ILLINOIS NATURAL HISTORY SURVEY

Reports

Spring 2004
No. 379

INSIDE

Prospects for Biological Control of Teasel in Illinois

Some plants that arrive in Illinois from exotic homes lack natural enemies to keep their populations in check and become invasive. The teasel species (*Dipsacus fullonum* [common teasel] and *D. laciniatus* [cut-leafed teasel]) are examples of such exotic plants. These Old World plants have been in North America since the 1800s and in Illinois for a number of years. The first records of *D. fullonum* (referred to as *D. sylvestris*) in the Illinois Natural History Survey (INHS) Herbarium date to 1934, but teasel recently has become more visible along roadsides, pastures, and untilled lands.

Mowing is considered to be one of the primary means of spreading teasel, and changes in mowing patterns may be responsible for the increased visibility. Teasel species are monocarpic perennials, meaning they only flower and set seed once. Unlike true biennials, a teasel can remain as a rosette for many years, until it reaches a size at which it bolts, flowers, and sets seed. Continual mowing likely had kept teasel plants small enough that they didn't bolt; fewer mowings (and occurring later in the season) have led to explosions of populations of the plant at many sites, giving the appearance that it recently had arrived. Methods for fighting teasel have included cutting and herbiciding, but costs of labor and chemicals, as well as harm to nontarget plants from overspray, have resulted in reduced effectiveness of these methods. Biological control is one of the few remaining approaches possible.

Brian Rector of the USDA-ARS European Biological Control Laboratory is dwarfed by a teasel in Greece. Photo by Rene Sforza, USDA-ARS European Biological Control Laboratory, Montpellier, France

Staff from the INHS Center for Ecological Entomology have developed a partnership with scientists at the USDA-ARS European Biological Control Laboratory near Montpellier, France, Millikin University, and the USDA-ARS Invasive Weeds Research Unit on the University of Illinois Urbana-Champaign campus. This partnership will, among other activities, search for natural enemies of teasel in its native range. Exploration by USDA scientists in southeastern Europe, southwestern Asia, and France has already uncovered a few potential arthropod agents that may prove useful in the fight against teasel. To date, a flea beetle (*Longitarsus strigicollis*), a leaf beetle (*Galerucea pomonae*), two leafrolling tortricid moths (*Cochylis roseana* and *Endothenia gentianaeana*), a nymphalid moth (*Euphydryas aurenia*), and an unidentified eriophyid mite have been found. Further exploration in Turkey, Greece, and Bulgaria is planned for the summer of 2004.

Teasel offers a unique opportunity for biological control. All species in the teasel plant

Continued on back page

Highlights of the Long Term Resource Monitoring Program at the INHS Great Rivers Field Station

The Illinois Natural History Survey Great Rivers Field Station is one of six field stations that collect data on the Upper Mississippi River System for the Long Term Resource Monitoring Program (LTRMP). In the Water Resources Development Acts of 1986 and 1999 (Public Law 99-662), the U.S. Congress recognized the national significance of the Upper Mississippi River System (UMRS) as both an ecosystem and a transportation system. To ensure that river managers would have access to the scientific information needed to maintain the UMRS as a viable, multiple-use ecosystem, Congress authorized the LTRMP as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is administered through the U.S. Geological Survey in cooperation with the five UMRS states: Minnesota, Wisconsin, Iowa, Illinois, and Missouri. Through this program, researchers at the Great Rivers Field Station have monitored water quality, fish, macroinvertebrates, and aquatic vegetation communities in Pool 26, a 41-mile reach of the Mississippi River above Melvin Price Lock and Dam 26, and 10 miles of the lower Illinois River, for over 10 years (Fig. 1).

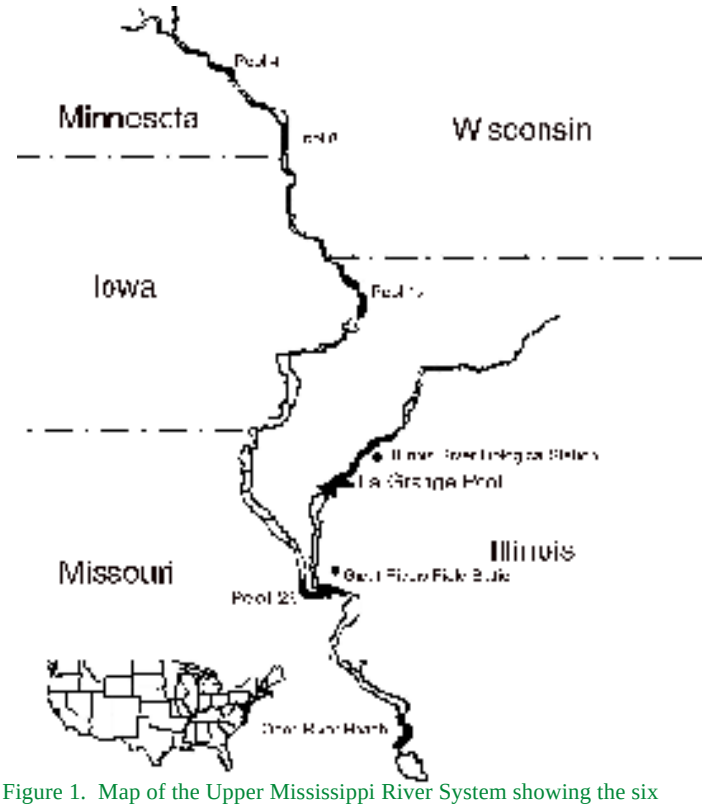


Figure 1. Map of the Upper Mississippi River System showing the six LTRMP regional trend areas, including Pool 26. The Illinois Natural History Survey operates two field stations conducting LTRMP monitoring: the Great Rivers Field Station and the Illinois River Biological Station on the La Grange Reach of the Illinois River.

