



IMPERVIOUS SURFACES

How They Impact Fish, Wildlife and Waterfront Property Values

Healthy lakes, rivers and streams are truly the basis for creating fond memories of time spent near the water, like walleye fishing on a crisp fall morning, swimming with the kids in the afternoon, and entertaining friends on the evening shoreline. Healthy fish, abundant wildlife, and clear, clean water all depend on the individual decisions that we make about our waterfront properties.



When we develop waterfront lots, trees and native plants are replaced by impervious (hard) surfaces. Driveways, rooftops, and other hard surfaces decrease the ability of the shoreland area to serve its natural functions. Removing trees and native plants eliminates the food sources and shelter on which wildlife depend. Water can no longer soak into the ground, which increases stormwater runoff that carries pollutants to lakes and streams. Fish eggs die when they are covered in a blanket of silt from runoff and erosion. A decline in water quality often lowers property values and our enjoyment of lakes.

Although the effects of one lot's development may not result in a measurable change in the water quality of a lake or stream, the cumulative effects of many developed lots can be substantial.

Photo by Robert Korth

How do impervious surfaces IMPACT lakes and streams?

This publication was developed for waterfront property owners and local officials to help answer this question. It does not discuss all of the potential impacts of impervious surfaces; rather, it primarily focuses on impacts to:

- 1.** Waterfront property values
- 2.** Fishing
- 3.** Wildlife

The decisions we make as individual landowners, whether small renovations or new development plans, have an additive effect on our waterbodies and the fish and wildlife that call these places home. For this reason, each and every property owner has a unique opportunity to help protect our lakes and streams.

For how-to information about minimizing impervious surfaces and their impacts, take a look at the publications described on page 9. Every property owner has a unique opportunity to help protect our lakes and streams.



What are impervious surfaces and how do they affect our waters?

Virtually any form of shoreland development leads to more impervious surfaces. Impervious surfaces are hard, man-made surfaces such as rooftops, driveways, parking areas, and patios that change the fate of precipitation – instead of soaking into the ground and being naturally filtered, water runs downhill directly into our lakes and streams.

Runoff from impervious surfaces washes pollutants such as sediments, nutrients, bacteria, car fluids and other chemicals into our lakes and streams. Runoff and the erosion it causes can be a serious problem for both the property owner and the lake. Gullies or large eroded channels are unsightly and may result in loss of land when soil is carried to the lake.

SHORELAND ZONING is in place to protect our lakes and rivers. Wisconsin Administrative Code NR 115 provides minimum standards for shoreland zoning. Many counties have chosen to adopt more protective standards. See your county zoning office for more information.



