Kickapoo Creek Stabilization Survey

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Abstract

The objective of this report was to identify specific locations of severe erosion along a 12-mile segment of Kickapoo Creek in Peoria County, IL, and formulate recommendations for stream channel stabilization in problem areas. This report also contains general recommendations for habitat restoration within the riparian zone of the study area. This information will be distributed to landowners along Kickapoo Creek in the form of brochures to provide them with assistance on stream channel management.

Introduction

The channel of Kickapoo Creek is experiencing erosion and sedimentation due to land use changes in the watershed and channelization of the stream. Downcutting and stream bank erosion that occurs is a reaction to increased volume and velocity of stormwater draining parking lots, agriculture fields, roof tops etc. This phenomenon has been characterized through a Channel Evolution Model (CEM) by Schumm, Harvey, Watson, 1984 (figure 1). This model demonstrates that the first reaction of a stream to increased water volume and velocity is to downcut or erode the channel bed. This is often seen in the newly urbanized areas of Peoria (head waters of the watershed) where the drainage channel has developed steep vertical banks. The next evolutionary phase of the channel is to widen and create a new floodplain at the lower elevation. In this phase, the banks begin to erode and the channel moves laterally. Theoretically the banks will eventually stabilize to the existing conditions; however, as the watershed continues to change and urbanize, the stream system will continue to adjust as it accepts the additional discharge (Federal Interagency Stream Restoration Working Group, 1998). While streams would naturally erode without human intervention, the current rate of channel erosion is detrimental to the habitat quality of the stream system.

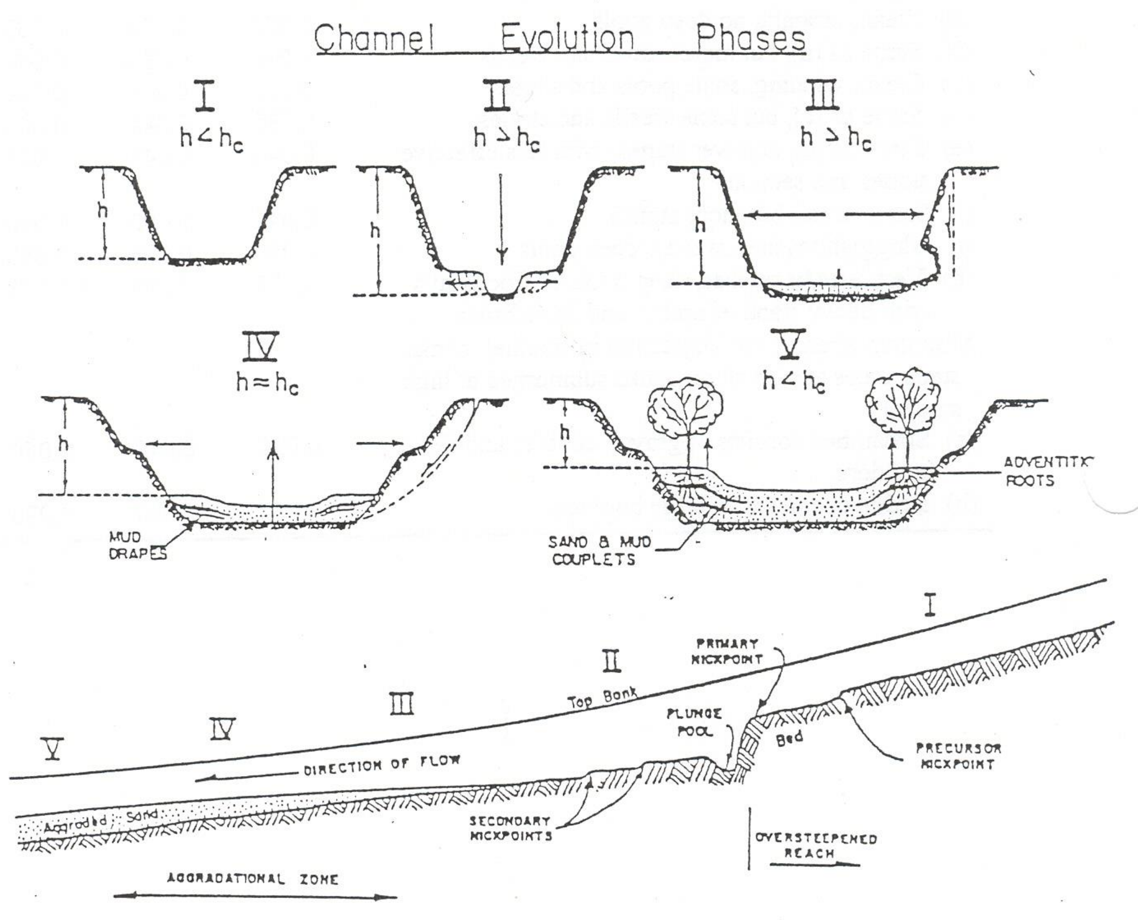


Figure 1.1 Channel Evolution Model (CEM) originally developed for Oaklimiter Creek (Schumm et al., 1981) has been refined for Hotopha Creek. If critical bank height (h_c) exceeds bank height (h), gravity failure is imminent.

Figure 1 This figure was taken from the *Streambank Manual* put together for the USDA/NRCS "Streams 201" course on streambank stabilization.

Riparian vegetation is an important factor in the vulnerability of eroding streambanks. Root systems of trees, shrubs, and herbaceous vegetation allow the channel banks to endure a greater amount of sheer stress than banks that have been stripped of riparian plant communities. Vegetation adjacent to the stream also acts as a buffer that filters and absorbs stormwater runoff. Riparian habitat is necessary to maintain a healthy aquatic ecosystem within the stream. The vegetation supplies shade, food, and shelter for flora and fauna of Kickapoo Creek.

The difficulty in stabilizing a specific location of a stream channel is that very few of these problem areas are localized. As mentioned, the stream is adjusting to *watershed* conditions, therefore it is necessary to understand the CEM and develop a stabilization method based on the current phase of the stream. Stone toe protection at the base of a bank, for example, would do little to stabilize a stream that is downcutting (phase II) but will protect banks of a channel that is beginning to move laterally (phase III). Also, a combination of hard (rock) and soft (vegetation) technologies is often most appropriate. Exclusively utilizing vegetation and biodegradable products does not supply the long-term hard toe needed for extreme bank erosion (Kinney, 2004). If an adequate seed bank is available, it is possible that vegetation will establish once the hard structure has stabilized the area. In summary, this report contains channel stabilization recommendations based on the current phase of the CEM and the condition of the riparian area.

It is recognized that a larger watershed-based restoration effort is necessary to attack the source, not the symptoms of water quality degradation in Kickapoo Creek. Currently Peoria County Soil and Water Conservation District is working with landowners in Kickapoo Creek to formulate a watershed plan. The two components of stream channel management (channel stabilization and riparian restoration) addressed in this study will complement the watershed plan by supplying a mechanism to ecologically and geologically stabilize the lower section of Kickapoo Creek in a dynamic watershed.

Study Area Description

The study corridor is a 12-mile stretch of Kickapoo Creek in Peoria County, Illinois. This section of the stream begins at Wildlife Prairie State Park and flows southwest through the unincorporated areas of Kickapoo (9N,7E) and Limestone (8N,7E)Townships, enters the Village of Belleview at study corridor mile eight, and winds its way to the stream terminus at the Village of Bartonville (figure 2).