Pool 26 provides important resources to nearby cities and towns in Illinois and Missouri. The Illinois Department of Natural Resources Critical Trends Assessment Program estimated that outdoors enthusiasts in the Pool 26 area purchase approximately 3.9% of all fishing licenses and 6.1% of all hunting licenses issued in the state of Illinois. Based on these license sales and expenditure data from the annual National Survey of Hunting, Fishing, and Outdoor Recreation published by the U.S. Fish and Wildlife Service, we estimate that hunters and fishers expend about $50 million each year in the Pool 26 area (Illinois only). Fish populations in the UMRS also are a resource for commercial fishers, with an average of 780,000 pounds of fish harvested each year from Pool 26 (data source: Rob Maher, Illinois Department of Natural Resources). Data from the LTRMP fish component can provide managers with important information on the status and trends of fish populations in this reach of the Upper Mississippi River, allowing for sound management of this valuable resource.

Fishery-independent data from LTRMP can be directly compared to commercial catch data. Because effort is accounted for in LTRMP data, trends in these data should reflect actual population trends, whereas commercial catch data do not account for effort and can vary with the market value of fish. For several species, including channel catfish and common carp, trends in LTRMP data and commercial catch are similar (Fig. 2). When trends in commercial catch data do not correspond to trends in LTRMP data, this can be a cause for concern, especially when commercial catch remains constant or increases at the same time that LTRMP trends are declining. This is the case for buffalo (*Ictiobus* spp.) in Pool 26 (Fig. 2), so it will be important to continue monitoring the abundance of these species.

Because LTRMP data have been collected consistently for over 10 years, important insights into population and community dynamics of fishes can be gained by examining responses to significant events within the time series. The Great Flood of 1993, perhaps the most important event in this time series, allowed greater access of fishes to the floodplain, which can provide important reproduc-

Continued on next page.

LTRMP

continued from previous page

tive and nursery habitats. By comparing the abundance of age-1 fish (based on length) in 1994 with all other years, we can look for evidence of increased reproductive success associated with the 1993 flood. Several fishes appear to have produced exceptionally strong year classes in 1993, including common carp, largemouth bass, and black crappie (Fig. 3). Further insights can be gained by following the fate of these year classes. For example, despite the 1993 year class, the overall abundance of most centrarchids (e.g., largemouth bass, bluegill, and crappie) declined for several years after 1993. We hope to identify environmental factors and ecological mechanisms with the potential to explain observed variation in fish communities by further analysis of LTRMP fish, water quality, and aquatic vegetation data.

John H. Chick, Eric J. Gittinger and Eric N. Ratcliff, Center for Aquatic Ecology and Conservation

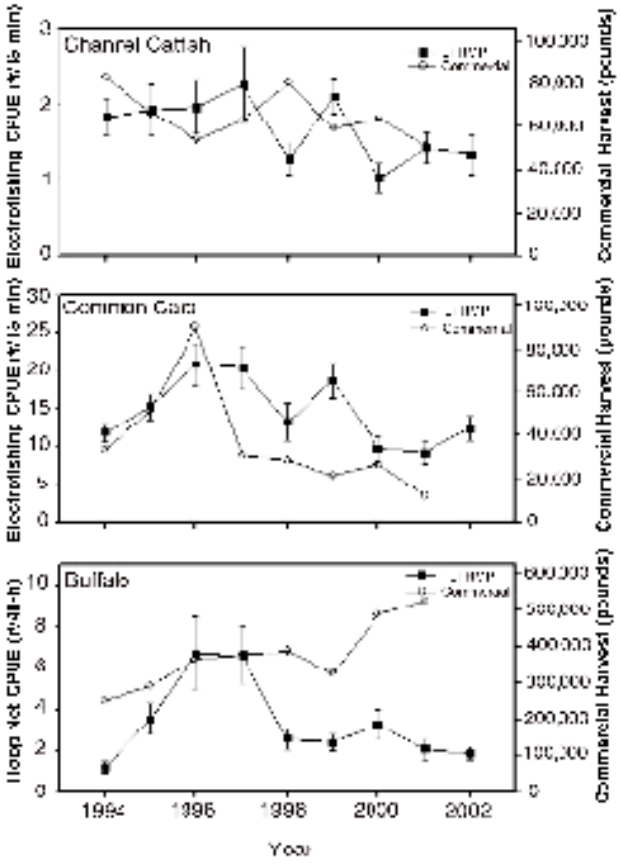


Figure 2. Comparison of LTRMP data and commercial fishing harvest for channel catfish, common carp, and buffalo (*Ictiobus* spp.) in Pool 26 of the Upper Mississippi River.

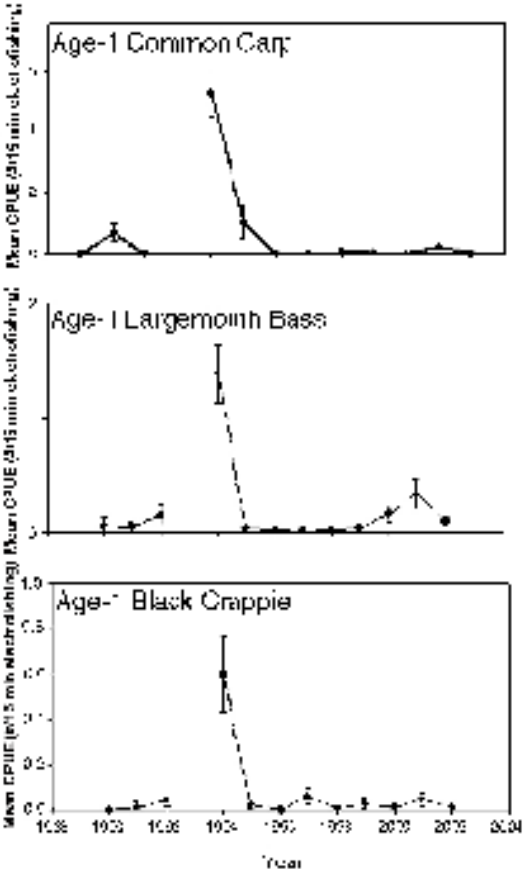


Figure 3. Abundance of age-1 (age estimated based on length) common carp, largemouth bass, and black crappie from LTRMP data collected in Pool 26 of the Upper Mississippi River.