Photos by Jeffrey Strobel

Figure 1

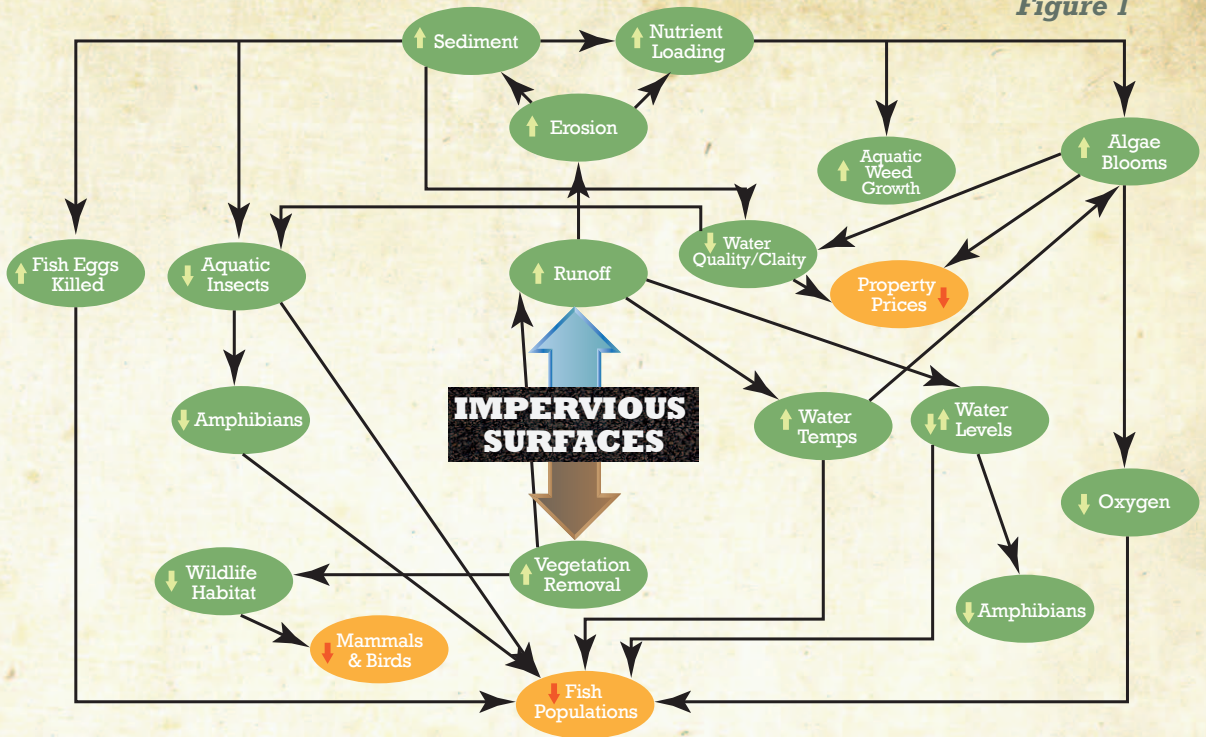


Figure 1: Impervious surfaces can cause a variety of negative impacts to lake and stream ecosystems. The orange ovals in this diagram indicate the three areas of impact that are discussed in this publication. The diagram illustrates how they are intricately connected to lake health. *For a comprehensive overview of how impervious surfaces affect waterbodies, see *Impacts of Impervious Cover on Aquatic Systems* from the Center for Watershed Protection.¹

3 REASONS TO MINIMIZE IMPERVIOUS SURFACES

1 Waterfront Property Values

We are drawn to shoreland properties for a variety of reasons. Some of us enjoy playing in the water on a hot afternoon in July, while others enjoy ice fishing during the frost-knipping cold of January.

Often, people choose to purchase a waterfront property based on how they plan to enjoy the water – be it for enjoying the peaceful, natural setting or the abundant fishing, swimming, or boating opportunities. In fact, a UW-Extension survey found that enjoyment of peace and quiet, natural beauty, and hunting and fishing opportunities were the top three reasons people enjoyed lakes.²

Minimizing the presence of impervious surfaces in the shoreland area can help to ensure that many of these qualities we care about are preserved, helping to protect property investments.

While many opinions exist over what the perfect shoreline looks like, most of us agree that clear water is desirable. Studies have found that the market value of a waterfront property can decrease if the lake has cloudy or murky water.³ Water clarity can be influenced by the presence of impervious surfaces in two ways. First, runoff increases erosion resulting in more soil being washed into the water, making it cloudy. Second, runoff from impervious surfaces carries additional phosphorus to the water. An unfertilized, developed waterfront lot that has 20% impervious surface carries six times more phosphorus to the lake than an undeveloped lot of the same size (see Figure 2). This additional phosphorus can fuel algae growth in our waters, which lowers water clarity and overall aesthetic appeal.

A recent study that tracked over 1,000 waterfront property sales in Minnesota found that when all other factors remained equal, properties on lakes with clearer water commanded significantly higher prices.³ A similar study conducted in Maine found that changes in water clarity of three feet can change lakefront property prices by as much as \$200 per frontage foot.⁴ This means that a three-foot increase in water clarity could increase the property value by as much as \$20,000 on a lot with 100 feet of water frontage. Perhaps more important, an identical decrease in water clarity would decrease property values by significantly more than \$20,000.⁴

Is gravel considered impervious?

A common question is whether gravel driveways or walkways are considered impervious surfaces. Noncompacted gravel “mulch,” such as that used as landscaping material, is generally not considered impervious. On the other hand, gravel used for driveways, parking lots, or other high-use surfaces becomes compacted. **After compaction, gravel driveways and parking areas will create runoff even during minor rain events.** If gravel is used, it should be free of clay and other fine particles to help prevent compaction and “clogging” of spaces between gravel particles.⁵ Half-inch or ¾-inch “clear” crushed rock is a good choice for this application. “Clear” indicates that the gravel is virtually free of fine particles.



