IMPERVIOUS SURFACES

How they affect fish, wildlife and waterfront property values

For how-to information about minimizing impervious surfaces and their effects, see the following valuable resources:

Controlling Runoff and Erosion from Your Waterfront Property: A Guide for Landowners.

www.burnettcounty.com/DocumentView.aspx?DID=119

Lakescaping for Wildlife and Water Quality. 176 pages, $19.95, available at

www.mnbookstore.com
(800) 657.3757

Rain Gardens: A How-To Manual for Homeowners.

http://learningstore.uwex.edu/assets/pdfs/GWQ037.pdf

Photo by Jesse Kloempken

Healthy lakes, rivers, and streams are the basis for creating fond memories of time spent near the water. Memories of a crisp fall morning of walleye fishing or of entertaining friends and family on the evening shoreline would never be made if our lakes and streams couldn't support healthy fish or were covered in thick blankets of algae.

The health of our lakes and streams is a direct reflection of our actions as landowners. 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. Fewer trees and native plants eliminate the food sources and shelter on which wildlife depend. Water can no longer soak into the ground, which increases stormwater runoff and 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 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.

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 roof tops, 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 property 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

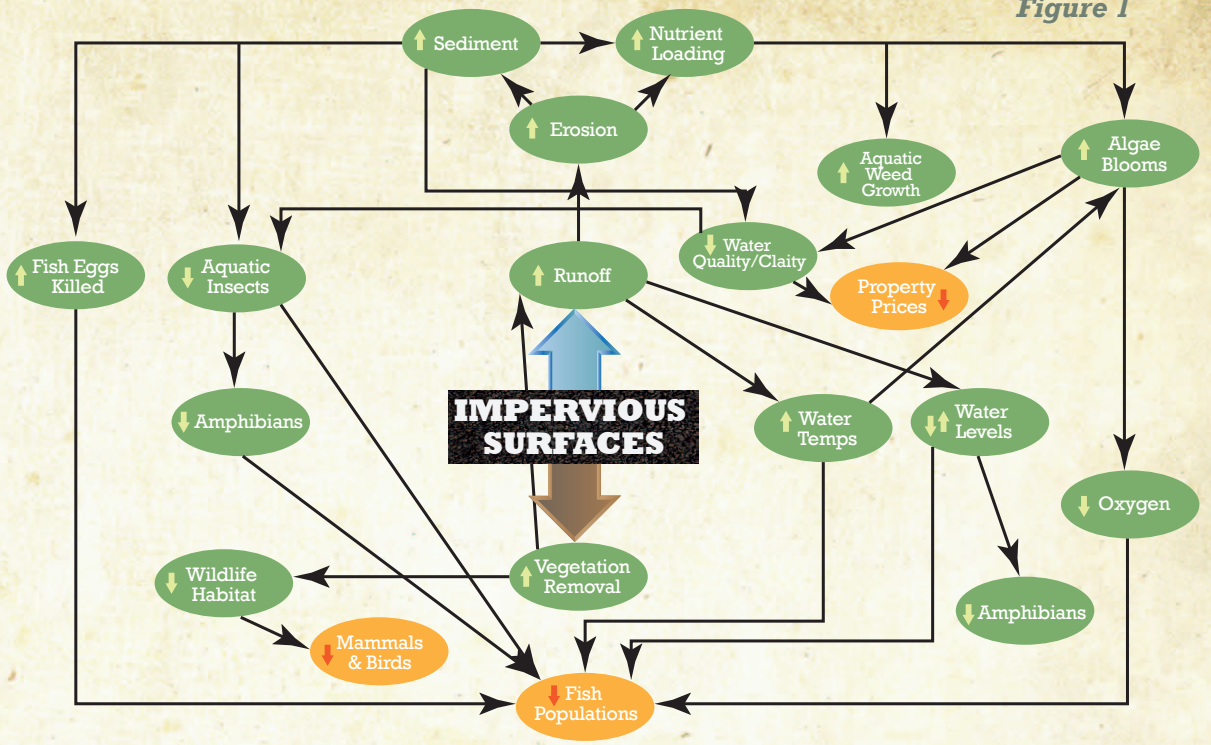


Figure 1: Impervious surfaces can cause a variety of negative impacts to lake and stream ecosystems. The orange ovals in this diagram illustrate the three areas of impact that are discussed in this publication and how they are intricately connected to the rest of the lake health. *For a comprehensive 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-nipping cold of January. Owning a shoreland property allows year-round access to the numerous recreational opportunities provided by lakes and rivers.

