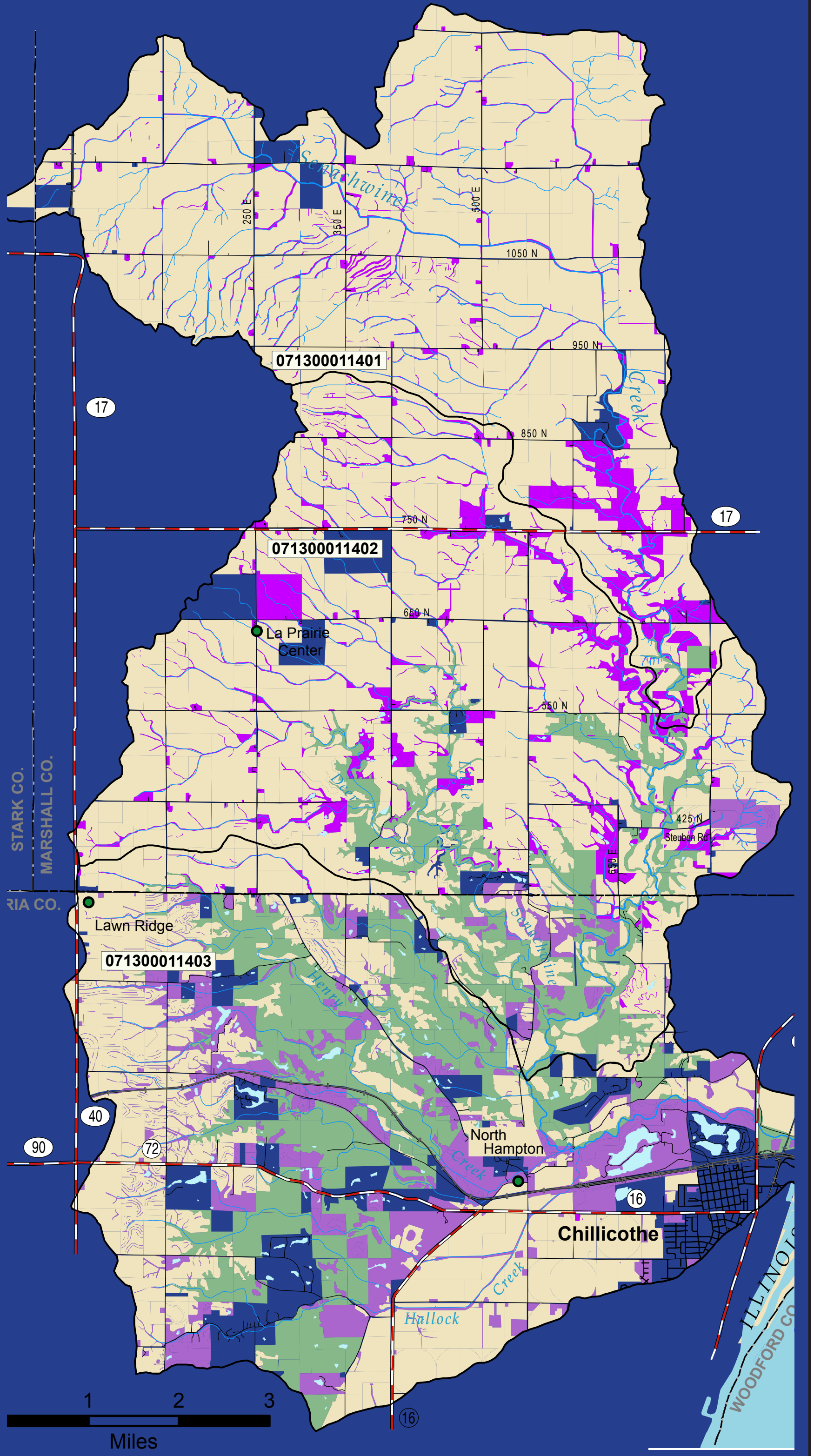

DRAFT

Senachwine Creek Watershed Assessment Report

By:

William P White
Andrew Phillips
John Beardsley
Denise Devotta
Geoff Pociask

Prepared for:

Illinois Department of Natural Resources
Office of Resource Conservation

and

United States Army Corps of Engineers

2008

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Table Of Contents

I. Study Authority

III. Location of Project/Congressional District

IV. Prior Studies, Reports and Existing Projects in the Senachwine Creek Watershed

V. Plan Formulation

Glossary

Name	Acronym
Best Management Practices	BMPs
Biological Habitat Index	BHI
Biological Stream Characterization	BSC
Channel Evolution Model	CEM
Conservation Practices Program	CPP
Conservation Reserve Enhancement Program	CREP
Conservation Reserve Program	CRP
Channel Stability Index	CSI
Crititcal Trends Assessment Program	CTAP
Clean Water Act	CWA
Cubic feet per second	cfs
Digital Elevation Model	DEM
Digital Orthophotographic Quadrangles	DOQs
Environmental Quality Incentives Program	EQIP
General Land Office	GLO
Global Positioning System	GPS
Historical Aerial Photographs	HAPs
Hydrologic Unit Code	HUC
Illinois Department of Argiculture	IDOA
Illinois Department of Natural Resources	IDNR
Illinois Department of Transportation	IDOT
Illinois Environmental Protection Agency	IEPA

Name	Acronym
Illinois Natural History Survey	INHS
Illinois State Geological Survey	ISGS
Illinois State Water Survey	ISWS
Illinois River Basin	ILRB
Illinois River Bluffs Assessment Area	IRBAA
Illinois River Soil Conservation Task Force	IRSCTF
Illinois River Valley Council of Governments	IRVCG
Index of Biotic Integrity	IBI
Land Use and Evaluation and Impact Assessment Model	LEAM
Large Woody Debris	LWD
Macroinvertebrate Biotic Index	MBI
National Wetlands Inventory	NWI
Natural Resources Conservations Service	NRCS
Non-Government Organizations	NGOs
Non-Point Source	NPS
Ohio Environmental Protection Agency	OEPA
Office of Resource Conservation (IDNR)	ORC
Quality Habitat Evaluation Index	QHEI
Ravine Overlay District	R.O.D.
Resource Rich Area	RRA
Senachwine Creek Watershed Assessment	SCWA
Senachwine Creek Watershed Committee	SCWC
Soil and Water Conservation Districts	SWCDs
Special Area Management Plans	SAMPs

Name	Acronym
Tri-County Regional Planning Commission	TCPRC
United States Army Corp of Engineers	USACE
United States Department of Agriculture	USDA
USDA/Soil Conservations Service	SCS
United States Environmental Protection Agency	USEPA
Watershed Land Treatment Program	WLTP
Water and Sediment Control Basins	WASCOBs

I Study Authority

A. Authority, Section 519

Authority for the Senachwine Creek watershed assessment comes from Section 519 of the Water Resources Development Act (WRDA) of 2000. The primary purpose of Section 519 funding currently used in Illinois is for planning, conservation, evaluation, and construction of measures for fish and wildlife habitat conservation and rehabilitation, and stabilization and enhancement of land and water resources in the Illinois River basin (ILRB).

B. Proposed Sponsors

Proposed sponsors include the U.S. Army Corps of Engineers (USACE) Rock Island District serving as federal sponsor and the State of Illinois as local sponsor. The Illinois Department of Natural Resources (IDNR) serves as primary coordinator and facilitator for the local sponsor. The Illinois State Water Survey (ISWS) coordinated preparation of this document with the Illinois State Geologic Survey (ISGS) and the Illinois State Natural History Survey (INHS) under contract with the INDR Office of Resource Conservation (ORC).

II Study Framework and Purpose

This Senachwine Creek watershed assessment (SCWA) documents past and current watershed conditions to identify potential restoration needs and locations. Both historical and new data were analyzed. Assessment data are being used specifically to understand past and current conditions and generally document previous conservation practices. The SCWA also was conducted to help locate, characterize, and prioritize potential conservation and restoration practices. Information provided in the SCWA eventually will be used to guide project considerations, including siting feasibility study projects, and design/construction of multi-objective restoration projects. Projects will be selected that reduce erosion, restore habitat, and protect overall ecosystem health to meet goals and objectives of the ILRB Comprehensive Plan (USACE, 2007). Those objectives include: 1) implementing projects that produce independent, immediate, and sustainable restoration; 2) implementing multi-goal projects with systemic impacts; 3) evaluating alternatives that address common system problems; and 4) using adaptive management concepts while being responsive to long-term management and maintenance needs (USACE, 2007).

The assessment is based upon USACE framework requirements and follows USACE preferred template. The assessment provides scientific guidance for the planning process and is essential for determining whether more detailed reconnaissance and feasability studies should begin and, if so, where. Decisions to design and build restoration projects will be based on preliminary appraisal of federal interest, estimated costs, potential benefits, and possible environmental impacts of various alternatives. This assessment also matches potential projects with appropriate federal and state agencies for further evaluation and /or implementation.

A framework to assess areas and select potential targets for critical restoration is required to implement a comprehensive plan for efficiently and effectively restoring ILRB ecosystem functions (White et al., 2005). Watersheds within the ILRB were prioritized for assessment of ecosystem restoration potential using criteria developed and applied by an IDNR-USACE system team, with input from regional teams and other study committees (Table 1, USACE; White et al., 2005). Assessment protocols used existing data along with new biological and geomorphological data. Erosion problem areas are being identified within the ILRB as erosion and sedimentation were identified as two of the most important problems in the Integrated Management Plan (State of Illinois, 1997) and the Comprehensive Plan (USACE, 2007). Sediment delivery and biological conditions were major criteria, but other criteria also were used to select initial assessment areas from broad areas of interest within the entire basin (White et al., 2005). These criteria include:

- Basin location (primarily sub-basins, watersheds, and sub-watersheds draining directly into Peoria Pool, areas upstream, and Alton and LaGrange Pools).
- Sediment budget information for the ILRB (assess watersheds with the most potential to reduce sediment delivery to the Illinois River).
- Increase base flows and/or decrease peak flows. Increased base flows ensure sufficient flow and depth for aquatic organisms during periods of low precipitation while decreased peak flows reduce occurrences of flash floods.
- Threats to ecological quality or system integrity (increased or changed population rate, rate of change in impervious surface, water quality impairment, etc.).
- Biologically significant areas and ecosystem partnership concerns (Biologically Significant Streams, Resource Rich Areas, regionally significant species and areas, etc.).
- Potential to improve, protect, and expand habitat for regionally significant species, patch size and spacing.
- Potential to be self-sustaining.
- Level of local, state, and federal support, including recommendations from agencies, non-government organizations (NGOs), the ILRB Ecosystem Restoration Project regional teams, Conservation 2000 Ecosystem Partnerships (now called Partners in Conservation), regional planning commissions, watershed planning and technical advisory groups, and other local coordination groups.
- Economic limitations and opportunities.

Senachwine Creek was one of several watersheds, all direct tributaries to Peoria Pool, given highest priority by an IDNR-USACE system team and recommended for reconnaissance-level watershed assessment because of criteria listed above and similarly outlined in Table 1. It was also necessary to develop additional criteria for targeting and prioritizing potential individual restoration sites within each watershed. These additional criteria are similar to those used to select the initial list of watersheds for assessment but with more detail on individual project concerns (White et al., 2005). Recommended criteria for selecting individual project sites include but are not limited to:

- Sediment contributions from the watershed and particularly the site in question.
- Availability of a watershed plan and progress with planning and implementation.
- Landowner willingness to participate.
- Availability of access.
- Future potential damages if a project is not implemented.
- Federal, state, and local ability to improve the area.
- Economic opportunities or limitations influencing project success.

Criteria Description	Basin Screening	Watershed Assessment
Location in IL River basin	Priority/greater initial weighting will be placed on watersheds draining into Peoria Pool and upstream, followed by Alton & LaGrange pools	
Reduce sediment delivery to Illinois River	Existing data from past reports and system study on delivery.	Verification of Basin Screening factors. Field investigation of geomorphological attributes—i.e., locating headcuts and monitoring erosion of banks.
Improve quality and/or increase area/connectivity of Biologically Significant Areas (BSA)/Resource Rich Areas (RRA)	Office assessment of existing biological and GIS data, including contiguous habitat, from Corps, DNR, TNC, EPA.	Verification of Basin Screening factors. Field investigation of biological attributes (ability to meet system patch size, spacing, connectivity, etc. goals).
Improve, protect and expand habitat for regionally significant species (including T & E), patch size and spacing	Number of Threatened and Endangered species.	Identification of specific species and potential to benefit.
Increase base flows and /or decrease peak flows	Preliminary Assessment	More detailed analysis
Threats to Ecological Quality/Integrity	Consider population density, pop. Growth rates, percent impervious cover, and water quality (303d streams)	Verification of Basin Screening factors. Land use changes, increased isolation, invasive species
Other Agency Efforts	Identify known areas where other agencys have restoration activity interests	Identify specific other agency actions and potential to collaboratively address problems.
Public support	Existence of local plan or ecosystem partnership group	Identified support in progress and landowner interest
Sustainability		Assessment of potential for restoration to be self sustaining or contribute to a self sustaining system.

Table 1. Basin, Watershed, and Project Prioritization Process

III Location of Project/Congressional District

A. Location

Senachwine Creek watershed is located in the middle sub-basin of the ILRB and within western Marshall County and northeastern Peoria County (Figure 1). The 58,185-acre or 90.9-square-mile watershed (NRCS, 2002) drains directly into Upper Peoria Lake in Peoria Pool, one of the largest riverine lakes on the Illinois River. Other sources, (i.e. IL GAP Analysis Land Cover Grid in Arc Map) show slightly different acre figures because of individual and/or source material differences, but all sources are significantly close in acreage. Three hydrologic units comprise the watershed, as defined by the hydrologic unit codes 071300011401, 071300011402, and 071300011403 (NRCS, 2002). Senachwine Creek originates near Camp Grove then flows approximately 29 miles to its confluence with the Illinois River near Chillicothe. Henry Creek, Hallock Creek, Gilfillan Creek, Deer Creek, and Little Senachwine Creek are larger tributaries of Senachwine Creek.

B. Study Area Congressional District

The study area is located in the State of Illinois 18th Congressional District currently represented by Congressman Ray LaHood (Figure 2). The 18th Congressional District of Illinois contains all or parts of 20 counties in Central and Western Illinois. The district is a mixture of urban (Peoria, Springfield) and rural areas. The district contains some of the most productive farmland in the world as well as maintaining a strong manufacturing base. Several historic and scenic rivers flow through the farm fields, small towns, and large cities of the district. The counties in the 18th District are: Adams, Brown, Bureau, Cass, Knox, Logan, Macon, Marshall, Mason, Menard, Morgan, Peoria, Pike, Putnam, Sangamon, Schuyler, Scott, Stark, Tazewell, and Woodford. The 18th District also contains all 11 of the counties that Abraham Lincoln represented during his one term (1847-1849) in Congress.

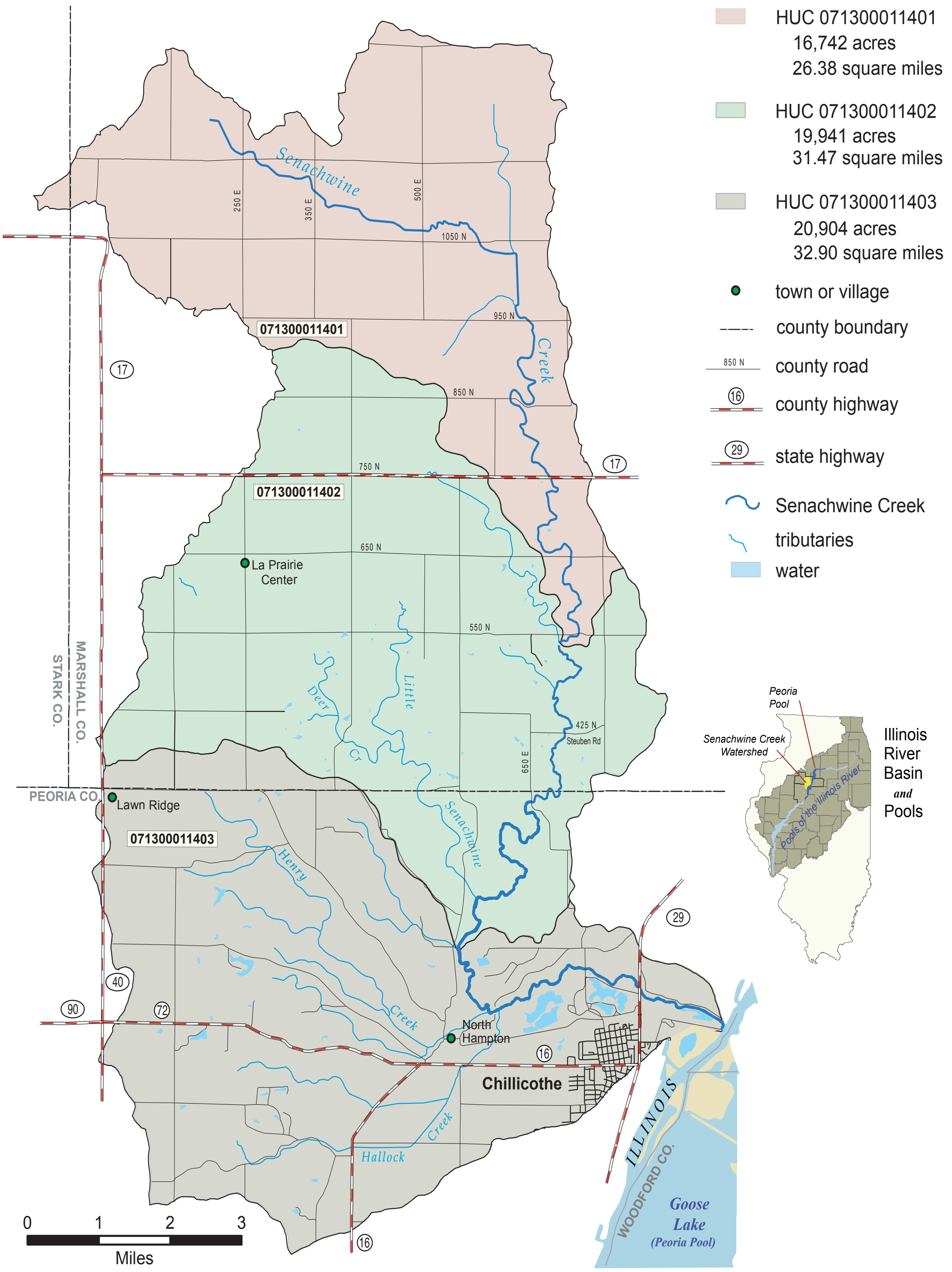


Figure 1. Location of Senachwine Creek in Marshall and Peoria Counties.

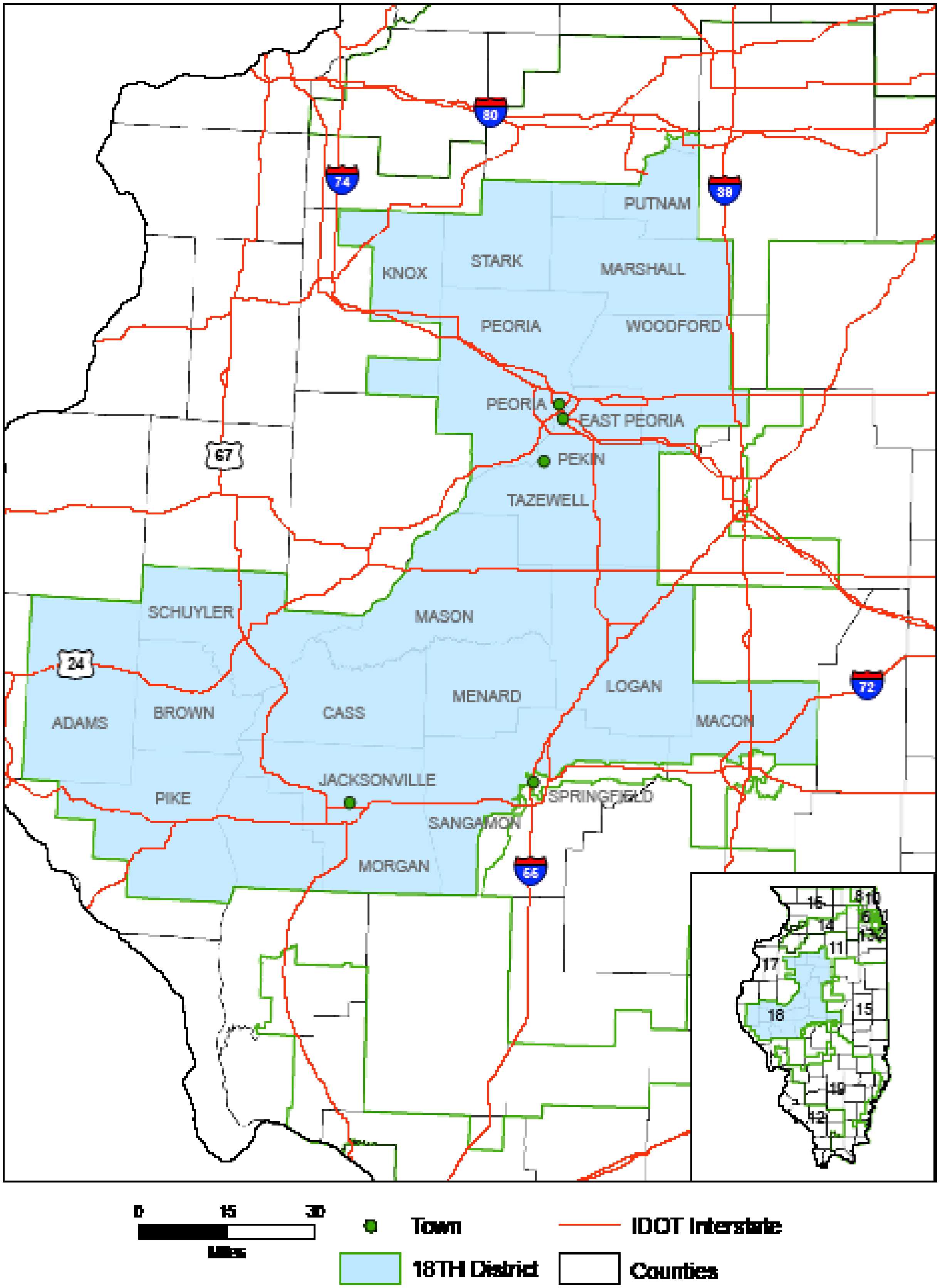


Figure 2. Location of Senachwine Creek in Marshall and Peoria Counties.

IV Prior Studies, Reports and Existing Projects

Planning and implementation of erosion control and water management projects have occurred in the Senachwine Creek watershed in the past. This section briefly discusses prior studies, reports, existing documents, and other activities pertinent to this study.

A. Assessment Goals

Senachwine Creek is in the Illinois River Bluffs Ecosystem Partnership Area in the portion designated as the Peoria Wilds Resource Rich Area (or the Peoria Wilds RRA) (Figure 3). These areas were identified under the IDNR Critical Trends Assessment Program (CTAP) and the IDNR Ecosystems Program. Regional analyses of Partnership Areas using existing statewide data were completed in the 1990s. The goal of those assessments was to provide baseline data to help set priorities and develop management plans. Reports for the Illinois River Bluffs Ecosystem Partnership comprise four volumes covering area geology (IDNR, 1998a); water resources (IDNR, 1998b); living resources (IDNR, 1998c); and the socio-economic profile, environmental quality, and archaeological resources (IDNR 1998d). Although the CTAP assessments were comprehensive, scale of existing data was too coarse for adequate assessment of past and current conditions of the watershed and fluvial system for use in identifying project implementation priorities.

The SCWA is part of a long-term project to provide watershed-specific information at a scale more appropriate for ecosystem restoration recommendations than the CTAP and other previous assessments. This study also addresses some directives of the Integrated Management Plan for the Illinois River Watershed (State of Illinois, 1997), including generating site-specific data to understand causes of tributary stream instability and evaluate public lands for wetland and surface water restoration. Finally, this study partly fulfills four of the five goals of watershed assessment recommended by Holtrop and Pegg (2004):

- Identify defining physical limits of the watershed.
- Document past and current watershed conditions.
- Identify practices and processes with watershed impacts.

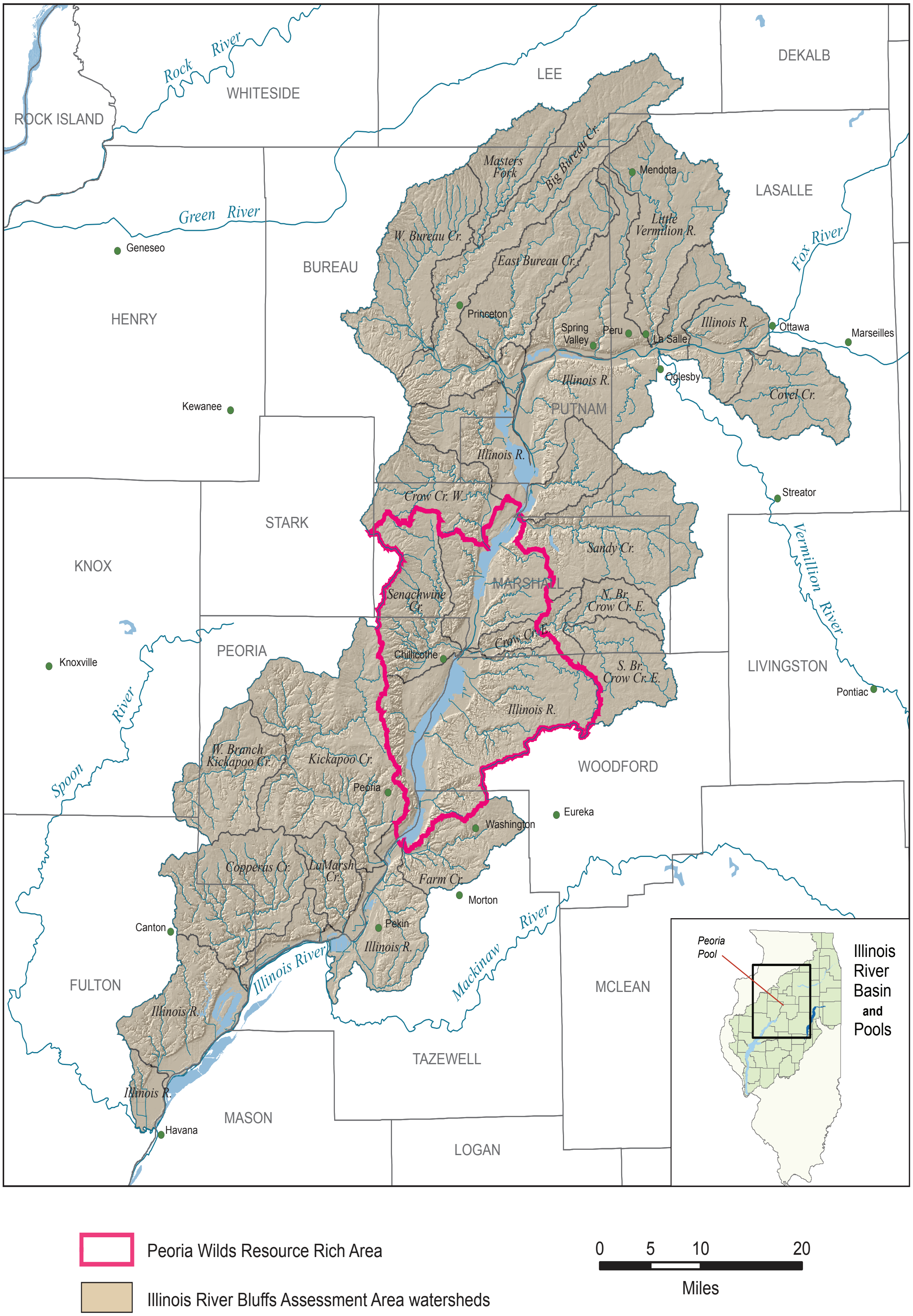


Figure 3. Location of Senachwine Creek within the Peoria Wilds Resource Rich area

- Recommend restoration projects based on identified cause and effect relationships.

It does not include a reference watershed in its scope as recommended by Holtrop and Pegg (2004), however. Watershed assessments that comply with USACE reconnaisance level studies do not lend themselves to detailed study of reference watersheds bacsue of time and funding constraints.

Various intrinsic (land use, land cover, and geology) and extrinsic (climate change) forcings have caused disturbances in stream systems throughout the ILRB (IDNR, 1998b). For example, rapid conversion of native prairie to agriculture in the past marked extreme changes in land use and water use that may have triggered erosion and deposition cycles that remain detrimental to native habitats, soils, and property. To mitigate disturbances to the landscape and stream systems, traditional water management and erosion control projects (e.g., grassed waterways, terraces, ponds, water and sediment control basins or WASCOBs, etc.) have been constructed outside the main channel in the Senachwine Creek watershed. Such projects may alter water and sediment loadings to the Senachwine Creek mainstem or have either positive or negative effects immediately after construction. For example, without compensating for flow regime changes or channel slope adjustments, sediment detention in upland areas can result in channel migration and/or channel incision, which would induce channel erosion and change channel morphology (White et al., 2008. In Review). By contrast, coordinated implementation of best management practices (BMPs) in and beyond the channel should reduce peak discharge, increase base flow, and establish a more balanced sediment regime.

Therefore, the SCWA intends to build on lessons from past BMP implementation to guide future projects. Further, a central focus of recommended treatments will be to coordinate upland and in-channel projects to enhance the ecological system by naturalizing or optimizing hydrologic, hydraulic, and sediment regimes. Treatments could focus on channel bed grade control, streambank stabilization, hydrologic and hydraulic optimization, wetland and riparian habitat restoration, or combinations thereof. Potential projects include riffle and pool structures for multiple benefits, such as channel bed control, habitat enhancement, improved aesthetics and oxygenation of water, lunker structures for bank protection and fish habitat, bioengineering techniques for bank stabilization and native plant diversity, improved stream connectivity for fish passage, improved riparian connectivity for nutrient filtering and terrestrial habitat, or channel re-meandering to reconnect channel-floodplain systems for naturalizing hydraulic and sediment transport conditions and enhancing habitat.

Potential to improve, protect and expand habitat for regionally significant species, vegetated patch size and spacing for habitat also will be important and, as with stream and riparian management, will be outlined and pursued as opportunities arise. More details on biological conditions and possibilities (i.e., forest management) will be discussed later in this document.

Earlier reports describe previous planning and implementation efforts. They are described below in Sections IV B-D. The locally guided committee became inactive after these projects were completed, but it is being re-established as a result of this SCWA effort (Josh Joseph, Peoria County Soil and Water Conservation District (SWCD), Personal Communication, 2006).

B. Draft Preliminary Investigation Report: Senachwine Creek Watershed, Peoria and Marshall Counties, Illinois

A group of landowners concerned about erosion control in the Senachwine Creek watershed established the Senachwine Creek Resource Planning Committee with direction from the SWCDs in Peoria and Marshall Counties in 1986 (Miller et al., 1997). Public meetings held in each county gave watershed residents and other stakeholders an opportunity to voice their concerns and interest (SCS, 1990). A local technical advisory committee also was established. This grass-roots collaboration led to the establishment of the Senachwine Creek Watershed Committee (SCWC). The SCWC produced a preliminary report that presented results of data collected by the U.S. Department of Agriculture Natural Resources Conservation Service [USDA-NRCS, then USDA Soil Conservation Service (SCS)] for the Senachwine Creek watershed. The report was prepared to determine the feasibility of a Public Law 83-566 Watershed Protection and Flood Protection Act project (SCS, 1990).

Erosion and sediment damages were the primary concern of the Senachwine Creek Resource Planning Committee. Resource concerns identified at a 1986 public meeting (SCS, 1990) addressed watershed erosion (21 comments), flooding (15 comments), economics (11 comments), social or other problems (8 comments), and sedimentation (5 comments). The SCS (1990) noted that erosion estimates in the watershed were 9-10 tons/acre/year. Cropland accounted for 82% of all water-related erosion in the watershed, but only 58% of the sediment that reached the Illinois River and Upper Peoria Lake. Of that 58%, streambank and gully erosion only accounted for 16% (~88,000 tons/acre/year) of watershed erosion but contributed 42% of the sediment from the watershed to the Illinois River and Upper Peoria Lake. In 1988, two major erosion control and water quality improvement initiatives were approved and received one-year funding under the state Watershed Land Treatment Program (WLTP) as a result of watershed planning efforts.

The SCS (1990) found that the WLTP-funded conservation program was inadequate to have significant impacts on annual sediment yields from erosion and as such, recommended four alternatives: (1) implement traditional land treatment, including conservation in steeper portions of the watershed; (2) construct 7 large and 50 small sediment basins; (3) stabilize 8 miles of severely eroded streambanks and 25 miles of moderately eroding lands; and (4) compile a detailed watershed inventory with cost-benefit analysis of alternatives 1-3 for reducing erosion, sediment, and flood damages. (The specific projects outlined in these alternatives, their funding levels, and cost-share requirements implemented under the WLTP are not known).

C. Senachwine Creek Nonpoint Source Control Project, Phase I

A 1994 grass-roots effort between the SCWC and the Illinois River Soil Conservation Task Force (IRSCTF) resulted in successful application to the Illinois Environmental Protection Agency (IEPA) for a grant under Section 319 of the U.S. Environmental Protection Agency (USEPA) Clean Water Act (CWA). The goal of the collaboration was to improve water quality by reducing nonpoint source (NPS) runoff by controlling sheet, rill, gully, and streambank erosion. Agricultural land use was identified as a major source of nonpoint source pollution (Miller et al., 1997). They described severe streambank erosion that destroyed farmland, threatened stability of bridges and roads, decreased water quality, and increased sediment loads in creeks and the Illinois River. Treatments of uplands and floodplains along with educational outreach and training were used to achieve NPS reduction goals.

With assistance from an established technical committee, the SCWC allocated funds towards upland treatments, ponds, and streambank stabilization. Ponds and upland treatments were cost-shared (75% federal and 25% local) with a maximum of $7,500 per landowner, as were streambank stabilization efforts (90% federal and 10% local). Fifty-three projects were constructed with NRCS technical assistance. Design and construction were in accordance with USDA-NRCS standards and specifications. Construction included 39 upland projects comprising 46,725 feet of terraces, 24.9 acres of waterways, 38 WASCOBs, and

2 grade stabilization structures (Miller et al., 1997). Streambank stabilization projects addressed 4,650 linear feet of stream channel and 8 ponds. Streambank stabilization workshops were conducted to educate landowners and the general public on methods for controlling streambank erosion. Combined, these projects reportedly improved water quality by preventing an estimated 23,600 tons of soil from entering the Illinois River annually.

Proposed project costs were $500,000: $300,000 in IEPA support and $200,000 in local match. Of the IEPA portion, $268,665 (89.5%) was directed toward conservation practices on the land. Matching funds actually accrued to $384,931, $184,931 (92%) more than the necessary $200,000 local match (Miller et al., 1997).

Miller et al. (1997) concluded that significant future work was needed. There was a lack of funding for public awareness, education and technical support. Funding was also needed to implement structural practices and incentives for long-term solutions. More control structures such as WASCOBs, ponds, dry dams, terraces, and grassed waterways were specifically identified in the report as being needed to slow runoff and trap sediment (Miller et al., 1997).

D. Senachwine Creek Nonpoint Source Control Project, Phase II

Senachwine Creek phase II was implemented under Section 319 Clean Water Act with IRSCTF funding under administration of Peoria and Marshall County SWCDs in December 1999 (Joseph et al., 2003). Goals were to build upon successes of phase I projects to reduce NPS pollution from uplands, floodplains, and streams by requiring improved and up-to-date farm plans, installation of proposed BMPs, and education of the general public about the project and NPS pollution.

Although only 92 projects initially were proposed, 107 BMPs were completed through the March 2000-February 2002 time frame of the agreement (Joseph et al., 2003). In 2006, the IEPA released a Phase II report(www.epa.state.il.us/water/watershed/reports/biannual-319/2006/march.pdf) in which they reported installation of an additional 36 BMP sites from 2002 to 2006, bringing the total to 143 sites in the watershed up to the present (Scott Tompkins, IEPA, Personal Communication, 2007). This Phase II report however, describes 107 constructed projects including 2,800 feet of streambank and shoreline protection, 11 ponds, 55,270 feet of terraces, 36 WASCOBs, 11.2 acres of waterway, 3 grade stabilization projects, and an animal waste management system (Figure 4). (See Appendix A for table of BMP project details). Three additional projects approved by IEPA as match were constructed through other funding mechanisms. These included a Conservation Reserve Enhancement Program (CREP) project in a floodplain area and two additional stream stabilization projects. The original Financial Assistance Agreement totaled $696,600, based on a 60-40% cost-share breakdown that included $471,960 of USEPA funds and $278,640 of local and state match. Final figures indicated that approximately $386,000 of USEPA funds and $439,000 of matching funds were used, which again far exceeded the projected amount of match funds required (Joseph, et al., 2003). The total budget included landowner match (53%), USEPA match (33%), NRCS technical assistance (10%), SWCD technical assistance (1%), SWCD administration (1%), and SWCD clerical work (2%).

E. Related Efforts of Significance to Forest Management in Senachwine Creek Watershed

The Tri-County area includes Peoria, Tazewell and Woodford counties and has strong local, state, and federal commitments towards ongoing preservation and rehabilitation of the Illinois River, Peoria lakes, the bluffs and the region's abundant natural areas. Numerous completed or nearly completed projects strongly support preservation of these valuable assets. The Tri-County Regional Planning Commission (TCRPC) created the Mossville Bluffs Master Plan in 2002, with funding made available through the IDNR Conservation 2000 program. While this plan was for an area south of Senachwine Creek watershed, it is very pertinent in that it made several important recommendations about erosion and sediment control, rural and urban forest management, stormwater management. and habitat enhancement. The Mossville Bluffs Watershed Restoration Master Plan identified an opportunity to create a ravine overlay district (R.O.D.) to be used as a mechanism to continue the ongoing preservation and rehabilitation of Peoria lakes and the Illinois River valley. After verbal encouragement from the Illinois River Valley Council of Governments (IRVCG), (an association of local municipal representatives), it became a priority to investigate the opportunity for developing a regional R.O.D.

The R.O.D. was created as a model for a zoning district to protect rapidly eroding bluff and wooded areas (particularly those areas under pressure from land development). Recent analyses completed using the Land Use and Evaluation and Impact Assessment Model (LEAM) predict that encroaching development will consume approximately 8,500 acres (9.5%) of Peoria area forests over the next 30 years. The LEAM is a tool for predicting regional growth patterns and analyzing subsequent results of those patterns. It was created at the University of Illinois at Urbana-Champaign and brought to Peoria as a demonstration project. Several

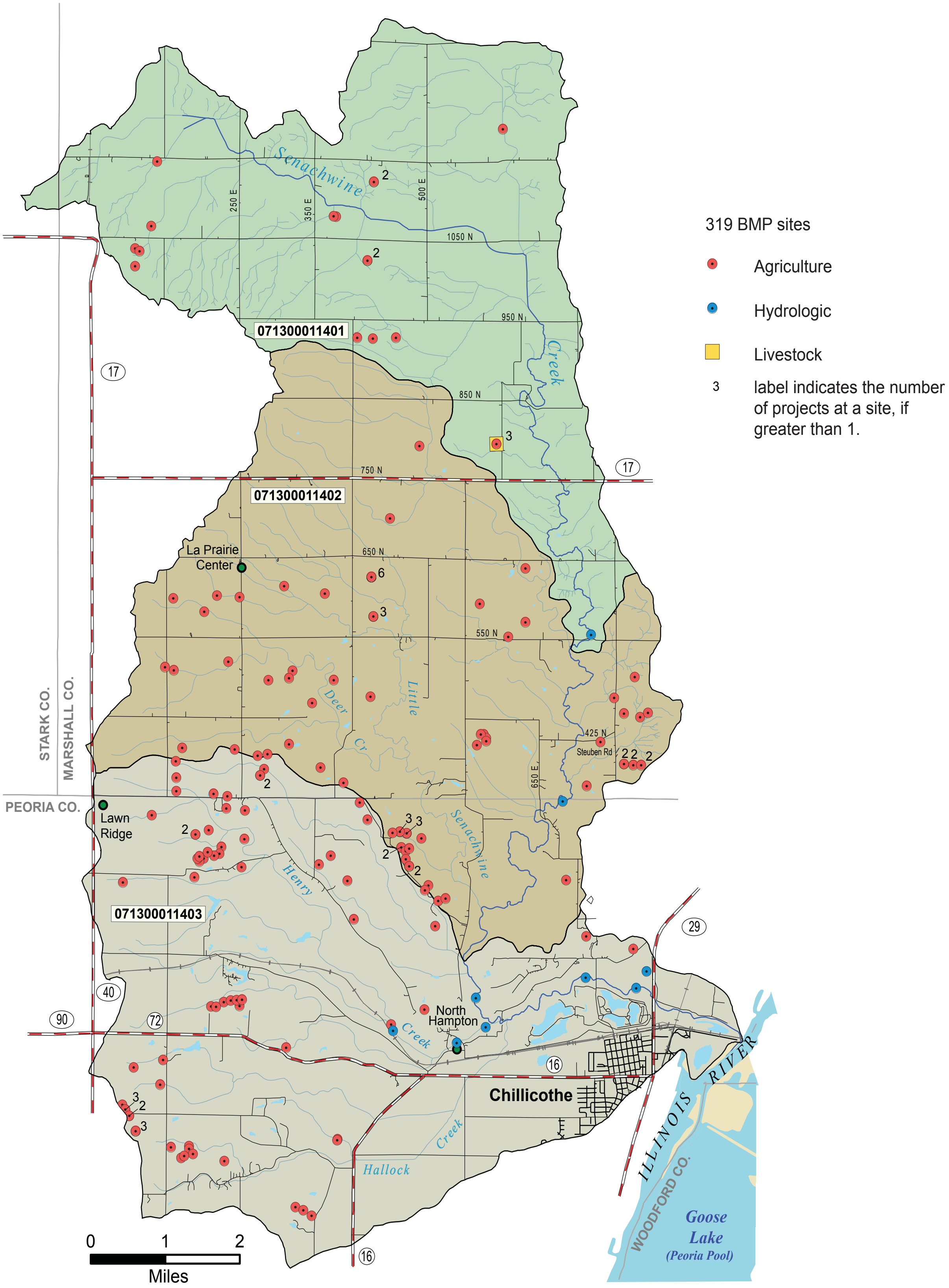


Figure 4. Locations and types of BMP projects installed within the Senachwine Creek watershed.

groups made the LEAM project possible including the Illinois Department of Natural Resources (IDNR), the Illinois Department of Transportation (IDOT), the Illinois Department of Agriculture (IDOA), the TRPC and the Governor's Sub-Cabinet on Balanced Growth. The model would help R.O.D. development by identifying threatened natural areas, gathering anecdotal information from local landowners, and analyzing potential impacts of growth on natural areas. Results of the LEAM modeling system identify the possibility of preserving a substantial portion of sensitive areas via tools such as the proposed R.O.D. Design of the R.O.D. model ordinance will allow wide use and adoption by entities both inside and out-side the Tri- County area.