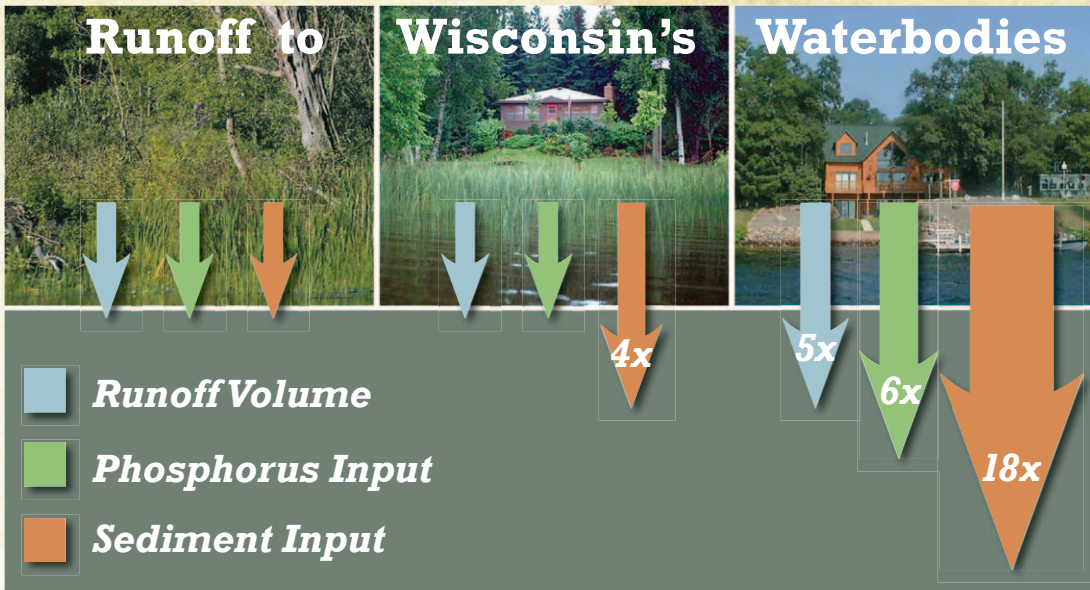


Figure 2: The far left picture indicates a half-acre undeveloped shoreland lot that causes minimal runoff, phosphorus and sediment inputs to the lake. The middle picture portrays a typical 1940s shoreland development with approximately 8% of its area covered by impervious surfaces. The picture to the right shows a shoreland lot with approximately 20% of its area covered by impervious surfaces. Notice how sediment inputs drastically increase as impervious surface coverage increases.⁶

2 Fishing

Fishing gives us a chance to sit back, relax and visit with friends and family while waiting for the familiar tug of an unseen fish on our line. Many of Wisconsin's lakes and rivers are prime designations for those in search of walleye, bass, musky or crappie, But runoff that carries sediments, nutrients and other pollutants into lakes and streams leads to decreased populations of many of these fish.

This is largely because:

- **More nutrients** result in less oxygen in the water, which fish need to survive
- **More sediments** and algae growth make it difficult for some predator species that hunt by sight to find their food

More sediments cover spawning beds of fish such as smallmouth bass, walleye, and crappie, potentially inhibiting reproduction.⁷

Streams are particularly sensitive to the effects of impervious surfaces because of increased potential for flooding during rainstorms. In addition, impervious surfaces reduce groundwater recharge causing lower water levels in streams during dry periods when stream flow comes from groundwater. Fluctuating water levels can degrade fish and amphibian habitat.¹ Another significant impact to streams is warm runoff coming from hot pavement and rooftops during warmer months. This increases stream temperatures, putting stress on fish that require cold water, such as trout.⁸

Figure 3

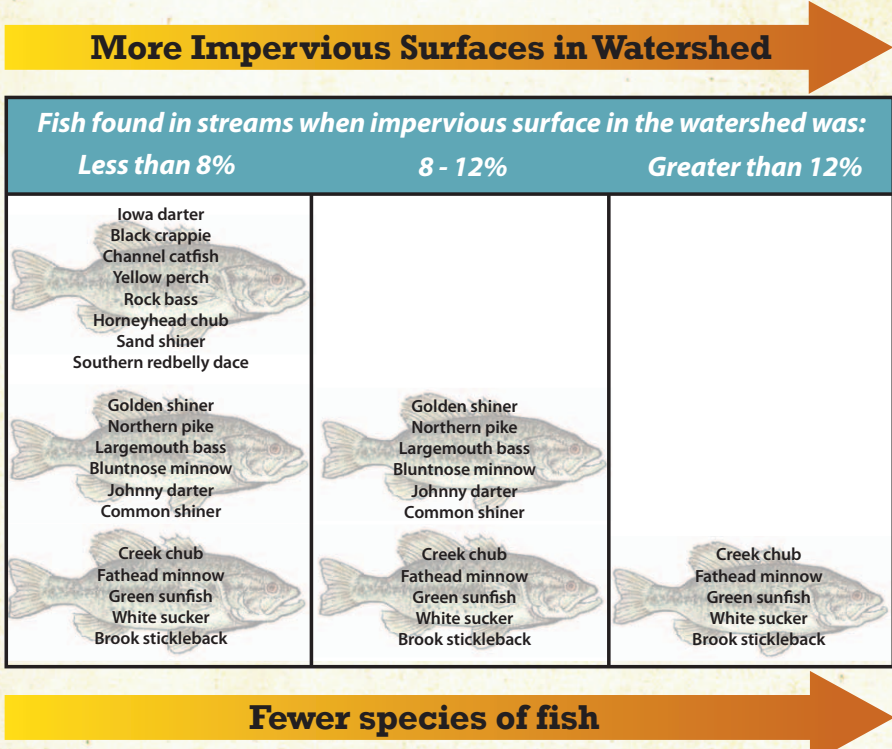


Figure 3: The number of different stream fish species found in streams declines as the effects of impervious surfaces kill off more sensitive species.⁹

Numerous studies on stream watersheds have shown that fish populations decline as impervious surface coverage increases. A study of 47 streams in south-eastern Wisconsin found that when impervious surfaces covered 8-12% of a watershed – the land that drains to the stream – the number of fish species was reduced.¹⁰ In watersheds with impervious surface coverage even slightly above 12%, researchers found that the overall number of fish species plummeted (see Figure 3). The same study also indicated that impervious surfaces immediately adjacent to the water, especially within the first 150 feet, had a significant impact on streams.



What can you do to minimize the effects of impervious surfaces?

For more information on particular topics, see numbered resources below:

Minimize hard surfaces like rooftops and driveways on your property

- Share driveways with neighbors where possible
- Use narrow driveways
- Minimize building footprints - build "up" instead of "out"
- Remove unneeded hard surfaces, such as extra parking spots

Use pervious materials where possible

- Green roofs
- Mulch walkways
- Permeable pavers for walkways or driveways **1**

Capture or infiltrate runoff

- In rain barrels **1**
- In gutters & downspouts **1**
- In rain gardens **2**

Control erosion during construction and after development **5**

Minimize fertilizer use

- Have soil tested first to see if fertilizers are needed, and use as little as possible.