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 our lakes, streams and rivers cloudy. Second, runoff from impervious surfaces carries additional phosphorus to the water. An unfertilized waterfront lot that has 20% impervious cover 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 aesthetics.

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 property prices.[3] A similar study conducted in Maine found that changes in water clarity of three feet can influence 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, the amount for 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. Non-compacted gravel "mulch", such as that used as landscaping material, is generally not considered impervious. On the otherhand, gravel used for driveways, parking lots, or other high-use 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] ½ 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

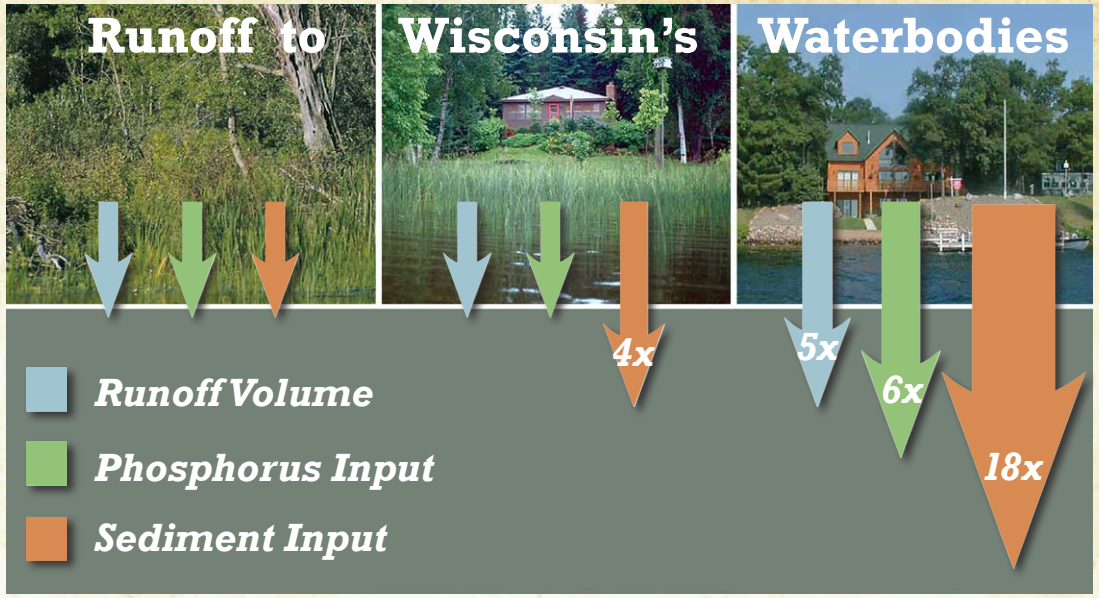


Figure 2: The far left picture above indicates a half-acre undeveloped shoreland lot characterized by minimal runoff, phosphorus, and sediment inputs. The middle picture portrays a typical 1940's shoreland development, with approximately 8% impervious surface coverage. The picture to the right has approximately 20% impervious surface coverage. Notice how sediment inputs drastically increase with impervious surface coverage.[6]

2 Fishing

Fishing gives us a chance to sit back, relax, and visit with friends and family all while waiting for the familiar tug of an unseen fish straining our fishing pole. Many of Wisconsin's lakes and rivers are prime destinations for walleye, bass, musky, or crappie fishing – making this a popular pastime for many of us.

Many of the fish anglers pursue are sensitive to changes in their environment. Runoff from impervious surfaces that carries sediments, nutrients and other pollutants into lakes and streams leads to decreased populations of those fish we enjoy catching.

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 utilized by 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 storm events and low water levels during dry periods. 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 conditions, such as trout.[8]

Figure 3

Increasing Impervious Surface in Watershed

Number of Fish Species

Fish found in streams when impervious surface in the watershed was: Less than 8%	8 - 12%	Greater than 12%
Iowa darter Black crappie Channel catfish Yellow perch Rock bass Horneyhead chub Sand shiner Southern redbelly dace		
Golden shiner Northern pike Largemouth bass Bluntnose minnow Johnny darter Common shiner	Golden shiner Northern pike Largemouth bass Bluntnose minnow Johnny darter Common shiner	
Creek chub Fathead minnow Green sunfish White sucker Brook stickleback	Creek chub Fathead minnow Green sunfish White sucker Brook stickleback	Creek chub Fathead minnow Green sunfish White sucker Brook stickleback