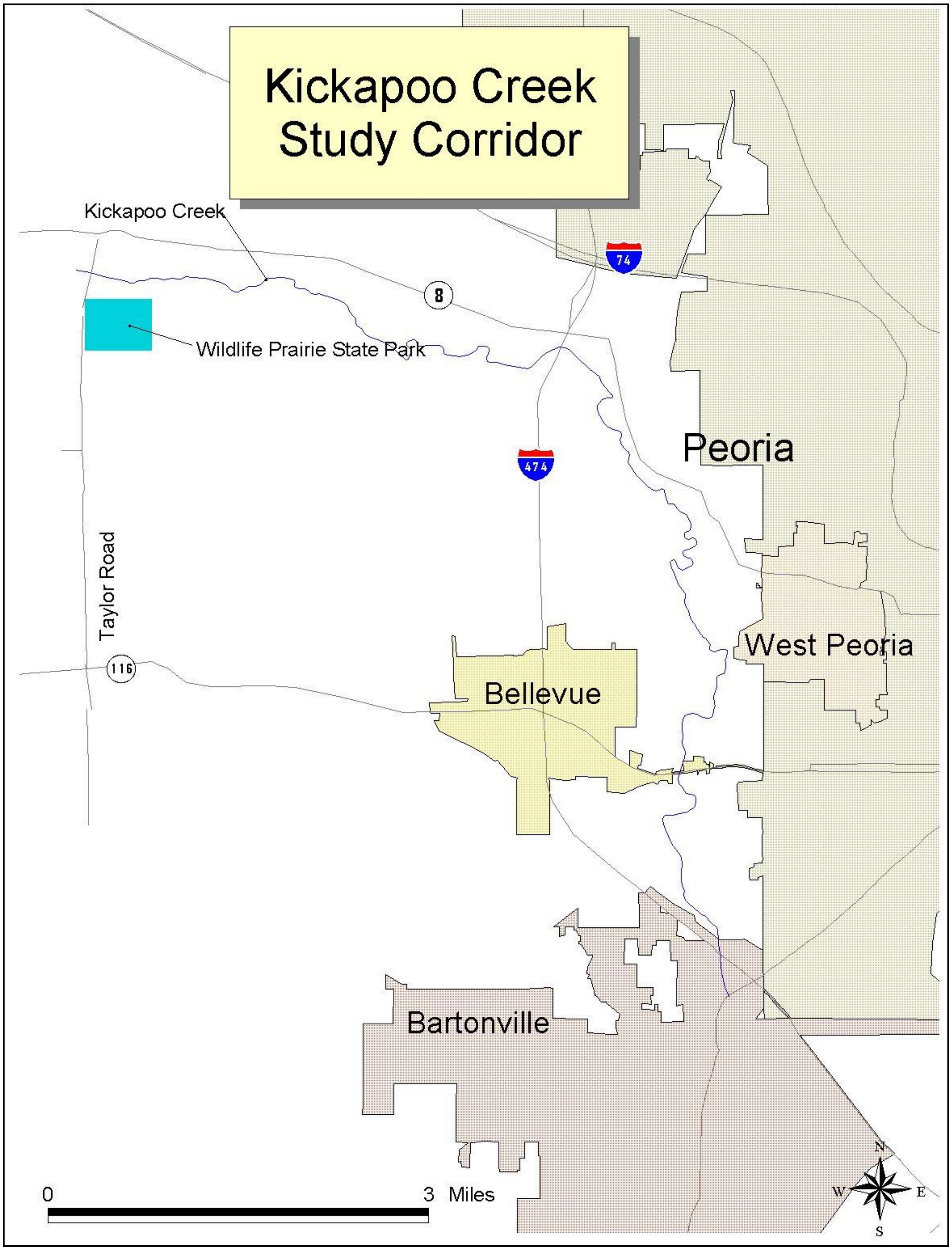


Figure 2 The 12-mile study corridor of Kickapoo Creek.

Kickapoo Creek Watershed

Approximately 480 miles of streams and 289 mi^2 of Kickapoo Creek Watershed drain into the study area. This watershed comprises 46% of Peoria County (286 mi^2) and 2.5 mi^2 in Fulton County. Land use within the watershed is characterized in table 1 and figures 3 and 4. Data for Fulton County is not available.

Table 1 (IDNR, 2002)

Land Use	ACRES	% coverage
High Density Urban	6959.9440	3.80
Low/Medium Density Urban	9012.8090	4.92
Urban Grassland	7626.7550	4.16
Open Water	1713.8090	0.93
Corn	48579.6550	26.50
Soybeans	44018.8750	24.01
Winter Wheat	1209.5940	0.66
Other Small Grains and Hay	92.8380	0.05
Other Ag	43.3730	0.02
Rural Grassland	21107.7810	11.51
Partial Forest/Savanna Upland	2136.5080	1.17
Upland Forest	34217.8680	18.66
Floodplain Forest	5771.4880	3.15
Barren and Exposed Land	244.4250	0.13
Shallow Marsh/Wet Meadow	215.5120	0.12
Temporarily Flooded Wetland	257.6800	0.14
Coniferous Forest	11.5640	0.01
Clouds	56.0400	0.03
Cloud shadows	28.6890	0.02
Shallow Water Wetland	21.2480	0.01
TOTAL	183326.4550	100.00

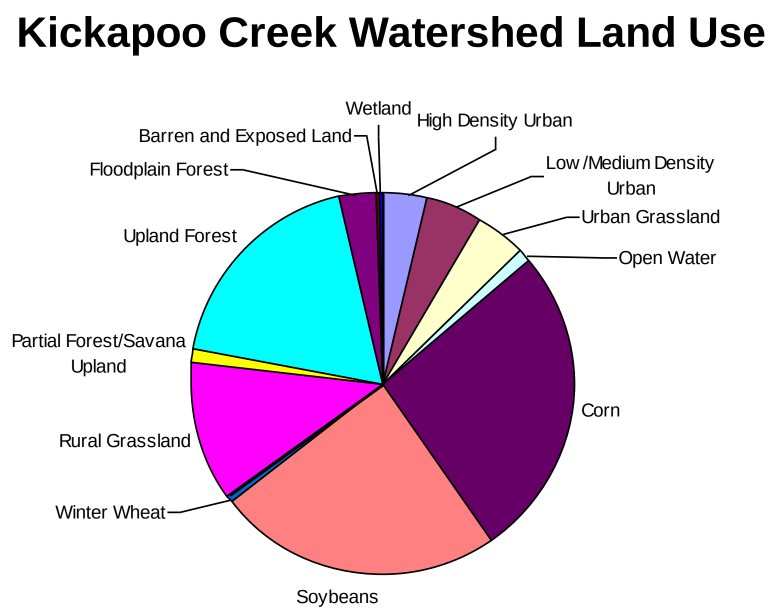
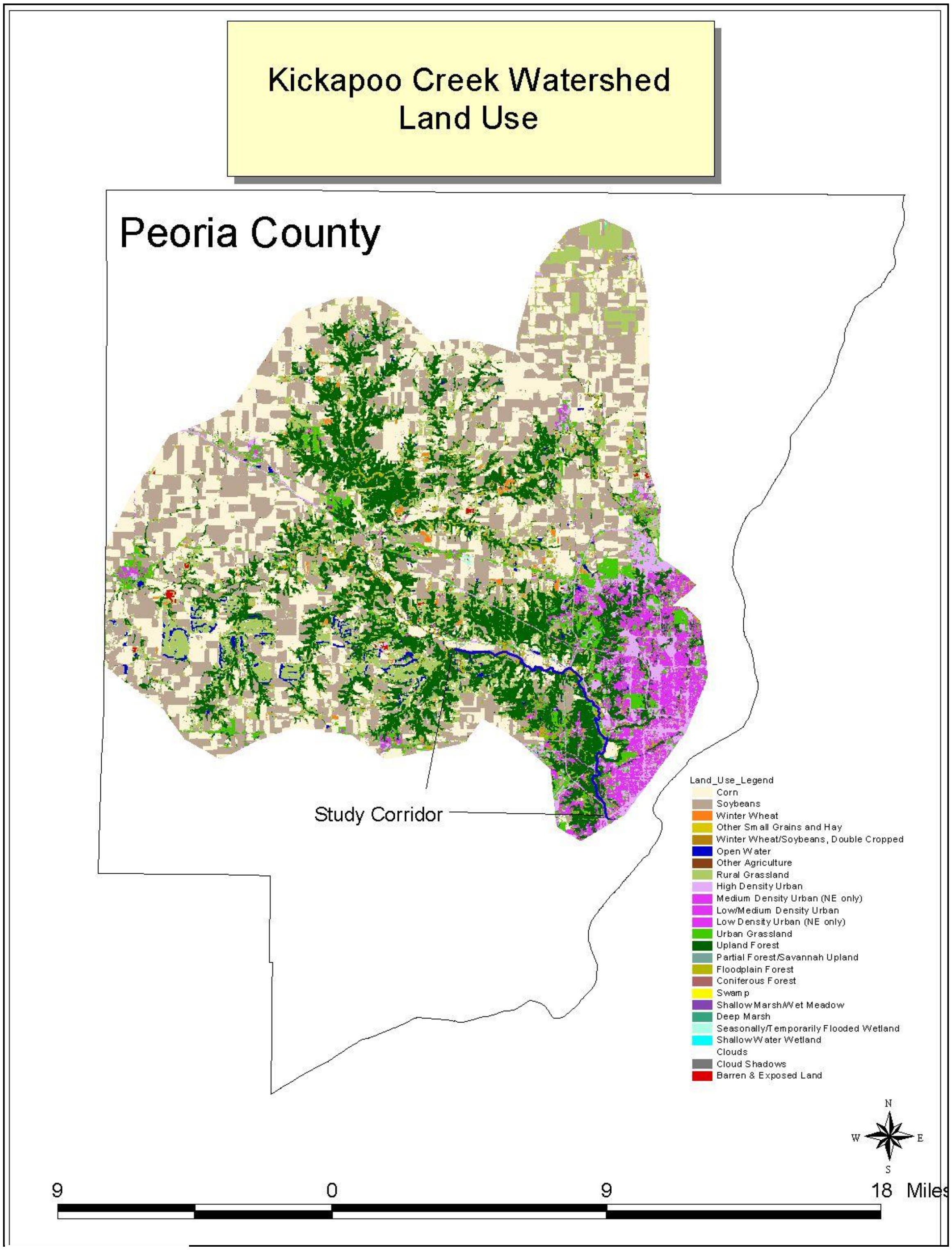