F. Lake Front and River Development Plan

This draft plan is currently referred to as 'Peoria Lakes Comprehensive Restoration and Ongoing Management Plan'. Currently the plan is divided into 3 segments; one detailing conservation potential for the Upper Peoria Lake, a second segment outlining a transitional management strategy for Middle Peoria Lake, and a third component for Lower Peoria Lake which discusses the construction of islands created from dredged material, a side conservation channel and beneficial use of dredged materials to be used as material for the islands and a conservation corridor along the riverfront. Research needs are being outlined and currently recommend a hydrology and hydraulics analysis to aide in design of capital projects, including construction of islands and a conservation channel among other conservation and development measures. These ideas were originally proposed by the ISWS over 20 years ago (Demissie et. al, 1988).

The Peoria Lakes vision plan pormoted by the Heartland Water Resources Council consists of several potential labfront property developments such as commercial redevelopment, conservation and recreation development and sediment mining on the deltas of several of the tributaries draining directly into Peoria Lakes (i.e. Farm Creek, Ten Mile Creek, Senachwine Creek, etc.).

Plans are already underway to revitalize one section of the riverfront. The City of Peoria's Department of Economic Development is conducting 'charettes' to develop landscape design ideas for redeveloping the southern gateway to the City of Peoria which is now primarily an obsolete industrial development. The City of Peoria is considering major reinvestment opportunities by intensively redeveloping the conservation amenities along Peoria's riverfront. One component of a plan under consideration is to develop a public "green edge" or linear park along the river from Water Street to War Memorial Drive. Over time the existing river edge could be converted to parks with a scenic riverfront drive and potentially with economic ‘drivers’ such as quality mixed use development with some new residential homes, beautification of the area and streets, enhanced connectivity between the downtown and riverfront areas, and enhancement of the natural environment. Linakge of green developments could occur all along Peoria Lakes riverfront from Senachwine Creel deltas to the City of Peoria.

V Plan Formulation

A. Watershed Conditions

1. General Geomorphic Setting and Recent Geologic History

The Senachwine Creek watershed developed in a valley between two glacial moraines deposited during the most recent glaciation (Figure 5). The glacier flowed over the Illinois River valley from the east, scraping pre-existing sedimentary cover down to bedrock and leaving subglacial and proglacial deposits upon retreat. This was followed by deposition of a blanket of wind-blown dust (loess) over the region, and erosion and re-sedimentation of existing deposits as the drainage network continued to develop. Prairie grasses and forests became established over lower and steeper slopes, respectively. Thus, the upper portion of the watershed is a composite of deposits from downwasting ice, till, debris flow, and stratified sediments (Ablation Plain), outwash streams (stratified sediments along Senachwine Creek valley) and ice-marginal lakes (Glacial Lake Plain). The lowermost part of the valley cuts through the Illinois River bluff and flows over a terrace left from outwash deposits of the last glaciation. Tributaries to Senachwine Creek mainstem are mainly incised into the till plain.

The present-day watershed has gently sloping areas on the flanks of moraines in the upper watershed, more steeply sloping valley areas along middle reaches of the Senachwine Creek mainstem and Little Senachwine Creek, and lower relief areas on the Illinois River terrace and floodplain between the bluff at North Hampton and the Illinois River (Figure 6). Upstream of North Hampton, the Senachwine Creek valley is 1-1.25 miles wide.

Three reaches of Senachwine Creek mainstem can be distinguished based upon planform configuration. In the upper reach, (approximately the upstream half of hydrologic unit code 401 (HUC 401)), the gently meandering stream is partly channelized, with an average 2-3% valley slope within 1000 feet of channel (Figure 6). Headwaters are incised into the Providence Moraine, whose crest forms the western watershed divide, while the lower part flows over the Glacial Lake Plain. Lineback (1979) interpreted the Glacial Lake Plain based upon the relatively low slope (~1%). The total elevation drop from headwaters to the lakeplain is 90 feet (~800-710 feet above mean sea level, (ft-msl)), whereas the elevation drop across the lake plain is only about 20 feet (710-690 ft-msl). The plain has a gently undulating surface that likely reflects interfingering fluvial

Figure 5. Landscape of Senachwine Creek watershed

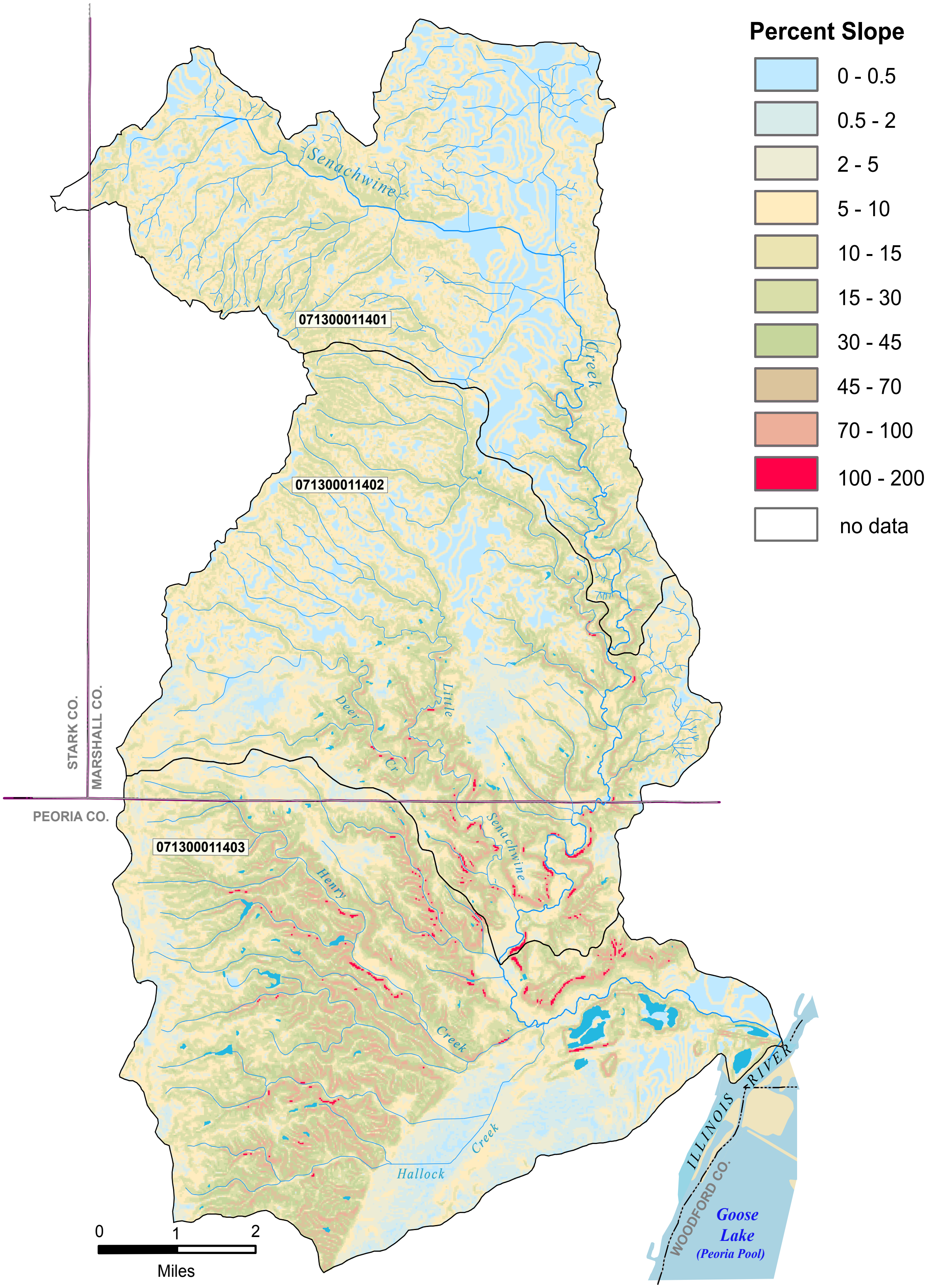


Figure 6. Slope of Senachwine Creek watershed, based on USGS 10m DEM

and lacustrine environments.

The Middle Senachwine valley begins where the stream exits the Glacial Lake Plain and flows through the Ablation Plain (Figure 5) formed by downwasting of ice that created the Providence Moraine and by meltwater streams flowing off the glacier terminus at the Eureka Moraine. The present channel along this reach moderately meanders and increases in sinuosity downstream. The valley slope is ~13% within 1000 feet of the channel, steepens abruptly where the stream cuts through Illinois River bluffs, then shallows to ~3% below the confluence of Little Senachwine Creek (Figure 6; note that the valley slopes differ from the channel slopes, discussed below). The Middle Senachwine valley thus includes the lower portion of HUC 401, all of HUC 402, and the upper portion of HUC 403.

In the lower reach on the Ancient Mississippi floodplain, the channel again gently meanders and has significant modified subreaches (Figure 5). The gentle valley slope drops only 20 feet over 3 miles (~0.1%) down to the Illinois River (Figure 6). East of Illinois Route 29, the channel has been straightened and maintained since before 1939. The Woerman maps of 1902-1904 were produced by the USACE and show the river and floodplain during low water after diversion from Lake Michigan began in 1900 (Woerman, J. W. 1902-1904). The Woerman maps show two outlets for Senachwine Creek: Spring Branch and the present outlet (Bhowmik et al., 1993). By 1939, Spring Branch no longer received flow and appeared to be cut off or abandoned. There is no distinct delta at the stream mouth, because either the Illinois River either transports sediment rapidly downstream or partly deposits it in streamwise-oriented sediment bars, islands, or both. Channel constriction and navigation channel and bridge maintenance activities also may influence morphology at the stream mouth.

2. Native Landscape and Pre-European Land Cover:

Influences from Soil Geomorphology and Slope

Settlers of the Senachwine Creek watershed found a landscape characterized by a mix of oak woodlands and prairie in the early 1800s (Suloway et al., 1996). Schwegman (1973) classed natural environments and biotic communities in Illinois based primarily on topography, soils, bedrock, glacial history, and distribution of plants and animals (Figure 7). The Senachwine Creek watershed is located primarily in the Grand Prairie Section of the Grand Prairie Division but also includes the Illinois River Section of the Upper Mississippi River and Illinois River Bottomlands Division, and a very small area in the Illinois River and Mississippi River Sand Areas Division. The

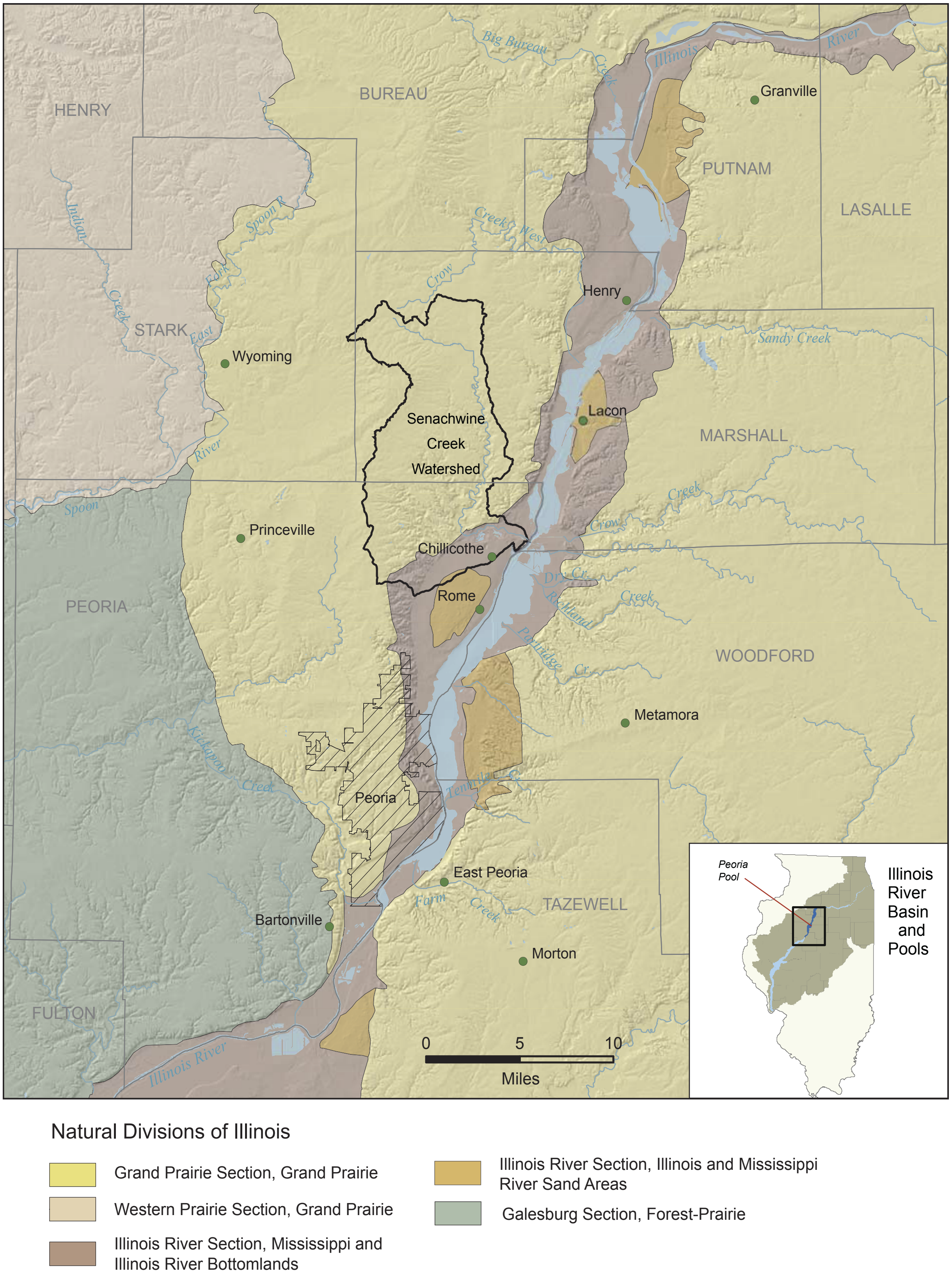


Figure 7. The Natural Divisions of Illinois (Schwegman, 1973) in the Illinois River Blufffs Assessment Area, including Senachwine Creek watershed

following descriptions of the natural divisions in the Senachwine Creek watershed are paraphrased, in part, from Schwegman (1973).

The Grand Prairie Section is a vast plain outside the Northeastern Morainal Division that was covered by the Wisconsinan stage of Pleistocene glaciation (Schwegman, 1973). These generally very fertile soils developed from recently deposited loess, glacial lakebed, and outwash sediments. Poor natural drainage resulted in many marshes and prairie potholes. Prairie grasses were the predominant vegetation. Forest bordered rivers and streams, as still can be found in lower segments of Senachwine Creek mainstem and its tributaries. There were occasional groves of trees on moraines, such as what is now Camp Grove; a small town in headwaters of the Senachwine Creek watershed. Prairie potholes, rivers, and creeks were the main aquatic habitats.

Tallgrass prairie probably covered much of the upland landscape and was once home to bison and great numbers of waterfowl that occupied marshes, potholes, and larger river floodplains. Most bison were hunted out by 1814 (Schwegman, 1973). Invention and implementation of the steel plow by the mid-1800s brought about rapid conversion of prairies to farms. By the 1870s, construction of ditches and tile drainage systems created with steam shovels and drag lines drained almost all marshes and potholes, displacing large numbers of waterfowl. The prairie is now one of the rarest plant communities in Illinois. Nearly 90% of native wetlands were degraded or destroyed, although they hold most of the rare and endangered plants in Illinois.

Headwaters of Senachwine Creek mainstem were generally a poorly drained plain of glacial drift, as discussed above. The Illinois Section of the Grand Prairie Division is generally relatively level but less level in transitional microenvironments within and along the flanks of end moraines, ground moraines, dissected till plains, and outwash plains as in the area encompassing the Senachwine Creek watershed.

Forests of the Grand Prairie Section generally are associated with stream valleys and crests of moraines (Schwegman, 1973). Forests on dry sites are dominantly white oak, black oak, shagbark hickory, and often shingle oak and bur oak. Basswood, sugar maple, slippery elm, American elm, hackberry, red oak, white ash, black walnut and butternut hickory are dominant on mesic sites, and bigtooth aspen are common in the northern part. Floodplain forests are of the silver maple-American elm-ash type. Recurrent fires influenced development of prairie groves, such as Camp Grove near headwaters of Senachwine Creek mainstem, of burr oak and American elm and hackberry.

A small portion of the lower end of the Senachwine Creek watershed occurs in the Illinois River Section of the Upper Mississippi and Illinois River Bottomlands Division (Figure 7). This section encompasses, among other things, bottomlands and associated backwater lakes of the Illinois River and its major tributaries south of LaSalle (Schwegman, 1973). Much of the section originally was forested, but prairie marsh also occurred. The lower segment of Senachwine Creek mainstem flows through bottomlands of the Illinois River valley, which are subject to backwater effects from the Illinois River mainstem and characterized by broad floodplain features and sand-and-gravel terraces formed by glacial outwash. Soils formed in this glacial outwash and recent alluvium drain poorly, are alkaline to slightly acidic, and vary from sandy to clayey in texture. Springs often associated with gravel terraces along the Illinois River occur near Chillicothe.

The Illinois River Section of the Illinois River and Mississippi River Sand Areas Division encompasses sand areas and dunes in bottomlands of both rivers. A minor part of lower Senachwine Creek mainstem lies within the Illinois River and Mississippi River Sand Areas Division (Figure 7). Natural vegetation of this section includes scrub oak forest and dry, mesic, and wet sand prairies and marsh. Several plant species here are more typical of the short-grass prairies west of Illinois. Several relic western amphibians and reptiles are known only from these sand areas. Dunes and blowouts are common topographical features in this Section, and various plant associations related to unstabilized sand are located here.

However, the Schwegman (1973) analysis was conducted at a regional scale. Using township maps, better suited to the size of the Senachwine Creek watershed, from United States General Land Office (GLO) records, Greer et al. (2002) developed a map of pre- to early Euro-settlement land cover (Figure 8). The GLO data are based on observations by surveyors in the watershed in the early 1800s. Independent interpretation of pre-settlement land cover can be obtained from surface soil color data reported on NRCS soil maps (Figure 9). In Illinois, dark soils formed under prairie (mollisols) and light soils under forested areas (alfisols). Analysis of soils helps characterize early ecosystems, and set the framework for understanding later patterns of natural and anthropomorphic disturbances.

The GLO observations closely reflect soil morphology data confirming that prairie and forests dominated the land surface since the last glacial episode. At higher elevations in the watershed (cf. Figure 5), GLO surveyors described nearly level to gently sloping prairie dominated by grasses such as big bluestem and many species of wildflowers (Figure 8). Hardwood forests dominated by oak, hickory, and maple covered steep

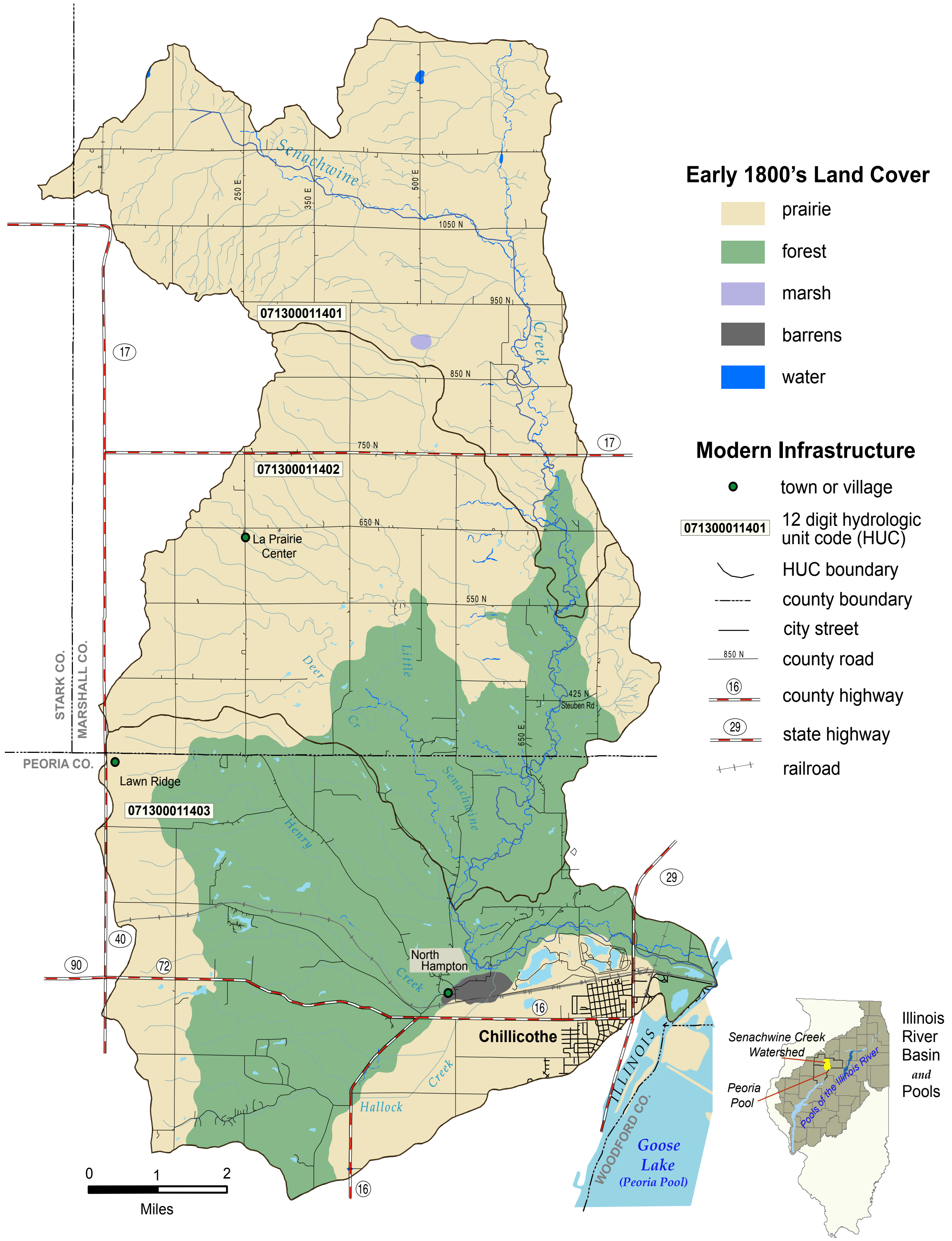


Figure 8. Early Europeon Settlement land cover reported by General Land Office surveyors in the early 19th Century. Data from Szafoni et al. (1998)

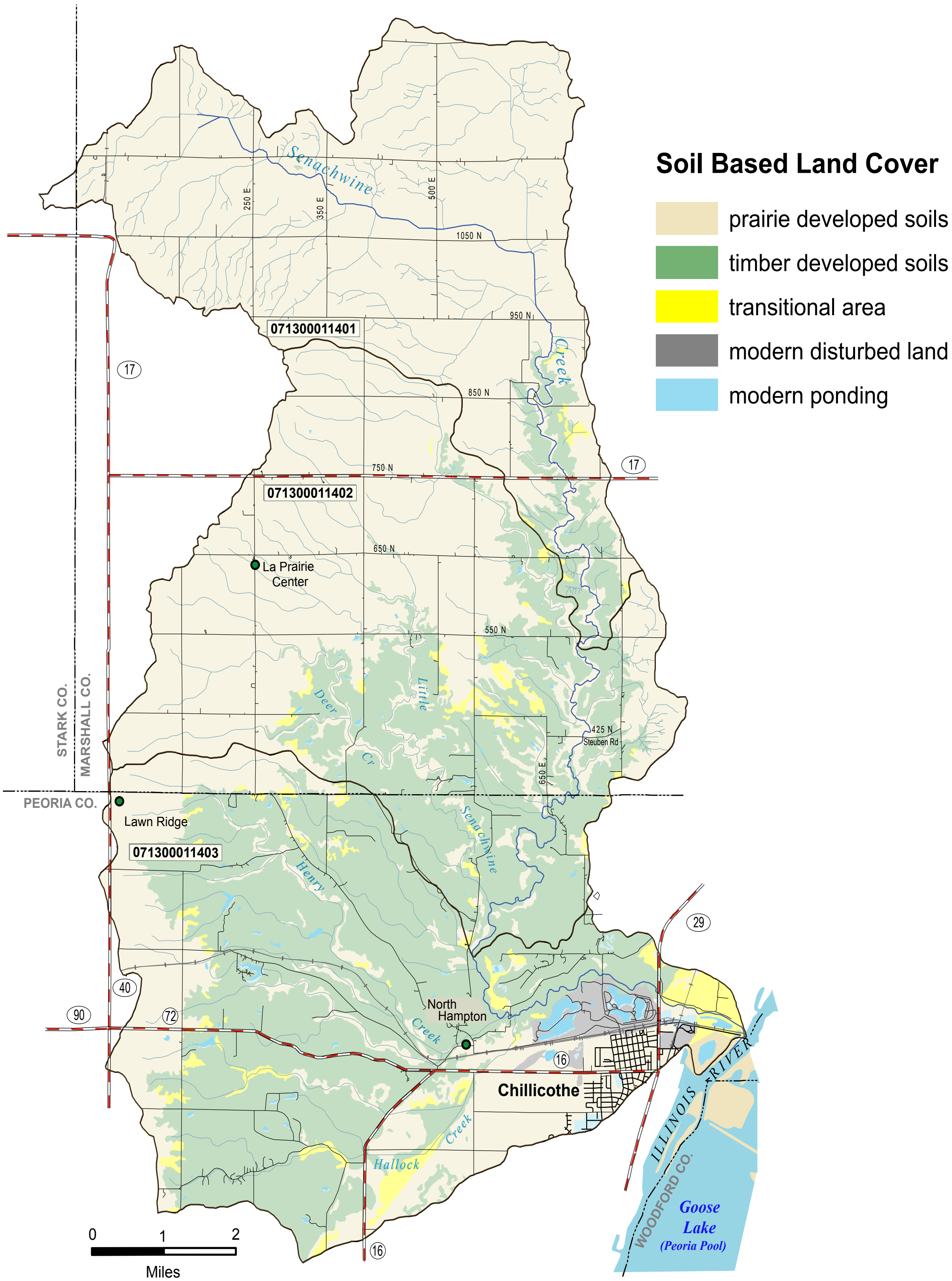


Figure 9. Soils-based land cover in the Senachwine Creek watershed, compiled using color as described in the Key to Illinois Soils (Windhorn, 2005)

uplands and much of the lower elevation floodplains of Senachwine Creek and its tributaries in the southern portion of the watershed.

3. Cultural Setting

a. Population

Early settlement was sparse. Joliet and Marquette documented an Algonquian Indian settlement on the banks of Upper Peoria Lake in 1673. Although there may have been very early intermittent French settlements in Senachwine Creek watershed, the first permanent European settlers probably arrived in 1829 in what would become Marshall County ten years later (NRCS, 1997).

Today, Senachwine Creek watershed is mainly rural. Urban development is limited to Chillicothe (population ~ 6,000). Nearby Woodford County's population has grown 70% since World War II, but overall, the area has grown at almost half the rate as the state as a whole since 1870 (IDNR, 1998d). The Illinois River Bluff Assessment Area, including Senachwine Creek watershed, is part of the Tri-County Peoria metropolitan area. Suburban development is occurring in these uplands (Figure 10) as population expands beyond Peoria.

b. Political Boundaries

Senachwine Creek watershed occurs in both Peoria and Marshall Counties and is subject to local county ordinances and local municipal laws. County engineers and township road commissioners would be interested in stream channel work because the watershed has 207 bridge crossings and fords.

c. Nongovernment Organizations

Some nongovernment organizations (NGOs) operate or have interest in Senachwine Creek watershed. A complete list of the involved NGOs is in Table 2. (More detailed contact information for each of these NGOs is found in Appendix B). For this report a non-governmental organization (NGO) is defined in one of five categories. The first (I) are private not-for-profit volunteer groups with focused interests in conservation issues, such as the protection and preservation of non-domesticated terrestrial or aquatic animals and plants; the Peoria Audubon Society or Peoria Wilds not-for-profits are examples. The second (II) are private not-for-profit groups with focused interests in conservation through developing

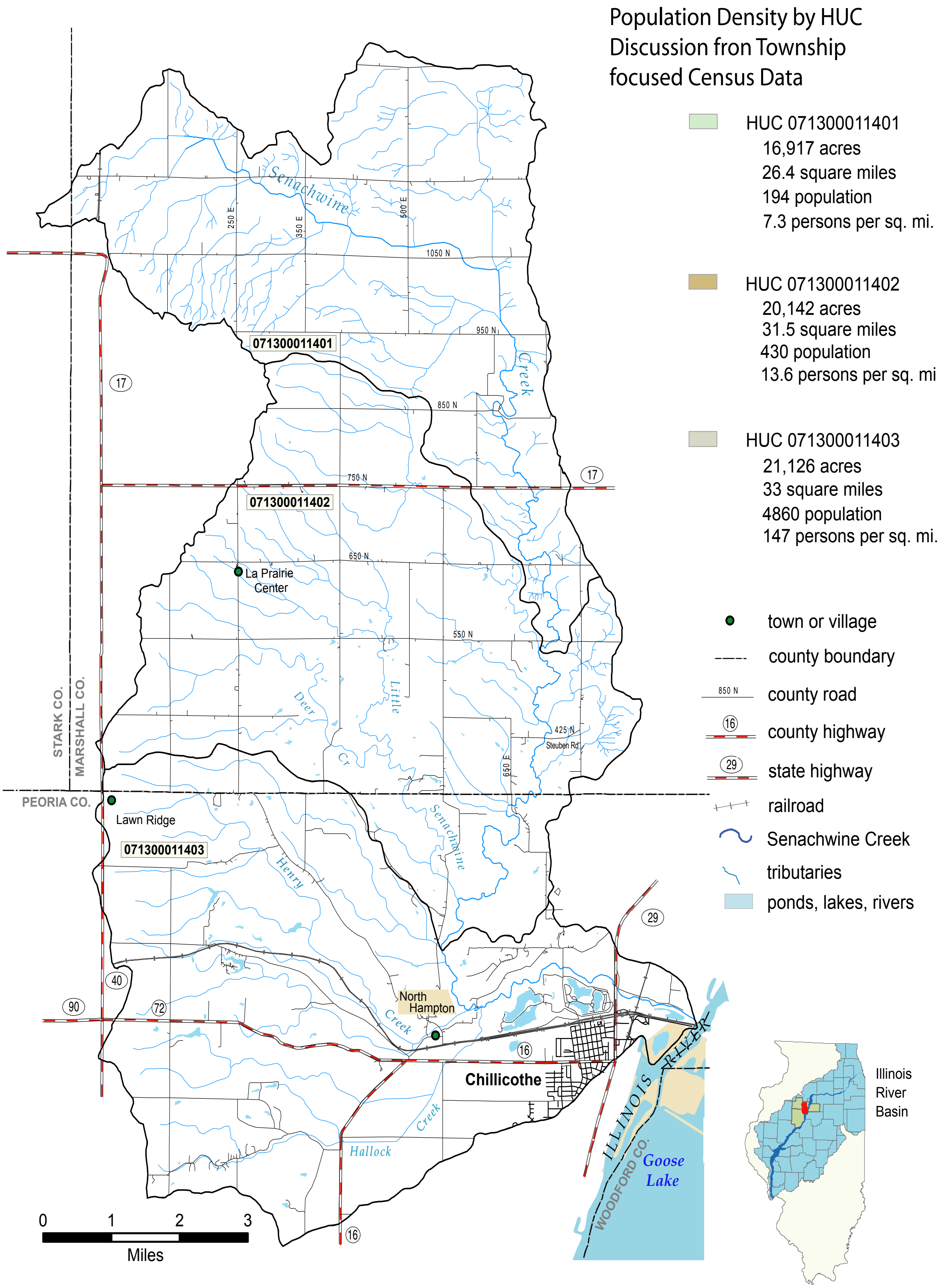


Figure 10. Population density in Senachwine Creek watershed

Non-govermental Organizations	Type*
American Eagle Foundation	I
Friends of the Illinois River	I
Heartland Water Resources Council of Central Illinois	I
Illinois River Bluffs Ecosystem Partnership	I
Illinois Stewardship Alliance	I
Living Upstream - Peoria Chapter (The Sun Foundation)	I
Peoria Audubon Society	I
Peoria Wilds not-for-profit Volunteers	I
Prairie Rivers Network	I
Sierra Club - Heart of Illinois Group	I
The Nature Conservancy - Peoria Office	I
Trees Forever - Illinois Buffer Partnership	I
Ducks Unlimited - Central Region	II
Peoria BassMasters	II
Pheasants Forever - Illinois River Valley Chapter	II
Tri-County Riverfront Action Forum Inc	III
Chillicothe Chamber of Commerce	III
Chillicothe Historical Society	III
Marshall-Putnam Farm Bureau	III
Peoria County Farm Bureau	III
Chillicothe Independent	IV
Illinois American Water Co Peoria District	IV
BP Pipeline North America, Inc	IV
Buckeye Partners, L.P.	IV
Ameren/CILCO & Central Illinois Light Co	IV
National Great Rivers Research and Education Center	V
Bradley University, Dept. of Biology	V
Senachwine Creek Watershed	UKN

Table 2. NGO stakeholders in the Senachwine Creek watershed

and maintaining habitat that support sporting fowl to preserve a hunting heritage; Pheasants Forever - Illinois River Valley Chapter is one example. Organizations in these two categories can provide significant funding, passionate advocacy, and reliable volunteer staffing (Tharp 2005).

The third category (III) contains special interest groups with members that have significant monetary (IL Farm Bureau) or social investment (Chillicothe Historical Society) in the watershed. Interest groups with members having significant monetary investments in commercial lands (agriculture) or infrastructure (pipelines) can bring considerable influence on legislation that affects environmental issues and watershed health. For example, legislation introduced in the Illinois General Assembly (February 2007 – Illinois HB613) amends the *Private Sewage Disposal Licensing*

Act and the *Environmental Protection Act* to require every owner of a discharging private sewage disposal system (designed to treat less than 1,500 gallons per day) that has a discharge to the surface of the ground that enters waters of commerce, the navigable waters of the State, or surface waters that are tributary to the navigable waters of the State, to file a permit application with the Environmental Protection Agency to allow regulation of the system under the blanket National Pollutant Discharge Elimination System permit (to read full text of HB0613 go to http://www.ilga.gov/legislation/95/HB/PDF/09500HB0613lv.pdf). This legislation has the potential to affect all rural and suburban property owners in this watershed and the Illinois Farm Bureau issued an action alert to bring the legislation to the attention of the rural community (Illinois Farm Bureau discussion at http://www.ilfb.org/viewdocument.asp?did=13128). Other special interests groups active in the watershed are working to develop tourism (Chillicothe Chamber of Commerce) or working to preserve archeological artifacts to better document the rich historical heritage of this area (Chillicothe Historical Society).

The fourth (IV) are private enterprise (for profit) operating in the watershed. These companies have significant interest in infrastructure such as power lines, substations, pipelines, and delivery/storage terminals (see Industrial Areas and Pollution Potential discussion). The fifth category (V) includes educational institutions that are located near the watershed or educational institutions that do research or fund research in the Illinois River Valley around the watershed.

d. Government Agencies

State, county, and local government agencies that have program interest or regulatory responsibilities in this watershed are listed in Table 3. (More detailed contact information for each of these government agencies is found in Appendix B)

e. Government Officials

Governmental offices and entities at local, county, state and federal levels that represent the watershed are listed in Table 4. ((More detailed contact information for each of these government officials is found in Appendix B)

f. Other Stakeholders

Other stakeholders include a local historical society and the IRVCG. The inactive Saratoga Drainage District and was established in June 1921 and

Government agencies	Type*
Chillicothe Park District	L
City of Chillicothe - Economic Development	L
Peoria Park District	L
Tri-County Regional Planning Commission	C
Marshall-Putnam Cty Soil and Water Conservation District	C
Peoria County Soil and Water Conservation District	C
Marshall- Putnam County Farm Service Agency	C
Peoria County Farm Service Agency	C
Marshall-Putnam River Conservation District	C
Illinois Nature Preserve Commission Area 4	S
Illinois Nature Preserve Commission Area 5	S
IDNR Region 1 Forester	S
Illinois River Coordinating Council	S
Illinois Department of Transportation	S
Upper Mississippi River Basin Association	S
Illinois Attorney Generals' Office	S
Illinois Environmental Protection Agency	S
US Fish and Wildlife Service -National Fish Habitat Initiative	F

* Government Level: L = Local, C = County, S = State, F = Federal

Table 3. Government agency stakeholders in the Senachwine Creek watershed

Government Officials	Type*
Mayor Office Chillicothe, Illinois	L
Marshall County Board	C
Peoria County Board	C
State Representative David Leitch	S
Congressman Ray LaHood	F
Senator Richard Durbin	F
Senator Barack Obama	F

* Government Level: L = Local, C = County, S = State, F = Federal

Table 4. Government officals who are stakeholders in the Senachwine Creek watershed

covered 1,824 acres. It was near Senachwine Creek mainstem's northwestern drainage divide between Camp Grove and Broadmoor, but its boundary appears to be just outside of Senachwine Creek watershed. Likewise, the inactive Whitefield-Saratoga Drainage District was established in June 1925, covered 1,375 acres 5 miles directly east of the Saratoga Drainage District just outside the watershed's northeastern drainage divide. It is not known whether these drainage districts will remain inactive. No other drainage districts are known to exist in or near Senachwine Creek watershed.

4. Current Land Cover and Land Use

a. Current Land Cover

Existing land cover (Figure 11) was simplified from IL-GAP (2001) to give a synoptic view of the watershed within the format of this report. Senachwine Creek watershed is predominantly in row-crop agriculture with a much smaller area of scattered rural grasslands and upland/ravine forests. Winter wheat accounts for a small portion of overall acreage. Statistics (Table 5) derived from IL-GAP (2001) were obtained from the Illinois Department of Agriculture (http://www.agr.state.il.us/gis/stats/landcover/index.htm). Urban development is limited. Chillicothe (population ~6,000) is the largest town, but suburban development is occurring, particularly in the uplands and along forested bluffs in the lower, steeper portion of the watershed.

Data for each HUC (Figures 12–14) within the watershed are shown at original scale (IL-GAP, 2001). Almost the entire HUC 401 (98%, Table 5) is in corn and bean production (Figure 12). Grassland and forest generally are limited to narrow bands along stream courses, but a riparian corridor widens abruptly downstream of County Road 950 N.

Row-crop agriculture is also the predominant land cover of HUC 402 (Figure 13). Forested land occurs along stream valleys as the stream descends the bluff (Figure 6). Floodplain forest wetlands comprise a small portion of watershed land cover but a significant portion of forest cover (Table 5).

