



ILLINOIS NATURAL  
HISTORY SURVEY

T E C H N I C A L   R E P O R T

**Developing a multi-metric habitat index for wadeable  
streams in Illinois (T-25-P-001).**

Annual Segment Report to the Illinois Department of Natural Resources.

Laura L. Sass, Leon C. Hinz Jr.,

and John Epifanio

Division of Ecology and Conservation Science

Section of Aquatic Ecology and Conservation

Prepared for: Illinois Department of Natural Resources

INHS Technical Report 2007 (37)

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Division of Ecology and Conservation Science**

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**(May 1, 2006 - April 30, 2007)**

Laura L. Sass, Leon C. Hinz Jr.,  
and John Epifanio

Submitted to

Illinois Department of Natural Resources  
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Springfield, Illinois 62702

Illinois Natural History Survey  
Division of Ecology and Conservation Science  
Section of Aquatic Ecology and Conservation  
1816 South Oak Street  
Champaign, Illinois 61820

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Illinois Natural History Survey Technical Report 2007/37

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Annual Project Report 2007  
Project: T-25-P-001

1 May 2006 to 30 April 2007

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## **Developing a multi-metric habitat index for wadeable streams in Illinois.**

### **Summary:**

In Illinois, existing methods for sampling stream habitat are time consuming, may not be sensitive enough to detect meaningful differences in stream quality in some circumstances, and are defined by the requirements of certain fish or macroinvertebrate communities. The following project will result in a qualitative, multi-metric habitat index that will help refine Illinois' Wildlife Action Plan by describing relative conditions of key aquatic habitats that reflect anthropogenic disturbance in the watershed and upstream catchment and provide a tool for monitoring the effectiveness of conservation actions, establishing restoration benchmarks, and prioritizing survey efforts. The Illinois Natural History (INHS) has partnered with Eastern Illinois University to sample habitat metrics in least-disturbed, moderately-disturbed, and most-disturbed sites throughout Illinois (Appendix A contains Eastern Illinois University annual report). Although the grant agreement was executed on April 1, 2006 INHS staff did not begin full time work on this project until August 1, 2006. This report summarizes work performed by the INHS for the period ending April 30, 2007.

### **JOB 1. Sample metrics at chosen sample sites.**

#### **1.1 Investigate utility of using existing disturbance ratings developed by Smogor 2000.**

Project staff from the INHS have discussed existing disturbance ratings with Roy Smogor (IEPA) and our collaborator at Eastern Illinois University (Bud Fischer) and concluded that currently available data allow for an improvement over existing ratings. During the development of the fish IBI Smogor (2000) divided the state into approximately 800 watersheds based on the information then available to him. Sampling stations located anywhere within one of these watersheds were assigned a common disturbance rating regardless of where they occurred or where disturbances were located within the watershed (e.g., upstream or downstream of the site). We currently have the ability to assess disturbance at the local watershed for individual sites which would eliminate some of these potential problems. Smogor (2000) used seven metrics to assess disturbance as it relates to fish communities: 1. proportion of undisturbed land, 2. proportion of disturbed land, 3. proportion of strip-mined land, 4. maximum storage of impounded water, 5. maximum storage of impounded industrial, mining and sewage waste water, 6. number of sewage points, and 7. number of hazardous points combined with an IBI and mIBI score to determine disturbance ratings. While these metrics may be associated with biological community measures they may not be appropriate for physical habitat within the reach (e.g., hazardous points). Therefore we developed an alternative approach that included some new metrics to rate disturbance.

#### **1.2 Develop alternative disturbance rating scheme if needed.**

We have developed a different disturbance rating based on local watershed and upstream catchment perturbations. We considered using biological indices of disturbance (i.e., fish IBI, macroinvertebrate IBI) to assist with rating anthropogenic disturbance of stream reaches but concluded this was problematic since physical habitat characteristics were used in

developing these measures. Instead, we used five metrics to assess watersheds at the local and upstream catchment level (over 50,000 watersheds state wide): 1. proportion of disturbed land in the upstream catchment, 2. maximum volume of impounded water in the upstream catchment, 3. proportion of strip-mined land in the local watershed, 4. proportion of undisturbed land in the local riparian zone (150 m buffer centered on the stream), and 5. density of road crossings in the local watershed. By using this local scale, we were able to get a rating that is more closely linked to the site that is sampled (Figure 1).

### **1.3 Select sites with range of disturbance for sampling.**

The INHS staff are currently in the process of assigning disturbance ratings to individual sites. Based on these ratings we will prioritize sites for sampling during the 2007 field season to ensure as complete coverage as possible throughout the state within each of the disturbance classes.

## **JOB 2. Identify potential metrics.**

### **2.1 Identify a list of candidate metrics by reviewing existing indices and the literature.**

The INHS staff worked with the Eastern Illinois University research staff to identify candidate metrics (Table 1).

### **2.2 Develop sampling techniques for each candidate metric.**

Sampling techniques were fine-tuned during the 2006 field season and procedures were developed to facilitate data collection (Figure 3a,b). Characteristics for substrate type (Table 2) and instream cover (Table 3) were defined based on existing methods (IEPA 1994).