Maintain or restore shoreline plants to slow runoff and provide habitat **3 4**

- Maintain or restore at least a 35-foot wide shoreline buffer
- Let nature reestablish the shoreline!



Photo by Sarah Congdon

Where to find these excellent resources:

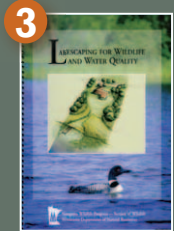
Controlling Runoff and Erosion from Your Waterfront Property: A Guide for Landowners. Available at www.burnettcounty.com/DocumentView.aspx?DID=119



Rain Gardens: A How-To Manual For Homeowners. DNR publication no. WT-776 2003, UW-Extension publication No. GWQ037. Available at <http://learningstore.uwex.edu/assets/pdfs/GWQ037.pdf>



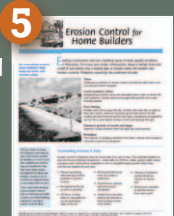
Lakescaping for Wildlife and Water Quality. 176 pages, \$19.95, available from the Minnesota Bookstore at 800-657-3757. Wisconsin DNR staff recommend this book as the best detailed planning guide for shoreland restoration projects.



The Shoreland Stewardship Series: Protecting and Restoring Shorelands. Available at <http://clean-water.uwex.edu/pubs/pdf/protect.pdf>



Erosion Control for Home Builders. UW-Extension publication No. GWQ001 and Wisconsin DNR No. WT-457-96. Available at www.bldgpermit.com/erosioncontrol.pdf



Brown Trout

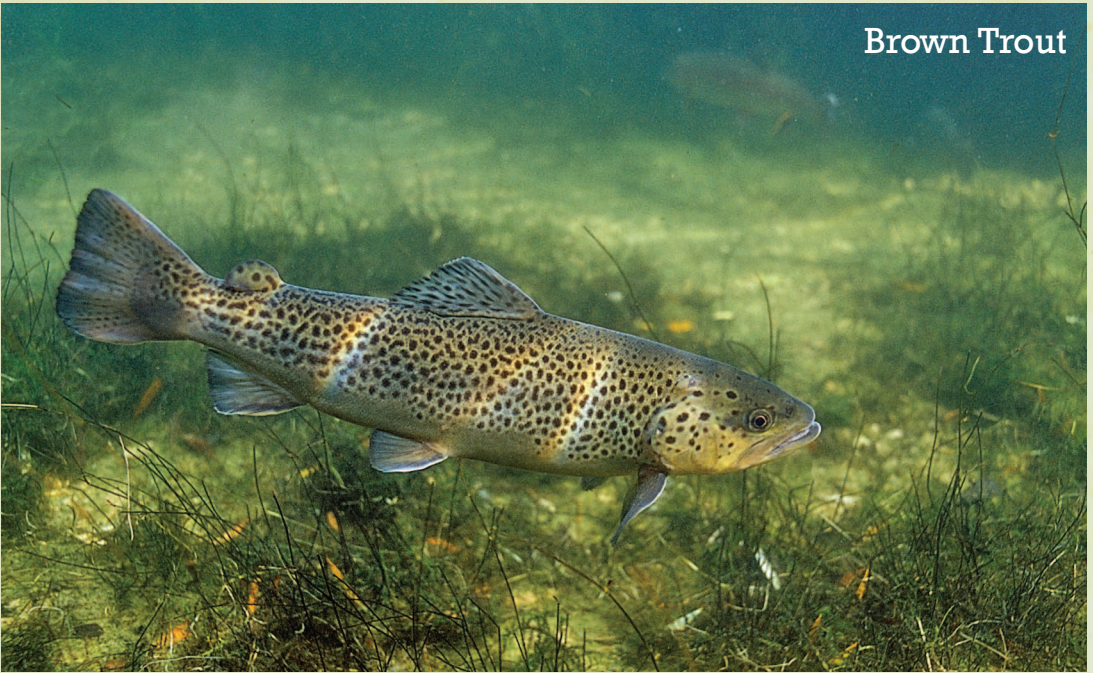


Photo by Eric Engbretson

Brook Trout and Brown Trout

Both brook trout and brown trout are found in many streams in Wisconsin, and require cold, clean water to survive. Both species are sensitive to pollution and low oxygen conditions. A study conducted on 33 coldwater streams in Wisconsin and Minnesota found that when impervious surfaces covered more than 11% of a watershed, trout were eliminated from streams.⁸