Figure 3: The number of different stream fish species 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 more than 8-12% of a watershed – the land that drains to the stream – poor quality fish populations and habitat were a result.[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
- Utilize narrow driveways
- Minimize building footprints- build "up" instead of "out"
- Remove unneeded hard surfaces, such as extra parking spots

Utilize pervious materials where possible

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

Capture or infiltrate runoff

- Rain barrels
- Gutters & downspouts 1
- Rain gardens 2

Minimize fertilizer use

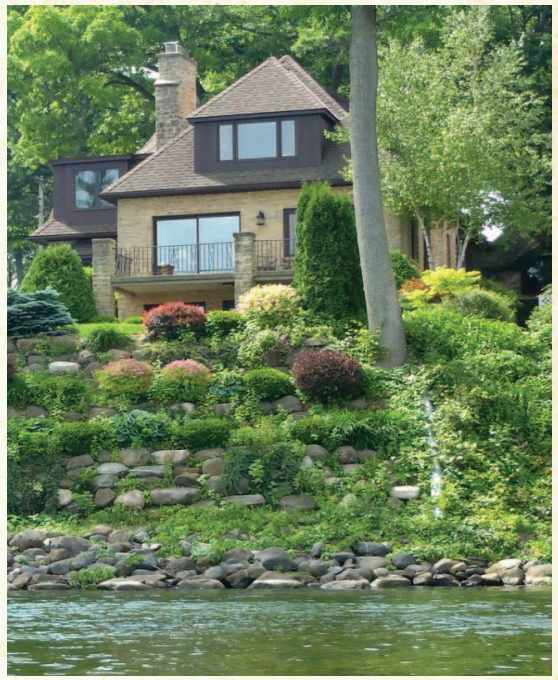
- Have soil tested first; are fertilizers needed?
- Minimize or eliminate use

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 re-establish the shoreline!

Control erosion during construction and after development 5

Photo by Sarah Congdon



Where to Access/Obtain These Excellent Resources:

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

2 *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**

3 *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.

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

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

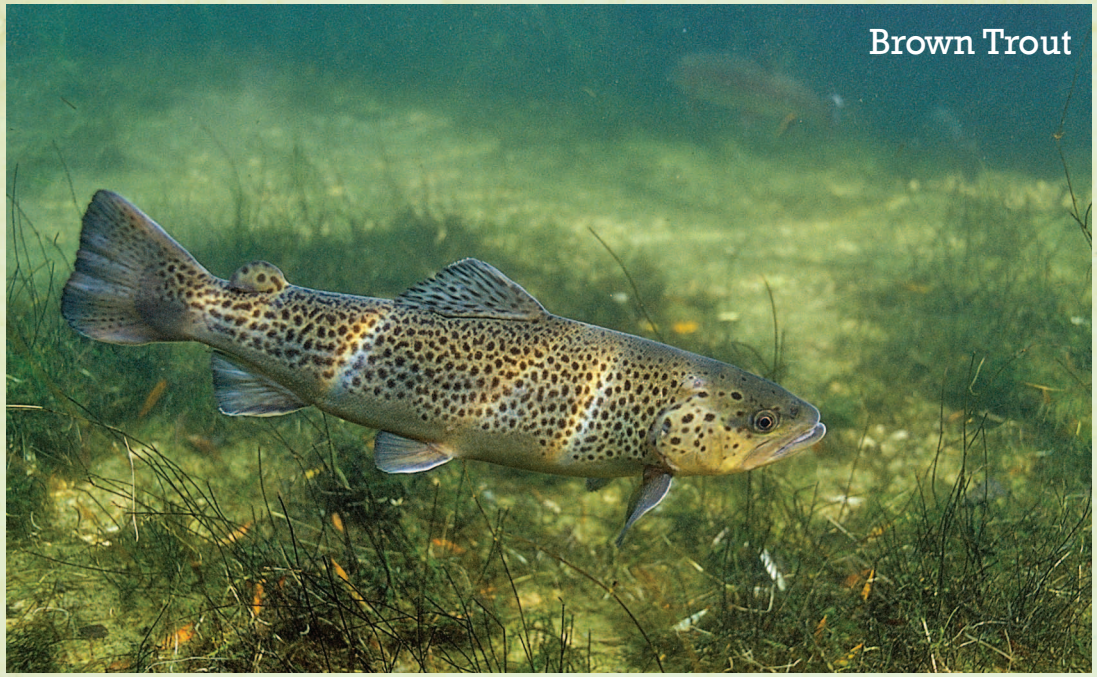


Photo by Eric Engbretson

Brook Trout and Brown Trout

Both brook trout and brown trout are found in many streams in Wisconsin, and require cold, clean water for survival. Both species are also 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]