### **2.3 Sample metrics at chosen sample sites.**

Following metric identification we sampled candidate metrics at a total of 78 sites during the summer and fall of 2006 (Figure 4). Additional sites will be visited during the 2007 field season to obtain a state-wide coverage of least-, moderately-, and most-disturbed sites (Figure 5).

## **JOB 3. Determine Regions**

### **3.1 Identify possible regionalization schemes (e.g., watersheds, natural divisions).**

INHS Staff is examining common regionalization methods in Illinois and is considering the use of Natural Divisions, ecoregions, fish IBI regions (Smogor 2000) and IDNR management regions for use with the habitat index currently under development. An analysis of the habitat data collected in the 2006 and 2007 field seasons will be used to select the appropriate regionalization scheme.

### **3.2 Identify degree to which metrics sample at least-disturbed sites differ among regions.**

No work was scheduled for this Job.

### **3.3 Select final regions.**

No work was scheduled for this Job.

**JOB 4. Select Final Metrics.**

**4.1 Select final metrics based on those that reflect levels of disturbance in each region.**

No work was scheduled for this Job.

**JOB 5. Develop scoring criteria for each region.**

**5.1 Establish regional scoring criteria for each metric.**

No work was scheduled for this Job.

**JOB 6. Prepare Final Report.**

**6.1 Prepare final report including a “how to” manual.**

No work was scheduled for this Job.

**6.2 Conduct a training workshop.**

No work was scheduled for this Job.

**Literature Cited**

Illinois Environmental Protection Agency. 1994. Quality assurance and field methods manual. Illinois Environmental Protection Agency, Bureau of Water, Division of Water Pollution Control, Planning Section. Springfield, Illinois.

Smogor, R. 2000. Draft manual for calculating index of biotic integrity scores for stream in Illinois. Illinois Environmental Protection Agency, Springfield, Illinois

**Table 1.** Candidate metrics that are currently collected by field staff. Scale refers to whether the metric is determined for each channel unit, once for the entire sampling reach or both.

Metric	Definition	Scale
Buffer Width	Width of the undeveloped buffer on each side of the stream	Reach
Riparian Type	Type of vegetation growing in the buffer zone	Reach
Stream Bank Vegetation	Type of vegetation growing on the stream banks	Reach
Predominant Channel Type	Pool, Riffle, or Run	Reach
Predominant Substrate	Most abundant type of substrate (see Table 2)	Both
Predominant Flow	Fast, Moderate, Slow, or No detectable flow	Both
Shading of Water Surface	Completely, mostly, half, most light, all light	Reach
Thalweg Depths	10 approximately equidistant depths taken	Reach
Channel Evolution	Per Schumm et al. 1984	Reach
Water Level	Rising, base flow, decreasing or pooled	Reach
Stream Modifications	Any human perturbations are noted	Reach
Wetted Width	Taken at the downstream, mid and upstream points	Reach
Thalweg Depth	Taken at the downstream, mid and upstream points	Reach
Channel Unit Type	Lateral pool, mid-channel pool, riffle, run or transitional	Unit
Cover	Abundance of cover (see Table 3)	Unit
Substrate embeddedness	Only applied to substrates fine gravel and larger	Unit
Depth of fines as bottom cover	None, 1-25mm, 25-50, 50-75, and >75mm	Unit
Cross section depths	Eight depths are taken across pools	Unit
Max depth	Deepest point of a unit	Unit

**Table 2.** Substrate and bottom type categories used in stream habitat assessment (taken from Illinois' Stream Habitat Assessment Procedure (SHAP)) (IEPA 1994).

Substrate type	Particle size
Bedrock	Solid rock
Silt	<0.062 mm
Hardpan	Compacted fines
Sand	0.062-2 mm
Fine Gravel	2-8 mm
Gravel	8-64 mm
Cobble	64-256 mm
Slab Boulder	>256 mm
Boulder	>256 mm

**Table 3.** Cover definitions for channel units. Amount of each cover type is estimated as none, sparse, intermediate or abundant.

Cover Type	Definition
Aquatic macrophytes	Non-terrestrial, emergent, floating, or submerged macrophytes, not including algae
Undercut bank	Bank with a cavity below the waterline
Overhanging vegetation	Plant foliage suspended over the wetted channel and within one meter of the water's surface
Rootwads	Root mass from a tree that is in wetted channel and diverting water flow
Rootmats	Fibrous roots from trees and other plants extending into the wetted channel
Boulder	Substrate particle larger than 250 millimeters (modified Wentworth scale) along the second shortest axis
Large woody debris (LWD)	Woody material (e.g. log or tree) with a diameter greater than 10 cm, length greater than 1 meter, in wetted channel and diverting water flow
Aggregate of woody debris	Two or more LWD, must be in wetted channel and diverting water flow



