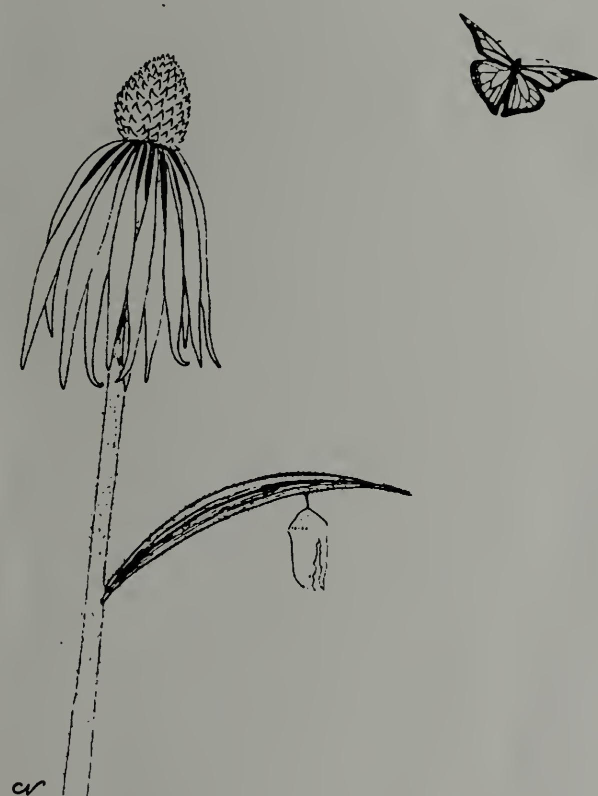
Critical Trends Assessment Program

2002 Report



Illinois Department of Natural Resources

Critical Trends Assessment Program
2002 Report

Illinois Department of Natural Resources

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Kankakee River
Kaskaskia River
Kinkaid Area
Kishwaukee River
Lower Des Plaines River
Lower Sangamon River
Lower Rock River
Mackinaw River
Prairie Parklands
Sinkhole Plain
Spoon River
Sugar-Pecatonica Rivers
Thorn Creek
Upper Des Plaines River
Upper Rock River
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Introduction

The Critical Trends Assessment Program was established in 1992 to inform policymakers about the state of Illinois' ecosystems. During the decade since then, CTAP has developed tools and programs to systematically monitor changes in ecological conditions in Illinois. These programs not only help policymakers determine the best course of action to protect our natural resources, but also provide information to state and local land managers and the public as stewards of Illinois lands and waterways.

Each year CTAP produces a report that provides the most current data and analysis on Illinois ecosystems. This year efforts have focused on making the information more accessible and understandable to the public and other users. Ten papers written by CTAP and EcoWatch scientists have been compiled. The CTAP scientists have just completed their first five-year cycle of monitoring streams, forests, grasslands and wetlands across the state. EcoWatch volunteers have completed another year of stream, forest, and prairie monitoring.

The first two papers are part of an effort to make all of the data that RiverWatch volunteers collect intelligible. Virtually every piece of data entered on a RiverWatch datasheet is boiled down into two numbers: a biological score and a habitat score. The biological score combines five measures of biological quality — MBI, EPT, taxa richness, dominance, and percent worms — into a single index. The habitat score incorporates habitat-related measures shown to be correlated with biological quality, including stream substrate, surrounding land uses, silt, water odor, water appearance, canopy cover, and channel disturbance. No longer will volunteers have to guess what their results mean. Their stream report card will tell them.

In the third paper, similar efforts were made with CTAP stream data. Overall quality rankings for each site were generated by combining EPT, HBI, and Habitat, three measures of stream quality. Rankings for the 149 monitoring sites varied significantly across the state with streams in the Shawnee Hills showing the best HBI scores and the highest proportion of excellent streams. In general, streams with meandering channels scored higher, supporting 40% more EPT taxa on average than channelized streams. Larger streams generally scored higher as well because of their more diverse habitats.

The fourth paper shows that, surprisingly, the sites we do not monitor often tell us as much as those we do monitor. In identifying monitoring sites, CTAP scientists often reject many sites before finding one suitable for monitoring. Grassland sites are most frequently rejected and forest sites least often rejected. One and a half forest sites are evaluated for each one that is found to be suitable for monitoring, while it takes three wetland sites and seven grassland sites to find a suitable monitoring site. Some sites do not meet the monitoring criteria; generally they are two small or too degraded. For example, grasslands are frequently regularly mowed monocultures. However, nearly a third of wetland and grassland sites no longer exist as that habitat even though they were identified by the Land Cover Map or the National Wetland Inventory. Most frequently they have been converted to row crops. It seems that many grassland or wetland sites move in and out of cultivation depending on weather and economics.

The fifth paper presents results from the initial five year cycle of bird censusing at CTAP sites, with a focus on habitat dependent, area dependent, threatened and endangered, and exotic species. Illinois forests seem to be in the best condition compared to wetlands and grasslands, with a fair diversity of forest bird species. Grasslands continue to be the most degraded habitat for birds. Almost one-third of grassland sites contain no grassland-dependent species and four-fifths have no area-dependent birds. A few wetland-dependent birds are relatively common in many Illinois wetlands (including Wood Duck, Mallard, and Willow Flycatcher), although half of the wetland sites contain no wetland-dependent species. The Brown-headed Cowbird, a nest parasite, was detected at a high percentage of sites across all habitats, ranging from 53% of wetland sites to

80% of forest sites. Overall, the data illustrate the degraded nature of Illinois habitats and the avian communities they harbor.

The sixth paper presents the results from the 58 ForestWatch sites monitored by citizen scientists during last year's fall monitoring session and 42 sites monitored in the spring session. One-fourth of the oak-hickory upland sites showed some degree of maple takeover. Half of the sites with flowering dogwoods reported dogwood anthracnose during the 2001 monitoring period, an increase over previous years. More than two-thirds of sites contain invasive shrubs, such as multi-flora rose or buckthorn. They cover 80 times the area covered by disturbance-sensitive plants.

The seventh paper highlights the data from EcoWatch's newest program, PrairieWatch. Of the 27 prairie sites monitored in 2001 and 2002, 11 were reconstructions and eight were remnants (the remainder were unspecified). While volunteers encountered a familiar excess of invasives and dearth of disturbance-sensitive species, the prairie sites were healthier than the typical forest site or the typical Illinois grassland that is dominated by introduced grasses. Disturbance-sensitive indicator plants covered one-fourth the area covered by invasives. At 13 sites PrairieWatch volunteers counted 735 butterflies, half of them indicator species that they had been trained to identify. The new Illinois Butterfly Site Index requires further testing to establish its relationship to plant habitat quality.

The eighth paper summarizes the findings from the 224 sites that RiverWatchers monitored in 2002. Most streams support high numbers of taxa that are somewhat tolerant of pollution, such as sowbugs and midges, indicating some level of habitat degradation or pollution. However, pollution intolerant taxa manage to survive in small pockets. Some watersheds are in better health than others. The Kaskaskia, for example, scores relatively low on most stream indicators, while the Rock River scores fairly high.

The final two papers examined the usefulness of Floristic Quality Assessment and leafhopper species to measure the quality of terrestrial ecosystems. FQA was found to be an excellent measure of the amount of degradation an area had undergone; it was highly correlated with natural area grade. Wetlands generally scored higher in floristic quality than grasslands and southern Illinois scored higher than other parts of the state. Further work is needed to take the wealth of leafhopper and other insect data collected by CTAP scientists and create indicators of ecosystem quality. Information on arthropod ecology, distribution, and diversity can help to complete the picture of the quality of Illinois ecosystems.

Creating a Report Card for RiverWatch Stream Quality: Multi-Metric Biological Score

David Baker

Introduction

EcoWatch citizen scientists collect and identify a sample of macroinvertebrates each spring during RiverWatch monitoring. This information becomes the basis for calculating five different biological indicators of stream quality—MBI, EPT richness, total taxa richness, dominance, and percent worms. RiverWatchers also collect a wide variety of habitat and physical data that can be, although so far has not been, used to gauge the quality of local streams. However, even for the biological indicators, it is not always clear what a particular value means.

This paper and the one following it describe an effort to make all of the data that RiverWatch volunteers collect intelligible. Virtually every piece of data entered on a RiverWatch datasheet is boiled down into two numbers—a habitat score and a biological score. Each of these scores gets a percentile ranking from 1 to 100, so that volunteers know whether their stream scored in the 5th percentile or the 99th percentile. Every site score also will be rated as excellent, good, fair or poor. No longer will volunteers have to guess what their results mean. Their stream report card will tell them.

Methods

Several steps were necessary to develop a biological report card for streams:

1. Put each indicator on a common scale,
2. Adjust for bias by using random sites weighted by natural division,
3. Assign weights to the indicators based on the strength of their relationships to watershed disturbance,
4. Combine the biological indicators into a single index or "biological score",
5. Stratify the streams by natural division and stream width,
6. Define undisturbed or "reference" conditions for each natural division/width group,
7. Categorize biological scores into quality categories based on the reference conditions.

RiverWatch Biological Indicators

Macroinvertebrate Biotic Index (MBI) provides a weighted average of the pollution tolerance of indicator organisms in a sample, measured on a scale from one to 11. Higher values indicate more organic pollution, while lower values indicate less organic pollution.

Taxa Richness is the total number of taxa identified in a sample out of the 37 indicator taxa that RiverWatchers are trained to identify. Generally, taxa richness increases with water quality and habitat diversity.

EPT Taxa Richness is the number of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa present in a sample. EPT are most diverse in natural streams and decline with increasing watershed disturbance.

Taxa Dominance measures the percentage of the three most common taxa compared to the rest of the sample. Dominance by just a few taxa indicates lower stream quality. Generally, a value greater than 80% is considered low aquatic diversity.

Percent Worms is the percent of the sample represented by Aquatic Worms and Bloodworm Midges. A high percentage of these organisms indicates poor stream health.

In the first few steps a composite or multi-metric biological score was created. In the last few steps we defined what the scores mean, in terms of stream quality. Like a teacher in a classroom, we determined the curriculum (a set of indicators in this case), assigned weights to each subject, and developed the grading scale.

A few different statistics were employed to create the multi-metric biological index for stream quality—means, standard deviations, correlations, and analysis of variance. The mean is merely the arithmetic average, while the standard deviation is a widely used measure of the dispersion of observations around the mean. Typically, about two-thirds of observations are within one standard deviation of the mean and 95% are within two standard deviations. In the analysis, the mean and standard deviation have been used to estimate what percentile rank a particular observation holds in the distribution of biological scores.

Correlation coefficients are used to gauge the strength of relationships among variables. A coefficient close to 1.0 indicates a perfect 1:1 relationship, while a coefficient close to zero indicates no relationship. In the analysis, the correlation coefficients were used to decide how to weight each biological indicator in the composite biological index, based on how strongly each was correlated with measures of disturbance.

Table 1. Mean and standard deviation of biological indicators

	Random Sites		All Sites	
	mean	stand dev	mean	stand dev
MBI	5.84	0.97	6.00	1.07
EPT	2.56	1.99	2.36	1.93
Taxa Richness	9.12	3.81	9.21	3.44
Dominance	0.79	0.15	0.80	0.14
%Worms	0.07	0.14	0.08	0.16
Bio Score	50	21	53	29

Table 2. Percentile ranks for biological indicators

Percentile Rank	MBI	EPT	Taxa Richness	Dominance	% Worms
0	11.0	0.0	1	100%	100%
10	7.1	0.0	4	98.4%	24.3%
20	6.6	1.0	6	91.7%	18.3%
30	6.3	1.5	7	86.8%	14.0%
40	6.1	2.0	8	82.6%	10.2%
50	5.8	2.5	9	78.8%	6.7%
60	5.6	3.0	10	74.8%	3.2%
70	5.3	3.5	11	70.7%	0%
80	5.0	4.0	12	65.8%	0%
90	4.6	5.0	14	59.1%	0%
100	≤2.6	≥7	≥17	≤48.5%	0%

In scaling the indicators, sources of bias must also be addressed—no cheating allowed. Most RiverWatch sites are selected by volunteers and may not be representative of statewide conditions. A subset of monitoring sites has been randomly selected, and it is these sites that have been used to scale the indicators. EcoWatch volunteers have collected 158 samples from 79 randomly selected sites.[+] Even these sites may not be truly representative, since it has been more difficult to recruit volunteers in some areas than in others. For example, 47.5% of random sites are located in the Northeast Morainal division, but only 6.9% of streams are located there. This additional source of bias has been addressed by weighting the mean and standard deviations of the random sites by the distribution of streams within each natural division (Table 3).

Table 3. Distribution of monitoring sites by natural division

Natural Division*	All Monitoring Sites (1877 samples)	Random Sites (158 samples)	Distribution of Streams**
Driftless/Rock	7.1%	5.1%	5.1%
Northeast Morainal	27.8%	47.5%	6.9%
Grand Prairie	23.8%	22.2%	39.5%
Western Forest-Prairie	17.3%	13.3%	16.6%
Southern Till/Wabash	12.7%	8.9%	25.5%
Shawnee/Ozark	12.0%	3.2%	4.7%
Other	0.0%	0.0%	1.7%

*The 14 Natural Divisions have been consolidated into six groups. See discussion below.
**Based on number of sections (each generally one-mile square) that contains streams.

Weighting Indicators Based on Watershed Disturbance

Just as core classes are weighted more heavily than gym or health, the core biological indicators should be weighted more heavily than secondary indicators. The best indicators of biological quality should score high when a stream is relatively undisturbed (that is, in a natural state) and low when the stream is disturbed by human development. The problem is to find an objective measure of watershed disturbance that can be used to gauge the strength of the biological indicators. In a recent effort to recalibrate the Index of Biological Integrity (IBI)—a multi-metric index based largely on fish data—the DNR and IEPA developed just such a measure of disturbance for the 815 watersheds in the state. In fact, they developed two different versions of the measure for evaluating disturbance to stream sites. The first reflects the disturbance in the watershed where the site is located, while the second assesses the disturbance in the entire drainage above the site.

The two disturbance ratings take into account seven different measures of disturbance:

1. Proportion of undisturbed land (i.e. upland forest, wetland, bottomland forest)
2. Proportion of disturbed land (i.e. urban, agricultural, barren)
3. Proportion of strip-mined land
4. Maximum storage of impounded water
5. Maximum storage of impounded industrial, mining, or sewage wastewater
6. Number of hazardous point sources
7. Number of sewage point sources

[+] Volunteers collected 181 total samples at the randomly-selected sites, but only the 158 that contained at least 25 organisms were included in the analysis, because low sample densities do not result in consistent scores.

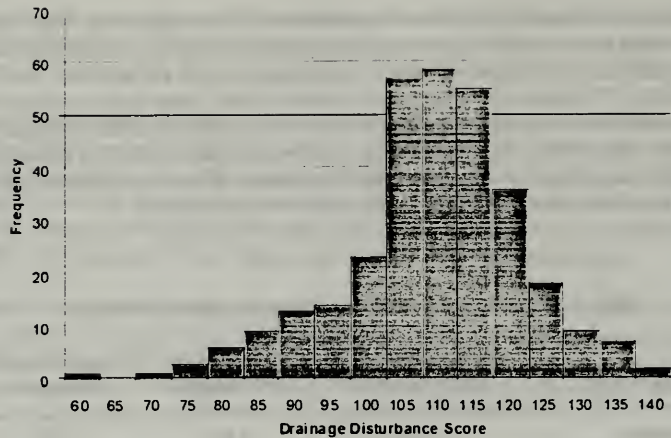

Figure 1. Distribution of disturbance scores for the 317 watersheds monitored by RiverWatch

Each watershed receives a score of 1 to 20 for each measure, resulting in a total possible score of 7 to 140. Actual scores range from 60 to a perfect score of 140, with an average of 110 (Fig. 1). Between 1996 and 2001, RiverWatch volunteers sampled streams in 317 of the 815 watersheds (nearly 40% of the total), collecting from 1 to 47 samples in each.

Table 4 shows the relationships between the biological indicators and the two different versions of the disturbance measure. Disturbance in the entire drainage seems to be more important to stream quality than the disturbance in the local watershed, based on the strength of the correlations. All of the RiverWatch biological indicators are significantly related to the drainage disturbance score. While the correlations are not extremely strong (.10 to .22), they are all statistically significant.

Table 4. Correlations between biological indicators and disturbance scores

Biological Indicator	Watershed Disturbance Score	Drainage Disturbance Score	Weights
MBI	**-.200**	**-.220**	2
EPT	**.136**	**.200**	2
Taxa Richness	.045	**.106**	1
Dominance	-.053	**-.125**	1
Percent Worms	**-.138**	**-.143**	1

Note: **Bold** are statistically significant at the .05 level or better.

MBI and EPT are more strongly correlated to disturbance than are taxa richness, dominance and percent worms. Therefore, the core indicators MBI and EPT are weighted double and the other indicators only once in the multi-metric biological index.

Defining Stream Quality Levels

Stratification by Natural Division and Stream Width

Junior high students naturally perform better than elementary school students. Teachers do not compare how a student performs in their first grade class with a student in sixth grade; they only compare their first grader to other first graders. Similarly, certain streams naturally perform better (or worse) on various measures based on certain natural conditions and should only be compared to streams of a similar type. Illinois has been divided into 14 natural divisions based on topography, glacial history, bedrock, soils, weather and distribution of plants and animals. Tetra Tech, the consultant that is assisting the IEPA in improving its stream indicators, categorized streams by natural divisions that were grouped into a handful of categories.*

Analysis of the RiverWatch data revealed that Illinois streams could be grouped into six categories based on similarities in the way contiguous natural divisions scored on the various stream indicators (Table 5).** For example, streams in the Ozark, Shawnee, and Coastal Plain natural divisions in far southern Illinois generally scored high on most of the biological indicators, while those in the Southern Till Plain and Wabash Border in southeastern Illinois generally scored low.

Table 5. Grouping of natural divisions based on indicator quality

	Disturbance Rating	MBI	EPT	Dominance	%Worms	Taxa Richness
Driftless Rock	Med Med low	Hi Med	Med hi Med	Med Med	Hi Med hi	Hi Med hi
NE Morainal	Low	Low	Low	Med low	Med	Med hi
Grand Prairie Upper MS/IL Bott.	Low Med	Med Med	Hi Hi	Hi Hi	Med Med	Hi Hi
Wn Forest Prairie Mid. Miss.	Med Med	Low Med	Med Med	Med Low	Med Med hi	Med hi Med
Southern Till Wabash	Low Low	Low Low	Low Med	Low Low	Low Low	Low Low
Ozark Shawnee Coastal Plain	Hi Hi Hi	Hi Hi Med hi	Hi Hi Med hi	Hi Med Hi	Hi Hi Hi	Hi Hi Hi

In addition to differences characterized by natural division, streams can vary in quality based on the size of the stream (Fig. 2). Generally, larger streams score higher on measures of biological integrity, largely because they have more diverse habitats (Table 6). Only in the older, unglaciated areas like the Driftless or Shawnee/ Ozark does stream width not seem to be related to quality, according to the analysis of variance. Eight meters or about 25 feet seems to be a critical cut off between large and small streams; so small streams are defined as those under 25 feet in width and large streams those that are at least 25 feet in width. About 70% of the streams monitored by volunteers are small and 30% large. All of the biological indicators show statistically significant differences between small and large streams.

* Based on a seminar by Tetra Tech sponsored by IEPA.,

** Two small natural divisions—Illinois River and Mississippi River Sand Area, and Lower Mississippi Bottomlands—had few or no sites and were left out of the analysis.

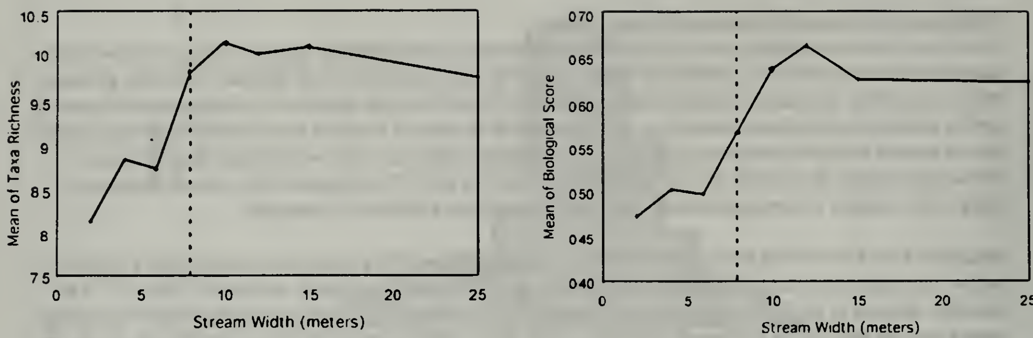

Figure 2. Mean taxa richness and mean biological score by stream width

Table 6. Differences between small and large streams

	Width Category	N	Mean
MB1	small large	1122 467	**5.80** **5.47**
EPT	small large	1122 467	**2.30** **3.57**
Taxa Richness	small large	1122 467	**8.60** **10.18**
Dominance	small large	1122 467	**82.1%** **76.7%**
% Worms	small large	1122 467	**6.3%** **4.2%**
Biological Score	small large	1122 467	**49.05** **63.02**

Note: **Bold** indicates statistically significant differences.

Figure 3 shows the final stratification of streams by natural division and stream width. It shows that the Northeast Morainal and Southern Till/Wabash streams scored the lowest on average, while the Driftless/Rock and Shawnee/Ozark streams scored the highest. It also shows that wider streams, at least in several natural divisions, also scored higher on average. It does not reveal, however, whether these differences are natural differences or attributable to local stream conditions and disturbances. Nor does it tell us what a good stream should score versus a poor stream.

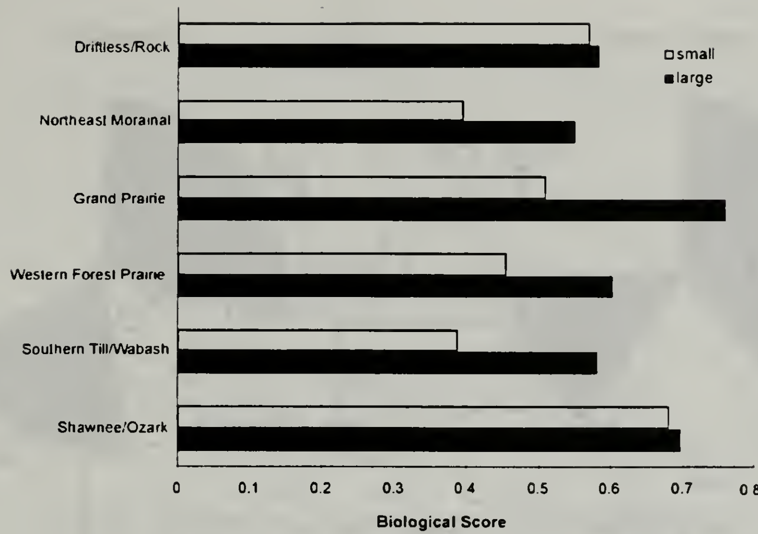

Figure 3. Average biological scores stratified by natural division and stream size

<u>Defining Reference Conditions</u>
What constitutes an "A" or excellent quality? Teachers often scale the grades on a particular term paper based on the best papers, those prepared by the best students. When evaluating natural systems, like a stream, scientists generally define excellent quality based on reference conditions, that is sites that are the most pristine. In Illinois, very few streams are in pristine condition, but those that are least disturbed can be identified.

Illinois EPA used the Watershed Disturbance Measure to help identify potential reference sites for the IBI along with a couple of additional "screens". If any "undisturbed" site showed chemical contamination it was excluded. The regional aquatic biologists were also asked to identify any sites that they knew to be locally "disturbed". The final list of reference sites included about 15% of the total pool of sites. Because of the lack of both chemical data and professionals familiar with local sites, a slightly different approach was applied in this study. The Drainage Disturbance Measure was used as the primary screen, but two other screens were applied as well.

- The reference sites must score above the 75th percentile on the Drainage Disturbance Score.
- They must score above the 75th percentile on the Habitat Score.
- The few remaining sites that score below the 25th percentile on the Biological Score are excluded.

An **excellent** stream is then defined as a stream that scores above the average of the reference sites, a **good** stream scores within one standard deviation of the average, a **fair** stream is within two standard deviations, and a **poor** stream scores beyond two standard deviations (Table 7). Other scoring schemes are possible, but this is one that is easily justified. The IBI similarly defines its highest category by the mean of the reference sites, but defines its other categories in a slightly different way. Figure 4 shows the distribution of reference sites and random sites throughout the state, while Figure 5 shows the percentage of poor to excellent stream quality grades for all of the 1,669 samples collected over the six-year period and for the 158 samples collected from random sites.

