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From Air to Water Contamination: Steps to Reduce High Sulfur Coal Pollution

In recent years, Illinois has consistently ranked among the top 10 states for both productive capacity and number of coal mines; underground mines are currently more common than surface mines. Illinois coal has a high BTU rating (produces more heat per pound), but because of the environment in which coal beds were formed, it is also relatively high in sulfur. In fact, as of 1997, 94% of Estimated Recoverable Reserves in Illinois fell into the "high sulfur" category. By comparison, only 7.5% of Estimated Recoverable Reserves of Wyoming are considered high in sulfur. The high sulfur content of Illinois coal presents problems for both coal burning power plants and coal processing facilities regarding compliance with environmental regulations enforced under the Clean Air and Clean Water Acts.

Upon combustion, sulfur in coal is released to the atmosphere, often in the form of sulfur dioxide, which reacts with water vapor to become sulfuric acid. These reactions are responsible for acid precipitation problems in much of the eastern United States. In an effort to reduce sulfur emissions as required

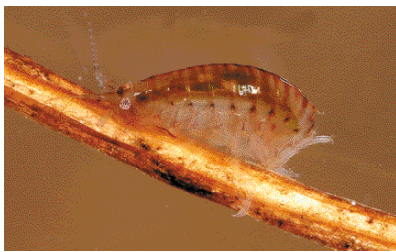


Abbott Power Plant at the University of Illinois that burns "scrubbed" high sulfur Illinois coal. Photo by Charlie Warwick, INHS Office of the Chief

under the Clean Air Act, coal preparation facilities now wash coal prior to combustion. This practice produces a liquid waste, or effluent, that must be released into a nearby receiving stream or river. Essentially, to reduce airborne sulfur emissions at power plants, processing facilities must increase sulfur contents in local watersheds. However, a process similar to the one that transforms combusted sulfur into sulfuric acid (H_2SO_4) in the atmosphere also occurs in freshwater. In order to comply with the Clean Water Act, acidic effluents must be neutralized prior to release, usually by the addition of a base like sodium hydroxide (NaOH). The result is an effluent with neutral pH (~7) containing high concentrations of dissolved sodium (Na^+) and sulfate (SO_4^{2-}). Be-

cause of the high concentrations of these dissolved chemicals (or ions), the effluent is more similar to saltwater than freshwater.

It has long been known that freshwater organisms do not function well in the presence of high concentrations of ions (i.e., in salty water). In fact, the first aquatic toxicity experiment is usually credited to the ancient Greek philosopher and scientist, Aristotle, who transferred freshwater fish to seawater to observe the effect. In present times, aquatic ecotoxicologists most often focus their research on contaminants that are toxic at minute concentrations, such as cadmium or dioxins; however, in some situations as described above, ordinarily "nontoxic" ions commonly found in freshwaters at



Hyalella azteca, a type of amphipod crustacean that is sensitive to sulfate toxicity in Illinois streams. Photo by Michael Jeffords, INHS Office of the Chief

Continued on back page

Fishing Illinois via the Internet

On April 1, 2004, the Illinois Department of Natural Resources (IDNR) announced the launch of a new Web site (www.ifishillinois.org) that provides the public with an array of informative resources about fishing and boating in Illinois waters.

Weekly fishing reports, sport fishing prospects, regulations, and fishing tips are just a few examples of the services provided by www.ifishillinois.org. Information is provided about more than 70 inland lakes, 8 major rivers and streams, and Lake Michigan, making it one of the most comprehensive on-line resources for Illinois fishing available. The Web site also includes a special section called "Kids and Family Fishing," that provides information on hotspots for kids and families, as well as beginner anglers.

The "Kids Fishing Hotspots" includes locations throughout the state,

identified by IDNR district fisheries biologists, where children are likely to catch a lot of fish. This section of the Web site provides a printable fishing guide that includes techniques for tying a knot, baiting a hook, as well as other useful information for the young angler. Access to information on how to get a fishing license, as well as a downloadable version of the statewide fishing regulations booklet is also available. Lastly, the section provides a variety of downloadable educational materials with activities for children excited about fishing.

