Wisconsin natural resources. Vol. 30, No. 2 April 2006

[Madison, Wisconsin]: Wisconsin Department of Natural Resources, April 2006

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Special insert: Groundwater: Wisconsin's buried treasure

WISCONSIN NATURAL RESOURCES

77 field trips you can take

Learning from small mammals

Birds and window pain

A burst of yellow glory

Its "flowers" are not petals and the marsh marigold's tiny leaves grow into giants the size of dinner plates.

Anita Carpenter

Masses of blooming marsh marigolds demand our attention. The buttery-yellow blossoms set against waxy, dark leaves add bold color to wet meadows, swamps, streambanks, lowland woods and alder thickets.

The first wildflowers to bloom each spring — the hepaticas, spring beauties, pasqueflowers and the like — splash gentle colors on the warming countryside dappling the brown earth with pastels of lavender, pink and white. Their subtle colors build to a blazing crescendo of yellow glory as the eye-catching marsh marigolds burst onto the springtime scene in late April and into May.

Marsh marigolds, *Caltha palustris*, are not true marigolds at all. These perennial marsh plants belong to the buttercup or Ranunculacae family while the orange and yellow garden-variety marigolds are members of the asters.

continued on page 28

WISCONSIN NATURAL RESOURCES

April 2006
Volume 30, Number 2

ROBERT QUEEN

MATT MANGAN

JACK R. BARTHOLMAI

FRONT COVER: Field trips provide a hands-on experience to see outdoor resources in the company of leaders who manage them for public enjoyment. While canoeing the Bark River on a field trip last July, Ben Lima of Milton carefully clinched a common musk turtle.
CHRISTINE TANZER, Mount Horeb

BACK COVER: Yellow water crowfoot, a member of the buttercup family, emerges from a swale at Richwood Bottoms State Natural Area in Richland County. For more information, contact the State Natural Areas Program, Bureau of Endangered Resources, DNR, P.O. Box 7921, Madison, WI 53707 or visit dnr.wi.gov/org/land/er/sna.
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Printing Schumann Printers

PUBLCE-012
ISSN-0736-2277

Wisconsin Natural Resources magazine (USPS #34625000) is published bimonthly in February, April, June, August, October and December by the Wisconsin Department of Natural Resources, 101 S. Webster St., Madison, WI 53702. The magazine is sustained through paid subscriptions. No tax money or license fees are used. Preferred Periodicals postage paid at Madison, WI. POSTMASTER and readers: subscription questions and address changes should be sent to Wisconsin Natural Resources magazine, P.O. Box 7191, Madison, WI 53707. **Subscription rates are: $8.97 for one year, $15.97 for two years, $21.97 for three years. Toll-free subscription inquiries will be answered at 1-800-678-9472.**

Take a field day

Book a weekend hike, tour or paddle from April through October.

Christine Tanzer

Want a little sound advice? Take a hike! Please consider joining us for one of the 77 day trips — guided walks, tours and leisurely paddles — led by naturalists and DNR staff who enjoy noting the plants, animals, progress and challenges in managing natural resources. These trips are annually coordinated by the Natural Resources Foundation of Wisconsin, celebrating its 20th anniversary this spring. Many trips visit State Natural Areas, noted as SNAs in the listings on the following pages.

CHRISTINE TANZER

Note these 77 trips are arranged chronologically from April through October. Assume these day trips fall on Saturdays unless otherwise noted. The physical demands of each trip are noted by the color tint behind each trip number: orange — accessible to people with walking disabilities; green — easy, short travel on level terrain; blue — average hike with a few hills; red — steeper terrain, more vigorous workout, or a longer trip.

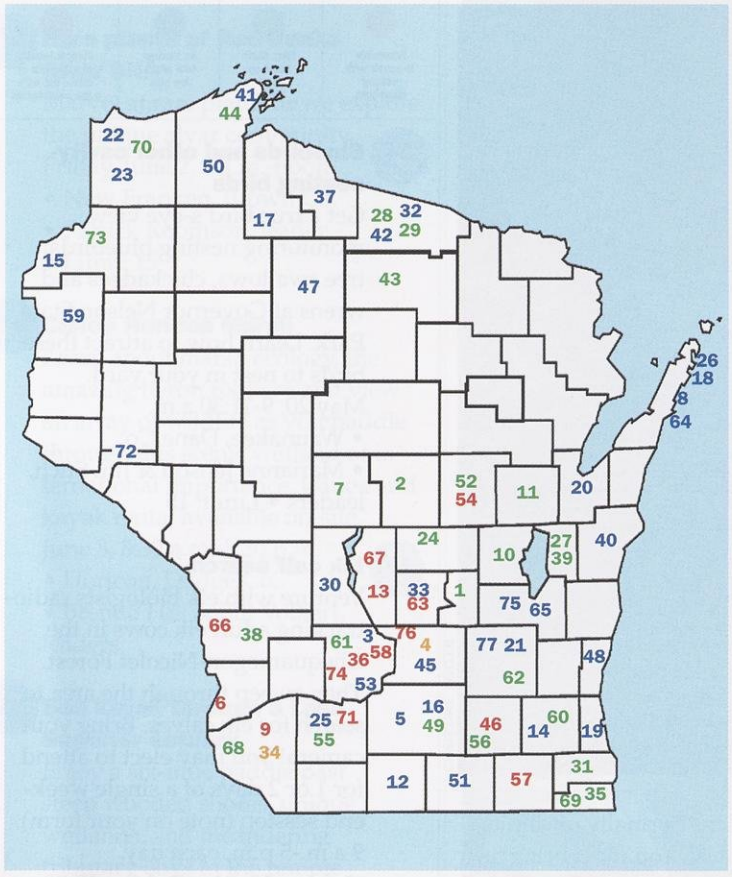
Space is limited and trips fill quickly on a first-come, first-served basis. Trips that can accommodate fewer than 20 people show these limits in the listing. Canoe and kayak trips are especially popular. Please only request one such trip per family or group.

Clip out or photocopy the registration form and fill it out in pen. List the trip number and number of people in your party. Tally any per person fees for those few trips that are fundraisers or charge for providing lunch, bus, boat or canoe rentals. Calculate total costs, include an annual $35 trip registration, and please mail one check payable to the Natural Resources Foundation of Wisconsin to the address indicated.

Details and directions will be sent to registrants two weeks before each trip. Fees are nonrefundable if you cancel, but parties on waiting lists that can't be accommodated will receive refunds.

You can check if trips still have space available at the Natural Resources Foundation website, www.nrfwis.org, or call toll-free (866) 264-4096 after 5 p.m. A recording provides trip updates. Further questions? Call me on Wednesdays at (608) 264-8548 or send e-mail to: christine.tanzer@dnr.state.wi.us.

Christine Tanzer is field trip coordinator for the Natural Resources Foundation of Wisconsin.



Accessible to people with walking disabilities

Easy, short travel on level terrain

An average hike with a few hills

Steeper terrain, a longer hike or canoe trip with a few small rapids

TRIP LOCATOR MAP

1. Owls and night birds

Venture into the nighttime world of White River Marsh to discover "who" is going bump in the night! An evening filled with the aerial display of American woodcock and the sounds of owls, bitterns, rails and frogs.

April 29, 6-10:30 p.m.

- Princeton, Green Lake Co.
- Andy Paulios, leader • Limit: 12

2. Prairie chicken booming

Marvel at the courtship dances of greater prairie chickens from a blind on their booming grounds. Have breakfast, then learn more about prairie chicken ecology on a grassland tour.

April 29, 4:30-10 a.m.

- Bancroft, Portage Co.
- Jim Keir & Kate Brashear, leaders
- Limit: 16 • Cost: $15

3. Parfrey's Glen SNA

Explore the natural and human history of this spectacular 100-foot gorge cut into the Baraboo Hills. Choose session A or B.

A. April 29, 9 a.m.-noon

B. May 6, 9 a.m.-noon

- Baraboo, Sauk Co.
- David Bouche, leader

4. Maple syrup making

Savor the taste and enjoy maple syrup making in the beautiful maple grove of MacKenzie Environmental Center.

May 7, 9 a.m.-noon

- Poynette, Columbia Co.
- Derek Duane, leader

5. Sunset at Pheasant Branch Marsh

Enjoy a sunset jaunt with an amazing hilltop view. Bask in the sights and sounds of returning birds and frogs.

Thursday, May 11, 6-8:30 p.m.

- Middleton, Dane Co.
- Pat Trochlell & Tom Bernthal, leaders

6. Blufftops of Rush Creek SNA

Savor breathtaking vistas of the Mississippi River while enjoying oak woods, hillside prairies, spring wildflowers and peak spring bird migration. Steep hills.

Friday, May 12, 9 a.m.-1 p.m.

- Ferryville, Crawford Co.
- Craig Thompson & Armund Bartz, leaders • Limit: 15

7. Birds of Sandhill

Tour the Sandhill and Wood County Wildlife Area by carpool with stops to see sandhill cranes, trumpeter swans, ducks, grouse, turkeys and migrating songbirds.

May 13, 10 a.m.-2 p.m.

- Babcock, Wood Co.
- John Kubisiak, leader

8. Logan Creek ramble — Door shore

Ramble through the hardwood forests and cedar/hemlocks of this satellite of Ridges Sanctuary SNA. Learn about geology and ecology of the Door County shore.

May 13, 1-3 p.m.

- Jacksonport, Door Co.
- Karen Newbern, leader
- Limit: 15

9. Effigy mounds of the Wisconsin River Valley

Travel back in time to learn about agricultural methods of the mound builders. Enjoy the panoramic river valley and visit the Ho-Chunk Bison Farm.

May 13, 10 a.m.- 2 p.m.

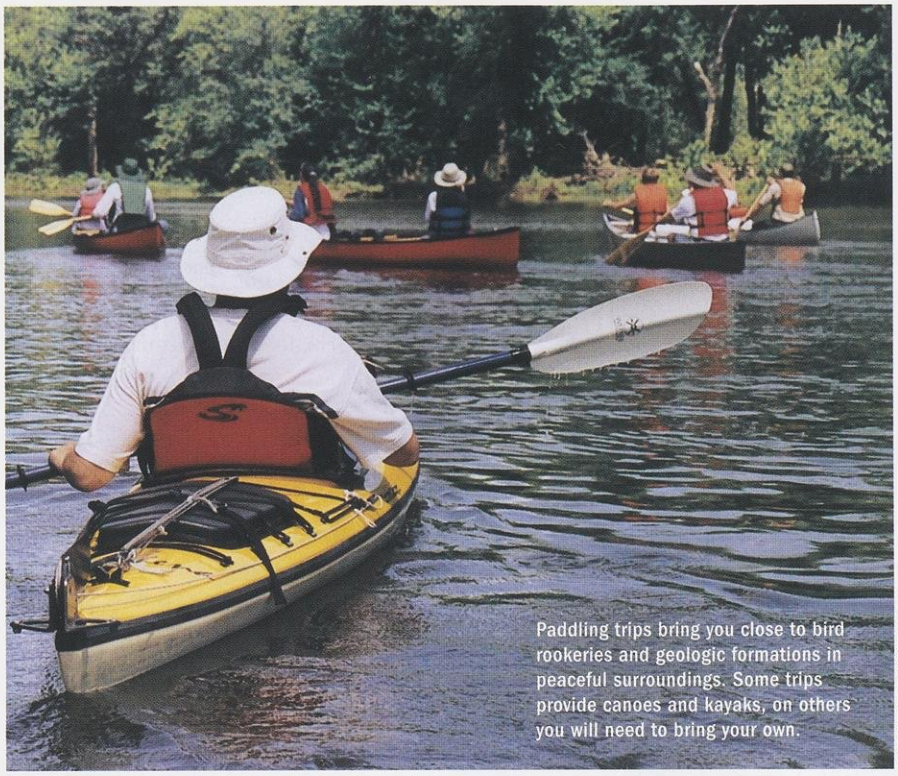
- Muscoda, Grant Co.
- Robert Salzer & Mark Cupp, leaders • Cost: $10

10. Archaeology of Rush Lake SNA

See artifacts from a recent archaeological dig at Rush Lake SNA and learn about Native Americans who lived in the area 1,000-2,000 years ago.

May 13, 9 a.m.-3 p.m.

- Waukau, Winnebago Co.
- Norman Meinholz & Kent Dickerson, leaders



Paddling trips bring you close to bird rookeries and geologic formations in peaceful surroundings. Some trips provide canoes and kayaks, on others you will need to bring your own.

CHRISTINE TANZER

Accessible to people with walking disabilities	Easy, short travel on level terrain	An average hike with a few hills	Steeper terrain, a longer hike or canoe trip with a few small rapids

11. Canoe Navarino Wildlife Area

View wildlife up-close as we paddle several flowages of the beautiful Navarino Wildlife Area. Learn about history, ecology and management along the way. Some canoes provided. Indicate on form if you need one.

May 13, 9 a.m.-noon
- Shiocton, Outagamie Co.
- Tim Ewing, leader
- Cost: $5 • Limit: 20

12. Beauty of Green County SNAs

Enjoy a hillside of shooting stars and pasqueflowers at Oliver Prairie SNA. Then cool off in the shade of Abraham's Woods SNA, a rich forest of sugar maple renowned for its spring wildflowers. Finally listen for grassland birds at Muralt Bluff Prairie SNA.

Friday, May 19, 9 a.m.-noon
- Albany, Green Co.
- Dawn Hinebaugh & Christina Isenring, leaders

13. Dells by land and water

Paddle past spectacular sandstone formations on a three-mile stretch of the Dells of the Wisconsin River SNA. Stop and hike through mossy glens normally off-limits to the public. You must bring your own canoe or kayak. Experienced paddlers only.

Friday, May 19, 9 a.m.-1 p.m.
- Wisconsin Dells, Adams Co.
- Thomas Meyer, leader
- Limit: 12

14. Funk Dam removal and wetland restoration

Funk Dam was removed 15 years ago, leaving behind wonderful wetlands. Learn about this restoration process and hike along the Ice Age Trail through a gorgeous maple woods.

Friday, May 19, 10 a.m.-2 p.m.
- Oconomowoc, Waukesha Co.
- Thomas Boos & Bill Sturtevant, leaders

15. Crex Meadows prairie birds and flowers

Explore Crex Meadows and enjoy blooming lupine, phlox and spiderwort as sparrows, warblers and upland sandpipers fly about.

May 20, 10 a.m.-1 p.m.
- Grantsburg, Burnett Co.
- Jim Hoefler, leader

16. Bluebirds and other cavity-nesting birds

Get a true bird's-eye view monitoring nesting bluebirds, tree swallows, chickadees and wrens at Governor Nelson State Park. Learn how to attract these birds to nest in your yard.

May 20, 9-11:30 a.m.
- Waunakee, Dane Co.
- Marianne Jenson & Jim Stich, leaders • Limit: 15

17. Elk calf search

Venture with elk biologists radio-tracking adult elk cows in the Chequamegon-Nicolet Forest. Then sweep through the area to search for elk calves. Bring your camera! You may elect to attend for 1 or 2 days of a single weekend session (note on your form). 9 a.m.-5 p.m. each day.

A. May 20- 21 • **B.** May 27-28 • **C.** June 3-4 • **D.** June 10-11
- Clam Lake, Ashland Co.
- Laine Stowell & Matt McKay, leaders • Limit: 10

18. Orchids and boreal forest of Moonlight Bay

Fringed orchids, rare plants and geology await as we blaze a trail through a boreal forest and emerge at Moonlight Bay Bedrock Beach SNA.

May 27, 1:30-4:30 p.m.
- Baileys Harbor, Door Co.
- Mark Martin, leader

19. Franklin Park Savanna SNA flowers and birds

Enjoy spring posies and migratory birds as we hike under the towering canopy of open-grown oaks. Learn about this rare oak savanna remnant.

May 27, 9-11 a.m.
- Franklin, Milwaukee Co.
- Owen Boyle & Paul Kortebein, leaders • Limit: 15

20. Rare plants of Red Banks Alvar SNA

Marvel at rare plants as we explore the unique alvar community.
Friday, June 2, 9 a.m.-noon
- New Franken, Brown Co.
- Patrick Robinson, leader
- Limit: 15

21. Canoe Horicon Marsh

Learn about marsh ecology, the amazing heron rookery and view an array of wildlife as you paddle through this scenic wetland of international importance. Canoe and kayak rental available on-site.
June 3, 8:30 a.m.-3:30 p.m.
- Horicon, Dodge Co.
- Brenda Hill & Bill Volkert, leaders

22. Sea kayak through a Lake Superior estuary

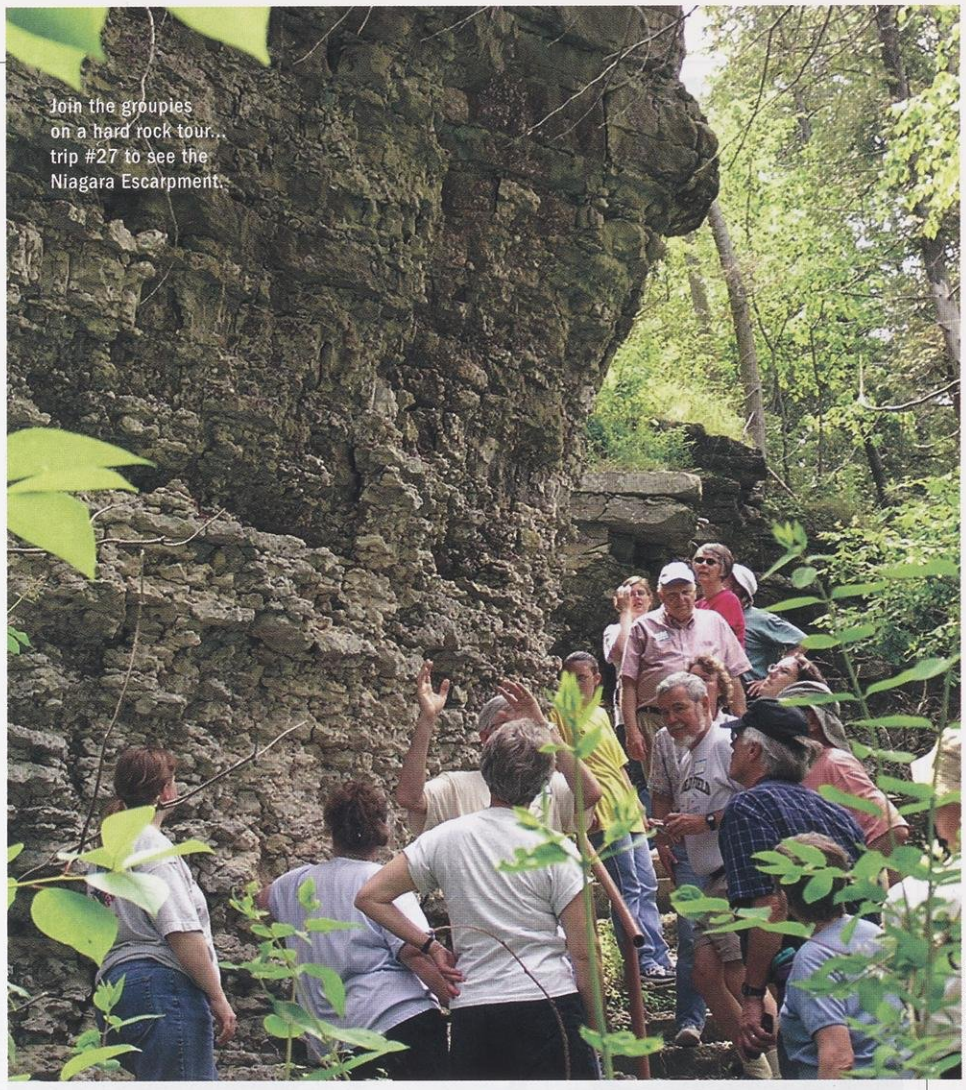
Enjoy a six-mile paddle past steep wooded shores, unique wetlands, and meandering tributary bays in the remote St. Louis River Streambank Protection Area. Sea kayaks and instruction provided by outfitter. Beginners welcome!
June 3, 9 a.m.-4 p.m.
- Superior, Douglas Co.
- Frank Koshere, leader
- Limit: 18 • Cost: $65 kayak rental, $25 if bringing your own kayak and gear.

23. Brule Valley glacial features auto tour

Drive into the past and envision a land formed by mile-high ice and covered by a great sea. Discover the rich geologic history of the Brule Valley.
June 3, 9 a.m.-3 p.m.
- Brule, Douglas Co.
- Jay Gallagher, leader

24. Karner blue butterflies

Tiptoe through lupines to catch a glimpse of the rare Karner blue butterfly. See many beautiful blooming flowers and learn about Karner blue biology at the best place to see them, Karner Blue Meadow SNA, of course!
June 3, 10:30 a.m.-1 p.m.
- Wild Rose, Waushara Co.
- Joe & Rebecca Henry, leaders
- Limit: 15



Join the groupies on a hard rock tour... trip #27 to see the Niagara Escarpment.

SHELLY SCHAETZ

25. Hiking Ridgeway Pines SNA

Head off-trail to explore relict pine forests nestled in southern Wis.
June 3, 9-11:30 a.m.
- Ridgeway, Iowa Co.
- Matt Zine, leader • Limit: 15

26. Toft Point SNA

Rare wildflowers and nesting birds abound in this old-growth pine and hemlock forest along the rocky shores of Lake Michigan's Door peninsula. See lichens, mosses and waterfowl.
June 3, 9-noon
- Baileys Harbor, Door Co.
- Roy Lukes, leader
- Limit : 20

27. Niagara Escarpment geotourism

Learn about this ridge of rock that extends from eastern Lake Winnebago to Niagara Falls. Explore cultural, environmental, economic and aesthetic aspects of tourism along the escarpment.
June 3, 10 a.m.-2:30 p.m.
- High Cliff State Park, Calumet Co.
- Shelly Schaetz, Joanne Kluessendorf & Thomas Pleger, leaders

28. Lessons of Little Rock Lake research

Boat about Little Rock Lake and learn about the acid rain and mercury experiments conducted here near UW Trout Lake Research Station.
Tuesday, June 6, 9 -11:30 a.m.
- Woodruff, Vilas Co.
- Tim Kratz, Carl Watras, Susan Knight, Greg Sass & Sandy Gillum, leaders • Limit: 20

Try a more strenuous five-mile hike through the Baraboo Hills to see spring wildflowers and birds on trip #36.

WILLIAM WEEGE

Accessible to people with walking disabilities	Easy, short travel on level terrain	An average hike with a few hills	Steeper terrain, a longer hike or canoe trip with a few small rapids

29. Goods from the Northwoods

Make your own bark basket and balsam wreath. Sustainably harvest balsam bows, birch bark and princess pine (club moss), then return to the Trees For Tomorrow facility and use them in making your projects.

Thursday, June 8, 9 a.m.-4 p.m.

- Eagle River, Vilas Co.
- Colleen Matula, leader

30. Mill Bluff — birds, savannas and rocks

Birds abound in this state park. Explore rocky, savanna and forest landscapes, each with its own unique birdlife.

Friday, June 9, 6-11a.m.

- Camp Douglas, Juneau Co.
- Randy Hoffman, leader
- Limit: 15

31. Understanding a river

Explore the Root River and learn hands-on why it looks the way it does, what lives there and what can be done to protect it.

June 10, 9:30 a.m.-noon

- Racine, Racine Co.
- Craig Helker, leader

32. Hike and canoe the Northern Highlands

See blooming moccasin flowers and visit Cathedral Point in an old-growth pine forest. Then jump into canoes to paddle Allequash Lake to glimpse a colony of black terns. Canoes provided. Bring lifejackets. Intermediate canoe skills required.

June 10, 10:30 a.m.-4:30 p.m.

- Boulder Junction, Vilas Co.
- Heidi Conde & Dan Jacoby, leaders • Limit: 16

33. Comstock Bog & Germania Wet Prairie SNAs

Visit two pristine wetlands to see pitcher plants, sundews, blazing-star and lobelia.

June 10, 9:30 a.m.-3 p.m.

- Montello, Marquette Co.
- Janeen Laatsch, leader
- Limit: 15

34. Wilson State Tree Nursery

Tour the Wilson State Nursery to see what is involved in producing 4-6 million seedlings of 30 different tree species and wildlife shrubs.

June 10, 10 a.m.-noon

- Boscobel, Grant Co.
- Joe Vande Hey & Roger Bohringer, leaders

35. Chiwaukee Prairie SNA

Tread among shooting stars as you explore the richest prairie in Wisconsin of more than 400 plant species. Learn about prairie ecology, invasives and management techniques.

June 10, 9-11:30 a.m.

- Kenosha, Kenosha Co.
- Marty Johnson, Dan Werner, Doug Robinson, & Kevin Burdick, leaders

36. Baxter's Hollow spring jaunt

Grab your hiking stick for a five-mile hike through this gem of the Baraboo Hills! Enjoy the blooming spring flora in the largest dry-mesic forest in Wisconsin. Steep terrain.

June 10, 10 a.m.-2 p.m.

- Sauk City, Sauk Co.
- Shane Lishawa & Kristin Shy, leaders

37. Eagle banding and Turtle Flambeau Flowage tour

Visit eagle nests and help band nestlings. Take a scenic boat ride through the flowage to see wildlife and a patterned bog. Delicious lunch included. This

trip is a fundraiser for the eagle and osprey monitoring program.
June 10, 8:30 a.m.-4 p.m.
- Mercer, Iron Co.
- Bruce Bacon & Roger Jasinski
- Cost: $65

38. Trout of Coon Valley

Brook trout are now restored in streams they have not swum for 100 years. Come to the "Montana of the Midwest" to leam about trout management.
June 17, 10 a.m.-noon
- Coon Valley, Vernon Co.
- David Vetrano, leader

39. Purple martins at High Cliff State Park

Learn the ecology of these interesting birds as we peer into their nests and assist in banding young and adults of the colony.
June 17, 10 a.m.-1 p.m.
- Sherwood, Calumet Co.
- Dick Nikolai, leader

40. Life's a beach

Explore life along the beaches and dunes of Point Beach SNA, a fragile ecosystem that harbors many rare and endangered plants and animals. Difficult terrain
June 17, 9:30 a.m.-noon
- Two Rivers, Manitowoc Co.
- Gene Tiser, leader

41. Big Bay sand spit and bog

Join us on a journey to Lake Superior to a beautiful spit in the Apostle Islands with a bog rich in flora and fauna.
June 17, 11 a.m.-1 p.m.
- Madeline Island, Bayfield Co.
- Jennifer Birkholz, leader

42. Bike through the northern forest

Pedal a paved forest trail. Enjoy short stops to learn about forestry management. You can pack a lunch and continue on your own after the trip.
June 17, 9 a.m.-noon
- Boulder Junction, Vilas Co.
- Susan Brisk, leader • Limit: 12

43. Willow Flowage hike and cruise

Enjoy a morning hike through a pine forest, then climb aboard a tour boat to cruise the flowage and learn about regional history, wildlife and ecology.
June 17, 10 a.m.-3 p.m.
- Minocqua, Oneida Co.
- Tom Shockley, leader • Cost: $15

44. Apostle Islands boat tour and water issues

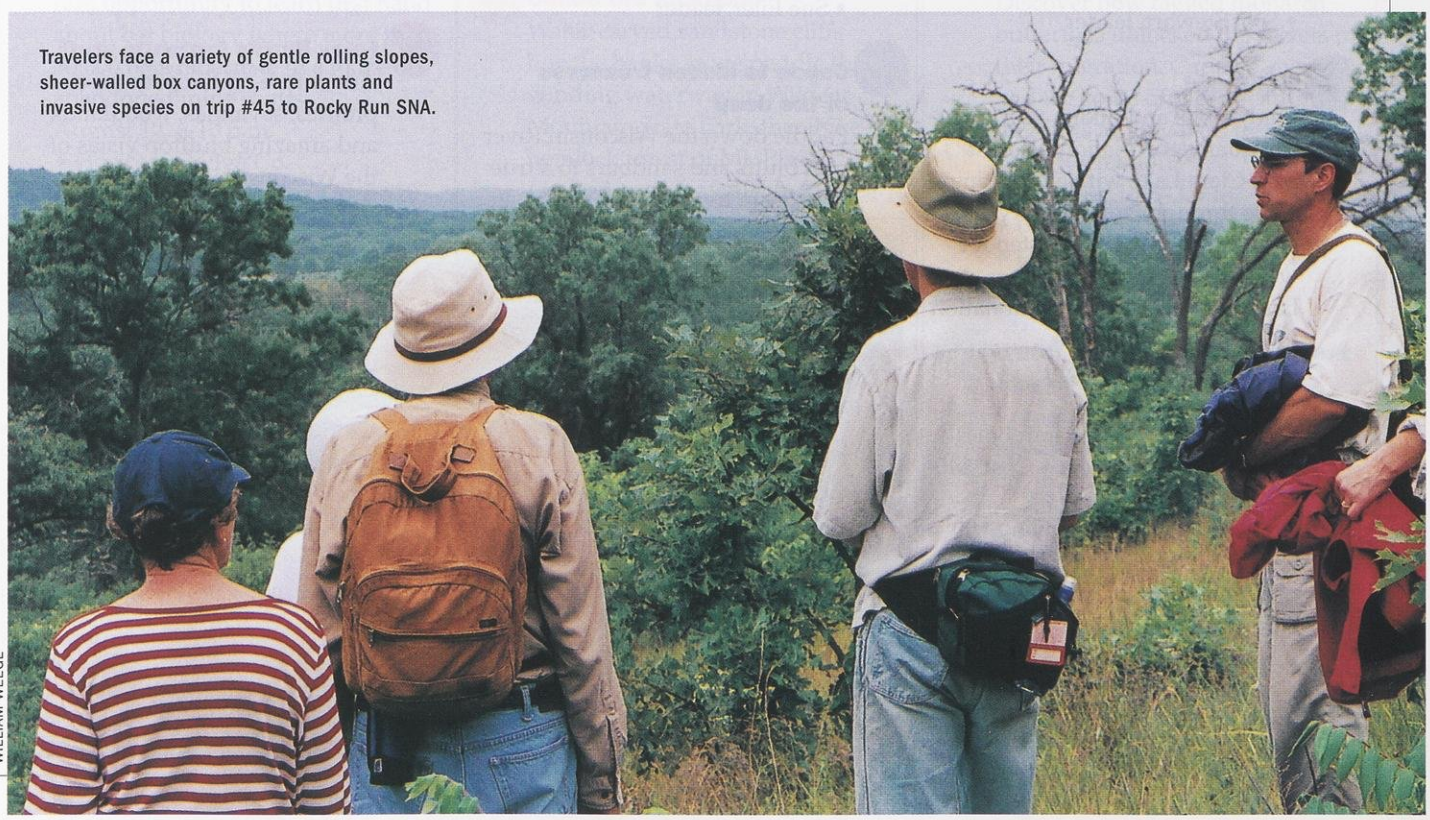
Board the *L.L. Smith* research ship to tour this beautiful area and hear about the environmental and cultural history of the Apostle Islands, then trawl to sample fish.
Sunday, June 18, 1-5 p.m.
- Washburn, Bayfield Co.
- Frank Koshere, Nancy Larson & Dan Rau, leaders • Cost: $15

45. Canyons and savannas of Rocky Run

Explore gently rolling slopes next to sheer-walled box canyons of Rocky Run SNA. See both rare plants and invasive species.
June 24, 9 a.m.-noon
- Wyocena, Columbia Co.
- Craig Anderson, leader
- Limit: 15

46. Fen geology

Marvel at this recently discovered calcareous fen remnant. See more than 200 species of rare plants. Tussocky difficult terrain.
June 24, 9:30 a.m.-noon
- Ft. Atkinson, Jefferson Co.
- Dr. Peter Jacobs, Kim & Dale Karow, leaders • Limit: 17



Travelers face a variety of gentle rolling slopes, sheer-walled box canyons, rare plants and invasive species on trip #45 to Rocky Run SNA.