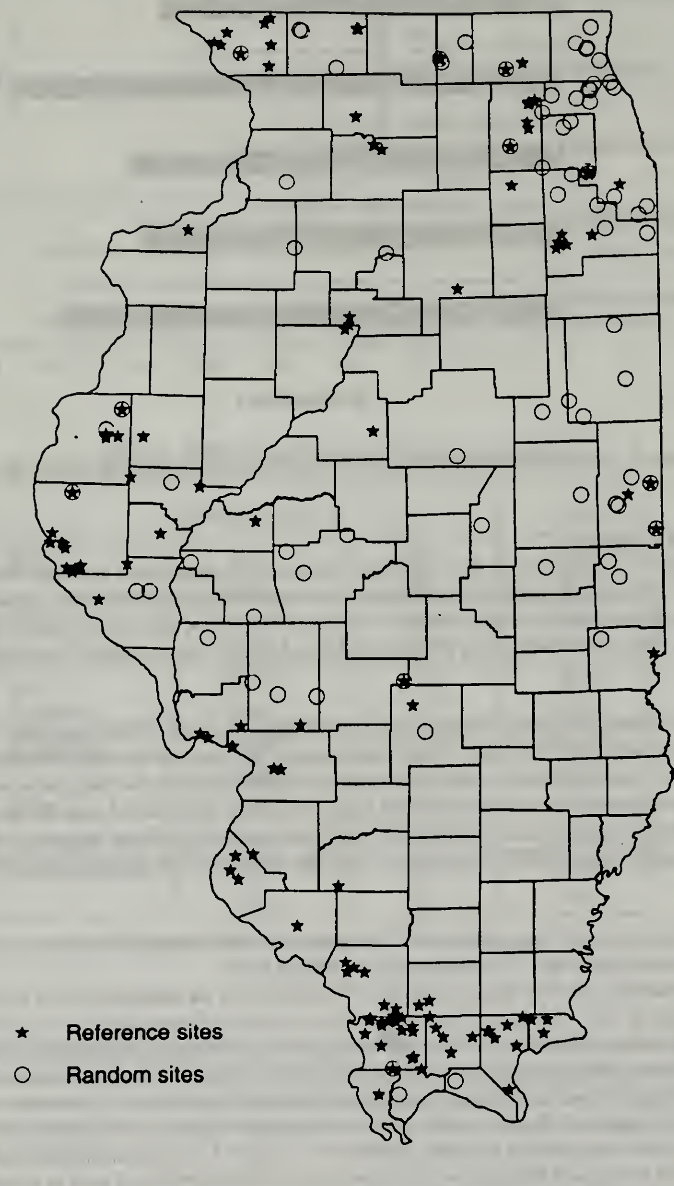

Figure 4. RiverWatch reference sites and random sites

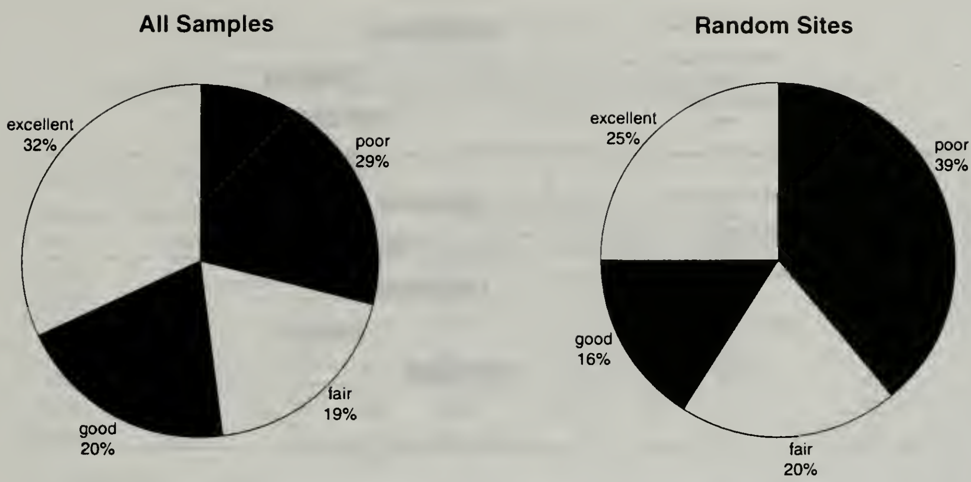

Figure 5. Distribution of stream quality grades, all samples and random sites

Table 7. Stream quality grades based on reference sites

	Excellent Greater than mean of biological scores	**Good** mean to -1 SD	**Fair** -1 to -2 SD	**Poor** <-2 SD
Driftless/Rock	>66.5	66.5 -48.1	48.1-29.7	<29.7
Northeast Morainal-small	>66.3	66.3-47.9	47.9-29.5	<29.5
Northeast Morainal-large	>78.7	78.7-60.5	60.5-42.3	<42.3
Grand Prairie-small	>73.9	73.9-54.7	54.7-35.6	<35.6
Grand Prairie-large	>86.5	86.5-73.3	73.3-60.2	<60.2
Western Forest Prairie-small	>65.1	65.1-43.0	43.0-20.8	<20.8
Western Forest Prairie-large	>70.9	70.9-57.0	57.0-43.1	<43.1
Southern Till Plain/Wabash	>69.6	69.6-48.0	48.0-26.3	<26.3
Shawnee/Ozark	>75.4	75.4-56.3	56.3-37.2	<37.2
Average	>72.2	72.2-52.5	52.5-32.8	<32.8

Figure 6 shows the distribution of stream quality across the natural division and width categories. About 45-50% of the streams in the Shawnee/Ozark and Driftless/Rock are in excellent condition, while about 40% of the streams monitored in the Southern Till Plain/Wabash and Northeast Morainal are poor in quality. Many of the larger streams in the Grand Prairie and Western Forest Prairie also had fairly high quality.

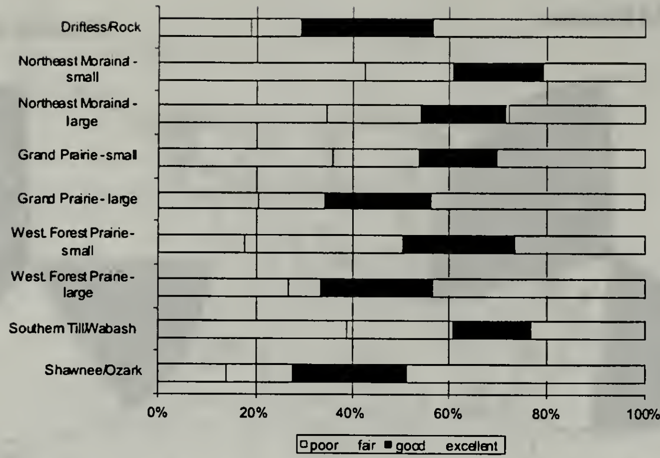

Figure 6. Distribution of stream quality grades by natural division/width categories

It should be pointed out that the professional data discussed in the third paper show a smaller percentage of excellent streams than the volunteer data. Volunteer-collected data generally do not provide as much resolution in quality as professional data and particularly have difficulty distinguishing good from excellent streams. An alternative to the grading scheme described above would be to define good streams as above the mean of the reference sites and adjust the other categories accordingly. The resulting scale would be closer to that used in the CTAP professional stream monitoring.

Conclusion

RiverWatchers can now create a report card to see how their site scores on the five biological indicators and the composite biological score. (This information will soon be available on the CTAP/EcoWatch web site.) The report card not only shows them the percentile rank for each indicator, but also whether the stream quality is excellent, good, fair or poor. Table 8 shows a sample report card from 1996 to 2001 for a site in the Shawnee/Ozark Natural Division. Generally this site has scored high on most of the indicators, except for the year 1997 when the site was monitored soon after severe flooding. Overall the quality of the site is excellent and it is one of the reference sites for its natural division. Similar report cards can be compiled for larger geographic units such as watersheds, ecosystem partnerships and ISIS Basins (Fig. 7 and 8). The next paper completes the report card by adding a habitat score as a final element.

Table 8. Stream quality report card for RiverWatch site R1008401 on Clear Creek

(percentile scores)

Stream Group: Shawnee/Ozark — Overall stream quality: *excellent*

Year	MBI	EPT	Taxa Richness	Dominance	% Worms	Biological Score
1996	84	99	100	98	66	97
1997	69	22	9	21	69	31
1998	80	77	39	83	69	84
1999	88	99	94	82	65	96
2000	90	77	90	75	69	92
2001	85	89	85	59	67	92
Average	83	77	69	69	67	82

(raw scores)

Year	MBI	EPT	Taxa Richness	Dominance	% Worms	Biological Score
1996	4.9	7	19	48%	1%	97
1997	5.4	1	4	91%	0%	31
1998	5.0	4	8	64%	0%	84
1999	4.7	7	15	65%	1%	96
2000	4.6	4	14	69%	0%	92
2001	4.8	5	13	75%	1%	92
Average	4.9	5	12	69%	1%	82

Figure 7. Average biological score of ISIS basins. The numbers denote the number of sites sampled over the period. Sites could have from one to six samples, and each site's scores were averaged and weighted by natural division before the basin score was calculated.

Figure 8. Average biological score in 33 sub-basins. Numbers denote the number of sites sampled over the period. Sites could have from one to six samples, and each site's scores were averaged and weighted by natural division before the sub-basin score was calculated.

Creating a Report Card for RiverWatch Stream Quality: Multi-Metric Habitat Score

David Baker

Introduction

What does it mean if the water in my stream is "milky"? Or if it smells "fishy"? Or if the stream is channelized or lacks canopy cover? Volunteers are familiar with MBI, EPT and taxa richness as measures of stream quality. These biological indicators are calculated when they fill out the RiverWatch data sheets or submit their data electronically. However, every spring trained volunteers collect a wide variety of physical data that can be used to gauge the quality of stream habitat. In addition to identifying a sample of macroinvertebrates, RiverWatchers collect information on the stream's substrate, turbidity, odor and color, surrounding land uses, disturbances to the stream channel, canopy cover, amount of algae, water and air temperature, and recent weather. Thus far none of this habitat-related data has been connected to the quality of the stream in more than a very general way. This paper examines the relationship of the habitat data to the biological indicators and to the multi-metric biological score described in the previous paper. The Habitat Score described here completes the effort to create a report card of Illinois stream quality. Together the Biological Score and Habitat Score use virtually every piece of information collected by RiverWatch citizen scientists to rate stream quality.

Methods

Three statistical techniques were used to examine the relationships between stream habitat and biological indicators—analysis of variance, correlation, and regression analysis. These enabled us to identify the habitat characteristics that are the best indicators of stream quality and to combine these into a single multi-metric index.

Analysis of variance (ANOVA) is a tool for determining if there are significant differences among groups on a particular variable. In this case ANOVA was used to determine whether biological quality varies based on habitat condition. For example, ANOVA showed that higher percentages of silt are associated with poorer stream quality and that certain land uses are better for stream quality and others are worse. Using ANOVA, most physical variables were given a score of one to four, with each higher value associated with higher biological quality. For example, 0-25% silt was given a score of four, 26-50% a three, 51-75% a two, and 76-100% a one. Table 1 provides the scoring scheme for all of the habitat measures.

Correlation coefficients were then calculated to gauge the strength of the relationships among variables. A coefficient close to 1.0 indicates a perfect 1:1 relationship, whereas a coefficient close to zero indicates no relationship. The coefficients showed which habitat characteristics are related in a statistically significant way with biological indicators. Because of the large sample sizes (more than 1,600 stream samples), even correlation coefficients lower than .10 could be statistically significant.

Finally, regression analysis was employed in the case of habitat measures which possess multiple components, such as land uses or stream substrate. At most sites several different land uses were present or dominant and, likewise, the stream substrates are generally composed of several different materials (boulders, silt, etc.). Regression was used to combine these various components into a single metric. In addition, it was used to create a multi-metric index using the strongest of the habitat indicators.

Table 1. Categorization scheme for habitat data

Habitat Measure	Category or score 1	2	3	4
Water appearance	Foamy, reddish, green, or other			Clear, milky, or dark brown
Water odor	Sewage, chlorine, rotten eggs, or petroleum	Other	Fishy	No odor
Turbidity	Heavy turbidity	Medium turbidity	Slight turbidity	Clear
Canopy cover	> 75%	0%, 50-75%	26-50%	5-25%
Coarse substrate, Weighted score = 2 x Cobble + Gravel + Bedrock, where 0 = 0%, 1 = 1-5%, 2 = 6-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-100%	Weighted score = 0-1	Weighted score = 2-4	Weighted score = 5-7	Weighted score ≥ 8
Silt/fine substrate	76-100%	51-75%	26-50%	0-25%
Dominant land uses Where 2=dominance of forest, pasture, cropland, or grassland, 1=presence of same, -2=dominance of urban land uses, -1=presence of urban land uses, or dominance of park or low density residential	total score of < -2	total of -1 or -2	total of 0 to 2	total of 3 or more
Other disturbances Channelization, wastewater discharge, pipe, upstream dam	3 or more disturbances	2 disturbances	Only 1 disturbance	No disturbances

Stream Habitat Indicators

An examination of the data collected by volunteers during the past several years shows some very definite relationships between the habitat data and biological indicators. In only a few cases are the relationships not statistically significant or are spurious in some way. Because many different factors affect stream quality, however, few habitat characteristics of the monitoring sites showed correlation coefficients greater than .30. In combination, the physical data can explain about half of the variation in biological scores. Each of the habitat variables and its usefulness as a stream indicator is discussed below.

Weather. Heavy rain in the two days before monitoring seems to adversely affect some of the biological indicators (Table 2). By washing indicator organisms out of the stream bed, heavy rain reduces the number of EPT taxa, increases the percentage of worms, and raises (worsens) the MBI. Less extreme weather events seem to have very limited impact. Higher water and air temperatures also have a slight impact on stream quality, although neither is significantly correlated with any of the indicators. The large differences between surface and air temperatures, as occurs in the Driftless/Rock River* area in northwest Illinois, may indicate greater groundwater vs. surface recharge. Overall, the weather variables would not make good indicators of stream quality, but data collected after heavy rain should be flagged and volunteers should be discouraged from monitoring shortly after major rain events.

Table 2. Correlations between biological indicators and weather

	Weather in Last 24 Hours	Weather in Last 48 Hours	Water Temperature	Air Temperature
Bio Score	-.023	**-.082**	-.015	-.017
MBI	.047	**.087**	.033	-.005
EPT	-.002	**-.089**	.023	-.008
Taxa Richness	.029	.000	-.025	**-.052**
Dominance	-.011	.029	-.011	.011
% Worms	**.065**	**.048**	-.042	-.043

Note: **Bold** are statistically significant at .05 level.

Water Appearance. Streams where the water is clear, milky, or dark brown in color seem to be higher in quality, while those where the water is foamy, reddish, or greenish are lower in quality. The first three are generally naturally occurring while the latter three indicate some kind of disturbance. While the statistical relationship between water appearance and biological quality is not extremely strong—a correlation of only .12 with total biological score—the relationship is consistent and statistically significant across all of the biological indicators except for total taxa richness (Table 3).

Water Odor. Water odor is also related to stream quality (Table 3). Streams with no odor score best on most indicators, while streams with a fishy smell are slightly impaired, and those with an odor of sewage, chlorine, rotten eggs or petroleum are even more impaired. For example, streams with no odor average 5.65 for the MBI, while those that are "fishy" average 6.10 and those that smell of sewage average 6.39.

* For purposes of this paper, the state's natural divisions have been aggregated into six groups: Driftless/Rock River, Northeast Morainal, Grand Prairie (including Upper Mississippi and Illinois River Bottomlands), Western Forest-Prairie (including Middle Mississippi Border), Southern Till Plain/Wabash, and Shawnee/Ozark (also including Coastal Plain). See previous paper.

Table 3. Correlations between biological indicators and selected habitat variables

	Water Appearance	Water Odor	Turbidity	Algal Growth	Canopy Cover
Bio Score	**.124**	**.180**	**.095**	**.159**	**.131**
MBI	**-.107**	**-.171**	**-.148**	**-.113**	-.036
EPT	**.105**	**.158**	**.058**	**.150**	**.180**
Taxa Richness	.043	**.107**	-.004	**.107**	**.146**
Dominance	**-.054**	**-.091**	-.005	-.005	**-.127**
% Worms	**.077**	**-.119**	**-.087**	**-.087**	-.032

Note: **Bold** are statistically significant at .05 level or better.

Turbidity. Turbidity has a statistically significant impact on MBI, EPT and worms, but seems unrelated to dominance or taxa richness (Table 3). Clear streams are highest in quality, those with heavy turbidity are worst in quality, and those with slight or medium turbidity are intermediate in quality. For example, MBI averages 5.4 in clear streams and 6.0 in heavily turbid streams, while percent worms averages 3.8% in clear streams and 8.0% in turbid streams.

Algal Growth. Streams with greater amounts of algae seem to be higher in quality (Table 3). This is counterintuitive and may show that volunteers are not performing this procedure properly. RiverWatch procedures ask volunteers to only look for filamentous algae, which bloom dramatically in nutrient enriched waters, but they may be reporting all types of algae. Volunteers most frequently report algae in the rocky bottomed streams in southern Illinois, which tend to be high in biological integrity. Volunteers should receive further instruction on the procedures for measuring algal growth before this measure can be used as an indicator of quality.

Canopy Cover. The relationship of amount of canopy cover to stream quality is not a straightforward one. RiverWatch sites with 1-50% canopy cover seem to perform better on the biological indicators, while those with greater than 50% canopy or no canopy cover perform worse. A mix of areas where water is fully shaded, some fully exposed to the sun and others receiving degrees of filtered light is optimal. Such conditions are found in a mature forest.

Substrate. Streams with a rocky substrate, such as bedrock, boulders, cobble and gravel, tend to have more EPT taxa, higher taxa richness, and fewer worms, while streams with higher amounts of silt score more poorly on most biological indicators (Table 4). The amount of sand seems to be unrelated to stream quality in the RiverWatch data. Cobble and silt are most strongly related to stream quality, with correlations of about .30. The composition of the substrate varies across the natural divisions. For example, the Shawnee/Ozark has the highest percentage of bedrock and boulders, while the Southern Till/Wabash, Northeast Morainal, and Grand Prairie have the highest percentages of silt. Two different indicators can be created from the substrate data—one using percent silt and the other a composite of the amounts of the various coarse substrates. A regression analysis shows that a new variable composed of two times the amount of cobble plus the amount of bedrock and gravel is more highly correlated to the biological scores than any other habitat characteristic measured.

Table 4. Correlations between biological indicators and stream substrate

	Bedrock	Boulders	Cobble	Gravel	Sand	Silt	Coarse Substrates*
Bio Score	**.105**	**.177**	**.277**	**.144**	-.021	**-.266**	**.329**
MBI	**-.101**	**-.168**	**-.286**	**-.121**	.023	**.280**	**-.322**
EPT	**.084**	**.129**	**.202**	**.135**	.026	**-.224**	**.266**
Taxa Richness	**.059**	**.098**	**.145**	**.072**	-.032	**-.077**	**.169**
Dominance	-.015	**-.063**	**-.092**	-.042	.023	.041	**-.126**
% Worms	**-.071**	**-.119**	**-.193**	**-.087**	.025	**.157**	**-.229**

Note: **Bold** are statistically significant at .05 level or better.

* Composite of 2 x cobble + 1 x (bedrock + gravel)

Stream Width, Depth, Velocity, and Discharge. Larger streams are associated with higher quality as measured by most biological indicators (Table 5). These relationships are strongest for stream width and discharge, and weaker for depth and velocity. Stream size is most highly correlated with EPT, showing a correlation of .233 with stream width. Streams that are more than 25 feet in width average 3.6 EPT taxa, while those under 25 feet average 2.3 taxa. Generally, wider streams have more varied macroinvertebrate habitats that support greater EPT richness.

Table 5. Correlations between biological indicators and stream size

	Width	Depth	Velocity	Discharge
Bio Score	**.164**	.044	**.084**	**.142**
MBI	**-.088**	-.006	**-.066**	**-.088**
EPT	**.233**	**.052**	**.088**	**.188**
Taxa Richness	**.126**	**.062**	.037	**.109**
Dominance	**-.099**	**-.057**	-.046	**-.081**
% Worms	-.037	.042	-.039	-.048

Note: **Bold** are statistically significant at .05 level or better.

Stream Channel Disturbances. Channelization clearly reduces stream quality as measured by MBI and EPT (Table 6). Other types of stream channel disturbances such as the presence of pipes, wastewater treatment discharge and, to a lesser extent, upstream dams all adversely affect stream quality as well. The more of the disturbances present the more quality seems to be affected. Streams in the Northeast Morainal natural division are the most channelized (23% of RiverWatch sites), most likely to have nearby water treatment plants (32%), and most likely to have discharge pipes (34%). Streams in the Shawnee/Ozark and Driftless/Rock are disturbed least by channelization (4%, 9%), pipes (13%, 12%), and water treatment (4%, <11%). Stream sites with upstream dams are distributed fairly evenly across the state, with the fewest in the Southern Till/Wabash. The number of these four disturbances present at a site is a fairly good stream quality indicator.

Habitat Sampled. As would be expected, streams with riffles are higher in quality than those where other habitats are the primary habitat sampled, particularly sediment. For example, the MBI averages 5.62 at sites where riffles are sampled compared to 6.03 where other habitats are sampled. However, the results are not statistically significant and the ANOVA demonstrates that by itself the habitats sampled would not be a good stream quality indicator.

Table 6. Correlations between biological indicators and channel disturbances

	Upstream Dam	Wastewater Discharge	Pipes	Channelization	No. of Channel Disturbances
Bio Score	-0.40	**-.094**	**-.108**	**-.109**	**.163**
MBI	**.051**	**.071**	**.082**	**.115**	**-.148**
EPT	-.003	**-.052**	**-.096**	**-.099**	**.116**
Taxa Richness	.014	**-.056**	-.033	-.039	**.053**
Dominance	.026	**.092**	**.058**	.019	**-.089**
% Worms	.030	.016	**.057**	**.071**	**-.082**

Note: **Bold** are statistically significant at .05 level or better.

Land Uses. Surrounding land uses definitely affect stream quality (Table 7 and Fig. 1). As expected, streams where forest or grassland is dominant score well on the biological indicators. However, perhaps surprisingly, agricultural land uses such as pasture and cropland are also associated with higher stream quality. Sites dominated by urban land uses—sewage treatment, construction, landfills, golf courses, high density residential, and commercial/industrial development—score more poorly on stream quality indicators. Streams where parkland or low density residential is dominant are of intermediate quality. Only logging and mining are not significantly correlated to the biological scores, but they are dominant at only a few sites.

Since volunteers may report multiple land uses to be dominant or present at a site, it is not straightforward to use land use as an indicator. ANOVA was used to categorize sites by the number of positive and negative land uses. The resulting composite variable was strongly related to stream quality, with a correlation of .29. Only substrate is more strongly related to the biological indicators.

Table 7. Correlations between biological indicators and surrounding land uses

	Forest	Logging	Golf Course	Grass-land	Commercial Industrial	Low Dens. Residential	High Dens. Residential	Composite Land Use Score
Bio Score	**.133**	.012	**-.104**	.031	**-.178**	**-.125**	**-.177**	**.290**
MBI	**-.143**	.000	**.122**	-.019	**.170**	**.127**	**.212**	**-.266**
EPT	**.115**	.029	**-.073**	.021	**-.144**	**-.074**	**-.161**	**.257**
Taxa Richness	.014	.020	-.034	**.056**	**-.100**	-.032	**-.064**	**.151**
Dominance	-.026	.019	.021	-.020	**.113**	**.050**	**.070**	**-.137**
% Worms	**-.077**	.013	**.061**	-.032	**.109**	**.051**	**.096**	**-.124**

	Cropland	Sewage Treatment	Parks	Mining	Landfill	Pasture	Construction	
Bio Score	**.139**	**-.096**	**-.083**	.003	**-.066**	**.141**	**-.104**	
MBI	**-.104**	**.067**	**.054**	-.014	.031	**-.096**	**.099**	
EPT	**.157**	**-.066**	**-.111**	-.003	**-.056**	**.137**	**-.083**	
Taxa Richness	**.089**	**-.053**	**-.071**	-.017	**-.056**	**.122**	**-.051**	
Dominance	**-.081**	**.088**	.028	-.006	**.069**	**-.090**	**.059**	
% Worms	-.027	.021	.017	-.014	.024	-.046	.035	

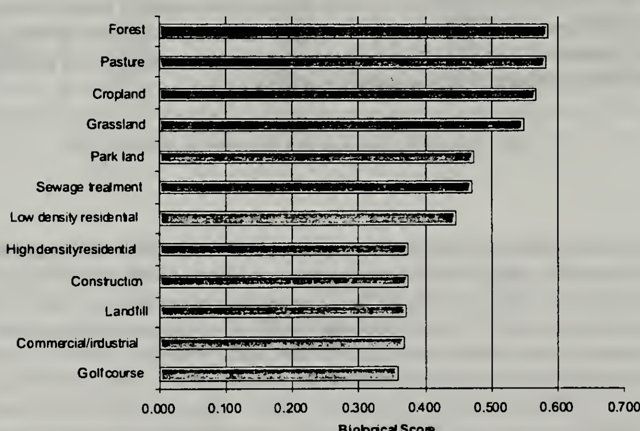

Figure 1. Biological scores by dominant land use

Creating a Multi-metric Index

Once all of the measures of habitat condition were rescaled with scores from one to four and the strength of relationships examined, it was fairly straightforward to create a multi-metric index using regression analysis. Figure 2 compares the correlations between each of the primary habitat variables and the composite biological score. The weather variables and the sampled habitats have not been included, since they are not good stream quality indicators. The stream size variables have also been excluded from the analysis, since stream width is being used to categorize streams for purposes of the biological scores. Stepwise regression included all of the remaining variables except for turbidity, which is the least correlated with biological score (Table 8). Its coefficient was not statistically significant in the regression equation, because other variables measure similar factors (i.e. water appearance and silt).