Brook Trout

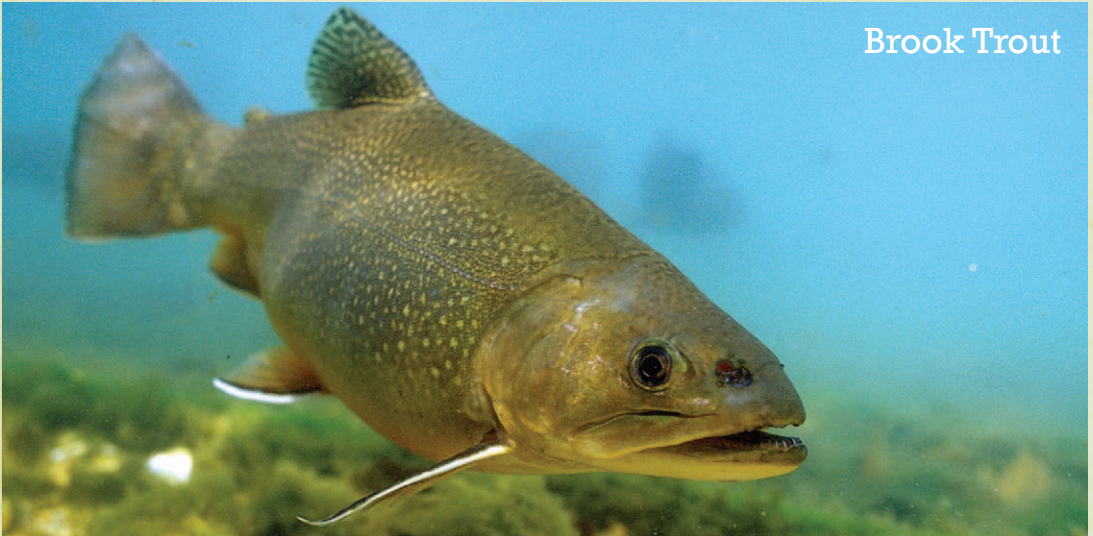


Photo by Eric Engbretson

The brook trout is the only trout species native to Wisconsin's waters. Part of their diet consists of aquatic insects and small fish, whose populations are negatively impacted by increased runoff and sedimentation.

The tendency for more impervious surfaces to lead to fewer fish species in streams also holds true for lakes, though less is known about specific thresholds where fish begin to be impacted. A 2008 study of 164 Wisconsin lakes found that certain fish species tended to be less common in lakes surrounded by high levels of impervious surfaces than in lakes surrounded by minimal impervious surfaces. Some of these species included game fish, like smallmouth bass and rock bass, but also nongame species, such as blackchin shiners, blacknose shiners, and mottled sculpin.¹¹ Many of the smaller, nongame species serve as vital food sources for game fish such as walleye, smallmouth bass, and northern pike. Increased impervious surfaces, removal of aquatic vegetation, and installation of beaches all contribute to the destruction of near-shore habitat for both larger fish and the smaller prey fish these predators depend on.¹² Fewer food options for game fish will likely lead to lower numbers of game species in the long run.

Walleye

Wisconsin is walleye country. Impervious surfaces can reduce walleye reproduction by causing soil erosion which leads to sedimentation. Although impervious surfaces aren't the only cause of sedimentation, when sediments cover spawning grounds, the spaces between the rocks and gravel become blanketed with silt. This can quickly cause walleye eggs to die because of inadequate water flow and oxygen deprivation.^{13, 14} Adult walleyes are often able to cope under these conditions, but harming the success of eggs and embryos puts the survival of a healthy walleye population at risk.¹⁵



Walleye

Photo by Eric Engbretson

Walleye typically spawn between mid-April and early May in Wisconsin when spring runoff is highest. Rock- and gravel-covered bottoms are their preferred spawning grounds due to the requirements of their sensitive eggs.

3 Wildlife

Whether looking out the front window of a waterfront home or from the bow of a canoe, opportunities to observe shoreland wildlife are abundant. The shoreline is a busy place. Northern pike, bluegills, bass and other fish spawn in the shallow water along the shore. Loons, ducks, geese and other water birds nest along the banks. Wildlife such as frogs, otters and mink live there too. Shoreline areas – on land and into the shallow water – provide essential habitat for fish and wildlife that live in or near Wisconsin's lakes and rivers. Overdeveloped shorelands can't support the fish, wildlife and clean water that are so appealing to the people attracted to the shoreline.¹⁶

Impervious surfaces can be thought of as biological deserts where animals cannot find food or shelter, making them easy prey. Disturbed open spaces increase wildlife mortality rates and decrease their chances of successfully raising young.

Although it may seem obvious, the creation of impervious surfaces in the shoreland area removes essential habitat for numerous species. Driveways, cemented paths, buildings and other types of impervious surfaces make our shorelands less inviting to wildlife. These areas can be thought of as biological deserts where animals cannot find food or shelter, making them easy prey. Shoreland habitat fragmented by impervious surfaces, mowing, or brushing are generally avoided by wildlife. These disturbed open spaces increase wildlife mortality rates and decrease their chances of successfully raising young.¹⁷

Habitat connectivity is key. Some animals like loons and frogs depend on habitat relatively close to the water. River otters, on the other hand, often choose denning sites in upland areas further from the water's edge.¹⁸ By minimizing how much of the shorelines we develop with impervious surfaces and maintaining habitat connectivity, we maximize the potential for seeing the unique wildlife that so intimately depend on natural shoreland habitats.