There are two distinct landscapes in HUC 403: steeply sloped areas along the bluff line and lower relief areas in the Illinois River floodplain (Figure 14; Table 5). Steeper slopes mark areas that Senachwine Creek mainstem and its tributaries incised into the Tiskilwa Till Plain. Valley walls in the incised Tiskilwa Till Plain are predominantly forested, whereas less dis-

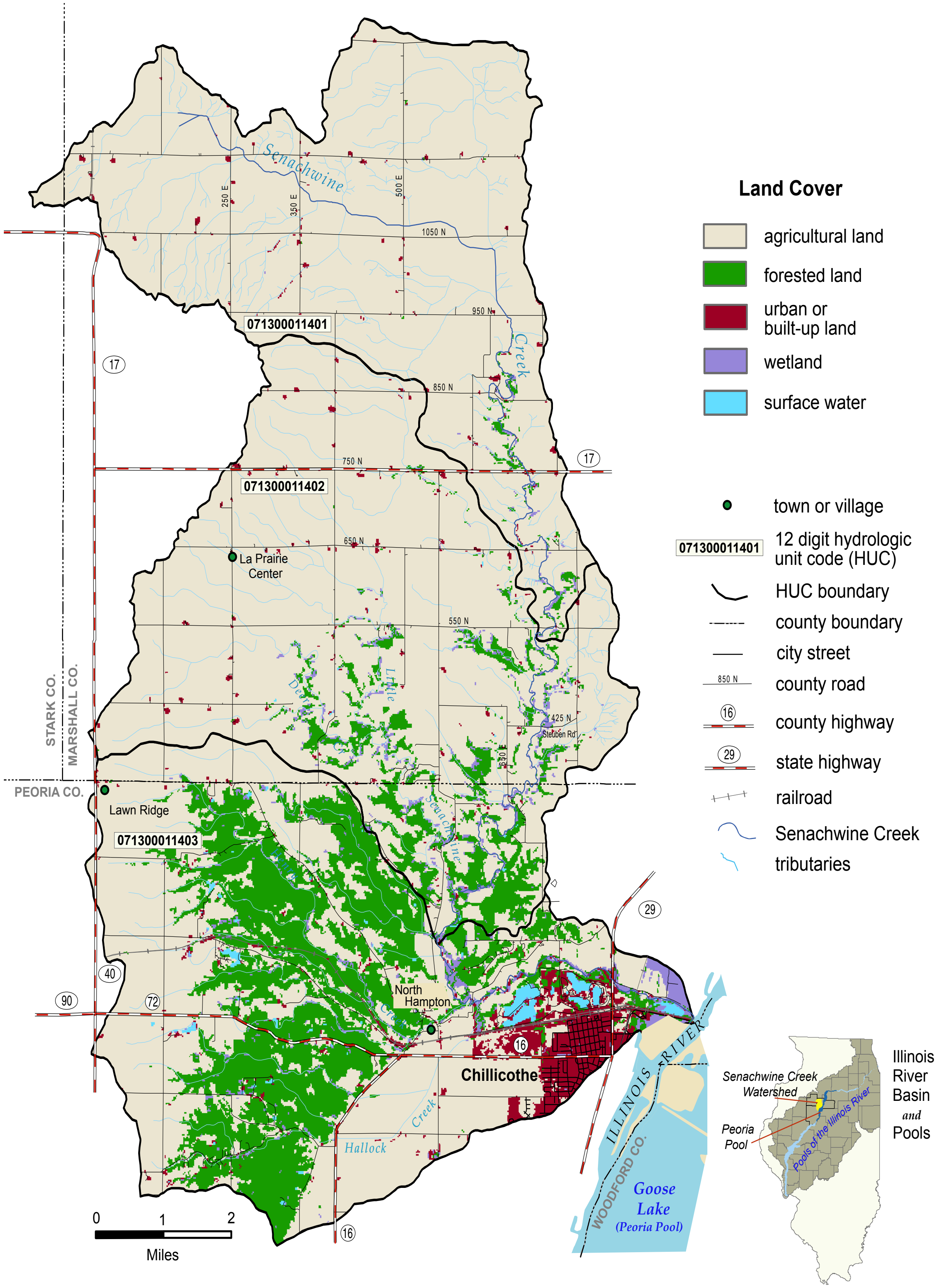


Figure 11. Land Cover of Senachwine Watershed (Illinois GAP Analysis Program, 2001)

GAP Land Cover Category	Statistics for LC*			Statistics for HUC 401			Statistics for HUC 402			Statistics for HUC 403*		
	Acres	Sq. Mi	Percent	Acres	Sq. Mi	Percent	Acres	Sq. Mi	Percent	Acres	Sq. Mi	Percent
Agricultural Land	**46348**	**72.44**	**79.73**	**16576**	**25.91**	**98.14**	**17917**	**28**	**88.9**	**11832**	**18.49**	**56.04**
corn	19041	29.76	32.76	7907	12.36	46.82	7172	11.21	35.59	3953	6.18	18.72
soybeans	19099	29.85	32.85	7438	11.63	44.04	7606	11.89	37.74	4045	6.32	19.16
winter wheat	60	0.09	0.1	23	0.04	0.14	35	0.05	0.17	2	0	0.01
small grains and hay	574	0.9	0.99	0	0	0	19	0.03	0.09	555	0.87	2.63
winter wheat/soybeans double cropped	30	0.05	0.05	26	0.04	0.16	3	0	0.02	0	0	0
other agriculture	32	0.05	0.05	0	0	0	1	0	0	31	0.05	0.15
rural grassland	7512	11.74	12.92	1181	1.85	6.99	3081	4.82	15.29	3246	5.07	15.38
Forested Land	**8846**	**13.83**	**15.22**	**132**	**0.21**	**0.78**	**1685**	**2.63**	**8.36**	**7030**	**10.99**	**33.29**
dry upland forest	796	1.24	1.37	0	0	0	110	0.17	0.55	687	1.07	3.25
dry-mesic upland forest	6572	10.27	11.3	46	0.07	0.27	1203	1.88	5.97	5323	8.32	25.21
mesic upland forest	888	1.39	1.53	28	0.04	0.16	224	0.35	1.11	637	1	3.02
partial canopy/savannah upland	580	0.91	1	59	0.09	0.35	147	0.23	0.73	374	0.58	1.77
coniferous	10	0.02	0.02	0	0	0	1	0	0.01	10	0.01	0.05
Urban and Built-up Land	**1572**	**2.46**	**2.7**	**105**	**0.16**	**0.62**	**151**	**0.24**	**0.75**	**1320**	**2.06**	**6.25**
high density	676	1.06	1.16	96	0.15	0.57	137	0.21	0.68	442	0.69	2.09
low/medium density	512	0.8	0.88	8	0.01	0.05	14	0.02	0.07	493	0.77	2.34
urban open space	384	0.6	0.66	0	0	0	0	0	0	385	0.6	1.82
Wetland	**1063**	**1.66**	**1.83**	**65**	**0.1**	**0.38**	**371**	**0.58**	**1.84**	**632**	**0.99**	**2.99**
shallow marsh/wet meadow	31	0.05	0.05	0	0	0	5	0.01	0.03	26	0.04	0.13
deep marsh	2	0	0	2	0	0.01	1	0	0	0	0	0
seasonally/temporarily flooded	108	0.17	0.19	0	0	0	4	0.01	0.02	106	0.17	0.5
wet-mesic floodplain forest	493	0.77	0.85	26	0.04	0.16	148	0.23	0.73	321	0.5	1.52
wet floodplain forest	419	0.65	0.72	36	0.06	0.21	207	0.32	1.03	176	0.27	0.83
shallow water	9	0.01	0.02	0	0	0	6	0.01	0.03	2	0	0.01
Other	**303**	**0.47**	**0.52**	**0**	**0**	**0**	**10**	**0.02**	**0.05**	**293**	**0.46**	**1.39**
surface water	303	0.47	0.52	0	0	0	10	0.02	0.05	293	0.46	1.39
Watershed Analysis Totals	**58132**	**90.86**	**100**	**16878**	**26.38**	**100**	**20134**	**31.47**	**100**	**21106**	**32.99**	**100**

*Statistics calculated using data extracted from IL GAP Analysis Land Cover grid in ArcMap ; see also http://www.agr.state.il.us/gis/pass/gapdata/#mapping

Table 5. Land cover statistics of Senachwine Creek Watershed

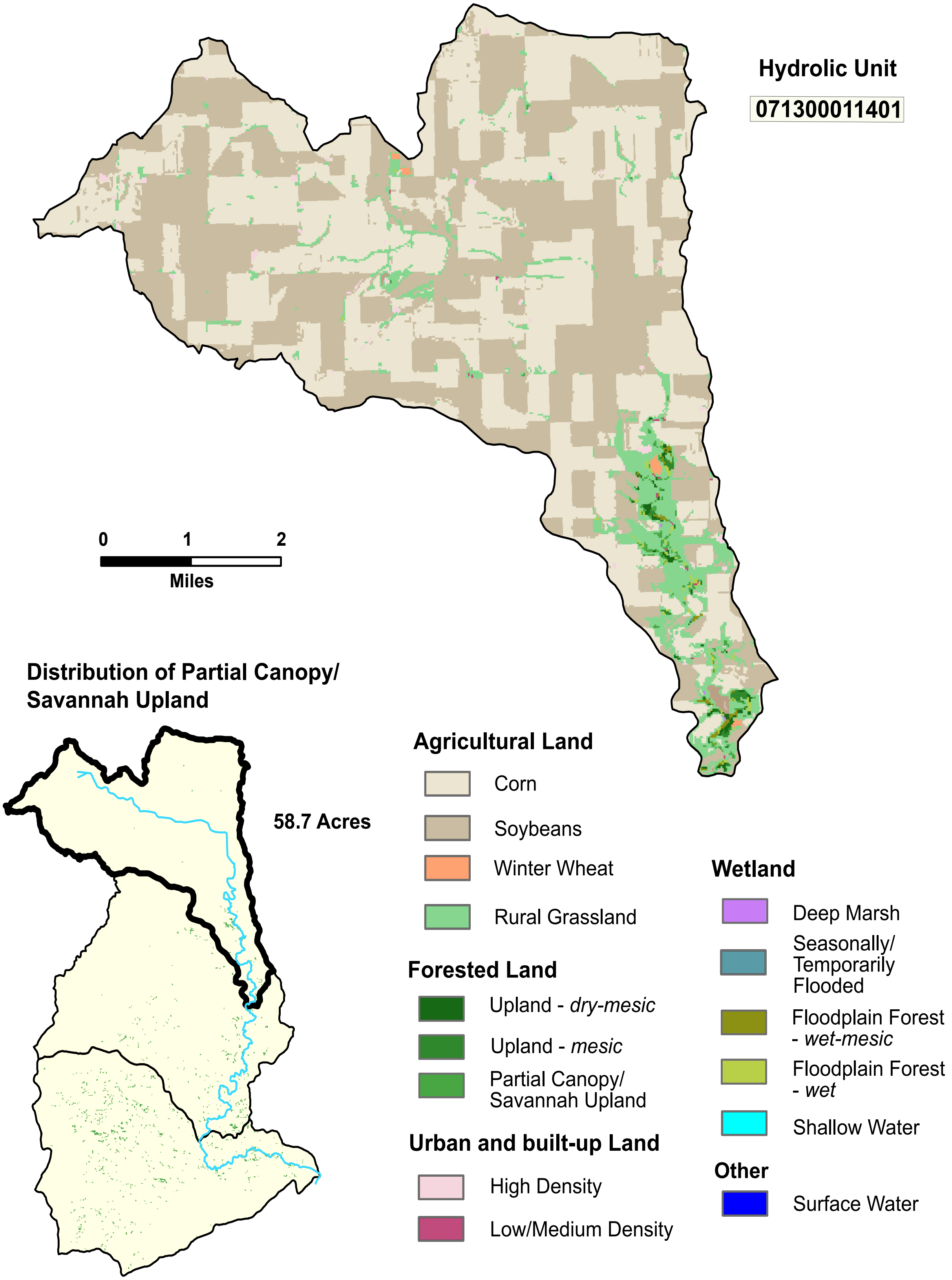


Figure 12. Land Cover of HUC 071300011401 of the Senachwine Creek watershed (Illinois GAP Analysis Program, 2001)

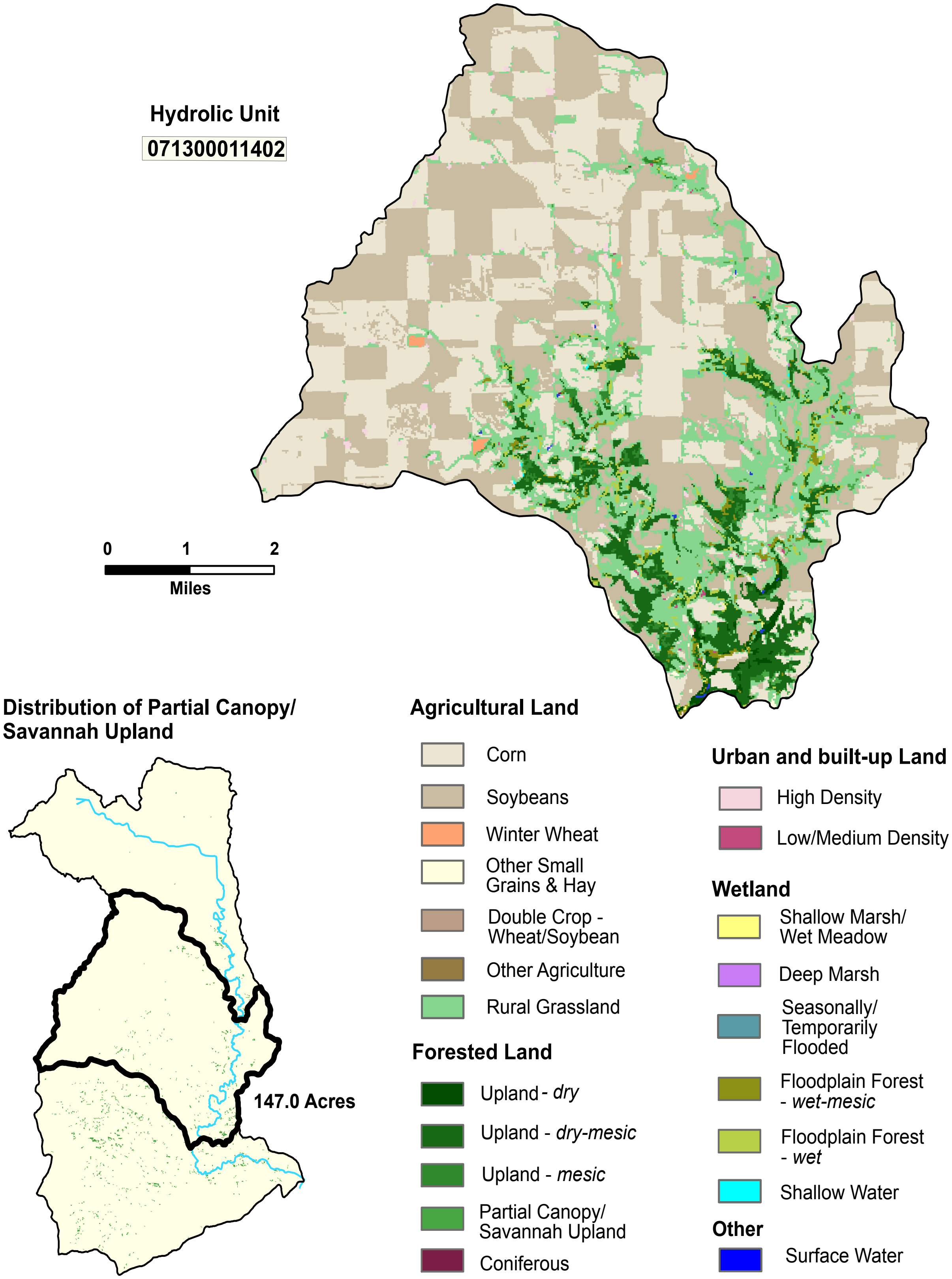


Figure 13. Land Cover of HUC 071300011402 of the Senachwine Creek watershed extracted (Illinois GAP Analysis Program, 2001)

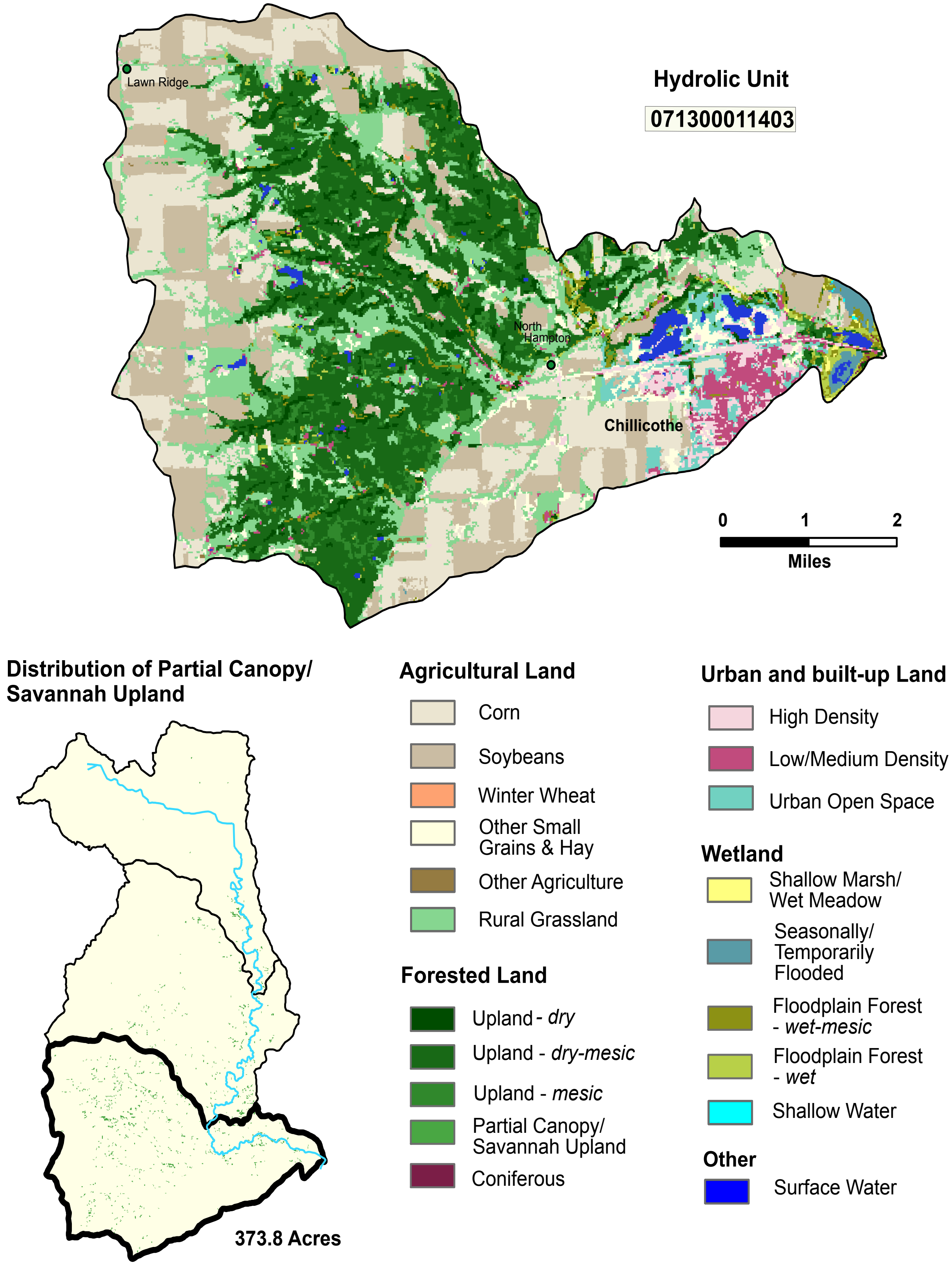


Figure 14. Land Cover of HUC 071300011403 of the Senachwine Creek watershed (Illinois GAP Analysis Program, 2001)

sected areas on the till plain and in the Illinois River floodplain are largely used for row-crop agriculture. Rural grassland occurs mainly at fringes of forested land on moderate slopes, along water courses, and in patches up to several acres in size across Post-glacial Floodplain and Outwash Terrace regions. Most existing wetland area in the watershed also occurs within the Illinois River valley, mainly near the mouth of Senachwine Creek mainstem in and around the Marshall State Fish and Wildlife area. Abandoned aggregate mines northwest of Chillicothe are classed as surface water, urban open space, and other urban categories.

b. Current Landuse

i. Urban Areas and Impervious Surfaces

The buried bedrock surface slopes down towards the narrow and deep Wyoming bedrock valley that trends subparallel to Henry Creek. In this location, the total drift thickens down the slope of the valley as well. This valley and its sediment fill are important for watershed assessment and represent the only groundwater source for residential or other development within the watershed. The Wyoming valley thus may define the region of most likely future development. Recent residential development beyond valley boundaries must rely on ponds and trucked or piped water (Andrew Stumpf, Illinois State Geological Survey (ISGS), Personal Communication, 2006). Rapid development is occurring in forested bluffs within this area.

ii. Public Lands with Ecological Designations

These areas include:

- Illinois River Bluffs Assessment Area

The Illinois River Bluffs Assessment Area was developed by the IDNR as part of the Conservation 2000 Ecosystem Partnerships programs (http://dnr.state.il.us/orep/c2000/assessments/Illinois_river_bluff/pagei.htm). The Illinois River Bluffs begins near Hennepin and ends at the southern end of Peoria Lake at East Peoria. Senachwine Creek mainstem is one of many tributaries that drain into this stretch of the river. These local tributaries drain nearly 561,000 acres in west central Illinois. The area includes most of Marshall and Woodford counties as well as small portions of Stark, Bureau, La Salle, Tazewell, Putnam, and Peoria counties. The Illinois River Bluffs marks the furthest reach of the massive glaciers that crept from the north and east during the most recent ice age. The rugged local topography supports a rich variety flora and fauna, such as a mix of woodland, savanna, and prairie and 16 species of birds that are officially recognized as threatened or endangered in Illinois (IDNR a, b c and d).

- Peoria Wilds

Senachwine Creek watershed also occurs within the RRA called Peoria Wilds (http://www.inhs.uiuc.edu/cwe/rra/site13.html). Peoria Wilds encompasses the floodplain of the Illinois River, deeply dissected bluffs and hills bordering the floodplain, and relatively flat agricultural areas away from the river (Figure 3). A large tract of forest runs along the bluff west of the Illinois River. Nonforested wetlands are concentrated next to the river. Several hill prairies in this area have been included in the Illinois Natural Areas Inventory. Sun- and wind-exposed west- and southwest-facing slopes of hill prairies create a harsh environment more suited to prairie than forest.

- Natural Areas

Peoria Wilds RRA includes 24 natural areas of woodlands, hill prairies, marshes, fens, seeps, and the Marshall County Conservation Area Hill Prairies. Few hill prairies have been plowed because of their steep slopes, but they are sometimes grazed. The Senachwine Creek watershed has no known hill prairies but does have two Natural Areas: the 21-acre Hatcher Woods and 41-acre Leigh Woods (Figure 15).

- Biological Stream Characterization

Senachwine Creek Mainstem is listed as a Class B stream (Figure 16; See Biotic Environment; Section V. A. 6). Class B streams are a highly valued aquatic resource with good fisheries for important gamefish species.

- 303(d) Streams

None of the streams in the Senachwine watershed were listed as impaired in the Illinois Integrated Water Quality Report and Section 303(D) List for 2006 (IEPA, 2006a). Other reports characterizing the watershed and its needs are lacking.

- Nature Preserves

Only one nature preserve exists in the watershed, the 2.5-acre Root Cemetery Savanna (Figure 15) near Northampton in Hallock Township. This

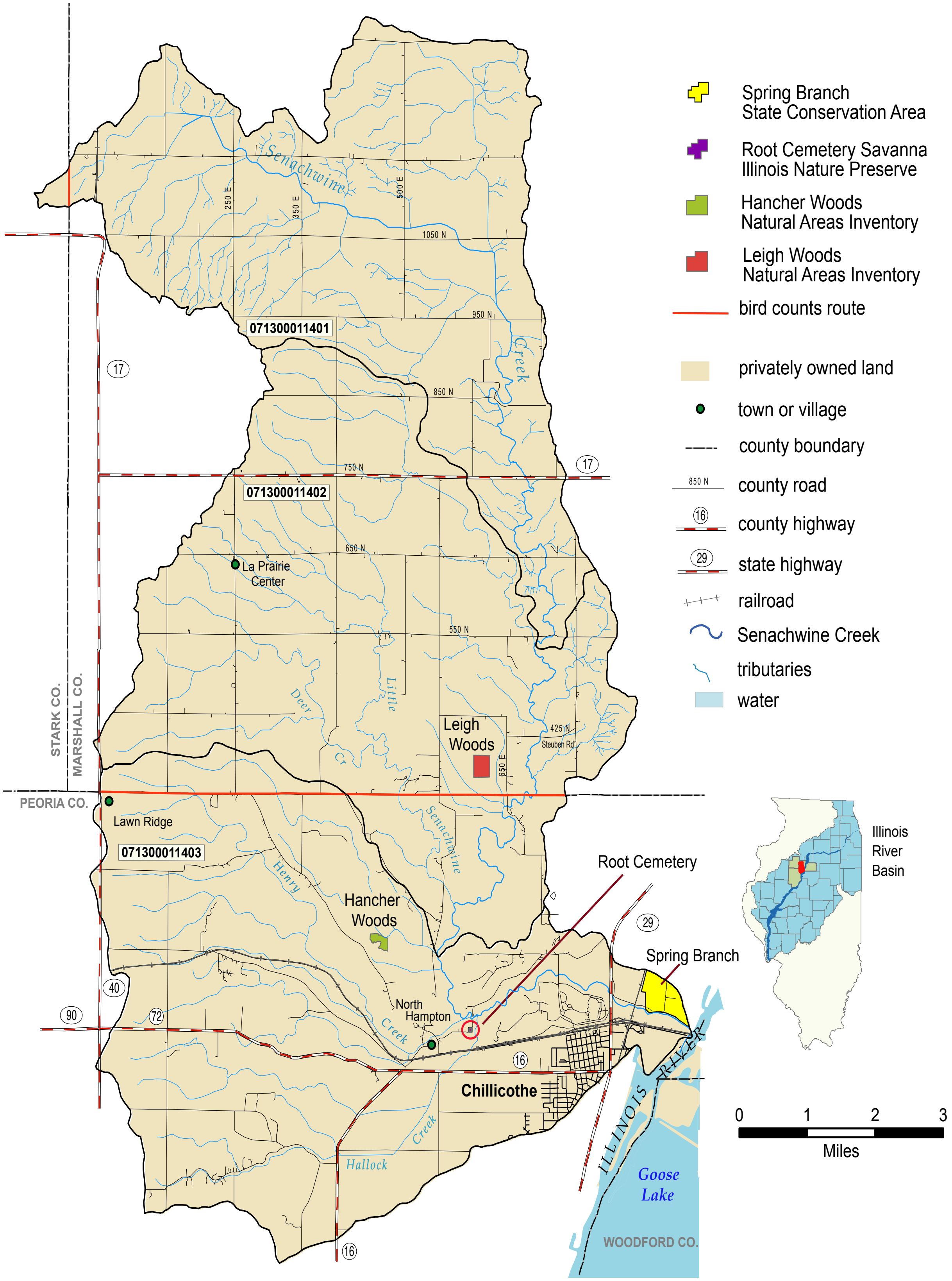


Figure 15. Public managed lands in Senachwine Creek watershed showing natural areas (Illinois Geospatial Data Clearinghouse, 1998-1999)

Figure 16. Biological Stream Characterization: The Senachwine Creek mainstem is designated regionally as a Class B stream: a Highly Valued Aquatic Resource (Bertrand et al., 1993)

preserve, dedicated in February 1994, is a mesic savanna of the Illinois River Section of the Upper Mississippi and Illinois River Bottomlands Natural Division. For further information about this sensitive site, contact the Illinois Nature Preserves Commission (217/785-8686).

- State Fish and Wildlife Areas

Nearby, the Marshall State Fish and Wildlife Area occurs in the Illinois River Floodplain. The IDNR Spring Branch Conservation Area is adjacent to the mouth of Senachwine Creek in Upper Peoria Lake on the north side of Chillicothe (Figure 15).

- Threatened and Endangered Species

The Senachwine Creek landscape is highly disturbed. Softleaf Arrowwood; (Viburnum molle) is a threatened and endangered species only found at the two designated natural areas, Hancher Woods and Leigh Woods (Figure 15).

5. Abiotic Environment

a. Geologic Setting

i. Bedrock Geology

Pennsylvanian age sedimentary rocks underlie the Senachwine Creek watershed in layers of interbedded shale, clay, sandstone, limestone, and coal in approximate order of abundance (McKay et al., in review). Shale tens of feet thick predominates, whereas limestone, coal, and clay tend to be only a few feet thick.

Based on ISGS field investigations (Figure 17), the glacier that formed the Providence Moraine (Figure 5) eroded the pre-existing landscape of the northern half of Senachwine Creek watershed to bedrock. Subsequent glacial and proglacial deposits comprise a generally thin drift cover. Bed rock is near or at the surface in approximately the northern half of the watershed. There are bedrock outcrops at elevations of 590-600 feet north of Chillicothe along the Illinois River bluffs to the east and near the bluff line of Gilfillan and Hallock Creek valleys (McKay et al., in review; Stumpf, in review). The buried bedrock surface slopes down towards the narrow and deep Wyoming bedrock valley that trends sub-parallel to Henry Creek; the total drift thickens commensurately. The occurrence of this valley is important for watershed assessment because its sedimen-

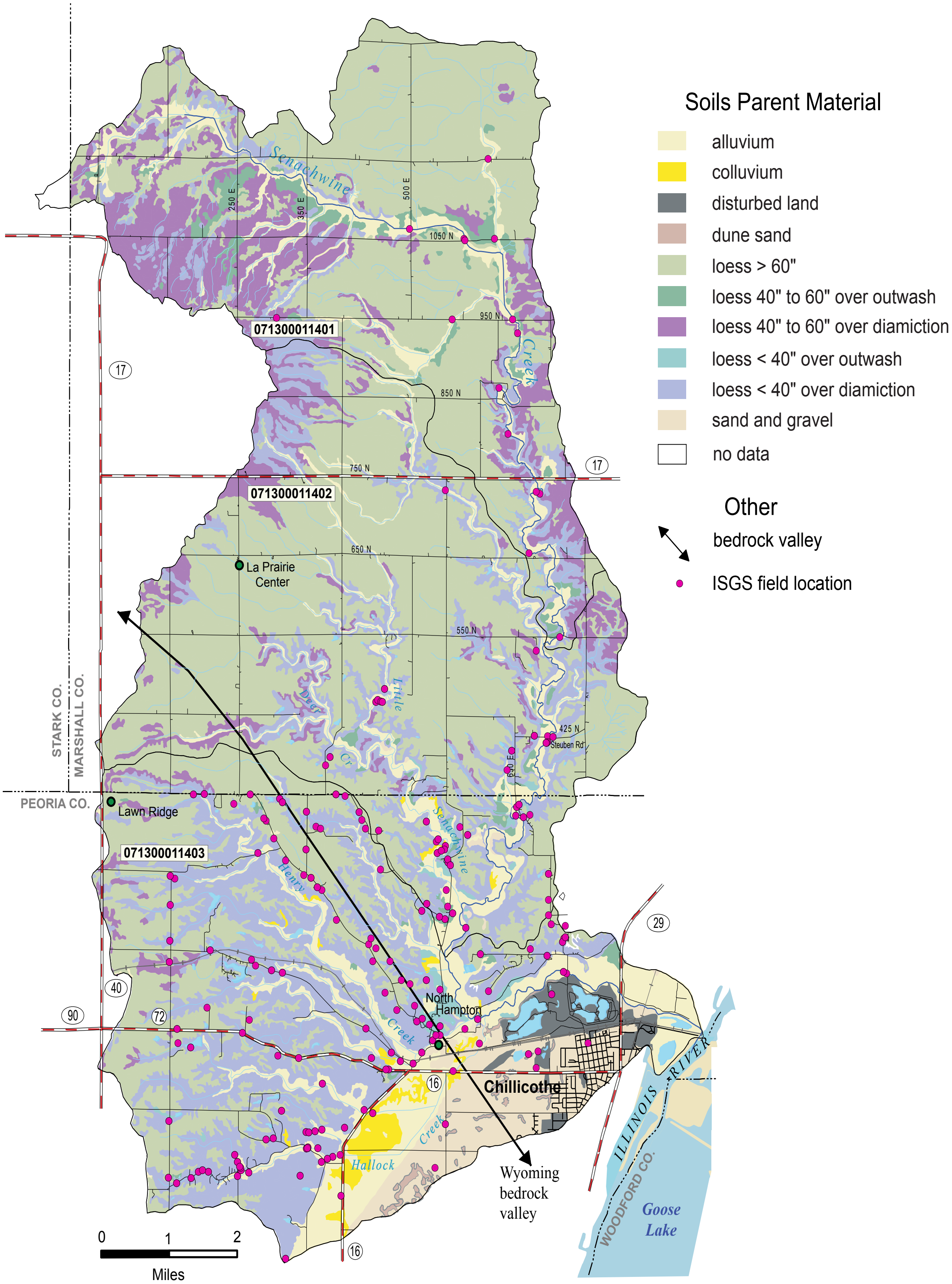


Figure 17. Soils parent material and ISGS field observation sites in the Senachwine Creek watershed. Compiled from USDA NRCS soil surveys for Marshall (NRCS 2002), Peoria (NRCS 1992) and Stark (NRCS 1996) Counties.

tary fill comprises the only groundwater source for residential or other development within the watershed. Recent residential development beyond valley boundaries must rely on ponds and trucked or piped water (Andrew Stumpf, ISGS, Personal Communication, 2006).

The Wyoming valley may thus define the region of most likely future development. Upstream of approximately County Road 700 N to County Road 950 N, the stream is incised into bedrock, typically shale outcrops up to 10 feet above the channel bottom in one or both channel walls. Where underlying rock is relatively erodible shale, the channel substrate comprises a veneer up to several feet thick of alluvial sediments over bedrock. Occasionally rock outcrops form ledges in the creekbed where underlying rock is relatively resistant sandstone and limestone. Further upstream (County Road 950 N to approximately County Road 500 E), shale fragments are common in the subsurface till. This suggests bedrock near the surface because glacial ice rapidly pulverizes shale. Bedrock appears to deepen in Lower Senachwine Creek mainstem, although large blocks of shale and limestone can be found as inclusions in till outcrops.

Bedrock tends to inhibit erosion, although erosion continues to occur as evident from several steep banks along the creek at the base of the eastern valley wall. Where the creek is incised into the rock, that is, where rock outcrops occur in both channel walls, the channel planform and channel cross section are relatively stable. Where the rock is exposed in the channel bed, however, stream power may enhance lateral migration. It was not possible to confirm this correlation in this limited study, however.

ii. Surficial Geology

The moraines, which border the Senachwine Creek watershed, were formed by the Wisconsin Episode glacier (Figure 5). The Providence Moraine, which comprises the western watershed divide, was deposited about 20,000 radiocarbon years ago (Hansel and Johnson, 1996). The Eureka Moraine, which comprises the eastern watershed divide, was deposited between about 15,500 and 18,500 radiocarbon years ago.

The entire upland surface is covered by 8-12 feet of loess where it is not eroded away. Loess probably comprises the main source of sediment in overland flow (Figure 17; cf. Stumpf, in review). Silt tends to be transported easily so sediment moves out of the watershed and deposits in the lower energy environment of Peoria lakes. The upper watershed is underlain by till and ice-contact deposits of the Tiskilwa, Lemont, and Equality Formations (Lineback, 1979). A region of fine glacial lake sediment (Equality Formation) shown on the statewide map (Lineback, 1979) was mapped by geomorphic expression of a very low sloping area between moraines. The landform is covered by thick loess (>5 feet), but subsurface materials cannot be confirmed with existing borehole data. A cutbank just north of County Road 1050 N contained ~5.5 feet of interbedded, soft, laminated to massive silt, fine to medium sand, and silty clay capped by loess (Figure 17). Below the creek level was soft, massive, fine pebbly silt. This sequence appears to represent alluvial sedimentation with seasonal lake sedimentation filling in the true glacial lake basin below creek level. The sequence thus may comprise a source of erodible fine sediment that Senachwine Creek mainstem erodes through channel incision. In the middle reach, the floodplain comprises ~7 feet of fine stream sediment (silty clay to silt loam) over ~8 feet of coarse stream sediment (fine sand to gravel), possibly glacial outwash. Approximately, the lower 7 kilometers (km) of Senachwine Creek mainstem flows through Illinois River terrace and floodplain before emptying into the Illinois River. Cahokia and Henry Formations underlie this portion of the Senachwine Creek valley. Sand and gravel from these formations have been quarried extensively between Chillicothe and the Senachwine Creek mainstem. Drift thickness in the watershed ranges from 0 in the southern part of Hallock Township to 200 feet in the southeastern part of Marshall County (Piskin and Bergstrom, 1975). The thickest drift cover occurs over the Wyoming buried bedrock valley, described briefly above but in more detail below, which trends West North West-East South East under the western portion of the watershed (Herzog et al., 1994).

Two soils, the Jules and Paxico map units, stand out because they each contain an A horizon (rich organic topsoil) of up to 9 inches of calcareous silt loam over stratified C horizon (parent material) sediment (Figure 18). The Jules and Paxico map unit soils are positioned mainly on the floodplain of Senachwine Creek mainstem through the near-bluff region and on the Illinois River floodplain. Because calcite is readily lost during sediment transport and deposition and soils lack B horizons, their presence may indicate areas where cultivation of calcareous loess on slopes has caused rapid erosion and deposition in nearby floodplains. Areas immediately upstream of these soils should thus be examined more closely for potential upland remediation.

b. Hydrogeomorphic Setting

i. Aerial Reconnaissance

The aerial reconnaissance stream and watershed assessment tool used either a private or State of Illinois helicopter with a high-resolution, stabilized aerial camera and Global Positioning System (GPS) for aerial videomapping and rapid identification of potential restoration project sites. Low-level aerial

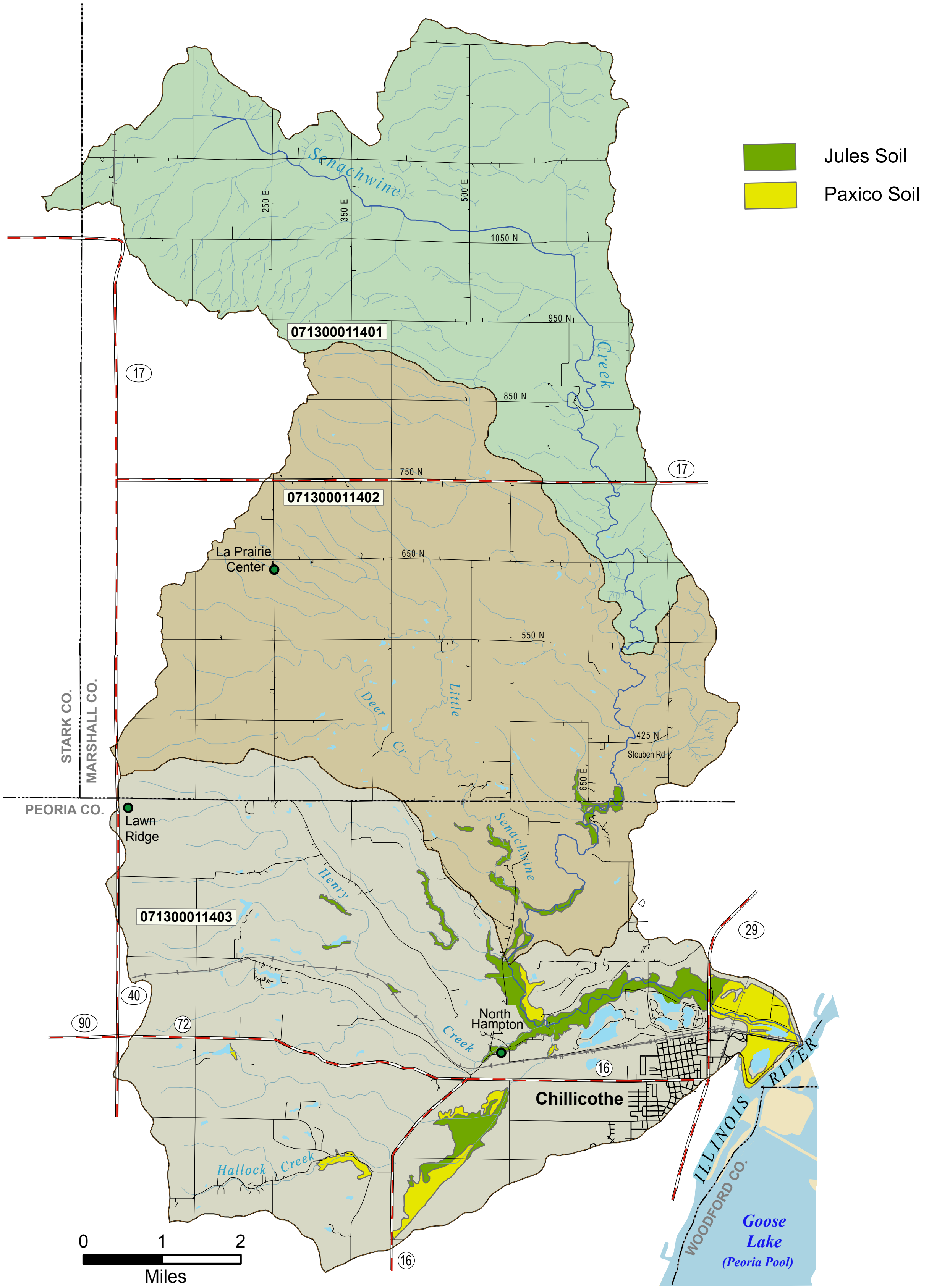


Figure 18. Occurrence of Jules and Paxico soils indicating recent floodplain deposition

surveys significantly help identify stable and unstable stream reaches using available technology. Although low-altitude aerial imagery cannot provide information on all sediment sources and disturbances, it, nonetheless, is an economical way for rapid reconnaissance to identify potentially significant problems in or near a channel that otherwise may not be recognized and addressed for years. Low-altitude aerial videomapping allows increased ability to see some channel and near-channel disturbances or sediment sources and possibly help identify some causative factors for channel morphology changes. After potential sites are identified, further analyses of 'still' panchromatic imagery and geomorphic and biologic field data help prioritize locations for design and construction of restoration work.

Aerial videomapping was conducted along 1292.04 miles (2079.18 km) of stream channels in the ILRB in spring 2004 and fall 2005 as a component of watershed and stream assessment efforts. A list of potential problem areas, including coordinates and a general description of the problem, was prepared for each channel system aerially surveyed in spring 2004, and a similar list is being compiled for channel systems overflown in fall 2005 and winter 2006 (Table 6). Further inspections both add and eliminate potential restoration sites based on intensive review of aerial features from historic panchromatic aerial photographs and geomorphologic field investigations. Data collected upstream and downstream of targeted sites to verify geomorphic history of the channel and near-channel environment, channel equilibrium conditions, and potential responses to restoration. Sites that continue to remain on the list for potential restoration will be monitored and analyzed further for project feasibility determinations. Those data will help managers with development of detailed restoration design, actual restoration, and performance evaluation.

Middle and lower reaches of Senachwine Creek mainstem were aerially surveyed for a rapid, synoptic view of general channel conditions and preliminary identification of potential project sites. Continuous video footage along the channel was obtained simultaneously along with synchronized GPS locations. Sites that appeared from the air to be unstable, (i.e., active sediment delivery to the stream channel from mass wasting, bank erosion, or bed incision, if detectable) were recorded and GPS coordinates marked. These sites were characterized further during field investigations generally described below in more detail. Potential project sites identified from the air are reported (Table 6). Considerable additional information on current channel and near-channel conditions could be interpreted from video footage after further, more detailed, data examination and analysis that would come later as part of a feasibility study.

Aerial reconnaissance of middle and lower sections of Senachwine Creek wa

Point	Video minutes	Longitude	Latitude	Description
1	1:05:27	89 27 49.33	40.55 48.71	Silt deposit
2	1:54:23	89 28 30.98	40 56 00.24	RB erosion
3	2:13:05	89 28 42.85	40 56 03.56	Riffle, sediment bar, tree debris
4	2:56:09	89 29 12.18	40 56 15.30	Stream bar
5	3:29:12	89 29 35.63	40 56 14.84	RB erosion near power line
6	4:11:16	89 29 59.30	40 56 25.04	Riffle, log debris
7	4:53:29	89 30 23.25	40 56 22.61	Riffle, mass wasting, log debris, bank erosion
8	5:00:21	89 30 28.06	40 56 15.71	RB erosion
9	5:18:05	89 30 38.35	40 56 16.45	Exposed pipe
10	6:08:05	89 30 51.74	40 56 13.60	Riffle, bank erosion
11	5:35:22	89 31 02.36	40 56 05.17	RB tree revetments
12	6:56:05	89 31 12.16	40 56 01.45	Riffle, bank erosion, cut off, knick point
13	7:08:11	89 31 32.26	40 55 56.06	Bank exposed pipeline
14	7:47:26	89 31 46.46	40 56 03.75	RB erosion
15	8:09:21	89 31 53.47	40 56 11.37	Bank erosion, log debris, riffle
16	8:29:04	89 31 48.41	40 56 21.29	LB erosion wide area
17	8:42:11	89 31 51.68	40 56 24.14	Break check
18	9:10:23	89 31 55.44	40 56 29.30	LB erosion
19	10:19:05	89 31 55.93	40 56 47.08	Knick point, riffle, mass wasting, bank erosion
20	10:28:05	89 31 43.36	40 56 54.49	Check riffle for structure
21	10:45:26	89 31 46.46	40 57 06.43	LB erosion ford upstream
22	11:10:01	89 31 45.32	40 57 11.15	Bank erosion, riffle, knick point
23	11:10:25	89 31 36.50	40 57 11.74	Check riffle break
24	11:28:23	89 31 29.64	40 57 12.23	LB erosion with building on edge of bank
25	11:40:13	89 31 24.90	40 57 12.85	Large break check
26	11:48:24	89 31 19.84	40 57 16.45	RB erosion
27	11:53:10	89 31 14.09	40 57 15.95	Bank erosion, riffle, knick point
28	12:17:02	89 31 09.72	40 57 18.81	Check LB for erosion and outcrop
29	12:45:21	89 31 03.35	40 57 26.13	Check break
30	12:51:08	89 30 57.13	40 57 30.49	Mass wasting erosion and break
31	13:20:25	89 31 02.48	40 57 34.94	Riffle, bank erosion, cut off
32	13:39:01	89 31 14.28	40 57 38.92	Check break
33	13:50:23	89 31 22.78	40 57 44.86	RB mass wasting
34	14:46:12	89 31 23.17	40 57 55.30	Riffle, bank erosion, mass wasting
35	14:48:10	89 31 20.66	40 57 59.38	Check break and LB

LB = Left Bank, RB = Right Bank

Table 6. Potential Project Sites Identified During Aerial Reconnaissance

Point	Video minutes	Longitude	Latitude	Description
36	15:29:20	89 31 02.84	40 57 49.59	Mass wasting
37	16:12:04	89 30 48.85	40 57 56.60	Riffle
38	16:40:23	89 30 48.98	40 58 07.20	LB erosion
39	17:28:08	89 30 50.59	40 58 16.49	Bank erosion, riffle
40	17:59:14	89 30 38.82	40 58 18.35	LB mass wasting
41	18:27:24	89 30 35.58	40 58 26.54	Bank erosion, riffle, knick point, mass wasting
42	18:55:25	89 30 27.23	40 58 20.23	LB mass wasting on bend about to be cut off
43	19:15:23	89 30 24.12	40 58 26.43	LB mass wasting
44	19:58:15	89 30 31.31	40 58 40.70	Bank erosion, riffle, log jam, beaver dam
45	20:51:03	89 30 22.00	40 58 58.80	LB mass wasting
46	21:17:03	89 30 19.23	40 59 05.98	Sediment bar, bank erosion, riffle
47	21:18:04	89 30 14.15	40 59 06.61	LB erosion
48	22:00:13	89 30 30.01	40 59 18.23	Beaver dam, bank erosion, riffle, log jam
49	22:13:28	89 30 27.22	40 59 25.21	LB erosion into field
50	22:59:23	89 30 26.56	40 59 36.63	RB erosion into field
51	23:10:24	89 30 15.32	40 59 39.48	LB active erosion trees in stream
52	23:30:15	89 30 09.02	40 59 41.22	LB erosion
53	23:55:03	89 30 08.44	40 59 46.82	Bank erosion, log debris, riffle
54	24:41:23	89 30 25.24	40 59 57.60	Check break RB erosion
55	24:57:20	89 30 23.11	41 00 04.30	LB erosion check
56	25:26:09	89 30 07.94	41 00 09.76	Riffle, bank erosion
57	26:12:08	89 30 16.24	41 00 17.83	RB slumping check
58	26:16:05	89 30 17.71	41 00 20.31	LB erosion
59	26:20:17	89 30 16.57	41 00 23.04	Erosion falling trees
60	26:33:24	89 30 10.84	41 00 25.27	LB erosion check
61	26:56:05	89 30 47.70	41 00 29.61	Bank erosion, riffle
62	28:08:24	89 30 14.93	41 00 54.06	LB mass wasting
63	28:58:02	89 30 23.17	41 00 07.24	Bank erosion, riffle
64	29:32:22	89 30 46.17	41 01 10.82	RB erosion minor check
65	30:00:00	89 30 44.39	41 01 20.75	Bank erosion, riffle
66	30:45:11	89 30 35.89	41 01 34.58	Bank erosion, riffle
67	30:59:08	89 30 38.15	41 01 42.73	RB erosion check
68	31:10:25	89 30 27.87	41 01 43.47	Erosion mass wasting
69	31:20:13	89 30 29.15	41 01 46.33	Erosion mass
70	31:55:29	89 30 39.79	41 01 58.62	LB erosion

LB = Left Bank, RB = Right Bank

Table 6. Potential Project Sites Identified During Aerial Reconnaissance (continued)

Point	Video minutes	Longitude	Latitude	Description
71	32:11:17	89 30 47.29	41 02 02.96	Knick point, bank erosion, riffle
72	33:10:11	89 31 01.06	41 02 24.81	Bank erosion, riffle
73	33:23:18	89 30 57.95	41 02 31.39	LB erosion
74	33:44:02	89 31 05.15	41 02 42.19	LB erosion mass
75	34:11:16	89 31 10.55	41 02 52.37	Bank erosion, riffle
76	35:47:07	89 30 55.38	41 02 58.71	Bank erosion, riffle
77	36:18:18	89 31 04.50	41 03 12.23	RB erosion
78	36:32:06	89 30 54.81	41 03 14.16	Knickpoint, bank erosion
79	37:05:17	89 30 51.73	41 03 31.85	LB erosion

LB = Left Bank, RB = Right Bank

Table 6. Potential Project Sites Identified During Aerial Reconnaissance (concluded)

tershed indicated 79 potential sites of concern. Another 18 sites were identified from the most recent low-altitude panchromatic black-and-white photos outside the area of GPS tracked aerial reconnaissance. The 97 potential project sites (Figure 19; Table 6) were investigated in the field for geomorphic and physical habitat characteristics in summer 2006.

ii. Channel Morphology

It has been widely recognized that some areas of the United States, including Illinois, would benefit from more focused integration of stream, riparian, and hillside management that complement more traditional upland conservation practices. Several studies document the importance of sediment contributions from streambanks and streambeds. A study on Court Creek in western Illinois used spatial and temporal channel morphologic data and suspended sediment transport information to determine that streambank erosion constituted more than 50 percent of sediment yield to the stream (Roseboom and White, 1990). Up to 90 percent of channel sediments in unstable stream systems in a similar loess-dominated region originated from streambanks (Grissinger et al., 1991; Simon and Rinaldi, 2000). Similarly, estimates of bank erosion contribution range from 40% in the Spoon River in western Illinois (Evans and Schnepper, 1977) to 50% in northern Illinois streams (Vagt, 1982). Streambed erosion also could be a very significant sediment source, however (Leedy, 1979; Lee et al., 1982).