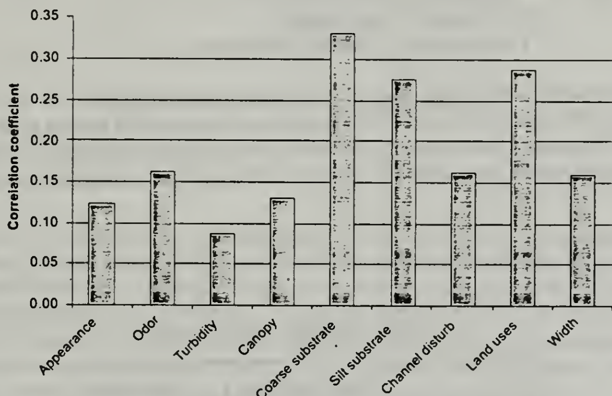

Figure 2. Correlation between measures of habitat condition and biological score

Table 8. Regression of biological score and habitat characteristics

$R = .495$, $R^2 = .245$, $F = 76.4$

Variable	β	t	significance
constant	-47.1	-9.3	<.001
Coarse substrate	7.6	10.4	<.001
Land uses	7.7	10.9	<.001
Canopy	3.6	6.4	<.001
Silt	4.0	4.9	<.001
Water Odor	4.0	3.8	<.001
Water appearance	2.3	3.7	<.001
Channel disturbance	2.5	3.2	.001

To simplify calculation of the composite habitat score the constant term was dropped and the following weights used:

• coarse substrate	3.0
• land use	3.0
• water odor	1.5
• fine substrate (silt)	1.5
• canopy cover	1.5
• channel disturbances	1.0
• water appearance	1.0

This results in a range in scores from 12.5 to 50 (12.5 if a site scores a one on all of the indicators and a 50 if it receives a 4 for all of the habitat measures). Thus in equation form:

Habitat score = 3 x (coarse substrate + land uses)
+ 1.5 x (canopy + silt + odor)
+ 1 x (appearance + channel disturbances)

Figure 3 shows that actual scores range from 20 to 50, with an average of about 39. The 10^{th} percentile is a score of 33 and the 90^{th} percentile a score of 45. Habitat quality scores can then be given descriptive grades as shown in Table 9. To assign a habitat quality grade to larger geographic units such as watersheds, ecosystem partnerships, and ISIS Basins, individual site scores are averaged by the geographic unit and then categorized (Fig. 4 and 5).

Table 9. Habitat quality grades

	Habitat score	Percentile
Excellent	43-50	75.1-100%
Good	39.5-42.5	50.1-75%
Fair	36.5-39	25.1-50%
Poor	21-36	0-25%

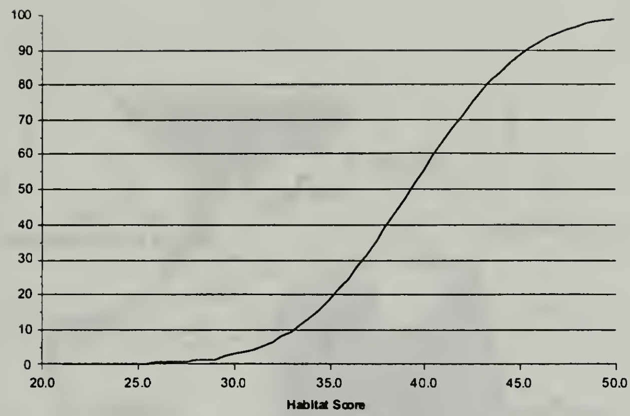

Figure 3. Percentile rank of habitat scores

Conclusion

The multi-metric habitat score provides an excellent indicator of stream quality to supplement the various biological indicators and the multi-metric biological score. It is significantly correlated to these biological measures (correlation coefficient of ~.5). Several of the stream habitat measures that it includes can be directly improved through management, restoration, or pollution control activities. The amount of canopy cover can be affected, the natural channel may be restored, nearby activities that affect stream odor and appearance (and turbidity) may be reduced or buffered, land uses can be changed. Such changes should improve overall stream quality and be reflected in both the habitat and biological scores.

Additional habitat characteristics will be added to the multi-metric habitat score in the future. Once the issues related to properly measuring algal growth are resolved, this factor could be included. RiverWatch procedures were recently revised to include a new measure of siltation to replace the embeddedness procedure, which was not consistently implemented. Siltation could replace silt substrate in the index, leaving a single substrate measure in the index. Turbidity may be added as well in the future, although it seems that other measures capture the effects of turbidity.

The habitat score would be a more powerful indicator if it were to incorporate additional physical characteristics of streams that are amenable to management and restoration. For example, channel sinuosity, width of the riparian vegetation zone, and stream bank cover or stability all are known to affect the quality of stream habitat. Volunteers could be trained to reliably measure each of these characteristics.

Scores on the two multi-metric indices—habitat and biological—are tools that will track stream quality and will help to gauge the success of activities to improve that quality. Together they take into account virtually every piece of information that RiverWatch volunteers collect to create a report card of stream quality.

Figure 4. Average Physical Score of ISIS basins. RiverWatch data, 1996-2001. The numbers denote the number of sites sampled over the period. Sites could have from one to six samples, and each site's scores were averaged before the basin score was calculated.

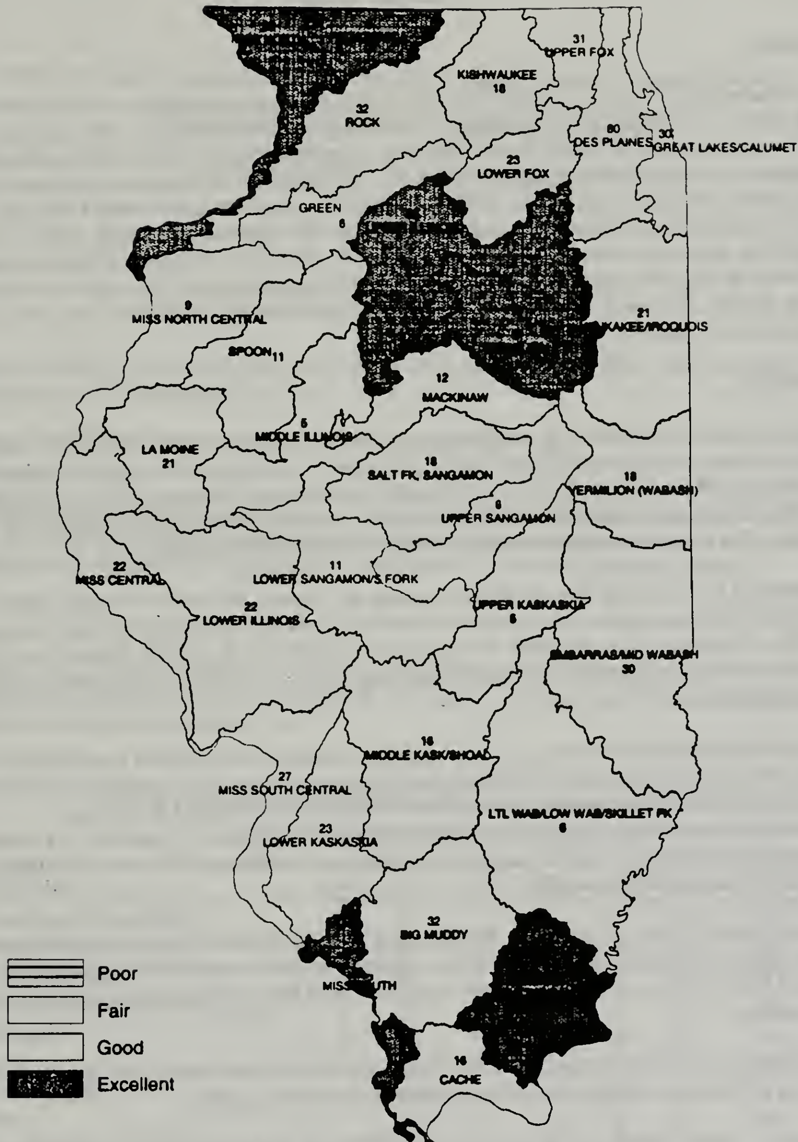

Figure 5. Average Physical Score in 33 sub-basins. RiverWatch data, 1996-2001. Numbers denote the number of sites sampled over the period. Sites could have from one to six samples, and each site's scores were averaged before the sub-basin score was calculated.

Aquatic Insects Report
Biological and Habitat Condition of Illinois Streams

R. Edward DeWalt

Introduction

Illinois Department of Energy and Natural Resources (1994) discussed several areas requiring additional research related to understanding the condition of flowing water habitats in the state. One such area was the need for long-term studies on aquatic insects. This is an assemblage for which long-term, quantitative information is lacking in Illinois. Systematic works provided qualitative information on where species of mayflies (Burks 1953), stoneflies (Frison 1935), and caddisflies (Ross 1944) were located and some indication of the quality of habitat in which they existed. The CTAP professional aquatic entomologist has been gathering quantitative data on mayflies, stoneflies, and caddisflies from randomly chosen streams since 1997. During the first five-year cycle of data collection, 149 sites were assessed. The objective of this first phase was to assess the current condition and geographic trends in stream quality across the state and prepare for investigation of long-term trends.

Methodology

Several parameters were measured to assess stream condition including water chemistry, habitat quality, EPT taxonomic richness, and Hilsenhoff Biotic Index. Each of these is explained below. Snapshot values of several water chemistry and physical attributes were collected at each site using a Solomat 520-C multiparameter meter. These include water temperature, dissolved oxygen (reported here as percent saturation), pH, and conductivity. The meter was calibrated each day of use for all parameters measured.

Measurement of habitat quality is important in estimating the potential for streams to support aquatic communities. Habitat degradation from a variety of sources causes the most damage to aquatic systems (Karr et al. 1986). CTAP uses a 12-point quality scoring scheme developed by the USEPA (Barbour et al. 1999 and Plafkin et al. 1989) to measure habitat quality. Values range from 0 to 180, with greater values indicating better habitat quality.

Stream conditions were also assessed using three orders of environmentally sensitive aquatic insects: the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) (collectively, EPT taxa). These often contribute a major proportion of the abundance and species richness to the aquatic macroinvertebrate assemblage found in streams. EPT taxa richness (number of unique taxa in a sample) is one of the most efficient indices of stream condition. The history and usefulness of EPT taxa was recently summarized by Lenat and Penrose (1996).

The Hilsenhoff Biotic Index, developed in Wisconsin, is a weighted average of the organic pollution tolerance of aquatic insects. Most taxa in the region have been assigned tolerance values that ranged from 0 to 10 (Hilsenhoff 1987). A site value may range from 0 to 10 also, with higher values indicating greater tolerance or poorer condition.

Regionalization of the results follows that of the 10 interior Illinois Streams Information System (ISIS) basins. This will aid in the interpretation of spatial patterns in stream condition.

Tests for fit to a normal distribution for all data subsets (EPT, HBI, and Habitat versus 10 ISIS basins) found only two of 30 subsets failing normality, both for the variable HBI. This level of non-normality was deemed insufficient to warrant data transformation; hence, all statistical analyses were conducted using parametric tests. A three factorial analysis of variance (ANOVA; SAS 1985) using ISIS basin, channel type (meandering versus channelized), and stream width code (1-5, largest streams had higher integer value) was conducted to find trends in the data. Each site was rated based on its position in percentile rankings of each ecological indicator on a statewide basis. Percentile rankings and their corresponding quality ratings are presented in Table 1.

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

Overall quality rankings for each site were generated as a weighted average of EPT, HBI, and Habitat percentiles 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 is EPT or Habitat, leading to the reduced weighting for this variable (DeWalt, unpublished data). Qualitative ratings (excellent, good, etc.) were constructed for each site based on the rating system developed for individual indicators (Table 1).

Results

From 1997 to 2001, 149 stream sites were sampled in 10 ISIS basins (Fig. 1, Table 2). The greatest percentage of sites fell in the Kankakee/ Vermilion N/ Mackinaw river basins, while the Little Wabash drainage was represented by the lowest percentage of sites.

Table 2. Number of CTAP randomly chosen stream sites sampled during a 5-yr cycle beginning 1997

ISIS Basin	1997	1998	1999	2000	2001	Total	%
Big Muddy/Saline/Cache	4	3	1	4	1	13	8.7
Embarras/Vermilion S	3	0	7	3	6	19	12.8
Fox/Des Plaines	2	4	2	0	4	12	8.1
Kankakee/Vermilion N/Mackinaw	1	8	5	7	3	24	16.1
Kaskaskia	4	6	1	1	5	17	11.4
La Moine	2	4	5	2	3	16	10.7
Little Wabash	1	1	1	2	1	6	4.0
Rock	3	3	3	4	3	16	10.7
Sangamon	4	1	2	4	1	12	8.1
Spoon	4	1	3	3	3	14	9.4
Total	28	31	30	30	30	149	100

Figure 1. Locations of CTAP stream sampling locations (1997-2001) and ISIS basin boundaries

Dissolved oxygen percent saturation (for 119 sites) was not significantly different across ISIS basins (ANOVA, F=1.52, p=0.15, df=9). However, some basins might, with more data, prove to have higher daytime saturation levels than others (Fig. 2). Conversely, conductivity varied significantly (F=2.87, p=0.0001, df=56), with basin designation as the only significant factor (F=2.45, p=0.21, df=9). The Fox and Des Plaines basin had a greater mean conductivity than any other basin (Fig. 3). Urbanization is a major factor increasing conductivity beyond background levels, and much of this basin is heavily urbanized or otherwise rapidly developing. There were no noticeable, significant pH trends across the state (F=1.15, p=0.30, df=57).

Streamside and in-stream habitat quality varied significantly across the state (F=3.13, p=0.0001, df=62). The most important factor explaining habitat quality was channel type (F=75.6, p=0.0001, df=1), with meandering streams scoring significantly higher (107.6 points) than channelized streams (70.9 points). A significant interaction between channel type and basin also was discovered (F=2.8, p=0.006). Rock and Spoon basins appeared not to have significant differences in habitat quality for the two channel types, whereas significant differences existed in the other basins (Fig. 4). Channelized streams in the former scored higher, probably due to having higher quality riparian zones, a factor that heavily influences habitat quality ratings taken at each site.

EPT species richness varied significantly across the state (F=2.68, p=0.0001, df=63), with channel type accounting for the greatest variation (F=13.9, p=0.0003, df=1). Streams with meandering channels produced an average of 11.8 EPT (n=88), while channelized streams produced 7.1 taxa (n=61). Stream width code was also a significant factor (F=3.53, p=0.01, df=5) such that larger streams supported more EPT taxa (p=0.05) (Fig. 5). Basin assignment was not a significant factor, although it was nearly so (F=1.9, p=0.06). Basin assignment and stream width code interacted significantly (F=1.8, p=0.02, df=4). EPT richness increased strongly with increasing stream width code in five of the 10 basins, while in the remaining five it demonstrated little or no relationship (Fig. 6).

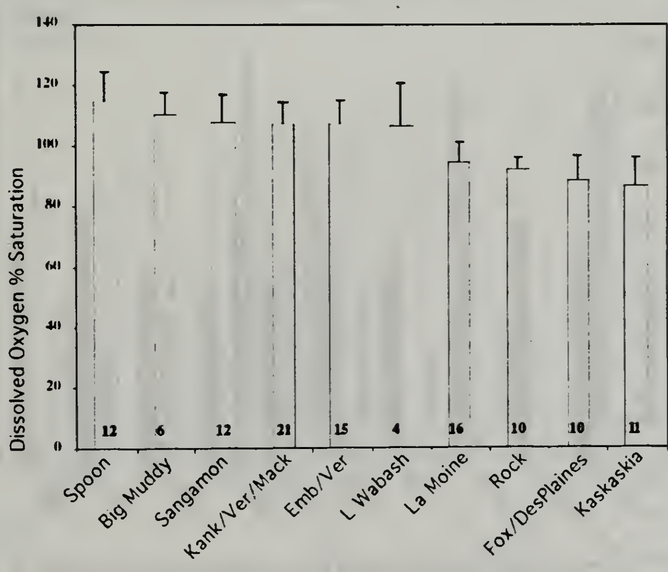

Figure 2. CTAP stream sampling mean dissolved oxygen percentage saturation + standard error for ISIS basins. Numbers in bars indicate sample size. No significant differences.

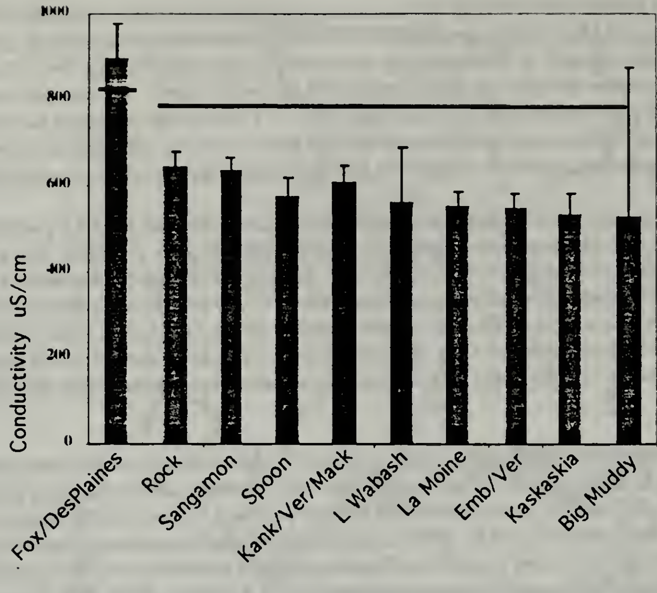

Figure 3. CTAP stream sampling mean conductivity (uS/cm) + standard error for ISIS basins. Numbers in bars indicate sample size. Horizontal bars indicate significant differences.

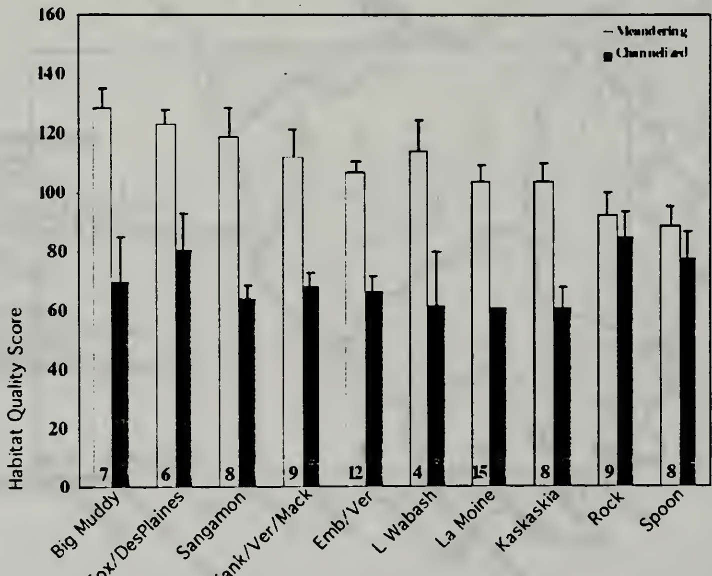

Figure 4. CTAP stream sampling mean habitat quality score + standard error for ISIS basins by channel type. Numbers in bars indicate sample size. Note Rock and Spoon basin differences.

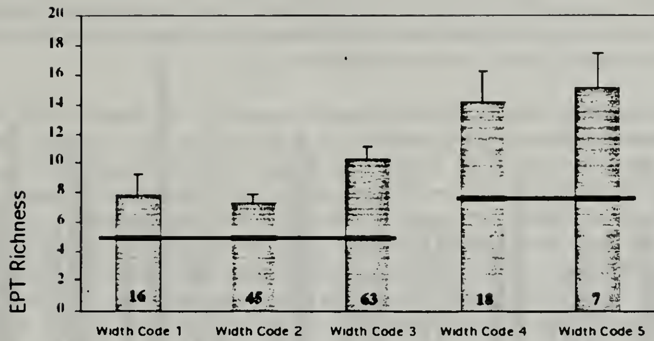

Figure 5. CTAP stream sampling mean EPT richness + standard error for five stream width codes (increasing integer = increasing stream width). Numbers in bars indicate sample size. Horizontal bars indicate significant differences.

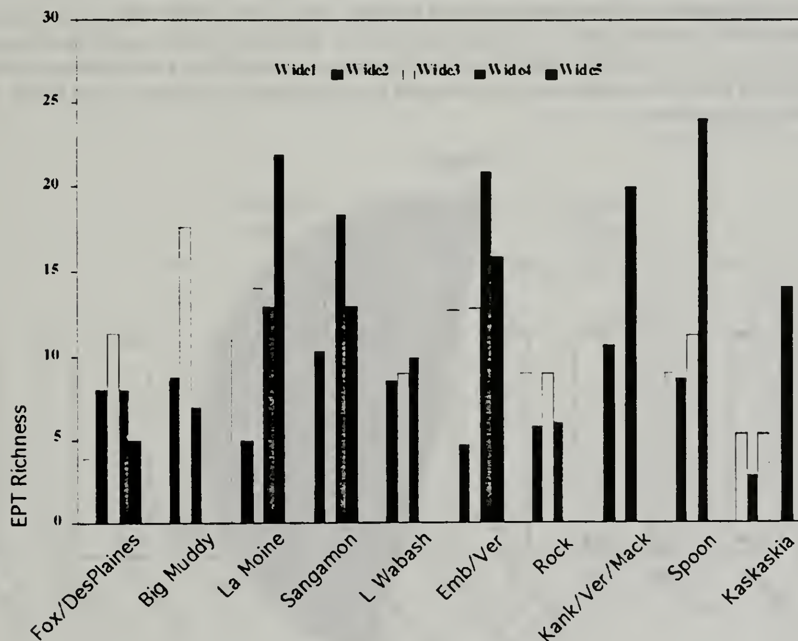

Figure 6. CTAP stream sampling mean EPT richness for ISIS basins and five stream width codes (increasing integer = increasing stream width)

HBI scores did not vary significantly across the state (F=0.9, p=0.66, df=62) (Fig. 7). The Big Muddy ISIS basin, an unnatural grouping of the Shawnee Hills and Coastal Plains natural divisions, produced the lowest average HBI. The five streams from the Shawnee Hills subset were of the highest quality available in the state. HBI there averaged 3.5 ± 0.73 (mean ± standard error) units.

Overall percentile rankings varied significantly across the state (F=3.1, p=0.0001, df=63), with channel type being the most important factor (F=57.6, p=0.0001, df=1). Meandering streams scored 61.8%, while channelized streams scored only 35.8%. Neither basin assignment nor width code alone were significant factors (F=1.1, p=0.4, df=9 and F=2.1, p=0.09, df=4, respectively). However, a significant interaction with basin and width code was noted (F=2.3, p=0.03, df=9). Statewide, overall percentiles increased with stream size (Fig. 8), as they did in the Sangamon, La Moine, Embarras/Vermilion, Spoon, and Kankakee/Vermilion/Mackinaw basins. However, the basins Big Muddy, Little Wabash, and Rock deviated from that trend. Figure 8 also suggests that the smallest streams were the most heavily degraded in two of the largely agricultural drainages (Sangamon, Kankakee/Vermilion/Mackinaw) and in the one mostly suburban drainage (Fox/Des Plaines).

Discussion

Given that 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 in "poor" or "very poor" condition (Fig. 9). Some of the worst offenders (Overall Percentile < 10%) in this grouping were Willow Creek (Fox/Des Plaines basin), Coal Creek (Rock basin), South Branch of Crow Creek and Rock Creek (Kankakee/Vermilion/Mackinaw basin), Bean Ditch (Embarras/Vermilion basin) and Pond Drainage Ditch (Little Wabash basin). These streams had less than two EPT (two had none), were channelized and had no wooded 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.

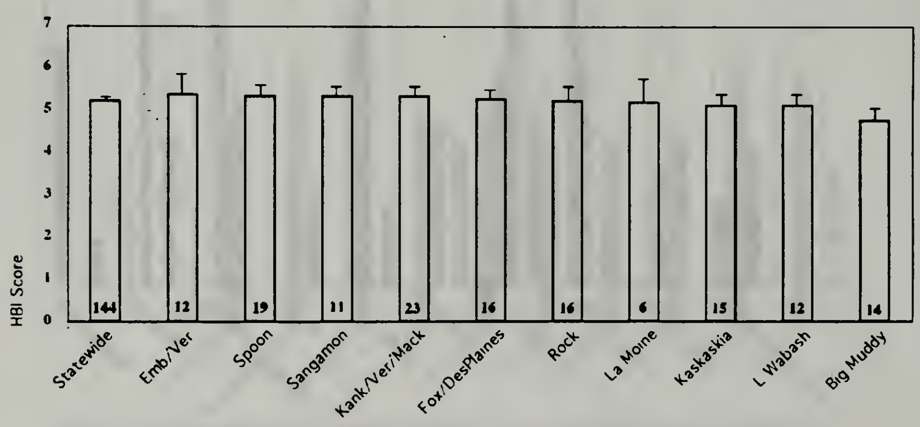

Figure 7. CTAP stream sampling mean HBI scores + standard error ISIS basins. Numbers in bars indicate sample size. No significant differences.

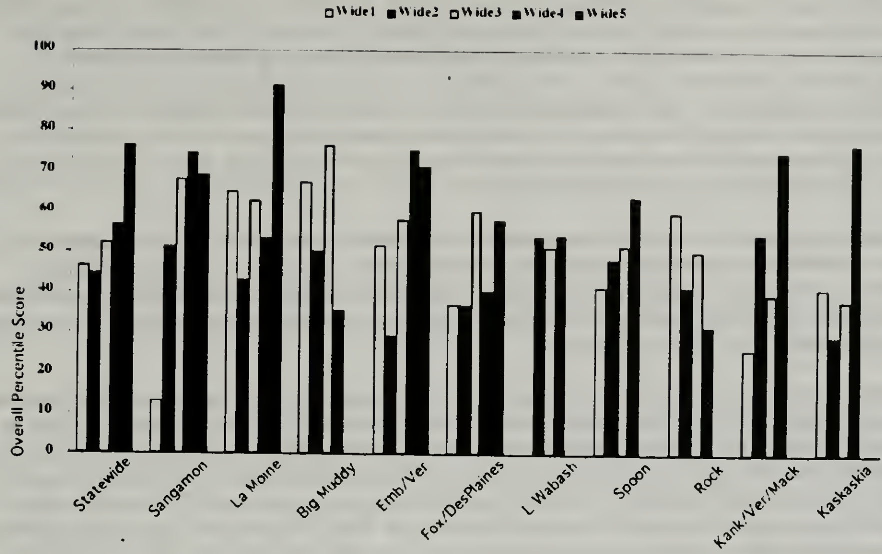

Figure 8. CTAP stream sampling mean overall percentile score by basin and stream width codes (increasing integer = increasing stream width)

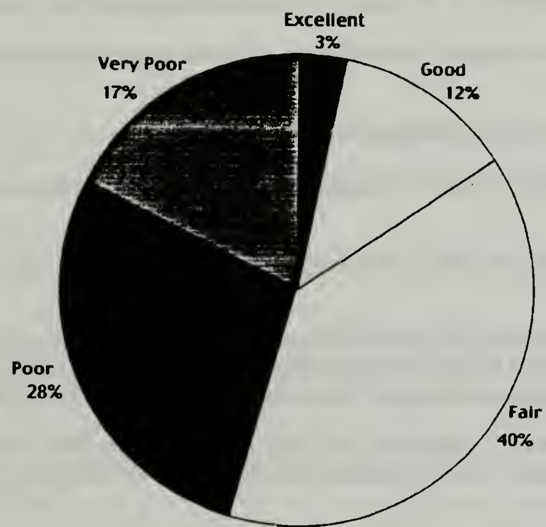

Figure 9. CTAP stream overall quality ratings and percentages of 149 streams ranking in categories

The chances of the program finding excellent quality streams was remote, but five (3%) were found that had overall percentile scores ≥90% (Fig. 9). These included Shokokon Slough (La Moine basin), Sugar Creek (Sangamon basin), La Moine River, and Gibbons and Threemile Creek (Big Muddy basin). These streams supported in excess of 18 EPT taxa, had meandering courses, wide treed riparian zones, and produced some of the lowest HBI index 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 elsewhere in the state. It is imperative that these best sites be found and characterized throughout the state, since they are the key to determining the upper threshold for quality.