WILLIAM WEEGE

47. Canoe the Flambeau River

See wilderness and wildlife while paddling a flat stretch of the Flambeau River. Learn about the history of this famed watershed. Enjoy a short hike at Mason Creek. (lunch provided)
June 24, 9 a.m.-3 p.m.
• Phillips, Price Co.
• Heidi Brunkow, leader
• Cost: $22 if renting a canoe, otherwise $15

48. Paddle Cedarburg Bog's Mud Lake

Wisconsin has over 100 "Mud" Lakes — paddle this special one within the Cedarburg Bog SNA and get an up-close look at its inhabitants. Some canoes provided, indicate on form if you need one.
June 24, 9 a.m.-1 p.m.
• Saukville, Ozaukee Co.
• Joanne Kline & Alice Thompson, leaders • Limit: 15

49. Token Creek dam removal

Tour Token Creek Springs to see how the dam removal changed this site. See a trout-shocking demonstration and do some hiking.
June 24, 9 a.m.-noon
• Sun Prairie, Dane Co.
• Scot Stewart, leader

50. Wolf howl

Enjoy a bus and hiking tour of the Chequamegon National Forest near Clam Lake with a nighttime drive through wolf territory and stops on back roads to listen for wolves. Cost includes dinner at Lakewoods Resort and a donation to wolf tracking efforts.
July 8, 3 p.m.-midnight
• Cable, Bayfield Co.
• Adrian Wydeven, Sarah Boles & Tom Matthiae, leaders • Cost: $40

51. Orchids at Fair Meadows SNA

See prairie fringed orchids on this privately owned prairie, wetland and savanna restoration.
July 8, 9 a.m.-noon
• Milton, Rock Co.
• Penny & Gary Shackelford, leaders

Go wild eating your vegetables. Kate Cooper puts the bite on burdock root teaching about edible and medicinal flowers and plants on trip #55.

CHRISTINE TANZER

52. Canoe the Upper Waupaca Chain O'Lakes

Canoe a chain of five connected lakes through boiling springs, spring-fed lakes and the pristine Pope Lake SNA. Bring your own canoe and gear.
July 8, 10 a.m.-2 p.m.
• Waupaca, Waupaca Co.
• Sue Eiler, leader

53. Canoe to hidden treasures of the deep

Paddle down the Wisconsin River past bluffs and sandbars to a true Wisconsin treasure — a freshwater mussel bed. Jump into the cool water to explore hands-on these amazing creatures. Bring your own canoe and gear.
July 15, 9 a.m.-4 p.m.
• Sauk City, Sauk Co.
• Kurt Welke & Lisie Kitchel, leaders

54. Skunk & Foster Lakes SNA

Hike the hemlocks as we explore this cluster of five undeveloped glacial pothole lakes nestled in a scenic moraine. Off-trail hiking.
Friday, July 21, 8-10 a.m.
• Waupaca, Waupaca Co.
• Darcy Kind, leader • Limit: 18

55. Wild edible/medicinal plants: munch your lunch

Traverse the woods to harvest edible and medicinal plants then head to the kitchen to prepare your foraged lunch.
July 22, 9:30 a.m.-2 p.m.
• Barneveld, Iowa Co.
• Kelly Kearns & Kate Cooper, leaders • Limit: 15 • Cost: $6

56. Prairie insects and blooms

Look under the hand lens to see butterflies, leafhoppers, the endangered Silphium borer moth and, of course, blooming flowers at Faville SNA and Tillotson prairie.
July 29, 9:30 a.m.-noon
• Lake Mills, Jefferson Co.
• Joe Henry, leader

57. Pristine Young Prairie SNA

A portion of Young Prairie SNA has never seen a plow. Behold this pristine wet-prairie in full bloom to see what Wisconsin looked like before European settlement.
July 29, 9 a.m.-1 p.m.
• La Grange, Walworth Co.
• Tom Boos & Pat Trochlell, leaders

58. Ferry Bluff's fantastic stuff

Adventure off the path to see prairies, savannas, woodlands and amazing blufftop vistas of the Wisconsin River! Steep slopes and off trail.
August 5, 9 -11 a.m.
• Sauk City, Sauk Co.
• Matt Zine, leader • Limit: 15

59. Wild edibles — Betty Crocker meets Davy Crockett

Venture to McKenzie Creek Wildlife Area and nibble your way learning about edible plants and ecology. Relax around a campfire and cook up some of your found bounty.
August 5, 9 a.m.-noon
• Frederic, Polk Co.
• Renae & David Paulson, leaders

Accessible to people with walking disabilities	Easy, short travel on level terrain	An average hike with a few hills	Steeper terrain, a longer hike or canoe trip with a few small rapids

60. Wildflowers of Scuppernong Marsh

Explore a former glacial lake basin that is now a restored 3,500-acre low prairie.

August 5, 9 a.m.-noon

- Eagle, Waukesha Co.
- Ron Kurowski, leader

61. Badger Army Ammunitions Plant

Discover how this land passed from vast prairie and Native American settlements, to old European farmsteads, to a large ammunition plant during WWII. This year ownership will transfer again. Find out about the hopes for its future, and glimpse the grasslands and birds that still inhabit this changing landscape.

August 12, 9 a.m.-noon

- Baraboo, Sauk Co.
- Craig Karr, leader

62. Bats at Neda Mine SNA

Using ultrasound bat detectors, infrared video cameras and your own eyes, watch as bats swarm outside the Neda Mine exits. A rare opportunity to learn first hand about bat biology where more than 50,000 bats hibernate in a maze of abandoned mine shafts.

August 12, 6-10 p.m.

- Horicon, Dodge Co.
- David Redell, leader • Cost: $20

63. John Muir's boyhood haunts

Hike the area of lakes, wetlands, prairie and savanna where John Muir grew up. Lunch at Observatory Hill atop a cedar glade with a spectacular view.

August 19, 9:30 a.m.-1:00 p.m.

- Montello, Marquette Co.
- Mark Martin, leader

64. Discovering Wisconsin's tallest dune

Venture along the dunes of the Lake Michigan shore. Hike to a hidden trout stream through an open meadow to one of the best beech forests in the state.

September 9, 9 a.m.-2 p.m.

- Whitefish Dunes State Park, Door Co.
- Carolyn Rock, leader • Limit: 15

65. Northern Kettle Moraine forests

This state forest has it all: glacial landforms, SNAs, wildlife, recreation and forest products. Hike along the Ice Age National Scenic Trail to take it all in.

September 9, 9 a.m.-noon

- Campbellsport, Fond du Lac Co.
- Tim Beyer & Jerry Leiterman, leaders

66. Canoe the Kickapoo

Water-carved sandstone cliffs line the banks as we paddle this winding waterway in Wildcat Mountain State Park, then hike the hemlock forest of Mt. Pisgah SNA. Limited canoes available for free use. Indicate if you need one or are bringing your own. Intermediate canoe skills required.

Friday, September 15, 11 a.m.-4:30 p.m.

- Ontario, Vernon Co.
- Hank Kuehling, Dave Siebert & Ron Campbell, leaders • Limit: 18

67. Lunch on Lone Rock

Enjoy the view from Lone Rock overlooking the vast Quincy Bluff and Wetlands SNA. Then hike three miles through an oak/pine barrens. Steep climb.

Friday, September 15, 10 a.m.-3 p.m.

- Adams, Adams Co.
- Rebecca Schroeder, leader
- Limit: 15

68. Fall raptor migration and Mississippi prairies

Observe raptors migrating overhead as we hike a bluff prairie with breathtaking views of the Mississippi River.

September 16, 9 a.m.-noon

- Cassville, Grant Co.
- Richard & Amy Staffen, Bob DeMars, leaders • Limit: 15

69. Migrating monarchs

Discover how tagged monarch butterflies unlocked the secrets of their migration. Capture, examine and tag some of these beautiful migrants as they pass through Bong Recreation Area.

September 16, 1-3 p.m.

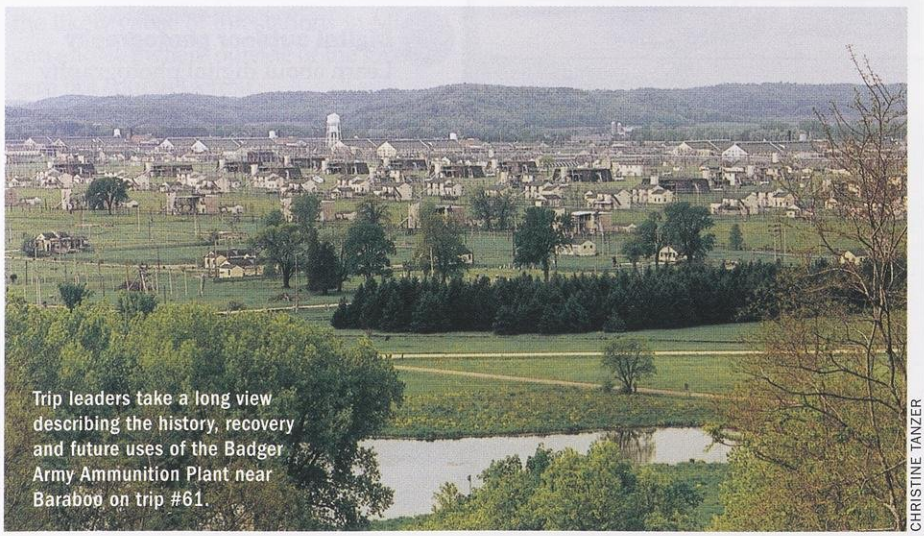
- Burlington, Kenosha Co.
- Donna Mosca & Beth Goeppinger, leaders

70. Water quality and history boat tour of Superior Harbor

Come aboard the *L.L. Smith* research vessel to talk about the environmental history and cultural development of the Duluth/Superior Harbor, including fishing, shipping and water quality.

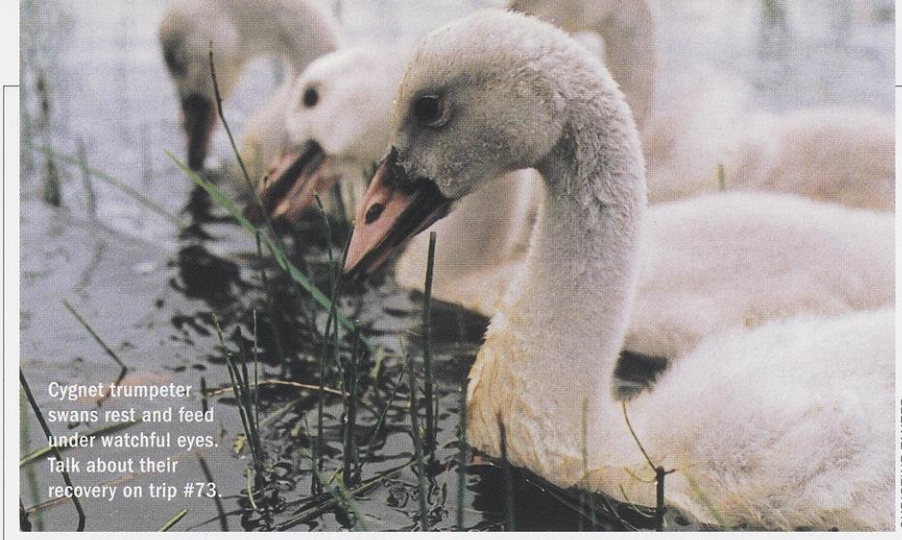
September 16, 9 a.m.-3:30 p.m.

- Superior, Douglas Co.
- Frank Koshere, Nancy Larson, Dan Rau & Sue O'Halloran, leaders



Trip leaders take a long view describing the history, recovery and future uses of the Badger Army Ammunition Plant near Baraboo on trip #61.

CHRISTINE TANZER



Cygnet trumpeter swans rest and feed under watchful eyes. Talk about their recovery on trip #73.

CHRISTINE TANZER

71. Rule Walnut Demonstration Forest

Enjoy an autumn morning in one of the highest quality walnut forests in the state learning about silviculture, timber stand improvement, deer exclosures and more.

September 23, 9 a.m.-noon

- Edmund, Iowa Co.
- Tom Hill, Jason Sable, Bill Carlson, leaders

72. Train ride into Tiffany Bottoms Prairie SNA

Ride in an antique open-air train with stops to hike into blooming prairies, hardwood forests, wetlands and sloughs near the mouth of the Chippewa River. Great birding!

September 23, 9:45 a.m.-3:30 p.m.

- Durand, Pepin Co.
- Karen Voss, Kris Johansen, Dr. Nate Molldrem, Gary Corkill & Deborah Freund, leaders
- Cost: $8

73. Trumpeter swans in autumn

Watch trumpeter swan parents and cygnets swim, forage and rest on the lakes of Crex Meadows. A rare chance to see these beautiful birds.

September 23, 9 a.m.-3 p.m.

- Grantsburg, Burnett Co.
- Pat Manthey, leader

74. Baraboo Hills geologic history

See the true gems of the Baraboo Hills. Hike the picturesque bluffs at Devil's Lake to examine quartzite, enjoy the beauty of Parfrey's Glen and take a rock hunting expedition into the Pink Lady Quarry.

September 23, 9 a.m.-4 p.m.

- Devil's Lake, Sauk Co.
- Phil Fauble, leader

75. Gifts of the glaciers

Enjoy the view atop Dundee Mountain and hear how glaciers created the geologic features of the Northern Kettle Moraine State Forest.

October 7, 9:30-11:30 a.m.

- Dundee, Fond du Lac Co.
- Jackie Scharfenberg, leader

76. Autumn dells hike

Stretch your legs on a "power-hike" through areas of the Dells of the Wisconsin River SNA not normally accessible to the public. Spectacular gorges, mossy glens and rare plants await on a strenuous, fast-paced hike on steep, off trail terrain.

Friday, October 20, 9 a.m.-2 p.m.

- Wisconsin Dells, Columbia Co.
- Thomas Meyer, leader

77. Digital outdoor photography

Learn about digital photography with an indoor lecture about digital equipment, image exposure and composition. Then venture into the field for one-on-one instruction as you try your hand at photographing outdoor scenes near Horicon Marsh. For intermediate photographers who have gone digital or are interested in making the jump.

October 21, noon-sunset

- Beaver Dam, Dodge Co.
- Dave Edwards, leader

Sign up for a field trip!

Name _____

Street Address _____

City _____ State _____ Zip Code _____

Phone (daytime) _____ (evening) _____

E-mail _____

I would like to attend the following trip(s):

Trip#_____ # of People_____ x Trip Fee_____ = $ _____

Trip#_____ # of People_____ x Trip Fee_____ = $ _____

Trip#_____ # of People_____ x Trip Fee_____ = $ _____

Trip Registration Fee: $ 35.00

NRF renewal or donation ($15, $25, $50, $100) $ _____

Total Enclosed $ _____

Make checks payable to Natural Resources Foundation of Wisconsin

Mail completed form and check to: NRF Field Trips, P.O. Box 2317, Madison, WI 53701.

Bundling up the borer

Containing firewood is an important plank in staving off a spreading forest pest.

Michael Skwarok

Just as towering elms and spreading American chestnuts were toppled by tiny fungi, so too foresters are concerned that ash trees in the Great Lakes region are threatened by a new tree killer. The emerald ash borer, an imported beetle from Asia, has killed millions of ash trees in southeastern Michigan and in nearby counties of Indiana and Ohio. Infestations have also spread into Ontario, Canada and just last September jumped across Lake Michigan and were discovered at Brimley State Park on the eastern edge of the Upper Peninsula. Other isolated pockets have also spread throughout Lower Michigan's forests and urban landscapes.

Wisconsin foresters and other experts believe it won't be long before the emerald ash borer (EAB) shows up here. And the popular opinion is that when it surfaces, EAB may tunnel into the state under the bark of a piece of ash firewood, the likely cause of infestations in Michigan and elsewhere outside of the ground zero hot spot in Detroit.

Armed with that knowledge, Wisconsin authorities have stepped up efforts to educate the public about pests and diseases harmful to both forests and urban landscapes as well as explaining the transmission route through firewood.

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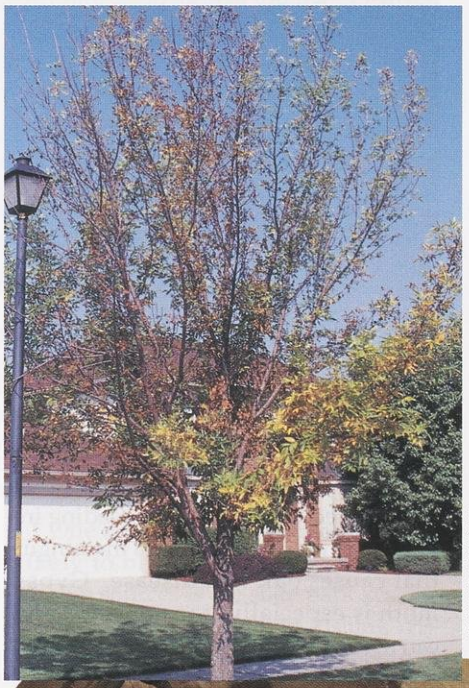
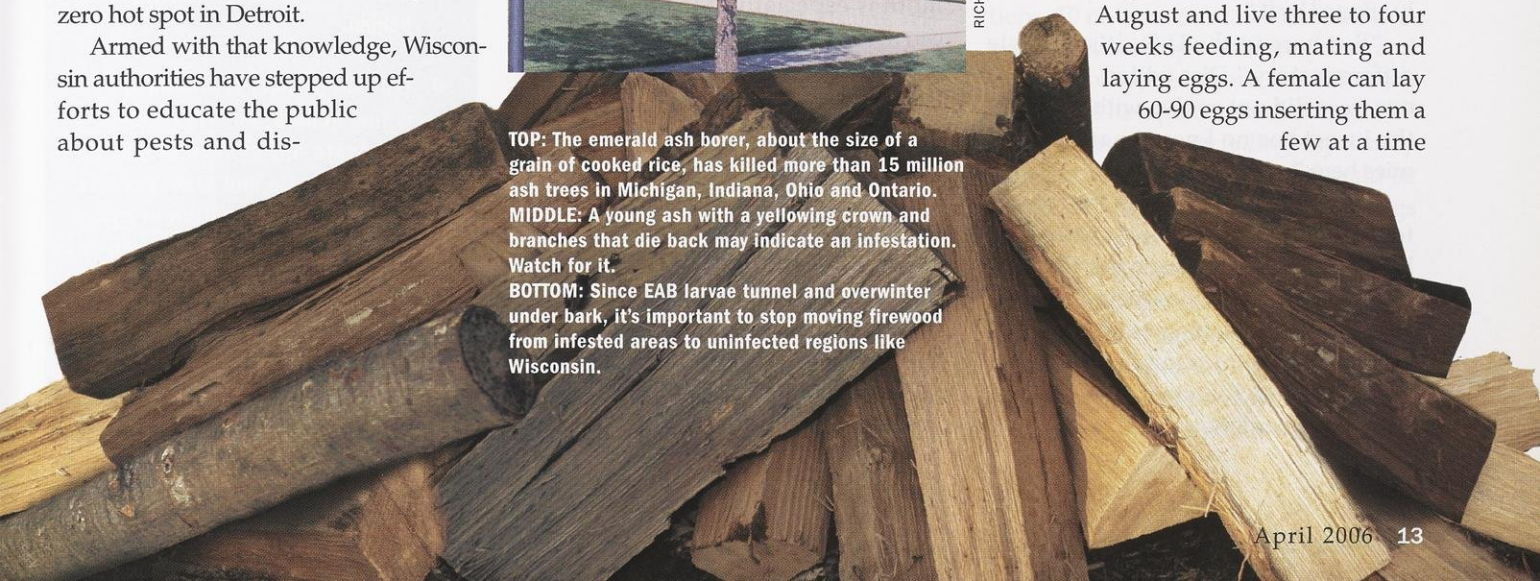


RICHARD RIDEOUT



TOP: The emerald ash borer, about the size of a grain of cooked rice, has killed more than 15 million ash trees in Michigan, Indiana, Ohio and Ontario.
MIDDLE: A young ash with a yellowing crown and branches that die back may indicate an infestation. Watch for it.
BOTTOM: Since EAB larvae tunnel and overwinter under bark, it's important to stop moving firewood from infested areas to uninfected regions like Wisconsin.

The latest beetle invasion

Emerald ash borer was first identified in the Detroit area in the summer of 2002, though investigators believe it arrived as much as a decade earlier in ash wood from Asia used to stabilize cargo in airplanes or seafaring ships. The beetles' numbers multiplied in that time in a core area of infestation that included six counties. Ash trees began to die and now, nearly four years after EAB was identified, the species is blamed for the deaths of more than 15 million ash trees in Michigan, Indiana, Ohio and Ontario.

The adult borer is only one-third to one-half inch long. Metallic emerald green wings cover a bronze, slender, bullet-shaped body. When it emerges in the late spring, it chews a 1/8-inch-wide hole shaped like a capital "D." Adults emerge from mid-May through August and live three to four weeks feeding, mating and laying eggs. A female can lay 60-90 eggs inserting them a few at a time

into tiny crevices in ash bark to begin the cycle anew. In cold climates where females may get a late start laying eggs, the larvae may actually stay in that phase for an entire year.

The eggs hatch within one to two weeks, tunneling through the bark into the thin cambium layer just beneath the surface. In this living layer the white, flat larvae grow to about 1½ inches and carve out winding, S-shaped tunnels that harm, and eventually kill, the tree. As the infestation grows and the tunnels become more numerous, they cut off the flow of water and nutrients, starving the tree. The borers attack at the top of the tree first, causing dieback at the crown. As adult beetles emerge, they reinfest the same tree, moving down and gradually weakening and killing the host tree within two or three years.

The cost to municipalities and property owners to contain and clear an infested area is enormous. In some places in Michigan, cutting down, removing and destroying trees has run close to $1 million an acre. Homeowners may sometimes share the expense of removing trees from their backyards and boulevards. To contain this disease, removed trees must be either chipped into small pieces that measure no more than 1 x 1 inch or the bark and first half-inch of the underlying wood must be removed and chipped or burned. The remainder of the downed trees can be moved and utilized.

"In its native Asia, the beetle is a minor pest," said Andrea Diss, DNR forest entomologist and coordinator of the agency's gypsy moth program. "Ash species there have evolved with EAB and developed natural resistance. They aren't significantly affected by it."

"But here in the U.S., it's a whole different story," Diss added, "because our trees did not evolve with EAB and the insect has no known natural enemies here."

Efforts to contain EAB in the core infestation area of southeast Michigan have met with limited success. Regulations restrict timber products and nursery stock from moving out of the area, but people are moving infested firewood around the state and beyond Michigan's borders.

How firewood gets its legs

"Anyone with a chainsaw or an axe, and a truck or trailer can get their hands on firewood without too much difficulty," said Melody Walker, plant pest and disease manager at the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP). "Pick up the phonebook and you'll find any number of firewood dealers. This wood moves around here as unnoticed as a milk truck or a boat trailer. It's just part of the landscape."

Firewood is commonly sold at gas stations, supermarkets, roadside stands, state parks and private campgrounds for daily or weekend use in campfires. Some large retail outlets bundle firewood in plastic or bind it with twine; an armful goes for as little as a few dollars.

Firewood has now become the latest target of scientists and state and federal officials concerned over the spread of harmful, usually exotic, pests and diseases that are killing trees in forests, parks and neighborhoods. Regulations and fines aim to prevent firewood movement in Michigan and Ohio where EAB has already spread. Penalties for moving firewood out of EAB containment areas range from $1,000 to $250,000 and jail time of up to five years. Michigan authorities have firewood checkpoints at a number of borders including the Mackinac Bridge and the ferry landings in Muskegon and Ludington.

It's not just the emerald ash borer that concerns foresters and others. Gypsy moth and the two-lined chestnut borer are equally adept at spreading infestations via firewood, as is the fungus that causes oak wilt disease. Gypsy moth is especially transmissible and can move to new locations on just about anything. The female moth lays eggs in late summer in a sticky, hair-covered mass about half the size of a golf ball that adheres to whatever she rests upon at the time. Trees, of course, are common targets, but it's not unusual to find egg masses in the wheel wells of automobiles, boat trailers, children's outdoor toys, camping equipment, picnic tables or lawn furniture.

"Just about anything in your backyard or campsite can play host to a new

ROBERT QUEEN

Thumbs-down to firewood hitchhikers

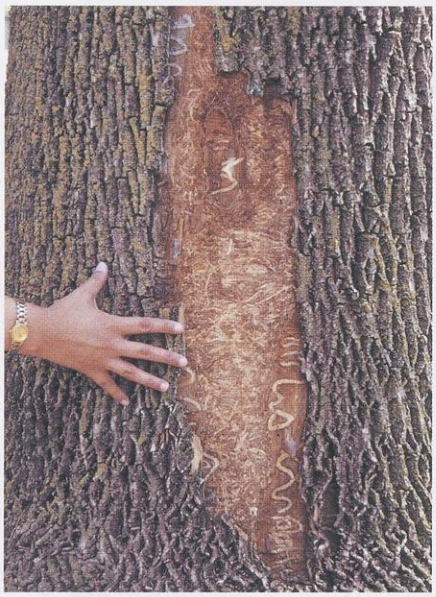
Don't be a carrier. To lessen the odds of transporting emerald ash borer or other forest pests on firewood:

1. **Purchase firewood from the same general location where you plan to use it. Local firewood is less likely to introduce new pests and diseases into your neighborhood.**

2. **When you go camping, leave your firewood behind at home and buy the wood that you need at your campsite or from a nearby vendor. Almost all state-run campgrounds have contracts with local firewood vendors.**

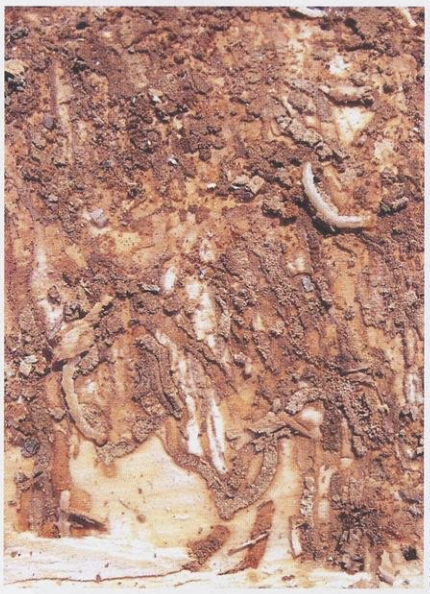
3. **If you do move firewood around the state for camping or use at a cabin or second home, be sure to burn up your firewood supply before spring, when pests and diseases begin to emerge. If moving firewood in the spring and summer, store it under a tarp and bury the tarp edges with dirt. Don't leave any unused pieces behind.**

4. **Only buy or move dry firewood that is free of bark. You will practically eliminate any chance of moving harmful pests and diseases this way, with the exception of gypsy moth egg masses, which could be found on any outdoor surface in an infested area.**



RICHARD RIDEOUT

Borer larvae feed on the thin cambium layer just under the bark.



RICHARD RIDEOUT

The whitish larvae carve out winding s-shaped tunnels that cut off the flow of water and nutrients, starving the tree from top to bottom over two to three years.

RICHARD RIDEOUT

Stopping EAB in an infested area can be a huge, expensive undertaking. In Michigan, all infected ash trees were cut down, trucked to a marshalling area, chipped, then burned to try and contain the pest. Such eradication steps are costly. Our efforts to stop EAB spread through tree monitoring, inspections and banning the movement of firewood are both prudent and economical by comparison.

batch of gypsy moths," Diss said. "If those items are mobile, there's the chance that you could be giving the moth eggs a free ride to a new home."

Watching out and planning for a border crossing

"We've known for a long time that some of these insects and diseases were moving around on firewood," said Jane Cummings Carlson, DNR forest health coordinator. "We try to educate folks and deal with the problem. Emerald ash borer is so costly to manage and so potentially devastating that we have to ratchet up our efforts."

One destination where campers are likely to bring in firewood from unknown sources is the state park system. Beginning in 2006, campers visiting Wisconsin state parks will be dissuaded from bringing in their own firewood and asked to buy campfire wood inside the park or from local businesses just outside the park. Those vendors will be required to show they are only selling firewood that's cut from a nearby source.

Minnesota is considering a similar approach in its parks and other Midwest states will be watching with interest.

"We realize this may be an unpopular policy for some of our guests, but the fact is infested firewood is spreading EAB in Michigan" said Wisconsin DNR Parks Director William Morrissey. "Given last fall's discovery of the beetle in the U.P., it looks like it's only a matter of time before EAB shows up here. We're charged with protecting our public lands to the best of our abilities, and this step will help keep the emerald ash borer out of our public campgrounds for as long as possible," Morrissey said.

"We hope that private and county-run parks and campgrounds will also take a firm position on the sources and use of firewood on their properties," Morrissey added.

Federal properties already forbid the use of ash firewood at Wisconsin campsites within the Chequamegon-Nicolet National Forests and on the Apostle Islands National Lakeshore.

Scientists and regulators in Wisconsin have been working on early detection plans for EAB and are ready to act quickly. DATCP is developing the authority to issue quarantines and restrict wood movement out of counties. In states without such rules, the federal government through the USDA's Animal Plant Health Inspection Service (APHIS) can issue quarantines affecting residents and businesses across the entire state.

The Wisconsin response plan includes comments from the timber and pulp industries, private arborists, Native American officials and local governments. DATCP would lead the response and rely on expertise from various other agencies and professionals.

DNR foresters have been setting traps to detect emerald ash borer since 2004. Forest health experts conducted visual surveys of all state parks that year and "trap trees" were prepared in 12 locations, 10 of them on state forestland. A trap tree has a strip of bark removed and a sticky gel applied above and below the wound. The open wound attracts all kinds of insects — including any nearby emerald ash borers — which would be trapped in the gel as insects deposit eggs on the wounded tree.

With some local assistance, trees at private and county campgrounds in northeastern Wisconsin nearest the area where EAB was found in Michigan are also inspected periodically. In 2005, the survey was expanded to include

Last year our message to campers about firewood stressed firewood safety and burning all wood brought to state campgrounds. This year the message is more aggressive advising campers to get their firewood locally, banning some firewood imports from quarantined areas, and explaining how campers can be vigilant to avoid moving invasive pests around the state or across state borders.

ROBERT QUEEN

detection trees along the Lower Wisconsin Riverway and visual surveys at 101 private and county campgrounds in northeast and southeast Wisconsin. A total of 2,447 trees were surveyed last year, including some on national forestland.

"We didn't find any EAB and we learned a great deal about the native insects infesting our ash trees," Cummings Carlson said.

Arresting disease in city trees

Wisconsin's forests contain approximately 717 million ash trees. And in urban settings ash varieties (green and white) are the second most common species behind Norway maples. Ashes grow quickly and do well against such urban hazards as salt runoff from roads. Coincidentally, they are resistant to defoliation caused by the gypsy moth and when Dutch elm disease ravaged many communities, homeowners and urban foresters replaced those trees with ash.