The "Weekly Fishing Reports" section provides anglers with types of fish being caught and bait being used on a selected lake. Each week, IDNR Fisheries person-

nel submit these fishing reports electronically for lakes around the state, and the Web site is then updated automatically, providing anglers with up-to-the-minute information on fishing conditions. Fisheries biologists also provide fishing prospects information for www.ifishillinois.org, giving the public an easy way to find a local lake with their favorite target species, all on-line.

Users of www.ifishillinois.org can browse over 70 lake profiles that include information lake maps describing habitat types and depth contours, information about on-site public recreational facilities, sport fishing prospects, and annual sport fishing status reports generated by IDNR Fisheries biologists. Major reservoirs (Rend Lake, Carlyle Lake, and Lake Shelbyville) as well as several river

understand angling and fish populations in Illinois. The "Science" section also profiles several fish studies in progress at INHS.

IDNR's fisheries programs are also highlighted on the Web site, including information on the Tackle Loaner, Urban Fishing, and Hatcheries and Stocking programs. The Urban Fishing program provides detailed information for each region including sites of free fishing clinics. The Access to Fishing and Tackle Loaner programs provide rod and reels for the public to borrow and lists the loaning locations, oftentimes public libraries or local park districts.

Clearly www.ifishillinois.org has much to offer the angling public. E-mail has already been arriving showing interest and pleasure with the site. As with

any Web site, material is always being added and modified—more lakes, rivers, and creeks will be added during the upcoming year as well as

more scientific information. We encourage readers to visit www.ifishillinois.org frequently, and most importantly, get out there and go fishing!

(www.ifishillinois.org is partially funded by the U.S. Fish & Wildlife Service Sport Fish Restoration Fund)

Thomasine McNamara and Jeff Stein, Center for Aquatic Ecology; Jim Mick and Mike Conlin, IDNR Division of Fisheries



systems and Lake Michigan are also profiled on this site. Profiles of major rivers provide information similar to lake profiles, as well as printable fishing guides and canoeing information and maps.

The Web site also features a "Science" section that highlights various fisheries-related studies conducted by Illinois Natural History Survey (INHS) and IDNR personnel, including creel survey reports, fish species profiles, and information about exotic and endangered species. Creel survey data and reports are generated by INHS personnel and continually updated. Analyses of creel data are provided so that both the general public and scientists from other institutions may benefit from INHS efforts to better

INHS Researcher Named Fellow by American Association for the Advancement of Science

Dr. Robert J. Novak, a Professional Scientist at the Center for Ecological Entomology, Illinois Natural History Survey, was recently elected and named Fellow of the American Association for the Advancement of Science. He was given this honor for his “fundamental biological studies of mosquitoes and for leadership in mosquito control in the United States, Africa, and the Caribbean.”

The American Association for the Advancement of Science is the world’s largest general scientific society, and publisher of *Science*. AAAS seeks to advance science and innovation throughout the world for the benefit of all people.

A fellow is defined as “a Member whose efforts on behalf of the advancement of science or its applications are scientifically or socially distinguished.” Examples of areas in which nominees may have made significant contributions are research; teaching; technology; or administration in academia, industry, government, and other institutions. The honor of being elected a fellow of AAAS began in 1874 and is acknowledged with a certificate and a rosette presented at the Fellows Forum during the Annual AAAS Meeting.

Election as a fellow of AAAS is an honor bestowed upon members by their peers. Fellows are recognized for meritorious efforts to advance science and its applications.

Dr. Novak received a B.S. in biology from the University of Southern Colorado in Pueblo; an M.S. in biology at the University of Utah in Salt Lake City; and a Ph.D. in entomology from the University

of Illinois. He then served as an NIH Post-doctoral Fellow in vector biology and parasitology at the University of Notre Dame.