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 focused on in policy and restoration guidance given by state agencies, given that the landowners followed suit. Reestablishment and widening of riparian zones (especially treed ones) would drastically reduce soil erosion, capture pollutants, reduce algal blooms, and ameliorate water temperatures.

There are several projects to restore streams across the state including the IDNR sponsored Pilot Watershed Program (Dodd 2000) and the restoration of natural meanders and bank structure on Nippersink Creek in McHenry County. The Nippersink Creek project, sponsored by the McHenry County Conservation District, began only two years ago and can already demonstrate dramatically improved habitat quality. Biological change may take longer, especially for aquatic insects, which are not as vagile as fish. They often require longer time spans to reinvade restored streams (Barbour et al. 1999). This and other large-scale restorations in the near future might require human aided reintroduction of the most sensitive, less vagile species to help bridge geographic gaps between restored habitat and recolonization sources. Nonetheless, the modest success of these projects gives us hope that improvement can be achieved.

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What are the discarded sites of CTAP terrestrial monitoring telling us about Illinois habitats?

Rhetta Jack

Introduction

During the initial five years of monitoring (1997-2001), the Critical Trends Assessment Program (CTAP) professional scientists have established and monitored 405 terrestrial sites for plants, birds, and insects. In the process of establishing the monitoring sites, many sites and entire townships were discarded because they failed to meet key requirements in the selection process. This report will cover the reasons why sites were discarded and what this information may tell us about habitat loss, fragmentation, and the degradation of Illinois ecosystems. Secondly, this report will investigate the role of the Illinois Land Cover Map and Atlas (ILCMA) and the Illinois National Wetlands Inventory (INWI) in the site selection process.

CTAP sites were selected via a multi-randomized procedure and subject to monitoring criteria (Table 1). Three main habitats are monitored statewide, which include forests, grasslands, and wetlands. The basic monitoring unit for the CTAP professional monitoring is the township. Thirty townships with sites for each of the three habitat types are monitored annually for a total of 90. For each of the three habitat types a full set of townships were randomly ranked. Potential sites in forest and grassland townships were then picked and randomly ranked using land cover data from the 1996 ILCMA. The ILCMA is based on data obtained from satellite imagery 1991-1995. It delineates seven major land cover categories with 21 sub categories and depicts what is covering the surface of the land (Illinois Department of Natural Resources 1995; 1996).

Table 1. Monitoring criteria

	Forests	Wetlands	Grasslands
Initial Selection	20 acres	2 acres	50x10m
Monitoring Criteria	trees in tract must average at least 10 cm (4") dbh —— stand must average ≥75% canopy cover —— site must contain 75m radius of one forest community type	must be at least 50m x 10 m (500m^2) in size —— ≤50% woody cover (trees or shrubs) —— ≥50% of wetland plant species (obligate or facultative) —— ≥30% plant cover if open water present	must be at least 50m x 10 m (500m^2) in size —— ≤50% woody cover (trees or shrubs) —— mowing frequency ≤3 times per year

Potential wetland sites were determined using the digital INWI. The INWI was generated from aerial photography acquired from 1980-1987; most from 1983 (Suloway and Hubbell 1994; Illinois Department of Natural Resources 1997). This database was not verified in the field and misses particular types of wetlands, such as small isolated wetlands (Levin et. al. 2002). Criteria used to identify potential wetland sampling sites were based on wetland type and size. Specifically, wetlands suitable for CTAP monitoring are dominated by emergent palustrine vegetation (i.e. rooted herbaceous hydrophytic vegetation such as sedges, rushes, forbs, and grasses) and they are greater than two acres in size (Taft et al. 2002). There were 16,542 discreet emergent wetlands larger than two acres known from within the State, totaling 166,256 acres (0.5% of Illinois), with a mean size of 10.1 acres. These emergent wetlands were randomly ranked (1-indeterminate) within each ranked township to establish sampling priority; field maps show their location (Molano-Flores 2002).

Townships are used in consecutive rank order and one primary site is monitored per township. Team members visit the townships to assess the ranked sites in one of the three habitat types. The site must meet the monitoring requirements (Table 1) at the designated center point, monitored by both botanists and ornithologists. If the site does not meet those requirements then it is discarded and the next ranked site within that township is evaluated, etc. Once all the ranked sites within a township are discarded, then the next available township is assessed. Additionally, if a landowner denies permission or cannot be located with reasonable effort, then that site is also discarded. A site becomes established for monitoring once the lowest ranked acceptable site with landowner permission is found (Jack et al. 2002). It should be noted that approximately 80% of all CTAP sites, used and unused, are on private property, which constitutes over 90% of land in Illinois.

Methods

As part of the CTAP site evaluation process, team members record whether or not an individual site is acceptable with the specific reasons. This information from 1997-2001 was used to develop a database for all sites, and each site was classified to one of 10 main categories (Table 2). Several of the 10 main categories concern habitat loss, fragmentation, and degradation. These categories are: no longer extant (i.e., habitat destroyed), does not meet CTAP monitoring criteria (Table 1), township had no habitat, and too dangerous. Grouping of the reasons for use or nonuse allows the data to be quantified and standardized across the three habitat types.

Results

From 1997-2001, 405 or 90% of the base pool of 450 monitoring sites were selected and monitored, including 140 forests, 139 wetlands, and 126 grasslands. During this period, 16 forest and 46 wetland townships were discarded because they contained no target habitat where sites could be picked. No grassland townships were discarded for this reason.

For forests, 151 townships were assessed for sites. Eleven entire townships (7%) were discarded because no designated site within that township met our monitoring criteria. Additionally, within assessed forest townships, 277 potential sites were discarded because of the following categories: did not meet the monitoring criteria, logistical reasons, were no longer extant, the landowner denied access, or dangerous conditions existed (Fig. 1). Specific reasons are listed in Table 3.

A total of 203 townships were assessed for sites in wetland townships. Fifty-nine of those townships (29%) had to be discarded because they contained no suitable wetlands for monitoring. Within the assessed townships, 672 potential wetland sites had to be discarded mainly because they were no longer extant or did not meet monitoring criteria (Fig. 2). Specific reasons are listed in Table 4.

Only 8 of 140 (6%) entire grassland townships assessed had to be discarded. However, within the assessed grassland townships, 2,857 sites had to be discarded. Over half of those thrown out (58%) did not meet the monitoring criteria and 35% were no longer extant (Fig. 3). The specific reasons are listed in Table 5.

Table 2. Ten main categories and subcategories

Main Categories	Subcategories (Reasons)
1. Sampled	site was used
2. No longer extant	logged (forests only) overgrazed (forest only) drained (wetlands only) bulldozed developed converted to row crops/monoculture
3. Did not meet monitoring criteria	mowed too often grown in by shrubs too much canopy cover (W&G only) too small too degraded not enough wetland vegetation (W only) too little canopy (forests only) overgrazed (wetlands and grasslands) too wet (grassland only) mowed yard mowed roadside golf course cemetery
4. Landowner denies access	said no unreasonable expectations
5. Logistics	inaccessible landowner not located islands inadequate time to assess
6. Too dangerous	meth lab explosives hazardous waste water too deep bull or aggressive cattle dog flooded
7. Did not need	used site with lower rank quota of townships attained
8. Extra bird site	additional surveys for birds
9. Township had no habitat	no habitat for initial selection
10. Miscellaneous	ranks used in different year data destroyed assessed too late unknown

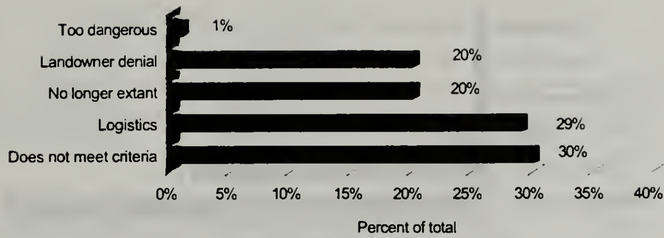

Figure 1. Forest sites discarded 1997-2001 (N = 274 sites).

Table 3. Reasons under the main categories for Forests

Categories	Reasons	Percent
Monitoring criteria	too degraded	50%
	too little canopy cover	37%
	too small	12%
	grown in by shrubs	1%
Logistics	inaccessible	49%
	landowner not located	49%
	inadequate assessment time	2%
No longer extant	development	54%
	overgrazed	13%
	bulldozed	13%
	logged	11%
	row crops	9%
Landowner denial	landowner denied access	100%
Too dangerous	methamphetamine lab	66%
	guard dog	33%

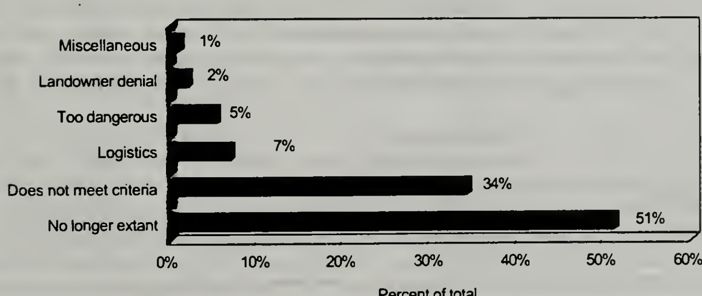

Figure 2. Wetland sites discarded 1997-2001 (N = 672 sites)

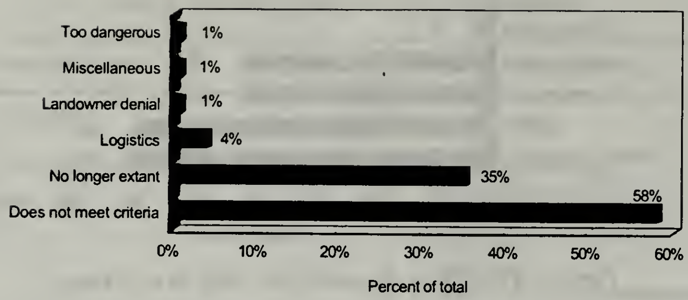

Figure 3. Grassland sites discarded 1997-2001 (N = 2,857)

Table 4. Reasons under the main categories Wetlands

Categories	Reasons	Percent
No longer extant	row crops	78%
	drained	12%
	developed	9%
	bulldozed	1%
Monitoring Criteria	too much canopy	30%
	too small	18%
	inadequate wetland vegetation	14%
	too degraded	13%
	overgrazed	13%
	grown in by shrubs	11%
	mowed	1%
Logistics	inaccessible	35%
	landowner not located	35%
	on islands	22%
	inadequate assessment time	4%
	site not located	2%
	permission too late	2%
Too dangerous	flooded	71%
	water too deep	26%
	hazardous waste	3%
Landowner denial	landowner denied access	100%
Miscellaneous	unknown	75%
	flash flood	25%

Table 5. Reasons under main categories Grasslands

Categories	Reasons	Percent
Monitoring Criteria	mowed/manicured	70%
	overgrazed	11%
	too small	7%
	too degraded	5%
	grown in by shrubs	3%
	too much canopy	2%
	too wet	1%
No longer extant	row crops	85%
	development	13%
	bulldozed	1%
Logistics	landowner not located	47%
	inaccessible	41%
	inadequate time to assess	12%
Landowner denial	landowner denied access	100%
Miscellaneous	data destroyed	79%
	assessed too late	14%
	point on map missing	4%
	rained out	3%
Too dangerous	flooded	48%
	explosives	26%
	bull/aggressive cattle	22%
	aggressive dog	4%

Discussion

During the process of attaining the 405 monitoring sites, a total of 3,803 sites were discarded in all three habitat types. The main reasons (88%) for sites to be unusable for CTAP monitoring are because they are no longer representative of the target habitat due to destruction, degradation, and fragmentation. The primary two categories representing these reasons are: no longer extant and did not meet monitoring criteria. Thirty-seven percent of all sites discarded were no longer extant; Figure 4 shows the percentage of all the forest, grassland and wetlands sites that were assessed and found to be destroyed. These sites were destroyed, or so altered that they no longer functioned as the target habitat and natural recovery to functional habitat is unlikely. The number one reason for this is conversion to row crop agriculture, accounting for 80% of all the no-longer-extant sites. The second most common reason is development, accounting for 13%. Both of these reasons should not be surprising since they show past and current land use changes in Illinois.

Of the discarded sites, 52% did not meet the monitoring criteria (Table 1). These sites are generally too degraded by a variety of anthropogenic factors to accurately represent or function as the target habitat, at least at the time of assessment. Some examples are overgrazing (removal of most groundcover or understory vegetation), inadequate size, too much or not enough canopy cover, mowing more that three times a year, partial development, and heavy logging (Table 2). One possible explanation for the high numbers of discarded sites (over 50%) can be that CTAP monitoring criteria are overly selective and that good sites are discarded. However, it should be pointed out that CTAP sites range from high quality to very poor, with most sites somewhere in the mid to low range. As a whole, the sites can be viewed as average for their respective habitats in the state. Finally, only 10% of the discarded sites were discarded because of reasons unrelated to the habitat quality such as landowner denial and logistic problems.

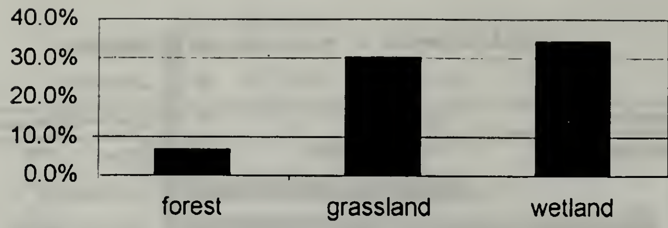

Figure 4. Percentage of forest, grassland and wetland sites that were assessed but discarded because the habitat was no longer extant

In addition to evaluating the status of Illinois habitats, the discarded CTAP monitoring sites data can be used to evaluate the accuracy of the Land Cover Map and Atlas (ILCMA) and the Illinois National Wetlands Inventory (INWI) in the site selection process. Of the three habitat types, forests sites are most intact, most accurately depicted by the ILCMA, and have the fewest sites discarded (Fig. 1). Half of the discarded forest sites were no longer intact or too degraded. In comparison, 85% of the discarded wetland sites and 93% of the discarded grassland sites were no longer intact or too degraded. Forest sites are well depicted on the ILCMA. Only a handful of forest sites do not match the map, and those sites most likely were cleared in the last few years. However, the ILCMA does not define the forest sites that have a full canopy but are disturbed underneath the canopy by development and overgrazing. This is not in conflict with the stated limitations by the authors of the ILCMA (Illinois Department of Natural Resources 1995; 1996).

In the case of grasslands the ILCMA is less useful for site selection for CTAP monitoring purposes; grassland sites account for 75% of all the discarded sites. Part of the reason is that the ILCMA does not discern between intact functional grasslands and regularly mowed monocultures. Ninety-three percent of discarded grassland sites were thrown out because they do not meet the monitoring criteria or are no longer extant. Seventy percent of the sites that do not meet the monitoring criteria are mowed or manicured (e.g., yards, roadsides, and golf courses). These differences only become apparent during the assessment of sites. In the case of no-longer-extant sites, 85% of discarded grassland sites have been converted to row crop agriculture. This is due to the conversion of pasture, hayfields, and former CRP grounds to row crops. This is an ongoing process and some of it has occurred since the publication of the ILCMA.

Finally, CTAP discarded sites data show that the INWI identifies wetlands where there are none and fails to identify some existing ones. For example, a third of assessed wetland townships were discarded because none of the picked wetlands were acceptable for CTAP. Half of the discarded wetland sites were no longer intact and most (78%) had been converted to row crop agriculture. This is in line with other data concerning wetland loss in Illinois and nationally (Havera and Suloway 1994). Some other reasons discarded wetlands were no longer intact include draining, development, and bulldozing. Currently, it is not known whether or not these differences between the sites and the depictions on the INWI were due to limitations of the INWI or if these changes occurred subsequently to the INWI. Rarely is any detailed history of discarded wetland sites known. However, in several instances landowners mentioned draining sites in recent years. Quite often new tile and drainpipes are visible at the designated wetland site or heavy equipment is on site. A portion of the discarded wetlands consists of wet areas in agricultural fields that are tilled in drier years. This evidence suggests some of the sites were destroyed subsequent to the publishing of the INWI, nearly 20 years ago. Another portion of assessed wetland sites, however, are not currently wetlands and appear to have been misidentified in the INWI. Finally, a few sites have been discovered accidentally that are large wetlands and have not been picked up on the maps. These do not include reclaimed or built wetlands since the INWI was published. Such information would point to errors in the INWI, but the extent of these types of errors is difficult to ascertain as assessment only occurs on selected sites. However, from 1997-2001 CTAP has assessed 1,060 wetlands

(6.4%) of 16,542 palustrine emergent wetlands in the state determined by the INWI. We believe that our discarded site database is further evidence of the limitations associated with the INWI. A recent study of wetlands in Lake County (Levin et al. 2002) has shown a similar pattern of missing or mis-identified wetlands associated with INWI.

The discarded site database, in addition to the monitored site data, can provide insights into habitat loss, habitat fragmentation and degradation of habitats in the state. The majority of sites that cannot be monitored by CTAP scientists are either lost or so altered they no longer function as the habitat. Since assessment of CTAP sites only occurs at the pre-designated sites picked using information derived from the ILCMA as well as the INWI, the CTAP sites are subject to the limitations inherent to those products. However, the CTAP discarded site data can provide information back to the ILCMA and INWI with on-the-ground assessment of sites.

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Ornithological Report:
The depauperate nature of the average Illinois bird community:
A CTAP study from 1997-2001

Steven Bailey and Rhetta Jack

Introduction

Habitat loss in Illinois since pre-settlement times has been well documented for all of Illinois's major habitats (Anderson 1970, Iverson et al. 1989, Suloway and Hubbell 1994). Fully greater than 99% of the original prairie from pre-settlement times is now gone, and it is thought that only about 10% of pre-settlement wetlands remain. At least one study conducted in Illinois looked at the drastic changes in habitats throughout Illinois and the corresponding change in bird populations over a fifty-year period (Graber and Graber 1963). In addition, the North American Breeding Bird Survey (BBS), a long-term (1966-2002), national, censusing program has shown that many avian species, from a variety of habitats, are experiencing continued, long-term declines, including population trends from Illinois (Robbins et al. 1989, Peterjohn et al. 1994, Pardieck and Sauer 2000). However, the BBS program is not designed to determine causal factors of population change, while the CTAP program is in a position to do so with the addition of botanical and GIS data and analyses, along with continued, long-term censusing.

The combination of the highly fragmented nature of Illinois's habitats, along with large populations of the parasitic Brown-headed Cowbird have been linked to these sometimes dramatic declines (Robinson et al. 1995). Most studies that have been conducted in Illinois to study how such factors are affecting the state's avifauna have concentrated their efforts on public landholdings, many of which are some of the larger or higher quality tracts of remaining habitat left in the state (Herkert 1994, Thompson et al. 1995, Paine 1997, Robinson et al. 1997). However, the great majority of Illinois land (>90%) is privately owned, and most habitat patches on such lands are small, very fragmented, or isolated from larger, more conterminous tracts of habitat. In this report, we will present the results from the initial five-year cycle of censusing done by CTAP across Illinois. Data on habitat dependent (HD), area dependent (AD), threatened and endangered (T&E), and exotic species will be presented for each of four habitats (forests, grasslands, wetlands, and shrub/scrublands). A brief section will also deal with game/huntable species. Results from the initial five-year cycle of avian censusing by the Critical Trends Assessment Program (CTAP), primarily on private land, further illustrate the very degraded nature of Illinois habitats and the avian communities that they harbor.

Methods

From 1997-2001, CTAP ornithologists censused 405 primary monitoring sites statewide (plus an additional 25 secondary, grassland sites). Of this total, 140 forest, 126 grassland (plus an additional 25 sites), and 139 wetland sites were censused from randomly selected townships in almost every county within Illinois (Fig. 1). Although study areas were located on a variety of public landholdings including city, county, state, and federally owned properties, the overwhelming majority of sites were located on private landholdings. Censuses were conducted from approximately the last week in May to the first few days of August.

For a complete description of CTAP avian and botanical protocols see Molano-Flores (2002). In general, study areas vary from small woodlots and pastures to some of the largest tracts of grasslands and forests in the state, as well as some of the better remaining examples of wetlands in the state. However, due to the extremely fragmented and degraded nature of most CTAP study sites, the size of many grassland and wetland study areas are towards the small end of acceptability. CTAP ornithologists attempt to place as many census points in any given tract of land as temporal, topographical and logistical constraints will allow. Most sights are only large enough for the placement of from one to three points, although some forest sites may contain as many as 16 ten-minute point counts.

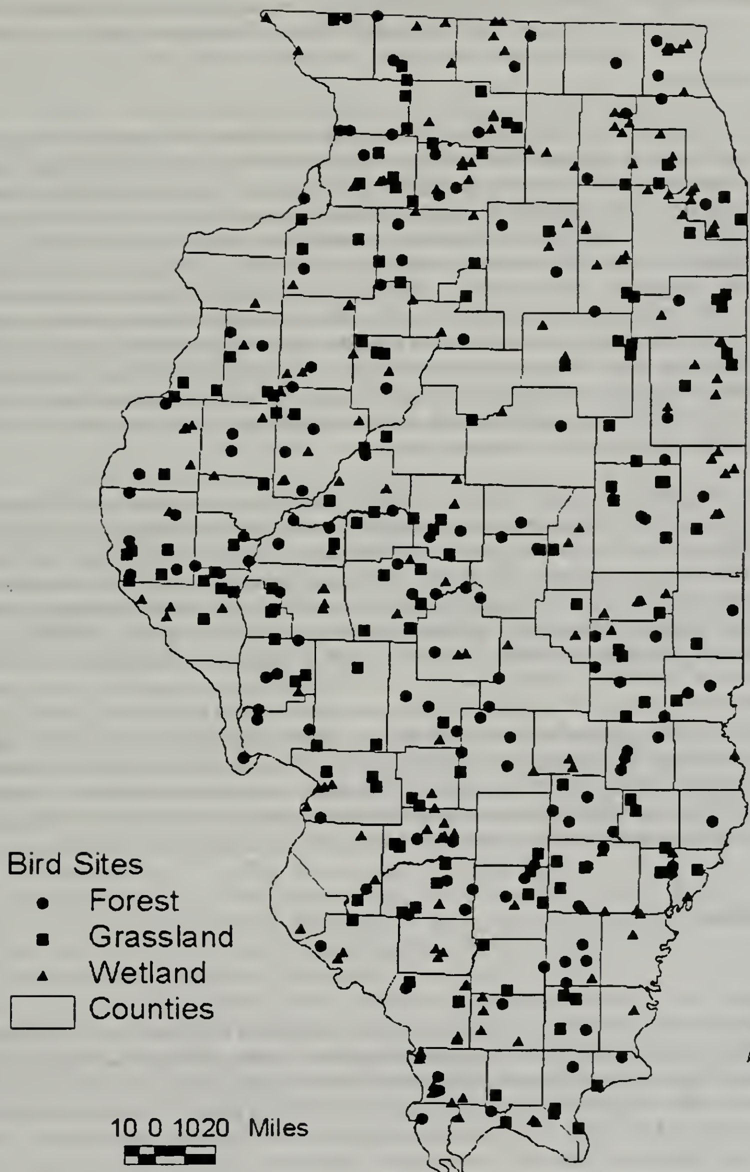

Figure 1. Location of monitoring sites across Illinois from 1997-2001

In wetlands an approximately 30 minute tape-playback of secretive, wetland bird species is played at each census point. Grasslands and wetlands generally have many fewer census points than forest study sites due to the small size of most sites. All birds detected are recorded (unlimited distance), with distance and direction noted for each individual.

As CTAP botanical protocols affect the size of many grassland sites, this in-turn has an effect on the species, species richness, and density of grassland dependent birds found at the study areas. Some primary grassland study sites are no more than 10-25 meter wide by 50-150 meter long grassy strips along roadsides or railroad right of ways. In such instances, an additional, randomly chosen grassland of ten acres or more is picked within the same township as the primary site. Similarities and/or differences between species make-up, richness, and dominance, for the 126 primary grassland sites and the additional 25 sites where such additional or "secondary" sites were needed, are discussed. In addition, sixty-five (65) additional wetland reference sites were chosen within the randomly chosen townships from the wetlands identified on our maps as two acres or greater in size. A large majority of these sites represent wetlands that were generally of much higher quality as wetland bird habitat (i.e. the habitat generally contained more habitat dependent species), as compared to the primary wetland site for that township. Detection rates are given for wetland dependent species for both the primary sites and both primary and reference sites, to show how these mostly "higher quality" reference sites compared with the randomly chosen "primary" sites.