INHS Researcher Named a Fellow by The Wildlife Society

Dr. Stephen P. Havera, Director of the Forbes Biological Station and the Frank C. Bellrose Waterfowl Research Center of the Illinois Natural History Survey, has been honored by The Wildlife Society (TWS) by being named a Fellow at the Society's annual conference in Burlington, Vermont. Dr. Havera was the first North Central Section recipient of the Fellow Award. The TWS Fellows program recognizes society members who have distinguished themselves through exceptional service to their profession. Fellows are appointed for life.

The Wildlife Society, founded in 1937, is the association of professionals dedicated to excellence in wildlife stewardship through science and education. It works to develop and maintain professional standards, advance professional stewardship of wildlife and its habitats, and increase public awareness and appreciation of wildlife management. It has thousands of members in more than 60 countries.

Dr. Havera, a TWS-Certified Wildlife Biologist and a 30-year member of the society, has over three decades of research experience with the Illinois Natural History Survey and has attained the highest rank of Senior Professional Scientist. His research interests include waterfowl, forest wildlife, mammalogy, ornithology, wetlands, and physiological ecology. He has been involved with a variety of conservation issues at the local, state, and national levels via The Wildlife Society, especially in promoting the use of nontoxic shot and strong conservation provisions in the Farm Bills. His work for TWS has included service as President of the Illinois chapter and Treasurer and President of the North Central Section.

His published works include 4 book chapters, 2 books, some 70 technical publications, and 60 reports. He received The Wildlife Society's 2000 Publications Award for Outstanding Book, for *Waterfowl of Illinois: Status and Management* and its accompanying *Abbreviated Field Guide*.

Dr. Havera received his B.S. in biology from Bradley University in Peoria, and M.S. and Ph.D. degrees in zoology from the University of Illinois, Urbana-Champaign. He served in the U.S. Army Military Police from 1968–1970. Havera lives with his wife Nancy and sons Steve and David near Lewistown.

Other recognition and awards include:

• Merit Award for co-chairing Planning Committee for the Governor's Conferences on the Management of the Illinois River System, February 26, 2004.

• Ducks Unlimited's 2004 Conservation Achievement Award in the Technical Category.

• The first Stephen A. Forbes Award for Exceptional Achievement, 2002, Illinois Natural History Survey.

• 2002 Golden Glow Public Servant Award, Association of Great Lakes Outdoor Writers.

• Distinguished Alumnus Award, 2001, College of Liberal Arts and Sciences, Bradley University.

• The Centurion Award for alumni with significant professional career achievements, 2001, Bradley University.

• The Upper Mississippi River Great Lakes Region Joint Venture 2000 Professional Award.

• President, 1994–95, Organization of Biological Field Stations

• Board of Directors, 1993–1994, American Institute of Biological Sciences.

• Member of several other professional organizations and committees including the Mississippi Flyway Technical Section.

• He was an organizational leader in the establishment of the U.S. Fish and Wildlife Service's Emiquon National Wildlife Refuge in Fulton County, Illinois, 1993.

Compiled by Katie Roat, Center for Wildlife and Plant Ecology

Channelization, a Major Factor Influencing Stream Condition in Illinois

Central Illinois was not always high and dry with tidy fields and arrow-straight ditches. During presettlement times this area was covered in native tallgrass prairie, a community promoted by fire. Along larger streams, because they provided firebrakes, a wooded riparian zone formed. This geologically young, prairie landform was poorly drained, a direct result of glaciation that scraped and filled extensive areas as recently as 10,000 to 15,000 years ago.

Despite the wet conditions, the soil was black, fertile, and attractive to farmers. To improve drainage, farmers straightened existing streams and shortening their length. In some cases, they created additional streams where none had existed, through ditching. In addition to creating ditches, farmers also tiled their fields, lowering the water table. Organization of farmers into cooperative, local drainage districts, with the power to levee taxes on landowners within a drainage, and the advent of powerful machinery have been effective at drastically changing drainage patterns. While these practices have allowed for a vast agricultural economy, they also have wrought negative consequences. Because of field tiling, stream channels now fill rapidly after rains and straightened stream channels carry this flow downstream causing erosion, flooding, and scouring of the streambed. The lowering of the water table contributes to low flows and algae-choked channels by late summer. The removal of trees from larger streams and the reduced groundwater flow in summer cause great fluctuations in stream temperature and losses of fauna needing cooler waters.

The Critical Trends Assessment Program (CTAP) (see http://ctap.inhs.uiuc.edu for details of this program) has been sampling Illinois streams at random locations. This design ensures that streams will be represented in the size and quality in which they occur statewide. This effort will help to assess the condition of both natural meandering streams and channelized ones, providing a clearer picture of how agricultural practices affect stream condition.

CTAP assesses stream condition using a Habitat Quality Index, the Hilsenhoff Biotic Index (HBI), and the EPT taxonomic richness (number of species of Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies]). The Habitat Quality Index estimates the potential for aquatic organisms to have suitable habitat in which to feed, hide, and reproduce in streams. It also assesses the ability of streamside vegetation to stabilize banks and trap nutrients. Habitat Quality Index values range from 0 to 180, with greater values indicating better habitat quality. EPT taxonomic richness is one of the most efficient biological indices of stream condition and corresponds well to more costly measures of ecosystem function. The HBI is a weighted average of the organic pollution tolerance of aquatic insects. Most EPT taxa in the region have been assigned tolerance values that range from 0 to 10; therefore, a site value may range from 0 to 10, with higher values indicating poorer condition.