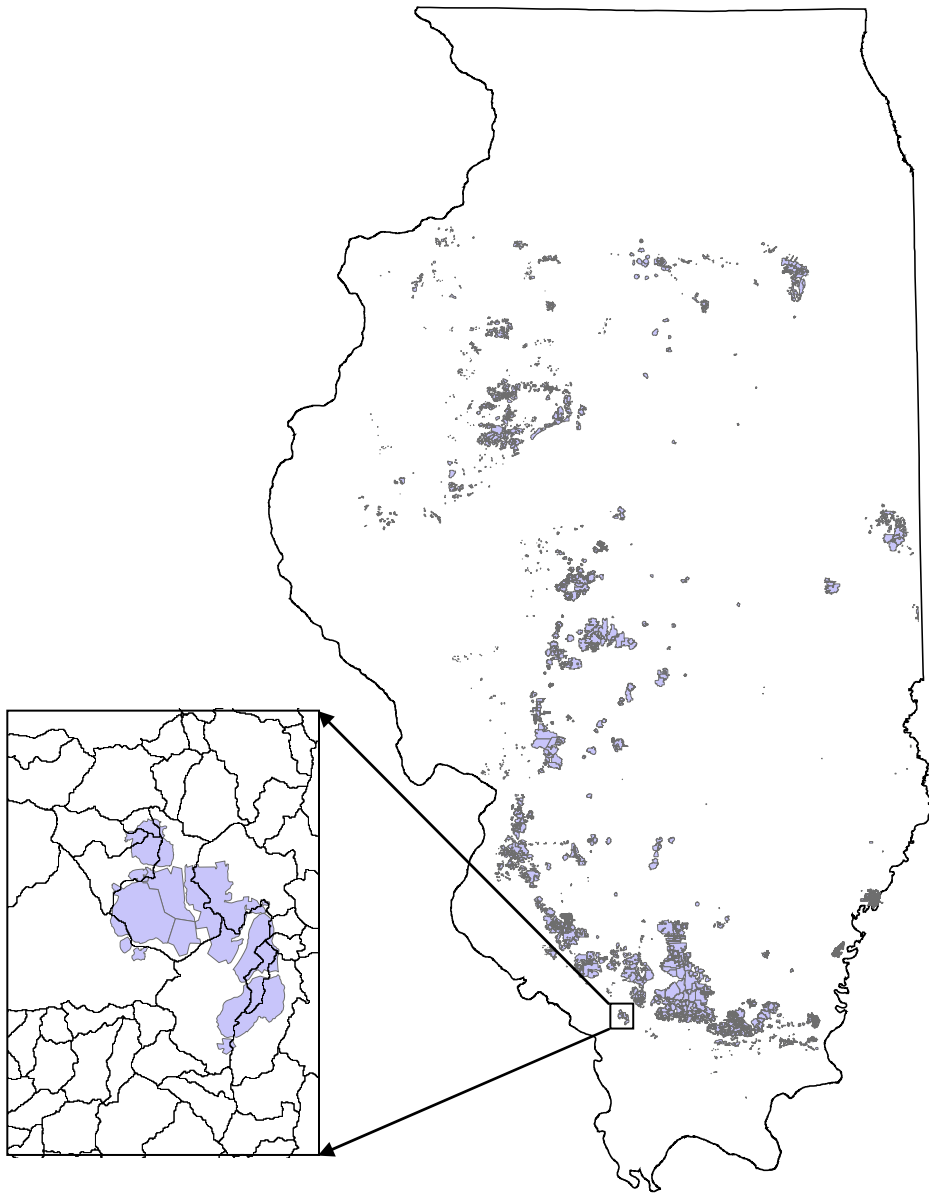


FIGURE 1. An example map of the proportion of mined land in each watershed assessed. Proportions were used to determine disturbance classes for each disturbance type. The inset shows the local watersheds outlined in black with the strip-mined land in gray.