The adapted geomorphic assessment approach involves gathering existing watershed and stream-channel data/information (historic and recent); evaluating watershed physical characteristics based on geology, soils, hydrology, land cover, and climate; conducting and recording aerial surveys that preliminarily evaluate channel conditions and identify unstable reaches; and conducting a field-based channel-stability/physical-habitat ranking of many sites within the watershed-

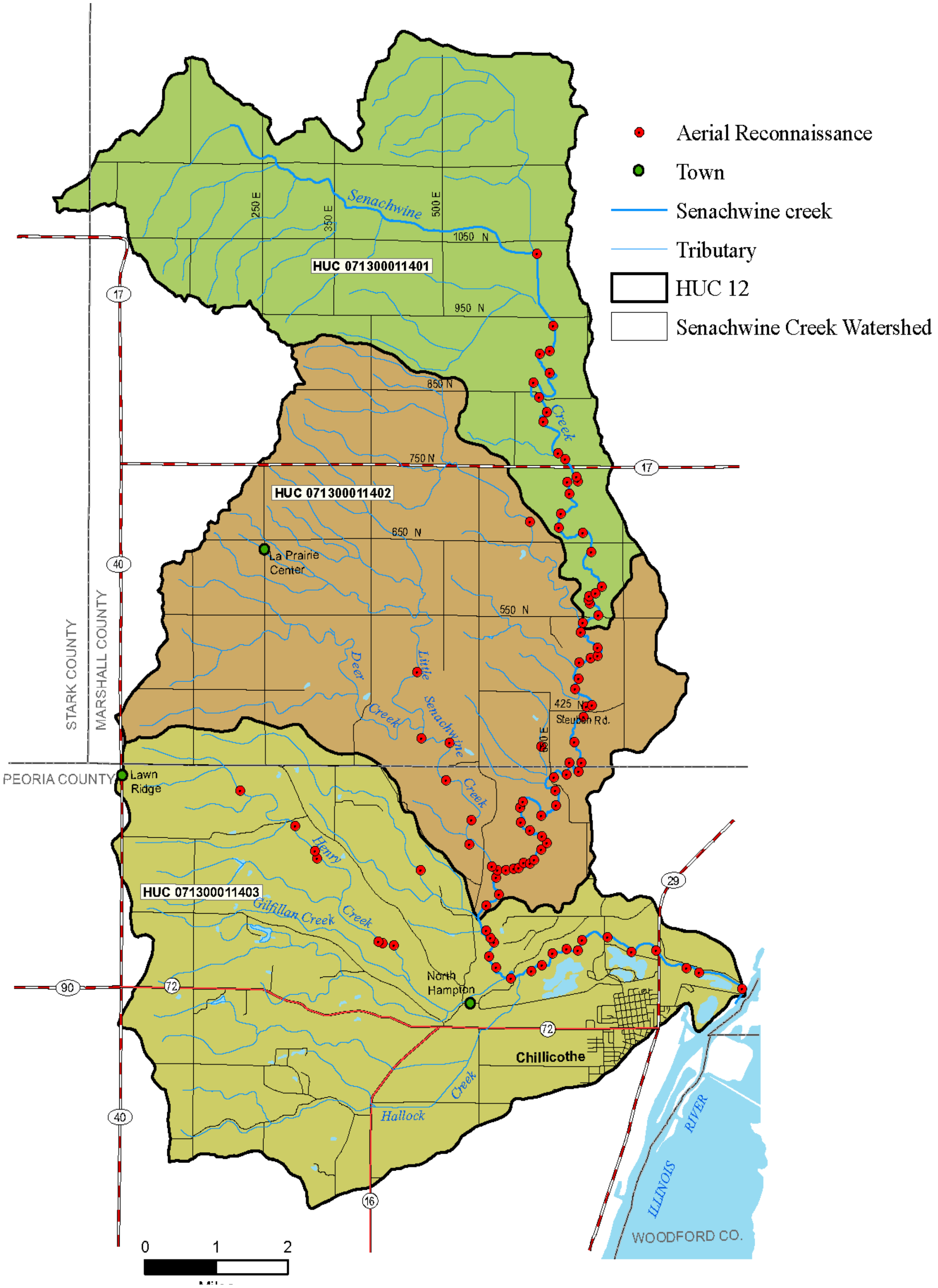


Figure 19. Map showing location of aerial reconnaisance sites

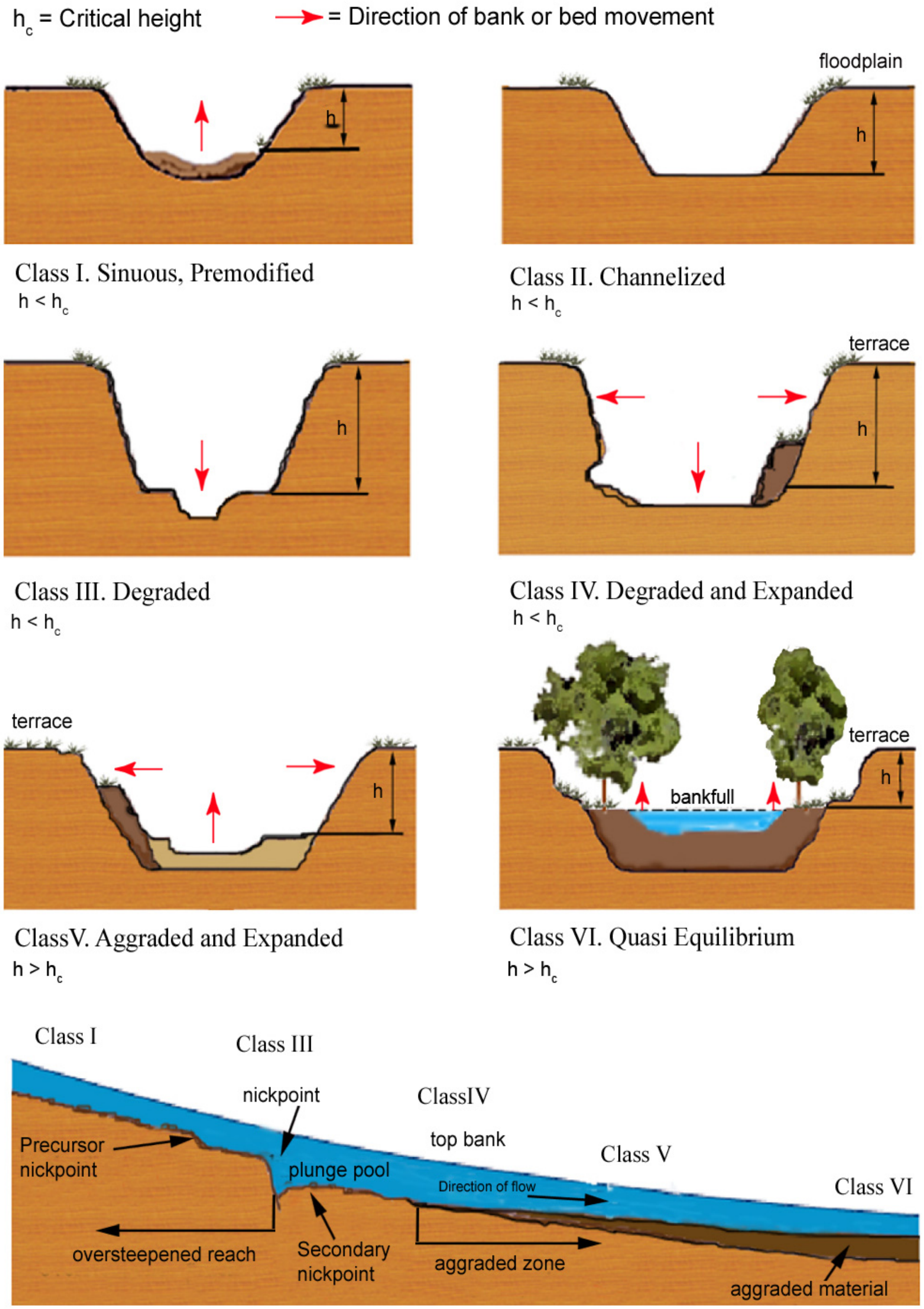
‘s drainage network.

Several geomorphic assessment approaches were adapted and streamlined for use in Illinois streams based on geomorphic studies in the United States and applicable to the Midwest (Keefer, 2006). Details on general field use of the geomorphologic and habitat protocols are also provided by Keefer (2006). Customized geomorphologic protocols are being developed and systematically incorporated into assessment efforts by the State of Illinois (White et al., 2005; White and Keefer, 2005). Conditions of Senachwine Creek mainstem, Little Senachwine Creek, Deer Creek, and Hallock Creek were assessed using channel geomorphic protocols (Kuhnle and Simon, 2000) and habitat condition protocols (Barbour et al., 1999). Both geomorphology and habitat protocols include determination of channel evolution stage, categorization of channel stability, and characterization of current physical habitat conditions in channel and near-channel environments. Geomorphology and habitat protocol data were collected from stream channel segments across a large portion of the watershed (Figure 20). These rapid watershed assessment data protocols were performed to give a general overview of the state of erosion and deposition and condition of habitat in the watershed. (See Appendix C for samples of data sheets used in field assessments of the watershed to collect stream geomorphological and habitat data).

Channel evolution models (CEMs) are useful for assessing the present and predicting future watershed conditions after a major channel disturbance (Simon 1989; Simon and Hupp, 1986; USACE, 1990; Federal Interagency Working Group, 1998). Identifying channel evolution after channel disturbance and corresponding ages of evolution according to a CEM is a key element of watershed restoration planning (Federal Interagency Working Group, 1998). The spatial relationship of CEM stage to known ongoing channel disturbances (e.g., dredging, channelization, urban development, agricultural tiling, climate change, tectonic uplift, etc.) also can be used to assess potential future stream response, including potential for slope and streambank instability. The CEM context also helps prioritize restoration activities when landscape modification is planned and helps match problems with appropriate solutions (Federal Interagency Working Group, 1998). Therefore, the six-stage Channel CEM developed by Simon (1989) and Simon and Hupp (1986) was used to characterize channel condition throughout the watershed. General spatial and temporal trends in channel erosion and deposition were assessed by determining CEM stage at selected reaches throughout the watershed.

The six-stage CEM was based on the original channel evolution concept of Schumm et al., 1984 (Figure 21; Table 7). Because the Simon (1989) and Simon and Hupp (1986) model was developed in sandbed streams with cohesive alluvial banks in the loess area of the Midwest, it is generally applicable

Figure 20. Map showing location of ISWS field sites



Class I. Sinuous, Premodified
$h < h_c$

Class II. Channelized
$h < h_c$

Class III. Degraded
$h < h_c$

Class IV. Degraded and Expanded
$h < h_c$

ClassV. Aggraded and Expanded
$h > h_c$

Class VI. Quasi Equilibrium
$h > h_c$

Figure 21. Illustration of the six stages of channel evolution following disturbance from Simon (1989, Figure 5; see also USACE, 1990). “Construction Stage” can be generalized to “Disturbance Stage”

Stage		Dominant Processes		Characteristic Forms	Geobotanical Evidence
No.	Name	Fluvial	Hillslope		
I	Pre-modified	Sediment transport – mild aggradation; basal erosion on outside bends; deposition on inside bends.	-	Stable, alternate channel bars; convex top-bank shape; flow line high relative to top bank; channel straight or meandering.	Vegetated bank to flow line.
II	Constructed	-	-	Trapezoidal cross section; linear bank surfaces; flow line lower relative to top bank.	Removal of vegetation (?).
III	Degradation	Degradation; basal erosion on banks.	Pop-out failures	Heightening and steepening of banks; alternate bars eroded; flow line lower relative to top bank.	Riparian vegetation high relative to flow line and may lean towards channel.
IV	Threshold	Degradation; basal erosion on banks.	Slab, rotational and pop-out failures.	Large scallops and bank retreat; vertical-face and upper-bank surfaces; failure blocks on upper bank; some reduction in bank angles low line very low relative to top bank.	Tilted and fallen riparian vegetation.
V	Aggradation	Aggradation; development of meandering thalweg; initial deposition of alternate bars; reworking of failed material on lower banks.	Slab, rotational and pop-out failures; low-angle slides of previously failed material.	Large scallops and bank retreat; vertical face, upper bank, and slough line; flattening of bank angles; flow line low relative to top bank; development of new flood plain (?)	Tilted and fallen riparian vegetation; reestablishing vegetation on slough line; deposition of material above root collars of slough-line vegetation.
VI	Restabilization	Aggradation; further development of meandering thalweg; further deposition of alternate bars; reworking of failed material; some basal erosion on outside bends deposition of flood plain and bank surfaces.	Low-angle slides pop-out failures near flow line.	Stable, alternate channel bars; convex-short vertical face on top bank; flattening of bank angles, development of new flood plain possible; flow line high relative to top bank.	Reestablishing vegetation extends up slough line and upper bank; deposition of material above root collars of slough-line and upper-bank vegetation; some vegetation establishing on bars.

Table 7. Six Stages of Simon (1989) and Simon and Hupp (1986) Channel Evolution Model

to watersheds within the ILRB.

Each channel stage and associated characteristic processes and forms are given (Table 8). The initial CEM stage (Stage I) is a pre-modified natural condition. Stage II is the channel condition resulting from initial channelization, dredging, construction, land-use change, climate change, tectonic uplift, or other major disturbance. Degradation (channel incision) after channel disturbance (Stage III) results from excess stream power initially that leads to oversteepening of banks just upstream of the disturbance. Eventually, a threshold (Stage IV) is reached in which continued oversteepening leads to excessive bank erosion and mass wasting that widen the channel and contribute increased amounts of sediment to the stream. Over time, channel widening and mass wasting proceed upstream from the location of maximum disturbance followed by aggradation and channel widening (Stage V) in reaches downstream of active mass wasting. Although channel reaches in Stage V generally trend toward increasing stability, upper portions of streambanks may continue to be unstable. The final stage (Stage VI) is development of a quasi-stable channel inset into disturbed channel valley with dimensions and capacity similar to those of the pre-disturbance channel (Simon and Downs, 1995).

Elevation of the post-disturbance bankfull level is typically lower than the pre-disturbance channel, however, and the pre-disturbance floodplain forms a terrace above the new active floodplain. In other words, the existing stream channel remains disconnected from the main valley floodplain and intrinsically forces the stream to curve into a new, lower floodplain. Relatively stable reaches typically occur downstream (Stages V and VI), and less stable reaches (Stages II and III) are upstream of those classified as Stage IV (i.e., threshold stage; Federal Interagency Working Group, 1998). This progression happens because initiation of channel incision by a major disturbance or modification produces an increased gradient (e.g., headcut or knickpoint) locally that advances upstream until it meets meets more resistant bed and bank material or until stream energy becomes too low to support erosion of the bed due to decreased slope or disch-arge in upper reaches of the watershed. Examples of CEM-guided restoration strategies are using “environmentally friendly” grade control structures to stem incision in reaches identified as early Stage III, treating bank instability with structural or bioengineering approaches such as riffles and pools in Stage IV and V reaches, and maintaining, preserving, enhancing, and expanding habitats supported within Stages I and VI. Generally, Stage III and IV reaches require more intensive restoration efforts than Stage V and VI reaches. It is important, however, to identify not only the CEM stage but also to coordinate watershed restoration strategies with planned channel disturbances, including but not limited to, bridge construction, channelization, maintenance dredging, and other in-channel BMPs for mutual success in watershed restoration and infrastructure and land-use needs. Spatial distribution of CEM stages based on the 2005-2006 field data collection campaign in Senachwine Creek are shown (Figure 22).

Overall, the watershed has 274 miles of stream. (See Appendix D for a list of 10 longest stream sections in the Senachwine Creek watershed). Forty-one miles had 239 assessed segments: 94 segments (39%) in Stage V, 84 segments (35%) in Stage IV, 35 segments (15%) in Stage II, 15 segments (6%) in Stage VI, 9 segments (4%) in Stage III, and 2 segments (~1%) more clearly evolving between Stage V and Stage VI. Most of the main channel of the Senachwine Creek watershed in this study was classed as Stage V. The Senachwine Creek mainstem, from its mouth at the Illinois River to a point about 22 miles upstream, had 101 assessed segments: 66 segments (65%) in Stage V, 6 segments (6%) in Stage VI, 12 segments (12%) in Stage IV, and 17 segments (17%) in Stage II. The Senachwine Creek mainstem had more Stage II channel segments than any of its tributaries. There were no Stage I or Stage III segments. An 8.5-mile reach of Little Senachwine Creek had 71 assessed segments: 38 segments (54%) in Stage IV, 16 segments (22%) in Stage V, 9 segments (13%) in Stage VI, 7 segments (10%) in Stage II, and 1 segments (~1%) in Stage III. Two segments (3%) scored between Stages V and VI, indicating morphology evolving more closely toward Stage VI. Deer Creek, a tributary of Little Senachwine Creek, had 30 assessed segments within a 4.5-mile reach: 19 segments (63%) in Stage IV, 6 segments (21%) in Stage III, 4 (13%) in Stage V and 1 segment (3%) in Stage II. Six miles of Hallock Creek had 37 segments assessed, including a 2-mile channelized stretch with levees on both sides of the stream channel. Hallock Creek had 15 segments (41%) in Stage IV, 10 segments (27%) in Stage V, 10 segments (27%) in Stage II, and 2 segments (5%) in Stage III. No reaches ranked as Stage I, and

CEM STAGE	GENERAL STABILITY CONDITION	DYNAMIC STYLE	BIOLOGICAL/HABITAT QUALITATIVE CONDITION
I	Stable	In Equilibrium	Highest
II	Transitional	Stable to Degrading	Variable
III	Unstable	Degrading	Low
IV	Unstable	Degrading	Low
V	Transitional	Stable to Aggrading	Variable
VI	Stable	In Equilibrium	Highest

Table 8. Results of CEM stage and Habitat analysis

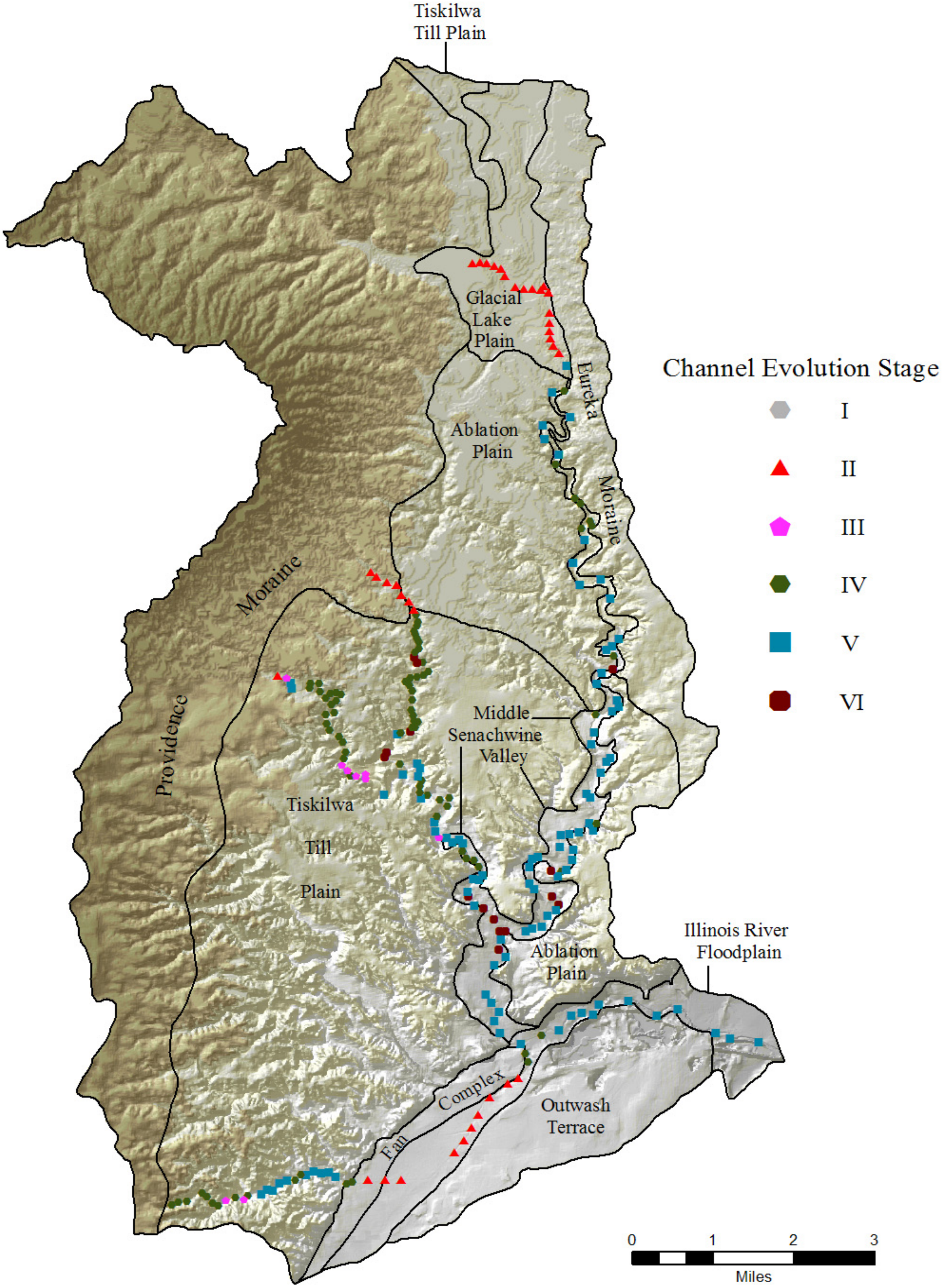


Figure 22. CEM Spatial Distribution

Deer and Hallock Creeks had no Stage VI segments. It would appear from CEM stage data alone that tributary systems feeding into the Senachwine Creek mainstem are less stable overall than the mainstem so prioritizing restoration of relatively unstable segments in those tributaries should be considered. The greater slope of the landscape and higher gradient tributary streams explains, in part, the more erosive channel morphology.

iii. Channel Gradient and Channel Bed Texture

Under quasi-equilibrium conditions, channel gradients and forms adjust to imposed sediment and water loads. The energy gradient (practically approximated as channel slope) along with discharge and specific water weight determine stream power, or energy amount available to erode or transport sediment (Rhoads, 1995). An imposed change in stream gradient from channel disturbance or base-level change, can initiate bed, bank, or watershed scour, thus increasing sediment load in the stream (Bhowmik et al., 1993). When this higher sediment load is delivered to the main channel, new delta growth could be initiated unless the mainstem can continue to transport it.

Gradients of stream channels (including headwater reaches) in Senachwine Creek watershed were determined by interpolating contours from topographic maps (Figures 23 and 24 and Table 9). Geomorphic and biologic field data collection occurred along approximately 41 miles of the 274 miles of channel in the watershed. (The ten longest channels are highlighted in red and black in Figure 23). Four of these channels were investigated in the field for this report: Senachwine Creek (mainstem), Little Senachwine Creek, Deer Creek, and Hallock Creek (Figures 23 and 24). Figure 23 also shows that the gradient of Little Senachwine Creek (0.63%, or 33.4 feet/mile) is much steeper than the gradient of the Senachwine Creek mainstem (0.25%, or 13.4 feet/mile). Channel gradients range from 0.25% in the Senachwine Creek mainstem to 4.9% in the case of some small tributary valleys in steeper, wooded, southern portions of the watershed. Overall, gradients were 0.02-1.0% (31 channels), 1.01-2% (82 channels), 2.01-3% (44 channels), 3.01-4% (11 channels), and 4.01-5% (4 channels) (Figure 24). These gradients are steeper than most streams in Illinois but typical of direct tributaries to Peoria Pool.

A clear downstream gradation in texture occurs within the assessed streams (Figure 25). Bed deposits above the bluff line contain more boulders and cobbles than those below the bluff line where gravels are concentrated. The Senachwine Creek mainstem has a concentration of gravels above rock outcrop areas in the channelized section of the stream. Glacial diamicton, glacial stream sediment, and bedrock outcrops supply

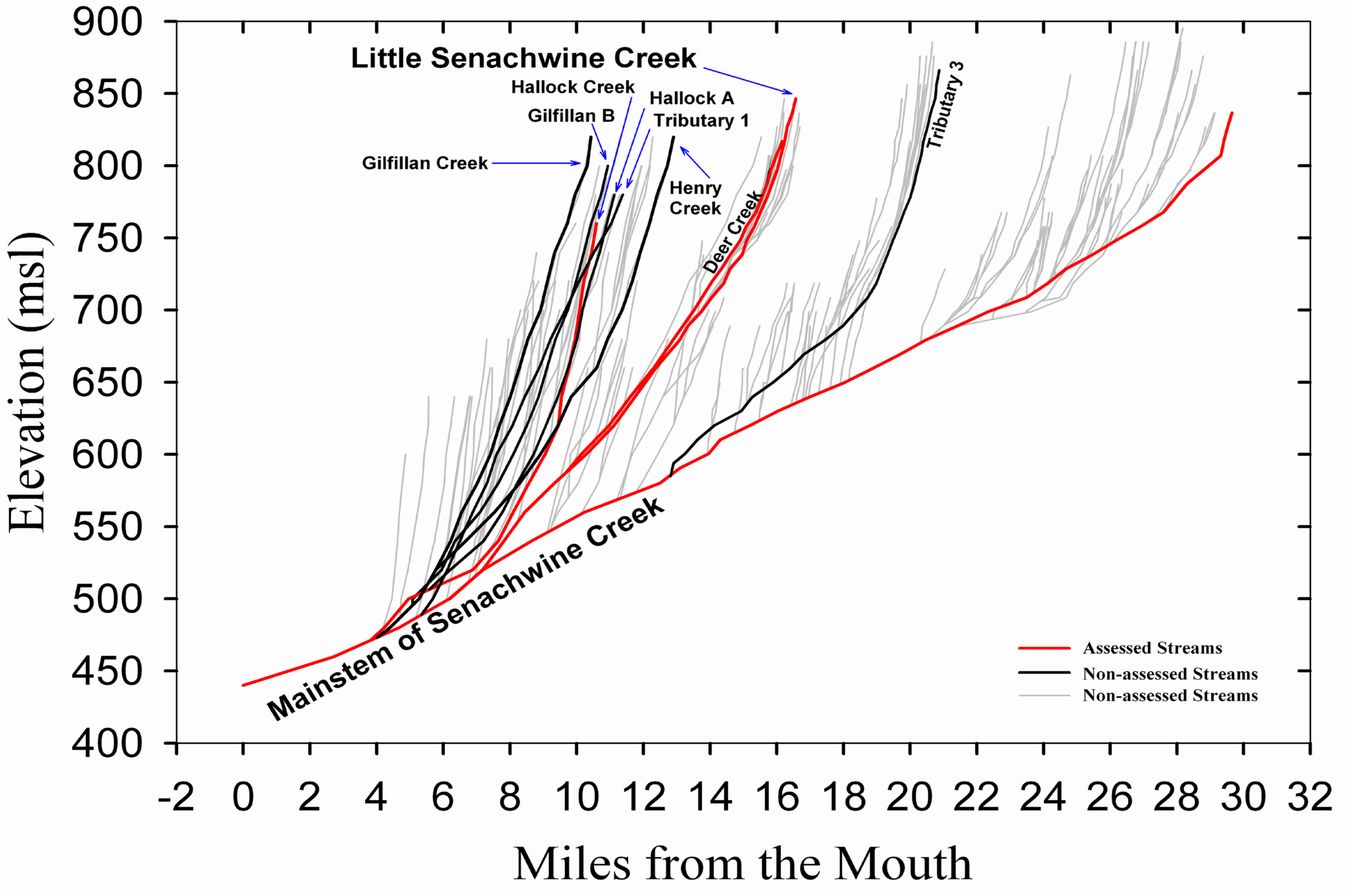


Figure 23. Gradients of Senachwine Creek and its tributaries.

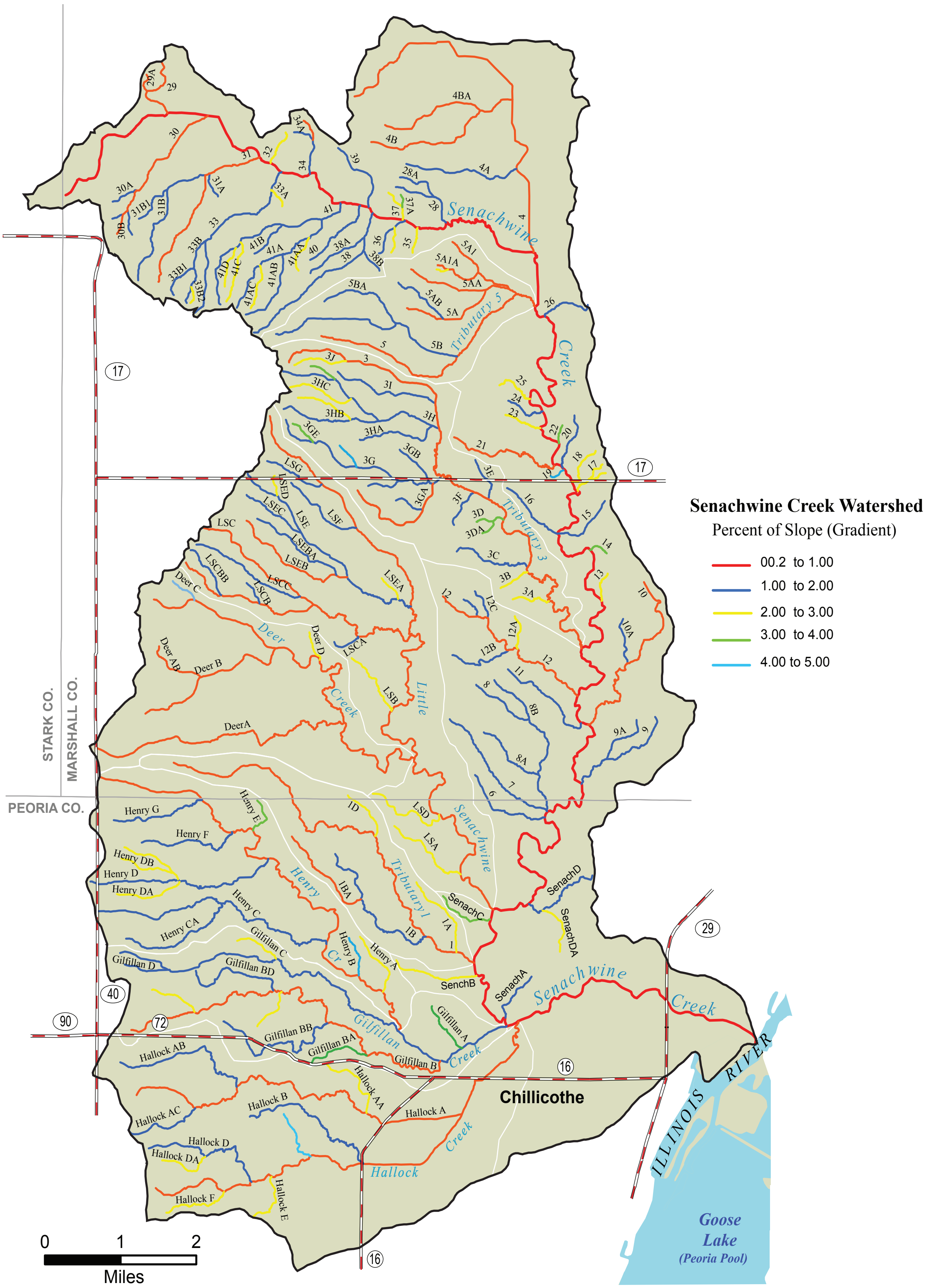


Figure 24. Percent slope in Senachwine Creek watershed

Name	Length in Miles from Confluence	Drop in Elevation in feet	Drop in Feet per Mile	Miles Coverted to feet	Drop Foot per Foot	% Gradient	Number of Right Bank Tributaries	Number of Left Bank Tributaries	Number of Crossings
Senachwine Creek	29.65	396.6	13.4	156557.3	0.0025	0.25	27	18	20
Tributary 4	5.02	79.7	15.9	26484.5	0.0030	0.30	2		2
Tributary 5A1	1.01	18.7	18.5	5327.5	0.0035	0.35	1		
Tributary 5A1A	1.65	38.2	23.2	8685.6	0.0044	0.44	1		
Deer B	2.29	76.0	33.1	12112.3	0.0063	0.63		1	2
Little Senachwine	10.38	346.5	33.4	54795.8	0.0063	0.63	8		6
Tributary 3	8.06	281.1	34.9	42562.1	0.0066	0.66	9	1	6
Deer Creek	6.50	229.9	35.4	34341.1	0.0067	0.67	3	2	4
Tributary 4B	2.20	79.6	36.1	11626.6	0.0068	0.68		1	1
Tributary 29	0.80	29.2	36.6	4224.0	0.0069	0.69	1		
Tributary 30	2.07	76.6	37.0	10940.2	0.0070	0.70	1	2	1
Tributary 4BA	1.91	71.1	37.1	10100.6	0.0070	0.70	1		1
Tributary 5	3.60	146.8	40.7	19018.6	0.0077	0.77		2	2
Tributary 5A	1.72	70.9	41.3	9065.8	0.0078	0.78		3	1
Tributary 3GA	1.56	65.0	41.8	8215.7	0.0079	0.79		1	1
Henry Creek	7.13	300.0	42.1	37641.1	0.0080	0.80	4	3	4
Tributary 10	2.88	121.5	42.1	15222.2	0.0080	0.80	1		2
Hallock Creek	6.74	288.0	42.7	35592.5	0.0081	0.81	2	4	11
Little Senachwine C	3.91	171.6	43.9	20629.0	0.0083	0.83	3		4
Deer A	3.92	180.0	45.9	20697.6	0.0087	0.87			2
Little Senachwine EB	1.71	82.2	48.0	9039.4	0.0091	0.91		1	2
Tributary 1	6.03	291.0	48.2	31854.2	0.0091	0.91	1	2	5
Tributary 21	1.83	88.8	48.4	9683.5	0.0092	0.92			1
Hallock A	5.55	273.5	49.3	29293.4	0.0093	0.93	1	2	2
Tributary 31	2.38	119.1	50.2	12540.0	0.0095	0.95	1	1	3
Tributary 12	2.66	135.2	50.9	14034.2	0.0096	0.96	1	3	2
Tributary 5AA	1.39	71.2	51.3	7323.4	0.0097	0.97			1
Little Senachwine CB	2.08	106.6	51.4	10961.3	0.0097	0.97		2	1
Gilfillan B	5.86	304.5	52.0	30930.2	0.0098	0.98	3	2	4
Tributary 34A	0.30	15.6	52.0	1578.7	0.0099	0.99			
Deer BA	0.84	44.2	52.5	4451.0	0.0099	0.99			1
Tributary 4A	1.57	84.1	53.6	8279.0	0.0102	1.02		1	1
Little Senachwine E	3.10	166.5	53.7	16378.6	0.0102	1.02	2	2	3
Tributary 3HA	1.12	60.4	53.8	5929.4	0.0102	1.02			1
Gilfillan Creek	6.41	347.0	54.2	33829.0	0.0103	1.03	2	3	9
Tributary 28	0.96	52.9	55.2	5058.2	0.0105	1.05			
Tributary 31B	1.91	106.0	55.5	10090.1	0.0105	1.05	2		1
Tributary 12C	0.39	22.0	55.8	2080.3	0.0106	1.06			1

Table 9. Senachwine Creek Watershed stream slope data sorted by % gradient

Name	Length in Miles from Confluence	Drop in Elevation in feet	Drop in Feet per Mile	Miles Coverted to feet	Drop Foot per Foot	% Gradient	Number of Right Bank Tributaries	Number of Left Bank Tributaries	Number of Crossings
Tributary 5AB	0.80	45.2	56.3	4239.8	0.0107	1.07			1
Tributary 5B	2.73	154.9	56.7	14419.7	0.0107	1.07		1	1
Tributary 8	2.28	130.0	57.0	12038.4	0.0108	1.08	1	1	
Tributary 30C	0.15	8.8	58.5	792.0	0.0111	1.11			
Tributary 31A	0.33	19.4	59.3	1726.6	0.0112	1.12			
Tributary 5BA	1.19	71.1	59.5	6304.3	0.0113	1.13			1
Little Senachwine CC	1.70	101.6	59.9	8954.9	0.0113	1.13			2
Tributary 28A	0.61	36.9	60.4	3226.1	0.0114	1.14			
Tributary 41	2.55	158.8	62.2	13479.8	0.0118	1.18	4		3
Little Senachwine CBA	0.31	19.7	62.9	1652.6	0.0119	1.19			1
Little Senachwine EBA	1.37	87.1	63.5	7244.2	0.0120	1.20			1
Tributary 10A	0.63	40.0	63.8	3310.6	0.0121	1.21			1
Tributary 33	2.40	153.7	64.0	12677.3	0.0121	1.21	1	1	2
Little Senachwine F	1.20	77.1	64.3	6325.4	0.0122	1.22			
Tributary 9	1.52	101.0	66.4	8025.6	0.0126	1.26	1		1
Tributary 30A	0.36	23.8	66.8	1879.7	0.0126	1.26			
Tributary 39	1.01	67.4	66.8	5327.5	0.0127	1.27			1
Tributary 38A	0.86	58.2	67.9	4530.2	0.0129	1.29			1
Tributary 26	0.75	51.3	68.7	3944.2	0.0130	1.30			
Tributary 30B	0.33	22.8	69.3	1737.1	0.0131	1.31			
Tributary 34	0.74	51.4	69.6	3901.9	0.0132	1.32		1	1
Tributary 38B	0.34	23.7	69.7	1795.2	0.0132	1.32			
Tributary 7	1.89	133.0	70.3	9984.5	0.0133	1.33		1	1
Tributary 3G	2.53	178.3	70.4	13369.0	0.0133	1.33	2	3	3
Henry C	3.62	256.0	70.7	19113.6	0.0134	1.34	1		1
Tributary 12D	0.31	21.8	70.8	1626.2	0.0134	1.34			1
Tributary 38	2.34	167.8	71.6	12371.0	0.0136	1.36	1	1	3
Tributary 3C	1.15	82.5	71.7	6077.3	0.0136	1.36			2
Henry D	2.67	192.0	71.9	14108.2	0.0136	1.36	1	1	3
Senachwine A	1.73	125.5	72.7	9113.3	0.0138	1.38			
Tributary 3GB	0.57	41.8	73.1	3020.2	0.0139	1.39			1
Hallock AB	2.08	152.0	73.3	10956.0	0.0139	1.39			2
Henry G	1.31	97.0	73.9	6927.4	0.0140	1.40			
Little Senachwine CBB	0.75	55.8	74.5	3954.7	0.0141	1.41			1
Tributary 1BA	1.38	104.0	75.5	7270.6	0.0143	1.43			1

Table 9. Senachwine Creek Watershed stream slope data sorted by % gradient (continued)