Figure 3

Corn, soybeans, upland forest, and rural grass land are the dominant land uses in the Kickapoo Creek Watershed. The urbanized areas of the watershed include the City of Peoria and the Village of Bartonville. Rapid urbanization is occurring in the northern section of the City of Peoria within the City's growth cells. While the City is making an effort to control stormwater and protect natural resources in this area, development under current regulations and ordinances will ultimately cause domino effect stream channel instability throughout the watershed.



Kickapoo Creek Watershed
Land Use
Peoria County
Study Corridor
Land_Use_Legend
Corn
Soybeans
Winter Wheat
Other Small Grains and Hay
Winter Wheat/Soybeans, Double Cropped
Open Water
Other Agriculture
Rural Grassland
High Density Urban
Medium Density Urban (NE only)
Low/Medium Density Urban
Low Density Urban (NE only)
Urban Grassland
Upland Forest
Partial Forest/Savannah Upland
Floodplain Forest
Coniferous Forest
Swamp
Shallow Marsh/Wet Meadow
Deep Marsh
Seasonally/Temporarily Flooded Wetland
Shallow Water Wetland
Clouds
Cloud Shadows
Barren & Exposed Land
N
W
E
S
9
0
9
18 Miles

Figure 4

Riparian Soils

The specific riparian soils of the 12-mile study corridor of the Kickapoo Creek fall into the three categories (figure 5) listed below (USDA, 1986):

<u>Jules silt loam</u> composes 78% of the floodplains and streambanks in the study area and is approximately 5 ½ feet deep. Jules soil is nearly level and well drained on flats and slight rises on flood plains. It is frequently flooded for brief periods from March through June. Water and air move through the soil at moderate rates and organic content is moderately low. Surface runoff is slow and available water capacity is high. The shrink swell potential is low, and the potential for frost action is high. It is well suited to cultivated crops, pasture and hay, but unsuitable for septic tank absorption fields due to flooding. Dikes or diversions are recommended to reduce crop damage caused by floodwater. Openland wildlife and woodland wildlife habitats are easily established, improved or maintained in this soil. Picnic areas, paths, and trails can be established on the soil with planning design and special maintenance. The soils are unfavorable for camp areas, playgrounds, or golf fairways. Jules is considered prime farmland by the U.S. Department of Agriculture.

<u>Paxico silt loam</u> soil composes 22% of the study area. It is approximately 5 ½ feet of nearly level, somewhat poorly drained soil on flats and slight rises on flood plains. It is frequently flooded for brief periods from March through May. Most areas are cultivated, but the soil is well suited to woodland. It is moderately suited to cultivate crops, pasture, and hay, but is unsuitable as a site for dwellings and septic tank absorption. Woodland wildlife habitat is easily established, improved or maintained in this soil. Openland and Wetland wildlife habitat can be established, improved, or maintained in certain places. No particular measures for erosion control are needed from habitat management such as burning, fire landes, and log-handling areas; however, if the soil is used as woodland, plant competition is a management concern. Trees to plant on Paxico soil include American sycamore, eastern cottonwood, green ash, red maple, and cherrybark oak. Picnic areas, paths, and trails can be established on the soil with planning design and special maintenance. The soils are unfavorable for camp areas, playgrounds, or golf fairways. Paxico soil is considered prime farmland by the U.S. Department of Agriculture.

<u>Orthents</u> soil composes 6 % of the study area. Orthents soil is 5 feet of moderately fine textured to moderately coarse textured soil intermingled with urban land. The soils have been cut, leveled, or filled during the construction of highways and urban structures. The rate at which water and air move through the soil varies because of the varying degree of compaction by construction activities. Organic matter content and natural fertility are generally low. The hazard of water erosion is severe in areas that are not protected by a plant cover. Within the study area, the only Orthents soil is located at the intersection of Interstate 474 and U.S. Route 24. This area is mostly wooded and mowed turf grass.