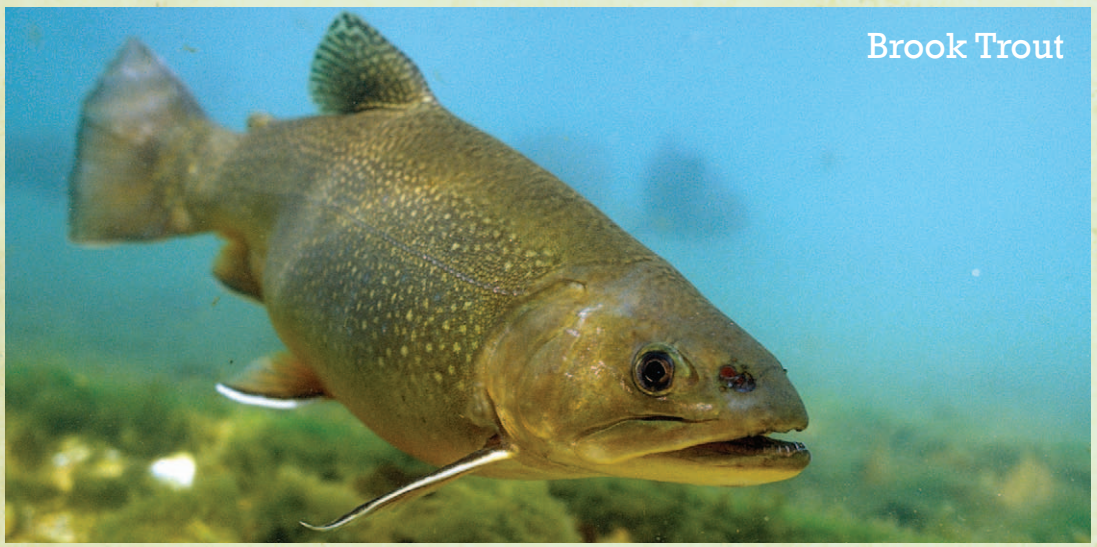


Photo by Eric Engbretson

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

The trend of more impervious surfaces leading to fewer fish species also holds true in 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

Walleye are synonymous with northern Wisconsin's lakes and rivers. Impervious surfaces can reduce walleye reproduction through soil erosion, which leads to sedimentation. Although impervious surfaces aren't the only cause of sedimentation, when sediments cover spawning grounds, the spaces in between the rocks and gravel used as spawning grounds 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. Harming the success of eggs and embryos puts the survival of a healthy walleye population at risk.[15]

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]

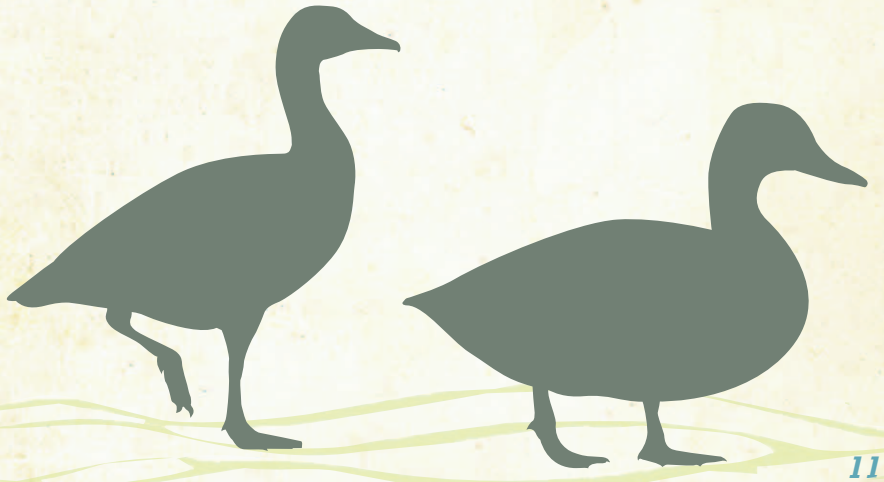
Habitat connectivity is key. Some animals like loons and frogs depend on habitat relatively close to the water. River otters, on the other hand, often choose denning sites in upland areas further from the water's edge.[18] By minimizing how much of the shorelines we develop with impervious surfaces and 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



In place of impervious surfaces or manicured lawns, the maintenance or reestablishment of a 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.