Name	Length in Miles from Confluence	Drop in Elevation in feet	Drop in Feet per Mile	Miles Coverted to feet	Drop Foot per Foot	% Gradient	Number of Right Bank Tributaries	Number of Left Bank Tributaries	Number of Crossings
Tributary 12B	0.91	69.5	76.2	4815.4	0.0144	1.44			1
Tributary 31B1	0.61	46.6	76.3	3226.1	0.0144	1.44			
Tributary 11	1.43	110.5	77.1	7566.2	0.0146	1.46			
Tributary 3I	1.44	112.4	78.3	7576.8	0.0148	1.48			2
Tributary 3H	2.43	190.3	78.4	12819.8	0.0148	1.48	3	1	2
Tributary 40	1.08	85.1	78.5	5723.5	0.0149	1.49			2
Little Senachwine EC	0.88	71.8	81.2	4667.5	0.0154	1.54			1
Gilfillan BB	2.15	175.0	81.3	11362.6	0.0154	1.54			2
Gilfillan D	0.79	64.5	81.4	4181.8	0.0154	1.54			
Tributary 1B	2.18	180.0	82.5	11515.7	0.0156	1.56		1	
Tributary 41A	1.78	146.8	82.6	9382.6	0.0156	1.56	3		3
Tributary 31B2	0.34	28.3	83.7	1784.6	0.0159	1.59			
Henry CA	1.82	152.0	83.7	9583.2	0.0159	1.59			1
Deer C	0.39	33.1	84.8	2059.2	0.0161	1.61			1
Tributary 41B	0.54	46.1	85.7	2840.6	0.0162	1.62			
Tributary 8B	0.73	63.5	87.2	3843.8	0.0165	1.65			
Tributary 3GAA	0.41	35.7	87.9	2143.7	0.0166	1.66			
Hallock B	2.19	192.5	88.1	11536.8	0.0167	1.67			2
Little Senachwine G	0.87	76.6	88.4	4577.8	0.0167	1.67			1
Tributary 15	0.85	75.6	88.5	4509.1	0.0168	1.68			
Tributary 20	0.80	70.7	88.7	4208.2	0.0168	1.68		1	
Tributary 8A	1.01	90.0	89.0	5338.1	0.0169	1.69			
Tributary 16	0.95	85.4	90.0	5010.7	0.0170	1.70			
Senachwine D	1.21	109.5	90.5	6388.8	0.0171	1.71		1	1
Tributary 33B	0.89	80.8	91.0	4688.6	0.0172	1.72	1	1	
Henry F	1.41	129.0	91.4	7455.4	0.0173	1.73			
Tributary 3HB	1.35	124.3	92.3	7106.9	0.0175	1.75		1	1
Tributary 3F	0.55	50.5	92.7	2877.6	0.0175	1.75			
Tributary 6	1.22	114.0	93.4	6446.9	0.0177	1.77			1
Tributary 3E	0.60	56.0	93.6	3157.4	0.0177	1.77			1
Hallock AC	1.09	102.0	94.0	5728.8	0.0178	1.78			2
Tributary 36	0.60	56.7	94.8	3157.4	0.0180	1.80	1		1
Tributary 3GC	0.45	43.0	95.4	2381.3	0.0181	1.81			
Gilfillan BD	1.43	138.0	96.6	7545.1	0.0183	1.83			1
Tributary 33B1	0.52	51.8	100.4	2724.5	0.0190	1.90			
Little Senachwine CA	0.39	40.2	102.0	2080.3	0.0193	1.93			

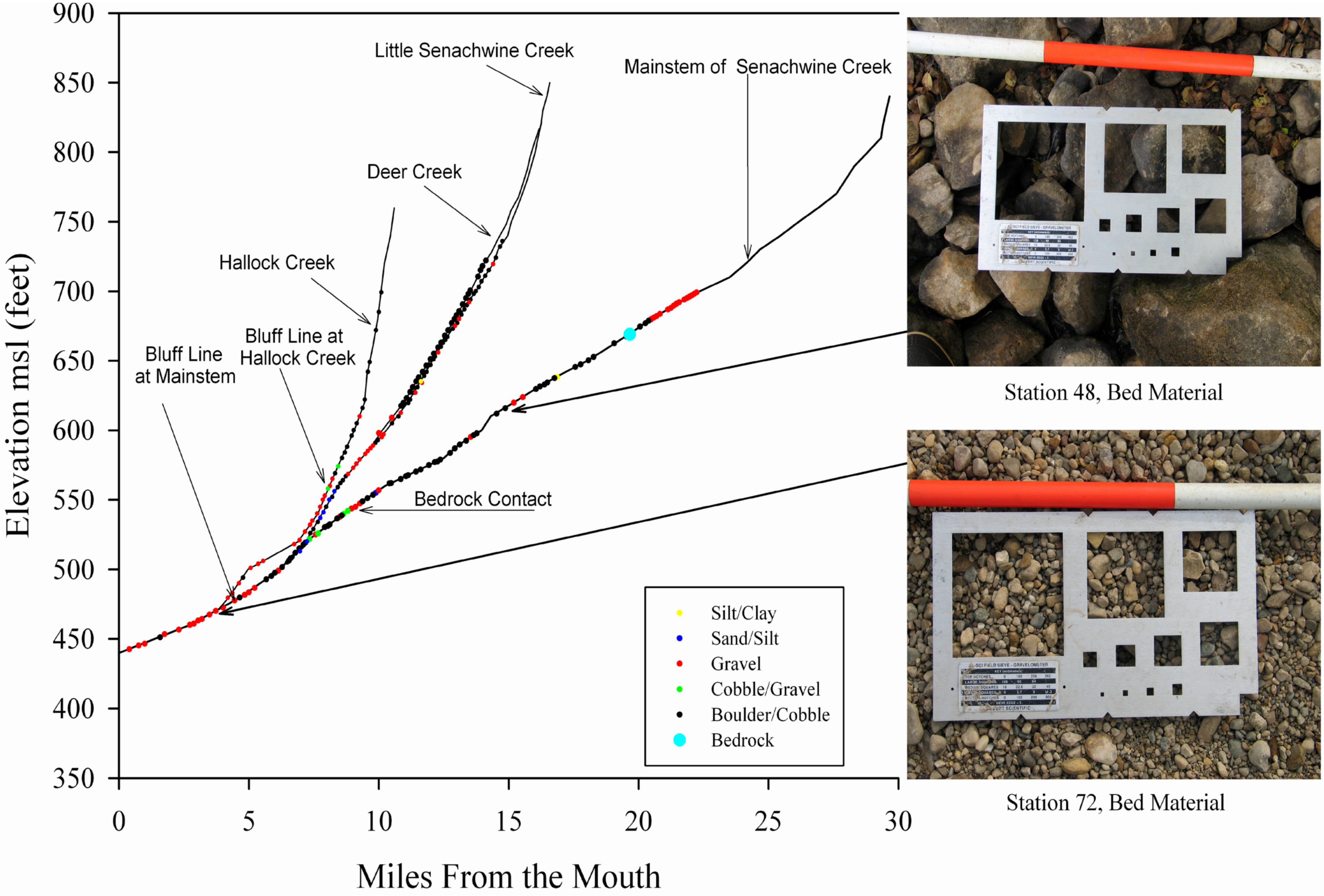
Table 9. Senachwine Creek Watershed stream slope data sorted by % gradient (continued)

Name	Length in Miles from Confluence	Drop in Elevation in feet	Drop in Feet per Mile	Miles Coverted to feet	Drop Foot per Foot	% Gradient	Number of Right Bank Tributaries	Number of Left Bank Tributaries	Number of Crossings
Hallock D	1.91	196.0	102.5	10100.6	0.0194	1.94	1		2
Tributary 9A	0.74	76.5	103.0	3923.0	0.0195	1.95			1
Tributary 41AB	1.04	107.8	103.4	5507.0	0.0196	1.96			
Tributary 24	0.57	59.9	104.7	3020.2	0.0198	1.98			1
Tributary 18	0.60	63.3	105.9	3157.4	0.0201	2.01			1
Tributary 33B2	0.23	24.8	107.0	1225.0	0.0203	2.03			
Tributary 36A	0.33	35.9	107.4	1763.5	0.0203	2.03			1
Gilfillan BE	0.86	94.0	109.0	4551.4	0.0207	2.07			1
Tributary 41C	0.81	88.8	109.4	4287.4	0.0207	2.07			
Tributary 41AA	0.48	53.1	109.9	2550.2	0.0208	2.08			
Little Senachwine B	0.97	107.0	110.0	5137.4	0.0208	2.08			1
Henry DA	0.90	100.0	110.7	4767.8	0.0210	2.10			1
Tributary 32	0.47	52.2	111.9	2465.8	0.0212	2.12			1
Henry DB	0.85	95.0	111.9	4482.7	0.0212	2.12		1	1
Henry DBA	0.75	85.0	113.5	3954.7	0.0215	2.15			
Tributary 25	0.59	67.0	113.6	3115.2	0.0215	2.15			1
Tributary 5A1B	0.16	18.2	113.7	844.8	0.0215	2.15			
Little Senachwine EA	0.42	48.2	113.9	2233.4	0.0216	2.16			
Tributary 17A	0.25	28.5	114.3	1314.7	0.0217	2.17			1
Tributary 41D	0.55	64.1	116.3	2909.3	0.0220	2.20			
Little Senachwine D	1.24	145.0	116.9	6547.2	0.0221	2.21			
Tributary 33A	0.27	32.4	118.2	1446.7	0.0224	2.24			
Little Senachwine ED	0.27	31.9	119.6	1409.8	0.0226	2.26			1
Tributary 17	0.54	64.8	120.3	2845.9	0.0228	2.28		1	1
Tributary 35	0.32	39.0	121.2	1700.2	0.0230	2.30			1
Tributary 1A	1.16	142.0	122.7	6109.0	0.0232	2.32			
Hallock DA	0.73	90.0	124.0	3833.3	0.0235	2.35			1
Tributary 1D	0.72	90.0	125.7	3780.5	0.0238	2.38			1
Tributary 13	0.40	50.6	126.2	2117.3	0.0239	2.39			
Deer D	0.44	55.0	126.2	2302.1	0.0239	2.39			1
Tributary 3HC	0.89	114.0	127.9	4704.5	0.0242	2.42			1
Tributary 3A	0.55	70.5	128.1	2904.0	0.0243	2.43			
Gilfillan C	0.76	97.0	128.5	3986.4	0.0243	2.43			1
Senachwine B	1.16	153.5	132.1	6135.4	0.0250	2.50			3
Tributary 41AC	0.59	78.0	132.4	3109.9	0.0251	2.51			
Hallock F	0.92	124.0	134.8	4857.6	0.0255	2.55			1

Table 9. Senachwine Creek Watershed stream slope data sorted by % gradient (continued)

Name	Length in Miles from Confluence	Drop in Elevation in feet	Drop in Feet per Mile	Miles Coverted to feet	Drop Foot per Foot	% Gradient	Number of Right Bank Tributaries	Number of Left Bank Tributaries	Number of Crossings
Tributary 3B	0.40	54.5	135.2	2127.8	0.0256	2.56			
Little Senachwine A	1.21	165.0	136.0	6404.6	0.0258	2.58			1
Tributary 3J	0.72	99.5	137.8	3812.2	0.0261	2.61			
Henry A	0.89	123.5	139.2	4683.4	0.0264	2.64			
Tributary 23	0.52	72.5	139.7	2740.3	0.0265	2.65			1
Hallock AA	1.03	146.0	141.5	5449.0	0.0268	2.68			
Gilfillan BC	0.60	85.0	141.7	3168.0	0.0268	2.68			
Tributary 37	0.38	55.7	146.6	2006.4	0.0278	2.78	1		
Tributary 12A	0.45	67.0	150.5	2349.6	0.0285	2.85			1
Senachwine DA	0.72	109.0	152.0	3785.8	0.0288	2.88			
Hallock E	0.80	124.0	154.4	4239.8	0.0292	2.92			
Tributary 3HBA	0.78	121.0	154.7	4129.0	0.0293	2.93			1
Henry E	0.53	85.0	160.4	2798.4	0.0304	3.04			1
Tributary 37A	0.16	24.9	160.5	818.4	0.0304	3.04			
Gilfillan BA	0.85	137.0	161.6	4477.4	0.0306	3.06			1
Tributary 3D	0.40	64.0	162.0	2085.6	0.0307	3.07	1		
Tributary 14	0.27	44.5	163.4	1436.2	0.0310	3.10			
Tributary 3GE	0.37	61.0	167.0	1927.2	0.0316	3.16			1
Tributary 3DA	0.24	39.5	167.4	1246.1	0.0317	3.17			
Senachwine C	0.79	141.5	178.2	4192.3	0.0338	3.38			1
Gilfillan A	0.85	153.0	180.4	4477.4	0.0342	3.42			2
Tributary 3HD	0.38	70.3	187.5	1980.0	0.0355	3.55			
Tributary 22	0.23	46.5	198.6	1235.5	0.0376	3.76			
Henry B	0.52	114.0	217.6	2766.7	0.0412	4.12			
Hallock C	0.74	165.5	223.0	3917.8	0.0422	4.22			2
Tributary 19	0.23	51.0	223.6	1203.8	0.0423	4.23			
Tributary 3GD	0.35	91.1	258.7	1858.6	0.0490	4.90			
Tributary 27	NA	NA	NA	NA	NA	NA			
Tributary 29A	NA	NA	NA	NA	NA	NA			
Total Miles =	273.68		Total LB Trbutaries =		75				
Total Tributaries =	174		Total Crossings =		207				
Total RB tributaries =	100								

Table 9. Senachwine Creek Watershed stream slope data sorted by % gradient (concluded)



Station 48, Bed Material

Station 72, Bed Material

Figure 25. Bed materials and channel gradient along Senachwine Creek

the channel with rock debris in the area above the bluff line. Exposed bedrock is mostly shale, which easily breaks down into fine sand and silt. Shale debris therefore typically occurs in the bed only up to 100 feet downstream of an outcrop. More resistant sandstone and limestone debris between County Road 950 N and the bluff line is an important coarse bed material component locally, but the drift is probably the main source of bed material of all size ranges. The relatively low slope of the channel on the Holocene Floodplain of the Illinois River (Figures 5 and 23) limits downstream transport of the coarser material, thus constraining the lowermost reach to sand and gravel and transporting silts and clays the farthest, into Goose Lake of Peoria Pool (Figure 24).

Flows in Senachwine Creek probably are only rarely sufficient to transport bedload coarser than fine gravel. Those coarser bed materials provide some degree of armoring of the bed, inhibiting incision. In the middle part of the watershed, bedrock is exposed in the streambed, and incision is also relatively slow. Bedload size there is approximately one grain to two feet thick. Aggrading reaches, mainly downstream of County Road 650 E are evident by accumulation of sandbars and evidence of overbank sedimentation. By contrast, several incising reaches are evident by exposed oil and gas pipelines (Photos 1 and 2). Sands are transported downstream to the Holocene Floodplain, some reaching the stream mouth at Peoria Lake, whereas silts and clays may be deposited on floodplains (e.g. Figure 17) or transported out of the watershed in the washload. Bed texture of Hallock Creek consists of mostly gravel in the channelized reach, which extends from approximately halfway upstream from the mouth of Hallock Creek to the bluff line (Figure 25). Gravel bed material is prevalent below the confluence of Deer Creek and Little Senachwine Creek; however there are also some concentrations of sand and silt in the bed.

iv. Mass Wasting

Mass wasting of high valley walls is common to many watersheds draining directly into Peoria Lake. Twenty-two (22) mass wasting sites were identified throughout assessed channel segments in Senachwine Creek watershed. Field investigation along Senachwine Creek identified 11 mass wasting sites that episodically contribute large amounts of glacial sediment and bedrock debris directly into the channel (Figure 26). Six sites were along the channel of Little Senachwine Creek, and five sites were along the channel of Hallock Creek. Deer Creek did not exhibit any signs of mass wasting. Inspection of the 1998 DOQ aerial photographs indicated additional areas of mass wasting sites located in the non-assessed subwatersheds of Senachwine Creek.

Photo 1. Exposed active gas pipeline with pipe protection along lower Senachwine Creek (Pipelines are data for interpretation of channel incision or migration)

Photo 2. Exposed abandoned gas pipeline along Hallock Creek

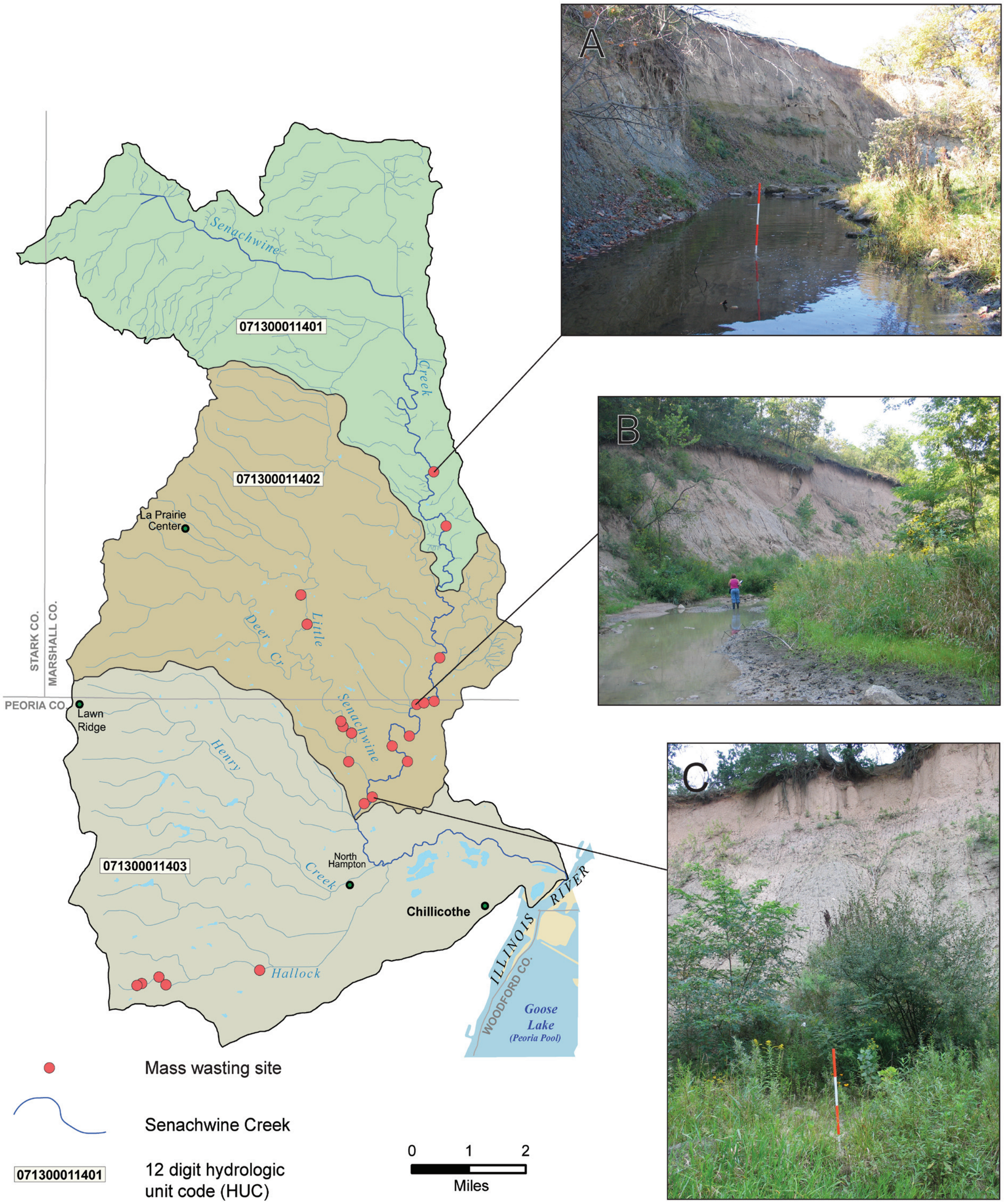


Figure 26. Figure showing mass wasting sites within Senachwine Creek watershed

Mass wasting sites tend to occur where the stream impinges on upland valley walls (Figure 26). Geologic settings are varied. For example, the stream is incised 10 feet into shale bedrock overlain by sand-and-gravel outwash and silty loess shown in inset A in Figure 26. (Inset A corresponds to field site # S53 on Senachwine Creek Mainstem. For more information on field site # S53, see Appendix E. All raw field data collected at and photos of individual assessment sites are found in Appendix E. Field data from miscellanous subwatersheds in Appendix E refer to data collected from isolated sites that were not connected to any of the the other subwatersheds investigated in this assessment). Although the shale seems relatively resistant to vertical incision, it is clearly less resistant to lateral erosion, perhaps because bedding planes are exposed. By contrast, a 100 foot high bank comprised entirely of stiff pebbly diamicton (till) is overlain by approximately 10 feet of silt loam (loess) as shown in inset B in Figure 26. (Inset B corresponds to field site # S20 on Senachwine Creek Mainstem. For more information on field site # S20, see Appendix E). Persistent erosion at the toe of the slope maintains a steep escarpment, however. Inset C in Figure 26 is estimated to be around 92 feet high and consists of loess materials. (Inset C corresponds to field site # S10 on Senachwine Creek Mainstem. For more information on field site # S10, see Appendix E). This mass wasting appears to be active despite the attempt of woody vegetation to establish itself at its toe, and may be on its way to recovery if the young woody vegetation remains. In a similar geologic setting in southwestern Illinois, Straub et al. (2006) found what may other researchers have discovered and that is slope failures occurred during waning of flood flows as hydrostatic support of the base of the slope decreased.

v. Hydrologic and Sediment Transport Conditions

In a previous study, the ISWS collected 275 water samples, 32 stage samples, and made 90 discharge measurements at Benedict Bridge (Photo 3) from October 1988 to November 1990 (Bhowmik et al., 1993). As an example of flow variability, Bhowmik et al., 1993 reported that the creek was completely dry for five of the first 12 months of that project period, and average water discharge was about 6 times lower in 1989 than 1990. During the early dry period, Senachwine Creek received some flow from snowmelt over frozen ground, but no significant flow until a storm in early June 1989, after which the creekbed was dry again two weeks later. Recorded stages showed extreme variability in spring 1989. Field measurements showed that the streambed was absorbing streamflow. Senachwine Creek was again dry for an extended period during fall 1988 and summer 1989. Following recovery from that prolonged drought period, the creek was very flashy during storm periods, rising 10 feet or

Photo 3. Picture of Benedict Bridge

Water Year	Water Discharge (cfs·days*10^{-3})	Sediment Yield (tons*10^{-3})	Total Precipitation (inches)
WY1981	27.2	57.8	49.30
WY1982	32.4	79.4	32.84
WY1983	30.4	70.6	33.48*
WY1984	25.4	51.1	21.79*
WY1985	27.6	59.6	32.89*
WY1986	24.9	49.4	46.11
WY1987	22.6	41.5	34.83
WY1988	15.9	22.1	21.66
WY1989	4.6	2.4	34.38
WY1990	32.2	78.5	41.21
WY1991	26.8	56.3	32.95
WY1992	19.5	32.1	37.62
WY1993	67.6	296.1	46.12*
WY1994	19.6	32.3	24.68
WY1995	32.8	81.3	42.75
WY1996	18.5	29.1	37.72
WY1997	18.8	30.1	35.90
WY1998	38.8	109.7	35.12
WY1999	33.8	85.8	29.61
WY2000	14.0	17.6	29.83
Average	26.7	64.1	35.41

* indicates missing data for that year

Table 10. Discharge and Sediment Yield for Senachwine Creek (Modified from Demissie et al. 2004. Precipitation data from Mid-Western Regional Climate Center, Station (111627) Chillicothe, IL)

more during 3- to 4-hour periods, then dropping 8 feet within 12 hours. Bhowmik et al., 1993 also reported that over the period of record, five events occurred in which peak stage exceeded 10 feet. At these stages, discharge was nearly 10,000 cubic feet per second (cfs). The two-year average sediment load was 85,200 tons and 1,000 tons/square mile.

Because monitoring data are very limited, a sediment rating curve developed by Demissie et al. (2004) was used to estimate sediment yields. Demissie et al. (2004) reported a sediment load for Senachwine Creek that was half that reported in earlier work (Bhowmik et al., 1993). Demissie et al. (2004) also estimated sediment yields from tributary streams of the Illinois River based on suspended sediment load data collected by the USGS. The duration of the sediment data ranged from one to 20 years, although most stations had records of less than five years. Because rating curves often underestimate sediment yield, Demissie et al. (2004) also developed a procedure to minimize underestimation. Annual water discharge and sediment yield of mainstem Senachwine Creek estimated by this method and annual totals of precipitation received in the Senachwine Creek watershed for Water Years 1981 to Water Year 2000 are shown (Table 10).

Annual sediment yield values typically vary with log-transformed annual discharge values (Figure 27). Low-flow years 1988, 1989, and 2000 contributed the least sediment into the Illinois River valley (Demissie et al., 2004). Precipitation data confirms these events. 1988 and 2000 rank among the top five driest Water Years (in terms of total precipitation received (Table 10). In Water Year 1993, average annual water discharge and sediment yield were highest out of the 20 years of recorded data in Table 10. Again, precipitation data corroborates this occurrence as 1993 ranks as the second wettest Water Year out of precipitation data for all the 20 Water Years presented in Table 10. (Additional precipitation data from the Mid-Western Regional Climate Center's Chillicothe Station covering the period 1940 to 2008 is found in Appendix F). Intrinsic (e.g., local land use) and extrinsic (e.g., global climate change) effects on variability of flow are not clearly understood. It is known, however, that regional climate has been cooler and wetter over the past 30 years than in the first half of the 20th Century (Changnon et al., 2004). Evaluation of effects of future BMPs will require at least 5-10 years of continuous monitoring of rainfall, flow, and sediment discharge in Senachwine Creek, including monitoring of initial baseline years.

A waterbody inventory was conducted by inspection of the 1998 DOQ aerials and the 2004 DOQ aerials with the intent of determining the density of waterbodies per subwatershed (Figure 28). The impact of these

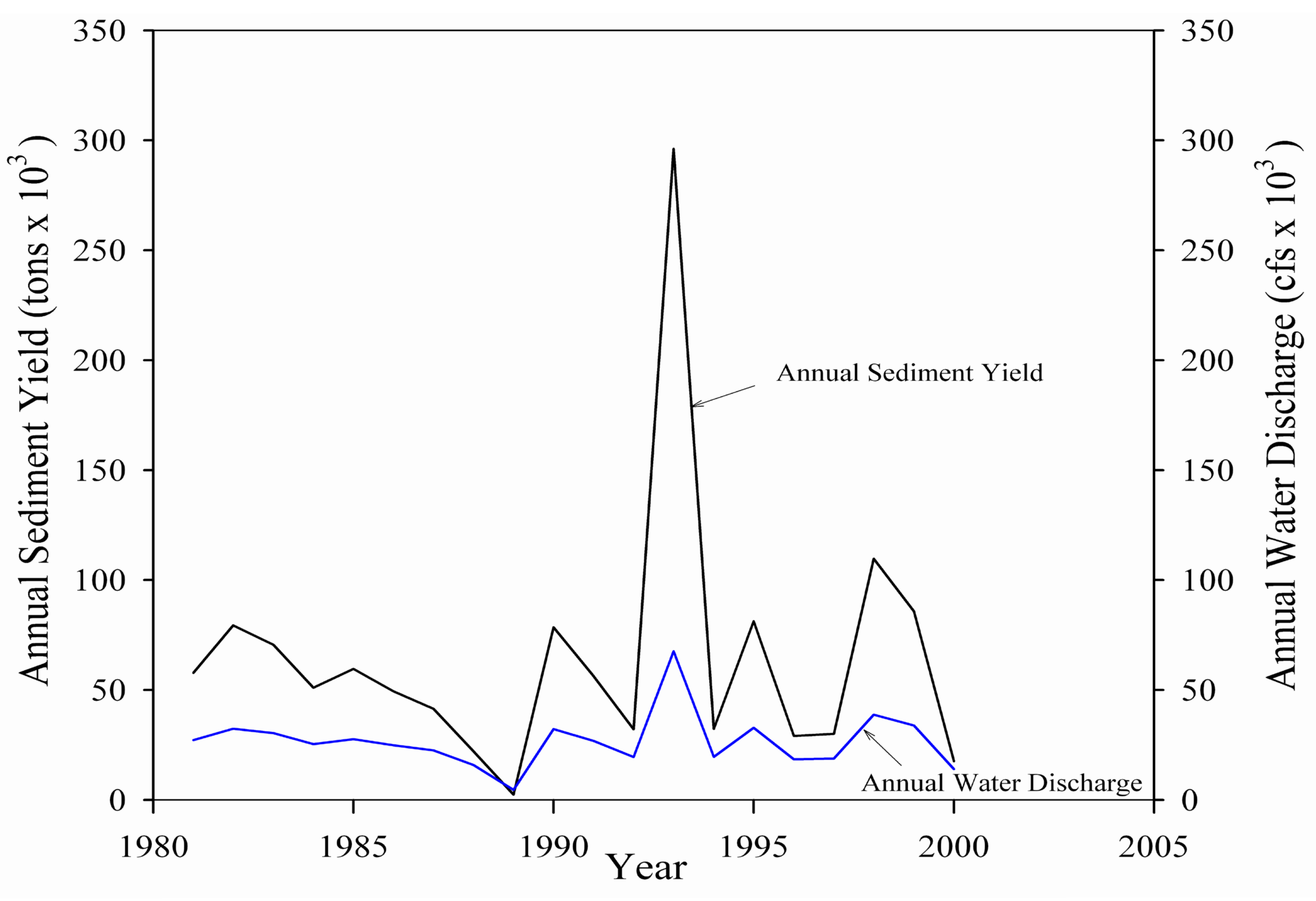


Figure 27. Estimated Annual Sediment Yield and Water Discharge

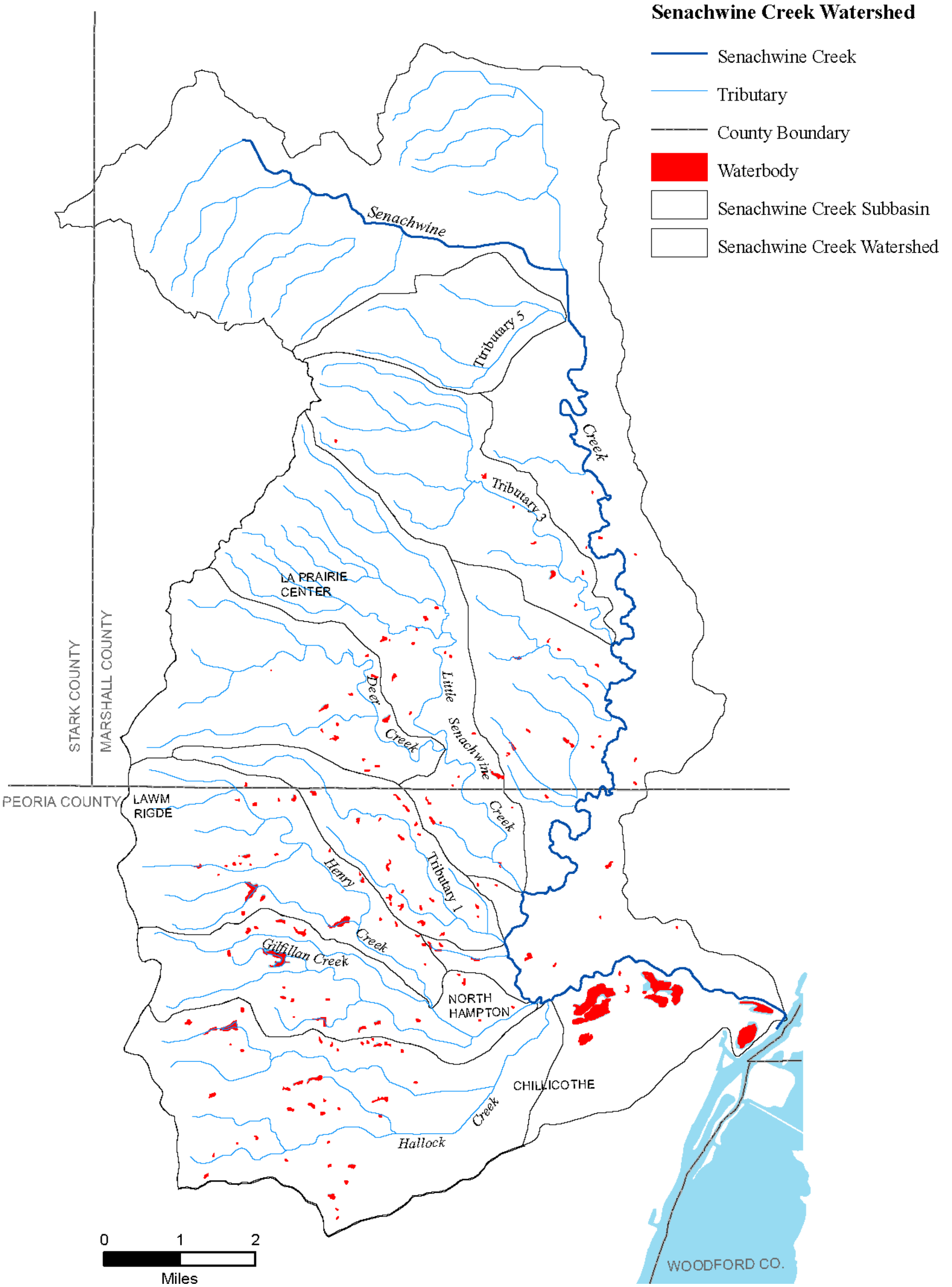


Figure 28. Map showing locations of waterbodies within Senachwine Creek watershed

waterbodies on the channels within the subwatersheds depends on the storage capabilities, base level, outflow and the number of waterbodies that occur in the subwatersheds. Because of time constraints, this inventory only focused on the number of waterbodies and their location. To answer the questions "Are waterbodies contributing to reduction of peak discharges, increase in base flow, or impact to the channel evolution process by promoting channel incision or aggradation?" would require much more analysis. This inventory may give guidance to help select which areas in the Senachwine Creek watershed could help answer these questions.

Table 11 shows the Senachwine Creek mainstem as having the highest number of waterbodies at 42 (22.0%) and a ratio of 1 per 599 acres. Hallock Creek had the second highest number of waterbodies at 41 (21.5%) with a ratio of 1 per 167 acres. Tributary 1 was 6th with a total of 19 (10%) and the smallest subwatershed with a ratio of 1 per 125 acres. Tributary 5 subwatershed is situated in the northern part of the Senachwine Creek watershed where there are no waterbodies (Figure 28). The upper watershed of Senachwine Creek is primarily agricultural and is highly drained. The overall concentration of waterbodies in the Senachwine Creek watershed lies in the southern portion where subwatershed ravine systems outline the Illinois River bluffs. Between 1998 and 2004 there was an increase of 48 waterbodies which is due primarily to the construction of BMP projects during Phase II of the Senachwine Creek Nonpoint Source Control Project.

vi. Changes in Stream Planform: 1939 and 1998 Comparison

Streams evolve dynamically over time in response to natural (e.g., climate and geology) and anthropogenic (e.g., land use and channel manipulation) forcings. Stream channels change their planform by eroding their banks laterally, incising the bed, and depositing sediment on floodplains and within channels. The rates and modes of these behaviors are functions of the geomorphic, hydrologic, and geologic setting.

Stream dynamics were characterized by comparing the 1939 channel planform position of Senachwine and Little Senachwine Creeks to the 1998 position using methods adapted from Phillips et al. (2002; see also Rhoads and Urban, 1997; Urban, 2000). The basic method is to compare channel centerlines digitized from aerial photographs taken at two different points in time. Because only two points were considered in this study, it is not possible to draw definitive conclusions about modes and rates of channel planform change, nor to identify process-response relationships. Instead the goal is to identify relatively active reaches with respect to planform evolution. It was possible to compare those data with channel stability data collected in the field. Observation of features such as exposed sandbars and floodplain deposits can also indicate stream behaviors. During the analysis of aerial photos, observations of land use and land cover change were noted.

Historical aerial photographs (HAPs) taken in 1939 were provided in digital (TIFF) format by the ISGS Digital Archive of Illinois Historical Aerial Photography (http://www.isgs.uiuc.edu/nsdihome/webdocs/ilhap/). Images were orthorectified to a 30 meter (m) digital elevation model (DEM) using Erdas Imagine 8.7, Leica Photogrammetry Suite. Recent (1998) imagery was obtained as digital (Mr. Sid format) orthophotographic quadrangles (DOQs) from the Illinois Natural Resources Geospatial Data Clearinghouse (http://www.isgs.uiuc.edu/nsdihome/ISGSindex.html). (See Appendix G for all the 1939 aerial photographs (and their metadata information) obtained from the ISGS Digital Archive of llinois Historical Aerial Photography). Stream channel centerlines were traced digitally from the 1939 and 1998 imagery using ESRI ArcGIS software. Buffers were generated in the GIS for each stream trace using respective image root-mean-square error. Areal change polygons, representing gross areal change in stream planform between 1939 and 1998, were generated by merging the pair of buffers and extracting the interstitial area.

Subbasin Name	**Square Miles**	**Acres**	**Number of Waterbodies**	**# of pond as Percent of Total**
Subbasin of Mainstem	39.33	25169	42	22
Hallock Creek Subbasin	10.68	6835	41	21.5
Henry Creek Subbasin	6.61	4228	26	13.6
Little Senachwine Subbasin	8.95	5730	23	12
Gilfillan Creek Subbasin	5.4	3455	20	10.5
Tributary 1 Subbasin	3.71	2376	19	9.95
Deer Creek Subbasin	6.34	4060	13	6.8
Tributary 3 Subbasin	6.42	4106	7	3.66
Tributary 5 Subbasin	3.46	2216	0	0
Totals	**90.9**	**58175**	**191**	**100%**

Table 11. Details of waterbodies in subbasins of Senachwine Creek

Change polygons were divided into five dynamic behavior classes: lateral or downstream migration, avulsion, channelization, post-channelization, and chute development. Lateral or downstream migration is a natural process by which streams erode sediment from their outside banks and deposit sediment along their inside banks. Avulsion, an abrupt change in channel position, occurs when a chute develops on the floodplain during high flow and subsequently incises and captures the main flow of the stream. Chutes may also be ephemeral features that may not develop fully to an avulsed channel. Channelization is usually recognized as abrupt change in channel planform that results in a straightened channel where construction activities and an apparent advantage to expedited drainage are evident. Where avulsion, chute formation, or migration occur after a reach shows evidence of channelization, post-channelization is assigned as the dynamic class.

Preliminary results of stream dynamics analysis are given (Table 12 and Figure 29). The ratio of total areal change per unit stream length is a metric of total planform change, with planform stability inversely related to magnitude. Total areal change per unit stream length was greatest (14.9 m^2/mile) in the lower portion of the watershed and least in the middle portion (9.0 m^2/mile) of the watershed. Most of the change not attributed to channelization occurred via lateral and downstream migration of meanders along Little Senachwine Creek and below its confluence with Senachwine Creek, with the magnitude of the changes increasing downstream (Figure 30). Both activity and downstream increase in magnitude could be due to downstream increases in valley slope, discharge, or bedload.

The relatively low ratio of change to stream length (i.e., planform stability) in the middle HUC is probably partly due to bedrock control of the channel that inhibits incision and, where the stream cuts into the eastern valley wall, inhibits lateral migration. The relatively high ratio (11.6 m^2/mile) in the upper HUC is attributable to channelization, the predominant mode of channel planform change there (Figure 31). Channelization was a relatively small portion of total change further downstream. Only two observations of planform change following channelization were initially identified, and those were in the lower watershed where observations of extensive meander migration suggest relatively high intrinsic change.