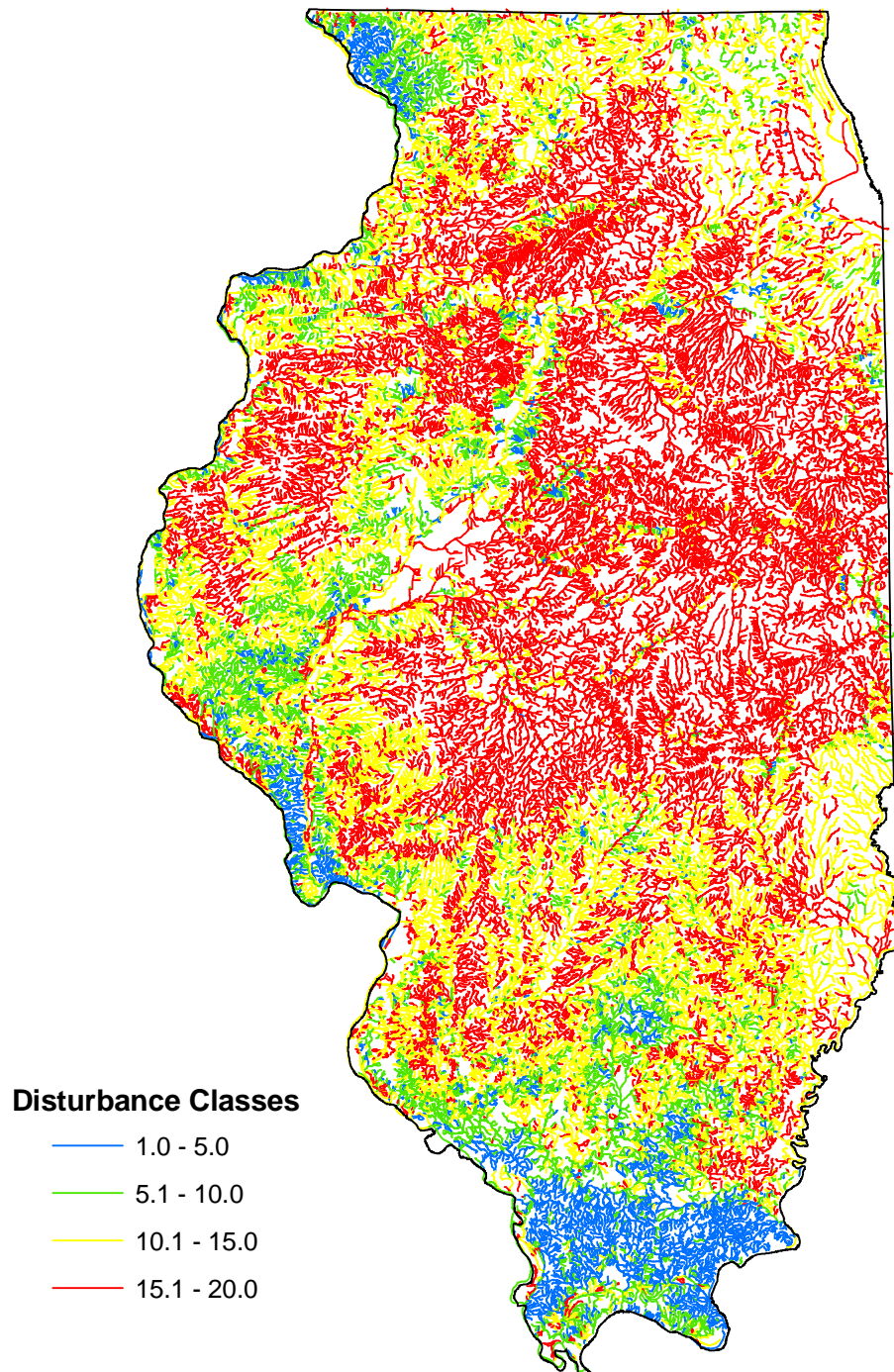


FIGURE 2. Preliminary disturbance ratings for Illinois streams. Local watersheds with lower disturbance are blue and those with the highest levels of disturbances are red.

## HABITAT EVALUATION FORM

Station Code: _____	Stream: _____	Location ( include road crossing): _____
Date: _____	Scorer(s): _____	Gaz pg: _____

Page   1   of

**REACH CHARACTERISTICS**  
Check one box per bank. River right looking upstream.

Buffer Width (Top of Bank)		Riparian Type		Stream Bank Vegetation			Predominant Channel Type	
L	R (Per Bank)	L	R (Predominant Per Bank)	Left	Vegetation <small>1=Sparse, 2=Intermediate, 3=Abundant</small>	Right		
<input type="checkbox"/>	<input type="checkbox"/> Very Wide > 100m	<input type="checkbox"/>	<input type="checkbox"/> Trees	0 1 2 3	Herbaceous	0 1 2 3	Pool	
<input type="checkbox"/>	<input type="checkbox"/> Wide 50-100m	<input type="checkbox"/>	<input type="checkbox"/> Woody/Shrub	0 1 2 3	Woody/Shrub	0 1 2 3	Riffle	
<input type="checkbox"/>	<input type="checkbox"/> Moderate 10-50m	<input type="checkbox"/>	<input type="checkbox"/> Herbaceous	0 1 2 3	Trees	0 1 2 3	Run	
<input type="checkbox"/>	<input type="checkbox"/> Narrow 5-10m	<input type="checkbox"/>	<input type="checkbox"/> Mixed	0 1 2 3	Bare	0 1 2 3	Total # of Channel Units: _____	
<input type="checkbox"/>	<input type="checkbox"/> Very narrow 1-5m			0 1 2 3	Bedrock	0 1 2 3		
	<input type="checkbox"/> None <1m (if checked, list land use adjacent to stream)							
L _____				<b>Predominant Flow in Reach</b>			<b>Shading of Water Surface</b>	
R _____				Check one			<input type="checkbox"/> Water surface completely shaded <input type="checkbox"/> Water mostly shaded with some sunlight <input type="checkbox"/> Half water surface shaded, half full sunlight <input type="checkbox"/> Most water surface receiving sunlight <input type="checkbox"/> Lack of canopy; full sunlight reaching water	
<b>Predominant Substrate in Reach</b> <small>(1=Predominant, 2=Next Dominant)</small>				<input type="checkbox"/> Fast <input type="checkbox"/> Moderate <input type="checkbox"/> Slow <input type="checkbox"/> No detectable flow				
<input type="checkbox"/>	Boulder (>256 mm)	<input type="checkbox"/>	Sand				<b>Thalweg Depths in Reach</b> 1 _____ m 2 _____ m 3 _____ m 4 _____ m 5 _____ m 6 _____ m 7 _____ m 8 _____ m 9 _____ m 10 _____ m	
<input type="checkbox"/>	Slab Boulder (>256 mm)	<input type="checkbox"/>	Hardpan					
<input type="checkbox"/>	Cobble (64-256 mm)	<input type="checkbox"/>	Silt					
<input type="checkbox"/>	Gravel (8-64mm)	<input type="checkbox"/>	Bedrock					
<input type="checkbox"/>	Fine Gravel (2-8 mm)							
Comments:								