Results presented here are from 149 sites sampled over a five-year period beginning in 1997. Sites were categorized as channelized or meandering, were regionalized by which of 10 Illinois Streams Information System (ISIS) basins they came from, and by stream width code (Code 1 = 1–2 m wetted width, width code 5 =>30 m). Additionally, an Overall Index, based on statewide percentiles for EPT, Habitat, and HBI was calculated for each site using the following equation:

Overall %ile = (EPT %ile * 0.4) + (HBI %ile * 0.2) + (Habitat %ile * 0.4)

HBI is not as sensitive to degradation of stream condition as EPT or Habitat; hence, its influence on the score has been reduced. Qualitative ratings (excellent, good, etc.) were constructed for each site based on the Overall Index (Table 1). Analysis of Variance was used to examine the effects of channelization, stream size, and ISIS basin on EPT, Habitat, HBI, and Overall Index.

RESULTS

EPT taxonomic richness was most affected by channelization. Streams with meandering channels produced an average of 11.8 EPT (n=88), while channelized streams produced 7.1 (n=61) taxa. This is a 40% difference! Stream width was also an important factor, with larger streams supporting more EPT taxa (Fig. 1). ISIS basin appeared not to be a significant fac-

Table 1. Percentile ranges and tentative quality ratings for stream ecological indicators.

Percentile Ranking for Ecological Indicators	Tentative Quality Rating
≥90	Excellent
≥75 to <90	Good
≥50 to <75	Fair
≥30 to <50	Poor
<30	Very Poor

Continued on next page.

Channelization

continued from previous page

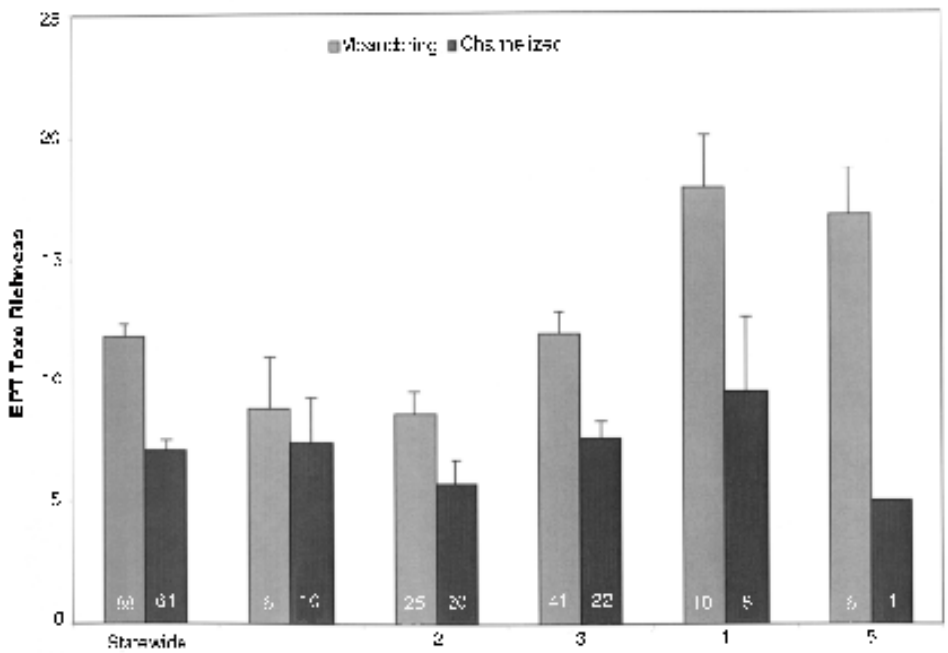


Figure 1. Mean EPT taxonomic richness + standard error for meandering and channelized streams statewide and for five stream width codes (increasing integer = increasing stream width). Numbers in bars indicate sample size. Statewide, channel types were statistically distinct as were widths 1, 2, and 3 and widths 4 and 5.

tor on its own, but an interaction between basin and stream width was detected. This complicates the picture somewhat, as it appears that some basins did not display an increase in EPT richness with increasing stream width. HBI, calculated from the EPT community, did not vary significantly in relation to the three factors. Most often, values were between five and six units. However, sites with much lower values were found in the Shawnee Hills of southern Illinois with a mean of 3.5 (n=5). It appeared that this index only has value in isolated areas across the state and in the Shawnee Hills in particular.

Habitat quality was heavily affected by channelization, with meandering streams scoring significantly higher (107.6 points) than channelized streams (70.9 points). While ISIS basin was not an important factor alone, it did interact with channelization to produce a significant result (Fig. 2). The Rock River and Spoon River basins appeared to have no significant differences in habitat quality for the two channel types, whereas significant differences existed in the other basins. These basins had the lowest habitat scores for meandering streams; hence, it may be that meandering streams in this region are too heavily impacted to demonstrate differences with channelized ones.

Overall Index values varied significantly with channelization, with meandering streams scoring an average 61.8% (fair quality from Table 1) and channelized streams scoring only 35.8% (poor quality). Neither ISIS basin nor width alone was a significant factor explaining Overall Index; however, a significant interaction between basin and width was noted. It appeared that Overall Index values (condition) improved with stream size, except in the Big Muddy, Little Wabash, and Rock basins. It appears that the smallest streams were the most heavily degraded in large agricultural drainages (Sangamon, Kankakee/ Vermilion/ Mackinaw) and in an urbanized one (Fox/ Des Plaines).