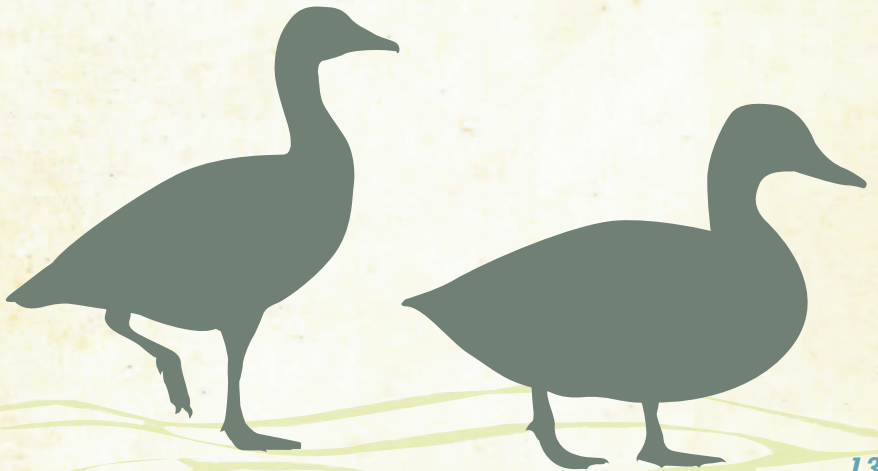
In addition, the impact of impervious surfaces on wetlands can pose a risk to waterfowl. Wetlands provide critical breeding and feeding grounds for mallards as well as many other waterfowl species. Increased impervious surfaces can cause water level fluctuations in wetlands due to increased runoff volumes.¹⁹ Rising water levels during the nesting season can make it difficult for ducklings to survive.²⁰

Mallard

The familiar raspy “quack” of a mallard is a sound common to Wisconsin’s water bodies. When we see mallards dabbling in ponds with a following of ducklings, they are often in search of aquatic insects. During the first two weeks of a mallard duckling’s life, its diet is comprised almost exclusively of aquatic insects. The same dietary needs also hold true for many other species of ducks.²¹ Research has shown that sedimentation tends to decrease aquatic insect densities.²² Without an adequate food source, mallards will have to move elsewhere to raise their young.

Photo by Mark Lasnek

Mallard



Replacing impervious surfaces or manicured lawns with a reestablished shoreline vegetated buffer can have a positive impact on wildlife. The same types of plants that provide animals with cover often provide diverse food sources as well, especially for birds.²³ Dead trees (standing or on the ground) provide homes and cover for species such as wood ducks and ruffed grouse.

Wildlife depend on three “layers” of native vegetation along the shore for their habitat: trees, shrubs, and lower-growing wildflowers and grasses. For an introduction to shoreland buffers, see *The Shoreland Stewardship Series: Protecting & Restoring Shorelands*, available at county UW-Extension offices and at clean-water.uwex.edu/pubs/pdf/protect.pdf For greater detail, see the publication *Lakescaping for Wildlife and Water Quality* described on page 9.