**CHANNEL EVOLUTION STAGE**

I - STABLE  $h < h_c$  Terrace<sub>1</sub>

II - INCISION  $h > h_c$  headcutting

III - WIDENING  $h > h_c$  bank failure

IV - STABILIZING  $h = h_c$

V - STABLE  $h < h_c$  Terrace<sub>1</sub> Terrace<sub>2</sub>

**Predominant Channel Stage:**

I  
 II  
 III  
 IV  
 V

h=streambank height; h<sub>c</sub> = critical streambank height (slope failure is imminent depending on the strength of the soils in the bank)

**ADDITIONAL STREAM INFORMATION**

<b>Water Level</b> <input type="checkbox"/> Rising <input type="checkbox"/> Normal/Base Flow <input type="checkbox"/> Decreasing <input type="checkbox"/> Pooled	<b>Stream Modifications</b> <small>Check all that apply</small> <input type="checkbox"/> Outfalls/pipes <input type="checkbox"/> Canopy Removal <input type="checkbox"/> Dredging <input type="checkbox"/> Artificial cover/substrate <input type="checkbox"/> Impoundments	<b>Wetted Width</b> <b>Thalweg Depth</b> DS _____ m      _____ m MID _____ m      _____ m UP _____ m      _____ m Mean _____ m      _____ m
<b>GPS Location (NAD83)</b> Latitude: _____ Longitude: _____		Reach Length: _____ m
Photos Taken: <input type="checkbox"/> Yes   # Taken _____ <input type="checkbox"/> No		
Comments:      Reach starts _____ m upstream/downstream from bridge.		

FIGURE 3A. Example field sheets including information collected at each site.

Unit #:	<b>CHANNEL UNIT (Circle One):</b>	<b>Lateral Pool</b>	<b>Mid-Channel Pool</b>	<b>Riffle</b>	<b>Run</b>	<b>Transitional</b>
<b>Substrate Type (1=Predominant, 2=Next Dominant)</b>		<b>COVER (0=None, 1=Sparsce, 2=Intermediate, 3=Abundant)</b>				
<input type="checkbox"/> Boulder (>256 mm)	<input type="checkbox"/> Sand	0 1 2 3 Undercut Bank		0 1 2 3 Aquatic Macrophytes		
<input type="checkbox"/> Slab Boulder (>256 mm)	<input type="checkbox"/> Hardpan	0 1 2 3 Overhanging Vegetation		0 1 2 3 Logs or Woody Debris		
<input type="checkbox"/> Cobble (64-256 mm)	<input type="checkbox"/> Silt	0 1 2 3 Rootwads		0 1 2 3 Aggregate LWD		
<input type="checkbox"/> Gravel (8-64mm)	<input type="checkbox"/> Bedrock	0 1 2 3 Boulder		0 1 2 3 Rootmats		
<input type="checkbox"/> Fine Gravel (2-8 mm)				0 1 2 3 Other _____		
<b>Substrate Embeddedness (1°substrate)</b> Applies when 1°substrate is ≥fine gravel		<b>Depth of Fines as Bottom Cover</b>		<b>Cross Section Depths</b> (Pools Only) Measure from LAB to RAB		
<input type="checkbox"/> Not Embedded	<input type="checkbox"/> Pool (N/A)	<input type="checkbox"/> None		1 _____ m	<b>Predominant Flow</b> (Circle One) Fast Moderate Slow No Detectable Flow	
<input type="checkbox"/> 0-25% Embedded	<input type="checkbox"/> 1°substrate is fine (N/A)	<input type="checkbox"/> 1-25 mm		2 _____ m		
<input type="checkbox"/> 25-50% Embedded		<input type="checkbox"/> 25-50 mm		3 _____ m		
<input type="checkbox"/> 50-75% Embedded		<input type="checkbox"/> 50-75 mm		4 _____ m		
<input type="checkbox"/> 75-100% Embedded		<input type="checkbox"/> > 75 mm		5 _____ m		
				6 _____ m		
				7 _____ m		
				8 _____ m		
<b>Comments:</b>				<b>Max Depth:</b> _____ m		

