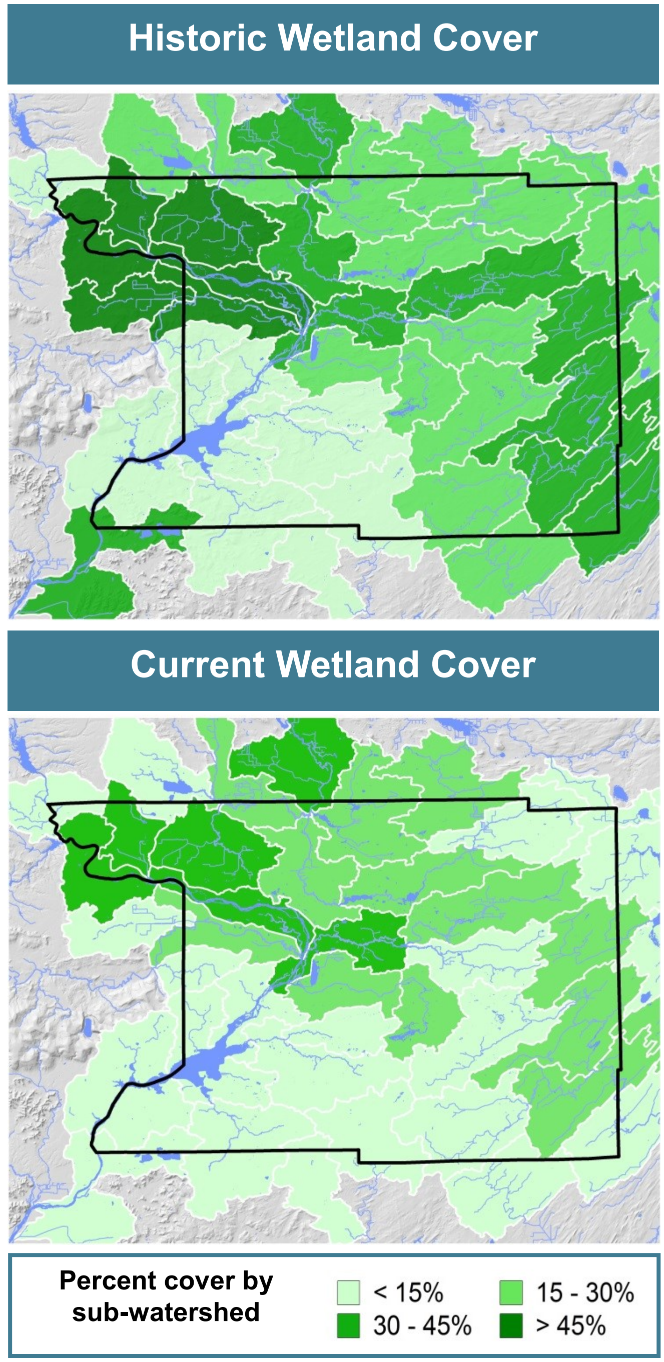
This information can be used in planning to set measurable goals for where wetlands can be protected and restored to help solve specific water resource problems. Options to implement wetland priorities include ordinance updates, easement programs, tax incentives, restoration projects, and more.

Community leaders should keep in mind that the most effective solutions to local water resource issues may be located far upstream from where the problems occur - possibly even beyond the boundaries of your county, city, village, or town. Identifying such opportunities requires adopting a watershed perspective (*see reverse*).