DISCUSSION

Because this sampling program was based on randomly selected sites, it is assumed that they are representative of the state as a whole and that inference about the quality of other streams, and the frequency in which they occur, may be drawn from this sample. Based on overall percentile scores, 45% of streams sampled by this program were rated as "poor" or "very poor" (Fig. 3). Some of the worst offenders (Overall Index < 10%) had less than two EPT (two had none), were channelized, and had no natural riparian zone. The percentages of fine sediment (sand, silt, and clay fractions combined) usually exceeded 80%, a trait promoted by heavy erosion. These poorest-of-the-poor were not relegated to any one basin, but could be found in any, whether urbanized or agricultural.

The chances of the program finding excellent quality streams were remote, but five (3%) were found that had overall percentile scores ≥90%. These streams supported in excess of 14 EPT taxa, had meandering courses, wide treed riparian zones, and produced some of the lowest HBI values in the state. The greatest proportion of streams with these characteristics can be found in the Shawnee Hills subsection of the Big Muddy basin, but can also be found anywhere in the state. It is imperative that these best sites are characterized, since they set the regional biotic potential for stream condition.

Channel type appeared to be the most important factor determining overall quality (and its components). Vast improvements could be made if this one stream characteristic was foc- used on in policy and restoration guidance given by state agencies. Re-establishment and widening of natural riparian zones

Continued on next page.

Channelization

continued from previous page

would reduce soil erosion, capture pollutants, reduce algal blooms, and ameliorate water temperatures. Restoration is a long-term endeavor, especially so for sensitive aquatic insects that reside now only in islands of suitable habitat or at the periphery of the state.

Large-scale restorations might require reintroduction of the most sensitive, least vagile species to help bridge geographic gaps between restored habitat and recolonization sources.

Dr. R. Edward DeWalt, Center for Biodiversity Critical Trends Assessment Program

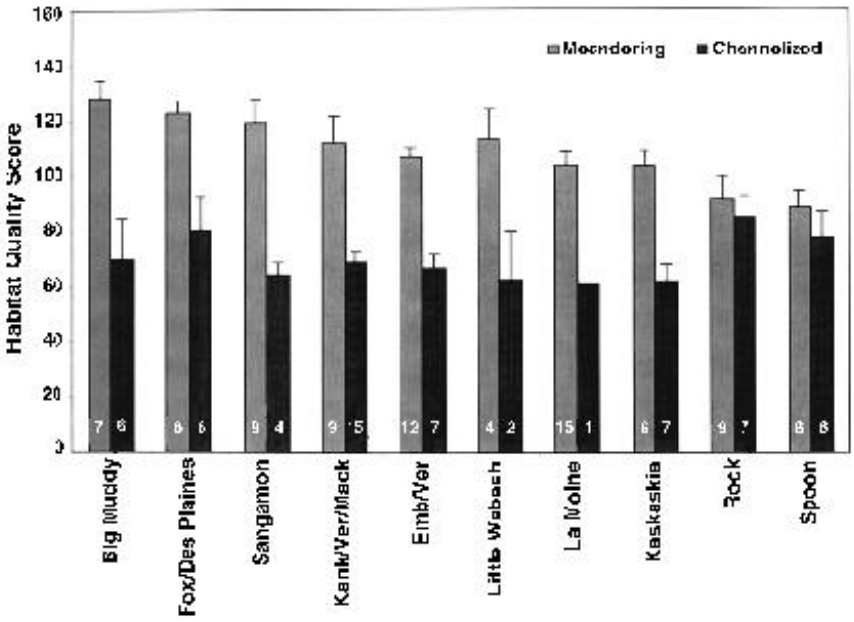


Figure 2. CTAP stream sampling mean Habitat Quality Index score + standard error for ISIS basins by channel type. Numbers in bars indicate sample size. Note that Rock and Spoon basins are similar for both channel types.

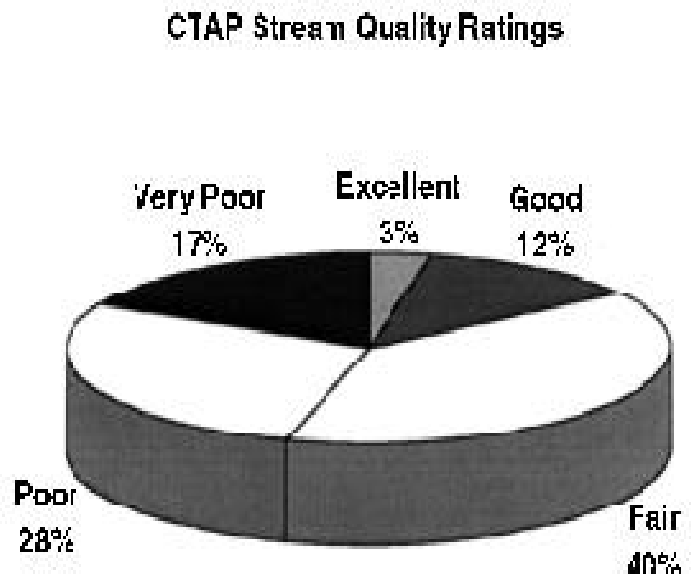


Figure 3. Summary of qualitative stream ratings based on Overall Index values for 149 streams.

Critical Trends Assessment Program Web Page: A Window into Illinois Habitats

The Critical Trends Assessment Program (CTAP) is a long-term endeavor to monitor the condition of forests, wetlands, grasslands, and streams throughout the state of Illinois. Data on plants, birds, and terrestrial and aquatic insects are collected. The main purpose of conducting this monitoring is to assess long-term changes in ecological conditions as well as to develop a baseline from which to compare regional and site-specific patterns throughout Illinois. In 2001, the Illinois Natural History Survey CTAP biologists finished the first five-year cycle of this statewide monitoring program. After collecting data from 1997 through 2001 and putting out written reports, it became clear that a new format was needed to present our data. The Internet provided a perfect tool to accomplish this. The new CTAP Web page (http://ctap.inhs.uiuc.edu/) was created to meet the challenges of promoting the program and presenting statewide data to the people of Illinois.