Unit #:	<b>CHANNEL UNIT (Circle One):</b>	<b>Lateral Pool</b>	<b>Mid-Channel Pool</b>	<b>Riffle</b>	<b>Run</b>	<b>Transitional</b>
<b>Substrate Type (1=Predominant, 2=Next Dominant)</b>		<b>COVER (0=None, 1=Sparsce, 2=Intermediate, 3=Abundant)</b>				
<input type="checkbox"/> Boulder (>256 mm)	<input type="checkbox"/> Sand	0 1 2 3 Undercut Bank		0 1 2 3 Aquatic Macrophytes		
<input type="checkbox"/> Slab Boulder (>256 mm)	<input type="checkbox"/> Hardpan	0 1 2 3 Overhanging Vegetation		0 1 2 3 Logs or Woody Debris		
<input type="checkbox"/> Cobble (64-256 mm)	<input type="checkbox"/> Silt	0 1 2 3 Rootwads		0 1 2 3 Aggregate LWD		
<input type="checkbox"/> Gravel (8-64mm)	<input type="checkbox"/> Bedrock	0 1 2 3 Boulder		0 1 2 3 Rootmats		
<input type="checkbox"/> Fine Gravel (2-8 mm)				0 1 2 3 Other _____		
<b>Substrate Embeddedness (1°substrate)</b> Applies when 1°substrate is ≥fine gravel		<b>Depth of Fines as Bottom Cover</b>		<b>Cross Section Depths</b> (Pools Only) Measure from LAB to RAB		
<input type="checkbox"/> Not Embedded	<input type="checkbox"/> Pool (N/A)	<input type="checkbox"/> None		1 _____ m	<b>Predominant Flow</b> (Circle One) Fast Moderate Slow No Detectable Flow	
<input type="checkbox"/> 0-25% Embedded	<input type="checkbox"/> 1°substrate is fine (N/A)	<input type="checkbox"/> 1-25 mm		2 _____ m		
<input type="checkbox"/> 25-50% Embedded		<input type="checkbox"/> 25-50 mm		3 _____ m		
<input type="checkbox"/> 50-75% Embedded		<input type="checkbox"/> 50-75 mm		4 _____ m		
<input type="checkbox"/> 75-100% Embedded		<input type="checkbox"/> > 75 mm		5 _____ m		
				6 _____ m		
				7 _____ m		
				8 _____ m		
<b>Comments:</b>				<b>Max Depth:</b> _____ m		

Unit #:	<b>CHANNEL UNIT (Circle One):</b>	<b>Lateral Pool</b>	<b>Mid-Channel Pool</b>	<b>Riffle</b>	<b>Run</b>	<b>Transitional</b>
<b>Substrate Type (1=Predominant, 2=Next Dominant)</b>		<b>COVER (0=None, 1=Sparsce, 2=Intermediate, 3=Abundant)</b>				
<input type="checkbox"/> Boulder (>256 mm)	<input type="checkbox"/> Sand	0 1 2 3 Undercut Bank		0 1 2 3 Aquatic Macrophytes		
<input type="checkbox"/> Slab Boulder (>256 mm)	<input type="checkbox"/> Hardpan	0 1 2 3 Overhanging Vegetation		0 1 2 3 Logs or Woody Debris		
<input type="checkbox"/> Cobble (64-256 mm)	<input type="checkbox"/> Silt	0 1 2 3 Rootwads		0 1 2 3 Aggregate LWD		
<input type="checkbox"/> Gravel (8-64mm)	<input type="checkbox"/> Bedrock	0 1 2 3 Boulder		0 1 2 3 Rootmats		
<input type="checkbox"/> Fine Gravel (2-8 mm)				0 1 2 3 Other _____		
<b>Substrate Embeddedness (1°substrate)</b> Applies when 1°substrate is ≥fine gravel		<b>Depth of Fines as Bottom Cover</b>		<b>Cross Section Depths</b> (Pools Only) Measure from LAB to RAB		
<input type="checkbox"/> Not Embedded	<input type="checkbox"/> Pool (N/A)	<input type="checkbox"/> None		1 _____ m	<b>Predominant Flow</b> (Circle One) Fast Moderate Slow No Detectable Flow	
<input type="checkbox"/> 0-25% Embedded	<input type="checkbox"/> 1°substrate is fine (N/A)	<input type="checkbox"/> 1-25 mm		2 _____ m		
<input type="checkbox"/> 25-50% Embedded		<input type="checkbox"/> 25-50 mm		3 _____ m		
<input type="checkbox"/> 50-75% Embedded		<input type="checkbox"/> 50-75 mm		4 _____ m		
<input type="checkbox"/> 75-100% Embedded		<input type="checkbox"/> > 75 mm		5 _____ m		
				6 _____ m		
				7 _____ m		
				8 _____ m		
<b>Comments:</b>				<b>Max Depth:</b> _____ m		

FIGURE 3B. Example field sheets including information collected at each site.