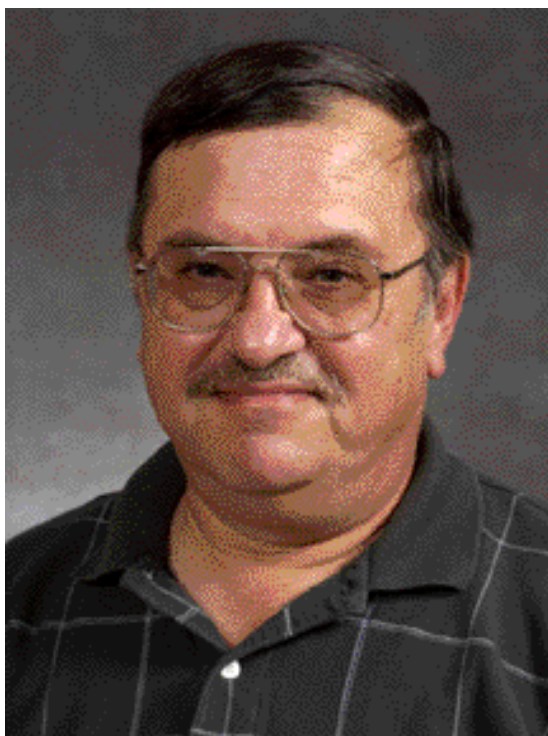
Prior to coming to INHS, Dr. Novak was a Research Entomologist with the U.S. Public Health Service, Centers for

and was awarded the Association’s Medal of Honor in 2003. He has been a consultant to numerous organizations and agencies worldwide, including the World Health Organization, Pan American Health Organization, U.S. Agency for International Development, U.S. Fish and Wildlife Agency, and the U.S. Army Medical Virology Institute.

Dr. Novak’s published works include more than 70 scientific and technical papers, book chapters and conference proceedings, as well as 2 bibliographies. He has been funded from a variety of sources over his career, including significant funds from the National Institutes for Health, Centers for Disease Control, National Science Foundation, and the Illinois Soybean Board.

Dr. Novak lives in Champaign with his wife, Loraine, and has two daughters Lisa and Karen.

*Compiled by Robert N. Wiedenmann,
Center for Ecological Entomology*



Disease Control, Vector-borne Viral Disease Division, in San Juan, Puerto Rico, and CDC’s Bureau of Tropical Diseases, in Atlanta, Georgia.

Dr. Novak has contributed consistently to the medical entomology community through his service as Vice President, President-elect, and President of the American Mosquito Control Association,

Hill Prairies Along a Stretch of the Illinois River

Hill prairies were once a common feature of south- to southwest-facing river bluffs in the Tallgrass Prairie Ecoregion from Minnesota and Wisconsin to Missouri. Prior to European settlement, most hill prairies were probably no larger than 1 ha, punctuated by forested ravines. They contained typical tallgrass prairie plant species, species disjunct from the Western Plains, and a few hill prairie endemics. The open prairie structure of these habitats was due to a combination of droughty soils, exposure to dry prevailing winds and sun, and periodic fires. With European settlement, hill prairies were mostly used to graze livestock, rather than for crop production, due to their steep topography. As a consequence, a higher proportion of hill prairie habitat persisted compared to other prairie types. Today, hill prairies are disappearing due to encroachment from adjacent forests and invasive native and exotic bird-dispersed shrubs, as well as extreme erosional disturbances.

In general, the decline in the abundance and sizes of hill prairies is related to the requirement for moderate disturbance to prevent woody encroachment. Woody plants invaded these canopy openings because livestock grazing decreased in the latter half of the 20th century and settlers suppressed natural fires, both of which kept woody species in check. Several researchers have documented area loss rates ranging from 55% to 72% on average at high-quality sites over intervals of 30–40 years.



The slope of a hill prairie along the Illinois River. Photo courtesy of Adrienne Edwards, INHS Center for Wildlife and Plant Ecology

Given the decline in the sizes and abundance of hill prairies in Illinois, we are examining the question, “To what extent do species diversity within hill prairies or species presence surrounding hill prairies correlate with hill prairie quality, size, or degree of isolation within a small landscape?” We focused on 21 small (< 0.5 ha) gravel hill prairies parallel to a 33-km stretch of the west bank of the Illinois River in Marshall and Bureau counties. Plant species composition and relative abundances were recorded periodically throughout the growing season (April – October 2002), and the resulting species lists were subjected to Floristic Quality Assessment. Woody species present around the perimeter of each prairie were also recorded. GPS readings were taken around the circumference of each prairie. GPS data were used to determine the area and perimeter-to-area ratio of each prairie opening, and to develop a distance matrix among prairies.