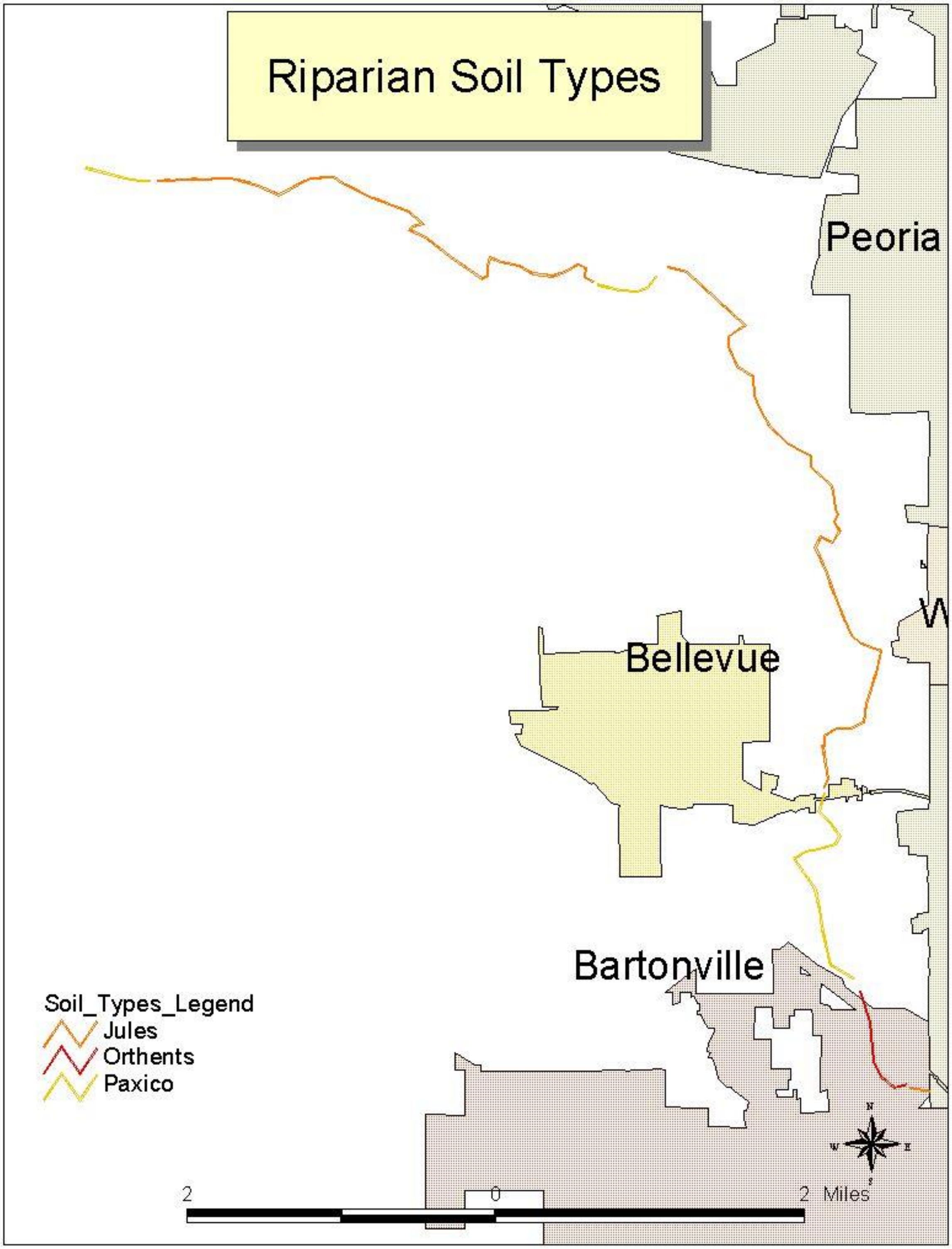

Riparian Soil Types
Peoria
W
Bellevue
Bartonville
Soil_Types_Legend
Jules
Orthents
Paxico
2
0
2 Miles

Figure 5

Riparian Habitat

The riparian land uses along the study segment of Kickapoo Creek are primarily forest and agriculture (table 2, figure 6).

Table 2 (IDNR, 1996).

Riparian Land Use	**Percentage of Study Area**
Forest	41
Mixed	15
Grass	11
Agricultural	15
Disturbed	8
Urban	10
Total	100

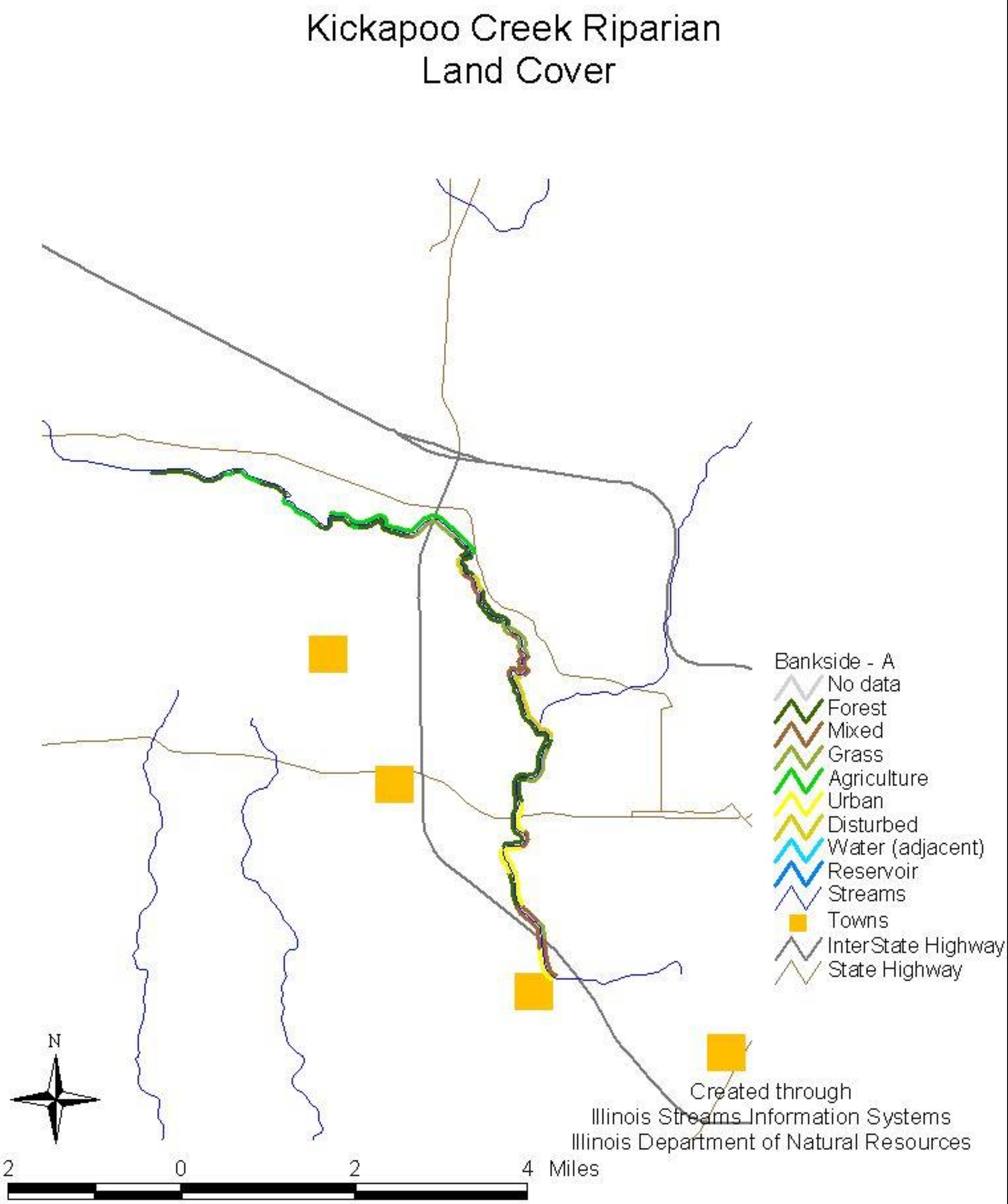

Kickapoo Creek Riparian
Land Cover
Bankside - A
No data
Forest
Mixed
Grass
Agriculture
Urban
Disturbed
Water (adjacent)
Reservoir
Streams
Towns
InterState Highway
State Highway
N
Created through
Illinois Streams Information Systems
Illinois Department of Natural Resources
2
0
2
4 Miles

Figure 6

Modifications within the study area

From analyzing year 2003 aerial photographs, it was determined that approximately 5.7 miles (12%) of stream has been channelized in the study area (figure 7). This is reflected in a low sinuosity value of 1.2 of the stream segment. Sinuosity is the ratio of stream length to valley length. Channelization occurred along farm fields, rail lines, and Kickapoo Creek Road.