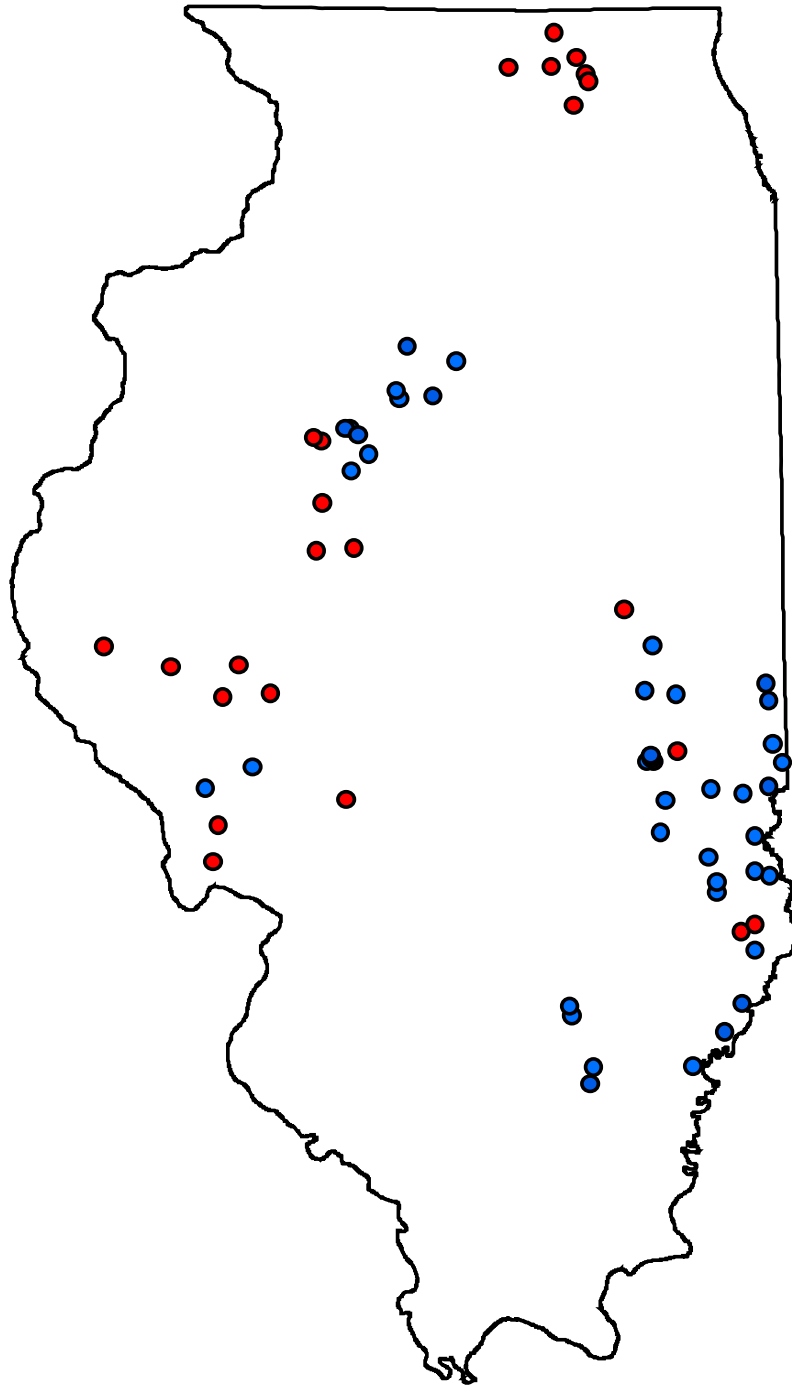


FIGURE 4. Sites sampled during 2006 Field Season. Red sites were sampled by the INHS field staff and the blue sites were sampled by Eastern Illinois University staff.