For the purposes of this report, all species have been classified as habitat dependent species (HDS) and/or area dependent species (ADS). Habitat dependent species (HDS) simply refers to those species which are essentially tied to only one particular habitat type in which they occur (breed) in. For example, the Pied-billed Grebe, a wetland dependent species (WDS), will virtually only be found in wetlands (with at least some standing water), whereas the Red-winged Blackbird, which is not a WDS, will breed in wetlands, but can also be found commonly breeding in grasslands. Area dependent (i.e. area sensitivity) species (ADS) refers to the tolerance of a species to habitat fragmentation. That is, if a species is highly area sensitive, then it will require a relatively large tract of its preferred habitat to breed in (i.e. will not generally use smaller, more fragmented patches). Classifications of these ADS and HDS follow or are adapted slightly from Herkert (1993) and Freemark and Collins (1992) grassland and forest bird species. Wetland Dependent Species (WDS) follow Paine (1997), with additional WDS added by the authors for species not included in that study. In addition, this report covers species richness (SR), or the number of bird species in a given area or habitat, for each of the three habitats and the occurrence of state and federally threatened and endangered species (T&E) at CTAP monitoring sites. Dominant species are also given for the former three categories for each habitat.

Results and Discussion

Forests

In forests, SR at any given site varied from 8-42 species. Again, it should be kept in mind that the number of individual point counts varied from as little as a single census point to as many as sixteen, so to some degree the number of species found reflects the size of the forest tract. However, this in turn is often a reflection on the highly fragmented nature of Illinois' forests. Sites ranged from a low of three (6 %) to 24 (50 %) forest species out of a possible 48 forest HDS, both very low compared to areas of unbroken tracts of forest which can be found in nearby Indiana and Missouri. However, both Robbins et al. (1989) and Freemark and Collins (1992) have shown that small forest fragments (especially those less than 25 acres) in eastern North America support few area sensitive or forest interior species. The most dominant species of these forest HDS at CTAP sites were Blue Jay, Tufted Titmouse and Acadian Flycatcher. Such widespread and common species as House Wren, Northern Cardinal, and Tufted Titmouse were the three most dominant species in forested sites between 1997-2001. The former two species are also considered two of the least area sensitive woodland species, with the latter only moderately sensitive. As has been shown in other studies, short distance migrants and resident species are some of the more common forest species found in highly fragmented forest habitats (Whitcomb et al. 1981, Ambuel and Temple 1983, Blake and Karr 1984, Hayden et al. 1985).

Concerning ADS (Table 1), 99 % of all forest sites had at least one moderately ADS, with a range of from 0-13 (0%-87%) ADS. Dominant species in this category included the Tufted Titmouse, Red-eyed Vireo, and the White-breasted Nuthatch. The nuthatch was present at 125 (89.2 %) of the 140 forest sites surveyed during the period, up slightly from the 88.2 % noted at sites between 1997-2000 (Molano-Flores et al. 2002a). The only forest species that had higher detection rates than the nuthatch were all species which exhibit low area sensitivity (LAS), and include such common species as Downy Woodpecker (95.7%), Blue Jay (92.1%), and Eastern Wood-pewee (92.1%). These three species were detected at 30 (100%), 29 (96.6%), and 29 (96.6%), respectively, of the 30 forest sites monitored in 2001. For those most ADS, there was a range of from 0-5 (0%-39%) species at any given forest site, with fully 52 % (67) of sites where no highly ADS were detected. Somewhat surprisingly, the Pileated Woodpecker, a relatively uncommon, statewide permanent resident, was one of the three most dominant ADS species detected, at 29 (20.7%) sites, with the Ovenbird (26; 18.5%), and Yellow-throated Vireo (47; 33.5%), being the two other most dominant ADS, both neotropical migrant species. The very loud, ringing drum and call of the Pileated Woodpecker likely greatly facilitates the detection of that species compared to virtually any other forest dwelling species. Two highly ADS which had previously gone undetected in CTAP surveys were found during the 2001 monitoring, the Black-and-white Warbler (at two sites), and the Hooded Warbler (at three sites). Detection rates for a large majority of both HDS and ADS were up when compared with the 1997-2000 results (Molano-Flores et al. 2002a), with the Wood Thrush (14.2%), Yellow-throated Vireo (9.0%), and Summer Tanager (6.9%), showing some of the largest gains. These likely represent increases in the size and/or quality of CTAP sites monitored, rather than any increase in the populations of these species. Unfortunately, the percentage of sites where Brown-headed Cowbirds (a nest parasite) were detected also increased slightly, from the four year trend of 76.3% to the five-year trend of 80.0%. The Brown Creeper, a statewide State Threatened (ST) species also was detected at an increasing rate, having now been detected at 7 of 140 forest sites (5%), up slightly from the four-year trend of 3.6%.

Although the Wood Thrush and Red-eyed Vireo, only moderately ADS, have been detected at 57.8% and 70.7% of all CTAP forest sites between 1997-2001 (Molano-Flores et al. 2002a), many sites that seem appropriate for these species have either contained few individuals of one or the other species, or none at all. Both species are a common component of a large variety of forested habitats in Illinois including both bottomland and upland forests, and the Red-eyed Vireo is often one of the most common species (Graber and Graber 1963, Graber, et al. 1971, 1985). Both species are frequent hosts of the Brown-headed Cowbird in the state as well (Graber et al. 1971, 1985, Robinson et al. 1995, Robinson et al. 1997). Studies in varying size woodlots in Illinois have shown that the productivity of species such as the Red-eyed Vireo and Wood Thrush is likely not good enough (due to predation and parasitism) to achieve replacement from local breeding areas, and such species are only "holding on" in these areas due to likely recruitment from outside areas from as far away as 100 miles or more in southern Indiana and Missouri (Brawn and Robinson 1994, Brawn and Robinson 1996). Localized extinctions or near extinctions of some populations of Red-eyed Vireos, Wood Thrushes and likely other species such as tanagers and some species of wood warblers may become increasingly common, and initial observations and census data by the CTAP ornithologists are beginning to bear this out at several of the small, highly fragmented forest sites common in this study.

Grasslands

In grasslands, SR was similar to forested sites, with sites varying from 5-46 species. However, primary grassland sites averaged fewer census points per site and species diversity in grasslands is much less than in forests. Grassland associated species such as the Red-winged Blackbird were the dominant species found at CTAP grassland sites, followed by the Common Yellowthroat and Song Sparrow (Table 2), also species

Table 1. Forest habitat dependent species detection rates
Total number of forests monitored from 1997-2001= 140

Neotropical migrants:

Statewide distribution

Species	# sites detected	% sites detected
Eastern Wood-pewee	129	92.1 %
Great-crested Flycatcher	115	82.1 %
Yellow-billed Cuckoo	105	75.0 %
Red-eyed Vireo	99	70.7 %
Wood Thrush	81	57.8 %
Scarlet Tanager	77	55.0 %
Yellow-throated Vireo	47	33.5 %
Ovenbird	26	18.5 %
American Redstart	6	4.2 %
Cerulean Warbler	2	1.4 %
Black-and-white Warbler	2	1.4 %

Mostly southern 1/2 of state, but present statewide

Species	# sites detected	% sites detected
Kentucky Warbler	48	34.2 %
Northern Parula	41	29.2 %
Lousiana Waterthrush	27	19.2 %
Prothonotary Warbler	10	7.1 %
Worm-eating Warbler	9	6.4 %
Hooded Warbler	3	2.1 %

Mainly present only in north or south 1/2 of state

Species	# sites detected	% sites detected
Summer Tanager	30	21.4 % (S)
Yellow-throated Warbler	9	6.4 % (S)
Veery	3	2.1 % (N)
#Pine Warbler	2	1.4 % (S)

= only found in large stands of mature pines

Short-distance migrant or resident:

Species	# sites detected	% sites detected
Downy Woodpecker	134	95.7 %
Blue Jay	129	92.1 %
White-breasted Nuthatch	125	89.2 %
House Wren	68	48.5 %
Black-capped Chickadee	67	47.8 %
Red-headed Woodpecker	61	43.5 %
Carolina Wren	59	42.1% – mostly southern IL
Carolina Chickadee	51	36.4 %
Pileated Woodpecker	29	20.7 %
Cooper's Hawk	13	9.2 %
*Red-shouldered Hawk	7	5.0 % – mostly southern IL
*Brown Creeper	7	5.0 %
Brown-headed Cowbird	112	80.0 %

* = State Threatened Species

Table 2. **Grassland HDS detection rates 1997-2001 (includes 126 primary sites and 25 additional sites for 151 total). (Area dependency from Herkert et al. 1993)**

Species	# sites detected	% sites detected	Area dependency
Eastern Meadowlark	94	62.2	moderate
Dickcissel	68	45.0	low
Grasshopper Sparrow	31	20.5	moderate
Vesper Sparrow (N)	18	11.9	low
Savannah Sparrow (N)	15	9.9	high
Bobolink (N)	15	9.9	high
Sedge Wren	12	7.9	moderate
Henslow's Sparrow**	8	5.2	high
Western Meadowlark (NW)	5	3.3	moderate
Northern Harrier**	2	1.3	high
Upland Sandpiper**	1	0.6	high
Short-eared Owl**	0	0.0	high
Grassland associated species			
Red-winged Blackbird	130	86.0	low
Common Yellowthroat	120	79.4	low
Song Sparrow	113	74.8	low
Field Sparrow	99	65.5	low
Loggerhead Shrike*	4	2.6	?
Brown-headed Cowbird	94	62.2	low

(N) = distribution in northern $^1/_2$ of state only
(NW) = distribution mainly in northwestern $^1/_3$ of state
* = State Threatened Species
** = State Endangered Species
? = likely moderate to high

common to other habitats in Illinois (wetland, shrub and edge areas). Of those species that are grassland HDS, the Eastern Meadowlark was by far the most common and widespread at CTAP monitoring sites, followed by the Dickcissel, Sedge Wren and Savannah Sparrow which were much less common and widespread. The Bobolink, historically a characteristic and common-to-abundant bird of the Grand Prairie Region of Illinois was the dominant species at only one site. Thirty-four (30%) of the 126 primary grassland sites contained no grassland HDS. Of the ADS species, four species are considered moderately area dependent. Sites ranged from 0-4 (0%-100%) of these species, but with only one site having all four moderately ADS. Fifty-one (40.5%) sites had no moderately ADS. Of the six possible grassland species that are considered highly ADS in the state, sites ranged from having only 0-2 (0%-33%) of these species, with the dominant species in this category being the Savannah Sparrow, followed by the Bobolink and the State Endangered (SE) Henslow's Sparrow. A large majority of the 126 primary CTAP grassland sites, 105 (83%), contained no ADS. Illustrating the small and highly fragmented nature of most Illinois grasslands, the four most common grassland species detected at CTAP sites all only show either low or moderate area sensitivity (Table 2).

Due to botanical protocols in choosing sites, many of the CTAP grassland sites are only small and/or narrow strips of grassland habitat, which are not acting as functioning ecosystems for grassland bird species. For this reason, in sites of less than ten acres, another (secondary) site is chosen for CTAP ornithologists (only) to monitor. In these larger areas, a significant trend has been noted. In 15 (60%) of the 25 additional or secondary sites that were chosen, at least one moderately ADS was noted where the primary site had no moderately (or highly) ADS. In addition, 9 (36%) of these 25 secondary sites also contained at least one highly ADS when the primary site had none, while in none of the remaining 16 sites did the primary site have any highly ADS. In 4 of the 9 instances, these were state threatened and endangered species.

When both primary and secondary sites are considered (for a total of 151 sites), not much changes in a list of commonality, with the most common species remaining the Eastern Meadowlark, found at 94 (62.2%) of the 151 sites. Dickcissel remained common, being detected at 68 (45%) sites, and Grasshopper Sparrow being the next most common HDS with 31 (20.5%) sites registering this species. Although the Brown-headed Cowbird parasitizes grassland species much less commonly than forest species in Illinois (Robinson et al 2000), it was recorded at 94 (62.2%) sites, though many of these were as fly-overs. Only ten (7.9%) of 126 primary grassland sites contained T&E species. Nine sites had a single T&E species and one had two T&E species. Other than the SE Henslow's Sparrow, recorded at 8 (5.2%) of the 151 sites, only two other SE grassland HDS were recorded. Two (1.3%) Northern Harriers (SE) and one (0.6%) Upland Sandpiper (SE) was noted in the combined 151 primary and secondary grassland sites. However, the grassland associated Loggerhead Shrike (ST) was also detected at four (2.6%) sites as well.

Wetlands

SR in wetland sites was comparable to both forest and grassland sites with a range of 6-40 species. Of the four most dominant species found at CTAP wetland sites, none were wetland HDS (Table 3). The percentage of wetland sites (49.7% or 69 of 139 sites) with wetland HDS remained relatively the same between 1997-2001 as compared to the four-year trend (1997-2000) of 46.7% (51 of 109 sites) (Molano-Flores et al. 2002a). However, as with forest sites, detection rates for a large majority of the wetland species was somewhat to substantially higher than the four-year trend (Table 3). This table shows twenty-four wetland HDS, five wetland associated species, and the parasitic Brown-headed Cowbird, along with a comparison of the four-year (1997-2000) trend with the first full five-year cycle (1997-2001), as well as sixty-five additional, mostly high quality reference sites.

There are more T&E bird species possible in wetland habitats than in all other habitats combined in Illinois (18 wetland, 5 grassland, 4 forest). However, there were only slightly more T&E species noted at CTAP wetlands, compared to grassland or forest sites, with only 13 (9.3%) of 139 primary wetland sites recording T&E species. Ten sites had a single T&E species, two had 2 T&E species, and one site had three. Interestingly, for 12 T&E species found at wetland sites, reference sites and primary sites each had six species where the majority of T&E species found were at those respective types of sites (Table 3). Of note though were King Rail (SE) which was found only at five reference sites and Yellow-headed Blackbird (SE) found at only two reference sites. However, the only sites where American Bitterns (2), Snowy Egrets (1), and Yellow-crowned Night-Herons (1) were recorded were at primary wetland sites.

Although wetland HDS do not appear to exhibit any area dependency, the number and quality (including and especially water depth) of other wetlands in a landscape seem to be just as important in attracting HDS. Of the 139 primary wetland sites, the range of HDS has only been 0-8 (0%-20%), by far the lowest of the three study habitat types. Unlike grasslands, wetlands have a relatively long list of HDS (Table 3). However, fully 50% (70) of the 139 primary wetland sites had no WDS. Of those that did, there were a few clear dominants, including Wood Duck, Mallard, and Willow Flycatcher. Canada Goose would likely replace Willow Flycatcher, but due to their early breeding season, many adults and young have left their breeding sites before CTAP censuses begin. CTAP wetlands are dominated by wetland associated species (Table 3), with the five main wetland associated species all having detection rates higher than the any wetland HDS. The extent to which Brown-headed Cowbirds use wetland habitats has been little studied. Cowbirds were noted at only 74 (53.2 %) of the primary wetland sites, the lowest percentage of the three main habitat types.

Table 3. Wetland habitat dependent species (HDS) detection rates

Species	1997-2001 (139 sites) # sites	1997-2001 (139 sites) % sites	1997-2000 (109 sites) # sites	1997-2000 (109 sites) % sites	1997-2001 (+ ref.) # sites	1997-2001 (+ ref.) % sites
Great Blue Heron	59	42.4%	31	28.4%	91	44.6%
Wood Duck	42	30.2%	16	14.7%	63	30.8%
Mallard	41	29.4%	19	17.4%	59	28.9%
Green Heron	33	23.7%	17	15.6%	57	27.9%
Willow Flycatcher	24	17.2%	15	13.8%	37	18.1%
Canada Goose	19	13.6%	7	6.4%	31	15.1%
Swamp Sparrow (N)	15	10.7%	9	8.3%	31	15.1%
**Little Blue Heron (S)	7	5.0%	1	0.9%	8	3.9%
Marsh Wren (N)	6	4.3%	5	4.6%	17	8.3%
*Least Bittern	5	3.5%	4	3.7%	6	2.9%
American Coot	4	2.8%	2	1.8%	7	3.4%
**Black-crowned Night-Heron	3	2.1%	2	1.8%	7	3.4%
Virginia Rail (N)	2	1.4%	1	0.9%	6	2.9%
*Pied-billed Grebe	2	1.4%	2	1.8%	5	2.4%
*Common Moorhen	2	1.4%	2	1.8%	5	2.4%
Sora (N)	2	1.4%	1	0.9%	5	2.4%
**American Bittern (N)	2	1.4%	0	0.0%	2	0.9%
**Sandhill Crane (N)	1	0.7%	0	0.0%	4	1.0%
**Yellow-crowned Night-Heron (S)	1	0.7%	0	0.0%	1	0.4%
**Snowy Egret (S)	1	0.7%	0	0.0%	1	0.4%
**King Rail	0	0.0%	0	0.0%	5	2.4%
**Yellow-headed Blackbird (N)	0	0.0%	0	0.0%	2	0.9%
Common Snipe (N)	0	0.0%	0	0.0%	0	0.0%
#Mute Swan (N)	0	0.0%	0	0.0%	0	0.0%
Red-winged Blackbird	121	87.0%			186	91.1%
Common Yellowthroat	119	85.6%			175	85.6%
Song Sparrow	118	84.8%			176	86.2%
Indigo Bunting	118	84.8%			167	81.8%
Killdeer	61	43.8%			96	47.0%
Brown-headed Cowbird	74	53.2%			104	50.9%

N = population mainly/entirely in northern $^1/_2$ of state
S = population mainly/entirely in southern $^1/_2$ of state
= statewide distribution
* = State Threatened
** = State Endangered
# = Introduced/feral species

Shrub/scrubland

Shrub/scrubland habitats are not studied in the CTAP program, per se, although shrub/scrubland bird species are often noted in censuses of all three habitats, especially wetlands and grasslands. Most grasslands have a shrub component to at least a small portion of the site. One of the most common of shrubland species in the state, the Brown Thrasher, was detected at 35 (23.1%) of all (151) grassland sites. Three shrubland species, all neotropical migrants, which were detected with some frequency at CTAP grassland sites included the Blue Grosbeak found at nine (5.9%), Yellow-breasted Chat noted at 21 (13.9%), and the Orchard Oriole detected at 25 (16.5%) of all 151 grassland sites. The Bell's Vireo, a species declining fairly precipitously over much of its range (Pardieck and Sauer 2000), in part due to heavy Brown-headed Cowbird parasitism, was detected with some regularity at both grassland and wetland CTAP study sites. This species was noted at 13 (8.6%) of 151 grassland sites and 12 (8.6%) of 139 primary wetland sites.

Exotic/Introduced Species

Exotic bird species are not the concern that many non-native plant species are to habitats throughout the state. However, CTAP censuses show that the two dominant species, European Starling and House Sparrow, remain relatively common in most Illinois habitats, and still present a problem to cavity nesting bird species (Table 4). This will likely only increase, especially as forests continue to become even more fragmented. As of yet, Mute Swans do not present the potential problem that they might present if they were to spread and become more common outside of their northeastern Illinois stronghold. They have yet to be detected at one CTAP site. Other species which have not been detected at a CTAP site, include the Monk Parakeet, which is currently only established in a relatively few urban/surburban areas in (mainly) Cook County and the Eurasian Collared-Dove. The latter species, although yet to be detected on CTAP censuses, will likely become at least a fairly common species throughout the state in the not too distant future. With the breadth of CTAP monitoring, this program should track the spread and colonization of this species across the state very nicely.

Game/huntable species

Table 5 presents detection rates for some of the avian species most sought after by the hunting community, but also see Table 3. Due to the timing of CTAP censuses, several game species are under-represented in the table, and so detection rates are somewhat-to-substantially lower than true population levels would otherwise indicate. They are given here for reference value only. In the case of the American Crow, most detections in all habitats usually represent calling birds heard at some distance (often greater than 300 meters) or are birds flying over the habitat and not actually utilizing that habitat. Pheasant and Northern Bobwhite are also heard at some distance, again many times greater than 300 meters from the census point where they are registered.

Table 4. Introduced/exotic species detection rates

	Forests (140 sites)		Grasslands (151 sites)		Wetlands (139 sites)	
Species	# sites	% sites	# sites	% sites	# sites	% sites
Mute Swan					0	0.0%
Ring-necked Pheasant			21	13.9%	14	10.7%
Gray Partridge			0	0.0%	0	0.0%
Rock Dove	2	1.4%	15	9.9%	14	10.7%
European Starling	18	12.8%	94	62.2%	55	39.5%
House Finch	20	14.2%	28	18.5%	20	14.3%
House Sparrow	10	7.1%	55	36.4%	24	17.2%
Eurasian Tree Sparrow	0	0.0%	5	3.3%	2	1.4%

Table 5. Game/huntable species (* = does not apply)

	Forests (140)		Grasslands (151)		Wetlands (139)	
Species	*# sites*	*% sites*	*# sites*	*% sites*	*# sites*	*% sites*
American Crow	113	80.7	103	68.2	87	62.5
Mourning Dove	83	59.2	109	72.1	85	61.1
Northern Bobwhite	37	26.4	66	43.7	37	26.6
Wild Turkey	30	21.4	3	1.9	4	2.8
Ring-necked Pheasant	*	*	21	13.9	14	10.7
Gray Partridge	*	*	0	0	0	0

Wild Turkey are also likely found in a much larger percentage of CTAP sites than detection rates suggest, but due to this species wary nature many birds likely go unnoticed. Of interest to at least some hunters, the virtual lack of detection of the Gray Partridge could mean that this species may be on its way out in Illinois. Other anecdotal evidence points to this, as very few sightings of this species have been made in recent years in their former range within the state. Again, the breeding season of the resident population of Canada Geese is virtually over by the time most CTAP censuses are begun. Rails, snipe and American Woodcock are all under-detected due to their secretive nature, timing of breeding season, or other issues of conspicuousness or a combination of all of these factors.

Conclusions

As with the four-year trends, results from the first five-year cycle show that highly ADS/HDS in all of Illinois's habitats have low to very low detection rates at CTAP study sites. This is a direct reflection on both the small size and fragmented nature of all of Illinois' habitats. Grassland sites continue to be the most depauparate, with few T&E species noted other than the Henslow's Sparrow (which is currently experiencing a population boom in Illinois), almost as few ADS, and even smaller numbers of HDS. Data collected by CTAP biologists show that this habitat is in the most serious need of restoration, and if some species of grassland birds are to continue to exist in the state, the quality and size of sites needs to improve dramatically in the years to come. The nature of the additional grassland sites that are chosen when primary sites are not large enough show that size is one of the main considerations grassland species use when determining what sites to attempt to breed in. Many of these extra CTAP sites are pastureland, hayfields, or set-aside lands, and almost all contain a higher avian species diversity, including the presence of both HDS and ADS, than randomly chosen primary sites. As botanical data show the poor quality and presence of exotic species at grassland sites (Molano-Flores et al. 2002b), the CTAP program also shows the higher importance to grassland birds of plant structure, rather than native or otherwise "higher quality" of plant species present at a site.

Data collected on habitat and area sensitive species at CTAP sites show Illinois forests to be in the best condition, at least for birds, of the three habitats. Even many of the smallest tracts still contain at least a remnant number and fair diversity of typical forest bird species. Although a few species such as the Cerulean (in trouble over much of its range), Hooded, and Black-and-white Warblers are detected at extremely low rates, most other declining neotropical migrant species and short-distance migrants are still occurring in Illinois forests in relatively good numbers. It will be interesting to see what kinds of long-term trends are noted for species like Wood Thrush and Red-eyed Vireo, which currently are still being detected at most sites, but which could have a precipitous decline (due to fragmentation, predation and cowbird parasitism) if large areas of intact forests in neighboring states begin to become more and more fragmented. Although Brown-headed Cowbird detection rates remain high, it is likely that they are actually even higher at CTAP sites than the data indicate, with virtually 100% of all forest sites not only having high detection rates but also likely having high cowbird parasitism rates (see Robinson et al. 1995 and Robinson et al. 1997). Likely the only reason many CTAP sites have yet to detect cowbirds is the fact that many sites have just one or two census points. With more points and/or repeat visits, cowbirds would likely be found at all sites. Cowbird/host ratios at many of the larger CTAP sites will likely provide even more evidence to back up findings of very high cowbird/host ratios (and high parasitism rates) found by other studies in Illinois at higher quality sites. Using GPS and GIS data, we should be able to determine what size of a habitat patch may be needed to lower cowbird/host ratios in a larger habitat matrix of forest (or grassland) habitat.

Data collected at Illinois wetlands over the first five-year cycle show that there are a few HDS that are still relatively common in many Illinois wetlands, especially at sites with at least some standing water throughout much of the breeding season. Water depth, or lack thereof, is one of the primary reasons that many CTAP wetland sites lack WDS of birds. This is also likely the main reason for the large number of wetlands that lack even one wetland HDS. Quality reference sites will become more important to give us a good comparison to judge just how poor many of the CTAP sites appear to be, both in quality and species diversity, especially in judging the fate of T&E species that are currently found very infrequently at CTAP sites.

Although the CTAP study was not set up to study all habitats within the state, some inferences will be able to be made regarding a few other habitats where bird use is concerned, especially shrubland habitats. Bird data from the three main habitat types will also be able to show general trends in the increase, decrease, spread, or lack thereof, of almost all of Illinois' introduced/exotic avian species. Although relatively few threatened and endangered species are detected at CTAP study sites, this program likely documents more T&E species than any other single program or agency within the state, and should provide a good indication as some species rebound, and a early warning system for species (like the Cerulean Warbler) that continue to decline.