Finding ash borer in city trees could again dramatically change the look of our communities and neighborhoods.

"When an infestation is discovered, it's not just infected trees that need to come down," Walker explained. "To slow disease spread, all ash trees within a one-half mile radius of infected trees are also removed. If an infested woodpile is discovered, authorities would strip bark from several nearby ash trees and monitor them for signs that EAB had spread. If discovered, a more drastic eradication plan would begin. You can see how that would quickly become an issue for more than just the homeowner where the emerald ash borer was found."

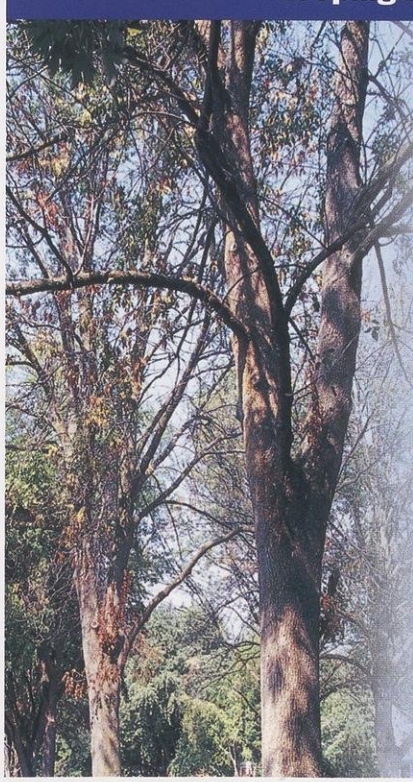
Walker is quick to add that new treatments are being studied and Wisconsin's response to an infestation might in the near future look much different from tactics Michigan employed just a few years ago.

Everyone working to contain EAB in the upper Midwest realizes that changing people's habits with firewood is going to take a concerted effort. Many people heat with wood. Some are using outdoor wood-burning furnaces to cut heating costs and many more enjoy a fire in home fireplaces. But most of that wood comes from local sources. Taking firewood to distant campsites appears to be a much more common route for hastening the spread of invasive species like the emerald ash borer more quickly.

"Controlling or containing EAB is going to require just a little attention from a whole lot of people," Walker said. "It's not hard work, but we need to change a couple habits and be aware. People need to understand that their actions are an important factor in either containing or spreading insect-borne diseases carried on firewood."

Michael Skwarok is a DNR communicator and educator working on forest pest and environmental issues.

Keeping an eye on ash



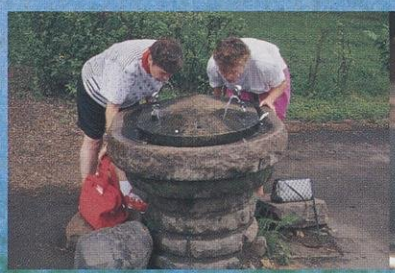
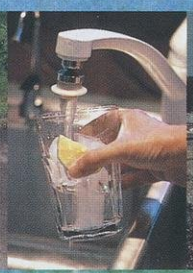
RICHARD RIDEOUT

Ash trees that are getting weaker (declining) can show the same symptoms from emerald ash borer that they show from several other stress factors and diseases. Nevertheless, if your ash trees show three or more of the signs below, please immediately report these symptoms to the Wisconsin Department of Agriculture, Trade and Consumer Protection at 1-800-462-2803.

1. **yellowing crown or branches dying back at the top of the tree**
2. **a dying tree that sprouts new growth from the trunk or near the base**
3. **heavy woodpecker activity on the tree**
4. **the presence of small, D-shaped holes about 1/8" wide**
5. **winding tunnels underneath the bark**
6. **bullet-shaped, iridescent green beetles present from June to August**

groundwater

wisconsin's buried treasure

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wisconsin's buried treasure

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Front Cover Photos:
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Water drop graphics:
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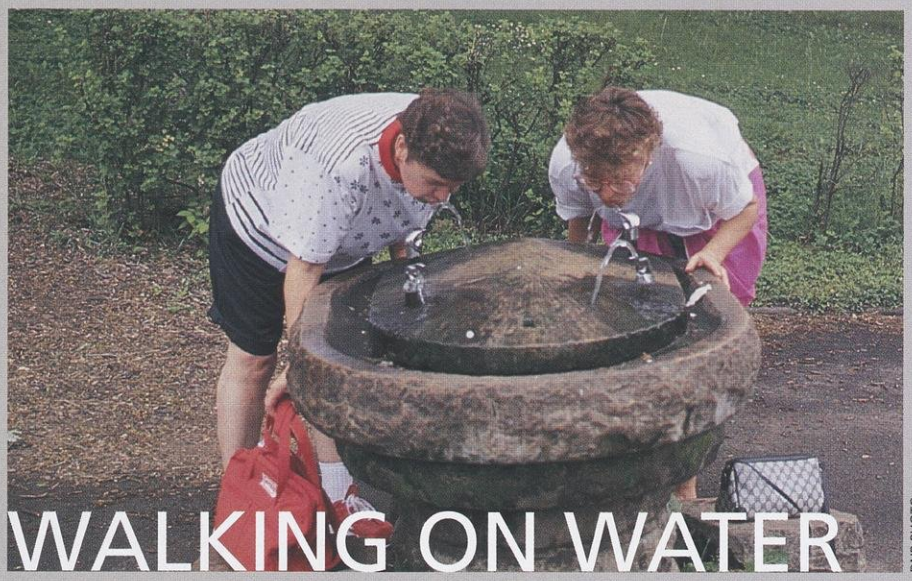
PUBL-DG-055-06

April 2006



DNR PHOTO

WALKING ON WATER

Groundwater in Wisconsin is indeed a treasure. But like all our natural bounties, it is a treasure whose high value must be sustained not by accident but by purpose.

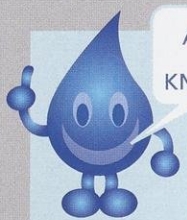
— 1983, "Groundwater: Wisconsin's buried treasure"

Catching trout in crisp clear streams, shooting the rapids in a canoe, lazing around the lake in an inner tube, quenching your thirst on a hot summer day — none of these activities would be possible without **groundwater**. For most of us in Wisconsin, the water we drink, wash with, float on and fish in comes from right below our feet. Groundwater is Wisconsin's invisible resource — our buried treasure. "Groundwater: Wisconsin's buried treasure" was first published in 1983 to educate citizens about the resource we use every day but can't see. Later versions of the publication highlighted actions state agencies and individuals were taking to safeguard groundwater. In 2006, we look back at the progress made and look forward to new challenges in protecting the groundwater resource. It seems fitting that we return to the original title for this new version of "Groundwater: Wisconsin's buried treasure."

Perspectives on groundwater

In 1983, the only option state agencies had for stopping groundwater polluters was litigation under public nuisance laws. The Environmental Protection Agency had set health-based drinking water standards for only 16 harmful substances. State agencies were learning more and more about where and how groundwater occurred and about how vulnerable the resource was. Our state's pioneering "Groundwater Law" was passed in 1984 and laid a plan for state agencies to work together for groundwater protection.

Fast forward to 2006: Wisconsin has limits for over 100 pollutants that threaten groundwater; a new "Water Quantity" law to regulate use; and groundwater flow has been studied in almost every corner of the state. Read on to learn about Wisconsin's groundwater, how state and local government agencies work together to protect this precious resource, and how you can help.



Look for the water drop, your guide to the truth about 10 common groundwater myths!

Using groundwater

Wisconsin is water-rich

When it comes to water, there's no place like Wisconsin. We are water-rich. Between the mighty Mississippi River and the Great Lakes of Michigan and Superior, there are more than 15,000 lakes, 7,000 streams and five million acres of wetland. And that just scratches the surface. Below our feet Wisconsin has a buried treasure — 1.2 quadrillion gallons of groundwater. It's hard to grasp just how much water is stored underground unless you look at how much we use every day:

Municipal drinking water (all uses)	330 million gallons/day
Commercial/ industrial use	256 million gallons/day
Livestock	100 million gallons/day
Irrigation (summer only)	182 million gallons/day
Home use	205 million gallons/day
TOTAL	**1,073 million gallons/day**

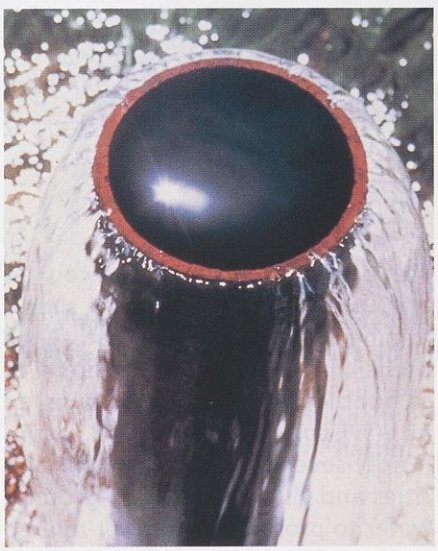
– USGS statistics estimates

Each year about 29 trillion gallons of water fall as rain or snow on Wisconsin's 36 million acres. Plants and animals consume some, some returns to the atmosphere through **evaporation** and **transpiration** by plants, and some flows into rivers, lakes and streams. The rest becomes groundwater by seeping through the soil and into groundwater **aquifers**.

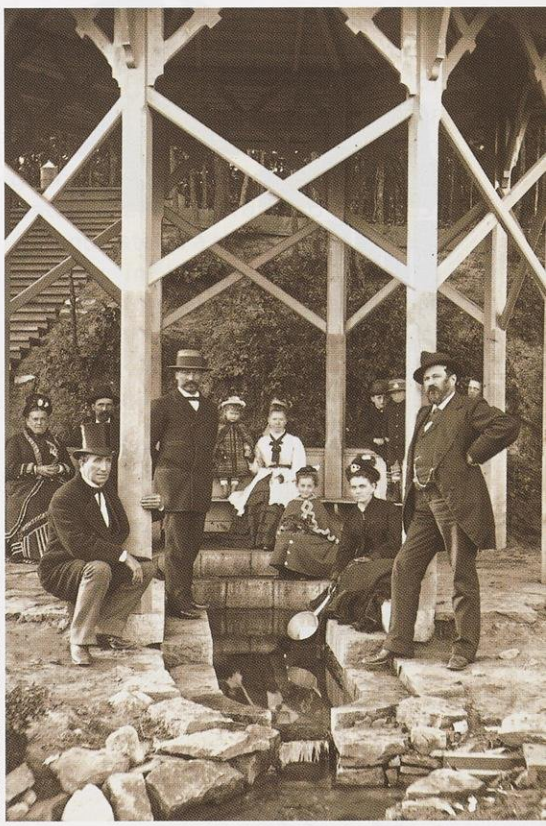
If you could somehow pour all the water below ground on top, you'd need to trade in your ranch house for a houseboat: Wisconsin's bountiful groundwater could cover the whole state to a depth of 100 feet!

Getting a clean glass of water isn't as easy as turning on the tap!

In Wisconsin, the quality and quantity of groundwater varies from place to place. The difference is caused by a combination of **geology**, varying precipitation and use. Cities and towns in the north central and northeastern third of Wisconsin receive the most precipitation in the state, but they are underlain by crystalline bedrock, a type of rock formation notorious for yielding only small quantities of water. Even though there may be plenty of rain, finding enough groundwater to supply municipalities in these regions can be difficult.



SUE SWANSON



ANDREW DAHL, COURTESY OF STATE HISTORICAL SOCIETY WHI (D31)672

Pure, healthy groundwater is vital to our present, past and future economies. (above) An artesian well at the Nevin Fish Hatchery. (right) A Beloit mineral spring 1873-79.

Groundwater levels have been going down by hundreds of feet around some of Wisconsin's growing metropolitan areas

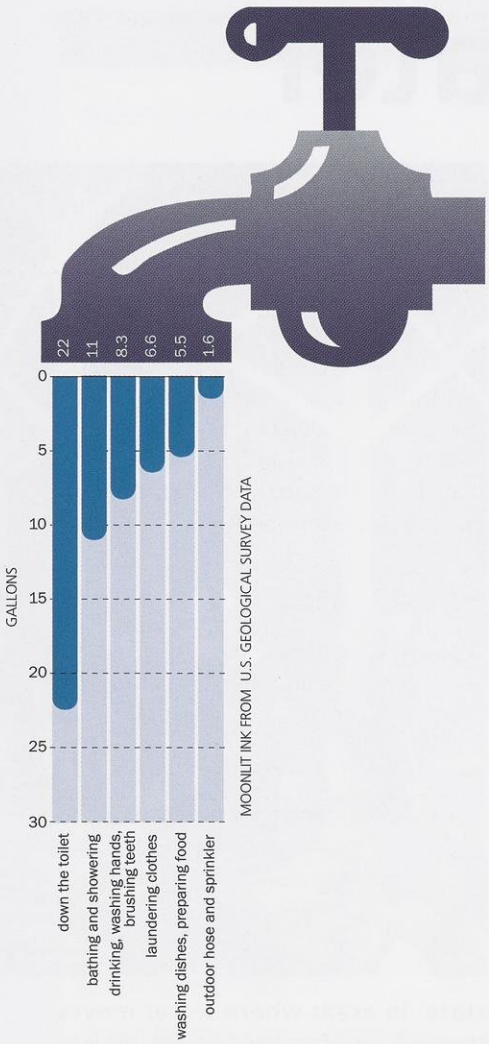
At last estimate, there were more than 850,000 **private wells** in the state. In areas where water moves through aquifers very slowly, private wells can still yield enough water for residential use. You can drill a hole just about anywhere in Wisconsin and find water. But is this water drinkable? Groundwater can be contaminated in several ways, which you'll read about here. But you'll also read about how you can take action at home to protect Wisconsin's buried treasure.

The worth of water

In Wisconsin, about three-fourths of us draw nearly 205 million gallons of groundwater daily at home to slake thirsts, scrub pots, boil spaghetti and shower. Per person, that's 55 gallons of groundwater per day.

How do you use Wisconsin's ample buried treasure? Take a look at the faucet diagram on page 4.

Fifty-five gallons of groundwater



per person per day may not seem like much, but there are hidden costs for excessive water use. Your community may have to install new wells or water and sewer pipes to accommodate increasing demand. Pumping more water from private or public wells requires more energy, which costs more money. Treating used water (referred to as "wastewater") to stringent standards of purity strains every budget.

ROBERT QUEEN

(above) Personal water use averages 55 gallons per day. That does not include groundwater used in water parks or agriculture.
(right) A spring bubbling up in Middleton.

ROBERT QUEEN

Thirsty cities

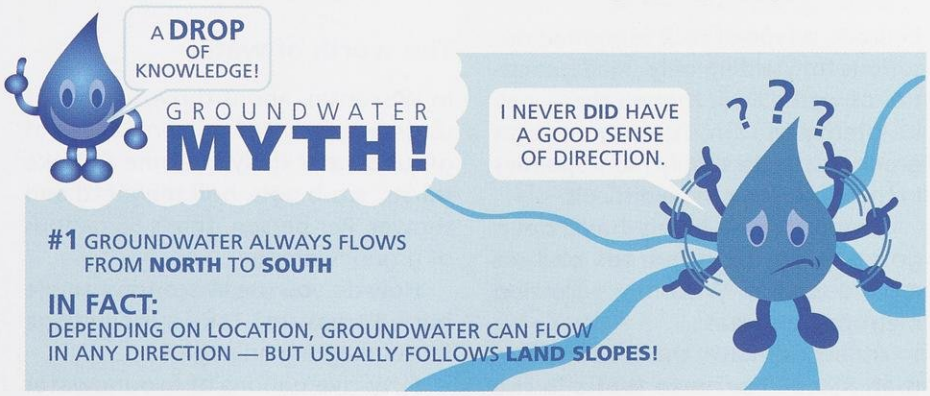
It's used to fight fires, clean streets, fill the local pool, sprinkle golf courses and parks, drench shade trees, supply commercial customers and satisfy the needs of thirsty residents at home or at bubblers (drinking fountains, to non-Wisconsinites) around town. Ninety-seven percent of Wisconsin's cities and villages count on groundwater to provide basic water-related services often taken for granted.

The top counties and main users:

- Dane County (Madison) area, 48 million gallons per day;
- Waukesha County (City of Waukesha), 27 million gallons per day; and
- Rock County (Janesville and Beloit), 20 million gallons per day.

(USGS statistics estimates)

The average daily cost to a family of four in 2005: between 26 and 35.2 cents — an increase of only a few cents since 1983, when "Groundwater: Wisconsin's buried treasure" was first published.



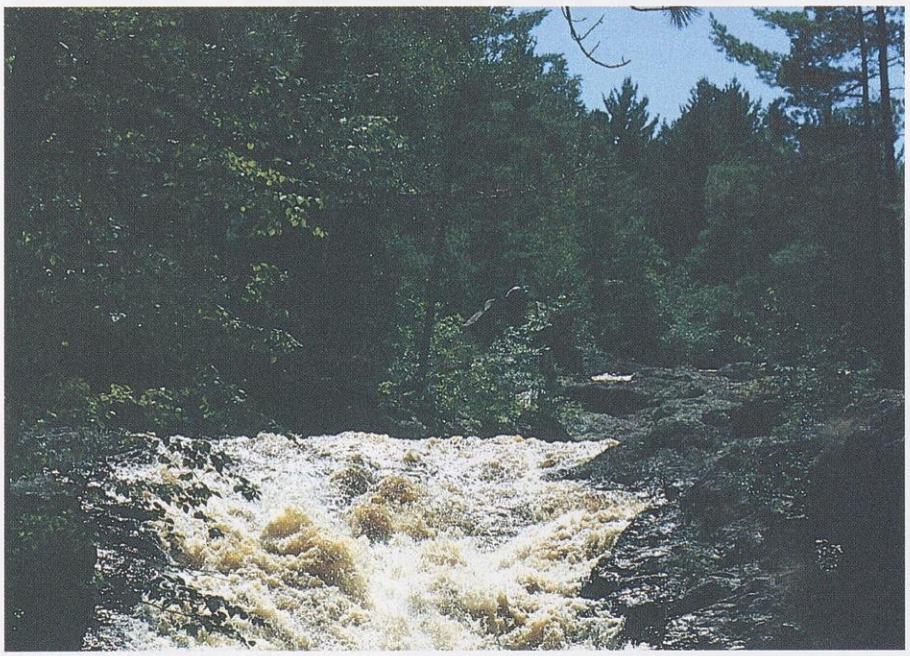
A fluid economy

Water is vital to Wisconsin's economic health. It's part of countless manufacturing processes, from metal fabrication to paper production to leather tanning. Some of our most important industries — fruit and vegetable processing, cheese-making, dairy farming, meat processing and brewing — need pure, clean groundwater to make the

goods for which Wisconsin is famous.

Big operators aren't the only ones who need this valuable resource. Consider your local laundromat, car wash, water bottlers, restaurants, health clubs, hairdressers...scores of services and products we use daily depend on groundwater.

Food processing soaks it up: processing one can of corn or beans requires nine gallons of water. Cars, fast or slow, also guzzle it up: six gallons of water are needed to produce one gallon of gasoline. And to manufacture that car and put four tires on it takes 39,090 gallons of water!



ROBERT QUEEN

(left) Rain and snowmelt that seep through soil recharge groundwater and are discharged to lakes, streams, rivers and spectacular sights like Amnicon Falls.

Commercial and industrial companies draw over 106 million gallons of groundwater each day from their own wells and use about 150 million gallons more provided by municipal water systems, according to the USGS. Groundwater is a silent but important partner in Wisconsin's economy because it provides more than one-third of Wisconsin's business and industrial water needs.

Wet and wild

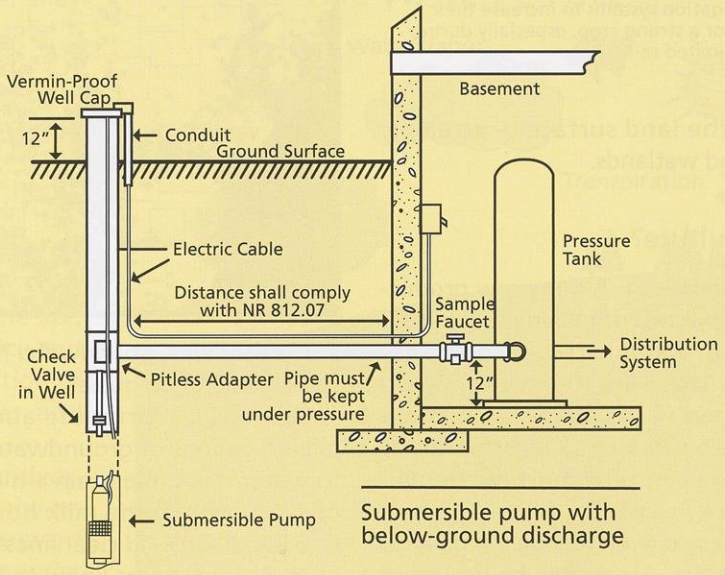
Thousands of tourists visit Wisconsin each year to enjoy the state's fabulous water resources. They spent an

How a well works

Wisconsin has had well regulations since 1936 and today is recognized as a national leader in well protection. Well drillers and pump installers must be licensed by the DNR to make sure wells are properly constructed and located.

This figure shows one of many types of private wells constructed in the state. A pump is set inside a drilled and "cased" well at a depth well below the level of groundwater. When the pump turns on, water is drawn through openings in the casing and pushed through pipes to a pressure tank inside a house. The pressure applied by the tank insures pipes will be filled with water when you open the tap. Large **municipal wells** work in a similar manner, but at a much larger scale. Large water towers use gravity to provide the pressure needed to make water flow into distribution pipes and finally to homes.

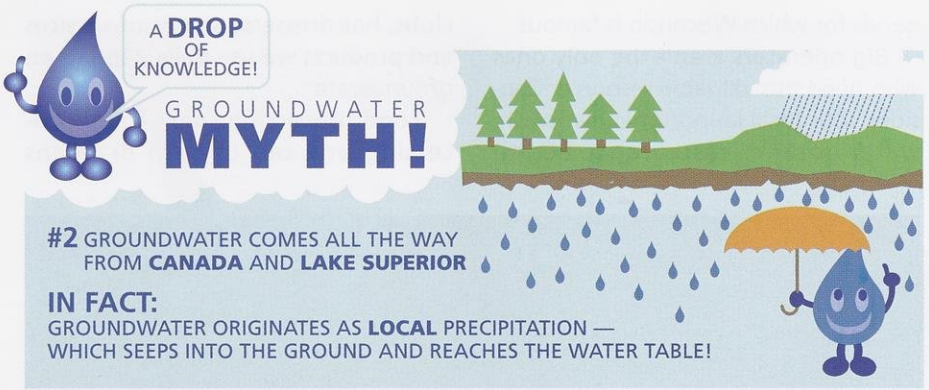
To protect public health, private and public wells must be located far from sources of contamination. For example, a new private well cannot be installed within 250 feet of a wastewater land application site or within 1,200 feet of a landfill. For more information on rules governing wells, check out the DNR Drinking Water and Groundwater webpages at: dnr.wi.gov/org/water/dwg/

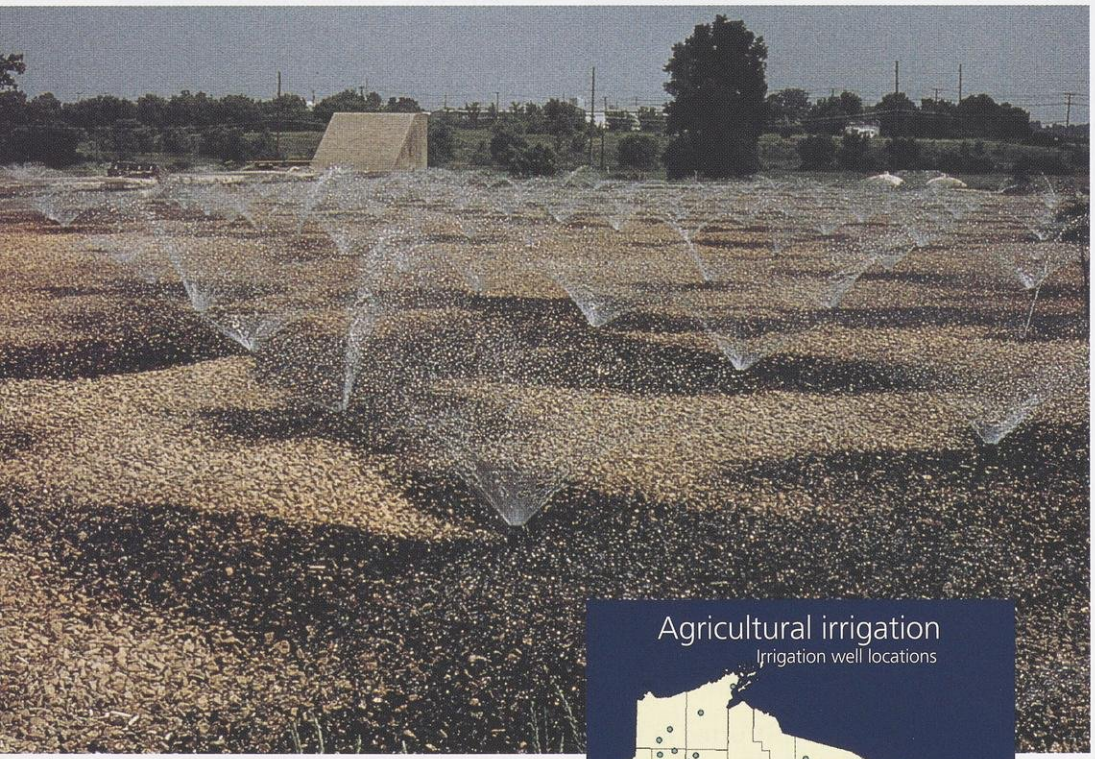


Submersible pump with below-ground discharge

DNR ILLUSTRATION

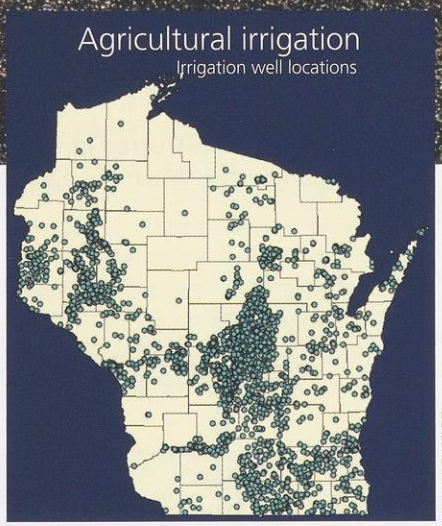
estimated $11.8 billion in 2005 alone. That's a lot of fishing, boating and swimming. What most see is a favorite fishing hole, a secret pond with an expanse of cattails perfect for observing herons, or those wild rapids waiting to devour the raft or roll the kayak. What visitors don't see is the groundwater flowing into those water bodies. After seeping through the soil and rock, groundwater discharges in low places where the water table meets the land surface — streams, lakes and wetlands.





DNR PHOTO

The demand for groundwater rises as farmers install irrigation systems to increase their chances for a strong crop, especially during times of limited rainfall.



AMY IHLENFELDT

Aquaculture?

Take a short test: A dairy cow producing 100 pounds of milk daily slurps 50 gallons of water each day to wet her whistle. There are roughly 1,235,000 dairy cows in the state. On average they each produce 17,800 pounds of milk per year. How much water will they drink in a year?

If you said over 10.9 billion gallons, you pass. For extra credit, how much of that water was groundwater? Ninety-six percent? Good guess!

Wisconsin's farms use about 100 million gallons of groundwater a day to water stock, maintain a high level of sanitation in the milk house and provide all-around cleanliness on the farm. Dairy farmers know that bringing a quality product to market means starting with quality materials — wholesome, nutritious feed and pure, clean water.

The demand for groundwater on the farm continues to rise as increasing numbers of farmers install irrigation systems to make the risky business of farming more certain. In 1969, Wisconsin had an estimated 105,526 acres of irrigated farmland. According to the U.S. Department of Agriculture, that figure now has risen to over 390,000 acres.

Irrigation equipment uses about 182 million gallons of water per day during the growing season, almost all of it groundwater. On average, eighty percent of irrigation water is consumed — it is used by plants and not returned immediately to the soil under the fields.

Much of Wisconsin's irrigated acreage is in the relatively flat 10-county Central Sands area, where the potato is king. The tuber grows well in the sandy, loose soil, which needs less plowing and seedbed preparation than heavier soils and makes for an easy harvest. Water quickly seeps into this permeable soil and drains away almost as fast, allowing the plant roots to breathe and prevent rot. But the sandy soil doesn't hold water well, so irrigation is almost essential to ensure a good crop.

While irrigation has helped formerly marginal lands turn a profit, there is a cost: Excessive irrigation may leach **nutrients**, fertilizers and **pesticides** into groundwater and lower the water table.

Understanding the resource

Recycling water

Water might be called our most recycled resource. The water you drink today contains the same water molecules that flowed in the Nile during the building of the Egyptian pyramids and froze in glaciers when mastodons roamed the earth. Distribution of the earth's total water supply changes in time and space, but the quantity remains constant.

Wisconsin receives an average 30 to 32 inches of precipitation per year. Seventy-five percent evaporates or transpires through plants and never reaches surface water or groundwater. The six to 10 inches that do not evaporate immediately or get used by plants run off into surface waters or soak into the ground, depending on local topography, soil, land use and vegetation. For every inch of water that runs off the land to a stream or lake in gently rolling Dane County, three inches seep to the **water table**. In the sandy plains of Portage County, nine inches seep into the ground for each inch running off the land.

Water distribution is governed by a phenomenon known as the **hydrologic**, or water cycle, which is kept in motion by solar energy and gravity. Start with a spring shower. As the rain falls to earth, some flows downhill as **runoff** into a stream, lake or ocean. Some evaporates; some is taken up by plants. The rest trickles down through surface soil and rock. This water eventually reaches the water table — the top of a **saturated zone** of soil or rock, called an aquifer. The water contained in the aquifer is groundwater. Groundwater is discharged to wetlands, lakes and streams — the low places where the water table meets the land surface. The sun causes evaporation from these surface waters, and, as water vapor accumulates in the atmosphere and clouds begin to form, the water cycle begins anew.

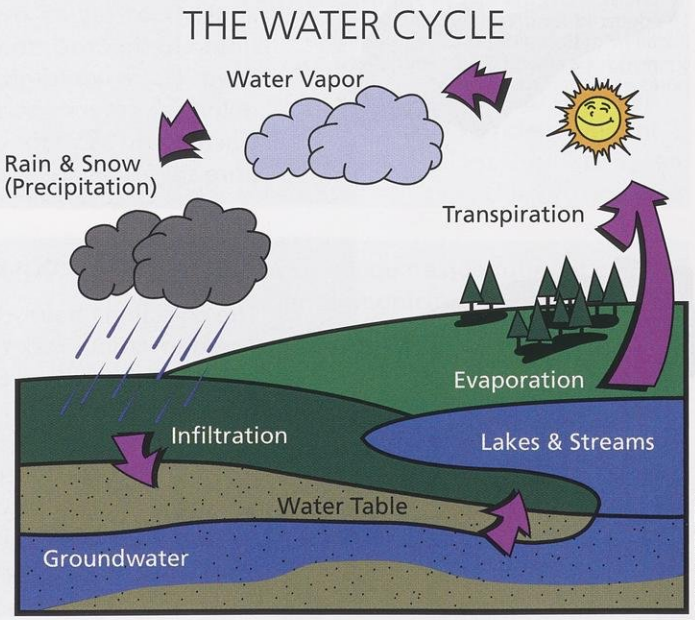
On the move

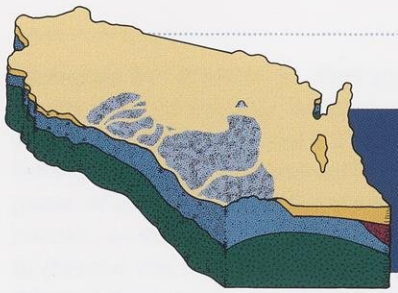
Geology controls the rate of groundwater movement. The size of the cracks in rocks, the size of the pores between soil and rock particles, and whether the pores are connected determine the rate at which water moves into, through and out of the aquifer.