The CTAP Web page provides a general description of the monitoring program. In addition, it provides links to the main Illinois Department of Natural Resources-CTAP Web page (http://dnr.state.il.us/orep/ctap/) where additional information about the history of the program can be found. Several features are available for the users on our Web site starting with "Monitoring Protocols." This portion of the site gives a general overview of our monitoring protocols. A PDF file with our official protocols is available for downloading. This file gives a detailed explanation of our protocols, including the site selection process, sampling procedures, and datasheets that the program uses. The main purpose of providing such detailed documents is to allow any group to download the information and conduct monitoring across the state using our protocols. The advantages are many since users can query our databases to answer questions related to state and local habitats.

Next, you can find "On-line Data," one of our vehicles of data dissemination. Several unique features are provided. The CTAP Database search engine allows searches by habitat, taxa, and geographical area. These searches are available under "Site Fact Sheets," "Regionalized Fact Sheets," and "Species." Site fact sheets are available for each CTAP study site for plants, birds, and aquatic insects (ETP), and, in the near future, the terrestrial insect data will be available. Each fact sheet has summary information for the site, including ecological indicators, site photos, and a species list. In addition, these site-specific data are compared with statewide averages. Also, you can view a map for each habitat with a hot link to each of these fact sheets.

Beside the CTAP Database search engine, we have summarized the data into tables under the heading "Data Matrix for Professional Scientists Monitoring—Plants, Birds, and EPT" under "On-line Data." These tables can be downloaded as text (i.e., tab delimited) or Excel files. Some fields have been password protected since we want to protect specific site locations. All the data are generated through an Access database. Also under "On-line Data" you will find that we host the EcoWatch data (our sister group) in a similar format as described previously, and we provide the link to the data entry portion of this program (see "Data Input").

In addition to the described features, the CTAP Web page provides other useful resources such as publications. Here you will find all CTAP professional scientists' reports including annual reports and other publications where CTAP data have been used. For example, CTAP—Invasive Plant Species in Illinois Forests is a series of maps showing the distribution of nine invasive species, such as garlic mustard, across the state. In addition, a link to CTAP regional assessments is provided. Our Geographical Information System page is still under development, but will provide links to very useful information such as the map *Land Cover of Illinois in the Early 1800s*. Also, you can find a glossary page that provides explanations for all pertinent scientific or data-related terms. Finally, we have a sign-in feature that allows users to access some protected data on the Web. However, additional data requests, such as the raw data, can be obtained by contacting one of our staff members (see "People").

As new information is gathered during the second cycle of the program (2002–2006), our data will be updated on the Web. Targeting a Web page that will meet the needs of every user is not an easy task. As a program, CTAP has realized the importance of developing a Web page that is easy to navigate and where with the click of a button, reliable information about the state can be found.

Brenda Molano-Flores, INHS CTAP Coordinator

Transmission Cycle of *Neospora caninum*: A Single-cell Parasite at the Interface Between Domestic and Wildlife Species

Neospora caninum is a single-cell parasite recognized worldwide as a major cause of abortion and neonatal mortality in cattle, resulting in substantial economic losses to the cattle industry. Cattle are believed to become infected through the consumption of soil, water, or feed contaminated with canine feces containing *N. caninum* oocysts (the stage of the parasite capable of surviving in the environment). In 1998, domestic dogs were confirmed as definitive hosts of *N. caninum*. That is, in dogs, *N. caninum* can complete its life cycle resulting in the shedding of oocysts in feces. Alternatively, *N. caninum* can only undergo part of its development in intermediate hosts such as cattle, where the parasite remains encysted (encapsulated) in tissues. Dogs and other scavengers may then become infected through the consumption of *Neospora*-infected tissues, such as bovine meat, placenta, or aborted fetuses.

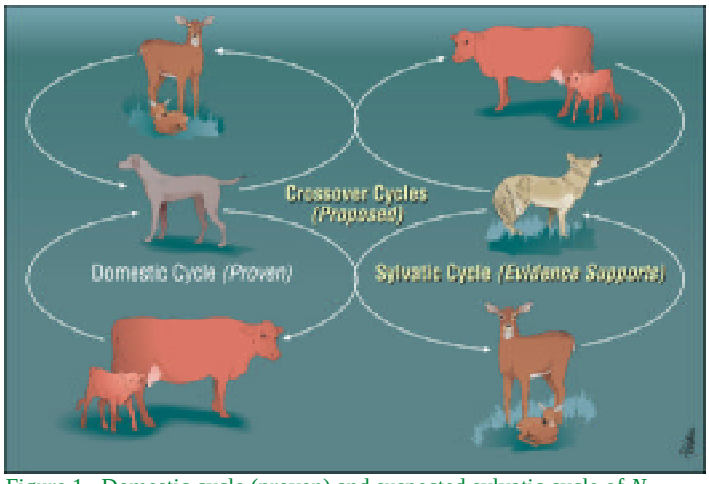


Figure 1. Domestic cycle (proven) and suspected sylvatic cycle of *N. caninum* (now confirmed) as they overlap across species. Illustration by Kerry Helms, University of Illinois

While the domestic cycle of *N. caninum* had been documented, the wildlife (sylvatic) cycle remained unknown. We suspected that wild canids and deer were natural reservoirs for *N. caninum* and that they shared the transmission cycle of the parasite with domestic animals (Fig. 1). During the hunting seasons, abundant offal (resulting from field dressing deer) becomes available for consumption by dogs and wild canids. This creates potential seasonal increases in the risk of *N. caninum* transmission from wild cervids to canids. Seroprevalence and clinical studies in deer had provided indirect evidence that deer may take the place of cattle as intermediate hosts. Likewise, reports of *N. caninum* antibodies in coyotes, dingoes, and red foxes suggested that like domestic dogs, wild canids could play a role in parasite transmission.