A first step in our analyses was to describe differences in species composition and characteristics of the prairie openings. We report a few of those findings here. Each prairie opening averaged 66 species (from 42 to 92), with 1 to 10 non-native species. Overall, mean Coefficients of Conservatism and Floristic Quality Indices ranged from fair to relatively high (3.7 to 5.2, and 27.3 to 41.4, respectively). Based on the most ubiquitous 76 prairie species (out of 239 recorded), hill prairies that were closer to each other were not necessarily characterized by the same species. Despite this, some less common species, (for example, the sedges *Carex cephaloidea*, *C. eburnea*, and *C. hirtifolia*), occurred only in prairies in close proximity to each other. Prairie openings



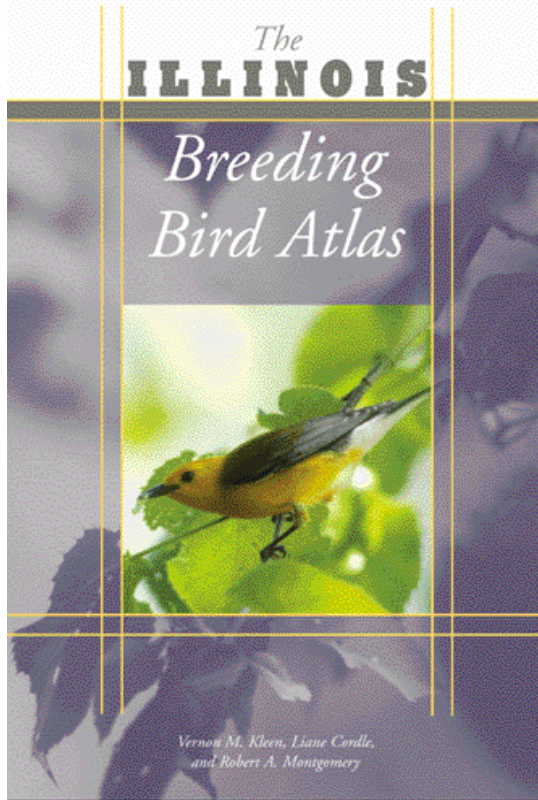
Researcher Adrienne Edwards at a hill prairie along the Illinois River. Photo courtesy of Jason Koontz, INHS Center for Wildlife and Plant Ecology

were all smaller than 1/200 ha, although prairie herbs persisting within adjacent forest canopies suggest larger canopy openings in the past, perhaps encompassing one or more of the present-day openings. Hill prairie size was not a good indicator of species similarity or habitat quality either, due to differences in the degree of degradation from factors such as past grazing and erosion caused by off-road vehicles.

Land use history may well be one of the most important factors determining the quality of any given hill prairie, but substantial differences in species composition and habitat quality could be maintained across landscapes. Hill prairies are a unique natural feature of the Tallgrass Prairie, and we need to document patterns of species diversity and habitat quality to prevent further loss in the future. It may be more efficient to preserve clusters of hill prairies embedded in the landscape than to preserve isolated examples of these dynamic habitats.

Adrienne L Edwards and Jason A Koontz, Center for Wildlife and Plant Ecology

New INHS Publications



Illinois Natural History Survey Special Publication 26— *The Illinois Breeding Bird Atlas*

by

Vernon M. Kleen, Liane Cordle, and Robert A. Montgomery

xviii + 459 pp.

softbound

8.5 X 11 inches

\$25.95 (price includes shipping)

ISBN # 1-882932-07-2

The Illinois Breeding Bird Atlas project is a comprehensive statewide survey of the birds that breed in Illinois. The introductory sections include a description of the project, its methodology, and a summary of results. The species accounts section includes information on the range, abundance, breeding habitat, life history, historical status, recent population trends, and distribution in the state for species which bred in Illinois during the Atlas project period.