Water generally moves quickly in coarse sand, sometimes as much as several feet per day. Openings between the grains are large and interconnected, resulting in high **permeability**. Very fine-grained material like clay has many pores where water can be stored, but the pores are so small that moving water through or out is difficult. Clay formations are relatively **impermeable** — water may move only a few inches a year. Permeability in **limestone**, on the other hand, primarily depends not on pore spaces, but on the size, frequency and distribution of fractures and cracks.

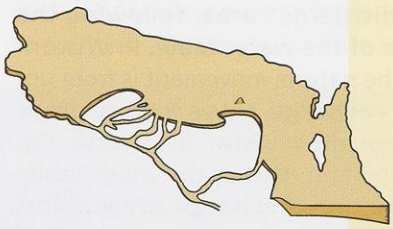
Groundwater is always moving toward a surface outlet or "discharge" area, following the slope of the water table. In Wisconsin, the natural movement is from upland **recharge areas** (places where rain or melt water infiltrates the ground and reaches the water table) to lowland **discharge areas**. Most precipitation seeping into the soil moves only a few miles to the point where it is discharged; in the vast majority of cases, it stays within the same **watershed**.

Perhaps you've wondered why some streams continue to flow during dry periods and in winter, when there's no rainfall. Winter stream flow is largely groundwater discharge (called **baseflow**) that remains at a relatively constant temperature year-round — about 50° F. During the winter, groundwater from the surrounding uplands constantly replenishes streams, and most lakes and wetlands. That same 50° F groundwater baseflow is the reason streams stay icy cold in the summer.





Wisconsin's aquifers



Sand and gravel aquifer

The sand and gravel aquifer is the surface material covering most of the state except for parts of southwest Wisconsin. It is made up mostly of sand and gravel deposited from glacial ice or in river floodplains. The glacial deposits are loose, so they're often referred to as soil — but they include much more than just a few feet of topsoil. These deposits are more than 300 feet thick in some places in Wisconsin.

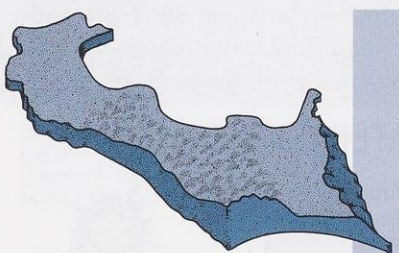
The glaciers, formed by the continuous accumulation of snow, played an interesting role in Wisconsin's geology. The snow turned into ice, which reached a maximum thickness of almost two miles. The ice sheet spread over Canada, and part of it flowed in a general southerly direction toward Wisconsin and neighboring states. This ice sheet transported a great amount of rock debris, called **glacial drift**.

Eastern **dolomite** aquifer

The eastern dolomite aquifer occurs in eastern Wisconsin from Door County to the Wisconsin-Illinois border. It consists of Niagara dolomite underlain by Maquoketa shale.

These rock formations were deposited 400 to 425 million years ago. Dolomite is a rock similar to limestone; it holds groundwater in interconnected cracks and pores. The water yield from a **well** in this aquifer mostly depends on the number of fractures the well intercepts. As a result, it's not unusual for nearby wells to vary greatly in the amount of water they can draw from this layer.

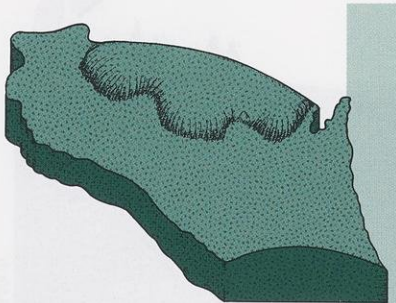
Groundwater in shallow portions of the eastern dolomite aquifer can easily become contaminated in places where



Sandstone and dolomite aquifer

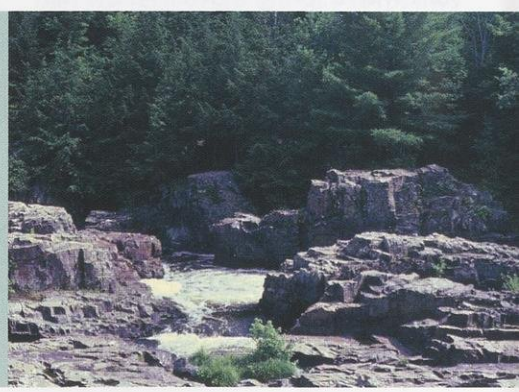
The sandstone and dolomite aquifer consists of layers of sandstone and dolomite bedrock that vary greatly in their water-yielding properties. In dolomite, groundwater mainly occurs in fractures. In sandstone, water occurs in pore spaces between loosely cemented sand grains. These formations can be found over the entire state, except in the north central portion.

In eastern Wisconsin, this aquifer lies below the eastern dolomite aquifer and the Maquoketa shale layer. In other areas, it lies beneath the sand and gravel aquifer. These rock types gently dip

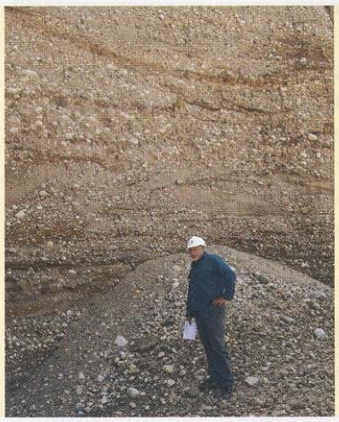


Crystalline bedrock aquifer

The crystalline bedrock aquifer is composed of various rock types formed during the Precambrian Era, which lasted from the time the Earth cooled more than 4,000 million years ago, until about 600 million years ago, when the rocks in the sandstone and dolomite aquifer began to be formed. During this lengthy period, sediments, some of which were rich in



An aquifer is a rock or soil formation that can store or transmit water. Wisconsin's groundwater reserves are held in four principal aquifers: the sand and gravel aquifer, the eastern dolomite aquifer, the sandstone and dolomite aquifer, and the crystalline bedrock aquifer.



THOMAS V. RIEWE

As the ice melted, large amounts of sand and gravel were deposited, forming "outwash plains." Pits formed in the outwash where buried blocks of ice melted; many of these pits are now lakes. The sand and gravel aquifer was deposited within the past million years.

The sand and gravel outwash plains now form some of the best aquifers in Wisconsin. Many of the irrigated agricultural lands in central, southern and northwestern Wisconsin use the glacial outwash aquifer. Other glacial deposits are also useful aquifers, but in some places, large glacial lakes accumulated thick deposits of clay. These old lake beds of clay do not yield or transmit much water.

Because the top of the sand and gravel aquifer is also the land surface for most of Wisconsin, it is highly susceptible to human-induced and naturally occurring pollutants.

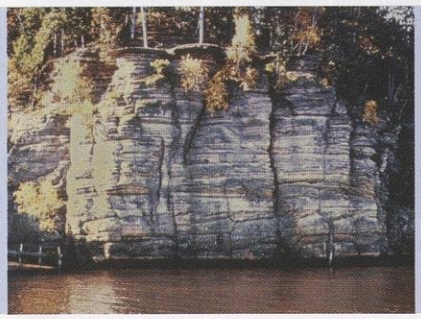
the fractured dolomite bedrock occurs at or near the land surface. In those areas (such as parts of Door, Kewaunee and Manitowoc counties), there is little soil to filter pollutants carried or leached by precipitation. Little or no filtration takes place once the water reaches large fractures in the dolomite. This has resulted in some groundwater quality problems, such as bacterial contamination from human and animal wastes. Special care is necessary to prevent pollution.

The Maquoketa shale layer beneath the dolomite was formed from clay that doesn't transmit water easily. Therefore, it is important not as a major water source, but as a barrier or shield between the eastern dolomite aquifer and the sandstone and dolomite aquifer.

KEN BRADBURY

to the east, south and west, away from north central Wisconsin, becoming much thicker and extending to greater depths below the land surface in the southern part of the state.

The rock formations that make up the sandstone and dolomite aquifer were deposited between 425 and 600 million years ago. The sandstone and dolomite aquifer is the principal bedrock aquifer for the southern and western portions of the state. In eastern Wisconsin, most users of substantial quantities of groundwater, such as cities and industries, tap this deep aquifer to obtain a sufficient amount of water.



KEN BRADBURY

iron and now form iron ores, were deposited in ancient oceans; volcanoes spewed forth ash and lava; mountains were built and destroyed, and molten rocks from the earth's core flowed up through cracks in the upper crust.

The rocks that remain today have a granite-type crystalline structure. These are the "basement" rocks that underlie the entire state. In the north central region, they are the only rocks occurring beneath the sand and gravel aquifer.

The cracks and fractures storing and transmitting water in these dense rocks are not spaced uniformly. Some areas contain numerous fractures while others contain very few. To obtain water, a well must intersect some of these cracks; the amount of water available to a well can vary within a single home site. The crystalline bedrock aquifer often cannot provide adequate quantities of water for larger municipalities, large dairy herds, or industries.

Many wells in the crystalline bedrock aquifer have provided good water. However, most of these wells do not penetrate deeply into the rock. Water samples from deep mineral exploration holes near Crandon and deep iron mines near Hurley have yielded brackish water.

Threats to groundwater

You name it — gasoline, fertilizer, paint thinner, antibiotics — if it's used or abused by humans and dissolves in water or soaks through soil, it may show up in Wisconsin's groundwater. New concerns about groundwater are coming to the attention of local citizens and state government. These emerging issues include the potential for pharmaceuticals, pathogens and viruses to contaminate public or private wells. A new area of research examines the combined effects of many contaminants that can occur in an aquifer. For example: What are the health effects of drinking water with very low levels of both pesticides and nitrate?

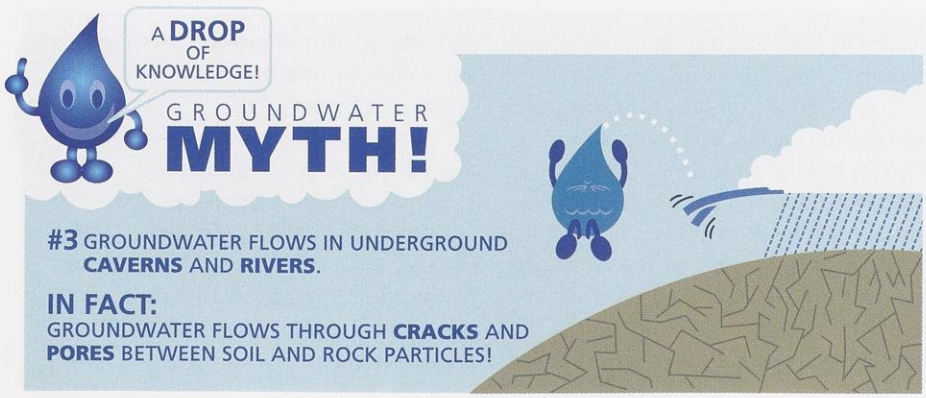
Activities in urban areas that pose significant threats to groundwater quality include industrial and municipal waste disposal, road salting, and petroleum and hazardous material storage.

In rural areas, different threats to groundwater quality exist; animal waste, **onsite sewage systems**, fertilizers and pesticides are the primary pollution sources.

The "Groundwater and land use in the water cycle" poster on pages 16 and 17 shows how activities on the land interact with the water cycle. Refer to the poster to see how what we do on the ground affects groundwater.

ROBERT QUEEN

As subdivisions replace cropland, commercial lawn fertilizer use in these areas may threaten groundwater.



Air pollution is water pollution, too

Particles clouding the air from car exhaust, smokestacks and dust from city streets or farm fields can contribute to groundwater contamination. These particles of hydrocarbons, pesticides and heavy metals settle on the ground, are washed into the soil by rain, and eventually trickle into aquifers. Although a rain shower may disperse the particles from the air, the rains can carry the pollutants down into the ground as the water hits land.

Fertilizer and manure storage and application

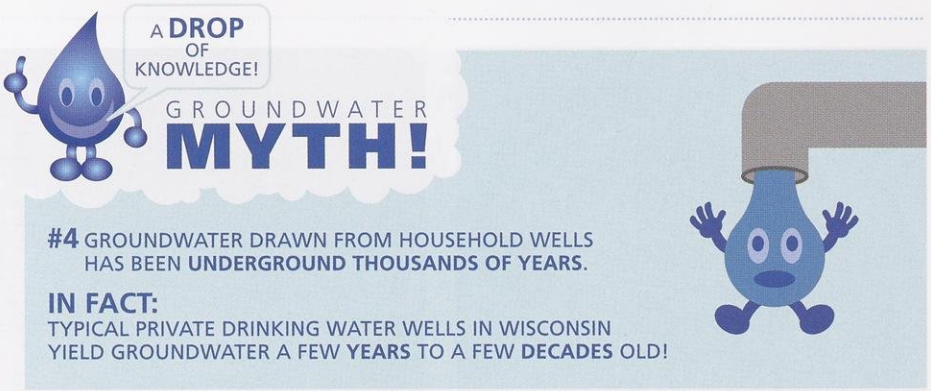
Protecting water quality and farm profits is a balancing act the UW-Extension's Nutrient and Pest Management Program is trying to perfect. To produce good yields, farmers need to apply nitrogen, phosphorus and other **nutrients** to their crops. If farmers don't account for the nutrients contained in the manure they spread on their fields, crops may be over-fertilized. Excess nitrate plants can't use will leach into groundwater and excess phosphorus will run off into lakes, streams and wetlands.

Proper measuring of nitrogen and phosphorus in manure saves farmers the cost of purchasing extra commercial fertilizer — and also protects groundwater.

Farmers also must be careful about

where and when they spread manure. Spring snowmelt or excessive rainfall can lead to fish kills and contamination of drinking water wells due to bacteria in manure that has run off from farm fields.

As subdivisions replace farm fields in rural areas, lawns replace crops. Overuse of commercial lawn fertilizer is an additional source of nitrate to groundwater.



Nitrate: a widespread contaminant

Department of Natural Resources scientists looked at nitrate contamination in groundwater and were concerned with some findings. Nitrate occurs in groundwater in every Wisconsin county; both rural and urban populations are exposed. Solving this problem means controlling all sources of nitrate to the environment.

According to a DNR survey, Wisconsin communities have spent more than 24 million dollars to bring nitrate levels down to acceptable levels in municipal wells. That cost has been spread out among 22 municipalities with a combined population of 150,000 or more.

On the private well side, present data indicate that more than 10 percent of the private well samples analyzed for nitrate statewide show groundwater contamination above the federal drinking water and state groundwater standard.

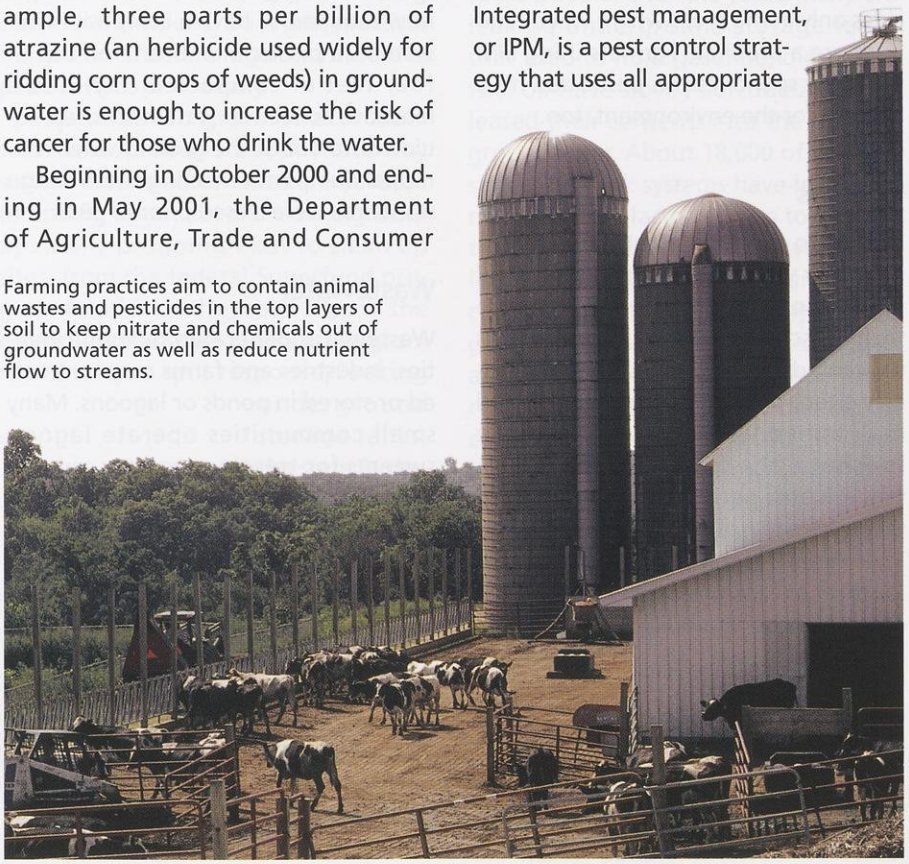
Infants under six months and pregnant women should not drink water with nitrate levels above 10 parts per million — the health-based federal and state standard. Mixing baby formula with high-nitrate water threatens infants under the age of six months, because their stomach acid isn't strong enough to kill certain types of bacteria capable of converting nitrate to harmful nitrite. Nitrite binds hemoglobin in the blood, preventing oxygen from getting to the rest of the body; the baby may lose its healthy color and turn blue. Methemoglobinemia, or "blue baby syndrome" can cause suffocation. Using water with low levels of nitrate can prevent the condition. Other health effects linked to nitrate in drinking water include certain types of cancer, thyroid problems and diabetes.

Use and misuse of pesticides

All types of pesticides (insecticides, herbicides and fungicides) have been used in Wisconsin agriculture for a long time. These pesticides can reach groundwater when spilled at storage, mixing and loading sites, or when overapplied to fields. "Empty" pesticide containers not properly disposed of are another source of trouble. Just a little spill of most pesticides can have a big impact on groundwater quality. For example, three parts per billion of atrazine (an herbicide used widely for ridding corn crops of weeds) in groundwater is enough to increase the risk of cancer for those who drink the water.

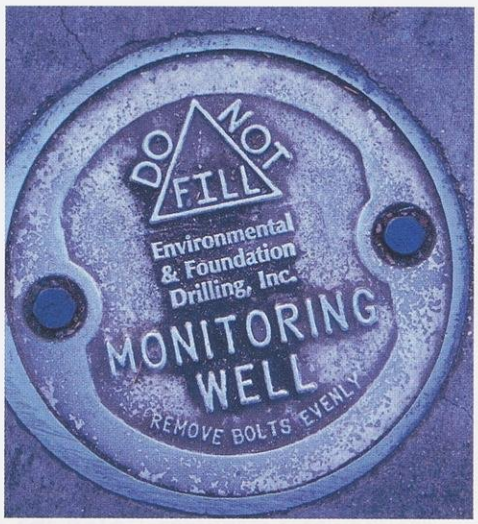
Beginning in October 2000 and ending in May 2001, the Department of Agriculture, Trade and Consumer Protection (DATCP) collected and tested 336 samples from rural private drinking water wells to determine the impact of agricultural pesticides on groundwater resources. DATCP analyzed the samples for commonly used herbicides. Results from the study showed over 35 percent of wells tested contained detectable levels of herbicides or their metabolites (compounds created when herbicides and other chemicals deteriorate in soils).

Protecting groundwater from pesticide contamination while maintaining farm profitability isn't easy — too much pesticide and the environment suffers; too little and crop yield goes down. Integrated pest management, or IPM, is a pest control strategy that uses all appropriate



Farming practices aim to contain animal wastes and pesticides in the top layers of soil to keep nitrate and chemicals out of groundwater as well as reduce nutrient flow to streams.

ROBERT QUEEN



ROBERT QUEEN

Monitoring is one way to identify groundwater threats.

ROBERT QUEEN

Recycling efforts and properly constructed landfills are preventing much of the groundwater contamination that was seen 35 years ago at landfills.

control methods (chemical and non-chemical) to keep pest populations below economically damaging levels while minimizing harm to the environment. Here's how it works: farmers "scout" fields for weeds and pests. After identifying what is present, the farmer purchases and applies the minimum amount of herbicides and insecticides only in the areas where weeds and bugs are a problem. Farmers using IPM find they spend less on pesticides. It's a bargain for the environment, too.

Landfills

Thanks to recycling efforts since 1995, each year we divert about 40 percent of the Wisconsin-generated solid waste from Wisconsin's landfills. The wastes we can't divert are disposed of in properly sited, designed, constructed and maintained landfills, which prevent **leachate** (the foul liquid that forms when water percolates through solid waste) from polluting groundwater. There are 72 highly engineered licensed landfills accepting solid waste in Wisconsin that do a good job of protecting groundwater.

We weren't always so fortunate. In the early 1970s about 2,000 dumps were identified by the DNR. Those located near navigable waters, within floodplains, wetlands or critical habitat were ordered closed. Remaining landfills posing a threat to the environment due to hydrogeologic setting or poor operation were required to monitor groundwater and surface water. The monitoring data indicated some landfills and open dumps were causing groundwater pollution.

Based on the data and current state and federal regulations, all landfills are now required to have a composite liner system (a plastic membrane on top of four feet of compacted clay) and a leachate collection system to keep liquid waste out of the groundwater. Municipal dumps not meeting these design standards were closed prior to 1993.

Wastewater

Wastewater generated by municipalities, industries and farms may be treated or stored in ponds or lagoons. Many small communities operate lagoon systems for treating sanitary sewage through bacterial degradation of organic material in the wastewater. A manure lagoon on a dairy farm can hold waste until conditions are right for field application.

Lagoons are sealed with compacted clay or plastic liners. Nevertheless, burrowing animals or soil movement can cause leaks. Routine inspections and maintenance are necessary to keep lagoons operating properly and to prevent contamination of groundwater.

Some industries dispose of their wastewater by applying it to farm fields or to land specifically operated as a disposal system. Most municipalities and some industries also apply **sludge** produced in their treatment systems to cropland as a nutrient and soil conditioner. The waste is applied according to how much water, solids and nutrients soil and crops can absorb. If the system isn't managed properly, and too much waste and water are applied to the land, or if the operator fails to adjust the amount applied to account for rainfall, groundwater and wells can be contaminated or the material may run off to surface waters.

Onsite sewage systems

There are more than 750,000 **onsite sewage systems** (private onsite wastewater treatment systems) in Wisconsin — serving approximately 30 percent of all households in the state. Most of these systems are located in unincorporated areas. Here's how onsite sewage systems work: wastewater flows from the house to a settling tank where solids settle out. The liquid continues out to an absorption field consisting of a series of perforated pipes that drain away from the house. The liquid is then absorbed into the soil. Bacteria in the settling tank break down solid waste, leaving a sludge that needs to be removed periodically

by a licensed septage hauler or "honey wagon."

When systems don't work properly, bacteria, nitrate, viruses, detergents, household chemicals and chloride may contaminate groundwater, nearby wells and surface water. Even properly installed systems may pollute groundwater if they are not located, used and maintained correctly. (For tips on maintaining onsite sewage systems, see page 27.)

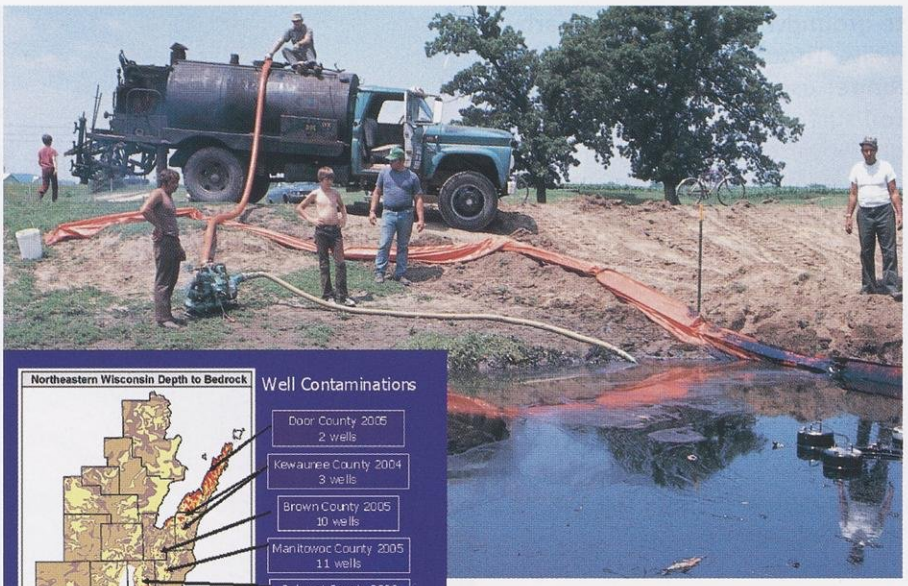
Spills and illegal dumping of industrial and commercial chemicals

When paint thinners, degreasers, pesticides, dry cleaning chemicals, used oil, fertilizers, manure and a host of other hazardous materials trickle into the groundwater, they create a potential danger to the public and the environment.

Accidents happen — over 1,000 spills of toxic or hazardous materials are reported each year in Wisconsin. **Volatile organic compounds** (VOCs) such as petroleum products account for many of the spills in the state. Topping the list is diesel fuel. Other substances such as pesticides, paint and ammonia, make up the rest. Most spills occur at industrial facilities or during transport of hazardous substances. Response efforts focus on containing and removing the hazardous material to a proper disposal facility. This protects groundwater and surface waters.

An undetermined number of spills go unreported, their presence a secret until area wells become polluted. Although there are strict regulations governing transport, storage and disposal of toxic and hazardous wastes, illegal dumping continues. Problems from past practices that occurred before regulations were in place surface periodically.

The threat to groundwater from these toxic products is real. That's why state and federal resources are devoted to finding these sites and cleaning them up. Many programs exist to clean up sites, from the federal Superfund program to address the worst sites in the nation, to the state cleanup program that includes spill response, leaking underground storage tanks, the state Superfund program, and a focus on cleaning up "brownfields" (properties that have been abandoned or are underutilized because of actual or perceived contamination).



LIZ HEINEN

DEAN TVEDT

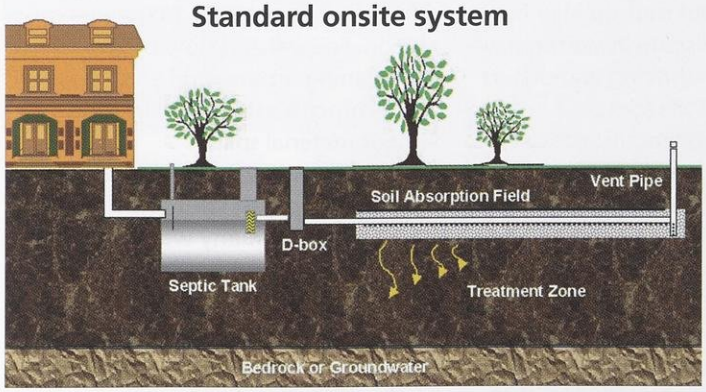
Quickly containing and removing pollutants are key to successful spill response efforts. (left) Northeastern Wisconsin manure contaminated wells 2002-05.

Leaking underground storage tanks

People in the environmental cleanup business call them LUSTs; for all of us, it spells trouble. Over the years, many old leaking underground storage tanks that used to hold gasoline, diesel and fuel oil have slowly corroded and released their contents into the soil and groundwater. About 18,000 of Wisconsin's older tank systems have leaked as rust and other factors took a toll on the tanks and dispensing lines. Even small leaks caused significant groundwater contamination; it takes only a little gasoline in water to make it undrinkable. Property owners and their environmental consultants have cleaned up contamination at over 16,000 sites during the past 20 years. New regulations require existing tank systems to be upgraded. This will help prevent future problems.

Unused wells

What happens to the old well can determine how the new well functions. If old wells are not filled properly with such impermeable materials as cement or bentonite clay, they provide a direct channel for pollutants from the surface



LEROY JANSKE

Have your onsite sewage system inspected once a year and go easy on the system by minimizing water use.

to groundwater and other nearby wells. Thousands of old wells no longer used but still open at the soil surface threaten Wisconsin's groundwater. Whenever you see an old windmill in the country, it's likely there's an unused well underneath. Licensed well drillers and pump installers are routinely hired to properly abandon or fill old wells.

Drainage wells draw water off a section of wet ground by piercing a clay layer and allowing surface water to run directly into groundwater. Drainage wells have been prohibited in Wisconsin since 1936, but they do turn up occasionally.

Stormwater

When development occurs, recharge to groundwater can be short-circuited. Rainfall, instead of infiltrating, runs off pavement and collects in lakes, rivers and streams. Stream levels become more variable or "flashy," floods and channel erosion are more common, and groundwater recharge decreases. To put the hydrologic cycle right and prevent stream banks from washing out, Wisconsin requires new developments to infiltrate most of the stormwater falling on their sites.

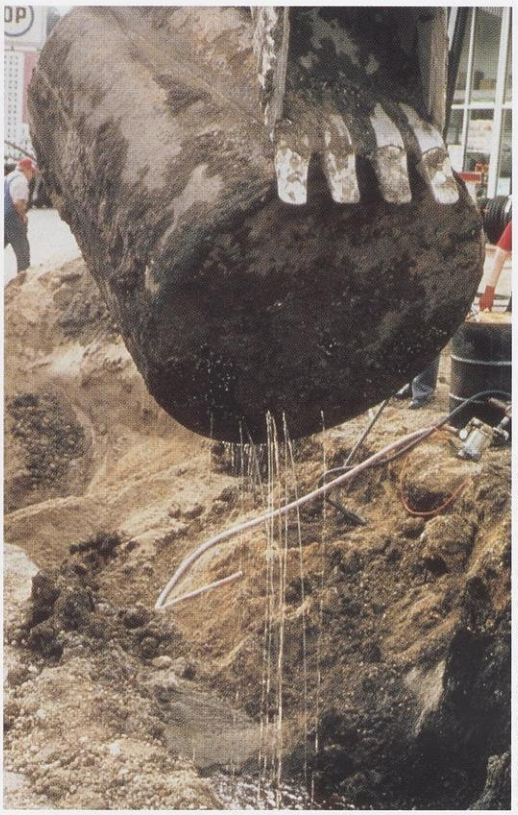
Because stormwater from roofs, driveways, parking lots and streets contains contaminants such as gasoline, metals and bacteria, it must be cleaned up or pretreated before it is put back in the ground using engineered stormwater infiltration devices.