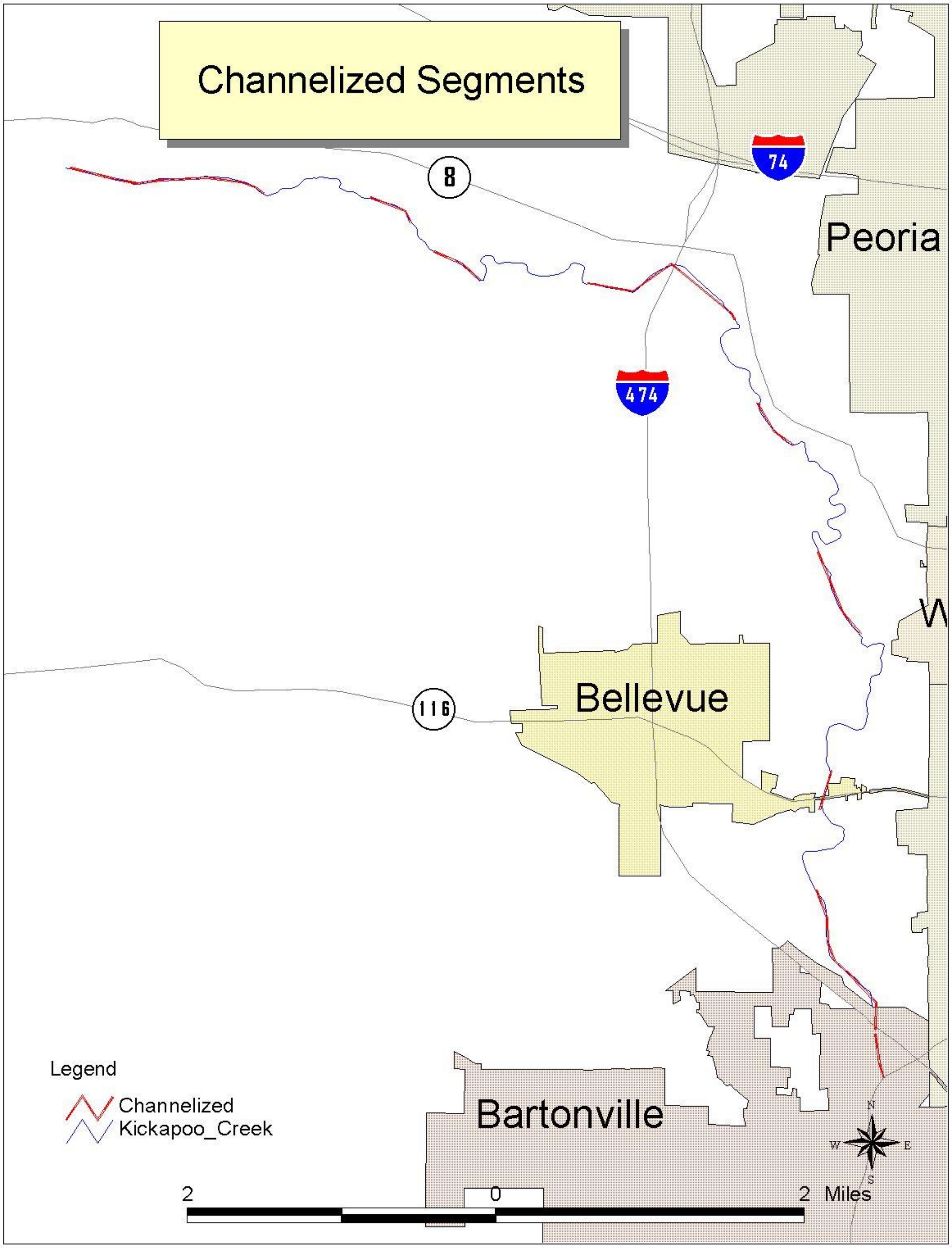

Channelized Segments
8
74
Peoria
474
W
116
Bellevue
Legend
Channelized
Kickapoo_Creek
Bartonville
N
W
E
S
2
0
2 Miles

Figure 7

Methodology

A multifaceted protocol using on-site analysis and Geographic Information System (GIS) technology was created to identify and describe the areas of the Kickapoo Creek undergoing stream channel instability.

Identification and physical descriptions of eroding banks

On-Site Analysis

An onsite analysis was conducted in the spring of 2003 and 2004. Steep eroding banks, large unvegetated point bars, and groundwater seeps were photographed and sited via Garmin Etrex Legend hand-held Global Positioning Unit. Six land surveys were conducted at specific areas of excessive erosion that were characterized by: trees falling into the channel, slumping of soil on the banks, vertical banks, and exposed root systems of existing vegetation. Standard surveying equipment was used to determine the following:

- Bankfull depth/width at meander and riffle site
- Height of the unvegetated point bar
- Width of bank at 2 X's bankfull depth
- Streambed gradient

Other data collected at the site include:
- Particle size streambed materials
- Particle size of point bar materials
- Presence of seeps or springs

The research team attempted to utilize a sub-centimeter Trimble 5700 GPS Receiver to record the above survey information in a digital format, however due to malfunctioning Global Positioning System broadcast towers, only 20 of 98 GPS points collected were accurate enough to be used in this study. The accurate information utilized in this report is indicated with "*"in the *results* section.

GIS Applications

With ArcView GIS 3.2© software, a secondary analysis was conducted utilizing digitized information from the Peoria GIS Consortium. Year 1997 black and white aerial photographs and 2-foot contours were compared to year 2003 color aerial photographs to determine additional locations of eroding banks and the formation of point bars within the six year timeframe. GIS shape files were created to outline the stream bank "blowouts" and new point bars, providing a mechanism to approximate volume of soil eroding from the banks.

Also using the GIS software and the 1997 2-foot contours, 95 stream channel cross sections in riffle and pool sequences and a stream profile (channel slope) of the study area was created. The profiles do not contain elevations below the water surface level due to the limitations of the digital topographic data. Patterns in elevation changes of the corridor were analyzed to determine locations of streambed head cuts. The general shapes of the cross sections lent insight as to the evolutionary stage of the stream system.

Formulating stabilization recommendations

Recommendations for stream stabilization techniques were formulated based on the USDA/NRCS methodology outlined in the *Streambank Inventory and Evaluation Training and Basic Stabilization Techniques*, "Streams 201" course (2002). This method utilizes the parameters below to determine 1) the stage of channel evolution according to the Schumm, Harvey, Watson 1984 Channel Evolution Model, and 2) the appropriate stream channel stabilization technique to be recommended.

- stream channel gradient
- radius of curvature along stream meanders
- bankfull width and depth in meander and riffle locations
- Width: Depth ratio
- stream width at 2 X's bankfull depth
- Entrenchment ratio (width at 2 X's bankfull depth ÷ bankfull width)
- bedload material size
- point bar material size
- height and width of point bars

With this information, streambank stabilization guidelines, developed by the USDA/NRCS, were utilized to determine appropriate stabilization techniques.

Identification of riparian habitat restoration areas

Any riparian land that contained a land use other than natural vegetation or vegetation purposefully planted for the purposes of habitat improvement, as viewed by 2003 aerial photographs, within 100 feet of the stream was selected as a potential site for riparian habitat restoration. One hundred feet of riparian zone with natural vegetation is viewed as prime condition for both nutrient capture by the buffer strip in row crop agriculture and for ecological conservation of the stream (Petersen & Petersen, 1991). General observations regarding the extent of habitat degradation were recorded during onsite inspections.

Results

On-Site Analysis

<u>Photographic Inventory</u>

A total of 131 pictures were taken in meander, riffle, and riparian areas. Appendix A contains all pictures and their locations along Kickapoo Creek.

Land Surveys

Eighteen locations were selected for potential streambank restoration sites based on visual clues of eroding banks including: trees falling into the channel, slumping of soil on the banks, vertical banks, and exposed root systems of existing vegetation. Of these 18 locations, data collection occurred on six sights; these six sights are numbered in figure 8. Once again, all 18 locations were originally intended for data collection; however, due to malfunctioning GPS towers, the information obtained was unusable for this report.

Results of the on-site data collection can be seen in table 3. Information obtained via GPS is indicated by “*”.