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ForestWatch Fall 2001 - Spring 2002

Matt Buffington

Fall Tree Survey

Data from 58 sites were submitted in fall 2001, 22 of which had never been monitored before. A total of 157 sites have been monitored since spring 1998. The tree composition of the forests from 2001 was similar to other years. As shown in Table 1, oaks and hickories, the species that historically dominated the majority of Illinois forests, contributed heavily to the total basal area of trees (51% of total basal area) and were fairly abundant (27% of total abundance). This is in contrast to many understory species that contribute relatively little to the total basal area as compared to their contribution to total abundance. For instance, flowering dogwood, persimmon, sassafras, hawthorn and ironwood combined for only 3% of the total basal area but 11% of the total abundance. Persimmon is somewhat common in the southern third of the state and was tenth in abundance and sixteenth in importance. This was the result of two sites that are heavily dominated by this species. In 1999, the most recent year many of these sites were previously monitored, persimmon was tenth in abundance and thirteenth in importance, again as a direct result of these same two sites.

Table 1. Importance values of trees from ForestWatch sites

Tree Taxa	Relative Abundance	Relative Basal Area	Importance Value
White Oak	4.8	18.5	23.3
Hickory spp.	12.3	10.3	22.6
Sugar Maple	10.2	7.3	17.5
Ash spp.	6.9	7.7	14.6
Black Cherry	9.1	4.3	13.4
Red Oak	2.3	8.8	11.1
Slippery Elm	7.3	3.6	10.9
American Elm	6.5	3.3	9.8
Hackberry	3.6	2.9	6.5
Black Oak	2.4	3.1	5.5
other 65 taxa	34.5	30.3	64.8

Thirty-one of the 58 sites monitored in 2001 also had tree data collected in fall 1999. There were a few sites that had some relatively large differences in the abundance and basal area values, but on the whole the average number of trees and average basal area for each site was similar between years.

The average diameter of all the trees monitored was 20.7 cm, or slightly over eight inches. Nearly 80% of the trees were ≤20 cm (Fig. 1). This is a rather small diameter and indicates that Illinois forests are mainly second growth with large amounts of moderately sized trees. This can be contrasted with the tree height data collected in the spring from these same sites. In the spring, 15 of the tallest trees are measured for height and diameter. The average diameter of these tall trees was 34.2 cm (13.6 inches). Although the tallest trees are not necessarily the largest in diameter, they are certainly among the largest in the forest.

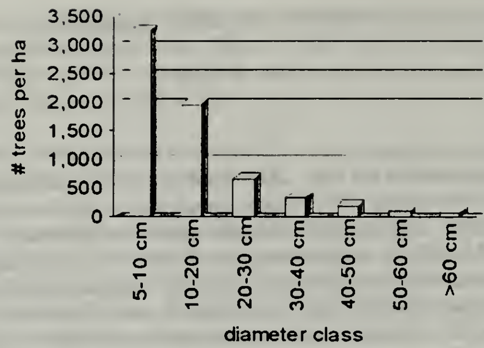

Figure 1. Number of trees by diameter class

Fall Shrub Survey

Forty of the 58 sites (69%) had one or more invasive shrub taxa present. Multiflora rose was the most common invasive shrub in terms of the number of sites in which it was recorded, while shrub honeysuckles averaged the greatest number of stems (Table 2). The ratio of invasive shrub stems to the total amount of shrub stems indicates the degree to which these species are dominating a forest. Among the sites with shrubs, the average ratio of invasive shrubs to total shrubs was 63%, with nearly half of the sites ≥90% (Fig. 2 and 3). The average ratio has been around 50% or greater every year of monitoring. Considering ForestWatch looks for approximately 18 invasive shrub species (including 12 shrub honeysuckle and two buckthorn species) and there are over 250 different shrub species in Illinois, the data indicate that a relatively small number of invasive shrub taxa are a major problem in forests.

Thirty sites at which shrubs were recorded in 2001 also had shrub data in 1999. Although the average number of stems for shrub honeysuckle, buckthorn, multiflora rose, and gooseberry was greater in 2001, the difference was not significant. The number of sites with gooseberry and Japanese honeysuckle in the shrub survey can be compared to the values from the quadrat survey in the spring. These two species were added to the spring survey because they often do not reach one meter in height, the minimum height required for shrubs to be included in the fall survey, and thus may be undercounted in the fall shrub layer survey. The other five invasive taxa are more likely to be at least one meter tall. There were 42 sites with fall and spring data.

Table 2. Amount of shrubs and vines recorded at ForestWatch sites

Taxa	# Sites	Average # Stems (m^2/ha)
Honeysuckle Shrub	18	564
Buckthorn	13	524
Highbush Cranberry	3	7
Autumn Olive	2	21
Multiflora Rose	29	422
Gooseberry	17	414
Other Shrubs	40	479
Japanese Honeysuckle	3	29
Other Vines	37	263

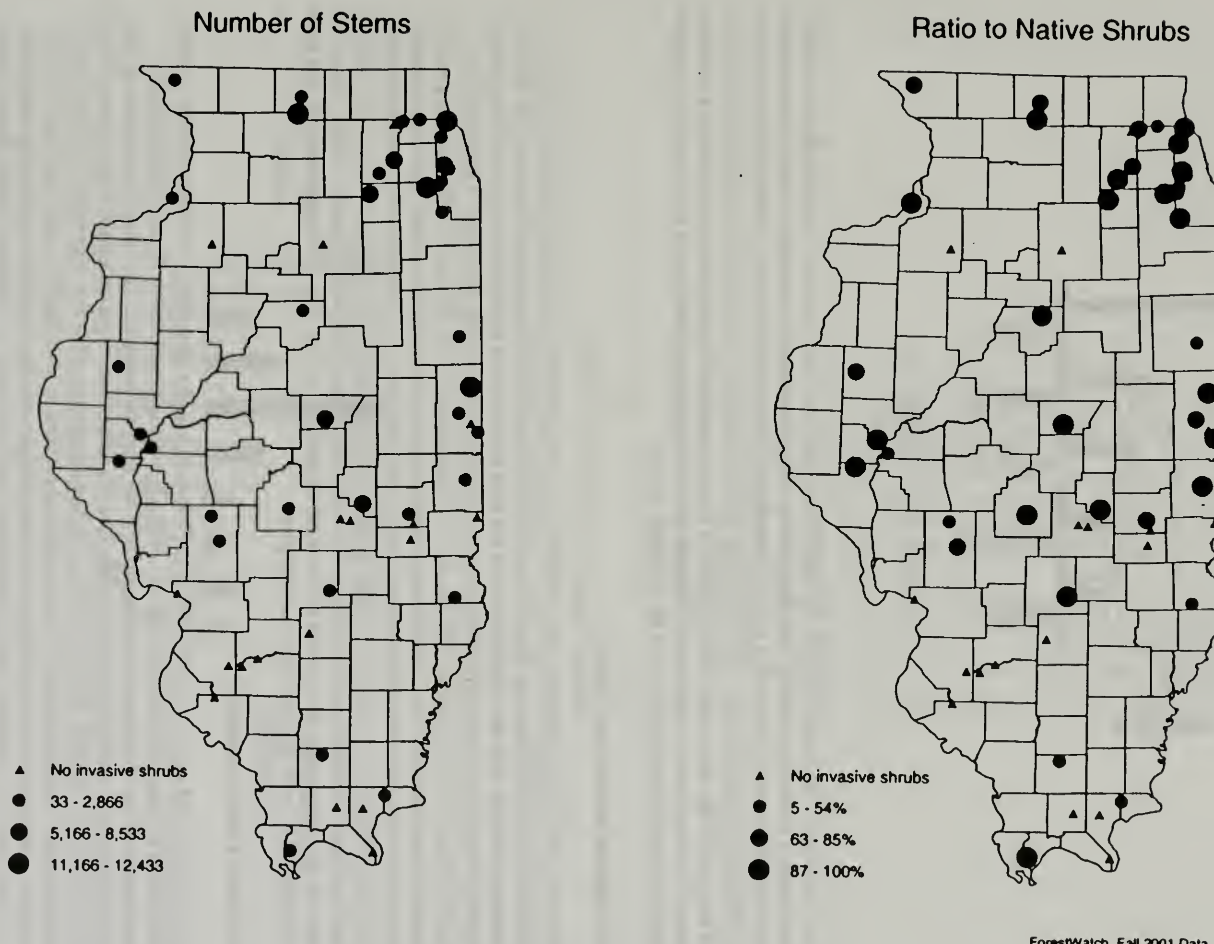

Figure 2. Invasive shrubs

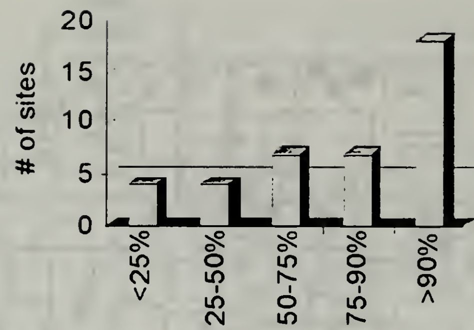

Figure 3. Invasive shrub ratios

Nine sites reported gooseberry in both fall and spring, while three sites reported it just in the fall and another three reported it just in the spring. Additional monitoring will determine if gooseberry is being undercounted in the fall shrub survey. There was a bigger difference with Japanese honeysuckle. Seven sites had this vine in the spring and one different site reported it in the fall. Although this vine does grow vertically up canopy trees and can overwhelm entire areas within a forest, it is often seen growing along the ground, covering extensive areas of the forest floor and understory trees and shrubs. This probably accounts for the increase in the reports during the spring survey compared to the fall shrub survey.

Fall Dogwood Anthracnose Survey

Dogwood anthracnose continues to be a problem in many forests where flowering dogwoods are found. Fifteen sites contained flowering dogwoods and eight of these reported dogwood anthracnose (Fig. 4). This percentage is higher than the roughly 30% that has been reported from ForestWatch sites in previous years. Whether this reflects a spread of the disease or inconsistency in identifying the disease is uncertain. The majority of the sites monitored in 2001 that were also monitored in 1999 did not have flowering dogwoods. However, there were some yearly differences in reporting for some sites. At some sites, flowering dogwoods may be reported in one year but not another. Year-to-year differences in the recording of flowering dogwood trees and saplings are not unexpected. Slight changes in the placement of the transect lines can result in one or more trees being recorded in one year and not another. What is most important is properly identifying and reporting the disease when it is present and tracking its spread over time. This information has only just begun to be gathered as more sites are revisited each year.

Fall Maple Takeover Analysis

Invasive shrubs and species-specific diseases are forces altering the composition of Illinois forests. Another factor that is affecting the makeup of forests is changes in management. Many forests, particularly oak-hickory uplands, are changing since the removal of fire from the landscape. The result is an increase in fire intolerant but shade tolerant species, especially those associated with mesic-uplands like sugar maple. Nine of the 37 oak-hickory uplands showed some degree of maple takeover. This was determined by looking at the number of trees in each size class for oaks, maples, and hickories. Sites that had a relatively higher ratio of maples as compared to oaks and hickories in the smaller diameter classes may be experiencing maple take-over. Some sites are borderline, such as a site from Kane County (Fig. 5). Other sites exhibit much greater evidence of takeover, as in Figure 6 which is a site from McDonough County. Finally, other sites have a major problem, as evidenced in Figure 7, a site from Coles County.

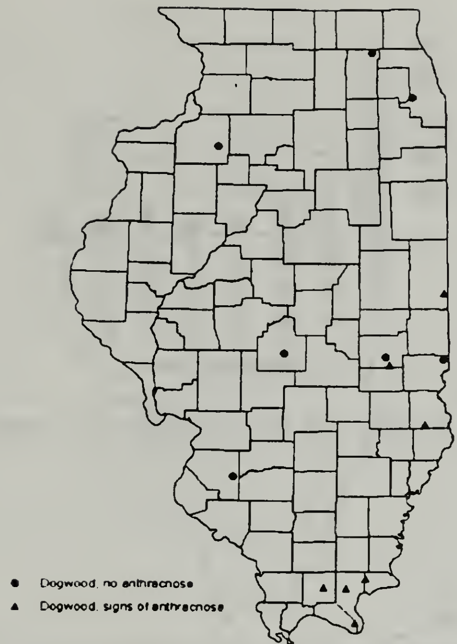

Figure 4. Presence of dogwood anthracnose

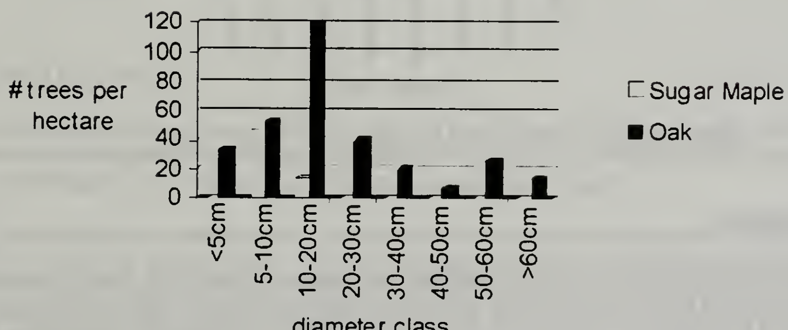

Figure 5. Example of a site that may exhibit maple takeover in the future

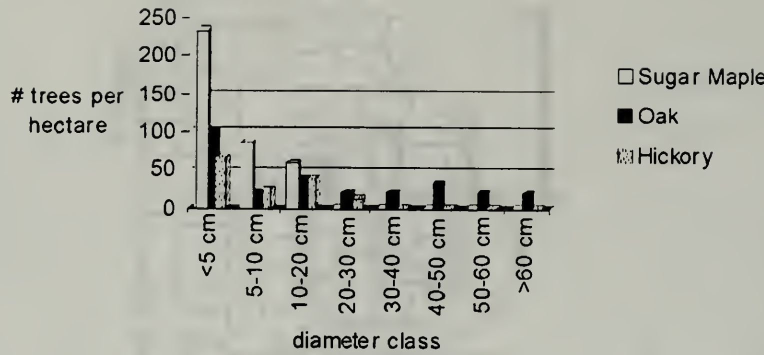

Figure 6. Example of a site that currently shows signs of maple takeover

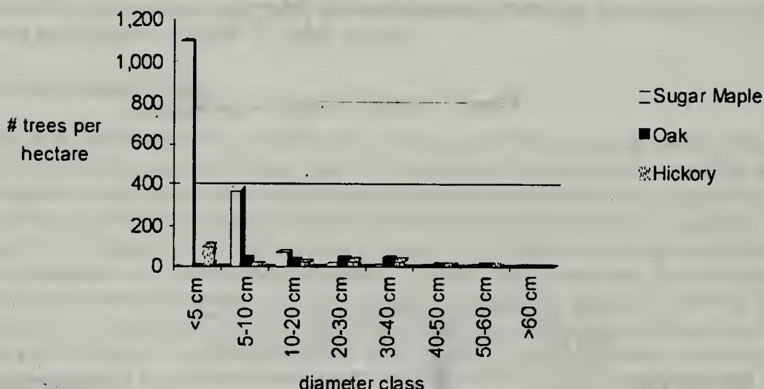

Figure 7. Example of a site that clearly has a major problem with maple takeover

Fall Correlations

Geography plays an important role in plant distribution and other ecological factors. This is especially true in Illinois which spans roughly 400 miles from north to south, has a very large urban area in the north, extensive agriculture in the central region, and more forest and rolling topography in the south. Therefore it is useful to look at the data in terms of where in the state the sites are located. In vegetative studies, analyses are often based on dividing the state into thirds and examining differences among these geographical regions (Fig. 8). Data from the fall 2001 and spring 2002 monitoring cycle came from 22 sites in the northern zone, 22 in the central, and 14 in the south.

Figure 8. The three biogeographical regions used in the analysis

Several indices were significantly correlated to the zone in which sites were located as shown in Table 3. The correlation between zone and the shrub data generally relate to the large amount of buckthorn found in the northern part of the state. Over 99% of the buckthorn was in the north zone. Honeysuckle and multiflora rose are relatively more common statewide but even these species tend to occur more often in the northern and central zones. The opposite is true of the presence of flowering dogwood and therefore anthracnose. Flowering dogwood is found primarily in the southern zone and reaches the northern limits of its range in the central zone.

Spring Ground Cover Survey

Forty-two sites were monitored in spring 2002; an additional four sites were flooded and could not be surveyed. The results of the ground cover survey were similar to other years—sensitive species were uncommon and when invasive species were present, they covered large areas (Table 4, Fig. 9).

Only six sites had disturbance-sensitive taxa in the quadrats and only two different taxa were recorded. This is in contrast to 24 sites that recorded invasive taxa in the quadrat survey. Total cover of invasive taxa was seven times greater than disturbance-sensitive and common native combined (Table 5). In order to compare invasive cover to other years, gooseberry and Japanese honeysuckle cover must be removed as these taxa were not previously included in the ground layer survey. If these two species are ignored, only 15 sites had invasive taxa in the quadrats and the amount of cover drops from 721.09 to 350.08 m^2/ha. The latter value is similar to that reported in spring 2000, the last time many of these sites were monitored. Obviously, these two species, especially Japanese honeysuckle which spreads horizontally and can cover large amounts of area, contribute heavily to the amount of invasive species cover.

Table 3. Correlations of various ForestWatch indices *

	zone	tree richness	up/bottom	tree abundance	tree basal area	mean tree DBH
inv per ha	**-.342** **.009**	.109 .416	.052 .699	.229 .084	-.175 .188	**-.299** **.023**
buckthorn	**-.323** **.013**	.060 .657	.093 .488	.032 .811	-.105 .435	-.110 .413
inv shrub ratio	**-.411** **.004**	-.304 .038	**.303** **.039**	-.046 .760	.175 .239	.116 .439
dogwood	**.311** **.019**	**.325** **.014**	.012 .929	.082 .543	.093 .490	-.035 .798
anthracnose	**.460** **.000**	**.272** **.040**	.018 .895	.054 .690	.176 .190	.080 .555
tree abundance	.192 .148	**.431** **.001**	.035 .793	1.0 -	-.129 .334	**-.754** **.000**
mean DBH	-.149 .265	**-.323** **.013**	-.086 .520	**-.754** **.000**	**.682** **.000**	1.0 -

*First line is Pearson correlation coefficient and second is significance value, or P-value. Values in bold are significant.

Many plants grow in widely scattered patches, making it unlikely that many species will occur in any of the 15 0.25 m^2 quadrats. It is more likely to encounter these occasional species during the presence-absence survey which covers 1500 m^2, whether the plant is patchy or not. If a species is recorded during the presence-absence survey but not the quadrat survey, this indicates the species has a rather patchy distribution. However, if a species is found during the presence-absence survey and in the quadrats, this strongly suggests the species is more uniformly distributed or has a greater abundance than many other plants. Garlic mustard and Japanese honeysuckle are good examples of this, as is bleeding hearts to a lesser extent. In addition to being recorded in many presence-absence sections, garlic mustard and Japanese honeysuckle were recorded in several of the quadrats on the sites in which they were detected. In contrast, six sensitive species were detected in the presence-absence survey but not in the quadrats. Even during the presence-absence survey, most of the disturbance-sensitive species are not recorded frequently. They were found at 15 sites during this survey compared to 33 sites for invasive species.

The data continue to point to the simple fact that when invasive species are in a forest, they tend to dominate. The best management is to prevent them from becoming established by removing them when they are first detected. Once they are established, invasive species can be quite difficult to eradicate. Just keeping garlic mustard out of a site is critical as this is the most prevalent non-native species encountered at ForestWatch sites. It continues to cover about three times as much area as sensitive and common species combined.

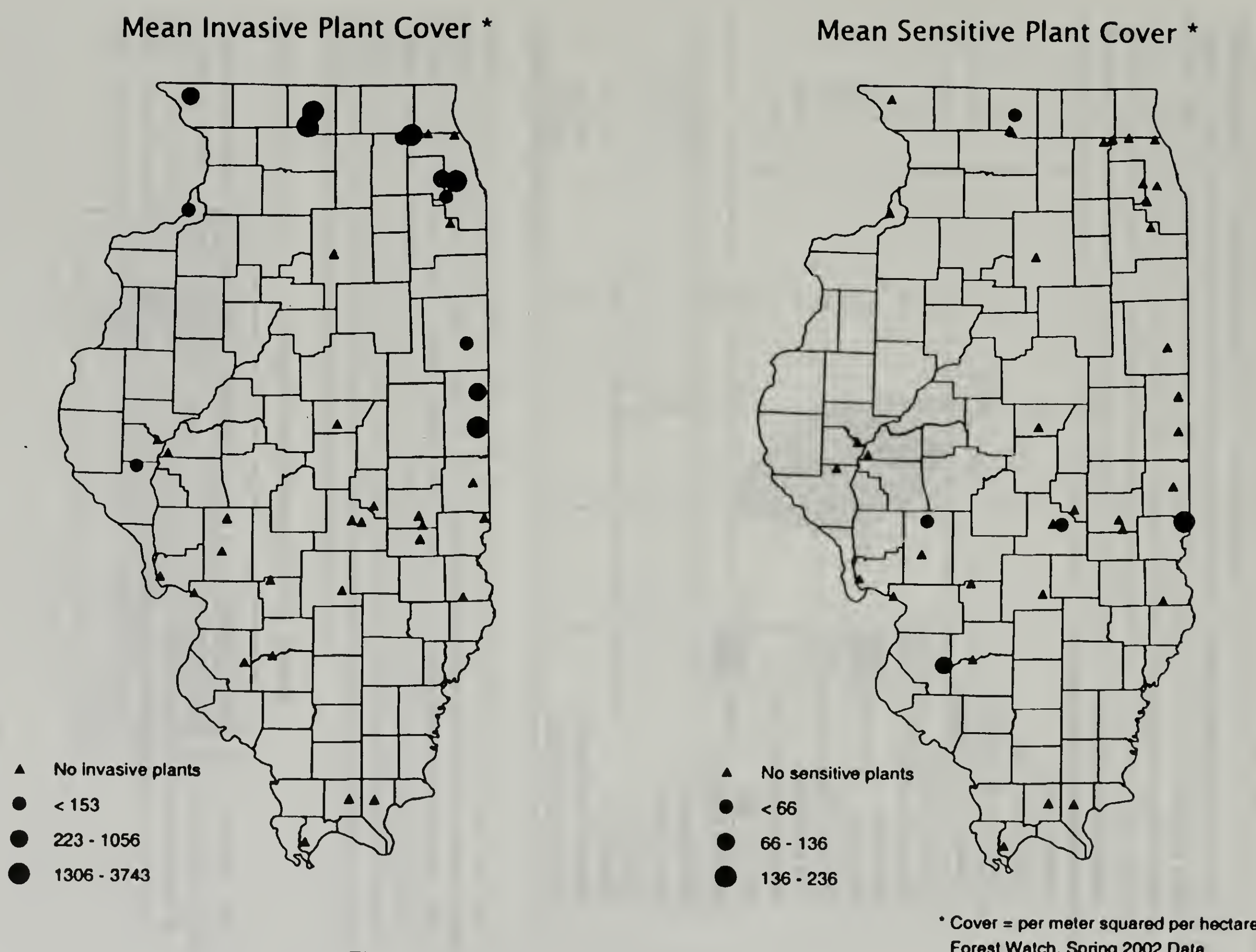

Figure 9. Mean invasive and sensitive plant cover

Table 4. Frequency and cover of indicator taxa

Disturbance-sensitive Species	Detection by site (# of sites, from quads)	Detection by site (# of sites, from pres abs)	Ground Cover (average m^2/ha)
Blue cohosh	0	1	0
White trillium (all species)	0	2	0
Doll's eyes	0	3	0
Large-flowered bellwort	0	3	0
Bleeding hearts (both species)	5	7	11.01
Maidenhair fern	0	1	0
Virginia spiderwort	1	1	0.78
Hepatica (both varieties)	0	2	0
Common Native Species			
Virginia bluebells	2	na	0.78
Wild columbine	0	na	0
Blue phlox	6	na	8.29
Red trillium	11	na	8.60
Blue-eyed Mary	1	na	5.89
Wild geranium	10	na	27.60
Swamp buttercup	3	na	39.15
Sensitive fern	0	na	0
Invasive Species			
Garlic mustard	16	16	308.22
Dame's rocket	1	1	0.39
Moneywort	0	2	0
Ground ivy	3	8	41.47
Missouri Gooseberry	13	25	146.19
Japanese Honeysuckle	8	10	233.65

Table 5. Cover of general plant categories

Plant Category	Average Cover (m^2/ha)
Total Herbaceous	2229.69
Total Woody	887.54
Disturbance-sensitive	11.78
Common Native	90.31
Invasive	721.09

Spring Downed Wood Survey

Downed wood provides important habitat to many organisms and is part of the normal functioning of a forest. Presence of downed wood in a wide range of diameter classes is an indication that the forest is mature. The majority of the downed wood was in the smaller diameter classes (Fig 10). The ratio of downed wood by size class in 2002 was very similar to the results from 1999-2001. It is unlikely this will change very quickly as the type of downed wood reflects the type of forests being monitored. Because Illinois forests are relatively young and there are a relatively small number of very large trees present in most forests, a large majority of the downed wood will likely continue to be the smaller classes, less than 30 cm. Only until the current large trees grow in diameter then fall over will there likely be a change in the size of downed wood being reported.

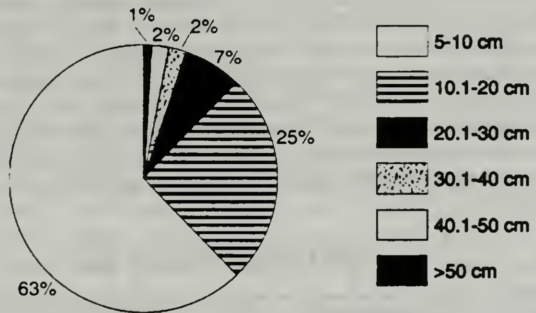

Figure 10. Distribution of downed wood by diameter

Spring Human Use Survey

Volunteers look for eight general human uses while monitoring, including looking for trash and trails, and noticing cut tree stumps and evidence of grazing. Strewn garbage continues to be the most common human use observed in forests, and was reported at almost half of the sites. Tree stumps were also common, being located at 17 sites. Three types of human use were correlated with each other. Many of the sites that had hiking trails were being used by people other than the monitoring group while the surveys were being completed. Another interesting but probably not too surprising correlation was that collected garbage was positively correlated with the presence of vehicle trails and human structures.