Since initial stream planform analysis, field staff were able to assess planform characteristics of the two mile channelized reach of Hallock Creek. The lower two mile reach of Hallock Creek expands across the Illinois River floodplain and appears to have been channelized and include constructed dykes upon inspection by the field crew (see appendix G for photos). Observation of the 1939 DOQ aerial photographs shows this reach was straight and dykes were present, indicating channelization of this reach

	Total plan change for all HUCs			HUC 401			HUC 402			HUC 403		
Dynamic Class	Number of Occurrences	Total Area (m^2)	Total Areal Change (%)	Number of occurrences	Total Area (m^2)	Total Areal Change (%)	Number of occurrences	Total Area (m^2)	Total Areal Change (%)	Number of occurrences	Total Area (m^2)	Total Areal Change (%)
Avulsion	14	49768	7	1	353	<1	9	26328	9	4	23088	16
Chute	7	18354	3	1	9147	3	6	14214	5	1	4139	3
Channelization	122	254582	36	93	243970	82	28	9606	3	1	1006	<1
Lateral or downstream migration	409	373438	53	112	45559	15	238	235529	83	60	114640	79
Post-channelization	2	2698	<1	0	0	0	0	0	0	2	2698	2
Total	5540	698839	100	207	299029	100	281	285676	100	68	145571	100
Areal Change: Stream Length	10.3 m2/m			11.6 m^2/m			9.0 m^2/m			14.9 m^2/m		

Table 12. Dynamic Classes of Planform Change in HUC 401, HUC 402 and HUC 403 between 1939-1998

Figure 29. Reaches in red showing significant differences in planform position between 1939 and 1998

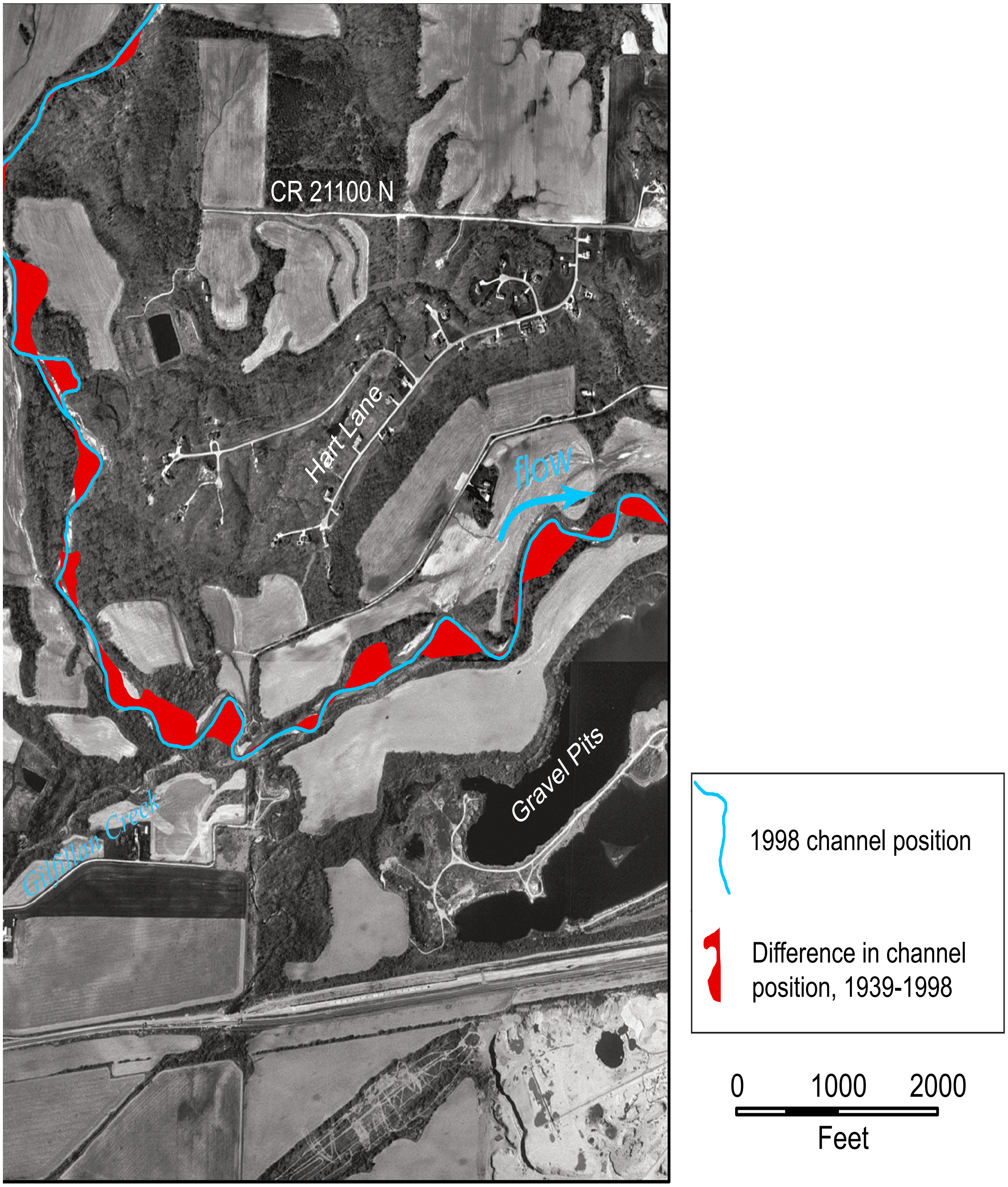


Figure 30. Meanders changed their position throughout this reach between 1939-1998. Red polygons indicate the affected areas

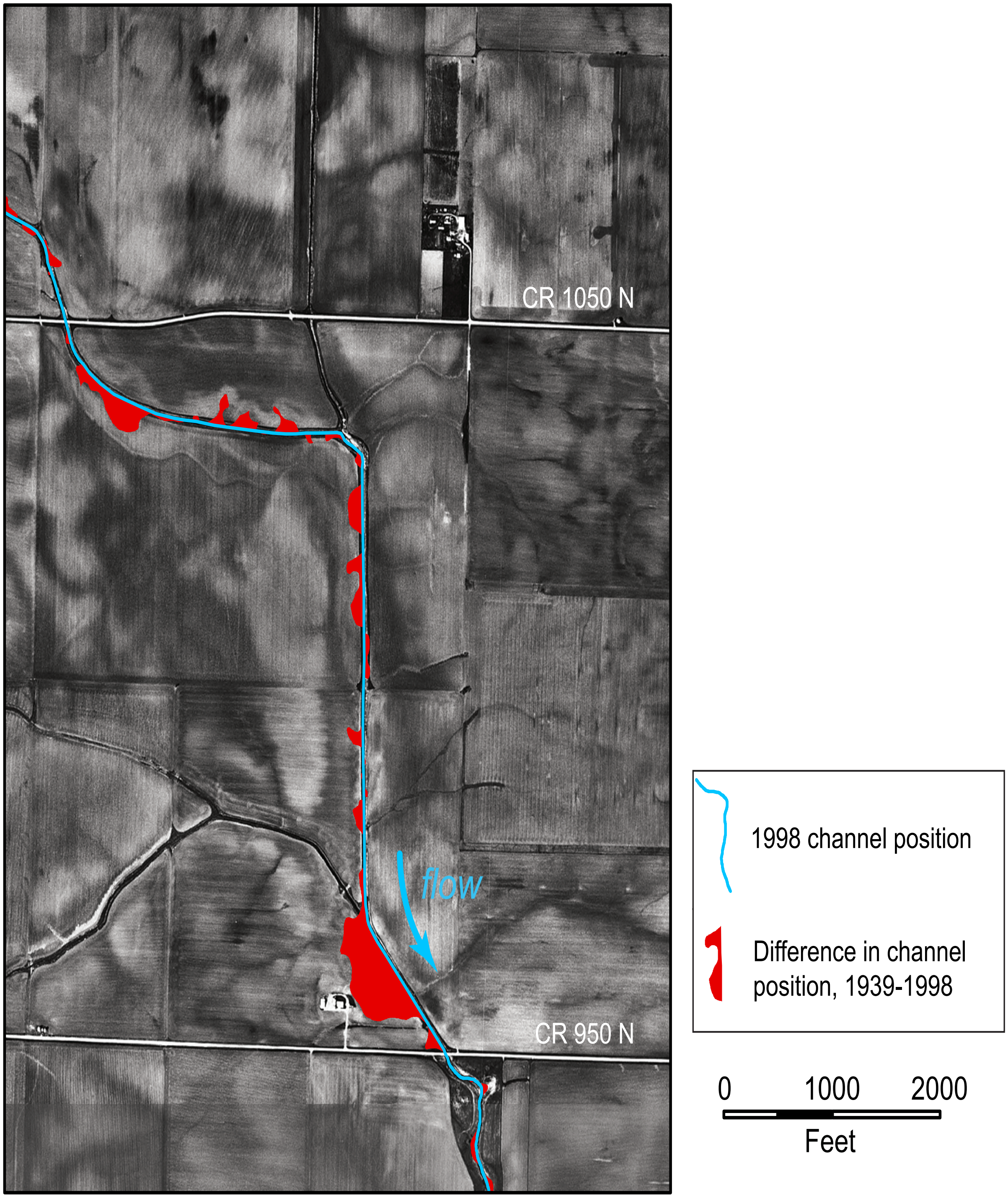


Figure 31. The dominant cause of stream planform change in HUC 401 between 1939 and 1998 was channelization

before 1939. Long-term stability of channelized reaches could be due to low stream power in the upper watershed because of low channel slope there, regular maintenance of straightened reaches, or limitations in discerning changes because of the imagery scale or limited temporal resolution. Field observations of active slumping and use of riprap and fill to stabilize banks along part of the channelized reach near County Road 1050 N (Figure 20) suggest that channel widening or deepening is occurring, phenomena not observable from imagery used.

This stream dynamics aspect of this report characterizes dominant modes and relative activity of stream planform change through the watershed. At this level of study, it cannot be determine if observed changes are in stasis or if they are progressive. However, correlations between areas of planform change and habitat, landscape erosion, channel form, and sediment delivery are strong. The planform analysis and field investigations of channel geomorphology provide corroborating evidence that projects intended to reduce sediment transport should be targeted to lower reaches of the Senachwine Creek mainstem. Relative effects of slope, discharge, and geology (erodibility of channel banks and substrate, and bedload availability) must be distinguished more clearly for project design to proceed. Geomorphic field data collection and analysis of channel gradients also suggest potential projects in tributaries (Little Senachwine, Deer, and Hallock Creeks) to the Senachwine Creek mainstem. It is important to reiterate that correlations between landscape or channel change and stream response are tentative. More comprehensive analyses of stream dynamics are necessary for individual project design and implementation. In particular, stream response cannot be determined after direct modification of stream channels (channelization) or other identifiable land-use changes. Only net rates of planform evolution can be estimated; and actual rates may be significantly higher. Understanding these responses is important for predicting long-term viability of stream restoration projects. Greater understanding could come from examining imagery of intervening years and estimating long-term and synoptic trends in stream power.

vii. Channel Stability and Habitat Integrity

Stage I and Stage VI channels of the CEM generally indicate relative stability. As such, morphological conditions in Stage I and VI stream segments are more likely to support the potential for greater habitat assemblages, barring other negative influences. Theoretically, these CEM channel stages would support relatively high-quality ecosystems (Table 7; Figure 21) (see also Simon, 1989; USACE, 1990; and Federal Interagency Working Group, 1998). The CEM classifications determined in the field in Senachwine Creek watershed generally correlate well with channel stability indices (CSIs). CSI scores greater than 20 have been interpreted to generally indicate dynamically unstable channel conditions. Scores of 11-19 indicate potential instability or transitional conditions, while scores of 10 and under indicate stable conditions (L. Keefer, ISWS, Personal Communication, 2004) (Figure 32). Significant autocorrelation between CEM stage and channel stability indices is expected because CEM stage is a parameter in the stability ranking scheme, and the two indices share some common parameters such as bed material and channel configuration. When poor correlations between stage and stability indices occur, they can almost always be explained by influences from other factors such as bedrock exposure, mass wasting, large woody debris accumulations, etc.

Senachwine Creek shows a lack of correlation between CEM stages and channel stability metrics in certain stream segments (Figure 33). The varied sediment textural classes that comprise the bed material in Stage IV, V, and VI channels in this watershed impact channel processes, modifying channel evolution. For example, Stage IV channels already have degraded and widened to a new state of dynamic stability (Channel Stability Index <10) and often occur where there are large sediment loadings from mass wasting of high valley walls. Such a circumtance is also found where sediment loadings are low because bedrock inhibits channel incision and channel banks are relatively low (insets in Figure 33). As such, instances of mass wasting, exposure of bedrock or large woody debris in the channel bed modify local channel conditions and lead to poor correlations between stage and channel stability indices.

The CEM stage can also be compared to the a biological habitat ranking scheme ‘tuned’ to assessment goals to assess ecosystem health in a watershed. Shields et al. (1998), for example, showed that fish species populations vary with stages of channel evolution in the loess hills of Mississippi. However, such a comprehensive analysis of biological indices and their correlation to CEM stage is beyond the scope of this assessment. Rather, ecological quality of physical habitat was evaluated by using a ranking scheme developed by Barbour et al. (1999). (Copies of evaluation sheets containing ranking schemes for channel stability and biological habitat used at field assessment sites are found in Appendix C).

The metrics of Barbour et al. (1999)s’ ranking scheme are similar to the Quality Habitat Evaluation Index (QHEI) method (OEPA, 1987), although simplified to efficiently and effectively meet the needs of these and similar assessment objectives. Biological habitat index (BHI) scores from Barbour et al. (1999) can range from a low of 11 to a high of 44, with higher

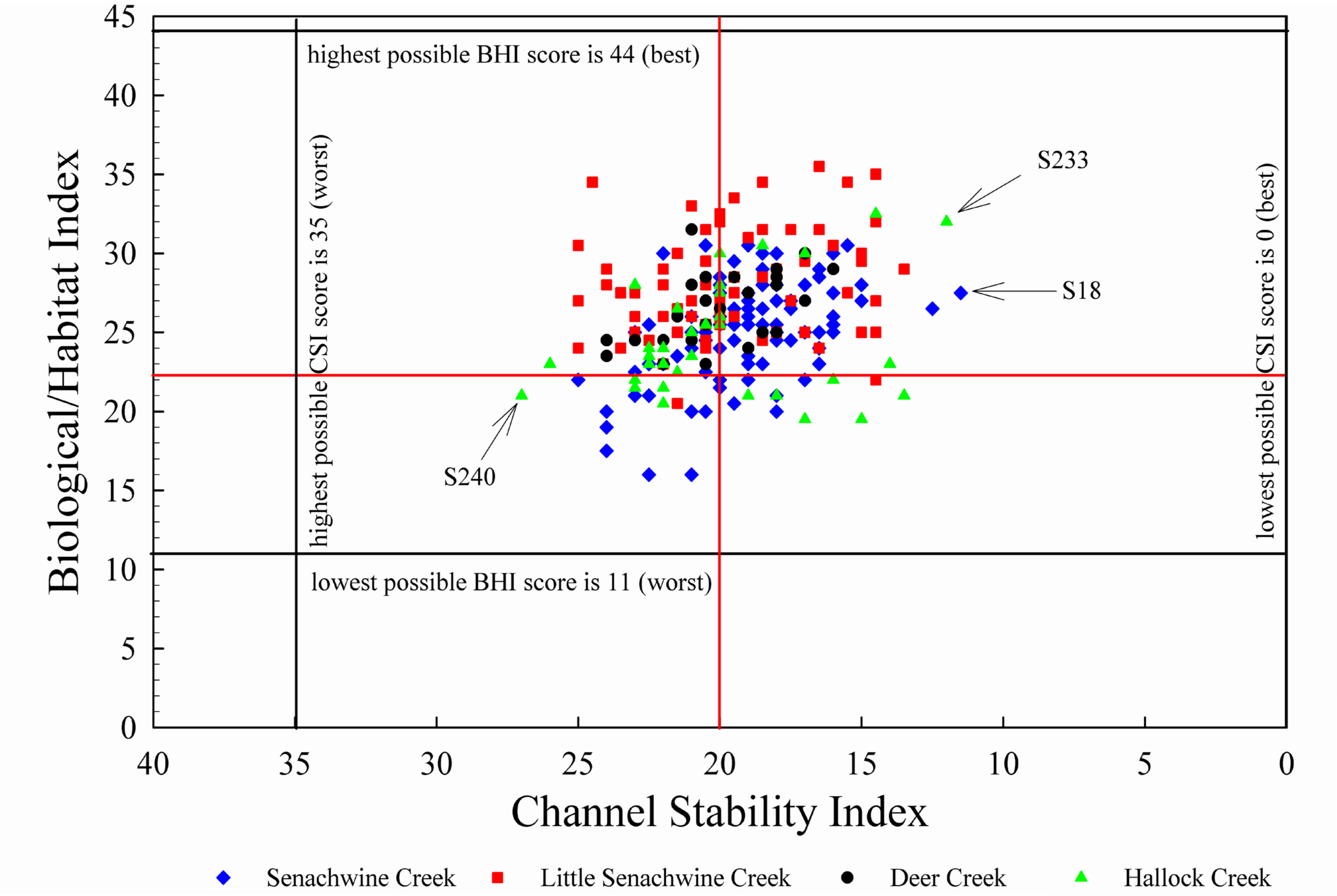


Figure 32. Stream rankings in Senachwine Creek watershed

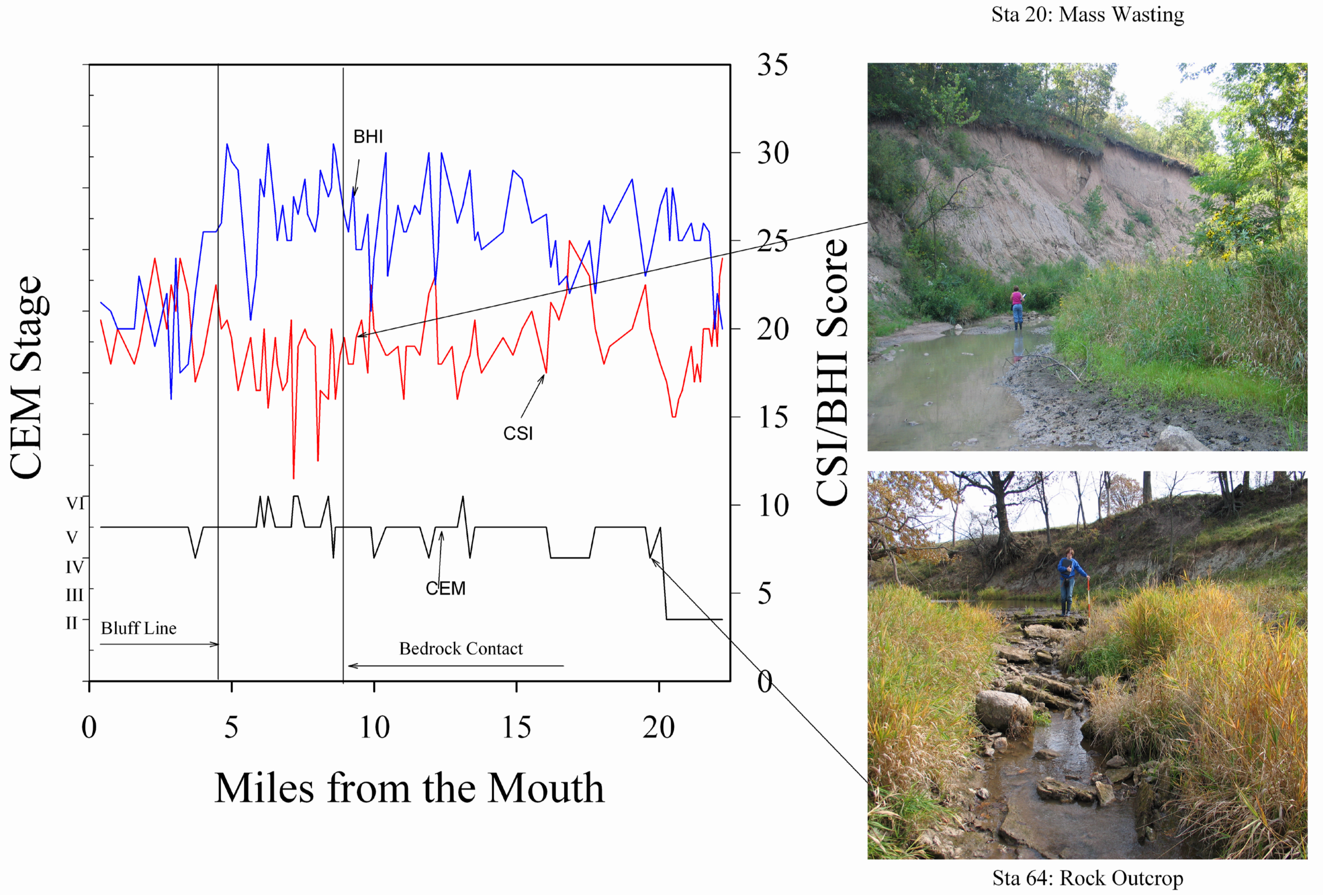


Figure 33. CEM stages as they rank with channel satbility and bilogical habitat indices

scores indicating better habitat (Figure 32). Where Stage VI channel segments occur in the CEM, habitat scores are generally higher. By contrast, where Stage IV channel reaches occur, habitat scores are generally lower unless some other influencing factor modifies the channel segment and its habitat. No statistical analysis has been performed yet on these data because detailed biotic information is lacking. For example, actual fishery and macroinvertebrate data are scarce for this watershed; therefore, these parameters were not examined in relation to stage of channel evolution or habitat indices. Currently, the authors suggest using a habitat score of 25 as a general "working" threshold to delineate between good and poor habitat areas in the Senachwine Creek watershed (Figure 35). Additional data may suggest adjusting this threshold score up or down for this watershed.

Relating BHI scores to more detailed channel stability information from CSI scores provides greater insight regarding stream segment quality (in terms of physical and biological habitat). BHI scores (Barbour et al., 1999) generally correlate well with CEM stages and with CSI scores (Figure 33). As previously noted however, these correlations are not always as clear because singular influences such as large pools formed by beaver dams or large woody debris control channel forms locally. On occasion when large pools were recently formed, channel segments with Stage IV channel forms also had relatively high BHI scores.

Plotting and analysis of CSI and BHI scores on a large, watershed scale offers a unique perspective of the quality of selective stream channels in that watershed. Figure 32 illustrates this for Senachwine Creek watershed. Sites having CSI and BHI scores that fall into the upper right quadrant of Figure 32 indicate better habitat quality systems, while stream segments having CSI and BHI scores that fall into the lower left quadrant are in critical condition, both in terms of stability and habitat conditions. Sites having CSI and BHI scores that fall into the upper left quadrant are unstable sites that seem to support better habitat, while stream segments having CSI and BHI scores that fall into the lower right quadrant are deemed to have potential instability or are transitional with poor habitat.

The mainstem of Senachwine Creek and Hallock Creek have scores concentrated in the lower quadrants whereas Little Senachwine Creek and Deer Creek have scores distributed in the upper quadrants. Notably, several stream segments within the mainstem of Senachwine Creek have scores that fall into the upper right quadrant indicating better conditions for those individual sites. Site # S233 in Hallock Creek had scores that plotted in the farthest upper right quadrant, indicating that this site ranked the highest, in terms of both BHI and CSI scores combined. Site

S18 in the mainstem of Senachwine Creek has the highest CSI score overall, yet with only a fair BHI score. Site # S240 in Hallock Creek had the worst overall CSI score, while simultaneously scoring poorly on the BHI.

Preliminary field data from the Senachwine Creek mainstem indicates relatively good channel stability for most channel segments but poor habitat conditions in lower reaches of the mainstem and in a long channelized reach HUC 401 (Figure 34). (The colored lines in Figure 34, 35, 36 and 37 represent channel stability and biological habitat data collected from all the field sites. Watershed map representations of field assessment results given in Appendix E are found in Appendix H). Based on the combination of channel stability and biological habitat indices, there are four reaches where the channel appears to be out of equilibrium, has relatively poor habitat, or both.

The upper two miles of Senachwine Creek are channelized and show signs of incision. Relatively low BHI scores indicate poor habitat conditions, and this area lacks any appreciable woody riparian vegetation. Dry conditions during the field survey (dry channel bed) contributed, in a large part, to the poor BHI scores that were recorded in the field. The low scores indicate relatively poor habitat in the lower reach of the mainstem of Senachwine Creek. The lower reach flows through the Illinois River floodplain and tends to run underground (dry up) during months of low precipitation. The sand and gravel structure of the Cahokia and Henry formations mentioned in Section V A 5 a ii, (Surficial Geology) is well drained and is much more susceptible to ground water flow than upland areas which contain clay and silt (loess) that are more capable of maintaining a perched groundwater table. Evidence of irrigation systems dotting the landscape throughout the Illinois River floodplain in the lower Senachwine Creek watershed testify to how well the area is naturally drained. A major active pipeline is exposed in lower reaches of Senachwine Creek where the lowermost problem area is delineated based on CEM, CSI and BHI scores. The exposed pipeline is in an area where one would typically expect sediment to aggregate. As such, the exposed pipeline in this location is an indicator of dynamic channel change. Other outlier areas where erosion was occurring also were recorded, but where the data showed scores below the estimated BHI threshold of 25 and exceeding a CSI score of 20 within the same reach helped pinpoint the location of critical target areas. Data suggests that there are primarily four target channel reaches (Figure 34).

Preliminary field data from Little Senachwine Creek indicates very good biological habitat for most channel segments (Figure 35). However, CSI scores indicate most segments are either unstable or relatively unsta-

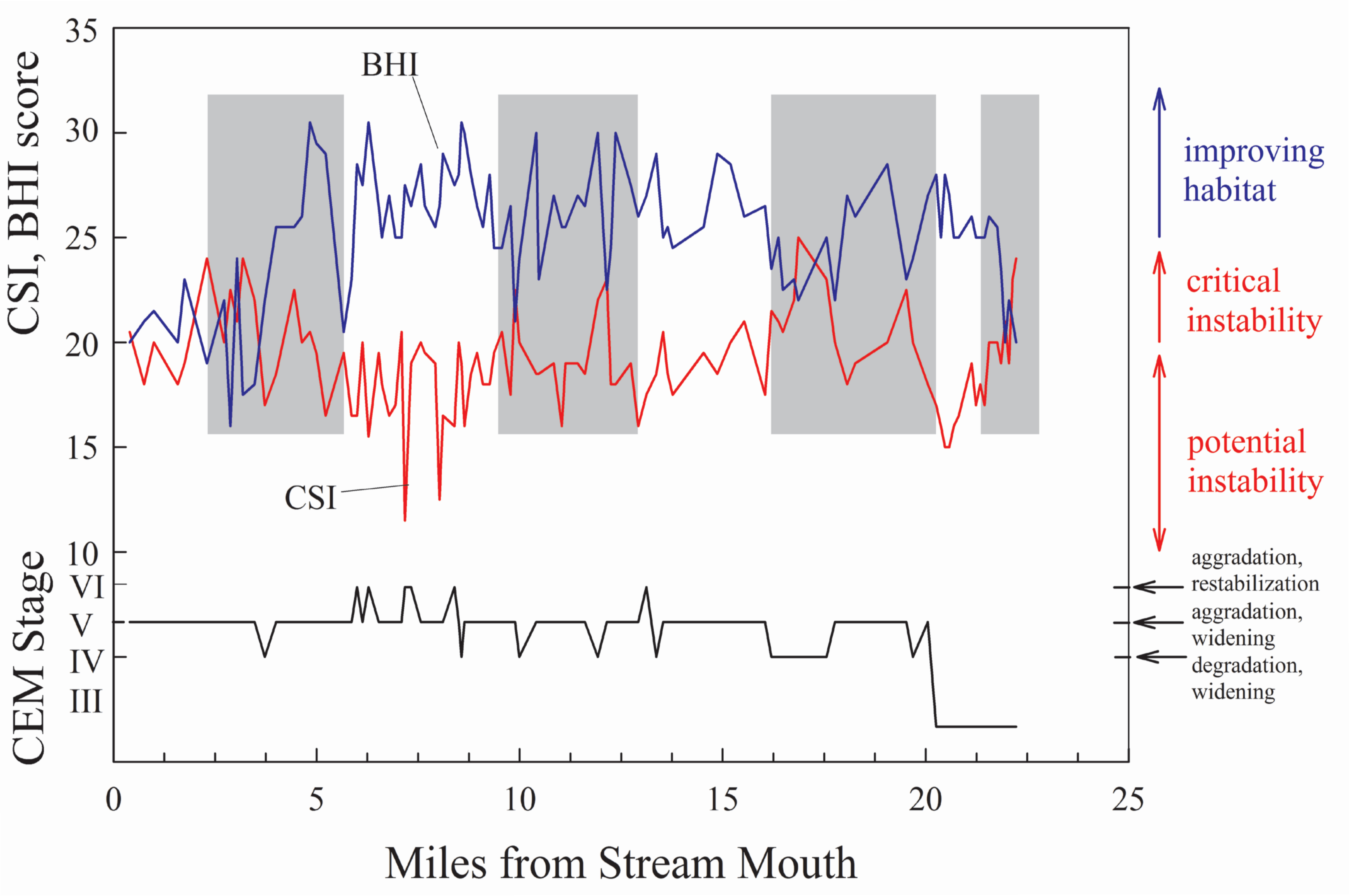


Figure 34. Rankings of Channel Stability (red) and Biologic/Habitat Integrity (blue) for Senachwine Creek mainstem.

ble. No channel segments are highly stable. The authors believe that the occurrence of beaver dams, log jams, and high-point riffles positively influence habitat scores by creating deep pools that contribute to good habitat scores, even though other aspects of channel morphology suggest instability. Channel segments that have indices which indicate channel stability and good biological habitat should show more divergence in CSI and BHI scores as the conditions become more stable and richer in habitat. Aberrations can occur, but they are generally explainable. For example, some mass wasting sites along the channel strongly influence channel stability ranking and establish conditions that register higher scores (less stability), but pooled water from beaver dams, log jams, high-point riffles, etc. minimize the anticipated strong divergence of scores (healthier stream conditions) between biological habitat indices and channel stability indices. Close examination of CSI scores, channel morphology (CEM), and BHI scores indicate at least five and possibly six distinct stream segments, (one to four miles long), that have problematic concerns and appear to either have less physical stability or less habitat or both. Little Senachwine Creek has CEM Stage II morphology in the upper channelized mile, with channel stability scores indicating potential instability and habitat scores indicating poorer conditions upstream. Although this upper channel segment is well vegetated with grass, no standing water and no pools exist. With respect to the entire assessed reach of Little Senachwine Creek, it is not year clear if the majority of segments exhibit problems predominantly from local or systemic causes. Problems in the upper reach appear to be from channelization. Other outlier channel areas exhibiting relatively significant erosion were also recorded, but the data suggest that the critical target areas are those 5-6 channel reaches decided above (Figure 35).

Preliminary field data from Deer Creek indicates three reaches of concern (Figure 36). The longest stream segment is in the middle area of Deer Creek. The next longest is at the upper end of the channel and the third is a short segment near the end of the channel about one-quarter mile upstream of the channel mouth at the confluence with Little Senachwine Creek. It is interesting to note that the segment 1-2 miles from the mouth of Deer Creek is in Stage III (in an actively downcutting phase of channel evolution) yet habitat is comparatively better and the channel is still somewhat more stable than other stream segments in this system. This aberration at the lower end of the channel requires further examination to more accurately explain these conditions. Another aberration exists at the upper end of Deer Creek where both habitat and physical stability scores are good, but channel morphology is in Stages II and III (downcutting phases of channel evolution). Two beaver dams at this upper end created deep pools that definitely improved habitat scores. A

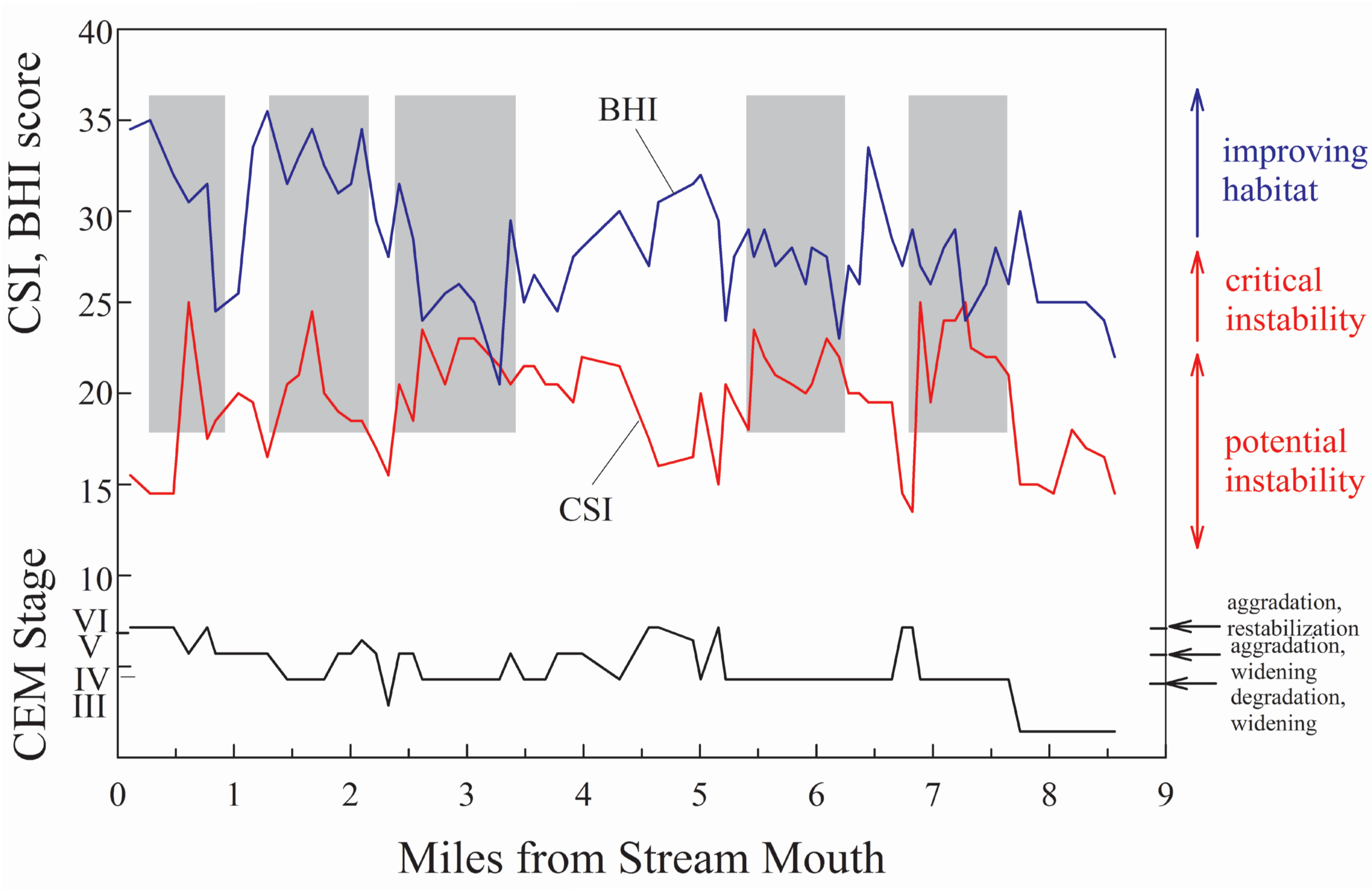


Figure 35. Rankings of Channel Stability (red) and Biologic/Habitat Integrity (blue) for Little Senachwine Creek.

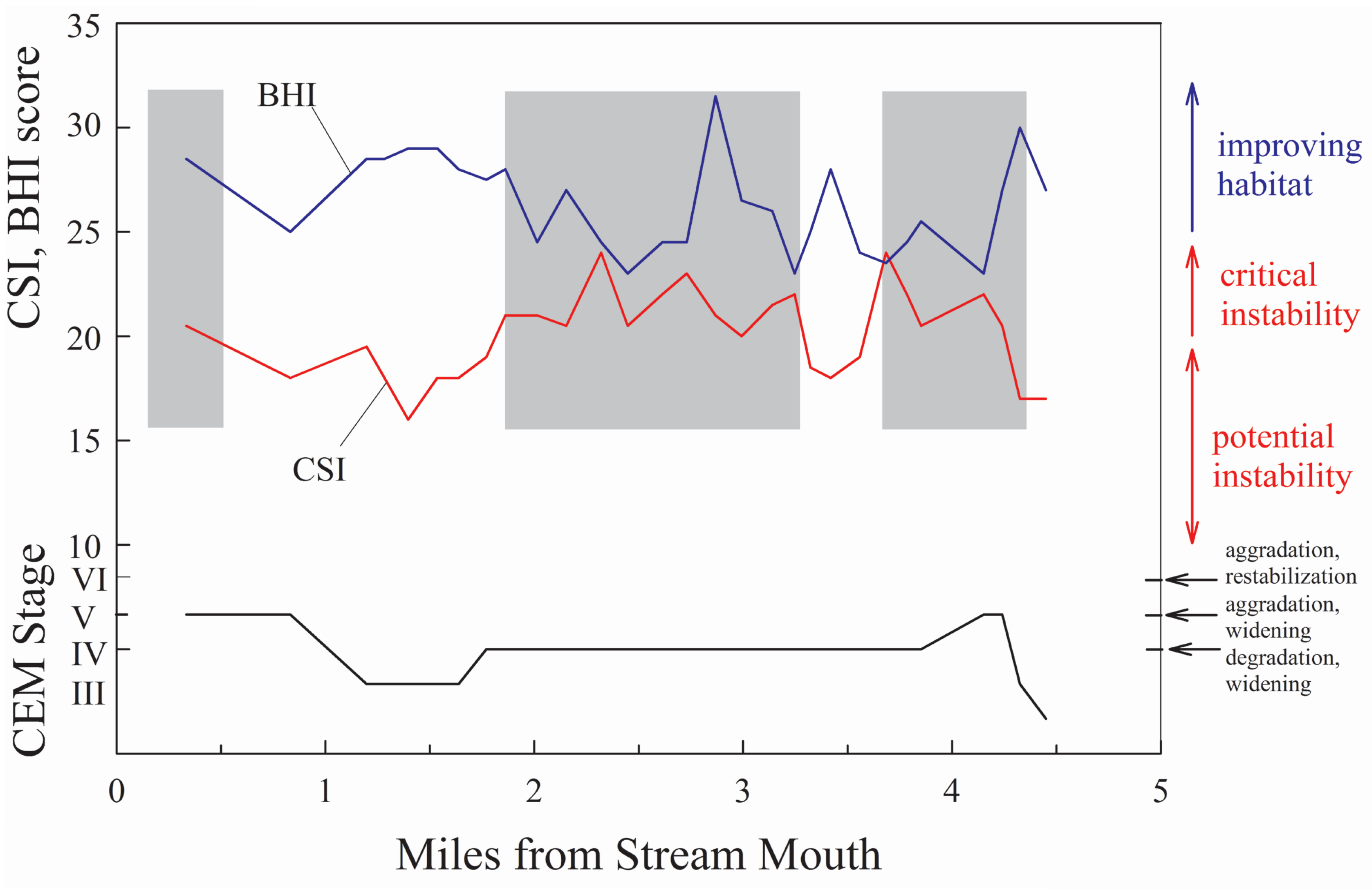


Figure 36. Rankings of Channel Stability (red) and Biologic/Habitat Integrity (blue) for Deer Creek.

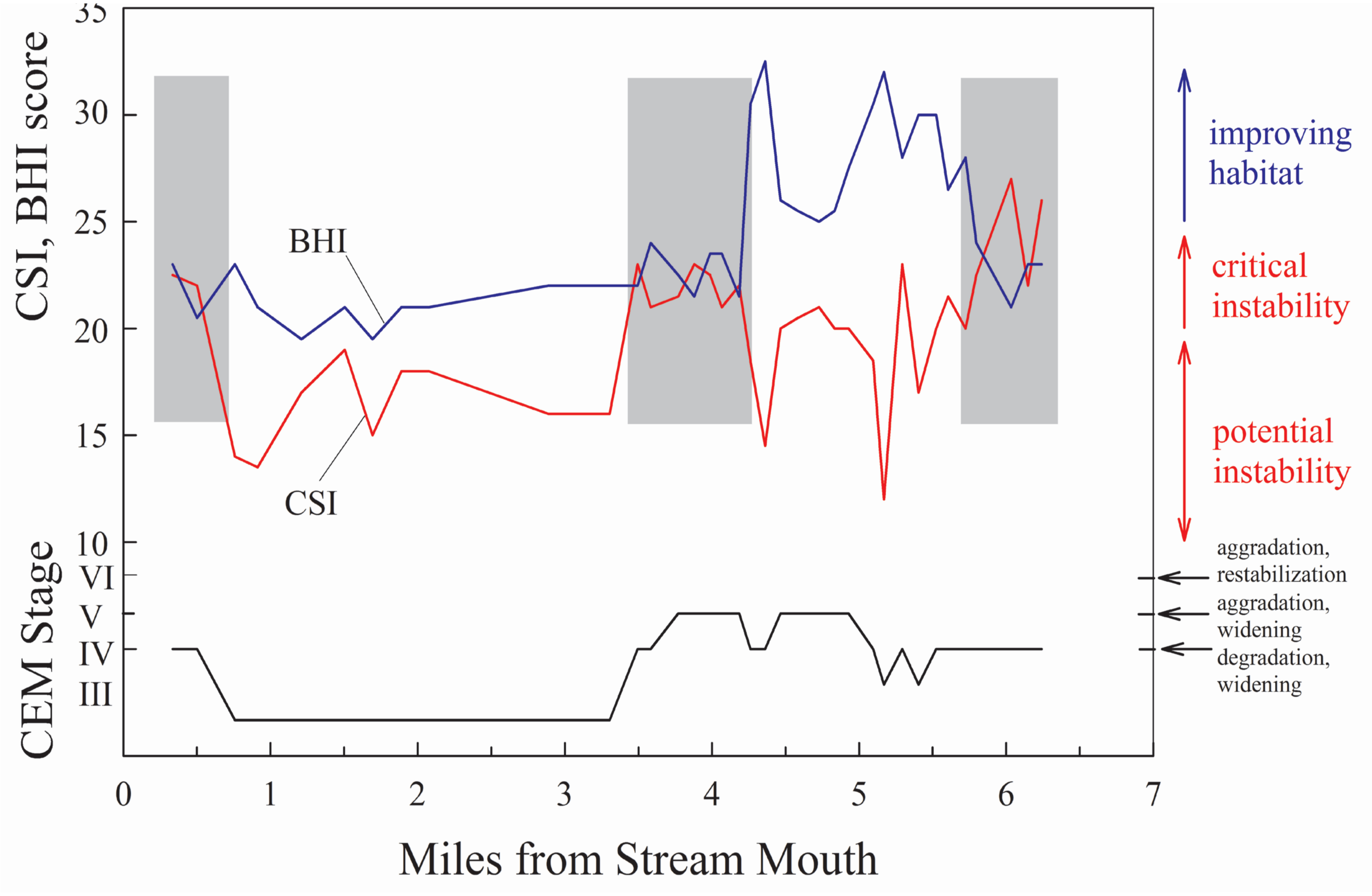


Figure 37. Rankings of Channel Stability (red) and Biologic/Habitat Integrity (blue) for Hallock Creek.

nearby nick-point (headcut) in a side channel that drains into Deer Creek was recorded and scored with the geomorphic CEM and stability protocols as well as with habitat protocols. This channel segment scores as having potential for critical instability and will require further examination and most likley, restoration/grade control.

Preliminary field data from Hallock Creek indicates three reaches of concern (Figure 37). The lowermost channel segment is indicated as a potential problem area based on CEM stage, channel stability, and habitat scores. This area also has an exposed gas pipeline. A channelized reach above this lowermost segment scores as fairly stable, yet has poor habitat scores. This area appears to be aggrading somewhat but also appears to be maintained, As such, it is currently not considered a critical candidate for restoration. The channel profile is steeper downstream of the channelized area and this steeper gradient is where the pipeline is exposed. Just upstream of the channelized area, the channel ascends from the floodplain into the bluffs. At this point, another potential critical channel segment about one mile long has CEM Stages IV and V channel morphology. Channel stability scores indicate a potential for critical instability, and habitat scores indicate relatively poor habitat. The upper most reach has one stretch of channel harboring a significant nick-point and appears to be at Stage II in an area with predominantly Stage IV channels both upstream and downstream. Channel stability scores in this upper segment are indicative of areas having potential for critical instability and relatively poor habitat.

viii. Water Quality

Existing water quality datasets are generalized and not specific to Senachwine Creek and its tributaries. The IEPA (2004) assessed Senachwine Creek as having fully attained its designated use in the aquatic life category based on waterbody-specific monitoring data. Tributaries of Senachwine Creek, including Hallock Creek, Henry Creek, Gilfillan Creek, Little Senachwine Creek, and Deer Creek, were listed in that report but were not assessed.

Many NPS control projects have been implemented in Senachwine watershed with funding made available through Section 319 of the CWA. Any BMPs implemented under Phase II of the Senachwine Creek watershed Project were estimated to have reduced sediment load in Senachwine Creek by 8507 tons/year, phosphorus by 1767 pounds/year, and nitrogen by 14,073 pounds/year (IEPA, 2006b).

The IEPA (2000) classed Senachwine watershed among those having the highest nutrient yields in Illinois, with total nitrate levels in Senachwine watershed of 6.0-9.9 milligrams per liter (mg/L) and phosphorous levels >4.5 mg/L (Figures 38 and 39). Measurements of nitrate concentrations at the mouths of agricultural watersheds during spring and fall field applications were low During the low-flow period of late summer, nitrate concentrations were below detection limits. Contributions of Senachwine Creek to the nitrate and phosphate load of the Illinois River were negligible compared to those of the metropolitan Chicago area (K. Hackley, USEPA, Personal Communication, 2006).

6. Biotic Environment

a. Terrestrial Habitat

Forested ravines are habitat areas of interest in the Senachwine Creek watershed. This ravine area also includes forests on interfluves, slopes, terraces, and riparian areas along Senachwine Creek, Little Senachwine Creek, and a host of other smaller tributaries. Forested ravines are management opportunities areas where both economic and ecological needs can be balanced. Managers of ravine areas can selectively harvest non-native and invasive woody species to open crown patches, allow sunlight to penetrate and the ground forest layer to flourish. Such practices improve overall forest structure, while simultaneously providing lumber for sale.

See Figures 40, 41, 42, 43 and 44. Tables showing detailed information on threatened and endangered species for plants, amphibians, birds, mammals and reptiles can be found in Appendix I.

b. Wetlands

Soils classed as “hydric” have properties that show they are, or were once, wetlands. Figure 45 shows soil map units within the watershed that are considered to have hydric properties throughout (Soil Survey Staff, 2005a, 2005b). These areas have potential for wetland recreation or restoration to achieve ecosystem restoration goals, including sediment runoff reduction, improved wetland quality, and flood control. Hydric soils cover about 14% of the watershed and range in size from 0.04 to 640 acres, although the median size is 5.8 acres. Peoria County also has soil map units with small inclusions of hydric soils, less than 0.3 acres each, and thus are assumed to be unlikely sites for wetland projects.