Ordering information:

Contact: Ruth Johnson—(217) 333-6880; rjohnson@inhs.uiuc.edu
Illinois Natural History Survey

Distribution Office
607 E. Peabody Drive
Champaign, IL 61820

Illinois Natural History Survey Special Publication 27— *Assessment of Created Wetland Performance in Illinois*

by

Allen E. Plocher and Jeffrey W. Matthews

ii + 22 pp.

paperback

8.5 X 11 inches

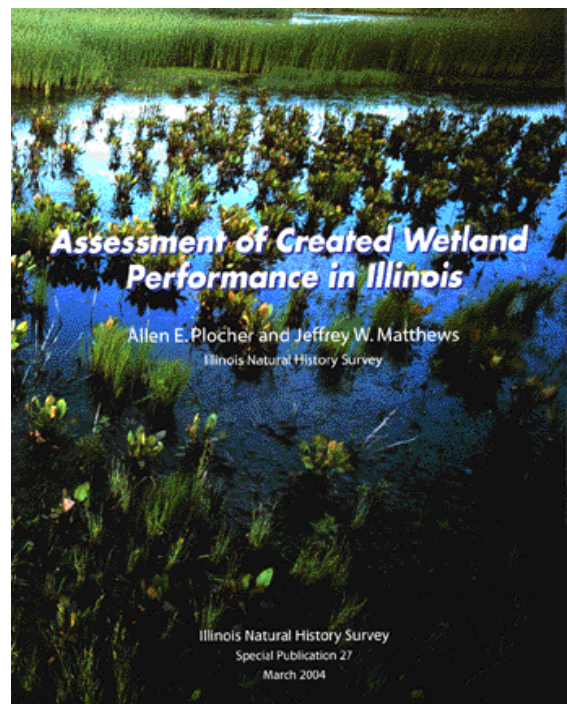
\$6 per copy

This new publication provides an easy-to-use procedure to assess newly created or restored wetlands in Illinois. Included are color photos that show examples of successful versus unsuccessful restoration efforts, as well as sample assessment forms to help determine wetland status, functional problems, and specific requirements.

Ordering information:

Contact: Ruth Johnson—(217) 333-6880; rjohnson@inhs.uiuc.edu
Illinois Natural History Survey

Distribution Office
607 E. Peabody Drive
Champaign, IL 61820



Species Spotlight

Bur Oak

Susan Post

“When the first settlers gazed westward across the vast prairies of Illinois, bur oaks were the burly trees on knolls and ridges which stood like ships in a sea of grass.”

Roberts Mann

Nature Bulletin No. 708
Cook County Forest
Preserve, 1963

The bur oak is a tree primarily of the midwestern and Great Plains states. Found further north than any other native American oak, it ranges north to central Manitoba and



Bur oak acorns with distinctive large, scaled, fringed cups. Photo by Michael Jeffords, INHS Office of the Chief

south to central Tennessee and southern Texas. It is present in all Illinois counties. Bur oaks grow on sites with deep rich soils that are moist but well drained, as well as dry upland sites. In the heart of its range the bur oak is often found growing by itself, standing alone in a farmer’s plowed field or in a flat bottomland. When grown in the open, the straight trunk supports a broad, irregular crown of stiff, gnarled branches, with the lower ones decidedly drooping. Under forest conditions, the crown is rather small and the trunk long and clear.

The bur oak even played a role in the Lewis and Clark Corps of Discovery. The Council Oak at Sioux City, Iowa, was a bur oak. Here during the week of August 13–20 in 1804, the tree shaded a meeting with Native Americans.

Its scientific name (*Quercus macrocarpa*) means oak with a large seed and refers to the large acorns. Its common names include prairie, bur, and mossy-cup, with the latter two referring to the seed, which is enclosed in a knobby cup with a fringed edge.

Bur oaks have simple, rounded, lobed leaves

with a deep sinus (space between two lobes of the leaf) near the center of the leaf that appears to split the leaf in half. The leaf will have 5 to 7 lobes and is 15 to 30 cm long and 7 to 15 cm wide. The leaves are arranged alternately on the twigs and are dark green and shiny from above. Below, they appear pale and somewhat hairy. Not much fall color is present as the leaves turn dull yellow or yellow green to yellow brown. The twigs are stout and yellowish brown and smooth, and as they age they develop corky ridges. Its acorn is 1.9 to 5.0 cm long and enclosed half or more in a deep cup adorned with conspicuous scales forming a gray-fringed margin. The kernel of the acorn is sweet and provides excellent mast.

The bur oak’s trunk bark is dark brown to gray, rough and deeply ridged. The bark is also thick and resistant to fire, allowing the bur oak to be the most abundant tree in many groves where the forest met the fire-prone prairie.