Spring Tree Height Survey

The average height of the tallest trees on ForestWatch sites was 21.7 m (range 10.5-30.7; S.D.=4.43). These trees had an average diameter of 34.2 cm (range 15.0-47.2; S.D.=8.24). This was very similar to that of spring 2000, the other year many of these sites were previously monitored. It is also similar to the values seen in 2001 in which a completely different set of sites was monitored. This gives evidence that the tallest trees in many Illinois forests are about 35 cm DBH and 22 m tall on average.

PrairieWatch 2001 and 2002

Matt Buffington

Between 2001 and 2002, 27 PrairieWatch sites were monitored, 16 of which were monitored for the first time. Of the 27 sites from the past two years, 11 sites were reconstructions, eight were remnants, and the remainder were unspecified. Forty-six total sites have been monitored since 1999.

Ground Cover Survey

Three different plant groups were examined during the ground cover survey using 0.25 m^2 quadrats: disturbance-sensitive, common native, and invasive species. Disturbance-sensitive species were not widespread on any of the sites. They averaged less than 250 m^2 per hectare cover, which is less than a fourth of the area covered by invasive plants (Table 1). Common natives were encountered at 23 of 27 sites and covered the most area of the three plant categories. Ninety-three percent of the common native ground cover is from the three dominant prairie grasses, big and little bluestem and Indian grass. This is not surprising as these grasses are often dominant in Illinois prairies. All of the common native species were found among all the sites, but disturbance-sensitive species cream wild indigo, green milkweed, and the gentians were not recorded at any sites nor were the invasive species daylily, teasel, Autumn olive, and black locust.

Table 1. Cover of indicator taxa

Plant Category	Average cover (m^2 per ha)	Detection (% of sites, n=27)	Detection (% of quadrats, n=540)
Sensitive	236.9	41%	13%
Common	1834.8	85%	53%
Invasive	1022.4	74%	44%

Table 2 shows the amount of cover for three major plant categories, plus bare ground and litter. Grasses and forbs were the main plant types observed in the quadrats, while there was very little woody plant cover. The relative scarcity of woody plants is promising as normally functioning prairies typically have only a small amount of woody cover. There appears to be some balance between bare ground and plant litter. Bare ground typically increases with an increase in fire frequency while litter decreases. The presence of litter and bare ground were inversely proportional, although not significantly so (Table 3).

Table 2. General cover types

Cover Type	m^2ha
Grass	4615
Forb	3742
Woody	311
Bare Ground	1919
Plant Litter	3184

Table 3. Correlations of various cover values

	DS	CN	IH	IW	NN	GRASS	FORB	WOOD	BARE	LITTER	SAPS
CN	0.30	1.00									
	0.13	.									
IH	0.03	-0.28	1.00								
	0.87	0.15	.								
IW	0.03	0.06	0.18	1.00							
	0.90	0.76	0.38	.							
NN	0.04	-0.27	**1.00**	0.27	1.00						
	0.86	0.17	**0.00**	0.17	.						
GRASS	-0.11	0.03	0.16	0.21	0.18	1.00					
	0.57	0.88	0.42	0.29	0.37	.					
FORB	0.33	0.03	0.21	-0.24	0.18	**-0.54**	1.00				
	0.09	0.90	0.30	0.22	0.38	**0.00**	.				
WOOD	0.34	0.20	-0.22	0.36	-0.18	-0.12	-0.32	1.00			
	0.09	0.31	0.27	0.06	0.38	0.55	0.10	.			
BARE	0.06	-0.18	0.29	-0.20	0.26	-0.18	0.25	-0.27	1.00		
	0.78	0.38	0.14	0.32	0.19	0.36	0.20	0.18	.		
LITTER	-0.07	-0.06	-0.09	0.36	-0.05	-0.03	0.16	-0.03	-0.22	1.00	
	0.72	0.76	0.67	0.06	0.81	0.86	0.42	0.87	0.27	.	
SAPS	-0.12	-0.31	0.00	-0.14	-0.01	**-0.48**	-0.02	0.34	0.12	-0.07	1.00
	0.56	0.11	1.00	0.49	0.95	**0.01**	0.93	0.08	0.56	0.74	.
IBSI	0.03	**-0.58**	-0.30	-0.07	-0.30	0.06	-0.07	0.13	-0.12	0.03	0.07
	0.93	**0.04**	0.33	0.83	0.32	0.85	0.82	0.66	0.71	0.93	0.83

Twenty-seven sites were used for all indices except IBSI, which had 13 sites.
The first line is the Pearson correlation coefficient and the second is the level of significance, or P-value.
Numbers in bold are significant correlations.
DS=disturbance-sensitive
CN=common native
IH=invasive herbaceous
IW=invasive woody
NN=all invasive species combined
SAPS=number of saplings per hectare.

There were several interesting correlations among the various cover types, three of which were significant—as grass cover increased, forb cover and the number of saplings decreased; and the butterfly index (discussed later) was positively correlated with the presence of invasive woody plants. In some prairies, grasses can become dominant at the expense of forb cover, perhaps as a result of regular spring burns, which often favor warm-season grasses like big and little bluestem. However, based on the data available it is difficult to determine if prescribed burning is affecting the relationship between forbs and grasses at PrairieWatch sites. Variations in fire frequency, timing, and intensity greatly affect what plants will be present in a prairie. This type of fire information is not currently available for many PrairieWatch sites. In addition, there are other environmental factors that affect the results of burning. For instance, burning in years of low precipitation is more damaging to many plant species than burning in years of average and above average rainfall. It must also be noted that a decrease in forb cover does not necessarily mean a decrease in richness. The effects of burning on richness are varied and likely depend on the interaction of numerous biotic and abiotic factors. Isolating one factor as the cause for changes in another is a daunting and often futile task.

The two other significant correlations require some explanation. Because most prairie grasses respond favorably to fire while tree saplings do not, it was not surprising that there was an inverse and significant relationship between these two plant groups. The correlation between the butterfly index and invasive woody cover must be viewed with much caution. There were only 13 sites that had IBSI values and of these only three had any invasive woody taxa. Thus there is not much data to make a strong argument that this is an actual relationship. Further discussion of the butterfly index occurs later in this report.

Since nine out of 11 disturbance-sensitive taxa are forbs, it was not surprising that forb and disturbance-sensitive taxa cover were positively correlated. Another intuitive correlation was the positive relationship between plant litter and the amount of cover from invasive woody plants. Litter and woody plants generally increase in the absence of fire so this relationship is not unexpected. Interestingly, cover of disturbance-sensitive taxa and woody plants was positively correlated. There is no clear explanation for this as disturbance-sensitive species are adapted to survive fires.

It must be noted that correlations only provide a small amount of information. For PrairieWatch, one of the primary interests is the change in condition over time, which cannot be surmised just through these correlations. Is there a change in the average amount of plant litter across all sites? Are disturbance-sensitive species becoming less common statewide?

Shrub Survey

Shrubs and saplings were recorded from 40% of the sites but only a small number of shrub and sapling stems were recorded overall. Prairie willow was the only native shrub recorded, and then only one plant from one site. Eight different sites had invasive shrubs present but only one had more than one species. The total number of invasive shrub stems was quite small except for the one site with multiple species. A total of 27 shrub stems were recorded from seven of the sites while the other site had 86 shrub stems, primarily buckthorn and honeysuckle. Sixty-five total saplings were recorded from seven sites. The number of saplings ranged from two to 28 among the sites, or 200-2,800 saplings per hectare. These results are promising but certainly cannot be used to depict the condition of prairies statewide. Many grasslands have a significant problem with invasive shrubs and saplings.

Large Tree Survey

The sampling area for large trees (≥ 5cm diameter at breast height) was the maximum width of 50 m for most sites but six sites were narrower than 50 m so the sampling area was therefore less than 50 m wide. Only five of 27 sites recorded large trees in the sampling area. Two of these had a fairly large number of trees, 63 and 75 trees each. Eighty-seven percent of these were ≤30cm in diameter. The other three sites had only one, three, or six trees each, and eight of these were ≤30cm.

Prairie Size

The size of the prairies being monitored was quite variable. The average area of the prairies was slightly under eight hectares, 77,683 m^2, and ranged from 1,893 to 700,000 m^2. The amount of edge was also variable, averaging 822 meters and ranging from 124 to 1,865 meters of edge. Two sites did not have perimeter data and if these are ignored, the average area was 73,663 m^2. Unfortunately, the minimum amount of edge required to meet this amount of area is 962 meters, which is actually greater than the value determined from the data. This indicates there is a problem with the estimates of area and/or perimeter. Efforts will be made to address this problem in order to provide accurate data concerning edge and perimeter. This is important because an increase in the amount of edge implies an increasing amount of stress. Edges are often composed of species that will invade a prairie if left alone. The more edge, the more work that is needed to maintain the prairie. In addition, the prairie plants become more isolated from each other with more edge.

Land Use Survey

Surrounding land use and conditions directly along prairie borders play a big role in determining what is happening at a site and what type of management may be required. Sites surrounded by savanna or forest face much different challenges compared to sites surrounded by residential areas and cropland. Ten of the 14 possible land cover types were recorded from PrairieWatch sites in 2001 and 2002. Seventy-five percent of the records were of four types: forest, cropland, residential, and other. Some of the more common "other" types were fields, quarry, and orchard. Many sites recorded a border type other than those provided, including a mowed area or fire break, trail, and ravine. There were also many instances (26%) where there was no border, meaning there was an abrupt change from the surrounding land use to the prairie. Of the actual border types, a paved surface was the most common (17%) followed closely by hedgerow (13%).

Butterfly Survey

Butterflies were monitored at 13 sites between 2001 and 2002. Monitoring at seven sites was completed during the official butterfly period (June 15 - August 1) while the other sites were completed during the plant survey later in the year (August 15 - October 1). This is acceptable as many of the sites were monitored for the first time and there was not enough time to register and establish a site before August. Much of the data collected reflect new volunteers testing their butterfly identification skills.

A total 735 butterflies were recorded from 13 sites. Average detection rates can be determined for 11 of these sites (two did not include the amount of area surveyed). Approximately 10.2 hectares were monitored in 9.58 hours in which 683 butterflies were detected. This translates to roughly 7.0 butterflies/ha/hour. Over half (313) of the butterflies were recorded as "Other", and thus were not one of the indicator species. The most common indicator was eastern-tailed blue followed closely by the pearl crescent (Table 4). Forty-nine of the 51 wood nymphs were recorded from one site. The three species most closely associated with high quality grasslands, silver-bordered, meadow, and regal fritillaries, were not observed at any of the sites nor were the dainty sulphur, American copper, or variegated fritillary.

PrairieWatch is attempting to quantify the condition of the habitat by using a new, experimental index based on the butterfly species present, their abundance, and their overall environmental significance, which relates to the butterflies' preferred habitat and their commonness. This index is termed the Illinois Butterfly Site Index (IBSI). Although this is an experimental effort it is conceptually based on standard diversity indices used in other ecological studies. The index is designed such that an increase in the IBSI value implies greater habitat quality. As this is a unique and thus far untested index, interpreting the data should be done with considerable caution and IBSI values can only be compared to other IBSI values. Table 5 shows the IBSI results from the 13 sites with butterfly data.

It is not certain if sites with high IBSI values are necessarily of greater quality. The site with the greatest IBSI value, for instance, did not have any disturbance-sensitive or common native plants in the quadrats but did have invasive plants. In contrast, the site with the second lowest IBSI value had above average disturbance-sensitive and common native cover and a very small amount of invasive herbaceous plants. These two sites are from the northeastern part of the state and both were monitored around the second week of September, although they were monitored in different years. In addition to different years of monitoring, there are various environmental conditions that can affect butterfly monitoring. For example, the site with an IBSI value of eight was monitored on a day with 90% cloud cover and moderate winds, conditions in which most butterflies are inactive. PrairieWatch will continue to experiment with this index to determine how well it applies to actual conditions at the site.

Table 4. Butterflies recorded from PrairieWatch sites, 2001-2002

Taxa	# Individuals
Eastern-tailed Blue	86
Pearl Crescent	84
Wood Nymph	51
Black Swallowtail	45
Monarch	28
Great-spangled Fritillary	21
Buckeye	12
Clouded Sulphur	9
Dogface Sulphur	8
Little Sulphur	8
Painted Lady	8
Aphrodite Fritillary	1
American Painted Lady	1
American Copper	0
Dainty Sulphur	0
Meadow Fritillary	0
Regal Fritillary	0
Silver-bordered Fritillary	0
Variegated Fritillary	0
Other	373

Table 5. IBSI values for PrairieWatch sites, 2001-2002

PrairieWatch Site ID	# Species	Total Abundance	IBSI
P0209706	8	46	263.04
P0412301	6	54	216.37
P0211101	5	59	191.38
P0412302	7	31	183.56
P0209705	4	44	131.46
P0611701	5	18	96.64
P0611702	3	39	90.79
P0204304	4	21	82.92
P0802901	4	19	80.75
P0204301	3	16	54.00
P0204303	4	7	43.84
P0108501	3	4	30.00
P0204302	1	4	8.00

Abundance includes butterflies recorded as "Other" and thus is not included in the IBSI calculation.

RiverWatch Data Summary Results for 2002

Alice Brandon

Introduction

The Illinois RiverWatch Program is the stream-monitoring component of the Illinois EcoWatch Network (EW), a volunteer monitoring initiative coordinated through the Illinois Department of Natural Resources (IDNR). RiverWatch seeks to document long-term trends in stream health as reflected by biological monitoring of 37 benthic macroinvertebrate indicator taxa, presence or absence of macroinvertebrates of "special interest," and a habitat survey that documents long-term changes to stream segments over time.

This report summarizes statewide results for the 2002 monitoring season. Data from 1996 to 1999 along with data from other EW programs was recently published in the report *Critical Trends in Illinois Ecosystems*. RiverWatch data from 2001 was also used in the most recent CTAP Annual Report (winter 2001).

Volunteers monitor both volunteer selected and randomly selected stream sites with an emphasis on increasing the number of random sites. Data from all sites was combined for this report, as RiverWatch does not have an adequate number of random sites at the watershed level. Readers interested in more in-depth analyses may access the RiverWatch database for years 1995-2002 at http://dnr.state.il.us/orep/ ecowatch/, and IDNR Critical Trends Assessment Reports at http://dnr.state.il.us/orep/ctap/

RiverWatch Metrics

The RiverWatch program uses multiple metrics to provide quantitative information on stream health. Metrics are based upon those of professional biologists and were developed with assistance from biologists with the Illinois Natural History Survey and Illinois Environmental Protection Agency. For more information please refer to the *RiverWatch Stream Monitoring Manual*, revised 5th Edition.

Why Multiple Metrics?

The metrics used by RiverWatch are useful indicators because they contribute unique information about stream quality and are also correlated with one another. For example, the "% of EPT taxa" is significantly and negatively correlated with the MBI. This supports the hypothesis that as the MBI scores increase and stream quality decreases so does the number of EPT taxa present (pollution intolerant taxa). While correlations confirm the relationships of the stream indicators to one another, results do not always fit the model. A watershed may score well on one indicator and poorly on another. For example, the Spoon watershed typically scores well on RiverWatch metrics such as the % of EPT taxa but according to state biologists it also has below average scores for native fish species and stream habitat quality (see *Critical Trends in Illinois Ecosystems*). This is why it is useful to use multiple metrics and track various indicator taxa, which may highlight different stream health concerns.

Other Data Collected

The presence or absence of certain native and invasive species provides RiverWatch with additional information on stream condition. Tracking invasive species such as zebra mussel, Chinese mystery snail, and Asiatic clam helps biologists track the distribution and migration of these species throughout the state. Native species such as fingernail clam and native mussels were once abundant species that are quickly disappearing from Illinois streams.

Table 1. Metrics utilized by RiverWatch to measure stream quality or health

Metric	How it is calculated	What it indicates
Taxa Richness	Total number of taxa identified in the sample.	As taxa richness increases; generally so does water quality.
% EPT	Number of mayflies, stoneflies & caddisflies taxa divided by the number of organisms sampled & multiplied by 100.	Streams with a high number of these pollution intolerant taxa are considered to be in good health.
% Worm	Number of aquatic worm and bloodworm midge taxa divided by the number of organisms sampled & multiplied by 100.	Streams with a high number of these pollution tolerant taxa are considered to be in poor health.
Taxa Dominance	Number of organisms from the three most common taxa collected divided by the number of organisms sampled.	Dominance by just a few taxa indicates low stream quality. Generally, a value > 80% indicates low aquatic biodiversity.
MBI*	Taxon's total tolerance value divided the number of organisms sampled. It provides a weighted average of the pollution tolerance of the organisms collected.	The MBI was developed to detect organic pollution such as sewage. A score of: < 6.0 = good water quality; 6.0 to 7.5 = fair water quality; 7.6 to 8.9 = poor water quality; > 9.0 = very poor water quality

**MBI = Macroinvertebrate Biotic Index; note that taxa dominance was not used in this report.*

Volunteers also collect habitat information such as the stream bottom substrate type(s), stream width, and stream discharge (a measure of the volume of water passing the stream site). This information documents how a stream segment changes over time and helps to explain the number and type of macroinvertebrates collected. For example, swiftly moving streams with rocky bottoms provide better habitat for most EPT taxa than do slow moving, muddy bottom streams.

Taxa and Sample Abundance Counts

In 2002, the most prevalent taxa statewide were midge, hydropsychid caddisfly, sowbug, scud and black fly (Fig. 1). These taxa are pollution tolerant and inhabit a wide range of stream types.

The armored mayfly, snipe fly and saddle case caddisfly were rarely collected (present < 2% of sites) and are the least common taxa detected this year. The saddle case caddisfly is especially sensitive and inhabits high quality streams that have thus far escaped degradation. The snipe fly, while also fairly intolerant to pollution, is at the end of its range in Illinois and is restricted to the northern one-third of the state.

In previous years, RiverWatch has been concerned that volunteers may not be collecting an adequate macroinvertebrate sample size. In most Illinois streams, volunteers should easily collect 50 macroinvertebrates. The program prefers samples with a minimum of 100 organisms as larger samples better reflect the macroinvertebrate diversity located at any given stream site. Collecting fewer organisms increases the likelihood many taxa at the stream will not be collected. This may ultimately affect taxa richness measures. In 2002, on average, volunteers collected 96 macroinvertebrates after sub-sampling with samples ranging from 1 to 472. Twenty-three percent of the monitored sites sampled less than 50 macroinvertebrates, 34% sampled 51 to 100 macroinvertebrates and 43% sampled more than 100 macroinvertebrates.

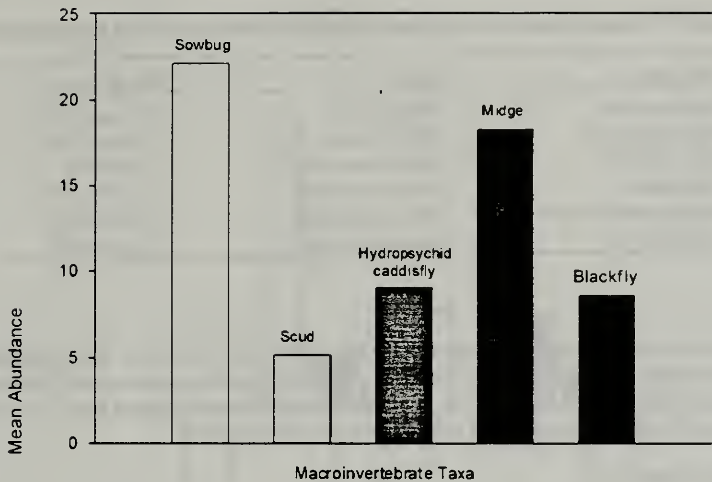

Figure 1. Mean abundance of the most common taxa identified statewide 2002 (N=234)

Taxa Richness, Percent Composition of Indicator Organisms & MBI

The number of taxa identified ranged from 1 to 21. Twenty-eight percent of the monitored sites identified five or fewer indicator taxa, 55% had six to 10 taxa, and 29% had 11 or more taxa.

EPT taxa comprised, on average, 22% of the organisms sampled while worm taxa made up less than 5% of the organisms. However, volunteers are most likely to sample riffle habitats, the preferred habitat for EPT taxa, rather than undercut banks and sediment where worm (aquatic worm and bloodworm midge) taxa predominate. The most common taxa were neither EPT nor worm taxa, but sowbugs and midges.

The average MBI score for monitored streams was 5.61. The poorest MBI score was 11.0 and the best score was 3.52. Less than 6% of sites have MBI scores above 7.0. According to the MBI few Illinois streams monitored by RiverWatch are in poor health.

Macroinvertebrates of Special Interest

Fingernail clams, a native species, are the most common taxa of special interest reported and occurred at 29% of the monitored sites. Volunteers reported no Chinese mystery snails or Zebra mussels this year. This most likely indicates these invasive species have not yet spread from larger rivers to the smaller streams monitored by volunteers. Volunteers noted the presence of native mussels at 12% of the sites and Asiatic clams at 10% of the sites (Table 2). These results are consistent with previous years, indicating native mussels are occurring at the same levels as reported previously.

Number of Monitored Sites

RiverWatch volunteers monitored 234 sites statewide in 2002. Another 18 could not be monitored due to reported flooding or low water. The number of monitored sites is 33% lower in comparison to previous years (for example, 349 sites were monitored in 2001). The decrease is likely attributable to the budget cuts experienced by EcoWatch in June / July 2002 during the height of monitoring. Numbers are fairly encouraging considering the timing of the cuts.

Table 2. Presence of macroinvertebrates of special interest across all monitored sites

Organism	Type	Occurrence
Native mussels	Native species	28 sites (12%)
Fingernail clams	Native species	67 sites (29%)
Zebra mussels	Invasive species	0 site (0%)
Asian clams	Invasive species	23 sites (10%)
Chinese mystery snail	Invasive species	0 sites (0%)
Rusty crayfish	Invasive species	20 sites (8%)

RiverWatch uses watershed designations based on the Illinois Streams Information System database, which puts all Illinois streams into ten major watersheds. The Fox watershed has the most monitored sites (78) and the Little Wabash watershed the least (0) (Fig. 2), a reflection of the large volunteer base in the Chicago metropolitan area. Most watersheds have a minimum of 15 monitored sites.

Stream Data by Watershed

The Embarras, Sangamon and Kaskaskia watersheds score the lowest across all RiverWatch metrics while the Rock and Kankakee score the highest. The La Moine, Spoon, Big Muddy and Fox watersheds score somewhere in between these two groups (Table 3). This contradicts previous results because typically the Embarras scores much higher across multiple RiverWatch metrics and is a prime example of the importance of long-term data.

Mean taxa richness at the watershed level ranges from 11 to 7 with the Kankakee having the highest taxa richness and the Embarras having the lowest (Table 3). This suggests the Kankakee is in better stream health than most other watersheds and is consistent with results in 2001.

The Kaskaskia and La Moine have the lowest mean % of EPT taxa. These organisms are less prevalent in streams with poor stream health. At the other end of the spectrum, the Rock, Kankakee, and Spoon watersheds have the highest mean % of EPT taxa. The Sangamon and Embarras have the highest mean % worm (aquatic

Table 3. Averages for RiverWatch indices separated by watershed for the 2002 monitoring season

Watershed	Sites (#)	MBI	Taxa richness	Organisms sampled	% EPT taxa	% Worm taxa	Rocky substrates (%)	Silt/sandy substrates (%)
Big Muddy	24	5.2	8	70 (77)	24	2	69	37
Embarras	24	6.0	7	58 (148)	19	10	46	68
Fox	78	5.6	9	105 (113)	23	5	57	43
Kankakee	15	5.3	11	98 (130)	26	3	69	48
Kaskaskia	21	6.1	8	100 (89)	12	7	48	65
La Moine	27	5.7	9	118 (108)	13	6	57	43
Rock	26	4.9	10	107 (142)	32	2	63	30
Sangamon	10	5.9	7	68 (145)	18	9	40	54
Spoon	8	5.2	8	109 (95)	38	4	50	59

Mean Macroinvertebrate Biotic Index (MBI), mean taxa richness, mean organisms sampled with means from 2001 in parentheses, and the mean percentage (%) of Ephemeroptera, Plecoptera and Trichoptera (EPT), bloodworm midge and aquatic worm (Worm) in the samples.

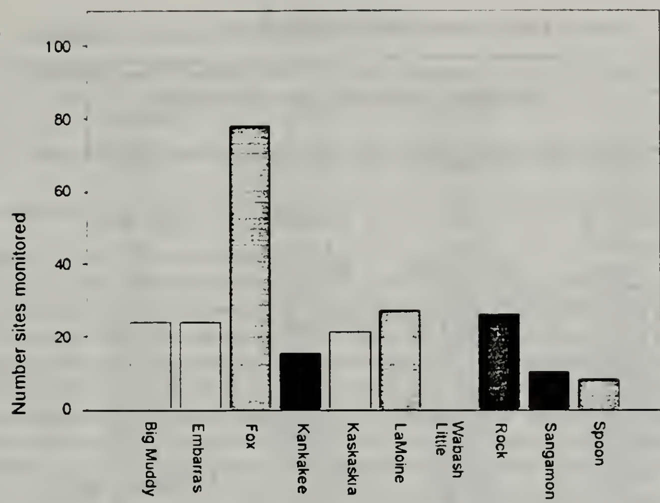

Figure 2. Number of sites monitored by watershed in 2002

worm and bloodworm midge) taxa and the Rock and the Big Muddy the lowest. This suggests pollution tolerant organisms are more common in the Sangamon, Kaskaskia and Embarras in comparison to other watersheds. The Embarras and Kaskaskia also have streams with high percentages of silt substrate types, which is the habitat preferred by worms. The Big Muddy, Kankakee and the Rock have a high percentage of streams with rocky bottom substrate types, which are all well above the statewide average of 56% (Table 3). The parameter % substrate siltation coverage (SSC) measures the percentage of the stream bottom covered in fine silty particles. High SSC may adversely impact macroinvertebrates as it decreases the amount of available habitat. This can cause sensitive EPT taxa to decline or be extirpated from a stream. The Kaskaskia watershed has an average SSC of 60.8, which is 50% higher than the statewide SSC of 40.7. This watershed also has the lowest percentage of EPT present.