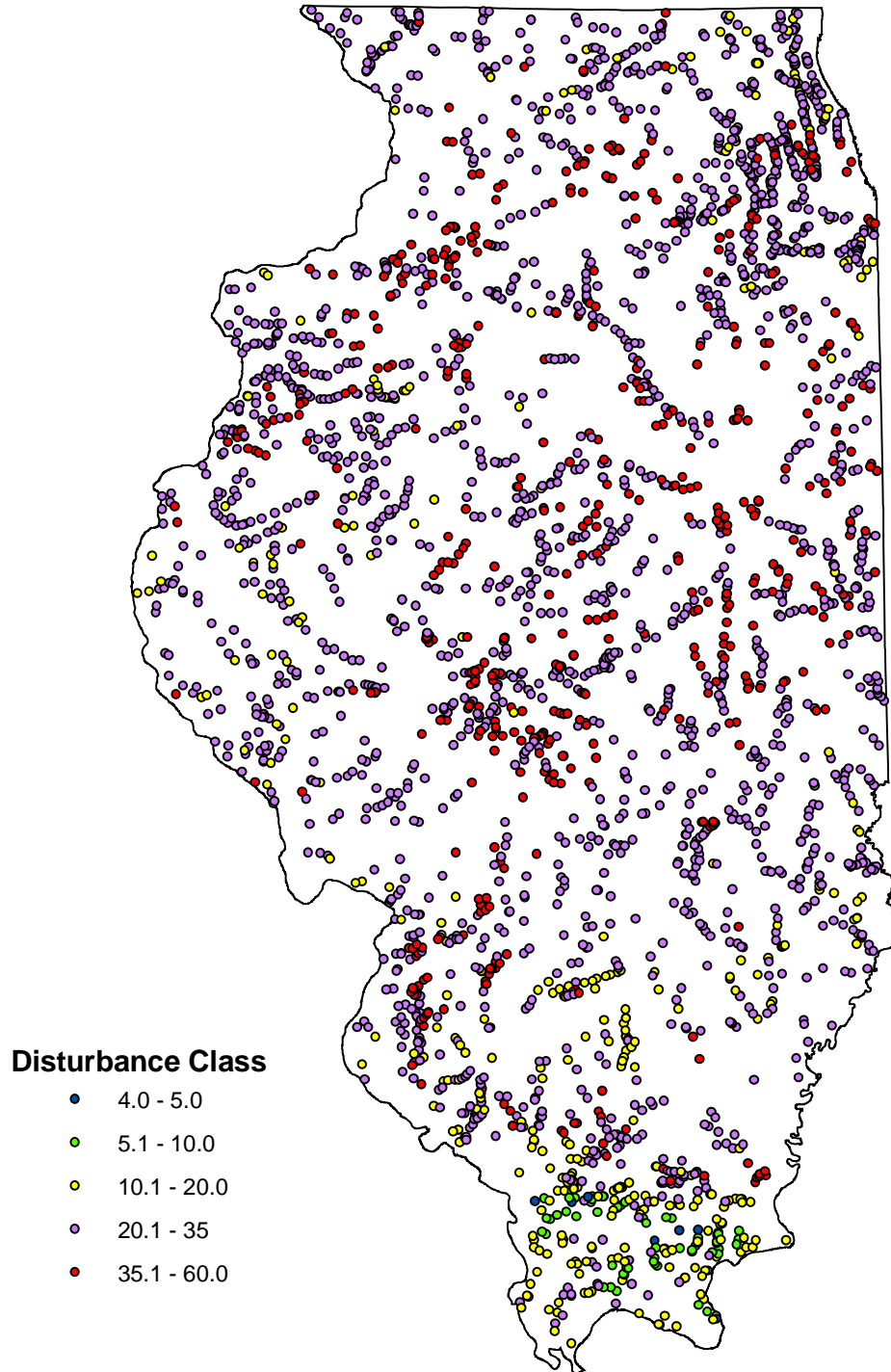


FIGURE 5. Potential sampling sites for 2007 Field Season. We anticipate the ability to complete more sites in 2007 due to an earlier starting date and increased field staff at INHS and at Eastern University. Colors indicate preliminary disturbance ratings for each site.

## **APPENDIX A. Annual report from Eastern Illinois University.**

### **PROJECT #: Eastern Illinois University Sub – Contract**

**PROJECT TITLE:** Developing a multi-metric habitat index for wadeable streams in Illinois

#### **Summary:**

In Illinois, existing methods for sampling stream habitat are too time consuming for staff to routinely collect, or are not sensitive enough to detect meaningful differences in stream quality. The following project will result in a qualitative, multi-metric habitat index that will help refine Illinois' Plan by: describing relative conditions of key aquatic habitats, establishing restoration benchmarks, prioritizing survey efforts, and providing a tool for monitoring the effectiveness of conservation actions. Work performed by Eastern Illinois University has focused on sampling habitat metrics in least-disturbed, moderately-disturbed, and most-disturbed sites throughout Illinois. Although the grant agreement was executed on April 1, 2006 staff did not begin full time work on this project until June 1, 2006. This report summaries work performed by Eastern Illinois University for the period ending June 1, 2007.

#### **JOB 1. Sample metrics at chosen sample sites**

The Eastern Illinois University research staff assigned to this project first worked with the research scientist of Illinois Natural History Survey to identify candidate metrics and potential sample sites. Following metric identification, researchers and students at Eastern Illinois University have sampled candidate metrics at a total of 78 sites during the summer and fall of 2006 from least-disturbed, moderately-disturbed, and most-disturbed sites throughout Illinois. Most habitat samples were collected at existing Illinois Environmental Protection Agency (IEPA) stations to ensure compatibility with existing data. For samples collected at other sites, the locations were well documented and staff requested station code designations from the IEPA. Habitat data collected from the sites sampled were photocopied and the originals sent to the Illinois Department of Natural Resources (IDNR) where data was entered into a database, designed by the project research scientist.

#### **JOB 2. Identify potential metrics.**

In addition to sampling habitat metrics, we coordinated with IDNR and IEPA staff conducting the state's cooperative basin survey program. During these basin surveys, fish, macroinvertebrates, and existing habitat indices are sampled in association with the candidate habitat metrics. We have also begun new sampling at additional sites to fill in gaps in statewide coverage through all levels of disturbance. Fish data were collected via electrofishing using standard IDNR collecting protocols. Macroinvertebrates were sampled according to IEPA sampling protocols. Fish data collected as part of this project were entered into IDNR's Fisheries Analysis System database to facilitate compatibility with other Departmental data.

#### **JOB 3. Prepare final report**

No work was scheduled for Job 3.

Prepared by:

Bud Fischer, Associate Chair, Department of Biological Sciences, Eastern Illinois University.