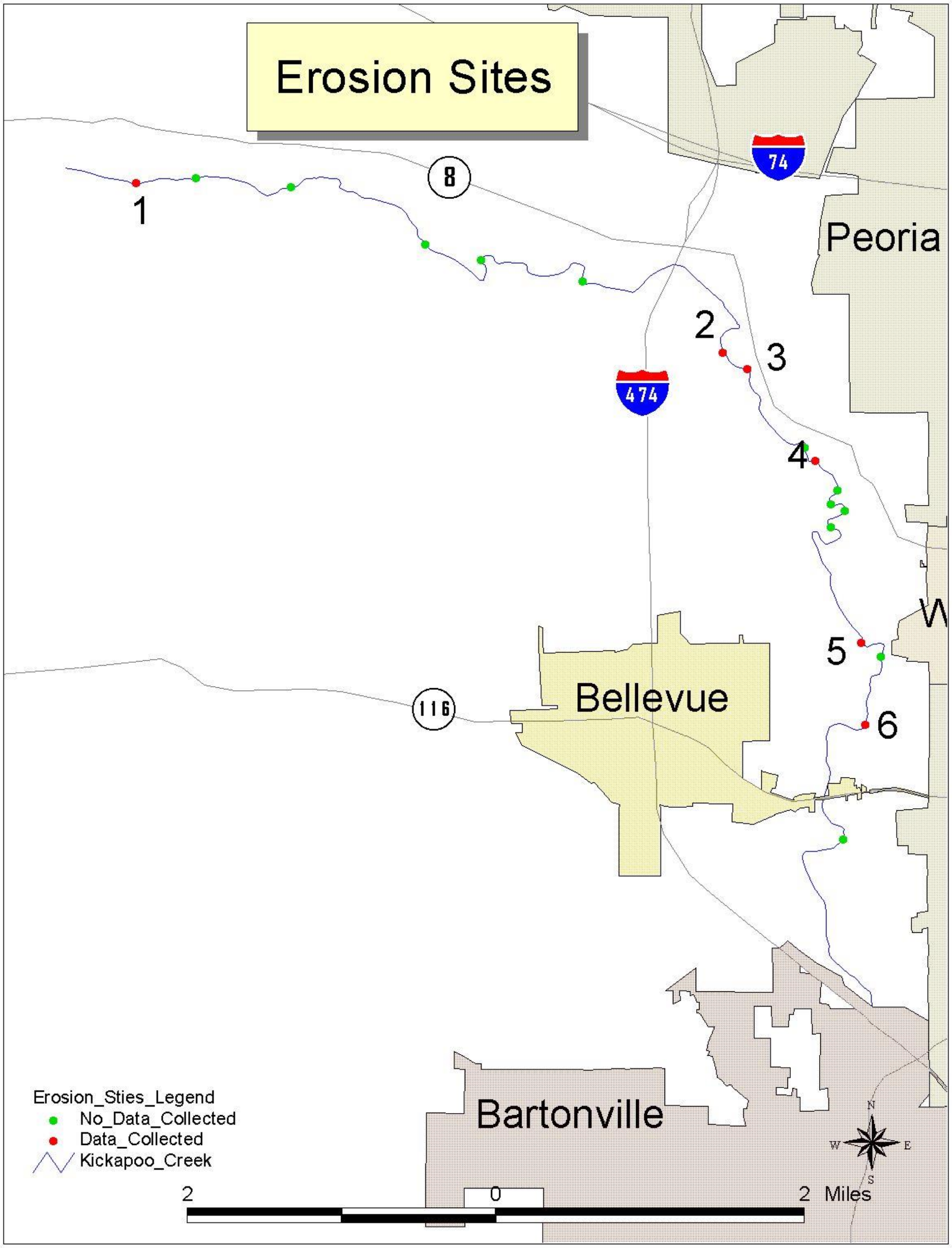

Erosion Sites
8
74
Peoria
1
2
3
474
4
W
5
Bellevue
116
6
Bartonville
Erosion_Sties_Legend
No_Data_Collected
Data_Collected
Kickapoo_Creek
2
0
2 Miles
N
W
E
S

Figure 8

Table 3

Site Number	1	2	3	4	5	6
Meander						
bankfull depth (ft)	5.00	-	7.05	4.60	*6.60	*11.00
bankfull width (ft)	84.00	*110.00	92.25	103.25	*200.00	*134.00
width:depth ratio	16.80	-	13.09	22.45	30.30	12.18
width @ 2X bankfull depth (ft)	104	-	250	118	*220	*180
Entrenchment ratio	1.24	-	2.71	5.26	1.10	1.34
D90 @ unvegetated point bar (in)	1	1	1	1	5	3
D50 @ unvegetated point bar (in)	0.25	0.25	0.25	0.25	3	1
Height of point bar (ft)	3.00	-	1.80	1.58	*3.14	*2.00
Width of point bar (ft)	26.50	65.00	37.00	55.83	*118.00	*84.00
Radius of curvature (Rc)(ft)	190	500	210	210	*300	465
Rc /bankfull width	2.26	5.00	2.28	2.03	1.50	3.47
survey gradient	0.0092	-	0.0040	0.0006	*0.01060	0.0192
seeps or springs	no	**Yes**	no	no	no	no
Riffle						
D90	4	4	4		4	2
D50	2	2	2		1	1
Bed material description	Unconsolidated	unconsolidated	unconsolidated	silt	unconsolidated	unconsolidated
bankfull depth (ft)	6.76	3.51	3.51	6.77	4.05	7.2
bankfull width (ft)	105.5	87ft 8in	87.66	117.58	119	101.5
seeps or springs	no	no	no	no	no	no

Riparian Areas

General observations of the riparian zones of Kickapoo Creek indicate that when an extensive vegetative buffer did exist, the quality of that riparian habitat decreased with distance downstream. Near Wildlife Prairie State Park, there was evidence of floral species diversity in herbaceous and trees species (no formal survey was conducted). Riparian areas ten miles downstream were overgrown with the invasive species garlic mustard (figure 9).

Figure 9 Infestation of garlic mustard in lower section of Kickapoo Creek

GIS Applications

Comparison of year1997 and 2003 aerial photographs

Sixty-eight locations, approximately 5 per mile, showed clear evidence of lateral channel movement with bank erosion mostly occurring on one side of the channel only. The total surface area of streambank lost, as perceived by aerial photographs, was 3 acres. The average height of the streambank eroded from the surface water level was 10 ± 1 ft. Multiplying these dimensions produces a crude estimate 1.3 million cubic feet of riparian soil lost to streambank erosion in the study area during the six year time frame. This number is likely an underestimate as the erosion occurring below the surface water and the less pronounced eroded areas (i.e. slumps) are not accounted for. An example of the 1997/2003 aerial photograph comparison can be seen in figure 10.

Figure 10 1997 and 2003 aerial photograph comparison at Site 5. The 1997 contours overlying the 2003 photo give the viewer a more accurate depiction of where land “used to be”.

Seventy-two individual point bars, 6 per mile, were documented. Total surface area of the point bars was 5.5 acres.

Stream Cross Sections: GIS

Ninety-one stream cross sections were created in riffle and pool locations (Appendix B). All ‘x’ axis intervals in the figures of Appendix B are 5 feet. No quantitative data was collected from the cross sections; however, in all cases the water level was well below (average approximately 10 ft) the top of the bank, indicating that downcutting has taken place or the channel has moved laterally adjacent to a steep bank. The cross sections also indicate steep slopes in channelized areas, particularly those near the beginning of the study corridor, and gentler slopes in the meandering areas where point bars have formed. Starting with cross section 52 in Appendix B, banks contain gently sloping point bars with a brake in slope (rapid increase in slope), indicating the beginning formations of a new floodplain at the lower elevation. Once again, these figures were created with year 1997 contours, and it is expected that the channel has advanced through the stages of the CEM in the 7-year time frame to the present.