We detected seropositivity (antibodies for *N. caninum*) in 16.6% of 42 coyotes sampled in Illinois between 1997 and 1998. On December 2001 during the second firearm deer hunting season in Illinois, we found seropositive test results in 50% of 30 hunter-killed white-tailed deer. Our subsequent serological studies aimed at the detection of antibodies for *N. caninum* in wild animals detected 38.4% of 164 gray wolves, 10.6% of 113 coyotes, 25.9% of 193 white-tailed deer, and 13.1% of 61 moose seropositive for *N caninum*.

These data supported, but did not confirm, the existence of a sylvatic cycle of *N. caninum*. In an effort to gather more information, paired blood samples and brain tissues were collected from deer during the 2001 deer hunting season. Tissue samples from *N. caninum* seropositive deer were fed to dogs which resulted in the shedding of *N. caninum* oocysts, indicating that deer are efficient intermediate hosts of the parasite and are capable of transmitting *N. caninum* to domestic dogs. Recently, coyotes were demonstrated to shed *N. caninum* oocysts after consuming tissues from *N. caninum*-infected cattle. In order to compare the isolated *N. caninum* parasites obtained from deer and from cattle, we sequenced the internal transcribed spacer 1 (ITS1) region of the ribosomal DNA from each isolate, and the results were identical. These findings indicate that *N. caninum* has probably been cycling between domestic and wild animals.

The discovery of new wildlife hosts of *N. caninum* and the ability of the parasite to cycle among domestic and wild animals pose new challenges for the control of neosporosis (disease caused by *N. caninum*). Further investigations are needed to determine the risk of transmission of *N. caninum* between wildlife and domestic livestock, and to compare the efficiency of the sylvatic and the domestic cycle based on number of oocysts shed by the definitive hosts under similar challenges. Additional studies are also needed to understand the impact of neosporosis on wildlife populations. A fatal case of neosporosis in a Californian black-tailed deer and postmortem findings of the parasite in a full-term, still-born deer in France provide evidence that clinical neosporosis in deer might be similar to cattle.

Luis F. Pita Gondim and Milton M. McAllister, University of Illinois; Nohra Mateus-Pinilla, Center for Wildlife and Plant Ecology; William C. Pitt, National Wildlife Research Center, Hilo Field Station, Hilo, Hawaii; David Mech and Michael Nelson, USGS Northern Prairie Wildlife Research Center, Minnesota; Mark S. Lenarz, Minnesota Department of Natural Resources

Species Spotlight

Devil Crayfish

Susan Post

Mudbugs, ditch bugs, river lobsters, crawly bottoms, or crawdads are all common names for crayfish, a group of arthropods that resembles miniature lobsters. Crayfish are common inhabitants of wetlands—from springs to large rivers, damp meadows to swamps and ditches. There are approximately 353 species of crayfish in the U.S. with 95% of them found in the Southeast. Illinois has 21 species of native crayfish.

The devil crayfish (Cambarus diogenes).
Photo by Chris Taylor, Center for Biodiversity

A species found throughout Illinois is the devil crayfish, *Cambarus diogenes*, named after the Greek philosopher Diogenes. They are multicolored, brown to brownish red, green to blue, and are 36 to 48 mm in length. Like all crayfish they have two body regions, a cephalothorax and abdomen. The cephalothorax is the head and thorax fused together and enclosed in a hard outer covering called a carapace. Crayfish breathe through gills that are located under the carapace. Their eyes are on moveable stalks that allow sight in different directions. Five pairs of jointed legs are present on the cephalothorax. The first pair are pincerlike and called chelae. On the last segment of the abdomen is a broad flipper that helps propel the crayfish through the water. By folding their abdomens down and forward, they are also able to swim backwards.

Crayfish are omnivores and will consume whatever food is available. While their primary food is usually decaying and living plant material, they will also consume aquatic worms, insects, snails, and dead animal matter.

The devil crayfish is abundant in the Shawnee Hills and the Coastal Plain of southern Illinois, while it is less common in northern and western Illinois. It is found primarily along streams or in lowland areas having clay soil. It is in these lowlands that colonies often occur with hundreds of chimneys.

The devil crayfish lives in a burrow with a cone-shaped mud chimney. Its burrow can be up to a meter in length and is usually at the side of a stream or pond. The chimney-topped hole leads to an underwater chamber and a second nearly horizontal tunnel leads into the stream. The crayfish does its digging at night. The chimneys are piles of pellets of mud or clay that the crayfish brings up and deposits around the opening of its burrow. These burrows can serve as refuges not only for the crayfish but other organisms. An interesting relationship has developed with the endangered Hines emerald dragonfly and the devil crayfish. The dragonfly's larvae will spend time in these burrows if their primary habitat dries up; however, the crayfish are potential predators of the dragonfly. This relationship is being studied at the Illinois Natural History Survey.

Crayfish leave their burrows either in the fall or late winter-early spring to mate in open water. The females will carry the sperm until oviposition. In Illinois, the devil crayfish will produce eggs from March to May. The female carries the eggs on the short appendages of her abdomen. These abdominal appendages are in constant motion to keep water flowing over the eggs. Females brood the eggs until they are hatched. The newly hatched crayfish hold onto their mother until they molt two or three times. Once the young leave their mother, they seek cover in rocky parts of streams or the marginal vegetation of standing water until they are large enough (about 20 mm in length) to burrow. The young crayfish will become capable of reproducing after they have molted 6–10 times.