Sources of natural contamination

Minerals found naturally in soils and rocks dissolve in groundwater, giving it a particular taste, odor or color. Some elements, such as calcium and magnesium, are beneficial to health. Radium, radon gas, uranium, arsenic, barium, fluoride, lead, zinc, iron, manganese and sulfur are undesirable ingredients found in Wisconsin groundwater. The levels of the contaminants depend on their concentrations in the aquifer and the amount of time the water or air has been in contact with them. Radioactivity in groundwater from naturally occurring uranium, radium and radon is a concern in Wisconsin. Radioactive contaminants expose those drinking the water to the risk of cancer. Public water systems are required to test groundwater for radioactivity. Recent sampling has detected **radionuclides** in some Wisconsin groundwater. **Gross alpha activity** and radium also have been found in Wisconsin water supplies. The EPA has drinking water standards for radium and radon.

Most natural contaminants aren't harmful; the problem is aesthetics rather than safety. Iron and manganese are found throughout the state. They stain plumbing and laundry, and can give drinking water an unpleasant taste and odor.

Excess fluoride, sulfur, lead and arsenic are less common and more localized. Changes in the aquifer system, such as declining water levels, can cause chemical reactions that release contaminants into groundwater. In northeastern and western Wisconsin declining water levels have caused the release of arsenic and heavy metals. Arsenic is a known carcinogen and has been found at very high levels (up to 15,000 parts per billion). Special well construction methods have proven effective in avoiding the problem, but add greatly to the cost of getting a water supply. In some parts of Wisconsin the groundwater is naturally acidic and can corrode pipes and plumbing, leading to elevated levels of lead and copper in drinking water. Well owners should test their water periodically to assure the water quality is acceptable.



DNR DRINKING WATER AND GROUNDWATER PROGRAM

An aggressive program aims to locate, replace or remove buried tanks that can leak stored fuels. Few tanks leak this badly, but even small amounts of gasoline make water unfit for use in residences, businesses and for animals. Cleanups are expensive.

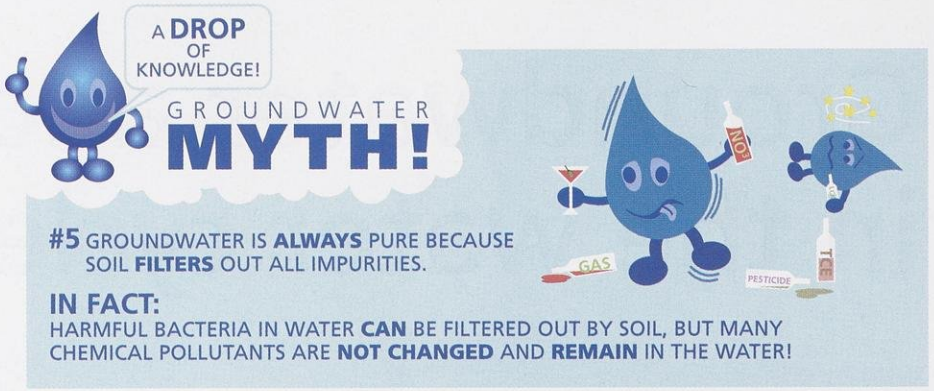
Groundwater cleanup

Groundwater contamination can be linked to land use. What goes on the ground can seep through the soil and turn up in drinking water, lakes, rivers, streams and wetlands. Tracking down and stopping sources of pollution is a lengthy and expensive process. It's usually impossible to completely remove all traces of a pollutant. Conducting a partial cleanup of an aquifer to a usable condition can cost a substantial amount of money.

Who pays the enormous cost of groundwater cleanup? The owner or facility operator causing the pollution should shoulder the cost. But what happens when the owner is bankrupt, out of business or dead? Taxpayers must step in. Federal and state money is used for cleaning up sites and enforcing laws governing waste disposal and hazardous material spills.

When it comes to groundwater, prevention is the best strategy. This means looking at the many ways we pollute groundwater and finding methods to keep those pollutants at bay. Landfills and wastewater lagoons need to be sited, designed and operated to prevent **infiltration** to groundwater. Pesticides must be applied according to need

and label instructions, and fertilizers and manure should be applied in carefully calibrated amounts to enhance crops without damaging the environment. With vigilance and care, we can protect our buried treasure.



Groundwater quantity — enough for all

With 1.2 million billion gallons of groundwater, the Mississippi River and two Great Lakes, there is no other state that comes close to having the water resources we have in Wisconsin. Yet Wisconsin has a growing thirst for groundwater. There are areas in the state where streams aren't running and **springs** aren't flowing because the groundwater that feeds them is being pumped dry. In a growing number of places we are pumping groundwater faster than it can be replenished.

In the past century, groundwater has been drawn down several hundred feet around Waukesha and Brown counties. In water-rich Dane County, groundwater levels have dropped 60 feet and are expected to drop more as the population continues to grow. These long-term drops in groundwater levels affect fish, wildlife and people from farmers to factory owners. Local scarcity sometimes pits communities against one another and the natural resources we all enjoy.

When a proposed water bottling plant in Adams County was opposed by citizen groups in1999, the interest of policymakers and the public in water quantity issues bubbled to the surface. It became clear that state laws didn't address the effect of high-capacity wells on nearby springs, wetlands or trout streams. The Big Springs case made people much more aware of the connection between groundwater, surface water and human activities.

(left) Portions of the Little Plover River, a Class I trout stream, dried up during the summer of 2005 likely due to increased water use and a lack of rain.

(right) The effect on wildlife and fish will be felt for a long time.

BOTH PHOTOS: BY BRYANT BROWNE

The Great Lakes Charter

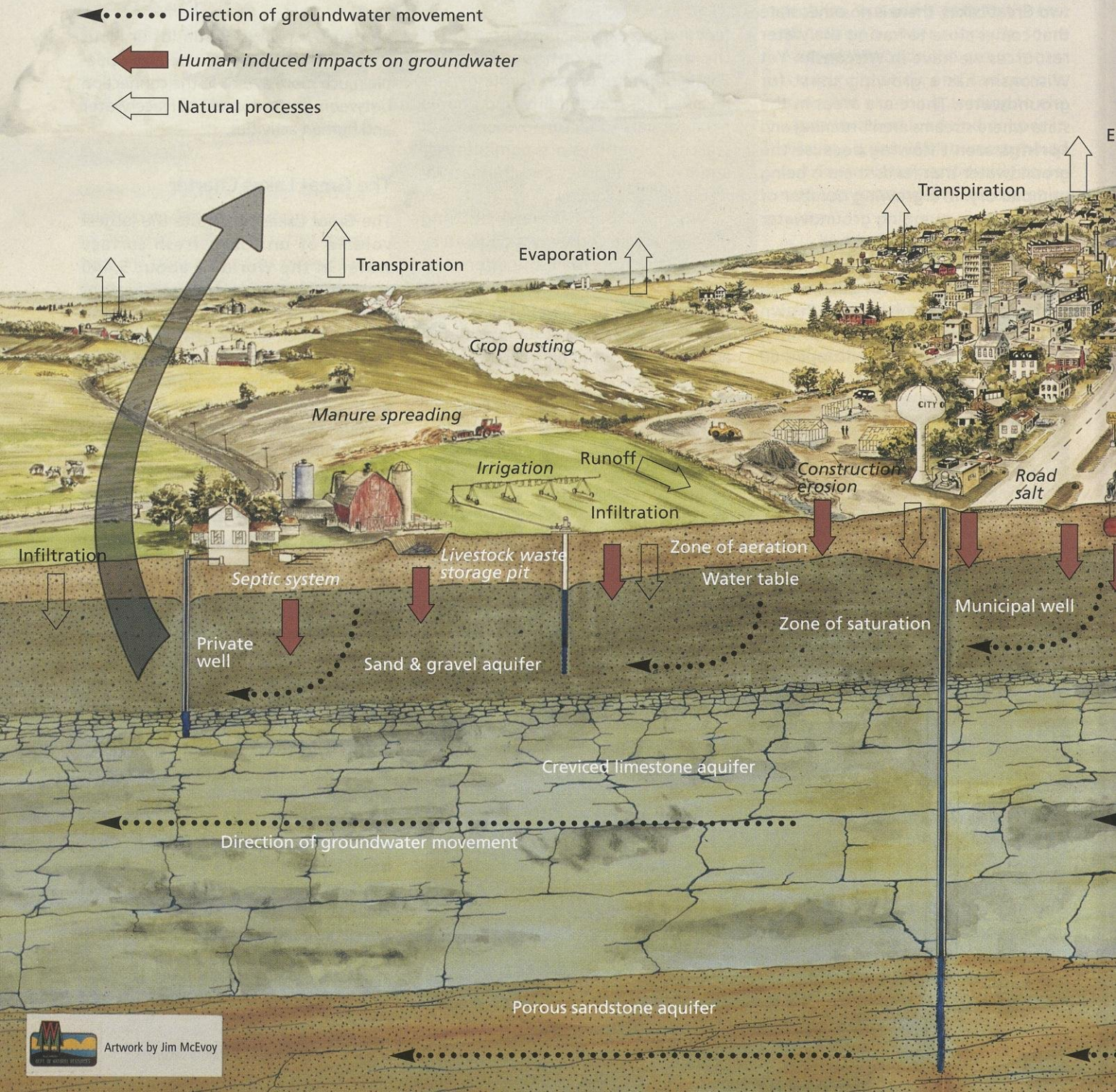
The Great Lakes constitute the largest volume of unfrozen fresh surface water in the world — about 5,440 cubic miles. There has been a great push in recent years to protect these waters. Much of the effort has been focused on updating the Great Lakes Charter, an agreement signed in 1985 by the eight Great Lakes governors and the premiers of Ontario and Quebec outlining principles for managing Great Lakes water resources.

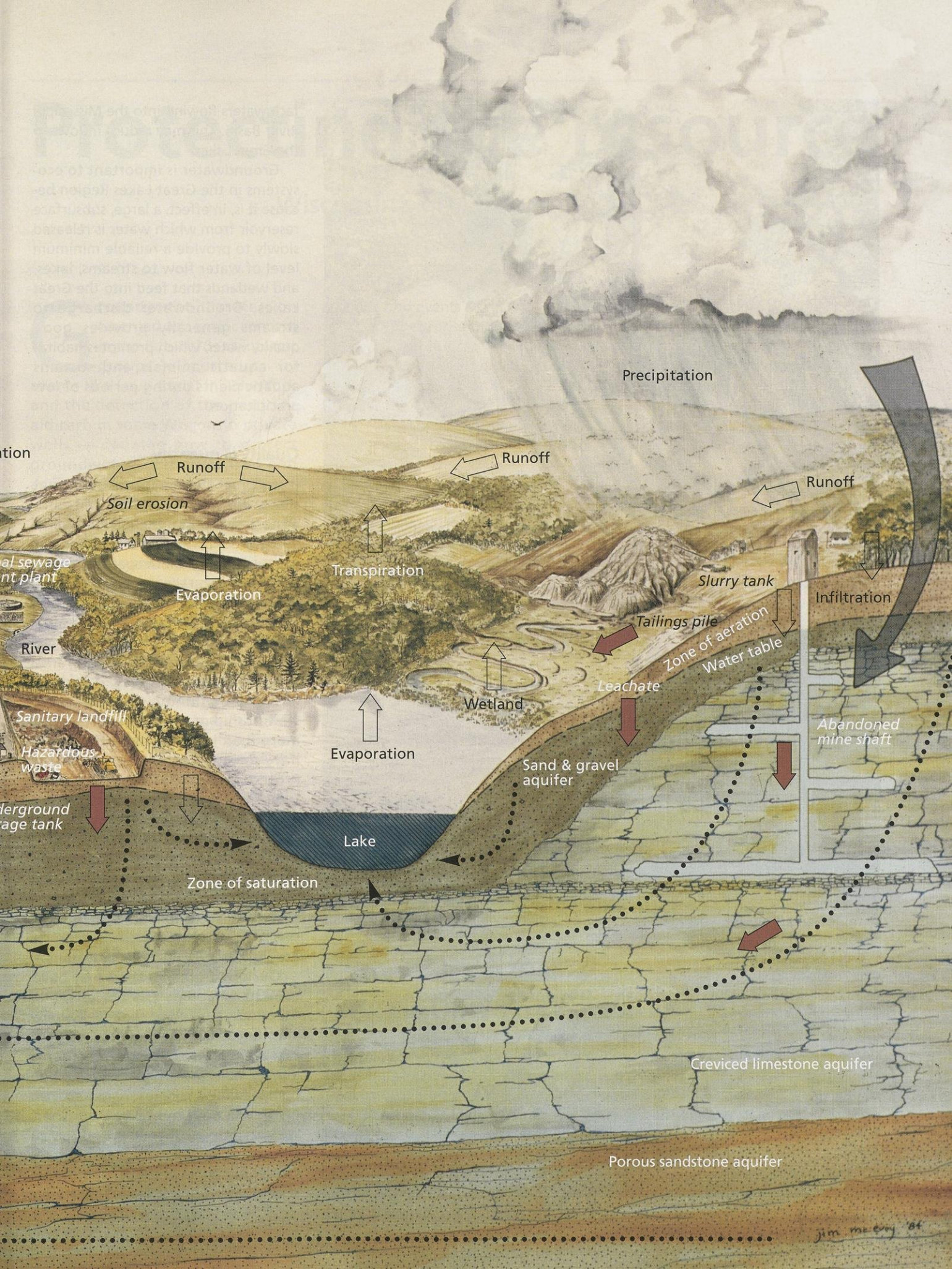
A 1998 proposal to export bulk quantities of Lake Superior water to Asia raised concerns that existing agreements were inadequate to protect these waters. It spurred action in 2000-2001 to develop an annex to the charter, which would strengthen it by establishing clear procedures for deciding whether to approve any proposed withdrawal of Great Lakes waters.

On December 13, 2005 the eight states and two Canadian provinces announced the Great Lakes Water Management Strategy, called Annex 2001. The agreement to manage water quantity in the Great Lakes basin and, with just a few limited exceptions, ban diversions of Great Lakes basin water, is the first multi-jurisdictional agreement of this magnitude in the world. All 10 governments have agreed to collectively manage water

continued on page 18

Groundwater and land use in the water cycle




Precipitation
Runoff
Runoff
Runoff
Soil erosion
Transpiration
Evaporation
Slurry tank
Infiltration
Tailings pile
Zone of aeration
Water table
River
Leachate
Wetland
Sanitary landfill
Hazardous waste
Evaporation
Abandoned mine shaft
Sand & gravel aquifer
Lake
Zone of saturation
Creviced limestone aquifer
Porous sandstone aquifer
Jim McEvoy '84

USGS PHOTO

For each new well drilled, a report detailing soil types, depths to bedrock and groundwater elevation is sent to the DNR. This information helps map subsoil geology and groundwater movement.

continued from page 15

usage according to the shared goals expressed in this agreement. The fundamental principle is that the most significant fresh water resource in the Western Hemisphere must be treated as one ecosystem. Procedures also address pumping from wells outside the basin that alter groundwater flow and capture groundwater originating within the basin.

The United States Geological Survey is exploring the connection between groundwater and the Great Lakes in southeastern Wisconsin.

The distribution and the amount of water pumped from shallow and deep rock formations in southeastern Wisconsin has changed significantly over time. Groundwater that once flowed toward Lake Michigan is now intercepted by pumping and diverted west, where it is discharged after use to surface waters flowing into the Mississippi River Basin. This may reduce inflows to the Great Lakes.

Groundwater is important to ecosystems in the Great Lakes Region because it is, in effect, a large, subsurface reservoir from which water is released slowly to provide a reliable minimum level of water flow to streams, lakes, and wetlands that feed into the Great Lakes. Groundwater discharge to streams generally provides good quality water, which promotes habitat for aquatic animals and sustains aquatic plants during periods of low precipitation.

Quality is quantity

It isn't just the amount of water at stake, but the quality, too. In southeastern Wisconsin, the resulting drop in the groundwater level means water is now drawn from deeper rock layers that have naturally occurring radium. The concentration of radium in drinking water is high, and the water must be treated to protect the health of citizens. The cost of treatment is borne by the ratepayers.

We're beginning to realize that stewardship of groundwater involves more than just keeping it clean. We have to conserve. The Groundwater Protection Act, passed in 2003, attempts to control well location and pumping rates to protect trout streams and other sensitive surface water bodies in the state. Regional efforts to assess and manage drinking water supplies are underway in southeastern Wisconsin, where use has resulted in the most severe drop in groundwater levels.

Our great-grandparents may have used hand pumps and buckets, but they knew how deep their wells were and they thought about how to protect their drinking water. Today, community wells are located far from our homes, and we take it for granted that water will pour out of the tap when we turn it on. It's time to ask ourselves, can we have it all — green lawns, swimming pools and quality springs, streams and drinking water?

Protecting the resource

Wisconsin's groundwater law

Groundwater protection emerged as a major concern in the late 1970s as interest groups — spurred on by events like Love Canal in New York and the detection of the pesticide aldicarb in some Wisconsin private wells — debated how to protect groundwater in an industrial and agricultural society.

On May 4, 1984, Chapter 160 of the Wisconsin Statutes was signed into law. Dubbed the "groundwater law," Chapter 160 has been called the most comprehensive regulatory program for groundwater in the country. All state agencies involved in groundwater protection must adhere to numerical standards that define the level at which regulatory agencies must act to clean up pollutants in groundwater. These standards are defined not only by public health, but also by the effect a pollutant can have on the environment and public welfare.

One of the most important features of Wisconsin's groundwater law is something that is not in it — aquifer classification. Aquifer classification involves looking at the use, value or vulnerability of each aquifer and allowing some to be "written off" as industrial aquifers not fit for human consumption. Wisconsin said "no" to aquifer classification. The philosophical underpinning of Wisconsin's groundwater law is the belief that our groundwater is capable of being used for citizens to drink, and must be protected to assure that it can be.

The Groundwater Coordinating Council (GCC)

When you think about the diverse activities and events affecting groundwater, it's no surprise the responsibility for managing our buried treasure is delegated to many governmental agencies. Cooperation is key — and the GCC is the group turning the key. Since 1984, the GCC has served as a model for interagency coordination among state government officials, the governor, and local and federal governments.

Representatives from the Departments of Natural Resources; Commerce; Agriculture, Trade and Consumer Protection; Health and Family Services; Transportation; the University of Wisconsin System; Wisconsin Geological and Natural History Survey and the governor's office serve on the council. The GCC advises and assists state agencies in coordinating non-regulatory programs and sharing groundwater information. Increasing public knowledge of the groundwater resource through public outreach efforts and educational materials is an important GCC function.

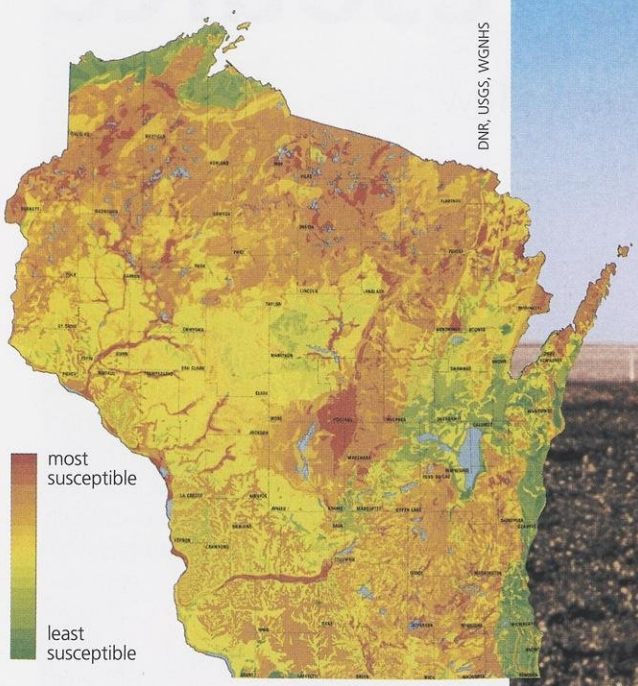
Department of Natural Resources (DNR)

It's only natural that a resource like

Trained lab technicians analyze groundwater for bacteria and chemicals.

DNR PHOTO

Groundwater contamination susceptibility in Wisconsin



DNR, USGS, WGNHS

Soil, rock and groundwater characteristics were used to make this map. Other important factors needed to determine groundwater susceptibility include land use, groundwater flow and location of nearby lakes, streams and wetlands.

DNR PHOTO

University of Wisconsin-Extension and DATCP provide farms with information and skills training necessary to maintain farm profitability with an eye on protecting the environment.

groundwater receives a lot of attention from the Department of Natural Resources. From insuring the water you drink is clean to making sure new landfills are properly sited and constructed, DNR staff is there. DNR's groundwater activities include protecting the resource, cleaning it up and making sure public health and environmental standards are set and met.

Protecting groundwater means preventing what goes on the ground from going into groundwater. By looking at soil and rock types, thickness of soil and rock layers, and depth to groundwater, DNR hydrogeologists, engineers and specialists can make decisions about where waste can be spread, or if a landfill can be safely installed at a particular site.

But looking at the natural environment isn't enough to predict how contaminants will move in the subsurface. The map of groundwater contamination susceptibility in Wisconsin shown above is only one piece of a very complex groundwater protection puzzle. Land use, groundwater recharge and proximity to surface water are also important considerations when trying to site landfills or large farm operations.

One way to help protect public health is to protect the area around water supply wells from sources of contamination. Wellhead protection programs require municipalities to restrict land use around new public water supply wells and encourage planning around older wells. Under the DNR's Source Water Assessment Program, land areas that contribute water to public wells were identified, potential contaminant sources were inventoried, and the susceptibility for each public water supply was evaluated. The assessments assist water system operators in preparing wellhead protection plans.

New rules for siting large livestock operations, stormwater infiltration devices and farm nutrient management require separation distances between contamination sources affecting private and public wells and direct conduits to groundwater.

In addition, starting in 2010, Wisconsin's smart growth laws require that local government programs and actions affecting land use must be guided by and consistent with a locally adopted comprehensive plan to address community water supplies.

At sites with contaminated groundwater, the responsible party must find and remove the source of pollution and determine how far contamination has spread. Groundwater monitoring wells are sunk to collect samples for chemical analysis. When the contamination boundaries are known, the difficult job of cleaning up the groundwater begins. Some sites take years and millions of dollars to clean

DNR PHOTO

Groundwater research verified how quickly nearby contaminants washed pollution through a sinkhole into groundwater and seeped out to a discharge area. Pollution spreads wide, deep and quickly where the rock is fractured near the surface.

up. In the case of groundwater, a drop of prevention is truly worth a gallon of cure.

Wisconsin Geological and Natural History Survey (WGNHS)

Since 1854, the WGNHS has cataloged Wisconsin's geology, **hydrogeology**, soils, biology and other natural resources. The state survey is the principal source for maps and records about Wisconsin groundwater and related geology. It supplies counties and regional planning agencies with information to make land use and wellhead protection decisions. Research conducted at the survey helps state agencies more effectively manage Wisconsin's groundwater. A collection of well cuttings and rock samples from about 300 wells per year are housed and described by the survey — "hard" evidence of what's hidden below ground. This collection from 44,000 wells has been cataloged in a database and can be viewed at the survey's Research Collections and Education Center in Mount Horeb. County and regional studies of geology and groundwater are produced for use by anyone interested in the **hydrology** of a specific area.

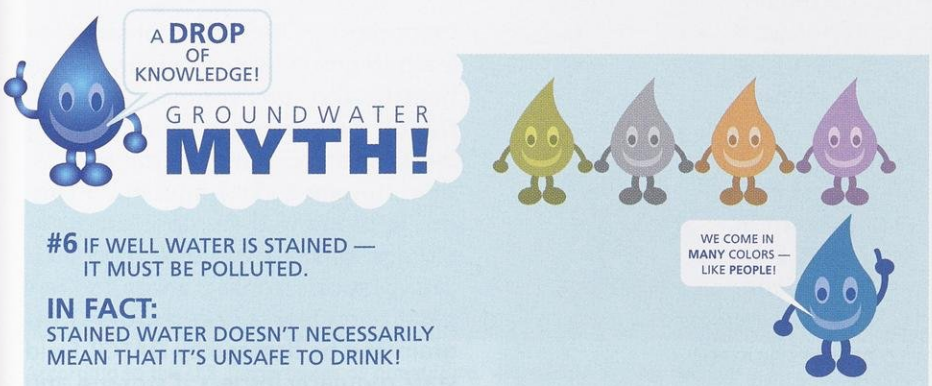
Department of Transportation (DOT)

Salt keeps Wisconsin's highways safe but can be a source of groundwater pollution. Because salt is bad for the environment and the roads, DOT is always looking for alternatives and ways to minimize salt use. Temperature sensors in pavement and remote weather stations along state highways help keep county highway crews prepared to do battle with winter storms and predict when pavement conditions will require applications of chemical agents or salt.

The Department of Transportation has construction standards for storing road salt to contain runoff that could contaminate groundwater. DOT works with DNR and Commerce staff to clean up groundwater pollution from petroleum storage tanks and other hazardous waste sites along DOT rights-of-way, and where new roads and bridges are planned. DOT also tests wayside wells for thirsty travelers.

Department of Health and Family Services (DHFS)

Who do you call to find out if pollutants in your well or drinking water supply are a health risk to you and your family? Start with your local health department. If they don't have the answer, the health experts at the DHFS can help you. The DHFS provides health information and advice on contaminants to individuals, and to state, county and local government agencies. When groundwater pollutants affect a community, DHFS staffers work with residents and participate in public meetings to let citizens know the risks associated with contaminants in the water supply.



ROBERT QUEEN

ROBERT QUEEN

Manure control in barnyards, careful fertilizer and pesticide applications, and tilling methods that minimize exposed soil can reduce chemical, nutrient and bacterial flow from farms to groundwater.

They advise how to best protect families and drinking water.

DHFS protects groundwater and the people who drink it by recommending standards to DNR for substances in groundwater that can cause health problems. DHFS conducts studies on the harmful effects of chemicals to determine "how much is too much." It also works with DATCP to determine how new pesticides will break down in groundwater and what health risks are associated with these compounds.

Department of Commerce (Commerce)

Commerce ensures underground and above-ground storage tanks don't leak. The agency keeps records on over 72,000 tanks used to store gasoline, fuel oil and other products. The Petroleum Environmental Cleanup Fund or PECFA, is used to reimburse owners for the cost of removing older tanks and cleaning up petroleum contaminated sites. Commerce regulates installation, maintenance and abandonment of new tanks.

Commerce helps individuals, businesses, local development organizations and municipalities revive abandoned industrial sites or "brownfields" by providing grant money for site assessment and cleanup. Since the program's 1997 inception, 1,240 acres have been revitalized. This translates into about 4,600 new jobs at over 100 different locations throughout the state.

Commerce regulates onsite sewage treatment systems and stormwater infiltration practices as part of the plumbing code. Restrictions on where and how onsite sewage systems are installed protect private and public wells and groundwater from contamination.

Department of Agriculture, Trade and Consumer Protection (DATCP)

Pesticides, fertilizers and nutrients can leach to groundwater, causing human health and environmental risks. DATCP is responsible for regulating most aspects of agrichemical application, storage and cleanup in Wisconsin. To promote the proper handling, storage and safe use of farm chemicals, pesticide applicators and sellers must complete a certification program and be licensed by DATCP. Field staff regularly inspect if storage and

mixing facilities comply with groundwater protection regulations. If a spill occurs, money and staff are available to help with the cleanup. The Nutrient Management Program helps prevent groundwater pollution by providing funding to counties to help farmers write nutrient management plans. The Clean Sweep program provides farmers and homeowners with safe options to dispose of pesticides and other hazardous chemicals for free. Businesses pay a portion of disposal costs for these substances.

University of Wisconsin-Extension

Wise groundwater use is a priority for the University of Wisconsin-Extension. Traditionally, extension agents and specialists provided farm families with agricultural tools, information and skills training. Today their role has evolved into promoting community development, maintaining farm profitability while protecting the environment, and conserving natural resources. Extension educators provide outreach to citizens, farmers, school children and public officials on water testing, water treatment devices, wise land use policy such as wellhead protection, and other groundwater topics. With offices located in each county, outreach activities can be tailored to local needs. Basin educators, located in each of the state's major river basins, provide land and water resources outreach to local communities. Extension promotes and assists private and public partnerships to conserve and protect our water resources.

The Nutrient and Pest Management Program's crop plots on working farms promote the careful use of manure and pesticides. The Farm*A*Syst program helps farmers identify and correct risks to groundwater around farmsteads. Community Drinking Water Programs help private well owners to identify individual water quality concerns and community-wide groundwater issues.

Educational institutions

From university classes on hydrogeology to state fair displays, education is the most important tool we can use to safeguard groundwater. Colleges and universities offer courses that prepare students for careers in hydrogeology, wastewater management, soil science and other disciplines vital to groundwater protection. They also conduct research on groundwater development, movement and cleanup technologies. Vocational and technical colleges offer associate degrees in fields related to agriculture and water resources management. Environmentally safe methods of farming are taught in UW agricultural "short courses."

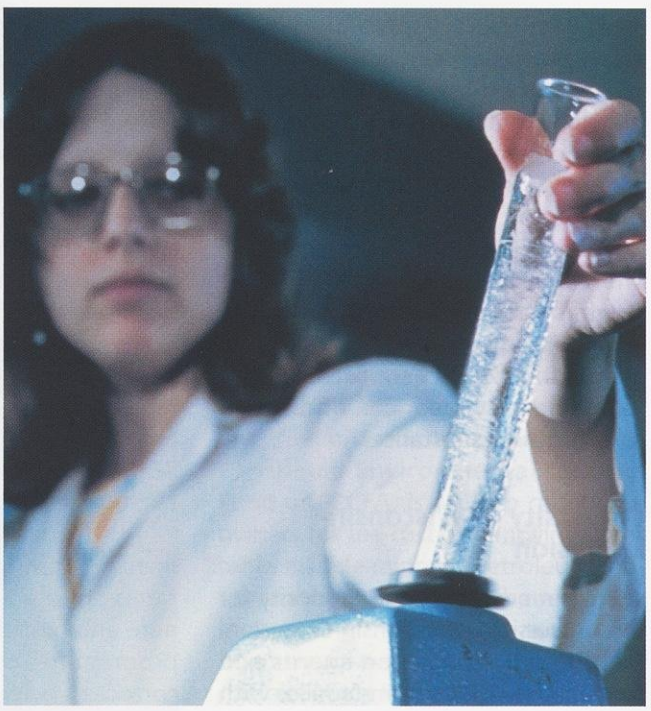
United States Geological Survey — Water Resources Division (USGS)

The USGS Water Division's job is to keep tabs on groundwater quantity in Wisconsin. Starting in 1946 with just

ROBERT QUEEN

According to the U.S. Department of Agriculture, Wisconsin has over 390,000 acres of irrigated farmland.