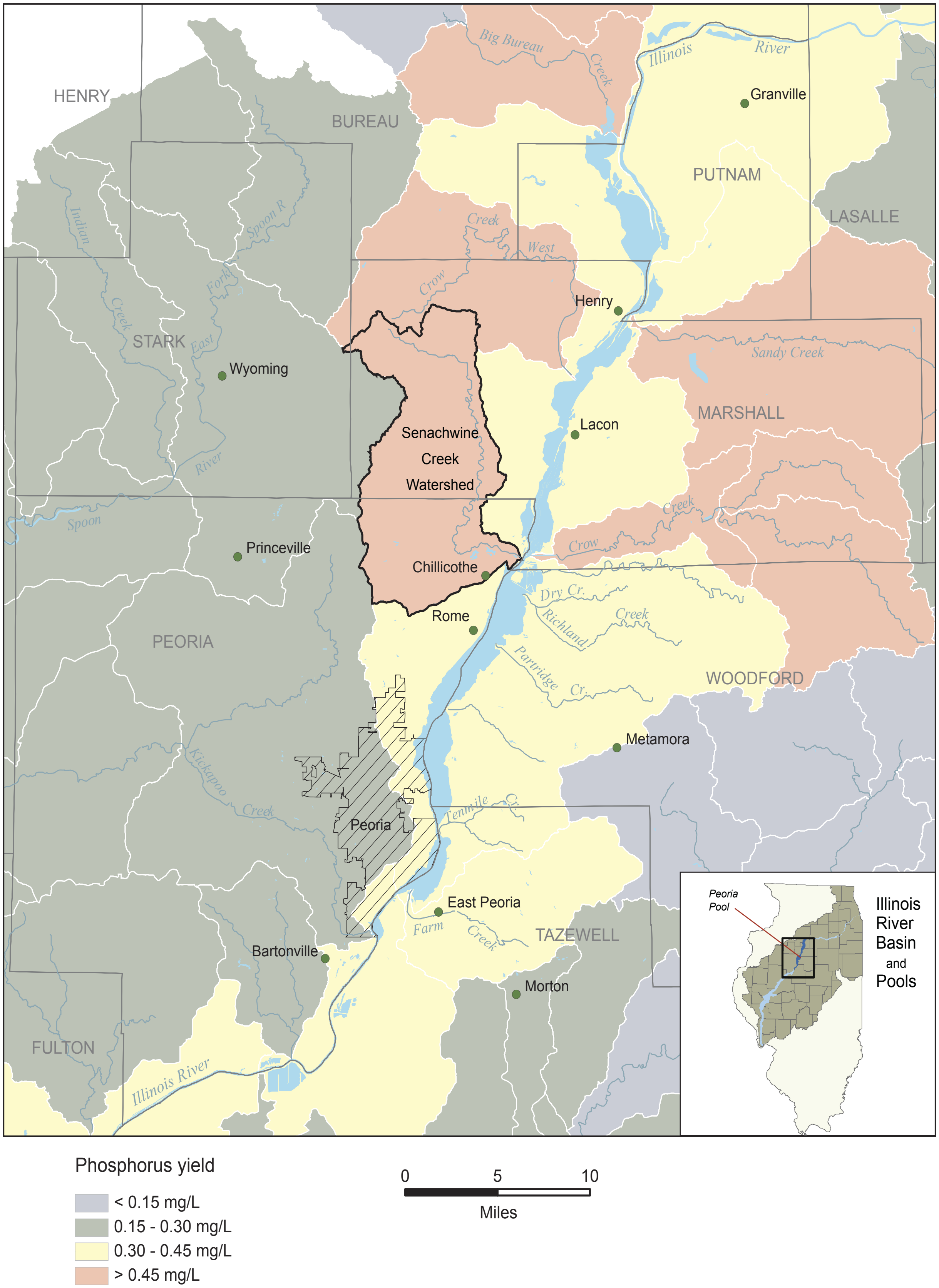


Figure 38. Estimated Phosphorous yield in Senachwine Creek watershed (Illinois EPA, 1999)

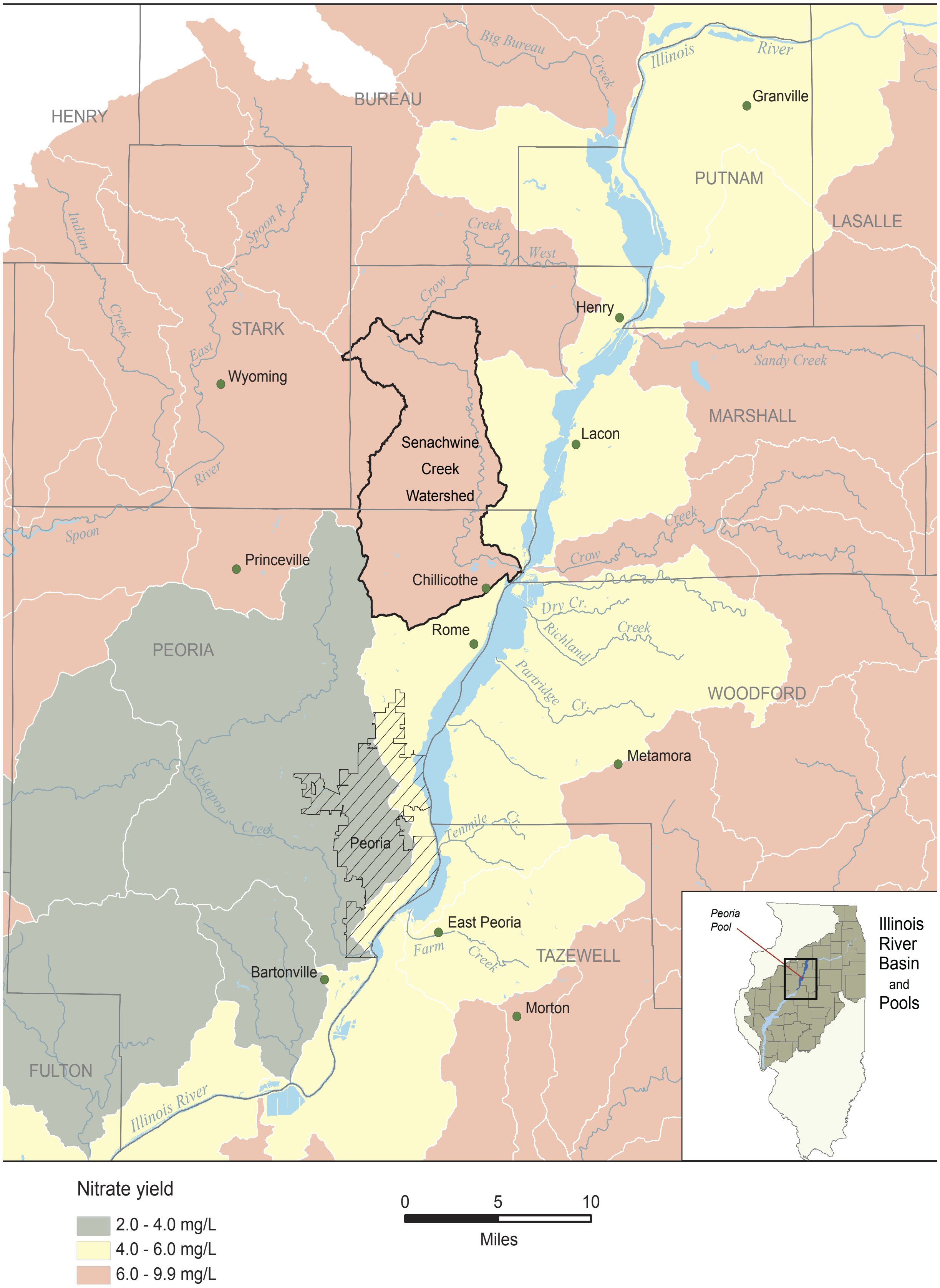


Figure 39. Estimated Nitrate Yield in Senachwine Creek watershed (Illinois EPA, 1999)

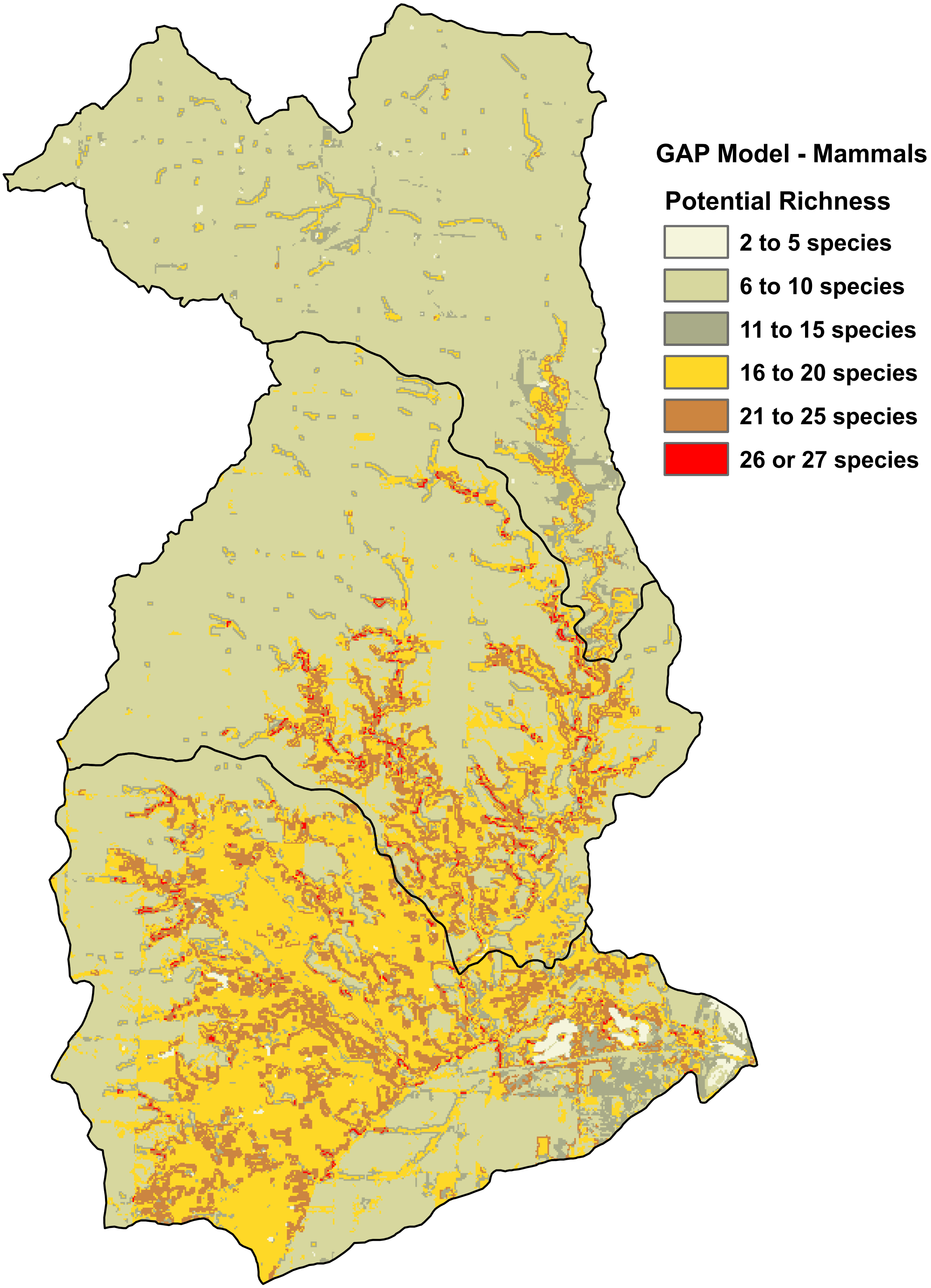


Figure 40. Species richness of mammals in GAP model (IL-GAP, 2004)

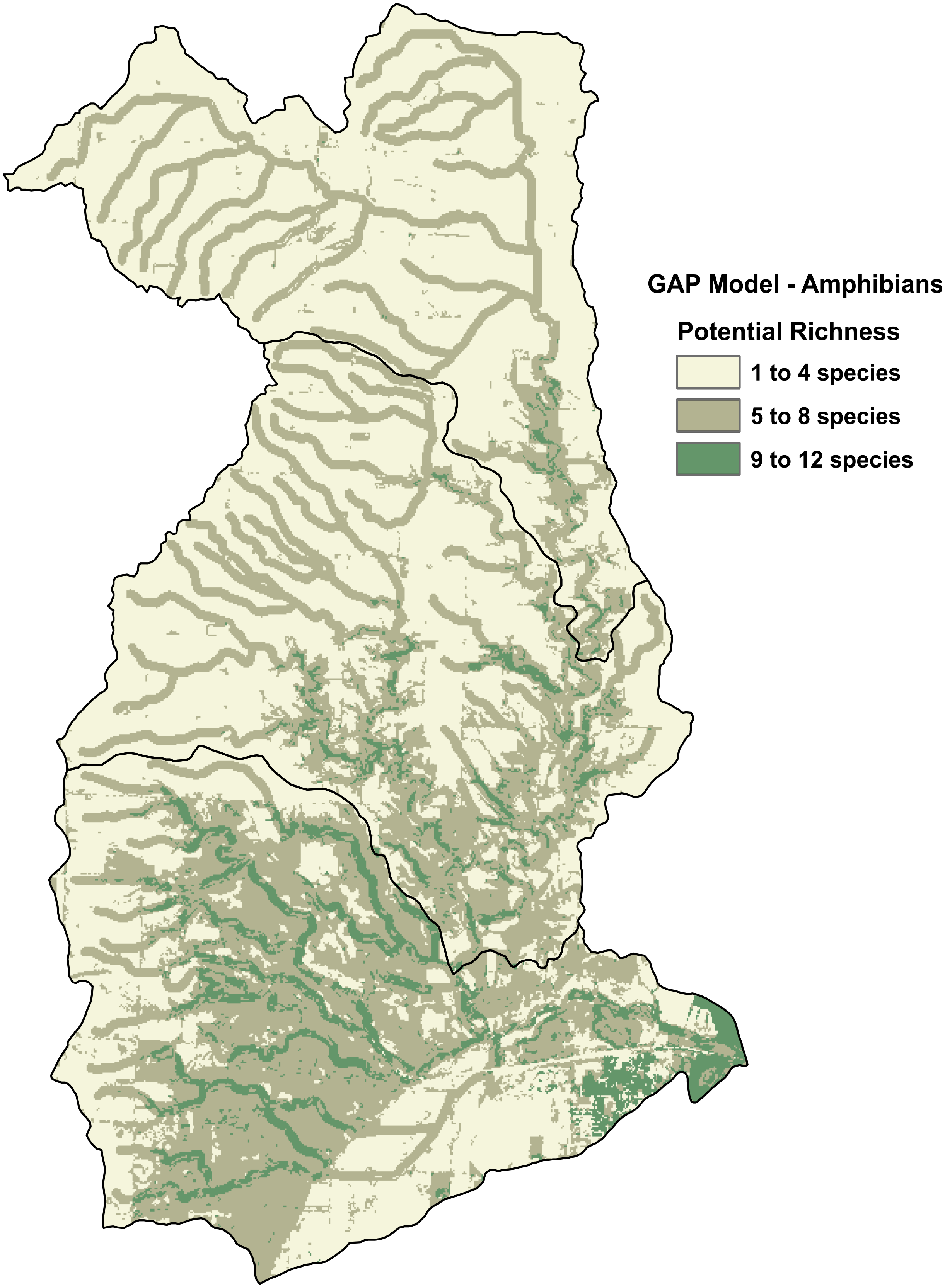


Figure 41. Species richness of amphibians in GAP model (IL-GAP, 2004)

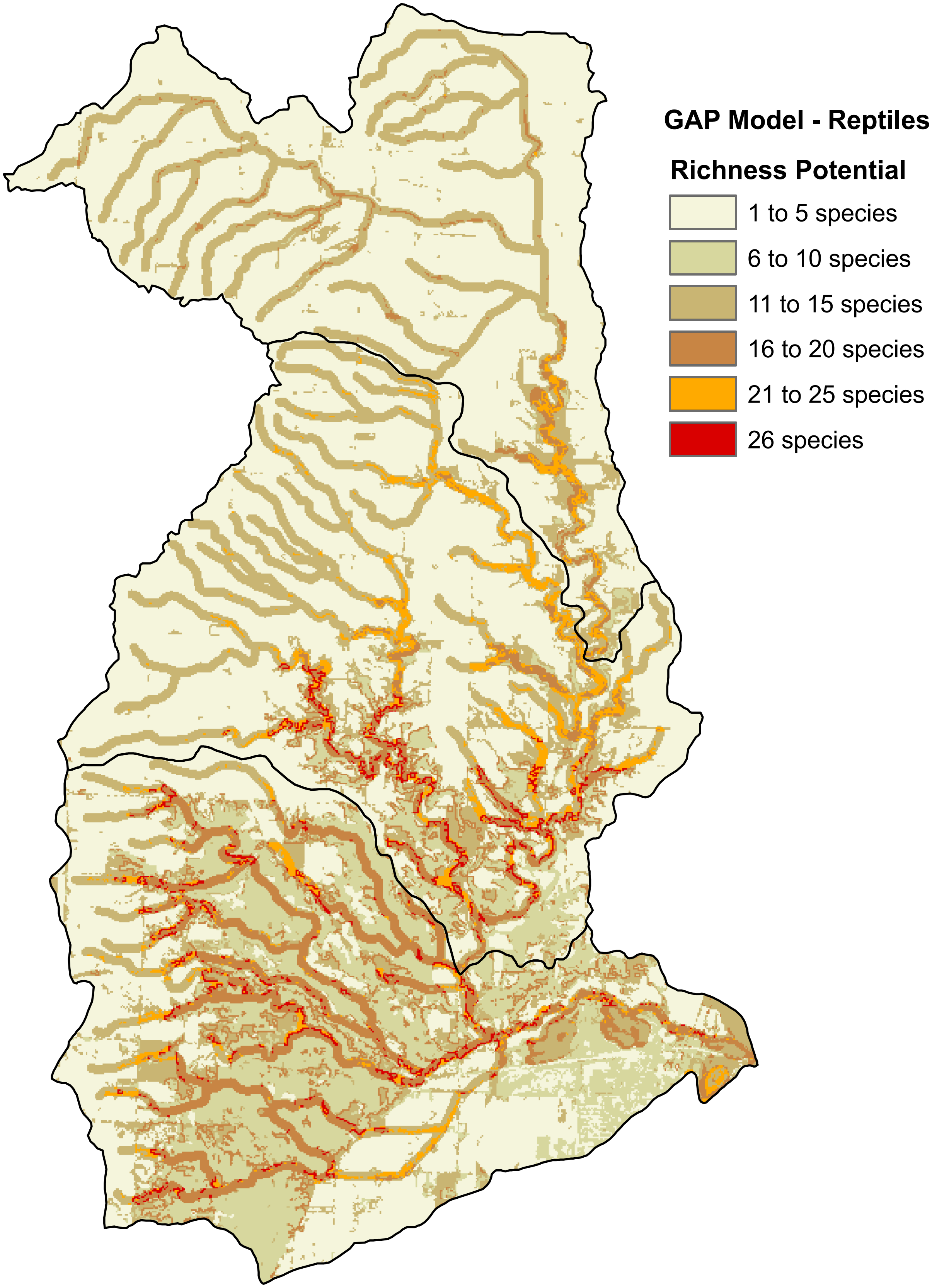


Figure 42. Species richness of reptiles in GAP model (IL-GAP, 2004)

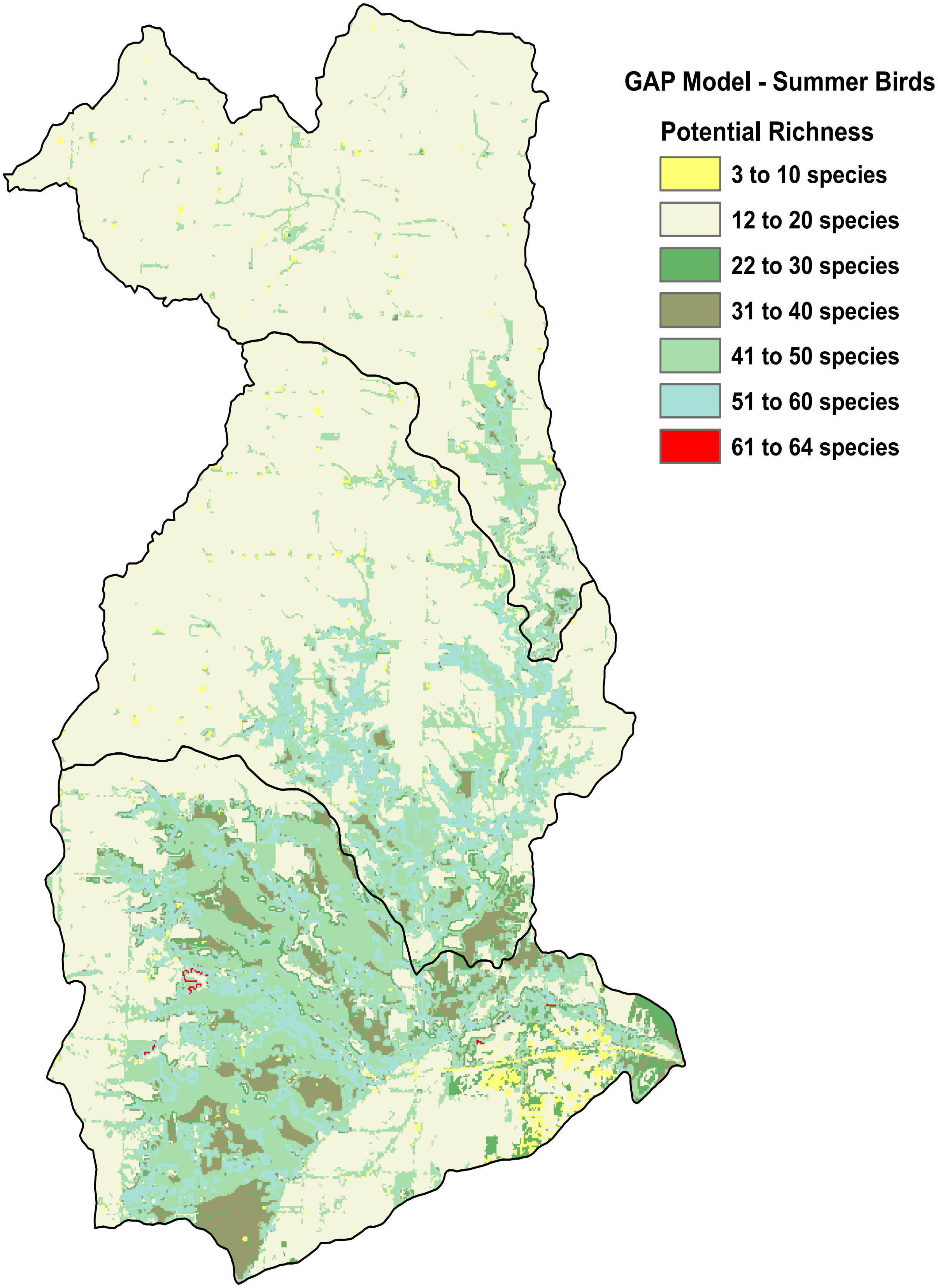


Figure 43. Species richness of birds in GAP model (IL-GAP, 2004)

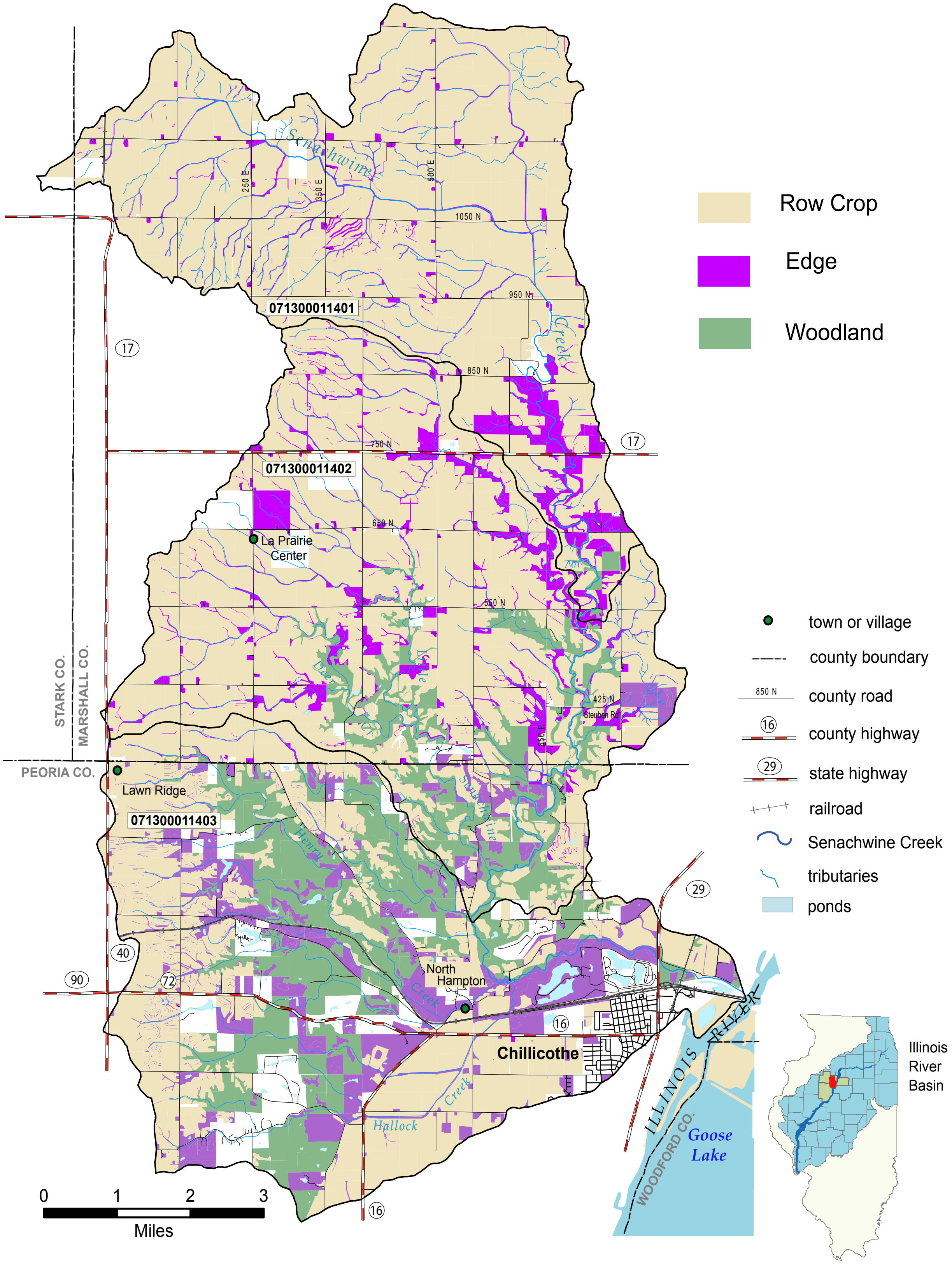


Figure 44. Potential Habitats in the Senachwine Creek watershed

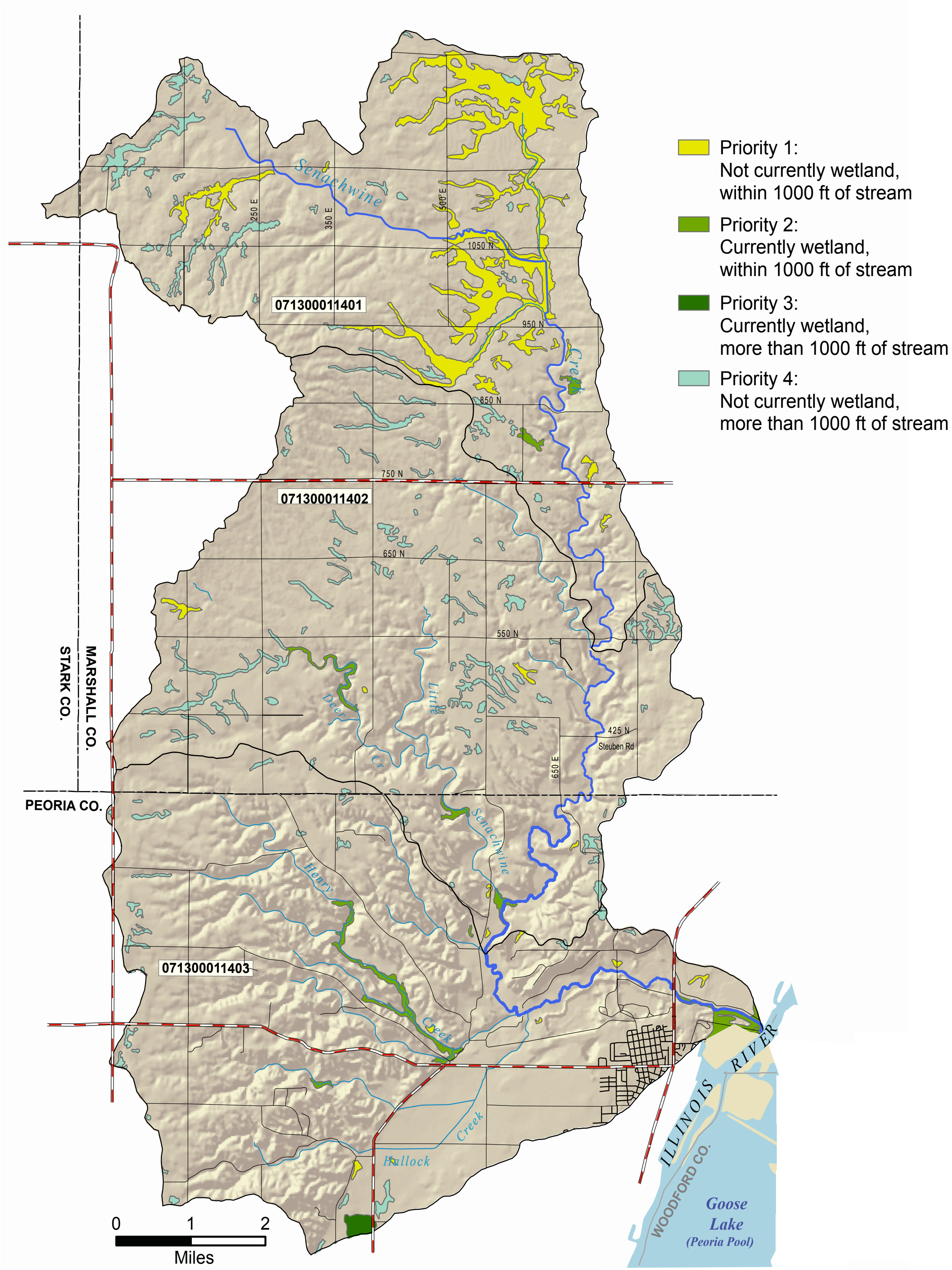


Figure 45. Areas of Soils Considered 100% Hydric (Soil Survey Staff, 2005a). To prioritize sites for potential wetland restoration or recreation, polygons were ranked by proximity to major streams in the watershed and occurrence of existing wetlands

Existing wetlands were interpreted for the land cover map (nominal 1:100,000 scale) of Figure 11. These areas are independent of the National Wetlands Inventory or NWI (nominal 1:24,000 scale). Although their accuracy is low and the scale is relatively coarse, IL-GAP data are preferred over NWI data because aerial imagery source data were 25 years newer, fluctuating water regimes were characterized, and results do not suffer from the digitization error inherent in the NWI creation (D. Luman, ISGS, Personal Communication, 2006). The wetland land cover class occurs over about 2% of the watershed across uplands and floodplains in the very lowest portion of HUC 071300011401, and across HUC 071300011402 and 071300011403.

Clearly, the largest area of hydric soils is in the glacial lake plain of HUC 071300011401 (Figure 45). This is also the one region where no wetland landcover class occurs (Figure 11). July 1939 aerial photography showed the northern tributary as partly ditched and tiled, but the main stream appeared to be strongly meandering and free flowing (Figure 46). By 1988, however, both the mainstem within the glacial lake plain and northern tributary were almost completely altered.

To prioritize areas for potential wetland restoration projects, proximity to main stream courses and existing wetlands were considered (Figure 45). Areas within 1000 feet of a stream were ranked higher because of the project focus on stream corridors. Present wetlands could be used in two different ways. On one hand, an existing wetland could be considered highly valuable as the start of a more extensive wetland because wetland function already exists that may be easier for projects to enhance than to create or restore an area with no wetland function. On the other hand, it may be more valuable to distribute wetland function more widely across the watershed; if so, areas where wetlands do not presently occur should be prioritized. The latter was chosen for illustrative purposes. Thus, Priority 1 wetlands are those areas not presently wetland and within 1000 feet of a major stream channel; Priority 2 wetlands are those that have one or more wetlands (IL-GAP, 2001) and are within 1000 feet of a major stream channel; and Priority 3 wetlands are those wetlands more than 1000 feet from a stream channel (Table 13). Areas with hydric soils but no existing wetlands and more than 1000 feet from a stream channel were classed as Priority 4. Nearly all of the soils classed as Priority 1 are poorly drained (Soil Survey Staff 2005a, 2005b), which may have implications for project goals, design, and long-term success.

c. Aquatic Habitat

A Biological Stream Characterization (BSC) Work Group was convened to

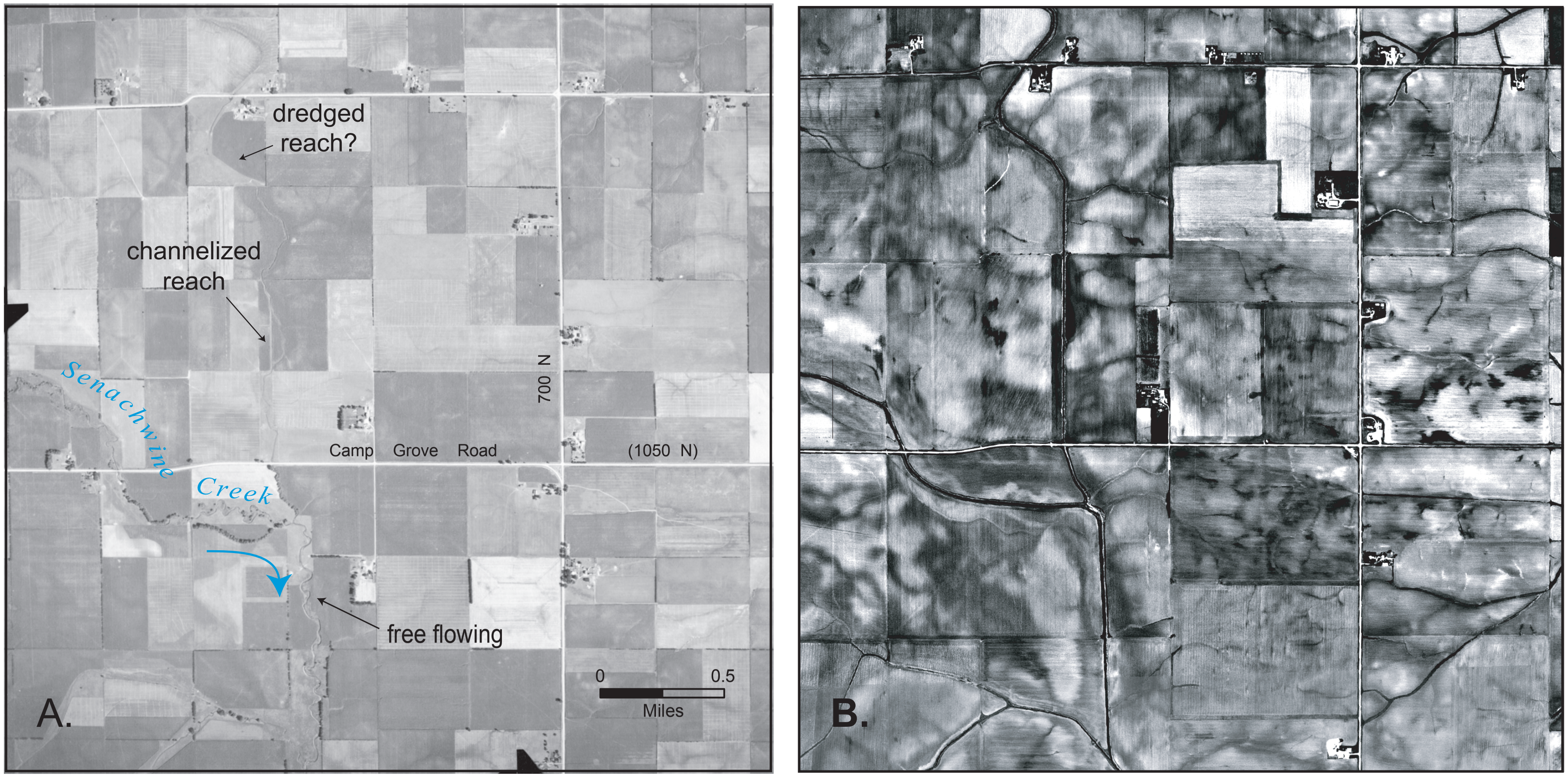


Figure 46. (A) Portion of July 30, 1939 airphoto of the confluence of Senachwine Creek and a northern tributary in a glacial lake plain. Some reaches showed signs of alteration, but the mainstem was free flowing. Image obtained from ISGS Historical Airphoto Archive. (B) The same area in 1998. Senachwine Creek was completely altered by this time. Image is a USGS DOQ

PRIORITY	CRITERIA	FREQUENCY	TOTAL AREA (acres)
1	No existing wetlands, <1000 ft from stream	68	3,680
2	Existing wetlands, <1000 ft from stream	20	1,040
3	Existing wetland, >1000 ft from stream	2	134
4	No existing wetlands, >1000 ft from stream	306	3,070

Table 13. Prioritization of Potential Wetland Projects

develop a statewide biological classification of Illinois streams in 1984. The first BSC report, published as Special Report No. 13 of the State Water Plan Task Force (Hite and Bertrand, 1989), provided a map of streams rated and described the process and criteria for developing BSC ratings. The BSC report was developed as an aquatic resource management tool. Criteria used to identify streams or stream segments were based primarily on the fish community as enumerated by the Index of Biotic Integrity (IBI). The 12-metric IBI encompasses trophic composition, abundance, and condition of the fish community (Karr et al., 1986). The IBI scoring system was adjusted to reflect regional differences and stream size (Hite and Bertrand, 1989). Resulting scores ranged from 12 to 60, with higher scores reflecting a fish community characteristic of a system with little human influence and lower scores for a fish community that departs significantly from the reference condition.

When qualitative stream fish data were unavailable, BSC scores were derived from subjective evaluation of fishery information or macroinvertebrate community data. The Macroinvertebrate Biotic Index (MBI) used for this BSC is a modification of a biotic index developed in Wisconsin (Hilsenhoff, 1982). Tolerance values assigned to each taxon and relative abundance of those taxa in the sample are summed to achieve a 0-11 scale, where low values indicate good water quality and high values, degraded water quality (Hite and Bertrand, 1989). The MBI primarily was used to rate poor (Class D) and very poor (Class E) streams (Bertrand et al., 1993; Table 14).

The BSC objectives were to inventory the nature, extent, and distribution of Illinois stream resources and to identify stream segments of exceptional quality that warrant special consideration for protection. A five-tiered classification system was developed, and streams were ranked into categories (Table 14). The Senachwine Creek mainstem was classified as a Class B stream (Bertrand et al., 1993; Figure 16). Those highly valued aquatic resources are characterized as good fishery for important gamefish species even though species richness may be moderately below expectations for the size of the stream or geographic region. Smaller

Stream Class	Range of Scores	BSC Category	Biotic Resource Quality Description
A	51-60	**Unique Aquatic Resource**	**Excellent**. Comparable to the best situations without human disturbance
B	41-50	**Highly Valued Aquatic Resource**	**Good**. Good fishery for important gamefish species; species richness may be somewhat below expectations for stream size or geographic region.
C	31-40	**Moderate Aquatic Resource**	**Fair**. Fishery consists predominantly of bullheads (Ictalurus spp.), sunfish (Lepomis spp.), and carp (Cyprinus carpio). Species diversity and number of intolerant fish reduced. Trophic structure skewed with increased frequency of omnivores, green sunfish or tolerant species.
D	21-30	**Limited Aquatic Resource**	**Poor**. Fishery predominantly for carp; fish community dominated by omnivores and tolerant forms. Intolerant macroinvertebrates rare or absent; moderate, facultative and tolerant organisms dominate benthic community. Species richness may be notably lower than expected for geographic area, stream size or available habitat
E	<or= 20	**Restricted Aquatic Resource**	**Very Poor**. Few fish of any species present; no sport fishery exists. Intolerant macroinvertebrates absent; benthic community consists of essentially tolerant forms, or no aquatic life may be present. Species richness may be restricted to a few oligochaete or chironomid taxa.

Table 14. Biological Stream Characterization

tributary streams to Senachwine Creek were not rated because of lack of data.

The IDNR completed a fish survey for a 1200-foot segment of the lower reach of Senachwine Creek immediately upstream of the Benedict Road Bridge and about 2.5 miles upstream of the mouth in September 1997 (D. Carney, IDNR, Personal Communication, 2005). This stream section encompasses one of the completed streambank stabilization sites recognized as the Bob Shepard site. This segment previously was sampled for fish in June 1967. Sample data indicate an increase in species diversity from 16 species in 1967 to 25 species in 1997. Additional species from the 1997 survey included, golden redhorse (*Moxostoma erythrurum)*, stonecat (*Noturus flavus*), largemouth bass (*Micropterus salmoides*), blackside darter (*Percina maculate*), fantail darter (*Etheostoma flabellare*), orangethroat darter (*Etheostoma spectabile*), and logperch (*Percina caprodes*). Among these are several species that indicate good water quality and habitat. Data also document increasing total catch and biomass of fish. A total of 88 smallmouth bass (*Micropterus dolomieu*), a highly valued sport fish, were collected in 1997 (Table 15) compared to three smallmouth bass in 1967 (Miller et al., 1997).

In 1999, the IDNR completed fish surveys on the same segment of Senachwine Creek surveyed during 1967 and 1997. Species diversity increased in the 1999 fish survey to 30 species and the IBI improved from 46 in 1997 to 50 in 1999 (Table 15). These scores confirm the BSC rating of Senachwine Creek as a Class B stream (Table 14). In general, this moderately diverse stream has five pollution-intolerant fish species present (Table 16). Two of the four pollution-intolerant species collected in the 1999 sample, black redhorse (*Moxostoma duquesnei*) and hornyhead chub (*Nocomis biguttatus*) previously had not been collected from Senachwine Creek (Table 16). These observations reflect good habitat and water quality of Senachwine Creek. The presence of smallmouth bass, largemouth bass, bluegill, and young flathead catfish (*Pylodictis olivaris*) indicate the importance of Senachwine Creek to the sport fishery of the Illinois River.

7. Prioritization Screening Criteria

Because not all areas could be selected for assessment in the first few years of the ILRB assessment effort, a general set of criteria (Table 1) has been used as a “working model” to select initial sub-basins, watersheds, and sub-watersheds for initial assessment (USACE, 2007; White et al., 2005; White and Keefer 2005). Assessment protocols were selected and used to rapidly identify and describe significant erosion problem areas within the ILRB as erosion and sedimentation were deemed to be two of the most important problems with impacts on ecosystem integrity. Sediment delivery, hydrology, and biology were used as major criteria (Table 1, USACE, 2007); however, other criteria also were used to select initial assessment areas from broad areas of interest within the entire basin (White and Keefer, 2005). See Section II of present report.

It also was necessary to develop additional criteria for targeting and prioritizing potential individual restoration sites within each sub-basin, watershed, and sub-watershed (White and Keefer, 2005). These additional criteria are similar to those used to select the initial list of sub-basins, watersheds, and sub-watersheds for initial assessment but are more specific to individual project concerns (see Section II of present report).