Wisconsin Wetlands Association

214 N. Hamilton St. Suite 201, Madison, WI 53703, 608-250-9971, wisconsinwetlands.org

Figure 2. Historic and Current Wetland Cover, Columbia County, Wisconsin

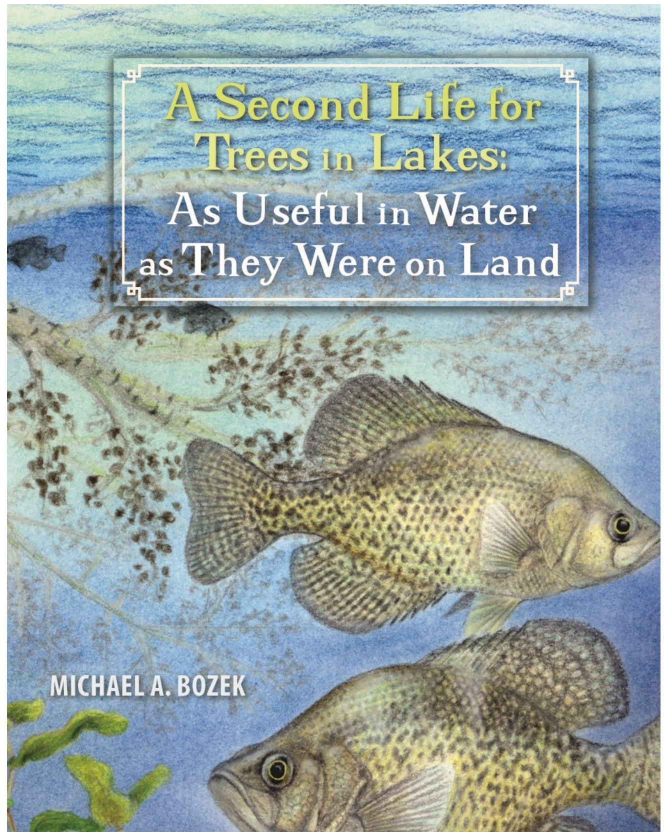


For More Information

Questions about WWA's County Wetland Fact Sheets should be directed to Erin O'Brien at 608-250-9971 or policy@wisconsinwetlands.org. WWA welcomes feedback on how you plan to use the fact sheets to promote wetland understanding and engagement in your community.

Understanding the Benefits of Trees in Lakes

By Michael A. Bozek, formerly with the Wisconsin Cooperative Fishery Research Unit, with updates by Lynn Markham, Center for Land Use Education



Ten thousand years ago, a tree grew on the shore of a lake somewhere in North America. For 140 years or more, fish swam in its shade and insects hatched on its branches and leaves; some were eaten by birds, some fell into the water to be eaten by fish, and some survived to continue the cycle of life. Birds nested and foraged in the tree's branches, kingfishers dropped like rocks, propelled by gravity to their next meal, while eagles perched amongst its highest branches. A wood frog chorus would start each evening in spring near the first crotch, and red squirrels would chatter for whatever reason red squirrels chatter. Then one day it happened: after years of increasing decay near the end of its life, the tree snapped at the butt during a windstorm and fell with a thunderous crash into the lake ending 140 years of silence and quiet rustling, punctuated by a single, quick, loud finale. Within a minute, the waves that had acknowledged the tree's entry into the water subsided, and all was quiet again.

Now the tree began its second life…in the lake. Within hours, crayfish crawled beneath its partially submerged trunk, to be followed by a mudpuppy and tadpoles, while minnows and small fish hovered within the lattice of its branches. Within days, logperch, darters, sunfish, bass, burbot, pike and even walleye and muskellunge had also entered the complex network of the newly established community. Algae and diatoms began establishing colonies, while dragonfly nymphs and mayflies followed to forage among the branches. A wood duck competed with a softshell turtle for basking space on the bole that once contained its nest site cavity. Herons, green and blue, alternated use as well: the bole presented a fine place to access the fish below. Use of the tree by a variety of organisms would continue again for much longer than its life on land. Remarkably, the tree might last another 300 to 600 years, slowly changing shape over time as it yielded to Father Time. Different organisms continued to use the tree until its cellulose had completely broken down and its chemical constituents had been fully integrated into the web of life in the lake.

Shoreland Development and Trees

Over time, humans have altered riparian areas of lakes at rapid rates across a large portion of the landscape: first, by logging, and more recently, by lakeshore development. In the Upper Midwest, forest stands in previously logged areas have more or less recovered and now sustain healthy second-growth forests. In contrast, many riparian owners along developed lakes have removed some or all of the trees from their lakefront property and the water. Where landowners continue to remove new understory trees and seedlings, they prevent recovery of shoreline areas to their natural state.

The rate and pattern in which trees fall in a lake depend on the stand of trees in the riparian area and activities of landowners. Trees in lakes tend to be most abundant (dense) in smaller lakes with undeveloped shorelines. Larger lakes have higher wind and wave energy which can break up trees faster and transport them offshore to deeper water. Greater development often results in landowners actively removing trees from shorelines and manicuring riparian areas.