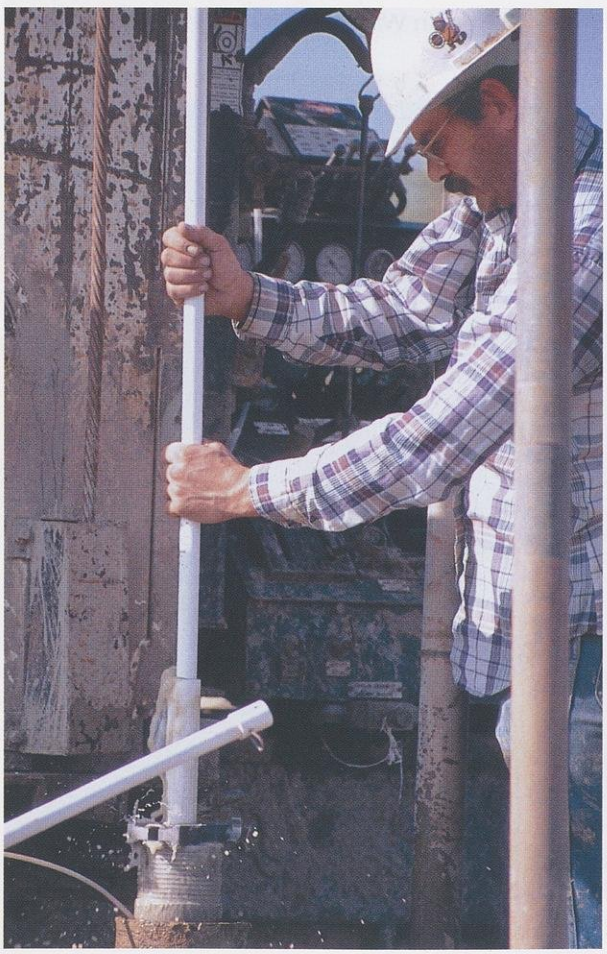
KEN BRADBURY



DNR PHOTO

(above) Research can benefit both surface waters and groundwater. (below) State well codes dictate how to drill and install wells to protect both water supply and groundwater.

Well water should be tested periodically for signs of bacteria, nitrate and any chemicals that may be used in your area.



ROBERT QUEEN

a few wells, the USGS, with the Wisconsin Geological and Natural History Survey, now collects water level measurements in over 170 Wisconsin wells. Some of the wells are measured daily using electronic recorders; others are measured weekly, monthly or quarterly. The data serves as a starting point for evaluating the effect new wells and land development will have on groundwater levels, wetlands, streams and lakes. For example, a study in the Great Lakes Basin showed groundwater that once flowed toward Lake Michigan is now pumped, used and discharged as treated wastewater to surface waters within the Mississippi Basin. This may affect surface water flow and fish habitat in tributaries feeding Lake Michigan.

Wisconsin State Laboratory of Hygiene (SLH)

The Wisconsin Laboratory of Hygiene is the main environmental testing laboratory for the DNR, DHFS and other state agencies. (See pages 28 and 30 for information on well testing.) The Laboratory performs a variety of chemical and biological drinking water tests, ranging from exotic pathogenic bacteria to potentially cancer-causing chemical contaminants. In addition to extensive testing of Wisconsin's public water supplies, the laboratory also offers private well owners basic drinking water tests such as an analysis for *E. coli*. The presence of *E. coli* indicates a water supply may be contaminated with fecal material and thus presents a health threat. Local commercial laboratories can also provide some well water tests, and the Laboratory of Hygiene partners with them so high-quality testing is readily available throughout the state.

How to protect the groundwater you drink and use

It's your turn

You've read about what government and industry are doing to guard groundwater. Now, here's what you can do to help.

Examine your own habits

Everyday activities affect groundwater quality. Think about the ways you use water at home. If you've always considered pure, clean water to be a cheap, unlimited resource, chances are you're accustomed to wasting water and haven't been concerned about what you pour down the drain.

Common sense goes a long way toward keeping Wisconsin's groundwater clean and plentiful. Here are some ways to cut back on water use and protect groundwater:

Conservation is wise use

Use water-saving devices and appliances: Since 1992, new toilets manufactured in the U.S. use only 1.6 gallons of water — much less than the six gallons each flush used to consume. If you have an older toilet, toilet dams or inserts placed in the toilet tank retain water during flushing and can save up to three gallons per flush. A plastic bottle weighted with washed pebbles makes a good insert. Low-flow faucet aerators (for either inside- or outside-threaded faucets) mix water with air and can reduce the amount of water flowing from your sinks.

Look for and fix leaks: A dripping faucet can waste 20 or more gallons of water a day; a leaking toilet, several thousand gallons a year. An inexpensive washer is usually all you need to fix a leaky faucet. Adjusting or replacing the inexpensive float arm or plunger ball can often stop toilet leaks.

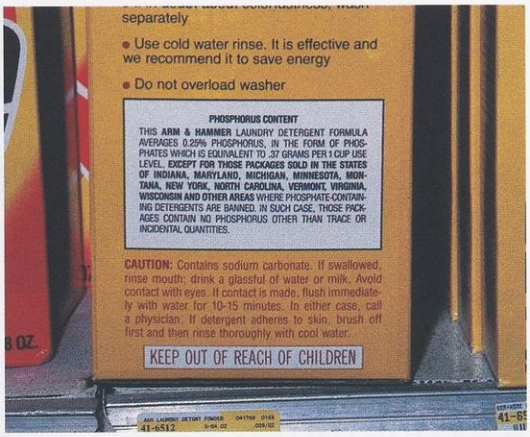
Drinking water: Keep a pitcher of drinking water in the refrigerator to quench your thirst without running the tap.

Bathing and showering: A water-saving showerhead can cut the amount of water used to about three gallons per minute without sacrificing the feeling of a good drenching. Turn off the water while soaping up during a shower to save extra gallons. New water-saving showerheads come with a button to shut off the flow without changing the mix of hot and cold water. Bathers should put the stopper in the drain before running the water, then mix cold and hot for the right temperature. Turn off the tap while shaving or brushing your teeth.

Dish washing: If you wash dishes by hand, don't leave the water running while washing them. Make sure the dishwasher is full before you turn it on; it takes as much water and energy to wash a half-load as it does to wash a full load. And scrape dishes

DAVE JOHNSON

TRACEY TEODECKI



DNR PHOTO

Homeowners can protect groundwater too. Take unwanted cleaners, paints and pesticides to Clean Sweep hazardous waste collection sites.

rather than rinse before loading the dishwasher.

Laundry: Always set the fill level to match the size load you are washing. Remember: Full loads save water because fewer loads are necessary. Front-loading washers use less detergent, electricity and water.

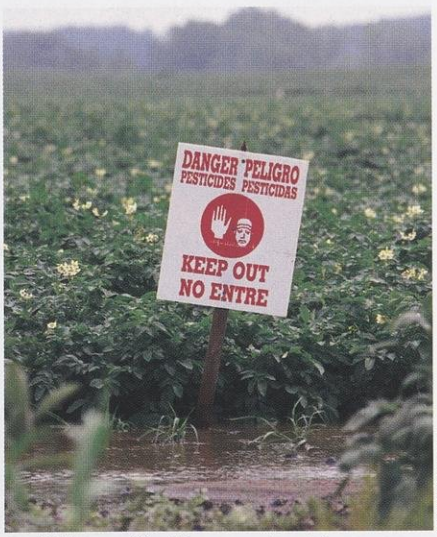
Lawn care: A rain barrel is a great way to save on water and it's not chlorinated, fluoridated or loaded with dissolved salt, so it's better for your grass and plants. Consider reducing the size of your lawn by planting trees, shrubs and ground covers. Rain gardens are attractive, low maintenance, and reduce runoff to lakes and streams.

Waste minimization

Household toxic wastes: Don't use household drains as ashtrays, wastebaskets or garbage disposals! Toilets (and kitchen sinks, garage drains and basement washtubs) are not places to discard varnish, paint stripper, fats, oil, antifreeze, leftover crabgrass killer or any other household chemicals. Just because it's down the drain doesn't mean it's gone! These products may end up in your water supply, especially if you have an onsite sewage system. Store your toxic products in tightly sealed containers in a safe, dry spot, share them with others who can use them, or bring them to Clean Sweep events in your community; call your County Extension office or DATCP for details.

Lawns: Reduce or eliminate the use of lawn pesticides and fertilizers. A significant amount of these chemicals can leach into groundwater. Test your soil first to determine if it needs additional nutrients. If you do apply fertilizer, do it in the first week of May or after September 15.

Recycle! Reuse or recycle plastic bags and containers, aluminum cans, tin cans, glass, cardboard, newspaper, paper bags and other paper products. Don't dump waste oil down the drain or on the ground — bring it to community collection tanks where it will be picked up and reprocessed. Recycling conserves landfill space. Less garbage in the landfill means less harmful leachate that could contaminate groundwater.



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Pesticides and fertilizers can leach to groundwater and cause health and environmental risks.

Biodegradable soaps and cleansers: Go easy on groundwater! Use nontoxic and biodegradable soaps and household cleansers. Or try environmentally friendly alternatives: Baking soda on a damp cloth to scrub sinks, appliances and toilet bowls; a mixture of white vinegar and water for cleaning ceramic tile, doors, windows and other glass surfaces; pure soap flakes and borax for washing clothes.

Dish washing: Use the minimum amount of detergent needed to clean plates, glasses and silverware satisfactorily. Choose a non-phosphate automatic dishwashing detergent.

Garbage disposals: They're noisy, use a lot of water and electricity, and increase the amount of waste in the water going to the wastewater treatment plant or your sewage system. Compost your kitchen waste and use it to mulch yard plants and hold moisture in the soil. For more ideas, look for the pamphlet "Better Homes and Groundwater" (publication number DG-070-2004) on the DNR website at: dnr.wi.gov/org/water/dwg/gw/ and select "publications."

Take care of your onsite sewage system

Even a properly sited, permitted, constructed and maintained onsite sewage system can pollute groundwater, especially if the soil is highly permeable or the water table is close to the surface. You can keep your system in good working order by following these four tips:

1. Be cautious about what you put in. Ordinary amounts of bleaches, lye, soaps and detergents will not harm the system, but household chemicals like paint thinner, drain cleaner, solvents, gasoline, oil and pesticides should NEVER go into an onsite sewage system. Once released in the absorption field, these toxic products can leach into groundwater.

Never flush bones, coffee grounds, vegetable peelings, fruit rinds, disposable diapers, sanitary napkins, tampons, bath oils, cigarette butts or other materials that do not break down easily into a septic tank. Avoid dumping grease down the drain. It can build up in the tank and clog the inlet or the soil absorption field.

2. Have your onsite sewage system inspected once a year. A licensed septage hauler can measure the level of scum and sludge that has built up. The tank should be pumped when the sludge and scum occupy one-third of the tank's liquid capacity. NEVER go into a sewage tank — it may be full of toxic gases. Hire only licensed septic tank haulers to clean out your tank. They should pump through the manhole, inspect inlet and outlet baffles for damage, and service any outlet filters that may be installed. County sanitarians will have the names of licensed septage haulers in your area.

3. There are no known chemicals, yeasts, bacterial preparations, enzymes or other additives for sewage tanks that will eliminate the need for periodic cleaning.

4. Go easy on your system. Don't do more than three loads of laundry per day (a dishwasher cycle equals one load). Minimize garbage disposal use.

Properly locate and construct wells

Wells can be safe, dependable sources of water if sited wisely and built correctly. Here are five points to remember:

1. Ask questions if you plan to drill a new well or intend to purchase property with an existing well. Talk to your neighbors: Do they have any problems with their wells? How deep are wells in the area? Were there contaminated wells in the area? How was the contamination taken care of? How was the land where you want to drill the well used in the past? What is its **Wisconsin Unique Well Number**?

Talk to local government officials: What laws govern private water supplies? Are housing densities low enough to ensure enough water for everyone's needs? Are there zoning restrictions limiting certain types of land use? What current land and water uses — irrigation, a quarry — in the area might affect your water quality or quantity?

2. Consult the Wisconsin Well Code. Established in 1936, the Wisconsin Well Code is administered by the Department of Natural Resources, which sets standards for well construc-

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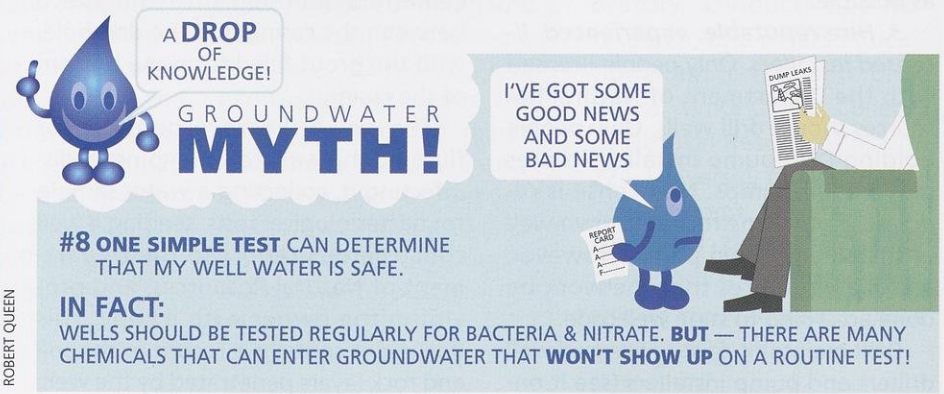
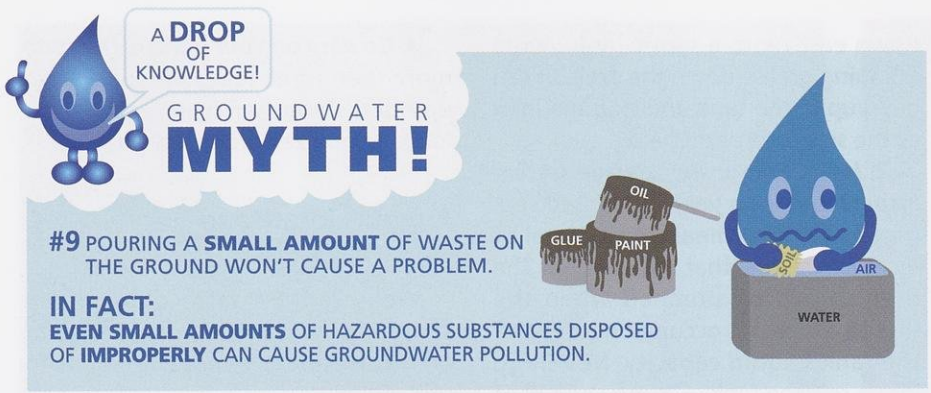
Teach children early to build lifelong habits that protect resources. (left) A school project shows how food wastes, leaves and grass settle down into rich compost. (below left) A lot of household grime can be cleaned up with less toxic products.





DNR PHOTO

DNR maintains a list of licensed well drillers and pump installers.

tion. The code lists the distances required between the well and sewage drain fields or dry wells, sewer lines, farm feedlots, animal yards, manure pits, buried fuel tanks, fertilizer and pesticide storage sites, lakes, streams, sludge disposal and other potential contamination sources. Wells should always be located up the groundwater gradient and as far from these potential sources of contamination as possible.

3. Hire reputable, experienced, licensed installers. Only people licensed with the Department of Natural Resources should drill wells. Only people holding DNR pump installer licenses may install pumps. No license is required if you construct your own well or install your own pump. However, state law requires that the work be done according to state well code.

DNR maintains a list of licensed well drillers and pump installers (see it online at dnr.wi.gov/permitprimer/water/pumps/). Be cautious of very low bids that appear, in comparison to others, to have a low per bag grout cost, or no grout listed. Make sure the successful bidder knows that notification is required as part of the contract to drill the well. Ask to be notified before grouting, and be at the site when the well is grouted. While the grouting is taking place, watch to ensure the cement is pumped into the space between the casing and the drill hole, with the grout filled from the bottom of the casing.

The well driller is responsible for flushing the well, test pumping it, disinfecting it, collecting a water sample for bacteriological tests, sending a well constructor's report to the Department of Natural Resources, and providing the owner with a copy. This document contains a record of the soil and rock layers penetrated by the well; lists the work performed and materials used; and the unique well number assigned to your well so the DNR can keep a record over time of your well water quality. This is important information to have if your well is ever contaminated. Reports collected over time in an area give researchers an idea of what's going on underground.

A pump installer, if different from the driller, must disinfect the well and collect a water sample to check for bacteria.

4. How often should I have my well tested? Annually test your well for bacteria and nitrate, and again at any time a change in odor, taste, color or clarity causes you to suspect contamination. Check for nitrate when infants or pregnant women use the water. (See page 30, "How safe is my drinking water?")

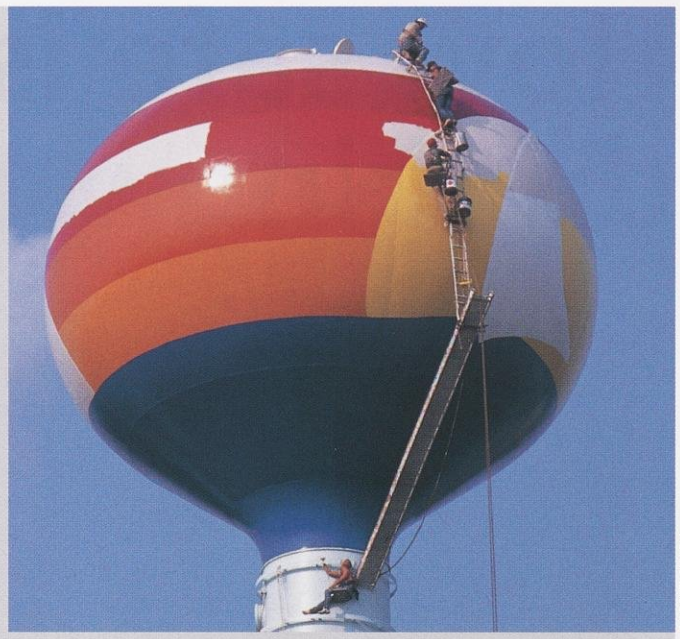
5. How do I fill in an old unused well? Fill and seal unused wells with concrete or bentonite, a type of clay. Licensed well drillers or pump installers can help you close off the old well to prevent groundwater pollution. For a copy of the pamphlet "Well Abandonment" (publication number DG-016-2001) go to dnr.wi.gov/org/water/dwg/gw/ and select "publications."

What else can you do?

Report illegal or abandoned waste sites. Call (800) 943-0003.

Keep up with local land use and waste disposal issues. Housing, commercial development, highway construction and landfills may have an adverse effect on groundwater quality if not carefully planned and constructed. City, town or county governments may need to institute zoning regulations or prohibit or restrict activities that could endanger groundwater. Find out what the land use issues are in your community and encourage your neighbors to do the same. Attend community meetings and let your elected officials and utility operators know provisions to protect groundwater must be the first step in any local land use or waste disposal proposal.

Where can I get answers to my questions about groundwater?



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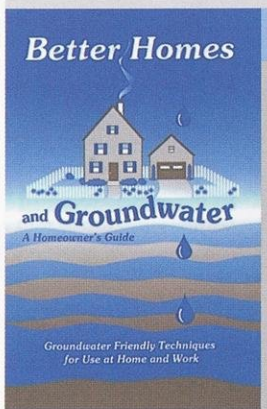
Public water system owners face many distinct challenges in managing a public water supply, among them, providing adequate supplies to all users, preventing contamination, and planning for a system's future needs.

1. **The DNR website** at dnr.wi.gov/org/water/dwg/gw/ provides answers to many groundwater questions. Need more information? Contact the DNR regional office or service center nearest you. Visit dnr.wi.gov/org/caer/cs/ServiceCenter/locations.htm for a complete list.
2. **The Wisconsin Geological and Natural History Survey** has maps, well construction reports and other information on aquifers and geology. For a list of WGNHS publications, write Wisconsin Geological and Natural History Survey, 3817 Mineral Point Rd., Madison, WI 53705-5121. (608) 262-1705. Visit the survey's website at www.uwex.edu/wgnhs/
3. **Your county University of Wisconsin-Extension office** can help plan safe, functional farmyards and rural homes. Call or write your extension office for booklets on safe drinking water, groundwater protection, best management practices for pesticide and fertilizer use and other topics. Look for the address and phone number under the "county" listing in the phone book white pages, or visit www.uwex.edu/
4. **The Department of Commerce** has the details on proper onsite sewage system operation. Write Department of Commerce, Division of Safety and Buildings, 201 W. Washington Ave., P.O. Box 7969, Madison, WI 53707-7969 and ask for publication SBD-7009, "Is the grass greener over your septic system?" Visit their website at www.commerce.state.wi.us/
5. **The Department of Agriculture, Trade and Consumer Protection** offers information on best management practices and Clean Sweep Program for farms and atrazine prohibition areas. Write DATCP, 2811 Agriculture Dr., Madison, WI 53708-8911. (608) 224-5002. On the web: datcp.state.wi.us/index.jsp
6. **The Central Wisconsin Groundwater Center** is a clearinghouse for information on groundwater issues statewide, with a strong focus on Wisconsin's Central Sands area. The center maintains a database of private wells tested through the UW-Stevens Point Water and Environmental Analysis Laboratory, conducts applied research, and offers educational materials and programs. Write CWGC, College of Natural Resources Room 224, University of Wisconsin-Stevens Point, Stevens Point, WI 54481-3897. (715) 346-4270. Visit the center's website at www.uwsp.edu/cnr/gndwater

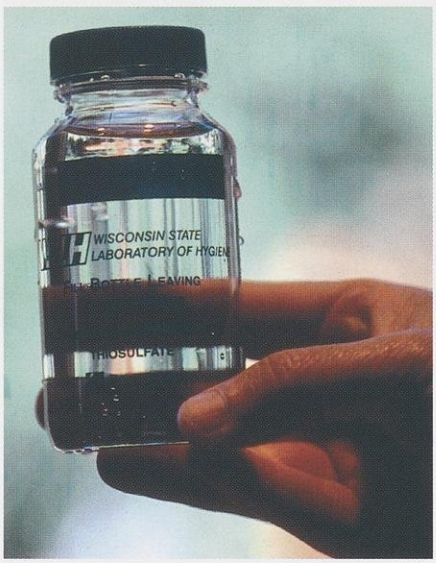


Better homes and groundwater

To request a copy of "Better Homes and Groundwater: A Homeowner's Guide," a booklet which provides groundwater friendly techniques for use at home and work, look online at the DNR website at: dnr.wi.gov/org/water/dwg/gw/ and select "publications" or call 608-266-6669 and ask for publication number PUB-DG-070-2004.

Visit the DNR website at dnr.wi.gov for more information about drinking and groundwater protection; choose "drinking and groundwater" from the drop-down program menu. Also check the UW-Extension website at cecommerce.uwex.edu and click on "water quality" under the natural resources drop-down menu.

How safe is my drinking water?



ROBERT QUEEN

Many Wisconsinites, urban and rural, are concerned about the quality of the water they drink, with good reason. Threats to a safe water supply exist everywhere, the result of our daily activities. How do you know if your water is safe to drink?

If your water is supplied by a community public water system, your water utility will mail a **Consumer Confidence Report** to you each fall. The report will include information on the source of the utility's drinking water, the treatment used to purify water, any contaminants that have been found in drinking water, and the potential health effects of those contaminants. Reports will also identify where additional information about the water supply can be found and how citizens can become involved in protecting water sources. Utilities must annually provide updated reports for their consumers.

Private well owners should have their wells tested periodically. Private laboratories do tests for chemical contaminants, such as volatile organic compounds or pesticides. Check the Yellow Pages under "laboratories" or "water analysis" or check the website dnr.wi.gov/org/es/science/lc/INFO/Lablists.htm for a certified lab in your area. Cost ranges from $30 to $1,000 depending on the number and type of chemicals analyzed and the test methods.

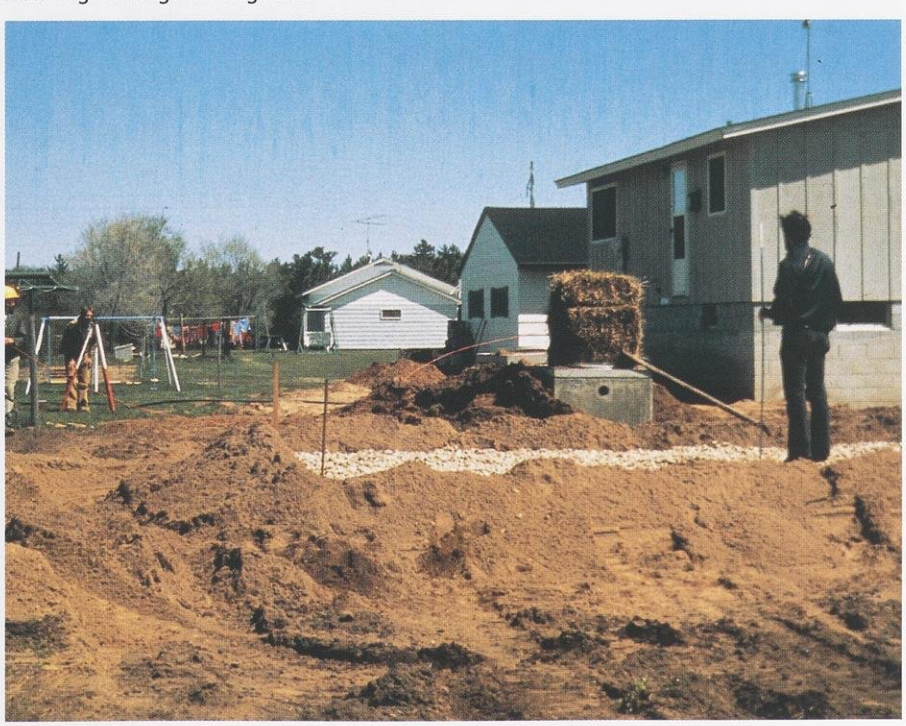
For a small fee, the State Laboratory of Hygiene will test your drinking water for several pollutants including bacteria, nitrate or fluoride. For a test kit, call the lab at (800) 442-4618 or write the State Laboratory of Hygiene, Environmental Health Division, 2601 Agriculture Dr., P.O. Box 7996, Madison, WI 53707-7996. Private labs will also do these tests.

Wells can be disinfected by displacing all the water in the well with a mixture of bleach (containing at least five percent chlorine) and water or by dropping chlorine tablets or powder down the well. Contact the DNR Bureau of Drinking Water and Groundwater, at P.O. Box 7921, Madison, WI 53707-7921 or call (608) 266-6669 for literature on private well operation.

If high nitrate is the problem, the well construction and location should be checked.

Wells can sometimes be deepened to get past contamination. Inadequate well installations may be upgraded. Wells located in pits, for example can be extended above ground and the pit filled in. These are costly options, however; it's best to have the work done properly in the beginning to avoid problems later. Your DNR private water supply specialist can give you advice on obtaining a safe

Installing a sewage drainage field.



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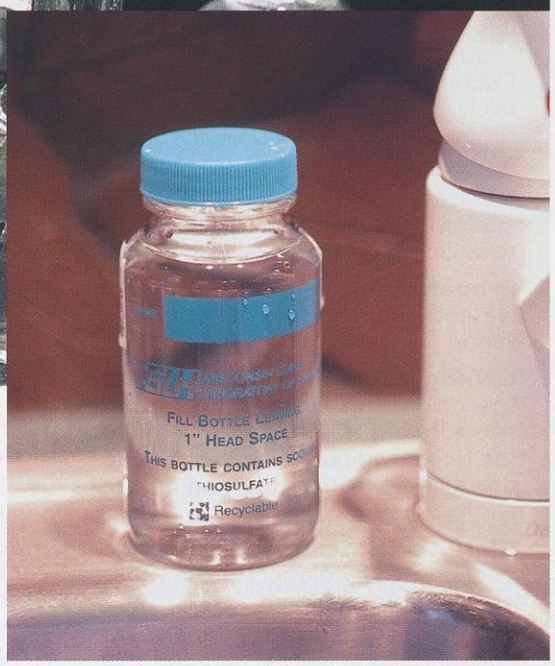

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Both private labs and the State Lab of Hygiene analyze well water samples.

drinking water supply.

If your water utility or a lab test alerts you to the presence of high levels of chemicals in your drinking water, you may be advised to drink bottled water or drill a new well. But what about low levels of contaminants? Will small quantities of benzene, a major component of gasoline, or perchloroethylene, a chemical used in dry-cleaning solvents, make your water undrinkable?

The answer is, No. That's not to say, however, that the water is totally safe to drink. For instance, the Environmental Protection Agency estimates that one part per billion of perchloroethylene in drinking water could lead to one or two additional cases of cancer in a population of one million people who drink such water over a 70-year lifetime.

Drinking water contamination, even at very low levels, should not be taken lightly, nor should the risks be exaggerated. To keep the risk of contamination as low as possible, public agencies and private citizens must continue to make tough decisions on what's worth the risk and what's not.

groundwater glossary

Aquifer: A rock or soil layer capable of storing, transmitting and yielding water to wells.

Baseflow: That part of stream discharge from groundwater seeping into the stream.

Consumer Confidence Report: A report, required under the amendments to the Safe Drinking Water Act, which lists contaminants found in community public well water systems, water treatment methods, devices used and potential health effects.

Discharge area: An area in which groundwater reaches the surface. Examples are springs, seeps, lakes or rivers, or by evaporation and transpiration.

Dolomite: Calcium magnesium carbonate, a common rock-forming mineral. Many rocks in Wisconsin referred to as limestone are actually dolomite.

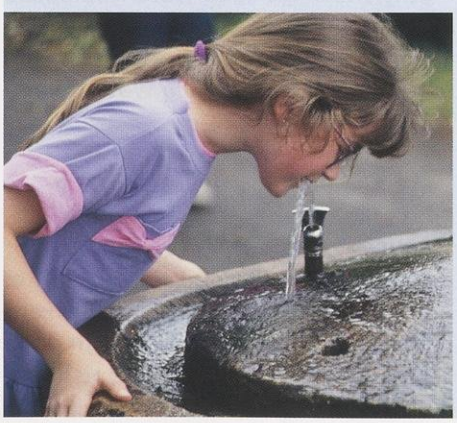
Evaporation: The process by which water is changed from a liquid into vapor.

Geology: The science dealing with the origin, history, materials and structure of the earth, together with the forces and processes operating to produce change within and on the earth.

Glacial drift: Sediment transported or deposited by glaciers or the water melting from a glacier.

Gross alpha activity: Decay of radionuclides in natural deposits. Can be either radium or uranium.

Groundwater: Water beneath the surface of the ground in a saturated zone.



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Hydrogeology: The study of groundwater and its relationship to the geologic environment.

Hydrologic cycle: The complete cycle through which water passes from the atmosphere to the earth and back to the atmosphere.

Hydrology: The science encompassing the behavior of water as it occurs in the atmosphere, on the land surface and underground.

Impermeable: Having a texture that does not permit water to move through quickly.

Infiltration: The movement of water into and through a soil.

Leachate: A liquid formed by water percolating through soluble waste material. Leachate from a landfill has a high content of organic substances and dissolved minerals.

Limestone: A sedimentary rock consisting chiefly of the mineral calcite (calcium carbonate).

Municipal well: A well, owned and operated by a municipality, serving more than 25 people for at least 60 days of the year.

Nutrients: Compounds of nitrogen, phosphorus and potassium that promote plant growth.

Onsite sewage system: Used to treat household sewage and wastewater by allowing the solids to decompose and settle in a tank, then letting the liquid be absorbed by the soil in a drainage field.

Permeability: The capacity of rock or soil to transmit a fluid, usually water.

Pesticides: A general term for insecticides, herbicides and fungicides.

Private well: A well serving one home maintained by the owner.

Radionuclides: Any manmade or natural element that emits radiation in the form of alpha or beta particles or as gamma rays.

Recharge area: An area in which water infiltrates and moves downward into the saturated zone of an aquifer.

Runoff: Precipitation not absorbed by the soil.

Saturated zone: The part of a water-bearing layer of rock or soil in which all spaces, large or small, are filled with water.

Sludge: Sediment remaining after wastewater has been treated.