Paul Strode, a recent University of Illinois doctoral student, used a prairie grove to look at the effects of global climate change on warblers and their food source. An interesting observation resulted. According to Paul, “For centuries, songbirds migrating through east-central



Magnificent bur oak tree Photo by Michael Jeffords, INHS Office of the Chief

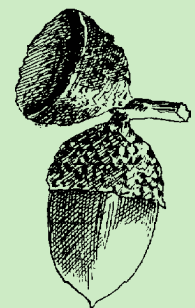
Illinois from South and Central America to Canada depended on oaks like the bur oak to supply them with caterpillars as a food resource. By observing the foraging behavior of wood warblers and vireos at Trelease Woods outside Urbana in spring, I found that bur oaks are still a critical tree species for these long-distance migrant songbirds. Warblers and vireos preferred bur oaks disproportionately to their availability in the forest, and bur oaks were found to contain over twice as many caterpillars per leaf than sugar maple and hackberry, the two most dominant tree species in the forest. My results are a strong indication that conserving bur oaks in our Illinois forests would help to conserve populations of wood warblers and vireos.”

Continued from facing page

trees may have been planted by people. Some of these trees may not be native to the area. Oaks occur over much of the Northern Hemisphere, and many European oaks are widely planted in North America. Some plant nurseries are even crossing European and North American oaks to produce new types of trees.

Mohlenbrock, Robert H. 1980. *Forest Trees of Illinois*. Eight edition. Illinois Department of Natural Resources, Division of Forestry, Springfield. 331 pp.

Mille, Howard and Samuel Lamb. 2003. *Oaks of North America*. Naturegraph Publishers Inc, Happy Camp, California. 327 pp.



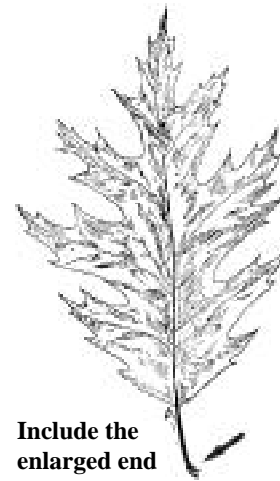
The Naturalist's Apprentice

Make an Oak Tree Collection

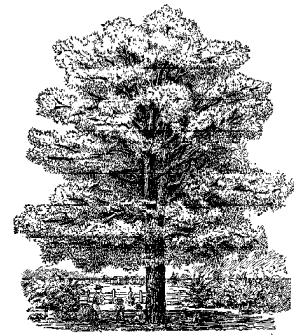
Carolyn Nixon

To learn how to identify the oaks in your area, you can make an oak collection. No, you won't be collecting trees; just parts of trees! By making a collection of leaves, acorns, winter buds, and bark rubbings, you will have much of the information you need to identify the tree. You can make this collection from oak trees on school grounds or nearby parks and natural areas. Before you collect anything from the trees, make sure you get permission from the landowner or property manager. Collecting leaves and acorns and taking bark rubbings will not harm trees. The leaves and acorns of an oak tree will be shed in the fall, anyway. Collecting twigs with buds should be done with care. Do not take too many buds from one tree as these are the next year's leaves.

Leaf Collection: Use a letter-sized spiral notebook for your leaf collection. Making a leaf collection can be done any time that the leaves are on the trees. However, it is best to wait until the leaves have reached their full size in late spring or when the leaves are shed in the fall. Once you have found a tree from which you want to collect, record some information about the tree. Include the date, where the tree is located, and a general description of the tree. A quick sketch of the shape of the tree can be useful (see the illustration). Give the tree a number on your notebook page. Anything else you collect from this tree will be given the same number. Carefully pull the leaf from the twig by pushing against the base of leaf petiole (the leaf stem) next to the twig. By doing this, you should retain the wide, flared end of the petiole. This may be helpful in leaf identification. Flatten the leaf against the notebook page and close the notebook. Turn four or five pages before you collect a leaf from another tree. Once you have collected all the leaves you need, place the notebook on a flat surface and place a heavy book on top of it. Let it sit undisturbed for at least two weeks. This will allow the leaves to dry, and they will then remain flat. After they are dry, you may tape the leaves down to the page.



Include the
enlarged end
of the leaf
stem.