Figure 4

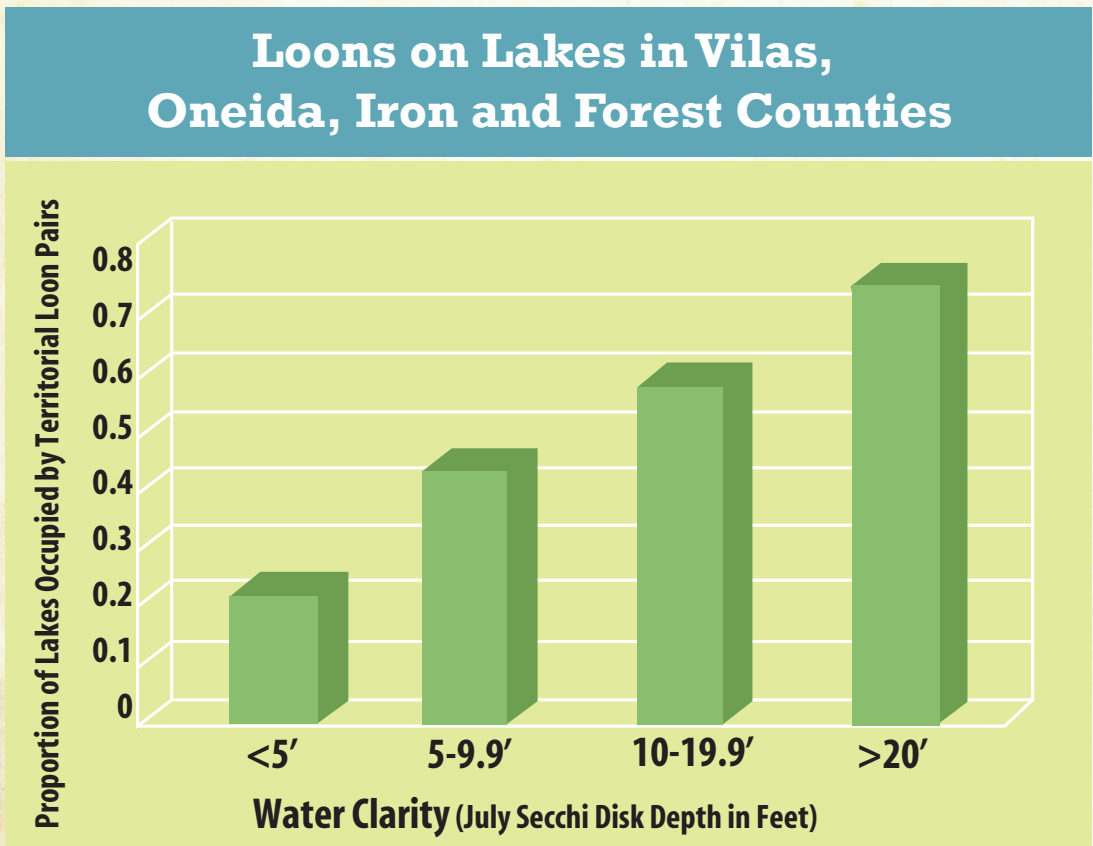


Figure 4: In northern Wisconsin, the number of loon pairs in lakes decreases as water clarity decreases. In southern Wisconsin shoreland development has caused loons to avoid lakes because of poor water quality and habitat degradation.²⁴

Common Loon

Common loons, famous for their primeval nighttime “laughter” heard echoing across lakes in Northern Wisconsin evoke a true sense of the Northwoods. Loons have been pushed northward, in part due to the effects of shoreland development.²⁵ Loons can be impacted by runoff from impervious surfaces that reduces water clarity. Loons search for fish from the water’s surface, making clear water key to finding food. Because of this, loon pairs appear to favor lakes with clearer water, as shown by **Figure 4**.²⁴ Additionally, nest predators like raccoons have been found to be more common on highly developed lakes. A recent study found that raccoons often raid northern Wisconsin loon nests in search of eggs. This naturally decreases the success of loon nests.²⁶

Photo by Michele Woodford



Common Loon

Loons nest near the water on either solid ground or floating vegetation and often construct nests out of needles, leaves, or other materials.²⁵ It's easy to see how vulnerable these nests can be to predators like raccoons.



Photo by John Haack

Conclusion

An undeniable connection exists between the decisions we make about our shoreland properties and the health of Wisconsin's lakes and streams. Each property is part of a bigger picture – a living waterfront of plants, wildlife, fish and people that are all interconnected.

When we establish impervious surfaces on our properties, we decrease the ability of the shorelands to serve their natural functions. Specifically, removing trees and native plants eliminates unique habitat required by the shoreland wildlife we enjoy watching. Increased runoff carries pollutants to our lakes and streams. Fish spawning grounds become unproductive when they are blanketed in silt. Decreased water clarity can also affect us by lowering waterfront property values.

On the other hand, when we leave shorelands in a more natural state, we all can enjoy healthy lakes and streams. Clean water allows our children to safely swim and play along our shorelines. Shoreland habitat and excellent water quality provide us with ample opportunities for memorable fishing trips and entertaining wildlife watching. Let's all do our part to give future generations these same opportunities.

REFERENCES:

1. Center for Watershed Protection. 2003. Impacts of impervious cover on aquatic systems. Watershed Protection Research Monograph No. 1. www.mckenziewaterquality.org/documents/ImpactsofImperviousCover-CWPReport.pdf
2. Korth, Robert, M. Dresen, and D. Snyder. 1994. Lake Tides survey. Wisconsin Lakes Program, University of Wisconsin-Extension, Stevens Point. Volume 19 No. 2. www.uwsp.edu/cnr/uwexlakes/laketides/vol19-2_summer1994/vol19-2.pdf
3. Krysel, Charles, Elizabeth Marsh Boyer, Charles Parson, and Patrick Welle. 2003. Lakeshore property values and water quality: evidence from property sales in the Mississippi Headwaters region. Mississippi Headwaters Board and Bemidji State University. www.friendscvsf.org/bsu_study.pdf
4. Michael, Holly, Kevin Boyle, and Roy Bouchard. 1996. Water quality affects property prices: a case study of selected Maine lakes. Maine Agricultural and Forest Experiment Station. University of Maine. Miscellaneous Report 398. www.umaine.edu/mafes/elec_pubs/miscrepts/mr398.pdf
5. Clemens, Cheryl. 2008. Controlling runoff and erosion from your waterfront property: a guide for landowners. Burnett County Land and Water Conservation Department. [dnr.wi.gov/waterways/shoreland/RunoffGuide_LR_locked_unlocked\[1\].pdf](http://dnr.wi.gov/waterways/shoreland/RunoffGuide_LR_locked_unlocked[1].pdf)
6. Panuska, John. Adapted from Wisconsin DNR memo, Nov. 6, 1994.
7. Wagner, Carmen, John Haack, and Robert Korth. 2003. Protecting and restoring shorelands, The shoreland stewardship series. Number 2. University of Wisconsin-Extension, Wisconsin Lakes Partnership, Wisconsin Department of Natural Resources, Wisconsin Association of Lakes, and the River Alliance of Wisconsin. WI DNR Publication No. WT-748 2003, UWEX Publication No. GWQ038. <http://clean-water.uwex.edu/pubs/pdf/protect.pdf>
8. Wang, Lizhu, John Lyons, and Paul Kanehl. 2003. Impact of urban land cover on trout streams in Wisconsin and Minnesota. *Transactions of the American Fisheries Society*. 132(5):825-839
9. Wang, Lizhu, John Lyons, P. Kanehl, Paul Kanehl, Roger Bannerman and Edward Emmons. 2000. Watershed urbanization and changes in fish communities in southeastern Wisconsin streams. *Journal of the American Water Resources Association*. 36(5):1173-1187.
10. Wang, Lizhu, John Lyons, and Paul Kanehl. 2001. Impacts of urbanization on stream habitat across multiple spatial scales. *Environmental Management*. 28(2):255-266.
11. Garrison, Paul, Martin Jennings, Alison Mikulyuk, John Lyons, Paul Rasmussen, Jennifer Hauxwell, David Wong, Jodi Brandt, and Gene Hatzenbeler. 2008. Implementation and interpretation of lakes assessment data for the Upper Midwest. Final report to the U.S. EPA.