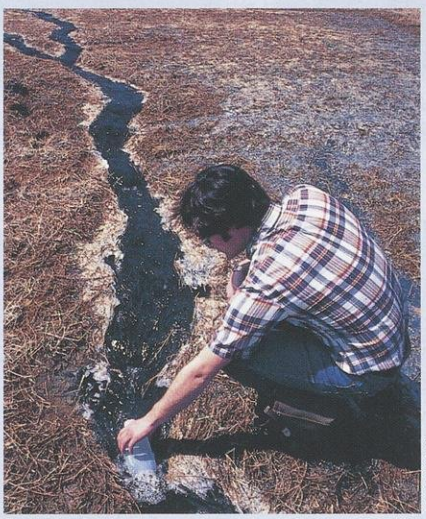
Spring: A flow or natural discharge of groundwater at the surface.

Transpiration: The process by which plants give off water vapor through their leaves.

Volatile Organic Compounds: A group of common industrial and household chemicals that evaporate or volatilize when exposed to air. Includes gasoline and solvents.

Water table: The level below which the soil or rock is saturated with water, sometimes referred to as the upper surface of the saturated zone.

Watershed: The land area from which surface runoff drains into a stream system.



DNR PHOTO

Well: A vertical excavation that taps an underground liquid-bearing rock formation. In Wisconsin, wells are drilled to obtain water, to monitor the quality of groundwater, or to determine the depth of the water table.

Wisconsin Unique Well Number: A number assigned to individual wells, which allows state agencies and the public to track groundwater quality through time. New wells drilled since January 1, 1988 are assigned unique well numbers.

Many window collision victims, like this Blackburnian warbler, are small and easily overlooked if they fall on the ground beneath windows or behind shrubbery.

SCOTT DIEHL

Threshold of *pane*

SCOTT DIEHL

ABOVE: This white-throated sparrow is one of the lucky ones. It was rescued by a Wings volunteer, rehabilitated and released. LEFT: Covering picture windows where birds habitually crash with plastic or metal screening can soften the blow and reduce fatal collisions.

ROY LUKES

William Mueller and Scott Diehl

It had been a rough winter for the wood thrush on her wintering grounds in Brazil. The lowland forest where she spent the last few winters had been cleared and was smoldering when she arrived last November.

She's had a difficult spring migration journey north to Wisconsin, too. When she arrived on the Texas coastline, thin and exhausted from crossing the Gulf of Mexico, the beachfront habitat she relied on for food, fresh water and rest was dotted with beachfront condos and radio towers. In Illinois, she narrowly escaped a hungry sharp-shinned hawk, also on its way north.

She was almost home. She had been flying at an altitude of over 1,000 feet for hours. As the first blush of dawn painted the eastern horizon, familiar shapes of the wooded hills and valleys of Wisconsin were revealed in the growing light. She began to descend, dropping down to face yet another grave danger…a landscape turned deadly, reflected in countless panels of plate glass.

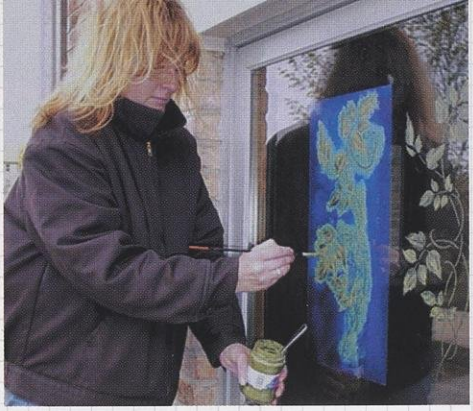
Birds already run a gauntlet of dangers going about the daily business of searching for food, establishing and defending territories, nesting and raising young, or migrating to and from their wintering grounds. Adverse weather and predators are obvious threats in their natural surroundings, but additional manmade hazards kill immense numbers of birds. At the top of this list? Collisions with glass windows.

Daniel Klem, professor at Muhlenberg College in Allentown, Pennsylvania, has studied bird/window collisions for years. Extrapolating his research results, Klem estimates that between 100 million and one billion birds of at least 225 species are killed by collisions with windows each year in North America alone. The numbers seem shocking for an event few of us see very often and rarely find first-hand evidence of. Birds killed following window collisions are quickly picked up by scavengers or may fall behind shrubs and other landscape plantings around homes or businesses where we don't notice them.

In the daytime, birds see the sky and landscape reflected in windows or they may see completely through a building where two windows line up. They do not realize that they cannot fly through these invisible obstructions. During spring and fall migration periods, the problem doesn't end when the sun goes down. Most of North America's songbirds migrate at night using the stars as navigational aids. These birds can be attracted to lighted buildings, especially tall ones, like moths to a flame on their migratory path. Birds can collide with lighted window panes or, captivated by bright exterior lighting, will circle a building until exhaustion overtakes them. Confused and severely weakened, they drop to the streets and sidewalks below where they are at great risk of predation, accidents with vehicles, and collisions with reflections in low-level glass. Whether daytime or nighttime, one of every two bird collisions is fatal, and injured birds are often scavenged by gulls, crows, raccoons, cats or other predators.

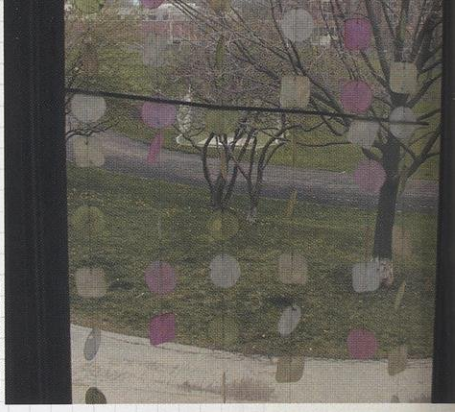
Preventing such collisions is a focus for a small group of private organizations and governmental agencies. The Humane Society's Wisconsin Night Guardians for Songbirds (WIngs), aims to educate the public about this threat, find and rehabilitate injured birds, and work with building owners and tenants to reduce collisions with windows. WIngs is patterned after similar pioneering programs in Toronto (FLAP, Fatal Light Awareness Program) and Chicago (the Chicago Bird Collision Monitors).

Launched in the spring of 2005, WIngs staff works with owners, managers and tenants of Milwaukee's tallest buildings to make their buildings safer for migrating birds. Volunteers also search city streets in the pre-dawn hours for stunned, injured and dead birds. It takes a hardy, dedicated lot to patrol around tall downtown office buildings as early as 4:30 a.m. during spring migration to find birds before scavengers get them. Live birds are gently captured and transported to the Wisconsin Humane Society's (WHS) Wildlife Rehabilitation Center at 45th and Wisconsin Avenues in Milwaukee. Dead birds are collected and transported either to the humane society or the Urban Ecology Center. Both centers are keeping records of the species found, specific locations and times each bird is found, and prevailing weather conditions. In compiling data, WIngs hopes to identify problem buildings and better recognize weather conditions that may increase the likelihood of window collisions. Collecting information in a consistent manner from WIngs, FLAP and the Chicago Bird Collision Monitors programs will make it easier to combine results into a single database to increase our collective knowledge about window collisions.



JENNIFER GOYETTE

Simple do-it-yourself projects can provide birds with warnings about windows. At Milwaukee's Urban Ecology Center attractive designs are stenciled with a "frosted" window solution to break up reflections on the outside surface of glass panes.



WILLIAM MUELLER

The Urban Ecology Center tests other solutions by hanging colorful acrylic discs on fishing line that turn and twist in the breeze alerting birds. Old CDs would work, too.

BETSY ABERT

This homeowner covered "accident prone" windows with plastic netting often used to protect fruit trees or other garden plants.

ROY LUKES

Wild turkey wing feathers attached by strings to the window frames flutter in even light winds acting as sca devices.

Attending to the injured

Injured birds arriving at the WHS Wildlife Rehabilitation Center are each placed in a warm, dark, quiet container and allowed to rest for 30 to 60 minutes. Handling birds too soon can lead to excessive stress that can kill them. Thereafter trained staff examine each bird, identify injuries, administer first aid and start treatment. Common injuries following window collisions include concussions and other head injuries, eye traumas, fractured bills and broken bones, especially the delicate bones in the bird's chest: the coracoids and furcula (the wishbone). These bones help support the bird's shoulder structure and when fractured, the bird cannot fly. The staff uses special splinting and stabilizing techniques to give the fractures a chance to heal. Birds are initially housed in small, quiet habitats, with a minimum of exposure to humans so they can rest, eat and recuperate. An injured bird may stay in the rehab center a few days to several weeks, depending on its injuries. Once injuries are healed, each bird is evaluated for fitness. Some birds may need additional exercise in a large aviary, or even physical therapy before they are ready to go. When ready for release, southward migrating birds are transported south of the city, northbound birds are released north of town.

Clear solutions

Last year's International Migratory Bird Day (observed the second Saturday each May) featured the theme "Clear the Way for Birds!" and included handouts describing practical solutions for reducing bird collisions. The problem can only really be solved one window at a time. There are a variety of options: some simple and inexpensive, others more complex and costly, but all windows don't have to be treated the same.

On private homes and in low-rise apartment buildings, installing simple mesh or screen barriers on the outside of windows that have been a problem helps in two ways: screens cut down on reflections birds see in the windows, and they provide a relatively soft cushioning barrier between the bird and the window that helps prevent injuries. Many new window installations and retrofits come equipped with full length or full width fiberglass screens on the outside. If your home has older aluminum triple-track windows, the screens typically cover only half of the window, leaving one pane still uncovered. You can cover the wooden frame outside the edge of that pane with screening or finer-mesh plastic

chicken wire that's available at most hardware stores. The mesh can be stapled in place outside the window if those windows can be opened from the inside for cleaning.

Roy and Charlotte Lukes of Baileys Harbor have gone a step further, installing mesh covering the large picture windows on their home. In addition, they fashioned strings with large turkey wing feathers and fastened them to the upper edge of some windows where they have observed bird collisions in the past. Any breeze sets these "feather-mobiles" in motion, hopefully letting nearby birds know not to venture too close.

For a more finished look over larger, extensive sets of windows, one can purchase commercially-produced "bird screens" that are placed in frames over the windows. Such a set was installed at the Rowe Sanctuary, an environmental education building in Gibbon, Nebraska. These screens can be removed during seasons where fewer birds are present, but if bird feeders are stocked year-round, window treatments should be left up all year too.

Another way to largely eliminate reflections from the outside of windows is to apply specially-made films, such as a product called CollidEscape. These films adhere easily and last for years without obscuring the view from inside. The films can be pretty readily removed, even years later if necessary.

Professor Klem and his colleagues have also found that where bird feeders are placed affects the numbers and severity of window collisions. Feeders placed nearer than three feet from windows or farther away than 30 feet substantially reduce fatal bird collisions. The middle zone between those distances is much more dangerous for birds.

Other simple techniques can prevent or substantially lower the frequency of collisions. Moving house plants farther from windows can reduce visual confusion. Though houseplants need natural light, birds sometimes think they can perch on these plants, unaware that there is a pane of glass between them and the landing site. Stenciled designs or decals applied to the outside of windows can be nearly as useful as screens or other barriers, if they are of sufficient size and number. Falcon silhouettes placed widely apart are largely ineffective: silhouettes and other designs need to be placed no more than the width of a hand apart to provide an effective visual warning for small birds. At the Urban Ecology Center in Milwaukee, staff and volunteers have created a display of a variety of methods of treating windows to prevent or limit collisions. The WIngs website has a gallery showing a variety of window treatments designed to reduce/prevent bird collisions.

You can also find directions for crafting temporary frosted pane window stencils at the FLAP program website. Stencils are also available at home remodeling centers and craft shops. Directions for temporary window "frosting" are available at www.hgtv.com/hgtv/rm_kitchen_bath_other/article/0,,_HGTV_3748_1380895.00.html.

More extensive modifications may be more practical for new commercial construction rather than retrofits, including installing window glass at angles of 20 degrees or more, tilted outward at the top. Experiments show that angling glass downward is particularly effective at reducing collisions. Experiments with new types of window glass are also being conducted. Some new glass has a series of frosted "dots" on the outside that are barely visible inside yet eliminate reflections. Others are experimenting with ultraviolet coatings visible to birds but not to people. Perhaps "bird-friendly" glass will one day be standard for new construction and replacement windows.

A Birds & Buildings Forum held in Chicago last spring hosted a symposium on windows and building design. The forum, a small Chicago-based nonprofit group, encourages architects and design professionals to develop and build bird-safe windows and glass walls. The conference discussed window features that attract and kill birds. Although targeted for Illinois and Wisconsin architects, the event attracted attendees from as far as Atlanta, Seattle and Edmonton, Alberta. Sponsors included Chicago architecture schools, three architecture professional associations and the City of Chicago. The forum also provides information that can be incorporated in university courses so architecture students can learn about bird-safe designs as part of green architectural projects, said Randi Doeker of the forum.

Whether you are a homeowner, renter or small business operator, simple techniques offer economical options to retrofit windows or install simple screen barriers, window treatments, films and stenciling to reduce bird collisions. Placing bird feeders carefully and supporting community educational programs like the Wisconsin Humane Society's WIngs program, can also help us prevent injuries and save many more of the birds we cherish.

William Mueller chairs the Conservation Committee for the Wisconsin Society for Ornithology and the Issues Committee for the Wisconsin Bird Conservation Initiative. Scott Diehl manages the Wisconsin Humane Society's Wildlife Rehabilitation Center in Milwaukee.

STORY CONTACTS

- The Wisconsin Humane Society's WIngs program: www.wihumane.org/wildlife/wings/default.aspx. Bird screens and CollidEscape are available for purchase through the society online or at their shelter
- Fatal Light Awareness Program: www.flap.org
- American Bird Conservancy's "Windows: A Human Hazard for Birds": www.abcbirds.org/birdconservationalliance/members/window_paper.PDF
- U.S. Fish and Wildlife Service information about birds and collisions: www.fws.gov/birds/documents/Collisions.pdf and www.fws.gov/birds/documents/Glass.pdf
- The Bird Conservation Network's "Window Kills": www.bcnbirds.org/window.html
- The Birds & Buildings Forum: www.birdsandbuildings.org/index1024.html
- Laura Erickson's windows page on her "Birder's Blog" at: www.birderblog.com/bird/Conservation/Part1/05-Windows.html
- Links to other collision sources at the Wisconsin Bird Conservation Initiative's "Issues Papers" page: www.wisconsinbirds.org/IssuesPapers.htm
- Chicago Bird Collision Monitors: www.birdmonitors.net/
- Urban Ecology Center: www.urbanecologycenter.org/.

Early signals

DNR communications staff

The long and the short of it. Fisheries biologists estimate the perch population and vigor at every phase of their life from eggs through adult in many locations of Lake Michigan and Green Bay. These are typical sizes for young of the year, yearling and adult fish sampled annually.

MATT MANGAN

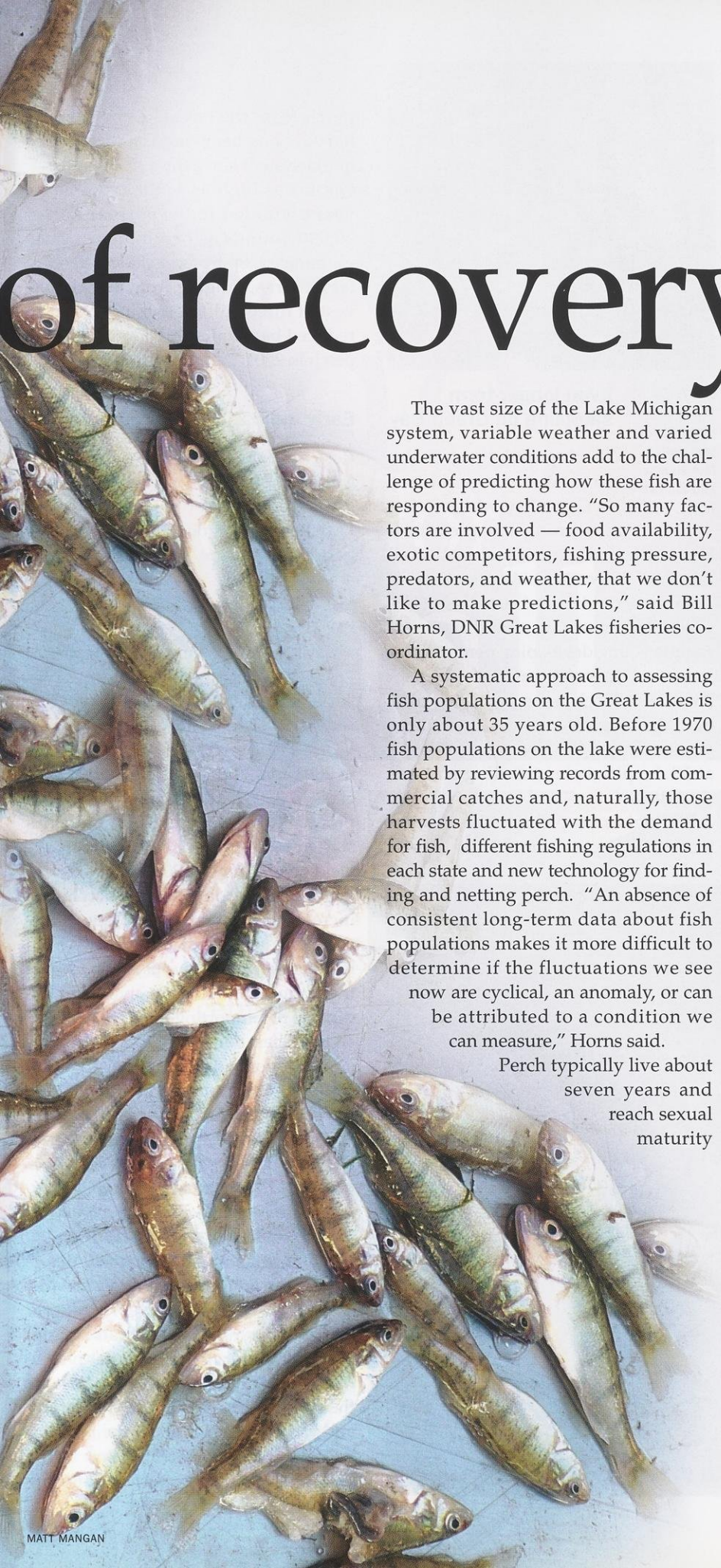
Are yellow perch inching back from a 15-year decline?

Fisheries biologists are cautiously optimistic that yellow perch in Green Bay and southern Lake Michigan are showing early signs of recovery from a sustained 15-year population decline.

Several survey techniques biologists employ to track perch throughout their development from eggs through adult size indicate yellow perch may be at the beginning of a slow comeback. More sampling and surveys will determine if these prized fish are recovering lakewide or if the populations are primarily making a comeback in smaller areas.

Teams of biologists, operations crews and university researchers continue to study perch, follow their progress and take steps to enhance their populations.

# of recovery?

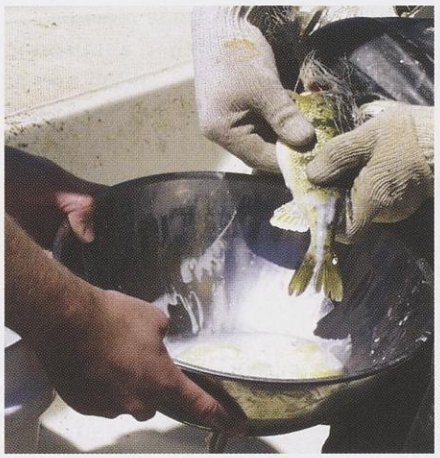


MATT MANGAN

The vast size of the Lake Michigan system, variable weather and varied underwater conditions add to the challenge of predicting how these fish are responding to change. "So many factors are involved — food availability, exotic competitors, fishing pressure, predators, and weather, that we don't like to make predictions," said Bill Horns, DNR Great Lakes fisheries coordinator.

A systematic approach to assessing fish populations on the Great Lakes is only about 35 years old. Before 1970 fish populations on the lake were estimated by reviewing records from commercial catches and, naturally, those harvests fluctuated with the demand for fish, different fishing regulations in each state and new technology for finding and netting perch. "An absence of consistent long-term data about fish populations makes it more difficult to determine if the fluctuations we see now are cyclical, an anomaly, or can be attributed to a condition we can measure," Horns said.

Perch typically live about seven years and reach sexual maturity at two to three years in Green Bay, three to four years in Lake Michigan. Commercial catches (which have been closed for 10 years) and an annual creel survey from sport anglers provide information about the adult perch population, but the fish are much more vulnerable to predation and the elements as fry, larvae and fingerlings than as adults. To assess population trends, biologists routinely sample perch at several stages in their development.



TOM BURZYNSKI

Perch milt and eggs are also collected to assess fish genetics that might help explain why perch population growth remains slow.

Frequent sampling during their first years in Lake Michigan

During the spawning season, typically early to mid-June, divers traveling on the research vessel *Perca* examine the lake bottom at traditional spawning grounds where fertilized masses of perch eggs might accumulate. Divers count the number of the accordion-like egg masses found on the rock and rubble on the lakebed. When the population is strong, divers might see as many as 50 egg masses per 300-meter

transect, in poor years, less than one. Last year they recorded 11.7 egg masses/1,000 square meters.

Similarly, adult perch are netted and sampled each spawning season to get a sense of their overall health. Biologists set a goal of examining 3,000 adult perch each year. Fish are measured and weighed. Gametes and eggs may be collected for scientific studies. A few fish are tagged and released for lakewide studies. Others are kept and tissues are analyzed for signs of contaminants.

Larval perch less than a half-inch long are sampled in fine-mesh nets at the surface to measure survival and dispersal rates after hatching.

Young of the year perch are again netted in late summer/early fall using beach seines, bottom trawlers and gill nets in at least 22 different sampling stations in the nearshore area of Lake Michigan from Kenosha north to Sheboygan.

In winter, graded mesh gill nets are set offshore near the Green Can Reef in Milwaukee to estimate the survival rates of young perch adrift in the open waters of Lake Michigan. Since the survey uses gill nets from one to three inches, we get an excellent picture of the overall yellow perch population.

TOM BURZYNSKI

ABOVE: Young of the year perch are sampled in late summer and fall every year.

Even longer-term sampling on Green Bay

Perch population studies have even a longer history in Green Bay, where spring spawning samples have been collected annually at Little Tail Point for 27 years. Seining stations at 15 sites spread over 130 miles of the Green Bay shore have served as sites to sample young developing perch during June and July for each of the past 23 years. Perch have been sampled every year in late summer at 60 trawling stations on the bay since 1978, and at 18 deeper water trawling stations since 1988.

Biologists keep close tabs on commercial netting and the sport harvest of perch from the bay. The commercial harvest has been regulated under a quota system since the 1983-84 season. Quotas as high as 475,000 pounds a year dwindled to the current low of 20,000 pounds as perch populations plummeted. Sport creels followed similar patterns, ranging from a peak harvest of three million fish in 1990-91 to reduced bag limits and a low of 52,429 perch in 2004.

Biologists net perch samples at 22 nearshore stations on Lake Michigan and more than 60 locations on Green Bay.

MATT MANGAN

Early indications of a comeback?

Results from all these sampling programs show perch populations that grew steadily in both Green Bay and Lake Michigan through the 1980s strongly declined in the '90s, with only one strong year class of perch in 1998 that grew into a strong class of adult perch in 2003.

Last summer's sampling results were more encouraging. Summer trawling surveys for yellow perch in Green Bay indicated 2005 produced another good year class, following decent year classes in 2002 and 2004 and the excellent year class in 2003. As expected, increased production over the past few years has started to improve fishing, and should yield good fishing in 2006 as well.

"Still, we recommend caution before increasing commercial and sport harvests too quickly," said Horns. "We are looking for unambiguous evidence that the young fish have survived and are capable of supporting larger harvests."

In December 2005, following fisheries recommendations, the Natural Resources Board approved a modest easing of restrictions on the perch harvest on Green Bay. Daily bag limits on Green Bay will increase from 10 to 15 yellow perch and the annual commercial harvest limit will climb from 20,000 to 60,000 pounds.

More sustained research will determine if bag limits can be eased lakewide.

"The 2005 year-class looks good in Lake Michigan too," said Brad Eggold, DNR fish supervisor for southern Lake Michigan. "They certainly seem to have the size to survive well over the winter and we're optimistic about their continued survival and contribution to the Lake Michigan fishery in the future."

Small for one, and one for small

Small mammals like the masked shrew are both prey and predator in the food chain. Ecologists can monitor small mammal populations as indicators of a healthy environment. For instance this shrew prefers moist woodlands, leaf litter, decaying logs, thickets, bogs and marshy areas over drier upland areas.

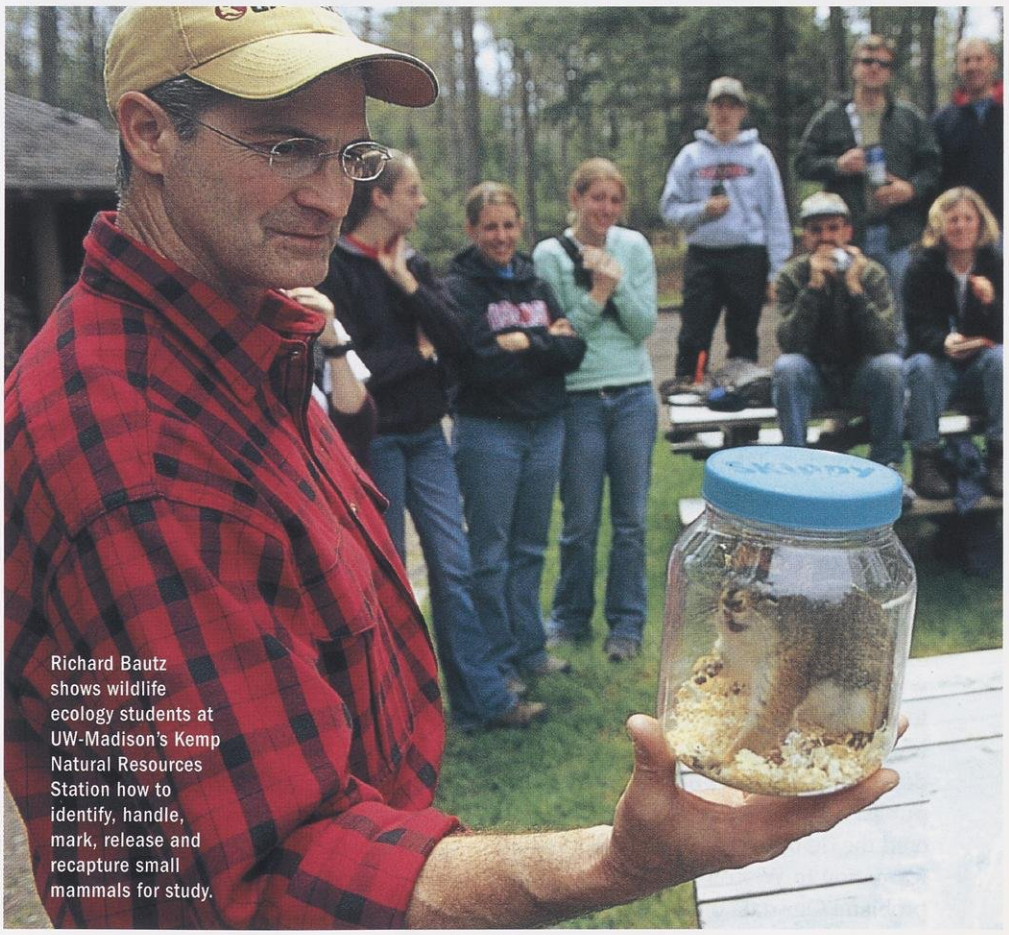
LOREN AYERS

Researchers champion the cause of the little mammals and strive to bring population studies into the 21st century.

Kathryn A. Kahler

Their names conjure up diminutive pictures in the mind's eye — least shrew, pygmy shrew, least chipmunk, pocket gopher. But these tiny creatures play an important role in the bigger scheme of things. They are part of the biodiversity we strive to protect and the web of life in which we are entwined.

Small mammals serve as a forage base for larger carnivores like coyotes, foxes or birds of prey. Insectivores like shrews and moles help control insects. Small mammals disperse seeds stuck to their fur, carried in their droppings or cached in winter stores. The tiny tunnels created by burrowing mammals help aerate soil



Richard Bautz shows wildlife ecology students at UW-Madison's Kemp Natural Resources Station how to identify, handle, mark, release and recapture small mammals for study.

ROBERT QUEEN

and allow water to percolate through, making a more suitable place for seeds to take root. Small mammal waste deposited in burrows fertilizes plant roots. Burrows also provide underground nesting sites for important pollinating insects such as bumblebees.

Ecologists monitor small mammal populations as environmental indicators of changing landscapes. Tracking fluctuations in the number of animals and the distribution of species helps assess the effects of agriculture, development, forest management, and other human activities on natural habitats. For instance, the red-backed vole prefers cool, moist, closed-canopy forests with plenty of large woody debris. By studying how these small mammals respond to forest harvesting and succession, foresters can determine whether red-backed voles can be used as indicators of forest sustainability.

Despite their importance, small mammals receive scant attention from the Department of Natural Resources and other research agencies. Mostly it's an issue of numbers: Following a single wolf pack of six, eight or even 15 members is easier than keeping tabs on a dispersed population of pocket gophers. But soon, thanks to the efforts of two Wisconsin ecologists, small mammals may receive more priority in research activities.

The big book of little creatures

Loren Ayers, an ecologist with DNR's Bureau of Endangered Resources, believes much can be learned from small mammal surveys and inventories. When it comes to funding projects, though, these mammals aren't just small — they're invisible.

"How does DNR use small mammal information in land management? We don't," says Ayers. "There are exceptions. We are working to improve the situation, and right now, we're focusing on infrastructure."

The "infrastructure" Ayers refers to will provide the means and information to update *Mammals of Wisconsin* by Hartley H. T. Jackson. Based on field work done from the early 1900s to 1952, and published in 1961, the book is still considered the definitive source of mammal information in Wisconsin. Therein lies the problem: Our data on the range, population and locations of small mammals is outdated.

RICHARD BAUTZ

Bautz designed a squeeze box for live traps so mammals like squirrels can be safely restrained, ear-tagged and released without injury.

RICHARD BAUTZ

The northern (woodland) jumping mouse moves on all fours but can hop 1-2 feet high in 2-3 foot bounds on its hind legs to escape predators.

"The primary purpose of most of our small mammal work right now is to update Jackson's *Mammals of Wisconsin*," says Ayers. "We're gathering information, trying to learn and get up to date about what's out there."

Determining what's out there can be done in several ways. Some of the specimens Jackson studied in his original research came from examining small mammal skulls found in owl pellets, the indigestible portion of an owl's diet that it regurgitates in a compact mass. Most often, however, researchers survey small mammal populations by setting up traplines.

"One or two people can't come close to inventorying all the small mammals in Wisconsin," Ayers observes. "So we train wildlife biologists and others who have an interest in small mammals, provide them with equipment and reimburse their travel expenses for doing inventories."

Ayers and Richard Bautz, a small mammal expert under contract with the Department of Natural Resources, have trained DNR wildlife biologists, student interns, U.S. Forest Service personnel, members of the Great Lakes Fish and Wildlife Commission, researchers from the Marshfield Clinic investigating infectious diseases, and private individuals. In exchange for training and support, the agency receives valuable information about small mammals and their distribution, habitat associations, population status and relative abundance.