Overall gradient of the study corridor as calculated by the stream profile and 1997 2-foot contours was 0.007 (figure 11). From 0-6.5 miles into the study corridor, the drop in elevation is fairly evenly distributed; however, from mile 6.5 to the terminus the elevation drops in more clustered fashion indicating possible knick points in the stream; however, some streams in Illinois do exhibit naturally occurring steeper slopes in the lower reaches (figures 12 and 13).

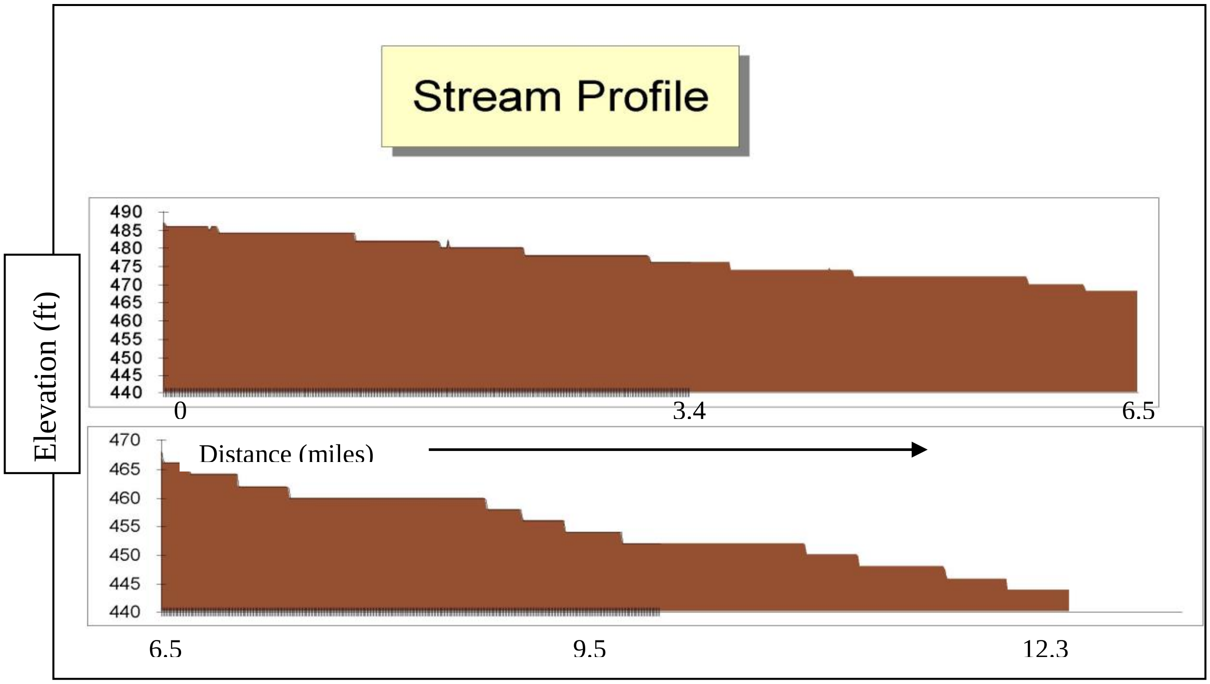


Figure 11 Stream profile of Kickapoo Creek study corridor.