12. Lyons, John. Personal Communication, March 6, 2012.
13. Kerr, S. J., B. W. Corbett, N. J. Hutchinson, D. Kinsman, J. H. Leach, D. Puddister, L. Stanfield, and N. Ward. 1997. Walleye habitat: a synthesis of current knowledge with guidelines for conservation. Percid Community Synthesis Walleye Habitat Working Group. www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@letsfish/documents/document/226887.pdf
14. Becker, George C. 1983. *Fishes of Wisconsin*. University of Wisconsin Press. 1052 p.
15. Leis, Amy L. and Michael G. Fox. 1994. Effect of mine tailings on the in situ survival of walleye (*stizostedionvitreum*) eggs in a northern Ontario river. *Ecoscience*. 1(3):215-222.
16. State of Wisconsin Department of Natural Resources. 2000. The Water's Edge: Helping Fish and Wildlife on Your Waterfront Property. Adapted from Minnesota DNR, Section of Fisheries publication: The Water's Edge. DNR Publication No. FH-428 00. dnr.wi.gov/fish/pubs/thewatersedge.pdf
17. Volkert, William. 1997. General observations on bird and small mammal use of shorelines and riparian corridors in Wisconsin. Chapter from *Effectiveness of shoreland zoning standards to meet statutory objectives: a literature review with policy implications*, prepared by Thomas Bernthal. Wisconsin Department of Natural Resources Publication No. WT-505-97. dnr.wi.gov/waterways/shoreland/documents/WT50597.pdf
18. Erb, John, Brock McMillan, Daniel Martin, and Jessica Homyack. 2006. Site characteristics of river otter (*Lontra canadensis*) natal dens in Minnesota. *The American Midland Naturalist*. 156:109-117. <http://filebox.vt.edu/users/gormant/Gorman.etal.2006a.pdf>
19. Reinelt, Lorin, Richard Horner, and Amanda Azous. 1998. Impacts of urbanization on palustrine (depressional freshwater) wetlands-research and management in the Puget Sound region. *Urban Ecosystems*. 2:219-236.
20. US Environmental Protection Agency. 1993. Natural wetlands and urban stormwater: Potential impacts and management. Office of Wetlands, Oceans, and Watersheds, Washington, DC. http://water.epa.gov/type/wetlands/restore/upload/1998_01_29_wetlands_stormwat.pdf Grant no. X7-83254601. Wisconsin Department of Natural Resources, Bureau of Science Services and Aquatic Sciences Section. p. 45-48.
21. Cox, Robert R., Mark A. Hanson, Christianne C. Roy, Ned H. Euliss, Jr., Douglas H. Johnson, and Malcolm G. Butler. Mallard duckling growth and survival in relation to aquatic invertebrates. *The Journal of Wildlife Management*. 62(1):124-733. www.npwrc.usgs.gov/pdf/npwrc1022_aquaduck.pdf
22. Zweig, Leanna D. and Charles F. Rabeni. 2001. Biomonitoring for deposited sediment using benthic invertebrates: a test on 4 Missouri streams. *Journal of North American Benthological Society*. 20(4):643-657

23. Byford, James L. 1990. Assessing/evaluating/improving your potential for wildlife. Proceedings from the Conference on: Income Opportunities for the Private Landowner through Management of Natural Resources and Recreational Access. West Virginia Extension Service, Rural Development Publication No. 740:169-183.
24. Meyer, Michael W. 2006. Final Report: Evaluating the impact of multiple stressors on common loon population demographics-an integrated laboratory and field approach. Wisconsin Department of Natural Resources. EPA Grant Number R82-9085.
25. McIntyre, Judith W. 1988. *The Common Loon: Spirit of Northern Lakes*. Minneapolis, MN: University of Minnesota Press.
26. McCann, Nicholas, Daniel Haskell, and Michael Meyer. 2004. Capturing common loon nest predators on 35mm film. *Passenger Pigeon*. 66(4):351-361. <http://images.library.wisc.edu/EcoNatRes/EFacs/PassPigeon/ppv66n04/reference/econatres.pp66n04.mccann01.pdf>



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