These three "layers" of vegetation provide the necessary habitat for species of all kinds. Only native vegetation should be planted in the shoreland buffer area and should include a variety of different species of grasses, shrubs, and trees. For more information on shoreland buffers, please see *The Shoreland Stewardship Series: Protecting & Restoring Shorelands*. This publication is available at county UW-Extension offices, and online at:

clean-water.uwex.edu/pubs/pdf/protect.pdf

Figure 4

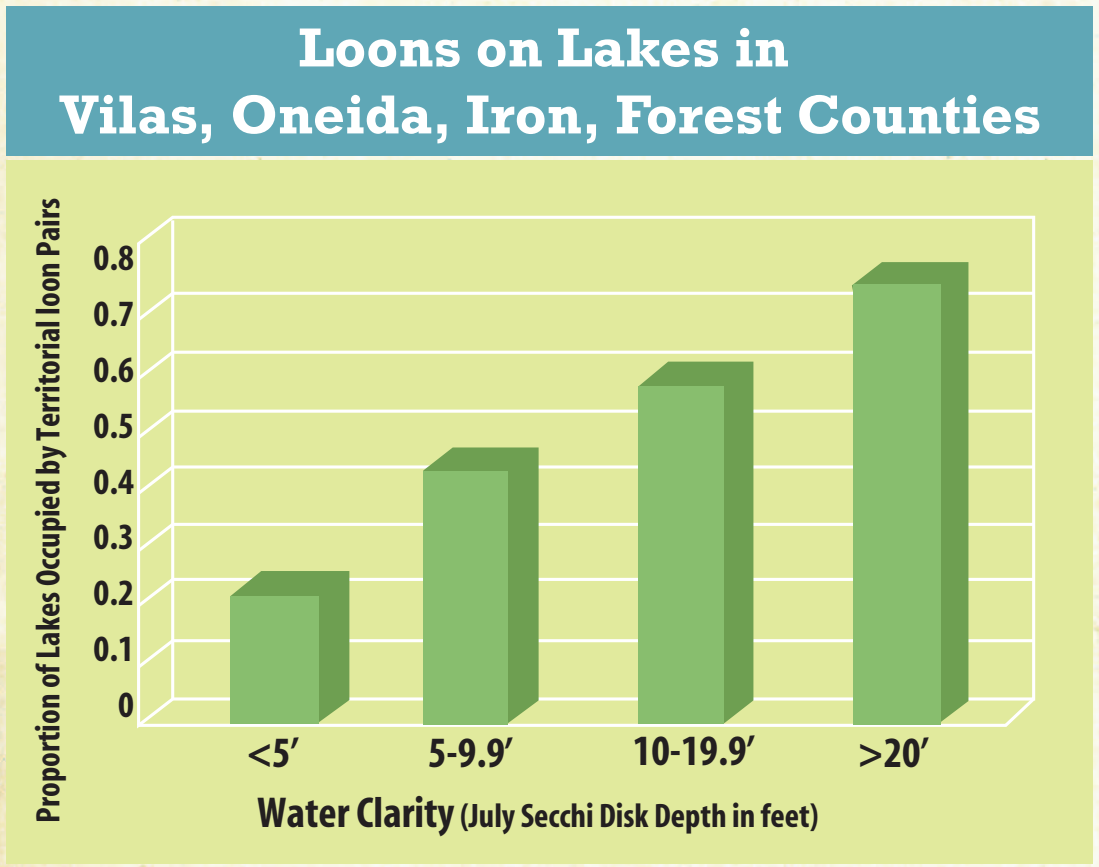


Figure 4: Loon pairs are decreasingly common as water clarity in northern Wisconsin lakes degrades. Shoreland development in southern Wisconsin has caused the loon to avoid these bodies of water because of poor water quality and habitat degradation.[24]

Common Loon

Common loons evoke a true sense of the Northwoods, famous for their primeval night-time "laughter" heard echoing across lakes in Northern Wisconsin. Historically, loons have been pushed northward, in part due to the effects of shoreland development.[25] Loons can be impacted by runoff from impervious surfaces through reduced 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

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 health of Wisconsin's lakes and streams and the decisions we make about our shoreland properties. 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***

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, L., J. Lyons, P. Kanehl, R. Bannerman, and E. 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. ***http://vilaslandandwater.org/water_resources_pages/fisheries/wang_paper.pdf***

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/std-prodconsume/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 characteritics 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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