Trapping to track small mammals

Both live traps and lethal traps are used to capture small mammals: live traps when researchers want to mark or tag an animal for recapture, or to survey the types of animals living in an area; lethal traps when collecting specimens to study anatomy, or to dissect to study food habits, disease or other biological factors.

A popular live trap for catching mouse-sized mammals is the Sherman box trap, made of aluminum or galvanized steel and measuring 3 by 3½ by 9 inches. Bait is placed in the back of the trap and the door is folded in, compressing a spring secured by a small latch. Lured into the trap, the animal steps on a treadle that releases the door, which snaps shut. Firm fruits or vegetables like apples or potatoes, or peanut butter mixed with oatmeal are commonly used baits.

Catching animals like rabbits, weasels and ground squirrels requires larger Sherman traps or Tomahawk traps. Tomahawks are made of wire mesh with a similar spring mechanism to trigger the door latch.

Another popular live trap is the pitfall trap. Typically made from coffee cans or plastic containers, a pitfall trap is buried so the top of the container is flush with the ground; the animal walks in and falls to the bottom. Pitfalls are most effective if placed next to fallen logs animals follow

Students learn to place their traps along logs and natural runways that small mammals travel on their journeys.

ROBERT QUEEN

as natural travel paths. If fallen logs are not available, a drift fence can be constructed of metal flashing or rigid plastic, and pitfall traps placed at either end. Animals walking through the woods bump into the drift fence and follow it into one of the traps, much in the same way fyke nets lead fish to collection nets for lake surveys.

When surveying an area for small mammals, an array of live traps works best placed near or under brush piles, along fallen logs, near burrow entrances, along streams, at bases of trees, or in hollow stumps.

Traps are shaded with plastic or sheet metal canopies to protect the captured animals from sun and precipitation. In winter, a trap must contain enough food to keep the animal alive until the trap can be checked. Shrews, for example, can eat their body weight in food every day, so they need a trap well stocked with provisions to survive. Flying squirrels are nocturnal and will need to eat if caught overnight. Nesting materials placed inside the trap, like wads of cotton, wool or leaves, help small mammals maintain body heat until they are checked and released.

Traplines are marked overhead with brightly colored plastic tape or strips of cloth so they can be located with ease. Coordinates of trap locations are mapped on a diagram or recorded using GPS equipment. Traps are checked frequently to prevent small mammals from becoming bait themselves if discovered by larger predators like raccoons, weasels or bears.

Other methods of documenting species involve setting up tracking stations and hair traps. Tracking stations can take a variety of forms. In some, an area is covered with carbon paper, graphite spray, talcum powder or another medium the animal walks through to reach the bait. White paper or sticky contact paper is laid between the graphite and the bait, and as the animal makes its way across, a pattern of tracks appears. A piece of PVC pipe placed along a known travel path or runway is another common tracking device; graphite spray at one end, sticky paper at the other, the bait in the middle.

Hair traps or tubes collect samples for lab identification. Hairs cling to double-sided tape or another sticky medium as the animal rubs against the trap trying to get the bait.

Many museums and colleges maintain collections of study skins and skeletons, usually taken by lethal trapping as research and educational aids. Snap traps like traditional mouse traps are available in different sizes. The Museum Special Trap, sized between a mouse trap and a rat trap, does not crush the animal's skull, which is often the most valuable part of the specimen for identification and subsequent museum work.

Neat little packages

Small mammals make excellent teaching specimens because they are easily caught and very convenient to work with. "What makes this group of mammals so well-suited for study," Bautz recently told a group of undergraduates in the UW-Madison Wildlife Ecology program, "is that they come in neat little packages."

Neat they are, but a little nasty, too. Trapped animals need to be handled cautiously to protect both the animal and the handler. Students were advised to wear surgical masks and gloves as a precaution against airborne viruses like hantavirus, which causes Hantavirus Pulmonary Syndrome (HPS), a respiratory disease that is fortunately rare in Wisconsin. The deer mouse *(Peromyscus maniculatus)* is the primary carrier of hantavirus and can transmit it without showing any signs of being sick. Deer mice can also carry deer ticks, the source that carries and transmits Lyme disease. Thorough hand-washing is absolutely essential after handling any wild animal, especially before eating or drinking; Bautz reminded the students to carry waterless hand cleaner for use in the field.

A nip from the tiny teeth of a mouse or shrew won't inflict much damage, but a bite from a larger, more aggressive species like the red squirrel can be serious. Wearing leather gloves provides good protection against biters. Bautz also has designed several simple devices to prevent larger animals like gray squirrels from chomping handlers. One is a "squeeze box" or modified Tomahawk trap: Bautz inserted a piece of plywood cut to the same dimensions as the trap floor. When a squirrel is inside the trap, the plywood piece is gently pushed up to restrain the animal between the wood and the top of the trap. An ear tag can be applied without touching the animal. It's less stressful for the squirrel and handlers alike.

Ensuring the animals' safety is a primary concern. Throughout the demonstration Bautz worked quickly and avoided excessive handling that might have stressed the animals. When removing an animal from a live trap, Bautz placed a plastic bag around the opening and held it tightly because these tiny creatures are adept at finding the smallest of escape routes. He then carefully released the trap door and allowed the animal to work its way into the plastic bag, grabbing the bag firmly just above the animal.

To mark an animal for recapture studies, Bautz first snipped one corner out of the plastic bag before transferring the animal from the trap. He gently worked the animal into that corner, and maneuvered its head out of the hole so it could breathe, but also be restrained safely. He then took body measurements, and put a dot of yellow paint on one ear or applied a numbered ear tag before releasing the animal.

When transferring an animal from the bag to a plastic jar or cage, Bautz gently worked it to the top of the bag, grabbed it by the scruff of the neck, then dropped it into an economy-sized peanut butter jar and quickly screwed on the lid, in which a square had been cut out and covered with wire mesh to provide air. Once in the jar, each animal was identified, measured, weighed and its sex determined. Any captured animal exhibiting signs of stress (such as panting or fatigue) or injury should immediately be released, Bautz said; red squirrels in particular are prone to stress because they are such a high-energy, aggressive species.

RICHARD BAUTZ

Recapturing animals like this 13-lined ground squirrel with an ear tag helps learn about animal ranges and habits. This seed-loving mammal is active in the daytime in short grasses but burrows underground in poor weather.

A hefty price tag for small mammal research

Ayers says expense is one reason small mammals are not studied as often as research biologists would like. One Sherman trap costs about $15 and one person can set a trapline of 100 traps per day. In 2005 museum snap traps cost $5.50, but now have gone up to $7.90. The price increase means researchers more often have to resort to using inexpensive, over-the-counter standard mouse traps, which are less effective.

"Other associated equipment can

RICHARD BAUTZ

Students record small mammals found as part of a species inventory near the Scuppernong Prairie in Waukesha County.

The southern bog lemming is mostly nocturnal, builds runways and snips grasses into even 1-3" pieces to reach the tender upper parts.

RICHARD BAUTZ

cost hundreds of dollars more," says Ayers. "A GPS unit, for example, is $300. It's an equipment and labor-intensive process."

To address the lack of funding, the small mammal research received help from the federally-funded State Wildlife Grants (SWG) program. One such grant funded a compilation of historic mammal distribution data to supplement Jackson's records with more modern data. Ayers and assistants scoured museum collections and teaching collections from colleges and universities in Wisconsin and throughout the country, reports from research projects, and other agencies such as the U.S. Fish and Wildlife Service, the USDA Forest Service and the National Park Service.

The project converted Jackson's records to electronic format and combined them with the new data to produce a mammal distribution model and predict ranges for 44 small to medium-sized mammals statewide based on vegetative cover and suitable habitat. The maps are being used to plan additional field inventories and may be useful for making land management decisions. In the future they may help wildlife teams and agency partners form State Wildlife Action Plans. These plans aim to conserve wildlife species before they become rare, while it is still economical to protect them and the habitat they need to thrive.

Ayers' program also partners actively with Wisconsin NatureMapping, a citizen monitoring project. On the website www.wisnatmap.org citizens can report wildlife observations of common, readily identifiable species, such as 13-lined ground squirrels; gray, fox and red squirrels; snowshoe hares and badgers. Nature mappers trained at the Beaver Creek Reserve in Fall Creek may also use the reports to complement their projects.

Ayers hopes a newly-funded State Wildlife Grant project will move small mammal surveying forward in a hurry. Genetics-based wildlife inventories have proven to be viable and effective alternatives to live trapping and lethal trapping, which are labor-intensive and expensive. The goal of the new $88,000 State Wildlife grant is to make DNA tissue sampling and species identification a routine option for mammal inventory, monitoring and research projects. Partners include researchers from the Marshfield Clinic Research Foundation, the U.S. Forest Service North Central Research Station, and Northland College. The project will use genetic tissue sampling when conducting field inventories of six mammals listed as "Species of Greatest Conservation Need" and 16 mammals listed as "Species with Information Needs" to see if the technique can be applied to a broader range of species. A genetic databank of 2,500 specimens will be accessible to research organizations and agencies by September 2007.

"We're hopeful this project, in conjunction with the work we're doing with our other partners, will move us down the road to a revision of *Mammals of Wisconsin*," says Ayers. "These little animals are just too important to continue to rely on 45-year-old information."

Kathryn A. Kahler is production and circulation manager for Wisconsin Natural Resources *magazine with offices in Madison.*

The short list of small mammals

The following are species most commonly considered small mammals in Wisconsin:

- arctic shrew, *Sorex arcticus*
- masked shrew, *S. cinereus*
- pygmy shrew, *S. hoyi*
- water shrew, *S. palustris*
- least shrew, *Cryptotis parva*
- northern short-tailed shrew, *Blarina brevicauda*
- eastern mole, *Scalopus aquaticus*
- star-nosed mole, *Condylura cristata*
- least chipmunk, *Tamias minimus*
- eastern chipmunk, *T. striatus*
- Franklin's ground squirrel, *Spermophilus franklinii*
- thirteen-lined ground squirrel, *S. tridecemlineatus*
- northern flying squirrel, *Glaucomys sabrinus*
- southern flying squirrel, *G. volans*
- pocket gopher, *Geomys bursarius*
- western harvest mouse, *Reithrodontomys megalotis*
- white-footed mouse, *Peromyscus leucopus*
- deer mouse, *P. maniculatus*
- southern red-backed vole, *Clethrionomys gapperi*
- prairie vole, *Microtus ochrogaster*
- meadow vole, *M. pennsylvanicus*
- southern bog lemming, *Synaptomys cooperi*
- northern (or woodland) jumping mouse, *Napaeozapus insignis*
- meadow jumping mouse, *Zapus hudsonius*
- ermine (or short-tailed weasel), *Mustela erminea*
- long-tailed weasel, *M. frenata*
- least weasel, *M. nivalis*

A burst of yellow glory

continued from page 2

Nor are marsh marigold "blossoms" true flowers. The five to nine bright yellow "petals" are really sepals, structures that in most plants are green and hang under the true petals. In this case, the sepals form a shallow cuplike flower in which 50 to 120 stamens look like a fuzzy button surrounding several female pistils. After bees and syrphid flies pollinate the blossoms, the flowers will quickly drop the sepals. Oblong purplish seeds develop follicles and the seeds drop when the follicles split open.

The marsh marigold's shiny green leaves are round, heart or kidney-shaped. Some have smooth edges and others are saw-toothed. The leaves are supported by hollow green stems that grow from eight to 24 inches high in their wet environment. Sometimes just one leaf tops a stem, but often the stems branch once or twice and an additional leaf tops each branch. The leaves are quite small when the masses of flowers put on their show, but they will continue to grow into dinner-plate sized giants once the blooms fade. Nothing dines on the leaves since they contain poisonous alkaloids.

The marsh marigold is also known by a second rather interesting common name — cowslip. Why and how the unusual name came to be is speculative. Many common names change or lose their true meaning over time. Early explorers often named "new" plants after similar-looking plants back home. Perhaps a European cowslip with yellow blossoms and large shiny leaves also grew in wet places. One similar European plant, *Primula veris*, is really a primrose, not a buttercup. Though the two plants resemble each other, they aren't related. Perhaps they grew in muddy places where cows slipped? Or perhaps the cowslip has been mispronounced all these years and the two syllables originally broke between the s and l — cow's lip instead of cowslip. The earliest recorded treatise on the history of English plants, written in 1568 in Olde English recorded the common name of *Primula veris* as oxis-lip or sometimes cowes-lippe. Over time the name may simply have slurred to cowslip.

Presently, marsh marigold is the preferred common name, yet I think cowslip has a fanciful quality about it. That gives rise to one final question: Have you ever seen a cowslip under the fence? What does that really mean? Find your own answer on a spring walk.

Anita Carpenter hikes near her Oshkosh home with a field guide in one pocket and a dictionary in the other.

READERS write

COMMENT ON A STORY?

Send your letters to: Readers Write, WNR magazine, P.O. Box 7921, Madison, WI 53707 or e-mail letters to david.sperling@dnr.state.wi.us

SNOWY SIGHTING IN MILWAUKEE

Last November 21, while driving home in Milwaukee, I was surprised to see a snowy owl perched on a light pole at 16th and Walnut. I walked close to the light pole and noticed how the bird turned its head and watched me — very intimidating. What an impressive bird! Your article on snowy owls ("A hunter in winter white," December 1997) was informative.

Kristine Rosalez
Milwaukee

It isn't unusual for snowy owls to migrate to Wisconsin or farther south in search of food when their Arctic food supply becomes scarce. A recent Stevens Point Journal *story quoted UW-Madison wildlife ecologist Stan Temple who said snowies will stay in Wisconsin "as long as the food supply remains steady before traveling back north sometime in February or March." The paper reported a number of owls had made their way to central Wisconsin last winter, but many did not survive the trip because northern food supplies are unusually low and they arrived in weak condition.*

THANKSGIVING TREAT

We really enjoyed Dave Crehore's Thanksgiving story ("Sweet and sour pie," December 2005). I e-mailed it to my brother and sister who live out of state in hopes of getting them to subscribe to your magazine. I'm trying to lure my daughter and family back to Wisconsin, so we'll get them a gift subscription.

Roberta Mallmann
New Berlin

We also enjoy featuring Dave's stories. We hope you have read his other reminiscences that we've been publishing since 1998 . You can find them online at our website, www.wnrmag.com. Search on Dave's name and you'll see ten previous stories starting with "The digging out of Nip" and other favorites like "The secret smallmouth lake in the UP," "The Butternut Buck" and "The Viggle Years."

WATERFOWL VAUDEVILLIANS

Your December article on coots, "Bobbing heads in the crowd," brought back joyful memories of these waterfowl vaudevillians. Duck hunting from a blind on the north shore of Lake Sinissippi in the late 1930s and 40s provided many occasions to be entertained. Throughout most of the fall the center of the lake held a large raft of ducks and coots, local and transient, that stayed until freezing weather drove them south.

On "bluebird" days our hunting ended with the bright sunshine, but on occasion my father and I would "waste away" the day in the blind, hoping for an occasional single duck to check out the decoys. As things became peaceful, the coots left the raft and swam toward shore to feed. There were hundreds of them. Slowly they would move in towards us until the decoys and bays on either side of the point were filled with bobbing, chuckling coots. As soon as they realized we would not harm them, the shenanigans began — chasing, diving, playing leap frog on muskrat houses and hide and seek in the bulrushes.

If an ill-advised duck swooped the decoys, our gunfire sent the coots pell-mell back to raft in the center, only to start back again as soon as it was peaceful. Within an hour or so they would be all around us again, feeding, fighting and playing. When we picked up the decoys to go home, the friendly mud hens barely got out of our way.

Early this November, I stopped on the shore of lower Nine Mile Lake to watch the sunset. There they were, spotlighted by the late afternoon sun,

performing the same old corny jokes, 30 to 50 of them. I watched, renewed, until it was too dark to see.

George Ellis, Sr.
Eagle River

Great article on coots. I've always admired their ivory bills, now I admire the entire bird. I didn't know they migrated and thought they always found open water some place on Lake Monona. When I saw them, there were so many together that it somehow seemed to make them less remarkable. Bad thinking — I'm smarter now.

Grace Stith
Madison

I think I saw some rafting coots on Lake Winnipesaukee yesterday. They were too small for Canada geese and I noted that what I saw was practically an armada! This is the first time I have noticed them. Perhaps they were taking a break from their migration. Also, I just loved the story by Dave Crehore, "Sweet and sour pie." Last year I stumbled across your magazine's website when I was trying to identify some animal tracks and happened to hook up with EEK! (the Department of Natural Resources' environmental education for kids website, www.dnr.wi.gov/eek/). Keep up the great work and greetings from New Hampshire!

Peter and Susan Bossert
Alton Bay, New Hampshire

I read with great interest your wonderful article. Early on in my wildlife research career at Horicon Marsh, I had an opportunity to work with coots. My supervisor at the time, John Beule, long since retired, wanted to learn more about nesting coots in a few local impoundments. With canoes and waders, I found and marked several dozen nests each summer, including measuring the vertical depth because the nests were perpetually sinking. The parents had to add fresh vegetation each day! I counted coot eggs and estimated their dates of hatching. I was surprised to learn that about 90 to 95 percent of all of their nests were successful — far higher than the upland nesting mallards and blue-winged teal that ranged from only 10 to 25 percent.

With the help of a talented, very hard-working UW grad student named Gerald Bartelt — now my supervisor at DNR's Research Center — we even captured a few birds and banded them. I found them to be one of the most aggressive and difficult-to-handle birds I've ever encountered! As you suggest in your article, they do peck, scratch, kick and bite — furious little buggers! I've often said that I would much rather handle a huge, comparatively sedate hawk or owl any day than a little wild coot!

When I first arrived at Horicon Marsh in the spring of 1975, coots could be found everywhere. I naturally assumed they would always occupy the great marsh. However, each spring thereafter their numbers seemed to decline. I soon realized that the high population of coots I first witnessed was the direct result of a huge carp removal a few years earlier. Once the destructive carp were removed, the basic fertility of the marsh supported many birds, including coots. I now realize that where a person spots coots, they are witnessing a very healthy wetland community.

As I worked more and more with coots, I came to really respect their parenting and survival skills. Your article brought back many wonderful memories.

Lawrence E. Vine
Research Technician
Horicon

What I thought to be a floating weedbed is about 100-130 coots in a 30-foot circular pattern assembling 100 yards in front of my cabin every evening from 4 to 5 p.m. They do not leave the circle and are diving within a pecking order. They move as a group. There is a leader and one that musters at the back of the flock ensuring no stragglers. They have been here every evening for three weeks now in the northeast bay of Palmer Lake.

We had prolific celery weed rejuvenation and growth here this year, so I presume they are feasting on submergent weeds. More and more coots come every day. I counted 97 through my spotting scope yesterday. Today there are near 150. The unseasonably warm water (53°F) after turnover could be a factor too.

Phil G. Smith
Palmer Lake, Vilas County

REMEMBERS "THE LEDGE"

I was surprised in your December article "Vertically inclined" to learn that the Oakfield Ledge State Natural Area was included as part of the Niagara Escarpment. I have fond memories of "The Ledge" going way back to the 20s and 30s. My uncle and aunt, William and Pauline Panzer, owned the farm adjacent to it. While my uncle helped build gravel roads in Dodge County, my aunt raised lambs and sheep there. I can still picture her in early spring bringing in a newborn lamb, cradled in her apron. She would warm it and bring it to life in front of her big wood cookstove.

We traveled up to visit my aunt and uncle in a 1924 Chevrolet and as a little child I was always petrified to ride down the Ledge Road, also known as Breakneck Road! The farm buildings are gone now, but their house is still standing next to "The Ledge." I will take a better look at the forestation next time I visit, but meanwhile I would like to know who owns and is watching over this piece of history?

Penny M. Gray
Milton

Oakfield Ledge is one of the most significant exposures of the Niagara Escarpment in Wisconsin. The Department of Natural Resources owns the 208-acre property that was designated a State Natural Area in 1983.

NIAGARA ESCARPMENT NETWORK

I was very pleased to see the extensive article regarding the Niagara Escarpment and its ancient cedar trees in the December issue ("Vertically inclined"). These unique aspects of the escarpment definitely need to be emphasized and shared with your readers, as well as residents of the area.

Our organization (the Niagara Escarpment Resource Network, www.escarpmentnetwork.org) has existed since 1998 and acts as a loosely knit coalition of experts and interested parties with some knowledge of, or ties to, the Niagara Escarpment. As the name states, we are a "network" and our primary mission is to provide and share information which encourages well informed and balanced land use decisions along this geologic feature. There is no cost to join our e-mail list and no commitment is sought from members. Our website contains a wealth of information about the escarpment and I encourage your readers to visit it and join us in our efforts.

A month-long celebration of the escarpment is planned for April and May, 2006 and will consist of a Common Ground Exhibit at Main Street Artworks in Hilbert along with an extensive series of guest lectures, workshops and tours. More information can be found on our website or at www.mainstreetartworks.com.

Eric W. Fowle
Co-chair, Niagara Escarpment Resource Network
Menasha

BIRD OR BUG?

This creature began appearing in my phlox garden this year toward the end of August. This little guy moved as fast as a hummingbird and was tough to catch in place. He would appear daily at

DON BLEGEN

approximately 5:15 p.m. and buzz around the phlox until 5:30. This occurred over a two-week period. And then he was gone. The body was a fuzzy yellow and black, like a large bumblebee. There were red feather-like projections appearing like a tail. The wings were a beautiful deep red. He had a black proboscis, shaped like a hummingbird's, and used for the same purpose, but it was flexible. He didn't mind my husband and me coming over to watch him, and let us get very close. Have you seen anything like this before?

Jennifer Vetter
Waterloo

Your garden visitor was probably a hummingbird moth (Hemaris thysbe), a member of the sphinx moth family. They are common throughout the eastern half of the United States and Canada, feeding on nectar from butterfly bushes, dogwood, purple cone flower, blackberry, trumpet vine, lilacs, monarda and phlox. As their name suggests, they are easily mistaken for hummingbirds. Look for the antennae and six legs to distinguish them as insects.

DEER SEASON SUCCESS

Opening day, deep in the heart of the Chequamegon National Forest scattered gunshots greet the daylight, heightening the excitement. As the shots become more infrequent and the morning wears on, doubt enters my mind. Maybe I should have been sitting somewhere else. Suddenly about 11 a.m., a deer comes into view just in front of me. The doe moves quickly, but why? There are no other hunters nearby. Maybe an overanxious buck has her in a hurry. As I wait for the answer, in mind's eye a big racked buck steps out of the spruce swamp. That vision keeps me company for the next hour. The afternoon is uneventful, save for two 30-minute periods of absolute silence. No gunshots, car horns, bluejays, ravens, squirrels or a single wolf howl. Even the wind falls silent. What is left is deafening. As the curtain falls on opening day, I climb out of my stand with nothing to show for ten and a half hours of sitting but an empty lunch bag, two great silences and the image of a big buck. It was a great day. As I walk out of the darkening forest I think, "All of this for $24 and I still have eight days left plus muzzleloading if I choose to. That is not a deal, that is a steal."

As always, the deer season ended all too quickly. Other than the last day, the weather was great. Did I get my deer? Does it really matter? I'll paraphrase the great Wisconsin conservationist Aldo Leopold: What was big was not the rack, but the chance. What was full was not my tag, but my memory.

Sure I would have liked to get a deer this year, but I guess that is what next years are for. That is the challenge of big woods hunting. Some years you see a few more, some years a few less.

I would like to thank the Wisconsin DNR for making this all possible. All of you, from office secretaries to Secretary Hassett, do a tremendous job protecting and enhancing our natural resources. It is not easy to satisfy the demands of myriad users while trying to maintain the integrity of the landscape and natural processes. Though DNR has critics, there are many, many, many more people who support their efforts. Keep up the good work.

Rob Weber
Weyerhaeuser

GRATEFUL WISCONSIN TROOPS

On behalf of the 2-127 IN "Gator" battalion, thank you and the Department of Natural Resources for donating back issues of your magazine. Currently we have soldiers from two Wisconsin battalions stationed at Camp Navistar. On any given day over 1,000 other soldiers pass through our doors. Many are from Wisconsin. I placed the magazines in our morale tent. I checked this morning and many were already gone. Thank you again.

Maj. Tom O'Brien
"Strike Forward"
Camp Navistar, Kuwait

We are happy to send surplus back issues of our magazine to troop companies overseas, as long as supplies last. Readers with such requests should send contact names and addresses to the Readers Write address listed at the beginning of this column.

MAPPING FIRE RISK A WIN-WIN OPPORTUNITY

The April 2005 insert on wildfires ("Spreading like wildfire") was excellent. Years ago, I participated in the first controlled burns on the Crex Meadows Wildlife Area. Observing crown fires in pine and oak stands on sandy soils, I was startled at their intensity and dangerous power. No force could stop such a conflagration. After the 1977 fires (in Black River Falls and Washburn and Douglas counties), the Natural Resources Board invited me to share my observations with them. I was appalled and saddened by the tragic loss of forests and homes in those areas. My comments to the Board have been reinforced by the Big Flats fire last spring on similar sandy soils. Let me summarize:

The sandy soils regions of the state were originally oak and prairie savanna created by repeated fires through many centuries set by Native Americans or lightning. Development and tree planting in such areas are totally incompatible with these natural ecological systems. Fires are inevitable.

In the decades ahead, through intelligent foresight (land use planning), we need to identify and map high-, moderate- and low-risk fire areas. Historians, ecologists and forest fire scientists should be involved. Then, through careful zoning and other land use management tools, development and forestry should be precluded, especially in high-risk areas. Existing incompatible uses can be identified and allowed as temporary nonconforming uses. Eventually they will disappear from the landscape. The public now accepts comparable restraints on building in dangerous floodways and floodplains.

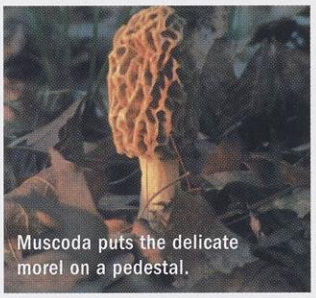
Hazard maps should be widely distributed to the public government agencies, mortgage lenders and insurance companies. Recalcitrant owners and local governments who lack the will to act should be required to carry catastrophic insurance to cover suppression costs. Today, in some parts of the U.S., insurance companies simply refuse to cover high-risk properties. Importantly, tax dollars used for suppression can be used for valuable forest practices on other sites. To be sure, the prairies will need management to ensure diversity of the flora and fauna and protect endangered prairie species. The costs will still be substantially less than fighting fires.

The Department of Natural Resources, working with many partners, can provide the necessary leadership as part of its management activities. A substantial benefit would occur from restoring the magnificent savannas now largely gone from the state and throughout North America. It's a win-win opportunity for all interests: the taxpayers, and property owners who all too unknowingly risk their homes, cabins and lives, and these unique and rare ecosystems that can become a model of working with nature.

Harold C. "Bud" Jordahl
Madison

A capital treat

Some call it civic-mindedness; others say it's unvarnished hubris, but this much your TRAVELER knows: In Wisconsin you will never catch anyone eating crow. (Shooting, yes; eating, no.) Our cities, towns and villages can't stomach the thought of descending into genteel obscurity, won't swallow the concept of second-rate. When it comes to food, Wisconsin places boast of the best, the most, the greatest. Some shyly claim only statewide honors, while others view the contiguous 48, Alaska, Hawaii, Puerto Rico and Guam as their self-appointed realm. For many, nothing short of global domination will do.



Muscoda puts the delicate morel on a pedestal.

DOUG ALFT
PHOTOS THIS PAGE COURTESY OF WISCONSIN DEPT. OF TOURISM

What all this pride adds up to is a boon to you, fellow traveler, for wherever your journeys take you in Wisconsin, you're sure to find an extraordinarily tasty local delight.

Consider tiny **Muscoda**, which modestly labels itself the **Morel Mushroom Capital of Wisconsin**. Gourmets and just plain folks with good appetites swoon over the elusive fungi's delicate aroma and indescribable taste. Set aside May 20-21 to join the smitten in honoring these utterly delicious 'shrooms during Muscoda's **24th Annual Morel Mushroom Festival**. Check www.muscoda.com/event-morels.html for a complete schedule of festival events.

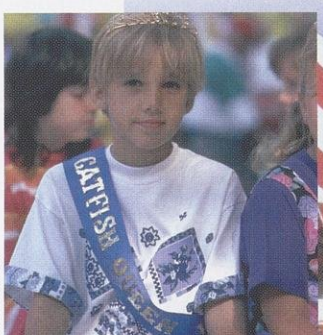
Noted in "Ripley's Believe It or Not" for having the World's Longest Main Street Without an Intersection, **Potosi** decided instead to bill itself as the **Catfish Capital of Wisconsin**. As you wander the long thoroughfare lined with shops and many of the original houses built by miners who settled the area in the 1840s, stop at a local café and munch on a catfish burger while you ponder how to cross the street legally. The Potosi Township Historical Society at www.vangrafx.com/PTHS/tour/main.html tells all.

Sheboygan lays claim to being the **Bratwurst Capital of the World** and as such invites all and sundry to **Brat Days 2006**, August 3-5. Visitors will witness serious sausage consumption under the watchful eye of the Bratmeister. When in Sheboygan, do as the Sheboyganese do: Order a "double with the works" — two grilled brats served on a crusty Sheboygan hard roll with pickles, ketchup, onions, and stone-ground mustard. Sauerkraut is optional. See www.sheboygan-jaycees.com/projects/bratday/ for the latest on the wurst.

Is it possible that somewhere on the planet there is a fete dedicated solely to *Brassica napobrassica*? Try **Cumberland**, our very own **Rutabaga Capital of the World**. The humble purple root with yellow flesh kept many a logger (and his sleigh team) going through Wisconsin's harsh northwoods winters. The **2006 Rutabaga Fest**, August 25-27, features a parade, fun run, live music and more. How many of these "great tasting vegetables with a delicate sweetness and flavor that hints of the light freshness of cabbage and turnip" to quote one culinary expert, are actually consumed during the event? Don't expect anyone in town to divulge. Visit www.cumberland-wisconsin.com/ for details.

Where will the trumpeting end? There's Wausau, Ginseng Capital of the World. Racine, Kringle Capital of the World. Eau Claire, Horseradish Capital of the World. And Ellsworth, Wisconsin's very own Cheese Curd Capital. It takes a lot of moxie to make that claim in America's Dairyland.

RJ & LINDA MILLER



GENE STAVER
WIS. DEPT. OF TOURISM

Cooking up celebrations in praise of brats, catfish and kringle.

Wisconsin, naturally

RICHWOOD BOTTOMS
STATE NATURAL AREA

Notable: Richwood Bottoms features a floodplain forest on a low terrace along the Lower Wisconsin River. Large swamp white oaks, along with basswood, silver maple, green ash, and hackberry trees, dominate the airy canopy. Ostrich fern, royal fern, buttonbush, and cardinal flower add color and texture to the understory. Beware of poison ivy, in all its growth forms! Seasonally-flooded swales add to the site's diversity and provide breeding habitat for a variety of amphibians. Cerulean and Kentucky warblers and red-shouldered hawks also find refuge here.

How to get there: From the junction of Highway 60 and County Highway T in Port Andrew in Richland County, go 5.2 miles west on 60 to an access lane on the south side of the highway, just before the bridge. Park at the end of the lane and walk southeast 0.5 mile to the site. Take a compass! Visit dnr.wi.gov/org/land/er/sna/sna249.htm for a map and more information.