In one study of undeveloped lakes in northern Wisconsin and the upper peninsula of Michigan, Christensen et al. found that humans greatly reduced the abundance of trees in shallow, nearshore areas of lakes.[1] Figure 1 shows the number of logs found in various shoreline settings.

Why Is This Important?

Fish use submerged trees in a variety of ways. Many species spawn on, adjacent to, or under trees. The trees provide cover helping some species protect their incubating brood. For example, smallmouth and largemouth bass preferentially build spawning nests near submerged trees, particularly large logs, while rock bass place them next to or under logs.[2, 3, 4] Because male bass and sunfish defend their eggs and young in nests, placing nests adjacent to or under submerged trees reduces the nest perimeter that they need to defend against predators. Once young have left the nest, newly hatched smallmouth bass will often inhabit submerged trees.[5] A decline in submerged tree habitat has been linked to reduced abundance of young smallmouth.[6] Yellow perch use submerged wood along with aquatic vegetation to lay eggs; long ribbon-like strands that can often be seen draped on them in early spring. Three studies have found a decline in yellow perch abundance when trees were removed from lakes.[7, 8, 9]

Figure 2. Fish Species Found in One Submerged White Pine Tree in Katherine Lake, Wisconsin

Black crappie	Pumpkinseed
Smallmouth bass	Mottled sculpin
Largemouth bass	Logperch
Walleye	Johnny darter
Muskellunge	Yellow perch
Rock bass	White sucker
Bluegill	Minnows

Figure 1. Abundance of Trees Found Near Lakes

Type of lake and shoreline	Logs per mile of shoreline
Undeveloped lakes	893
Undeveloped shoreline of developed lakes	601
Shorelines where houses have been built	92

Source: Christensen, et. al. 1996.

Fathead minnows, an important food item of larger fish and fish-eating shorebirds, spawn on the underside of wood in cavities. The young of many species of fish often disperse throughout the branches for protection,[10, 11] while predators, such as northern pike, muskellunge and largemouth bass[12] use the same trees for ambush foraging. Shade from branches and the bole provides daytime refuge for diurnal low-light species such as walleye. Use of trees can be species-, age-, and season-dependent, and trees provide many diverse habitats that attract fish for different reasons.

Current research has found that the association between fish and trees is clearly related to the complexity of branches and the location and position of the tree in water. More fish and more different species of fish use trees that have more complex branching.[10, 13] Large, individual, complex trees can host entire fish communities. In Wisconsin lakes, up to fifteen species or more may inhabit a single tree at a time (See Figure 2). Walleye and white suckers can be found beneath trees in deeper, darker water; adult smallmouth bass can be found beneath the bole; and many of the other species like cyprinids (i.e., minnows), bluegills, pumpkinseed, rock bass, muskellunge and more can be found throughout the complex web of branches.

How Can You Help?

Following are six simple steps that you can take to maintain the benefits of trees near water.

- Leave trees that fall in the water alone.
- Do not cut branches that are in the water to create pockets for easier fishing.
- Do not cut branches of trees that stick out above the water, even during winter as fuel for ice fishing. These branches will become valuable habitat as the tree settles further into the lake.
- Leave natural trees, seedlings and saplings along lakeshores intact and allow them to mature.
- Where trees have been removed along shorelines, and in particular, where understory trees, seedlings and saplings are gone, plant trees and shrubs, which will become fish habitat for future generations. Partial shoreline restoration is better than none.
- Learn to appreciate more natural shorelines rather than highly manicured sites, and encourage others to do the same.

Photo by Drew Feldkirchner

Trees in riparian areas emerge as seedlings. As they grow and mature, they drop seeds to establish future forest stands. When older trees die, they fall into lakes and streams creating habitat for fish and other aquatic organisms. Young seedlings continue the cycle, illustrating the important link between lakes and streams and their shoreland areas.

For More Information

This article was excerpted from: *A Second Life for Trees in Lakes: As Useful on Water as They Were on Land.* It was originally published in the Summer 2001 issue of Lakeline.

It can be accessed at: www.uwsp.edu/cnr-ap/clue/Pages/publications-resources/water.aspx
In the near future, you may order print copies from the UW-Extension Lakes Bookstore: www.uwsp.edu/cnr-ap/UWEXLakes/Pages/resources/bookstore/default.aspx. The publication is free with a small handling fee.

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