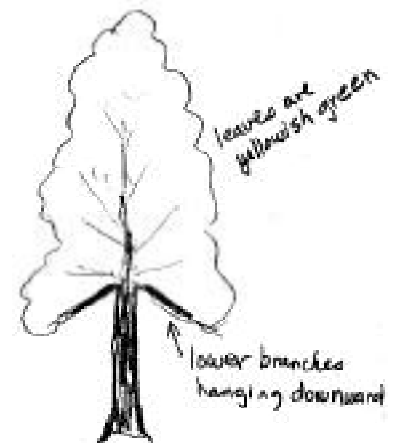
Acorn Collection: To make an acorn collection you will need several small paper bags and some 3" by 5" index cards. Pull the acorn from the tree, or pick one up from the ground directly below the tree. Make sure the acorn cap is attached. Place the acorn into a bag. Write the number on the index card. Remember, this is the same number you used for the leaf collection. If no leaf was collected, include the information about the tree as well (date, location, description, and sketch). Acorns from different trees should go into separate bags. The acorn collection can easily be stored in egg cartons or divided boxes. Be sure to include the tree number for each acorn on a label that is placed in the compartment with the acorn. If only a few acorns are collected, the egg cartons are easily cut in half.

Tree 3

Tree in front of school.
Sept. 1, 2003

Bark Rubbings: Hold a piece of unlined paper against the trunk of the tree. Vigorously rub over the paper with a crayon. This should give you a reasonable picture of the bark. Make sure you write the tree number on the piece of paper and record the other information (date, location, etc.).

Bud Collection: Once the leaves have fallen from the oak trees in the fall, and before the leaves begin to come out in the spring, you can collect a twig with its buds. Cut a short piece of twig from the end of a branch (3 or 4 inches should be adequate). Tape the twig down to a notebook page and number the twig. If you know it was the same tree from which leaves or acorns were collected, use the same number that was used for the tree. Record the date, location, and description of the tree on the notebook page next to the twig. Use a new page for each tree.



Sample tree sketch

Once you have your oak collection, use a field guide and try to identify each tree from your collected leaves, acorns and twigs, and your bark rubbings. Do not get discouraged if you cannot determine the species of oak you have found. Oaks can be difficult to identify. Sometimes oaks are hybrids (crosses of two different tree species). Also, if leaves are collected around homes or parks, the

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Contamination

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low levels (e.g., sodium, chloride, sulfate) can reach high enough concentrations to impair sensitive aquatic organisms. Despite this, the United States Environmental Protection Agency (U.S. EPA) does not currently set limits for protection of aquatic life on the amount of sulfate or sodium allowed in industrial effluents. However, several states, including Illinois, are in the process of developing new standards for sulfate. Current research being conducted at the Illinois Natural History Survey will support this new standard by determining how much sulfate may be released into receiving streams without causing impairment of the aquatic fauna.

Sulfate toxicity, and therefore sulfate standard development, is turning out to be more compli-

cated than originally thought. For example, our work has shown that increased water hardness decreases sulfate toxicity. In other words, when there is more dissolved calcium (one of the elements that determines water hardness) in a water body, the organisms inhabiting that water body can tolerate much more dissolved sulfate than if there was less calcium. This is likely a result of calcium reducing gill permeability, and therefore, the amount of sulfate that can enter the body and cause toxicity. Because of this, regulators might have to set standards for sulfate that vary based on the hardness of the water body to receive the effluent (a practice common for metal standards). An additional complication we have found is that for some organisms, like the scud, *Hyaella azteca* (a type of am-

phipod crustacean), the amount of dissolved chloride in the water controls sulfate toxicity. Our experiments suggest that reducing chloride from 30 mg/L to less than 5 mg/L reduces the safe amount of sulfate for *Hyaella* from about 2000 mg/L to about 200 mg/L. Obviously this complicates matters for both regulators and coal processing facilities that will be regulated by these forthcoming standards. Additional research is required to further clarify how different water quality parameters affect sulfate toxicity, but this work will help Illinois become one of the first states to have science-based limits on sulfate concentrations in industrial effluents for the protection of aquatic life.

*David J. Soucek and Joan C. Esarey,
Center for Ecological Entomology*

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