Common name	**Scientific name**	**Number of fish collected**	
		9/8/1997	8/10/1999
Gizzard shad	*Dorosoma cepedianum*	1	0
Carp	*Cyprinus carpio*	1	0
Golden Shiner	*Notemigonus crysoleucas*	0	21
Creek chub	*Semotilus atromaculatus*	8	2
Hornyhead chub	*Nocomis biguttatus*	0	1
Central stoneroller	*Campostoma anomalum*	535	526
Suckermouth minnow	*Phenacobius mirabilis*	13	68
Blacknose dace	*Rhinichthys atratulus*	1	1
Striped shiner	*Luxilus chrysocephalus*	56	1
Red shiner	*Cyprinella lutrensis*	26	54
Spotfin shiner	*Cyprinella spiloptera*	0	13
Bluntnose minnow	*Pimephales notatus*	48	63
Emerald shiner	*Notropis atherinoides*	0	5
Bigmouth shiner	*Notropis dorsalis*	652	436
Sand shiner	*Notropis stramineus*	188	503
Quillback	*Carpiodes cyprinus*	207	191
White sucker	*Catostomus commersoni*	1	4
Northern hog sucker	*Hypentelium nigricans*	132	83
Black redhorse	*Moxostoma duquesnei*	0	2
Golden redhorse	*Moxostoma erythrurum*	4	2
Shorthead redhorse	*Moxostoma macrolepidotum*	0	5
Yellow bullhead	*Ameiurus natalis*	5	5
Flathead catfish	*Pylodictis olivaris*	0	7
Stonecat	*Noturus flavus*	4	0
Mosquitofish	*Gambusia affinis*	0	1
Largemouth bass	*Micropterus salmoides*	3	142
Smallmouth bass	*Micropterus dolomieu*	92	23
Green sunfish	*Lepomis cyanellus*	9	13
Bluegill x Green sunfish hybrid	*Lepomis macrochirus x L. cyanellus*	0	1
Bluegill	*Lepomis macrochirus*	1	40
Orangespotted sunfish	*Lepomis humilis*	0	1
Blackside darter	*Percina maculata*	2	1
Logperch	*Percina caprodes*	1	40
Rainbow darter	*Etheostoma caeruleum*	6	0
Orangethroat darter	*Etheostoma spectabile*	0	13
Fantail darter	*Etheostoma flabellare*	1	0
Total fish		1997	2268
Total species		25	30
Electrode minutes		45	32
Index of Biotic Integrity		46	50

Table 15. Fish collected by electric seine from Senachwine Creek, Benedict Road Bridge, 1 mi. NNW Chillicothe, Peoria Co., IL

Family/common Name	Scientific Name	Senachwine Creek					Little Senachwine Creek
		Sparland (7-12N-9E)	Chillicothe (16-11N-9E)	Chillicothe	Chillicothe (17-11N-9E)	Chillicothe (16-11N-9E)	North Hampton (12-11N-8E)
		INHS, 1963	INHS, 1967	IDNR, 1997	IDNR, 1999	INHS, 2002	INHS, 2000
CATFISH/Flathead catfish	*Pylodictis olivaris*				X		
Stonecat	*Noturus flavus*		X	X			X
Mosquitofish	*Gambusia affinis*				X		
SUNFISH/Largemouth bass	*Micropterus salmoides*			X	X	X	X
Smallmouth bass 1	*Micropterus dolomieu*		X	X	X	X	
Green sunfish 2	*Lepomis cyanellus*	X	X	X	X		X
Bluegill x Green sunfish hybrid	*Lepomis macrochirus x L. cyanellus*				X		
Bluegill	*Lepomis macrochirus*			X	X	X	X
Orangespotted sunfish	*Lepomis humilis*				X		
DARTER/Blackside darter	*Percina maculata*	X		X	X		
Logperch	*Percina caprodes*			X	X	X	X
Orangethroat darter	*Etheostoma spectabile*	X	X		X		X
Fantail darter	*Etheostoma flabellare*	X		X			
Total of 39 species	**Number of species in sample**	19	20	24	30	15	15
	Number of intolerant species	1	2	2	4	3	0
	Number of tolerant species	8	7	7	7	3	6
	Number of non-native species	1	1	1	0	0	0

1 = intolerant species, 2 = tolerant species, 3 = non-native species

Table 16. Fish species records from the Senachwine Creek Drainage, Peoria and Marshall counties, Illinois. INHS denotes records from the Illinois Natural History Survey Fish Collection Database. IDNR denotes records from the Illinois Department of Natural Resources, Division of Fisheries Database.

B. Expected Future without Project Conditions of Watershed

1. Prioritization Screening Criteria (from Table 1)

Data suggest that stream channels in the Senachwine Creek watershed are evolving from highly unstable conditions to more equilibrated channel forms that produce less sediment. It is anticipated that increased fragmentation of habitats, increased impermeable acreage from urban development, and intense agricultural production will continue and sustain erosion and sediment transport at rates too high to maximize ecosystem integrity or improve water quality. Although there may be actions intended to improve water quality independent of projects derived from this study, projects not implemented under a comprehensive plan will have limited effects.

Without this project, watershed planning and implementation efforts may not proceed as vigorously as with the comprehensive project in place, and there will continue to be relatively high rates of sediment contribution to the Illinois River mainstem, including sediment delivery to specific high-value habitat from sources within the Senachwine Creek watershed. A reduction of habitat acres will occur in currently connected vegetated areas of floodplain, in larger patches of forest, in grassland areas, and in riparian areas. Without the project, there likely will be no reduction in unnatural peak discharge along the Senachwine Creek mainstem and its tributaries, nor a reduction in incidences of low-water stress to aquatic organisms. Exposed pipelines endanger ecosystem health and possibly public health and safety. It is considered questionable just how full-use support or even partial-use support for aquatic life can be achieved in certain areas and maintained in others. It is also possible that there will be a less vigorous and concerted effort to find contamination sites and clean up or mitigate for those hazardous wastes.

2. Future Geomorphic and Hydrologic Ramifications

Bank erosion and episodes of mass wasting along Senachwine Creek contribute sediment directly to the channel. Data used in the CEM analysis suggest, however, that portions of the watershed continue to adjust to past disturbance due to earlier channel modifications and land-use changes. In addition, stream reaches experiencing long-term net incision were observed, and there is some evidence of continued erosion of the landscape (Figure 18). Whether these point sources contribute "excessive" amounts of sediment to Senachwine Creek and the Illinois River cannot be determined within the scope of this watershed assessment.

Condition of excessive sedimentation must be assessed by comparing the range of intrinsic behaviors, possible changes in land use and climate that may cause them, and their effects on ecosystem goals (e.g., habitat quantity and quality, sediment delivery, decreased peak flows, increased base flows, water quality, etc.).

Without treatments that address not only actively eroding areas, but also mechanisms that trigger increased erosion rates, within the next few decades, as the stream network continues to adjust to past disturbance, sediment yield from the watershed are expected to approximate current amounts. Some additional modifications to the channel or changes in land use in the future could trigger a new cycle of channel adjustment and potentially increase sediment yield and undermine past and current efforts to curb sediment delivery to the Illinois River.

Table 10 and Figure 27 illustrate that sediment yield is tied directly to the hydrologic regime of the watershed. Thus, future rates of erosion and sediment yield depend on both climate change and management of the hydrologic regime. The influence of climate change on watershed hydrology cannot be predicted within the scope of this study. If regional warming continues, however, total precipitation will decrease but storms will be more intense, and runoff will increase but base flows will decrease (Easterling and Karl, 2001; O'Neal et al., 2005). Water and sediment discharge estimates approximate the expected range of variability and show that higher annual discharges generally yield more sediment (Table 10 and Figure 27). Further, existing data (Bhowmik et al., 1993) show that Senachwine Creek and its tributaries exhibit wide hydrologic variability on an event-to-event basis (i.e., "flashiness") leading to wide swings in erosive power and available energy to transport sediment. Although flashy hydrology is, in part, due to the geologic setting, changes in land use and land cover also are likely contributors to hydrologic variability. Without projects directed at watershed hydrology, the flashy hydrologic regime will remain, and change toward a wetter climate cycle likely will increase sediment yield.

Water and sediment conveyed by the stream system intrinsically lead to dynamic channel change. Banks are eroded, but deposition also occurs during the process, with net export of sediment out of the stream system. Preliminary assessment of channel dynamics shows the principle mode of channel change as downstream and lateral migration, particularly evident in mid- and lower segments of Senachwine Creek (Figure 29). Although the scale of channel change generally increases further downstream, comparison of the stream channel in 1939 and 1998 indicated notably less change within HUC 402 (Table 5). Less change along this portion of the channel most likely is related to local control of the channel by bedrock and relatively coarse bedload. Due to the intrinsic nature of natural planform dynamics (i.e., modes of change not directly due to channel modification), lateral and downstream migration are expected to continue throughout the watershed, with largest changes in the lower portion of the watershed. Channel planform probably will remain relatively stable in the middle portion of the watershed due to geologic constraints. Substantial ditching and channelization occurred in the upper part of the watershed between 1939 and 1998; channel planform adjustments likely will occur but at smaller-scales than downstream, given the tendency for channelized reaches to re-meander.

Residential development is expected to continue, especially in middle and lower portions of the watershed near access routes to Chillicothe and Peoria. Most of that development will be in the floodplain near Chillicothe. Without specific planning, however, further habitat fragmentation will occur. Long-term consequences of such development, unless actively mitigated during design planning and construction, include increased runoff from increased impervious roofs, sidewalks, and roads, and impacts on water quality from septic systems, lawn chemicals, and road salt (Zielinski, 2002). Increased impervious cover reduces infiltration rates and thus potentially contributes to upland erosion, stream flashiness, and increased peak storm flow discharges.

Residential development also places demands on groundwater and surface water. There may be reduced base flow to streams if shallow groundwater aquifers are drawn down from overuse. Some new development will have to rely on surface impoundments, which, if not designed properly, could impede efforts to naturalize volume and velocities of stream flow.

3. Future Biological Ramifications

With further unimpeded development, IBI and ecological sustainability will suffer. More pressure on ecosystem function would decrease ecological diversity while increasing pressures on sustaining biodiversity. Impacts on flora and fauna include less biodiversity because of fragmentation in forest understory environment. Stream segments will continue to degrade and transport an increasing amount of sediment to the mainstem.

C. Problems and Opportunities

Various problems in the watershed involving flooding, erosion, and sedimentation have been attributed to erosion and sediment yield from agricultural land (SCS, 1990; Miller et al., 1997; Joseph et al., 2003). Based on interpretation of data from this study and historical information (e.g., Greer et al., 2002), many of these problems may also be the result of progressive channel and hillslope adjustments triggered by major channel modifications and ditch construction during the first half of the 20th Century. Recent NPS control projects (Miller et al., 1997; Joseph et al., 2003) have applied BMPs to address those problems, and anecdotal evidence suggests improved agricultural productivity, reduced upland erosion, and reduced flooding. Impacts of these BMPs have not been evaluated in the context of geomorphologic processes, however. That is, it is not known how previous efforts have furthered other ecosystem goals, such as reduced sediment delivery, improved water quality, and enhanced habitat. Because locations of previously implemented BMPs are relatively well-documented (Figure 4) and various methods have been applied, it is possible to evaluate long-term impacts of these BMPs. Relating successes and failures of previously implemented projects in a process-based watershed context would allow increasingly informed watershed management decisions and increase probable success of future projects.

Several unfulfilled data needs potentially limit appropriate planning and design of restoration projects. By mandate, much of the information used in this study relied primarily on previously existing data. Those data were collected mainly to estimate long-term, statewide, and regional trends (e.g., CTAP and USEPA 305(b)/303(d) programs). Thus, the datasets provide only broad estimates of watershed characteristics, and data collection was not tailored to assess conditions and processes specific to the watershed. Further, the few watershed-specific datasets available were collected at intervals generally too coarse (e.g., water quality) or too short (e.g., monitoring periods for sediment delivery and hydrology) for adequately determining practices and processes with impacts on sediment production and yield, hydrology, and habitat in the watershed. Although one long-term fish survey provides data specific to Lower Senachwine Creek (Tables 15 and 16), these data are useful only for evaluating the fish community and generally cannot be used to assess the condition of other riparian, wetland, terrestrial habitats. Existing elevation data are at regional scales (100-foot horizontal accuracy) rather than local scales (3- to 30-foot horizontal accuracy), are up to 30 years old, and are provisional. Higher-resolution elevation data are critical for many aspects of watershed assessment and project implementation, particularly regarding vertical stability of the channel and slope stability. Although limitations of the existing datasets do not necessarily preclude watershed restoration planning, making project implementation decisions without more watershed-specific data may limit success of watershed restoration and/or undermine previous restoration and management efforts.

Current conditions in many tributaries to the Senachwine Creek mainstem were documented (Figure 20). Additional work is necessary, however, to assess past and ongoing processes in these and other tributaries, with a primary focus on tributaries along or just upstream of the bluff line in valleys with steep, high walls. Susceptibility of these areas to slope failure is relatively high. New cycles of channel degradation and recovery could be initiated either by natural (e.g., climate change) or artificial (e.g., channel modification) triggers. The disturbance potentially could trigger a new cycle of stream adjustment leading to bank instability, landslides, and mass wasting, and contribute a large amount of sediment to the system. Additional work should include additional rapid field assessments, and relate vertical (e.g., repeat channel surveys) and planform (e.g. Stream Planform Change; Section V. 5. b. vi) channel changes to land and water-use changes and climate changes (cf. Phillips et al., 2002).

D. Significance

1. Technical Significance

This study provides a compilation and analysis of existing data and also presents new information acquired through field investigations and from aerial imagery. Emerging technologies used include those established elsewhere but not well-known in Illinois, as well as experimental methods. Because a goal of the study is to provide a scientifically based context for project planning, much of this report relies on adaptation of established classification schemes to assess biological integrity, channel stability, and channel evolution. Innovative methods also were developed and applied to identify problems and processes both in uplands and in the channel corridor. They include:

- Interpretive maps compiled using existing geographic datasets for a summary perspective on geologic, channel geomorphologic, physiographic, hydrographic, and socioeconomic character of the watershed.

- Video imagery of the channel corridor taken by helicopter flyover for rapid synoptic reconnaissance and documentation of current watershed conditions.

- Systematic examination of historical aerial photography to assess channel planform change, with critical baseline information on historical channel processes within historical context of perceived problems in the

Senachwine Creek watershed.

Even so, this study was intended to be rapid, not exhaustive. Resolution of most available data does not permit definitive characterization. Further analysis is desirable, particularly for flow, sediment delivery, water quality, and terrestrial and aquatic biology. Thus, this study is a starting point for process-based analysis of the Senachwine Creek watershed to achieve ecosystem restoration goals.

Although various agricultural BMPs previously were implemented in the watershed (Figure 4), those practices mainly focus on NPS sediment on agricultural lands in the watershed. Agricultural BMPs are intended to maintain or improve productivity. By contrast, their effects on terrestrial habitat, aquatic habitat, fluvial hydrology, and sediment delivery may be profound but have not been well characterized. The BMPs may initiate new CEM conditions not yet manifested because of intrinsic process lag times, or they may be responsible for current conditions.

The SCWA adds information regarding point sources of sediment in the floodplain-channel corridor and historical context to changes in the watershed system, information essential to achieve ecosystem restoration goals. Opportunities exist for integrated management of water-sediment systems in the watershed, both on the landscape and within channel corridors. That is, individual practices may temporarily address a specific effect (e.g., streambank erosion) of a systemwide problem (e.g., abrupt changes in sediment and water discharge). Addressing symptoms rather than problems potentially could have negative long-term impacts on erosion, sedimentation, and habitat. Secondary treatments may counteract those negative effects, but identification and characterization of variability and rates of geomorphic and habitat processes are crucial next steps for informed project implementation decision making. Potential projects based on this SCWA report should incorporate long-term monitoring to document performance evaluation, long-term viability, and adaptive management needs. The SCWA baseline data greatly will supplement future monitoring data.

2. Public Agency Benefits

Many federal, state, and local agencies, as well as NGOs, have interests in ecosystem restoration of Senachwine Creek watershed (Tables 2, 3 and 4). Comprehensive and complex planning and implementation efforts require participation of a multitude of these agencies. Potential partners include the USDA-NRCS (CREP, Environmental Quality In-centives Program, Conservation Reserve Program, Conservation Practices Program, etc.); USDA Farm Service Administration; the local SWCD's; the Illinois Department of Agri-culture Streambank Stabilization Program; IDNR (e.g. State portion of CREP, Acres for Wildlife, Forestry Incentives Program, etc.), USEPA, and IEPA (Section 319 of the Clean Water Act, etc.). County Engineers and Township road commissioners would also be interested in stream channel work because of the many bridges crossing Senachwine Creek. In the context of creating the water, sediment and habitat resource management systems briefly referred to in the SCWA, there will be an important opportunity for inte-gration of many of these Agency efforts in project planning and implementation. Coordination between the State Scientific Surveys was a key element in preparing this comprehensive SCWA report. Along the way, many lessons were learned about data availability, application of analytical methods, and agency strengths. Opportunities to integrate agency technical and funding capabilities also were better understood. Using this report as a template should expedite future assessments of other watersheds.

3. Societal Benefits

The public stands to benefit in several ways from implementing ecosystem restoration activities based on SCWA recommendations. We hope to achieveThe intent is better preservation of land and water for varied uses through improved land planning and direct treatment. These efforts will address several goals of the Comprehensive Plan (USACE, 2007), including reducing sediment loads to the Illinois River mainstem and improving water quality. Land improvement could enhance agricultural production and provide higher quality recreational fishing, hunting, bird watching, etc.. Roads and bridges, as well as other transportation and economic infrastructure, could be better protected for longer periods. The Illinois River Valley Council of Governments (IRVCG) is an organization of local municipal representatives (mayors in most cases). The IRVCG encouraged the advancement of the R.O.D. and strongly supported its development. That organization brings immediate buy-in and regional project support.

E. Goals and Objectives

Goals and objectives of future activities based on this study follow those outlined in the Comprehensive Plan (Table 17; USACE, 2006). Within the Comprehensive Plan, the desired outcome for tributaries such as Senachwine Creek is the restoration of sustainable levels of floodplain

Goal	Objectives	Potential Features
Ecological Integrity	Restore and conserve natural habitat structure and function	Habitat spacing, habitat restoration (size recommendations) and connectivity
Goal 1: sediment reduction	Reduce sediment delivery to the Illinois River by 40%	Bank stabilization, grade control (riffles), buffers
Goal 2: backwaters, side channels, islands restoration	Not Applicable	Not Applicable
Goal 3: floodplain, riparian, aquatic restoration	Restore tributary floodplain/ riparian corridor, restore X stream miles	Wetland restoration, riparian corridor restoration, stream remeandering, invasive species control
Goal 4: fish passage	Not Applicable	Not Applicable
Goal 5: naturalize hydrology (peak flow, base flow, drawdown)	Decrease peak flows, increase baseflows	Stormwater storage, infiltration areas
Goal 6: water quality	Maintain good or improve impaired waters	Not Applicable

Table 17. Goals and Objectives of Ecosystem Restoration

and aquatic habitat functions. A portion of this would be accomplished by restoring 150,000 acres (collectively) of isolated and connected floodplain areas within the entire ILRB (USACE, 2006). This represents approximately18 percent of the ILRB tributary floodplain and riparian habitat areas (USACE, 2006). This level of restoration would provide the necessary building blocks for a sustainable floodplain ecosystem within the tributaries in conjunction with other restoration efforts undertaken for this effort, particularly reduction of sediment delivery. General conditions for floodplains and riparian areas include establishment, protection, and management of terrestrial patches of land (forests, prairies, savannas, etc.). Bottomland hardwood forest generally require from 500- 1,000 acres for avian species and 3,000 acres for some interior avian species. Grassland restorations requires 100-500 acres. Nonforested wetlands require a minimum of 100 acres, spaced 30-40 miles apart, and riparian zones for streams require a minimum of 100 feet on each side. Approximately 1,000 miles of impaired streams would need to be restored, approximately one-third of the streams impaired by channelization within the ILRB.

Projects implemented in the Senachwine Creek watershed could provide incremental progress toward several basinwide goals. The watershed contains channel, wetland, major river and tributary floodplain, and terrestrial areas potentially suitable for restoration. The overarching goal is to restore and maintain ecological integrity, including habitats, communities, and populations of native species, as well as processes that sustain them. Additional criteria were developed as part of the Comprehensive Plan (USACE, 2007), including giving priority to projects that improve quality and connectivity of habitats, provide habitat for regionally significant species, reduce sediment delivery, naturalize hydrology, maximize sustainability, consider and address ecological threats, improve water quality, consider other agency activities, have public support, etc.

With specific criteria in mind, all agencies and stakeholders must work together to achieve several goals:

1) Reduce total sediment delivery to the Illinois River mainstem from sources within the Senachwine Creek watershed to reduce excessive sed iment load. The basinwide target is to reduce sediment delivery at least 10 percent by 2025.

2) Reduce excessive sediment delivery to specific high-value habitat both along the Senachwine Creek mainstem and tributary streams.

3) Restore, rehabilitate, and maintain as many additional acres of habitat in currently connected floodplain areas as landowner support and incentives allow.

4) Find opportunities to restore large patches of forests and grasslands in the Senachwine Creek watershed and to provide incentives for this effort.

5) Restore acreage of isolated and connected floodplain along the Senachwine Creek mainstem and tributaries to enhance floodplain habitats and promote floodplain functions. The basinwide goal is to restore an additional 10% of acreage of isolated and connected floodplain.

6) Restore and/or protect additional stream miles of in-stream and riparian habitat in the Senachwine Creek watershed.

7) Restore and/or protect mainstem to tributary connectivity, where appropriate, to maintain fish mobility and community structure.

8) Reduce unnatural peak discharge along the Senachwine Creek mainstem and tributaries to the extent possible with a subjective target of a 2-3% reduction for the 2- to 5-year recurrence storm events by 2023. The basinwide target is to reduce peak discharge 20% over the long term.

9) Reduce the incidence of low-water stress to aquatic organisms in the

Senachwine Creek system by increasing base flows. The basinwide goal for tributary streams is to increase base flows 50%.

10) Ensure protection of exposed pipelines by in-stream geo- and biotechnical means or negotiation with pipeline owners for reasonable settlement between economic and public interests.

11) Maintain full use support for aquatic life in all surface waters with Senachwine Creek watershed, as defined in 303(d) of the Clean Water Act. Achieve full-use support for all waters in the Senachwine Creek watershed by 2055.

12) Encourage remediation of contaminated sites that affect habitat.
13) Achieve USEPA nutrient standards by 2025, following standards put in place by the USEPA by 2008.

14) Work with the USACE and the State of Illinois (IDNR) to identify beneficial uses of sediments.

F. Preliminary Evaluation of Alternatives

Section 519 of WRDA 2000 specifies that if an ILRB restoration project will produce independent, immediate, and substantial restoration, preservation, and protection benefits, the USACE shall facilitate project implementation. Restoration projects generally recommended in this document are preliminary and would require further feasibility study, however.

The stream channel is influenced by the glacial history of the watershed, surficial materials, and by combined dynamic processes, including climate, drainage modifications, land-use changes, etc. Unstable channel and near channel areas are demarcated (Figure 47) and recommended for environmental restoration and naturalization such that energy is dissipated and quasi-equilibrium is restored to the channel system. Restoration techniques that could be used in the watershed and stream system include bioengineered streambank and streambed stabilization; bioengineering techniques with low intensity structural controls such as naturalized riffle and pool construction, placement of lunker structures or stream barbs; riparian zone expansion and management; upland and floodplain wetland restoration; woodland structure and understory management in forested bluff areas; stabilization of mass wasting sites; and traditional upland conservation treatments.

Based on this analysis, four reaches along the Senachwine Creek main-

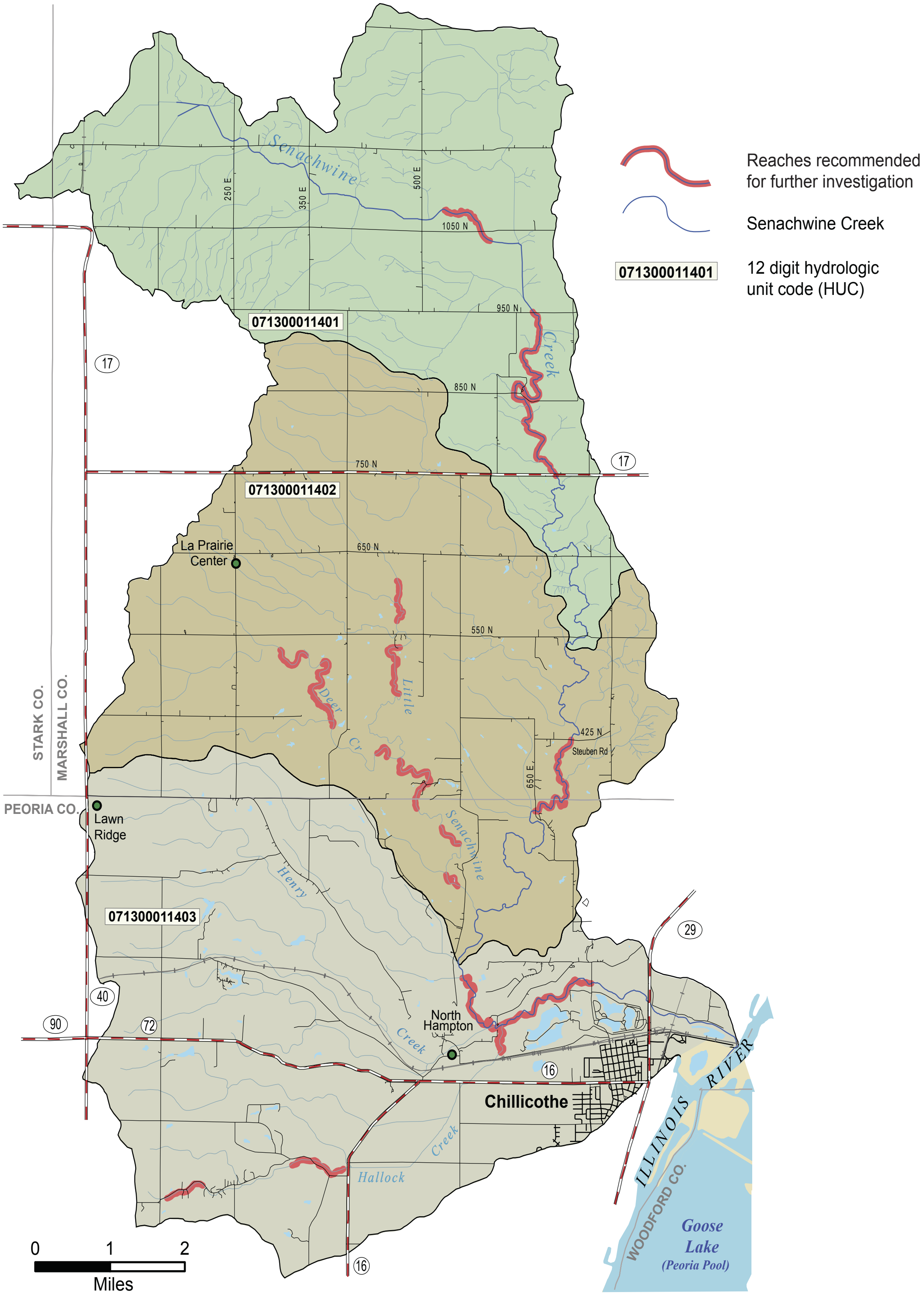


Figure 47: Reaches identified for possible ecosystem restoration activities

stem are relatively unstable (Figures 34 and 47) and should be considered as priorities. Further investigations may improve upon predictive capabilities. Investigations initially focused on the Senachwine Creek mainstem, but it became clear early on that tributaries such as Little Senachwine Creek, Deer Creek, and Hallock Creek (Figure 23) deliver considerable sediment to the mainstem. Additional work has shown that these tributaries also are high-priority candidates for restoration. Practices in the upper watershed and in sloping forested areas also require further consideration.

1. Senachwine Creek Mainstem

Thirty problem sites initially were identified from recent GPS tracked aerial flights along the assessed portion of the mainstem. An additional 49 potential problem areas were identified along the mainstem by carefully reviewing recently acquired aerial videotapes. Another 18 potential problem areas were identified from review of contemporary and historic panchromatic still aerial photos (Table 6). An additional four sites of concern were identified from in-channel field work and will require engineering surveys before proceeding further with project design. The upper target reach is approximately a mile long (Figure 47). Only existing panchromatic still aerial photos were available for this area.

The next target reach is approximately 3.5 miles long. Recommended treatments primarily include grade control and habitat enhancement by constructing riffle and pool structures (Figure 47). Where the channelized segment ends in upper reaches of the mainstem, bedrock is exposed in the channel bed. The channel was less stable and stability and habitat indices were poor just below this point. Bedrock was considered to be a good place to anchor potential upper end multi-objective riffle and pool structures. Some severely eroded stream reaches may require installation of lunker structures and associated bioengineered techniques in combination with riffle and pool grade/habitat structures.

The third target reach is 3.9 miles long. Recommended treatments here also include grade control and habitat enhancement with riffle and pool structures, possibly combined with bioengineered techniques and lunker structures.

The fourth and lowest reach is 2.3 miles long, and 11 potential project sites were identified from aerial reconnaissance. This complex area is generally aggrading but exhibits channel degradation/incision in a few short segments where two gas pipeline segments are exposed. Riffle and pool structures may be useful to protect those gas pipelines, but relatively low bank elevations have led landowners to express concerns about flooding fields if water backs up too much.

Four sites with extensive mass wasting occur within the 3.5-mile project reach. Two more sites occur between the uppermost 1-mile and 3.5-mile project reaches, and five other sites occur near the bluff line between the 3.5-mile and lower 2.3-mile project reaches. Mass wasting occurs where the stream impinges on the base of the eastern valley walls.

Several more eroding streambanks occur at more isolated problem areas outside potential project reaches recommended in this report. Treatments within recommended reaches could have positive impacts on some of these other sites, but further research and assessment are necessary to clarify this. Appropriate stabilization of these outlier eroding streambanks also may be considered for potential individual projects, but project impacts must be considered within the context of the overall plan. Assessment of impacts to the stream channel from previously installed BMPs in uplands also needs to occur to identify additional opportunities for integrated system resource management (cf. Figure 4).

2. Little Senachwine Creek

Little Senachwine Creek is 8.5 miles long and has 5-6 segments that may be suitable for projects (Figures 47 and 35). The uppermost reach defined here is about a mile long and exposed tree roots indicate ongoing incision. Various restoration practices could be considered, including riffle and pool structures for grade control, oxygenation of water, aesthetics, habitat, and energy dissipation in combination with bioengineering techniques or even “hard” structures such as stone toe protection.

The next channel segment downstream has two small segments that could be combined into one reach depending upon type of restoration practices considered for further assessment in a feasibility study. When combined, the two segments are about a mile long (Figures 47 and 35). Two mass wasting sites are located along this stream segment. Restoration of mass wasting sites requires considerable effort, financial commitment, and site access from a willing landowner. The remaining three channel segments are located in the lower third of the stream. The last stream channel segment has one mass wasting site, and three other mass wasting sites are just upstream (second to last channel segment). Therefore, the four mass wasting sites are located in lowermost 2 miles of the creek. These channel segments also would benefit from bioengineering, stone toe protection and riffle and pool structures.

3. Deer Creek

Deer Creek is about 4.5 miles long, and assessment data indicated three particular reaches with channel stability problems, poor habitat, or both (Figure 36). The longest stream segment is in the middle area of Deer Creek, the next longest is at the upper end of the channel, and the shortest segment is near the end of the channel about a quarter mile upstream of the channel mouth at the confluence with Little Senachwine Creek. Typical restoration practices described above would also be suitable for consideration in these three reaches. No mass wasting sites were reported for this channel.

4. Hallock Creek

Hallock Creek is about 6 miles long, and preliminary field data indicated three reaches of concern (Figure 37). An exposed gas pipeline and a lower channel segment where the channel gradient is a little steeper than in the middle portion (Photo 2), requires considerable work. This pipeline may not be active since steps had not been taken to protect it from exposure for many years. In particular, the pipeline had not been physically covered with a protective emulsion and wrapped with a polyurethane sealant. If the gas pipeline is active, then relocation of the line or armoring are common approaches to address public safety and potential pollution concerns. The gas pipeline company must be contacted to be sure this issue is addressed. Forest management also would be a major consideration in middle and upper segments. Other potential restoration practices include those provided above for other stream segments.

5. Forest

Much of the southwestern part of the watershed, in particular, could benefit from woodland management. Forested ravines are habitat areas of interest in the Senachwine Creek watershed for management opportunities. They include forests on interfluves, slopes, terraces, and riparian areas. Elimination of invasive plant species is highly recommended. Removal of some understory biomaterial and less desirable short story trees should be considered with overall timber stand improvement practices. Connection and structural enhancement of fragmented vegetated areas, especially riparian zones, would be of great benefit, not only for water quality but to enhance habitat for many floral and faunal species, including birds.

Most existing forest is limited to ravines because slopes are too steep for agricultural or residential development. Steep slopes also are less valuable than gentle slopes for wildlife [citation]. Opportunities for restoring additional forest acreage in low sloping upland and floodplain areas should also be investigated.

6. Agricultural Land

Various agricultural BMPs have previously been implemented in the watershed, mainly outside channel areas (Figure 4). Traditional water management and erosion control projects (e.g. grassed waterways, terraces, ponds, WASCOBs, etc.) also have been constructed outside the channel in the Senachwine Creek watershed. Those practices mainly focus on NPS sediment on agricultural lands. Agricultural BMPs are intended largely to maintain or improve productivity, but their effects on terrestrial habitat, aquatic habitat, fluvial hydrology and sediment delivery may be profound. These effects have not been well characterized in watersheds in Illinois and should be studied more thoroughly. These beyond-channel projects may alter water and sediment loadings to the Senachwine Creek mainstem and can have either positive or negative effects immediately after construction. For example, without planning for compensation of flow regime changes or channel slope adjustments, sediment detention in upland areas can result in channel migration and/or channel incision, which would induce channel erosion with channel morphology changes (White et al., in review). By contrast, coordinated implementation of beyond-channel and in-channel BMPs should reduce peak discharge, increase base flow and provide a more balanced sediment regime.

G. Proposed Methods for Benefit Assessment

Monitoring stream hydrology can help determine if peak discharges have been ameliorated and if base flows have increased in summer months. “Normalizing” discharges can benefit habitat, plant and animal communities. Monitoring sediment and nutrient data combined with rainfall determinations would document changes in sediment delivery and transport in the watershed system. Continued monitoring of channel stability conditions and habitat indices as already initiated would help determine responses of the channel and habitat as long as other factors can be isolated and eliminated as causes.

VI Federal Interest

A. Authority, Section 519

Authority for the Senachwine Creek watershed assessment comes from Section 519 of the Water Resources Development Act (WRDA) of 2000. The primary purpose of Section 519 funding currently used in Illinois is for planning, conservation, evaluation, and construction of measures for fish and wildlife habitat conservation and rehabilitation, and stabilization and enhancement of land and water resources in the Illinois River basin (ILRB).

B. Proposed Sponsors

Proposed sponsors include the U.S. Army Corps of Engineers (USACE) Rock Island District serving as federal sponsor and the State of Illinois as local sponsor. The Illinois Department of Natural Resources (IDNR) serves as primary coordinator and facilitator for the local sponsor. The Illinois State Water Survey (ISWS) coordinated preparation of this document with the Illinois State Geologic Survey (ISGS) and the Illinois State Natural History Survey (INHS) under contract with the INDR Office of Resource Conservation (ORC).

Potential project features will require resources from several federal, local, and state agencies. Integrated planning and management of these resources will be instrumental in achieving significant ecosystem restoration in the Senachwine Creek watershed and, in the larger sense, the ILRB. Federal interest exists and will be realized specifically when project plans, designs, and resources are integrated as seamlessly as possible with those of local and state organizations. This integrated effort and funding will foster ecosystem restoration most effectively and efficiently. The challenge to integrate efforts lies not only with federal agencies but also with local and state organizations. Potential project features and required federal interests are briefly outlined (Table 16).

Potential Project Feature	Appropriate Agency
Traditional Upland FarmTreatment (Terraces, WASCOB's, Grassed Waterways, No-till, etc...	USDA-NRCS USDA-FSA IDOA SWCD
In-Stream Naturalization (Riffle/Pool Stuctures, Lunker Structures, Bioengineering for Streambank Stabilization, etc...	IDNR-ISWS IDNR-ORC USFWS USDA-NRCS USACE
Priority Upland and Floodplain Wetland Restoration and Enhancement in Hydric Soil Areas	USDA-NRCS USFWS IDNR-ORC USACE
Forested Slope and Riparian Management	USFWS USDA-NRCS IDNR-ORC IDNR-INHS
Stabilization of Select Mass Wasting Sites	USGS USACE IDNR-ISGS IDNR-ISWS

Table 16. Potential Project Features

VII Recommendations

Based on study results, it is evident that various strategies could improve ecological integrity of the Senachwine Creek watershed and thus address several goals within Alternative 6 of the Comprehensive Plan (USACE, 2007). Some goals of the Comprehensive Plan are applicable to restoration efforts in the Senachwine Creek watershed and are outlined in Section VE above.

Goals can be met by incorporating appropriate combinations of resource management options into a resource management plan for the entire watershed. These resource management options could include: 1) traditional erosion and sediment control BMPs outlined in standards developed for NRCS use; 2) bioengineering techniques (combined with placement of lunker structures or perhaps even “harder” structures, such as stone toe protection, stream barbs, etc. when necessary) to stabilize or naturalize streambanks and address channel equilibrium issues; 3) control of channel incision using riffle and pool structures (Newbury weirs, etc.); 4) channel re-meandering and reconnection of streams to parent floodplains; 5) wetland restoration or enhancement; and 6) alternative futures planning and contemporary conservation designs for urban and rural stormwater infiltration and filtering, etc. Many of these options provide multiple benefits that enhance habitat while restoring or naturalizing flow regimes.

Traditional erosion and sediment control and water management practices and structures are recommended for additional design and construction. Innovative channel and near-channel restoration projects must be constructed to naturalize the fluvial environment and also managed to establish and sustain biologic diversity. Several unstable channel segments and near-channel areas on the mainstem identified for restoration are shown (Figure 51). Likewise, several areas were identified as potential sites for feasibility consideration. Because many factors may have contributed to these areas becoming unstable (e.g. glacial history of the watershed, surficial materials, combined dynamic processes including climate, drainage modifications, land-use changes, etc.) closer examination of causative factors and processes is recommended before implementing specific channel and slope stabilization projects. Initiating restoration projects that focus on stabilizing active degradation (e.g. knickpoints and headcuts) and regulating variability of water and sediment supply to the channel (reducing peak flow and increasing base flow) would rapidly improve habitats in the watershed, increase the likelihood of success of many other treatments, and possibly reduce long-term maintenance costs.

Application of the CEM shows that most stream reaches classified were post-Stage III. More-over, the majority of these reaches were Stage V (Table 4), suggesting that general stability of the watershed is late-stage transitional, characterized by aggradation of the channel bed, mild mass wasting, heavy bank accretion, anastamosing channel thalweg, and diverse bank forms (Hupp, 1987). Within the CEM context, general stability of the physical habitat should trend toward improvement unless there are further extrinsic stimuli such as channel disturbances or modifications. What is not known, however, is how long observed conditions have existed. In west Tennessee where the CEM was developed, system recovery was on the order of 65 years (Hupp, 1992). Analysis in Illinois has been insufficient to document similar process-response rates, but continued data collection in this and other watersheds eventually will fill this data gap. Forest management techniques specifically must applied within wooded bluff areas and along riparian zones in the watershed. The IRVCG, as mentioned previously, encouraged R.O.D. advancement and strongly supported its development,bringing immediate acceptance and regional project support.

Channel and near-channel sources of sediment (particularly from streambed, streambanks, and riparian areas of the Senachwine Creek mainstem, Little Senachwine Creek, and other tributaries to Senachwine Creek) must be controlled and habitats must be enhanced using in-stream and riparian naturalization techniques. These techniques include variations of bioengineering, rock weir establishment, thinning of some wooded bluff areas and intense understory management. Control of invasive species, protection of Threatened and Endangered species, concentrated management and expansion of terrestrial habitat types (such as forest, prairie, and savannah) and protection and enhancement of aquatic (fish and macroinvertebrate) habitats all must be considered in a comprehensive manner with systematic programs that appropriately address systemic problems.

Implementation of solutions that effectively and efficiently address problems must be coordinated with all local, state and federal agencies proficient at handling these problems from both technical and funding perspectives. The Senachwine Creek watershed assessment was modeled after the Special Area Management Plans (SAMPs) outlined in the USACE Comprehen-sive Plan (USACE, 2007), but adjustments were made to accommodate assessment scaling issues between the larger ILRB and subwatershed levels. The study attempted to conduct a comprehensive review of aquatic and terrestrial resources in the entire watershed. Assessment reports help define where SAMPs or resource management plans should be developed for key watershed areas in which considerable planning and restoration activities occur or where scientific information suggests a need to target restoration. The approach to build upon this SCWA effort with a more specific feasibility effort is more environmentally sensitive than the traditional project-by-project process. The traditional approach may lead to cumulative loss of resources over time. With the SAMPs approach, potential impacts are analyzed at a watershed scale to identify priority areas for preservation, identify potential critical restoration areas and determine not only the least environmentally damaging locations for proposed projects but al-so the most important target areas for restoration. The goal is to achieve balance between terrestrial and aquatic resource protection and reasonable economic development. These com-prehensive and complex efforts require multi-agency participation at local, state and federal levels.

Potential partners include the USDA-NRCS (CREP, Environmental Quality Incentives Program, Conservation Reserve Program, Conservation Practices Program, etc.), USDA Farm Service Administration, local SWCDs, the Illinois Department of Agriculture Streambank Stabilization Program, IDNR (e.g., Illinois portion of CREP, Acres for Wildlife, Forestry Incentives Program, etc.), USEPA and IEPA (Section 319 of the Clean Water Act, etc.) and a host of other partners and funding sources.

Restoration in the Senachwine Creek watershed is complicated because public interests control very little of the watershed. Participation in ecosystem restoration efforts by private landowners is vital for achieving ecosystem goals. Recommendations include continuation of the traditional "sign-up" programs currently in place and further incentives to private landowners to participate in construction of restoration projects outlined and targeted as potential projects in this assessment report.

In summary, several BMPs have been applied in this watershed in the past, but more work is necessary. This report describes watershed conditions, both past and present, and recommends implementation of specific restoration techniques, many targeted to specific locations. Restoration of target areas would reduce water and sediment discharge variability in the watershed, expand management of riparian zones, increase upland and floodplain wetland restoration, enhance woodland structure and understory management (particularly in bluff areas), stabilize mass wasting sites and further install traditional upland conservation treatments. Various channel and streambank treatments that could be applied include bioengineered streambank erosion control, bioengineered low-intensity structural controls such as naturalized riffle and pool construction, lunker structures, longitudinal peak stone protection, stream barbs, etc. A renewed focus should be on restoration of target areas as described in the assessment report, continued focus and interest in capabilities and funding needs of local landowners, and increased landowner incentives would maximize restoration while providing more sustainable ecological diversity.

VIII Acknowledgements

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IX Disclaimer

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In collaboration with the following divisions of the Illinois Department of Natural Resources:

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