Threats to crayfish populations include habitat damage caused by impoundments, stream channelization, pollution, and sedimentation. The biggest threat,however, is nonnative crayfish introduced as fishing bait.

Definitions

jambalaya—an herb-seasoned, southern rice dish often prepared with crayfish, shrimp, or oysters.

etouffee—a crayfish stew, usually served over rice.

Solution

The Naturalist's Apprentice

Crayfish Word Search

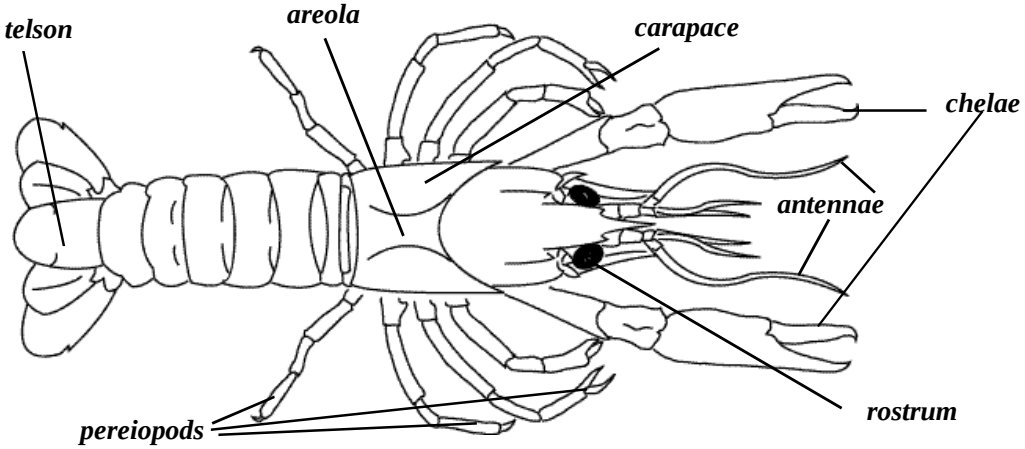
Carolyn Nixon

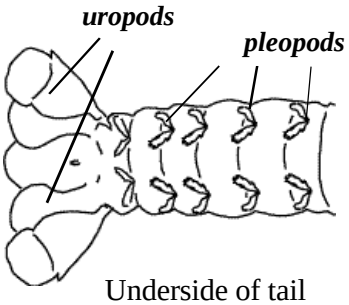
Crayfish Word Search

Below are lists of crayfish names, habitats, anatomy, and recipes that use crayfish as an ingredient. There is also a diagram showing crayfish external anatomy. Search the grid of letters below for these hidden words. The words can be horizontal, vertical, or diagonal and begin from either end (for example, rivers or srevir).

Crayfish names	Crayfish habitats	Crayfish recipes	Crayfish anatomy
decapoda	**rivers**	**jambalaya**	**telson**
crustacean	**marsh**	**etouffee**	**chelae**
crayfish	**streams**		**areola**
crawfish	**swamps**		**pereiopods**
crawdad	**chimneys**		**pleopods**
mud bug	**caves**		**antenna**
			carapace
			uropods
			rostrum

G O D G I L L I E C A P A R A C
Y P L E O P O D S R T C W L T M
S E V A C R A Y F I S H O R R A
P H I L H A L I K I T E L S O N
P E R E I O P O D S R L L A S T
D E K I M S T O S A E A I Y T E
A N T E N N A M D Z A E W A R N
D R O S E C C S W A M P S L U N
W L A D Y O R K Y P S I D A M A
A C R U S T A C E A N K O B S I
R E I R A C W W I G M A P M U T
C M E T O U F F E E I T O A S S
N I X O N R I V E R S B R J A O
L A M A R S H S G U B D U M N P





Underside of tail

ILLINOIS
NATURAL
HISTORY
SURVEY

607 East Peabody Drive,
Champaign, Illinois
61820 USA

Non-Profit Org.
U. S. Postage
PAID
Champaign, IL 61820
Permit 75

Teasel

continued from front page

family (Dipsacaceae) are exotic—there are no native relatives in the family. Thus, when conducting tests to assure specificity of arthropod agents, there are no close relatives to test, meaning the initial assays will be conducted using relatives of teasel from the Old World. Although host specificity of agents is still critical, the lack of close relatives may make the process of finding biological control agents a little easier.

At the same time that the foreign exploration is ongoing, we are studying the ecology of the plant in Illinois habitats. Our studies along Interstate 72 near Decatur and at the Mascoutin State Recreation Area at Clinton Lake have already shown increases in size of teasel patches due to mowing and dispersal of seeds by wind, rather than by vehicular traffic. We currently are looking to determine if any native insects or mites may be feeding on the plant. We also are assessing other control methods, such as the optimal timing of mowing to minimize seed spread and whether combinations of mowing and herbicide use may make the plant more vulnerable to multiple tactics. We hope that these studies will prepare us for the potential introduction of arthropod agents and help us fit biological control into the current management regimens.

Teasel leaf in France shows insect feeding damage caused by its natural enemies. Photo courtesy of USDA-ARS European Biological Control Laboratory, Montpellier, France

Robert Wiedenmann, Center for Ecological Entomology and Judy A.D. Parrish, Millikin University and affiliate of Center for Ecological Entomology

Illinois Natural History Survey Reports is published quarterly by the Illinois Natural History Survey, 607 East Peabody Drive, Champaign, IL 61820. Headquartered on the campus of the University of Illinois at Urbana-Champaign, the Survey is a division of the Illinois Department of Natural Resources.

INHS Reports is edited by Tom Rice and Charlie Warwick and printed on recycled and recyclable paper. Design by Otto-Walker Communications.