The Embarras watershed appears to change from having relatively high stream quality to having low quality. However, there is a 30% drop in the number of monitored sites from 2001. It is likely this decrease skewed the data rather than there being a drastic change in stream quality over a one-year time period.

Most watersheds have high mean sample abundances of sowbug, scud, hydropsychid caddisfly and midge (Table 4). The Kankakee, Rock and Embarras are the only watersheds without sowbug in the list of the top five most common taxa. The Kaskaskia watershed has an unusually high abundance of midges. This watershed's streams are primarily muddy-bottom, where midge taxa survive well. The Rock and Embarras are the only watersheds where mayfly taxa mean abundances are high. Hydropsychid caddisfly has the highest mean sample abundance for any EPT taxa, and is also the most pollution tolerant EPT taxa.

Table 4. The five most common indicator taxa for each watershed

Watershed					
Big Muddy (24 sites)	Scud (16.4)	Sowbug (13.4)	Midge (8.2)	Caddisfly[1] (6.9)	Riffle Beetle (5.5)
Embarras (24 sites)	Midge (23)	Damselfly[3] (4.8)	Mayfly[2] (4.1)	Scud (3.7)	Black Fly (2.8)
Fox (78 sites)	Sowbug (28.6)	Midge (15.9)	Caddisfly[1] (12.6)	Riffle Beetle (9.5)	Black Fly (8.6)
Kankakee (15 sites)	Midge (22.2)	Riffle Beetle (8.6)	Black Fly (6.6)	Scud (4.8)	Stonefly (4.3)
Kaskaskia (21 sites)	Midge (31.4)	Black Fly (15.8)	Scud (12.5)	Sowbug (10.3)	Riffle Beetle (6.9)
La Moine (27 sites)	Midge (26.0)	Sowbug (19.0)	Scud (17.1)	Black Fly (17.0)	Bloodworm Midge (7.1)
Rock (26 sites)	Scud (26.8)	Midge (14.4)	Caddisfly[1] (12.1)	Mayfly[2] (9.7)	Black Fly (6.6)
Sangamon (10 sites)	Sowbug (21.2)	Midge (11.8)	Black Fly (5.1)	Left-handed Snail (4.8)	Black Fly (3.3)
Spoon (8 sites)	Scud (26.1)	Caddisfly[1] (25.8)	Midge (15.6)	Sowbug (12.0)	Riffle Beetle (7.4)
Statewide (233)	Midge (18.3)	Sowbug (16.0)	Scud (11.5)	Caddisfly (9.0)	Black Fly (8.5)

N = mean abundance across all samples; [1]Hydropsychid Caddisfly. [2]Swimming Mayfly, [3]Broadwinged Damselfly. Note: Three additional sites were added to the database after the data analysis was performed. Therefore, 236 sites have data this year.

Summary

Most streams have high numbers of taxa tolerant to pollution such as sowbugs and midges. In addition, results for taxa richness, % EPT taxa, % worm taxa, and the MBI suggest streams of intermediate quality predominate the monitored sites. Most Illinois streams have experienced some level of habitat degradation or pollution. This is not surprising considering agriculture or urbanization cover most of the state with little remnant natural areas intact. However, pollution intolerant taxa manage to survive in small pockets. These streams also tend to have high mean taxa richness and % EPT taxa. Bloodworm midges and aquatic worms, while fairly common, did not dominate at most streams.

Results by watershed indicate that some watersheds are in better health than others. However, the Kankakee, Spoon and Sangamon watersheds have relatively low sample sizes (below 20 sites) making it somewhat difficult to be certain if the data reflect actual stream conditions or variability in volunteer selected sites. While RiverWatch has an adequate number of randomly selected sites at the statewide level, it is still working to increase the number of randomly selected sites at the watershed level.

Watersheds with high % EPT also tended to have streams with rocky bottom substrates and low SSC. In 2002, the Kankakee and Rock watersheds have better than average stream quality while the Embarras and Kaskaskia watersheds have lower than average stream quality. The results for the Embarras are somewhat surprising, since in previous years it had high stream quality (see summary report 2001). One possible explanation is a 30% decrease in the number of streams monitored from 2001 to 2002. The other watershed results are consistent with previous years' findings.

Botanical Report

Floristic Quality Assessment (FQA) as a Measure of the Naturalness of the Grasslands and Wetlands of Illinois

Greg Spyreas, Connie Carroll, James Ellis, and Brenda Molano-Flores

Introduction

Throughout the United States, biological systems have been extensively degraded by human activities (Whitney 1994). In Illinois, less than 0.01% of the original grasslands and less than 0.07% of the original wetlands remain in an undegraded, natural state (IDNR 1994). The difficulty of measuring the "naturalness" or "natural integrity" of the few remaining habitats across our highly disturbed landscape has long been a problem for plant ecologists. How does a field botanist confer years of experience and knowledge about a natural area and its plants in a brief and meaningful way to laypersons? For example, the State's more than 3,200 plant species differ tremendously in their predilection for natural versus disturbed habitats. How do we objectively designate which habitats are biologically valuable as natural areas and which are less valuable? At a time when the willingness and enthusiasm for re-creation and restoration of natural areas in our region is increasing, how can we gauge and explain the ecological success of habitat restorations? These questions highlight the need for standardized, scientifically meaningful, botanical information that can be easily interpreted by everyone. Unfortunately, to date, the most commonly used indicators of ecologically valuable native habitats (e.g. species diversity, the presence of rare species) are often insufficient and unpredictable.

Recently, Floristic Quality Assessment (FQA) has become a popular method to measure habitat integrity, or more specifically, vegetative natural area quality. National, state, and local agencies that are both public and private (e.g. IDNR, IDOT, The Nature Conservancy, Kane County Forest Preserve) charged with managing large natural areas now rely heavily upon these measures.

FQA scores are comprised of two measures: the value *C*, the average Coefficient of Conservatism; and the value *I* ($I = C\sqrt{N}$ [N = the number of plant species at a site]). Coefficients of Conservatism (CC) are set integers (0-10) assigned to each vascular plant in Illinois (Taft et al. 1997). Highly conservative plants (CC=10, 9, 8) only thrive in high-quality, intact, natural areas, and non-conservative plants (CC=0, 1, 2) are usually common (i.e. horsetail, ragweed) (Taft et al. 1997). Non-native plants are assigned values of zero (CC=0). An area with a high floristic quality score would be expected to have many species with high Coefficients of Conservatism (5-10). For example, we would expect an undisturbed old-growth forest in Illinois to score approximately 4 - 5 for its *C*, and 35-45 for its *I*. On the other hand, a weedy lawn would score at around 1-2 for its *C*, and 3-7 for its *I*.

Despite the increasing usage of FQA, no studies have rigorously tested its effectiveness in gauging natural area quality (Nichols 1999; Traina 2001; Mushet et al. 2002; Rooney and Rogers 2002). Using the uniquely extensive, statewide dataset collected through the Critical Trends Assessment Program (CTAP), we set out to determine if FQA is a precise measure of natural area quality. We also sought to see how other measures, such as diversity and the presence of non-native species, correlate with other measures of natural area quality. By comparing a site's disturbance grade with its floristic quality we attempted to determine how well the FQA measures correlate with perceived naturalness. Additionally, we also used FQA to illuminate general trends in the State's floristic quality. For example, which habitat types or regions of the state score higher in FQA measures than others? Or, how does the presence of introduced species affect a natural area's FQA score?

Methods

Site data was gathered as part of the Illinois Critical Trends Assessment Program (CTAP) (IDNR 2001). Sites were randomly selected in forests, wetlands, and grasslands using satellite based geographic information systems vegetation coverage. Over four years (1997-2000) a total of 108 palustrine emergent wetlands and 97 grasslands of many different community types across the state were sampled following CTAP protocols (Carroll et al. 2002) (Fig. 1). Forest data was not used in this study in order to simplify the analysis. Sites were sampled beginning in southern Illinois and finishing in northern Illinois, where wetlands were visited from June through July, and grasslands were visited from July through the last week of August. For geographic comparisons, the state was roughly divided into thirds (i.e. North, Central, and South) (Fig. 1).

At each site, twenty 0.25 m^2 permanent quadrats along a 41-m transect were used to estimate ground cover. Along this transect, woody stems <1 meter tall and <5cm dbh were counted in a 4 by 41 meter plot. Trees > 5 cm dbh were also tallied in a 50 by 41 meter plot incorporating the transect. Using historical and current land usage information gathered from landowners we ranked the amount of human disturbance each site had incurred, and designated this disturbance as its "Grade". Grade A sites are the most natural and have received little to no noticeable human disturbance. Grades B, C, and D sites are increasingly more degraded by disturbances. Finally, grade E sites are so disturbed that they have none of their original plant community or native vegetation left (e.g. planted pasture, planted hayfields, roadsides).

Results and Discussion

A number of trends emerged from the data. The majority of CTAP sites were of grades C, D, or E, and therefore very few high quality sites were encountered. Overall, we found FQA to be an excellent measure of the amount of degradation an area had undergone, that is, FQA measures were highly correlated with natural area quality (grade) (Table 1, Figs. 2 and 3). But, it should be noted that because we sampled relatively few high quality natural areas, the sensitivity of FQA at separating small differences between our best natural areas is still uncertain. The number of species (often called species richness or diversity) that an area contained was not a consistent measure of natural area quality (Table 1). Despite the high correlation between grade and FQA, some community types (sand prairie, natural ponds) scored idiosyncratically higher or lower when compared to the pooled wetlands and grasslands.

Table 1. Spearman rank correlations for floristic quality measures of Illinois grasslands and wetlands

	Grade	Number of species	Number of introduced species	Number of native species	Shannon diversity	Introduced cover
I	0.53**	————	-0.34**	————	0.47**	-0.68**
C	0.60**	0.15	-0.62**	0.45**	0.14	-0.65**

** *P*< 0.0001, * *P*<0.001

Empty cells indicate invalid correlations because one value is used in the calculation of the other.

N = 205.

"Grade" is a measure of disturbance to a site from human uses.

"Shannon diversity" is a measure of diversity.

"Introduced cover" is the percentage of a site that is dominated by introduced species.

Differences are significant if *P* < 0.05.

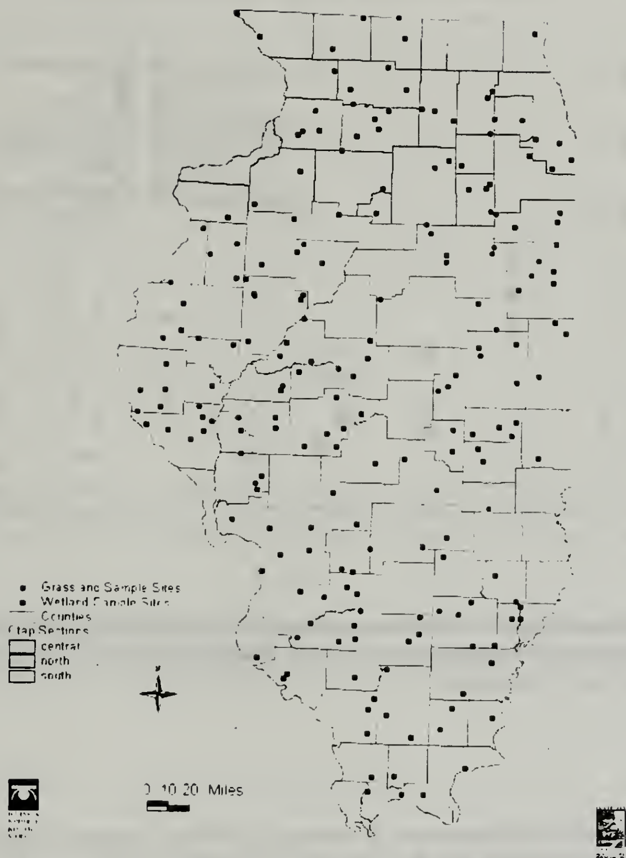

Figure 1. Location of wetland and grassland CTAP sites sampled from 1997-2000

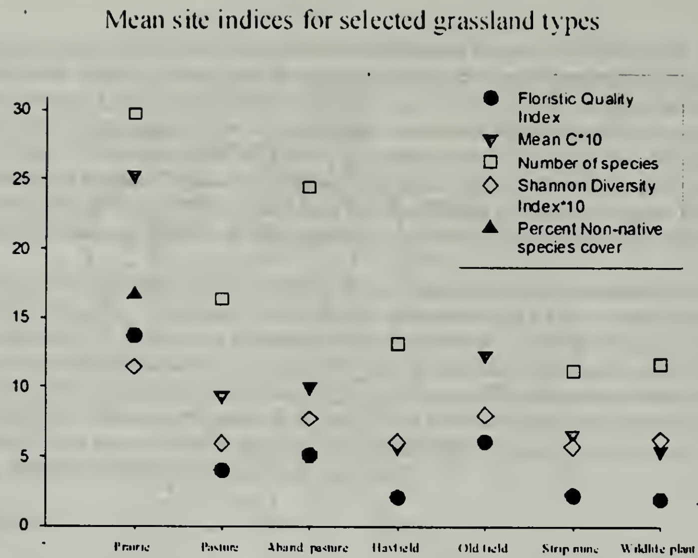

Figure 2. Mean site measurements for natural and anthropogenic grasslands grouped by community type. All communities shown besides Prairie are grade E. Some site measurements were multiplied or divided by 10 to facilitate comparison on one graph.

For the state as a whole we found that the more an area was dominated by non-native species the lower its FQA scores (Table 1). Additionally, wetlands on average scored higher in floristic quality (wetlands I = 8.14 per site, C = 2.24 per site, grasslands I = 4.65 per site, C = 1.00 per site) despite having fewer species (wetlands species per site 14.4, grasslands species per site 18.7) than grasslands. This is probably because wetlands were far less dominated by non-native species than grasslands (Table 2). Additionally, the southern third of Illinois scored higher in FQA compared to the rest of the state (Fig. 4), which we believe appropriately reflects its distinct topography, soils, climate, and land use (i.e. the Shawnee National Forest, IDNR 2001).

When assessing the conservation value of any area, many critical factors such as wildlife habitat, fauna, soil microbia, genetic heritage, hydrologic function, aesthetics, etc., are not measured by FQA. There is no single value that will ever encapsulate the dense interactions and complexities of worth in a natural area. However, we found that FQA is generally a simple, objective, and repeatable measure of habitat degradation that foregoes individual judgments. Further studies of FQA are still warranted, especially focusing on higher quality sites. Additionally, as other authors have pointed out FQA should be used in concert with other factors of importance such as size, presence of rare species, rarity of community type, and proximity to other valuable sites, when determining natural area quality (Taft et al. 1997). However, we have generally found FQA measures to be useful in providing easily understandable information that assists us in our evaluations of ecosystems and their biological health.

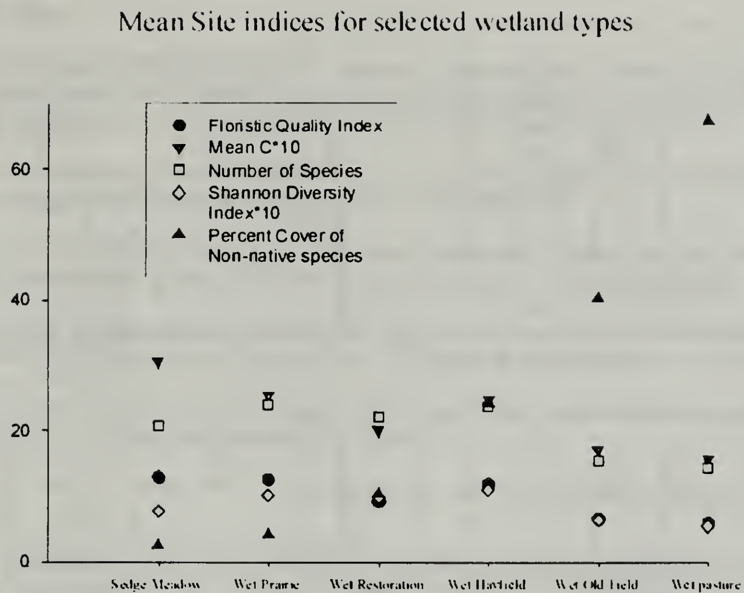

Figure 3. Mean site measurements for selected wetlands grouped by community type. All communities shown besides Wet Prairie and Sedge Meadow are grade E. Some site measurements were multiplied or divided by 10 to facilitate ease of comparison on one graph.

Table 2. T-test comparing site measures for Illinois grasslands and wetlands

	Grasslands	Wetlands	*P*
I	4.65	8.14	<0.0001
C	1.00	2.24	<0.0001
Number of Species	18.7	14.4	<0.0022
Introduced cover	70.7	34.0	<0.0001

Number of species = 205.
"Introduced cover" is the percentage of a site that is dominated by introduced species.
Differences are significant if $P < 0.05$.

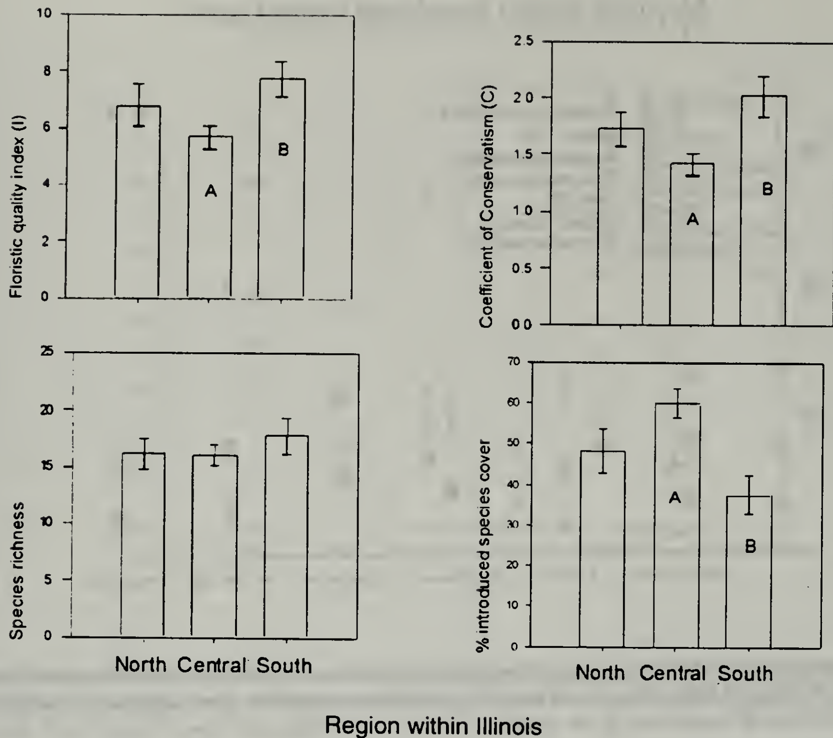

Figure 4. Regional comparisons for wetland and grassland sites (± 1 Standard Error) ANOVA: N = 205. I: p<0.036, C: p<0.018, Species Richness p<0.543, Introduced Cover p<0.001. Different letters indicate significant differences between groups.

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Terrestrial Insect Report

The Importance of Leafhoppers (Hemiptera:Cicadellidae) collected by the Critical Trends Assessment Program

Adam Wallner

Leafhoppers are insects that belong to the infraorder Auchenorryncha in the order Hemiptera. They are recognized by their piercing-sucking mouthparts, which they use to feed on a wide variety of vascular plant species, including grasses, sedges, broad-leafed woody and herbaceous plants of many families, conifers, as well as fungi (Dietrich 2000). Hemiptera is the fifth most speciose order of insects, after beetles, flies, wasps, and moths (McKamey 1999). The suborder Homoptera, particularly, the infraorder Auchenorryncha (sensu lato = Hemiptera: Homoptera + Heteroptera), comprises most of these, with about 50,000 known species. As part of the Critical Trends Assessment Project (CTAP) from 1997 – 2001, data on these insects have been collected. In this report, information on three species of Auchenorryncha will be presented. These species have been selected because they can be considered either a new state record or they have economical/ecological importance.

From the Auchenornnhycha species sampled, *Lebradea flavovirens* (Gillette and Baker), a leafhopper from the family Cicadellidae, was the only state record (Fig. 1). One individual was recorded from a wetland site in Lee County (Fig. 2). *Lebradea flavovirens* is an exotic species, naturally occurring in Finland, Siberia, Kamchatka, Kurile Islands, Sakhaim, Korean Peninsula, Maritime Territory – Neartic region, and considered threatened in Finland (Ossiannilsson 1983). They have been observed to feed on *Calamagrosits spp.*, or reed grass, and are therefore found in dry as well as in marshy habitats (Vilbaste 1980). Native reed grass has been documented in several counties throughout Illinois, as well as distributed in patches where *L. flavovirens* was collected (Mohlenbrock and Ladd 1978, Mohlenbrock 1986). Therefore, it seems likely that additional collecting will show *L. flavovirens* distribution coincides in large part with that of reed grass species throughout Illinois.

Figure 1. Lateral view of Lebradea flavovirens

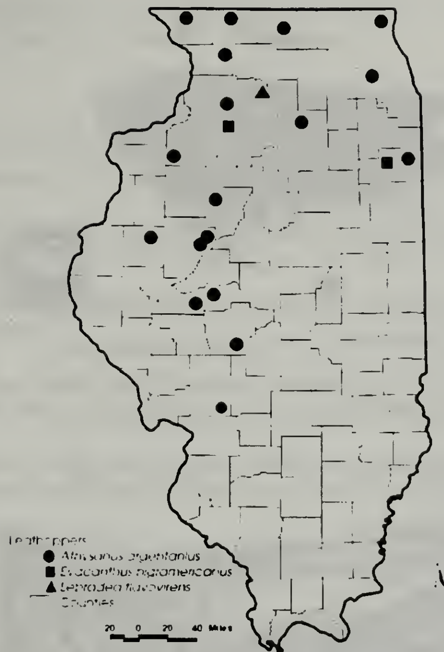

Figure 2. Location of collected specimens in Illinois

Ecologically important Auchenorryncha observed in the CTAP samples, is the leafhopper species *Evacanthus nigramericanus* (Hemiptera: Cicadellidae) Hamilton (Fig. 3). This species is recognized by its black coloration, as well as reddish-brown spots located on its face (DeLong 1948, Hamilton 1983). Only three individuals were found in the CTAP forest samples – two collected in Kankakee County, 1999, and one collected in Bureau County, 2000 (Fig. 2). Many species of *Evacanthus* are grass-feeders in the Korean Peninsula (Kwon 1983); in England *Evacanthus interruptus* has been recorded from hops, and the overwintering eggs may be laid in the cracks of dead wood (Massee 1943); on some Japanese mountains, *E. interruptus* is reported to feed on the aster plants (Ishihara 1953); and *Evacanthus acuminatus* is reported to inhabit and feed on sphagnous spruce wood and rich swampy wood (Linnavouri 1952). *Evacanthus nigramericanus* has been found on herbivorous vegetation in moist woodlands of Illinois, particularly feeding on closely related fern species (DeLong 1948). Additionally, this insect resides in primary forest habitats that have little disturbance. Since this species is only found in relatively pristine habitats, it may be a useful biological indicator of the health of Illinois forest habitats and could be used to infer conservation management decisions on private as well as public land.

Athysanus argentarius Metcalf (Hemiptera: Cicadellidae) (Fig. 4), a grass-feeding leafhopper species, is both an ecological and economically important auchenorrhychan. This leafhopper was introduced to North America from Europe and has been observed in southern Ontario and in western Canada (Chiykowski 1979). *Athysanus argentarius* is a phytophagous feeder of grasses, grasslike herbs, rushes, sedges, and various herbaceous plants. This leafhopper is ubiquitous in many wetland and grassland CTAP samples (Fig. 2). In addition, this leafhopper species has also been found in fields containing brome grass (*Bromus inermis*). Brome grass is a native species from Europe and has been introduced into the Midwest where it occurs in

Figure 3. Lateral view of Evacanthus nigramericanus

Figure 4. Lateral view of Athysanus argentarius

pastures and at the edges of moist woodlands (Mohlenbrock 1986). Thus, high numbers of *A. argentarius* found in the CTAP sites may suggest poor habitat quality.

Economical importance of this leafhopper has shown that they are potential transmitters of aster yellow virus in several commercial crops, such as celery and barley species (Chiykowski 1979). It should be pointed out that the primary vectors for this disease are leafhoppers from the genus *Macrosteles* (e.g., *M. quadrilineatus [= M. fascifrons] and M. phytoplasma*) (Chaput and Sears 1998; Heu et al. 2002). The aster yellow virus is thought to be native to eastern Oregon, Washington, and Idaho (Lenzen and Hutchison, 2002, Oregon State University Extension Services 2002); however, it has been introduced into the Midwest and is of concern to commercial vegetable (i.e., carrots) growers there. In the Hermiston, Oregon area, leafhoppers enter potatoes when surrounding vegetation desiccates. Symptoms of infected plants are rolled up tip leaves, development of an off-green or yellowish cast, aerial tubers form, and interveinal leaf tissue dies. Further research is needed to examine if *A. argentarius* is a vector of commercial crops in Illinois.

As previously stated in CTAP Terrestrial Arthropods Reports (Dietrich and Biyal 1998 and 1999 unpublished), CTAP provides a unique opportunity to compile invaluable new data on Illinois terrestrial arthropod ecology, distribution, and diversity. By incorporating this type of data, a close-to-complete picture of the quality of ecosystems in Illinois can be obtained.

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