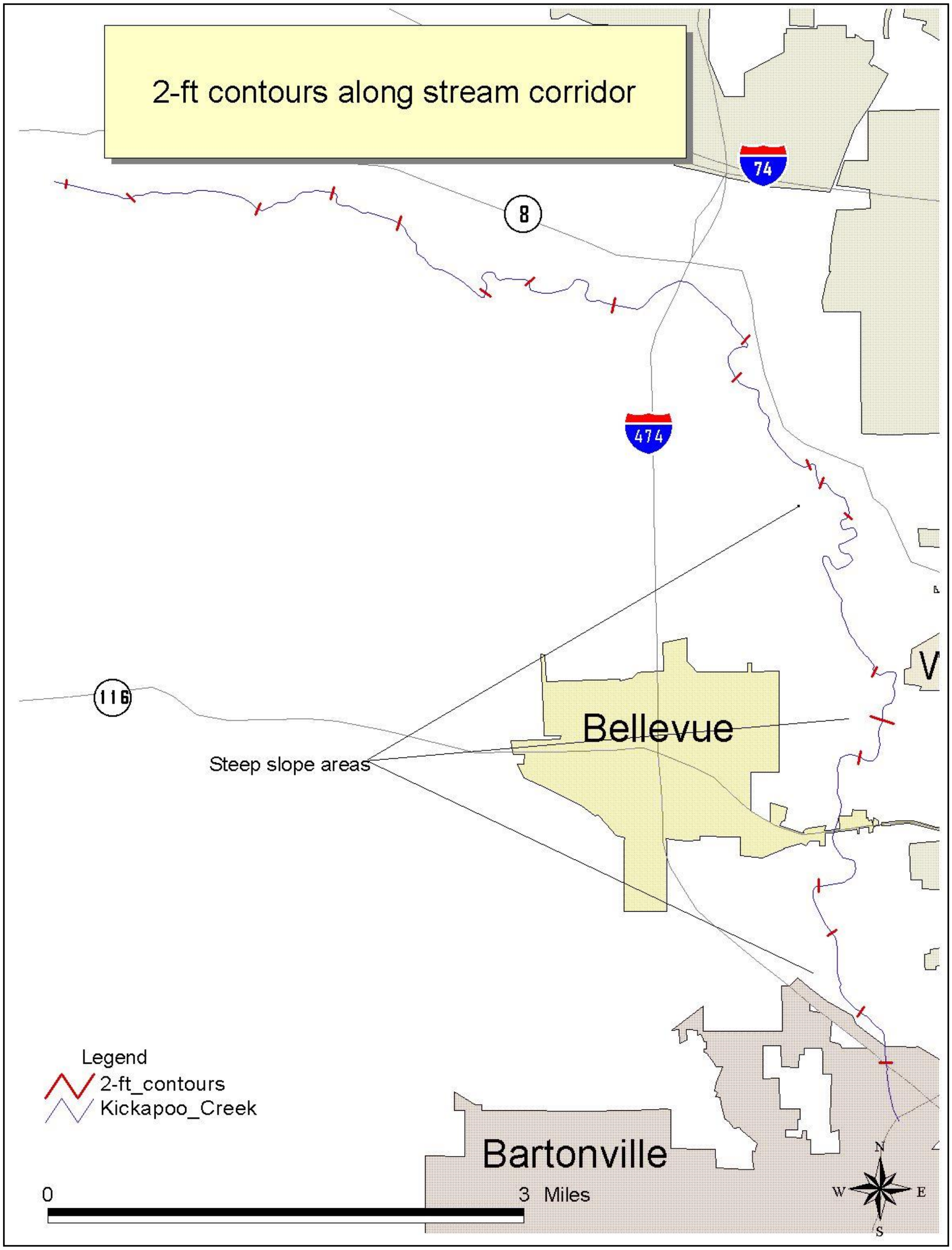


Figure 12 Locations of 1997 2-ft contours along corridor

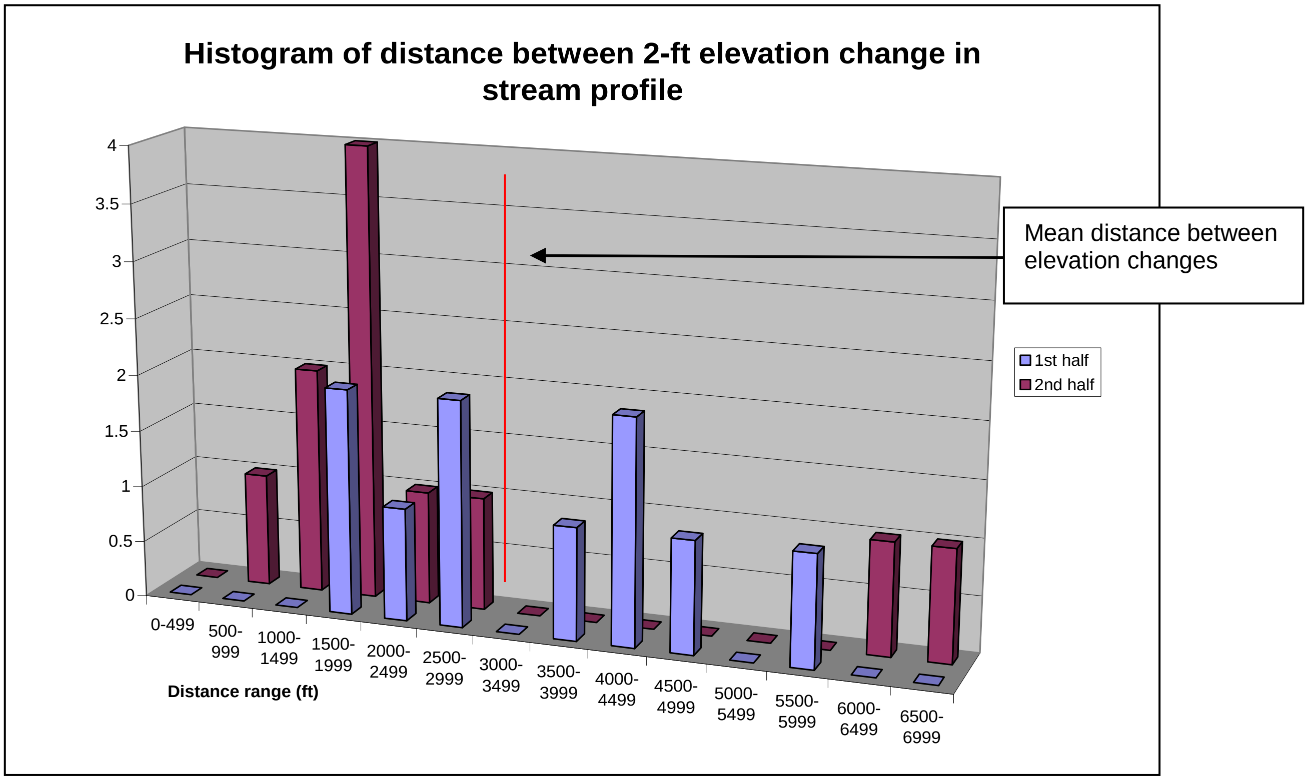


Figure 13 The distances between elevation changes in the first half of the study corridor are fairly evenly distributed from 1500-6000 ft, whereas the values for the second half of the corridor are weighted towards the extremes of the spectrum reflecting the steep slopes in this area.

Riparian Areas

Riparian areas that lacked a minimum 100-foot vegetative buffer, as seen from year 2003 color aerial photographs, were marked via GIS ArcView mapping systems. Locations of those areas can be seen in figure14. A total of 5.5 miles of streambank are in need of additional vegetative buffer. The areas selected do not include those directly adjacent to roadways where restoration is not feasible.

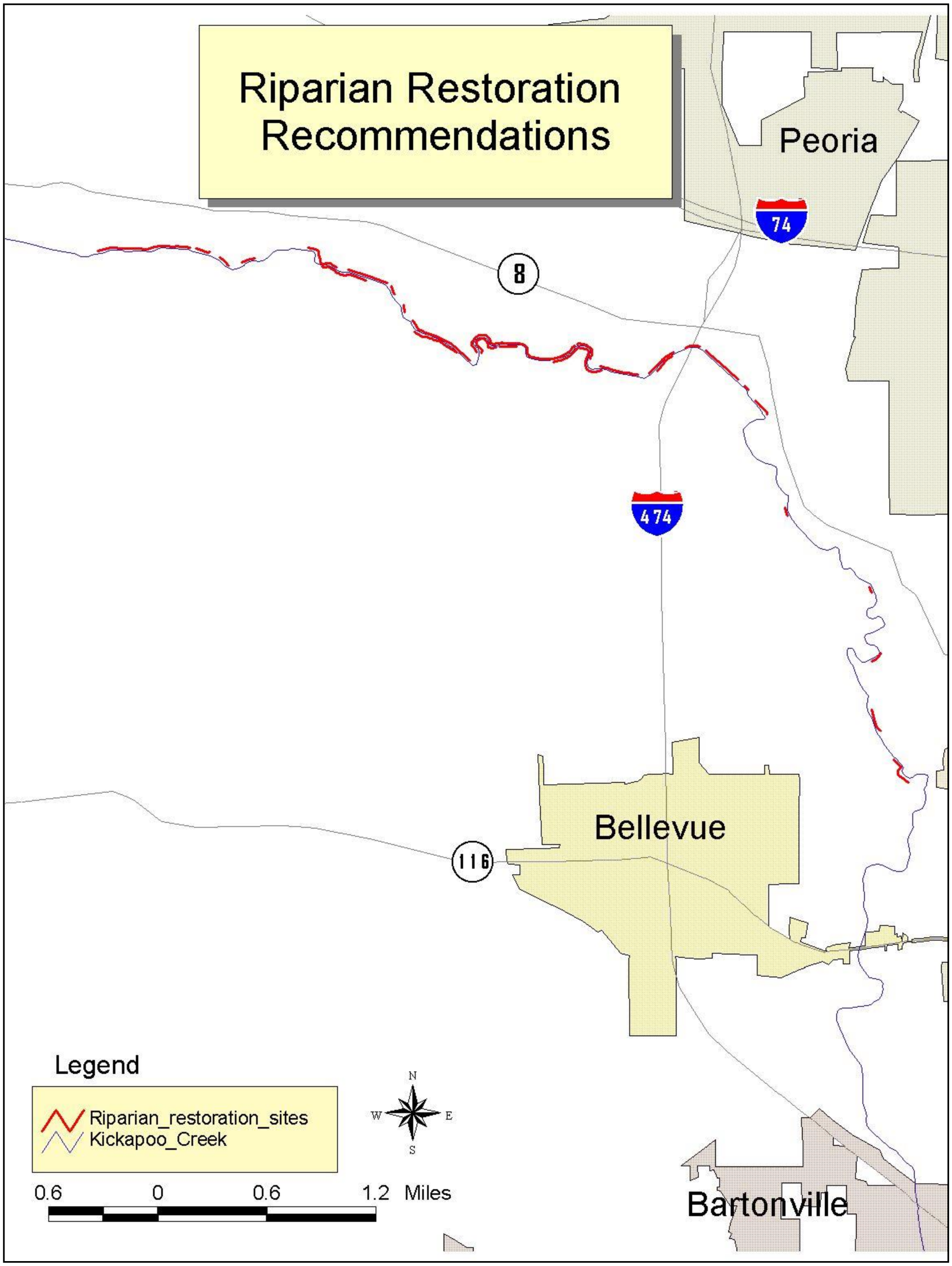

Riparian Restoration
Recommendations
Peoria
74
8
474
Bellevue
116
Bartonville
Legend
Riparian_restoration_sites
Kickapoo_Creek
N
W
E
S
0.6
0
0.6
1.2 Miles

Figure 14

Discussion

It is apparent from the photographic inventory that stream channel instability and channel erosion occurs along Kickapoo Creek. Park benches and numerous large trees were found fallen into the channel from failing streambanks and the sides of the channel were often barren of vegetation due to erosive action. This change in the channel has not gone unnoticed by landowners as riprap was found at numerous locations to protect agricultural fields, rail lines, and roadways.

As mentioned, it is important to properly identify the stage of evolution of the channel at current conditions when deciding on appropriate stabilization techniques. Figure 15 is a flow chart of streambank stabilization guidelines developed by the USDA/NRCS. The characteristics described in each box are indicative of specific stages in the Channel Evolution Model.

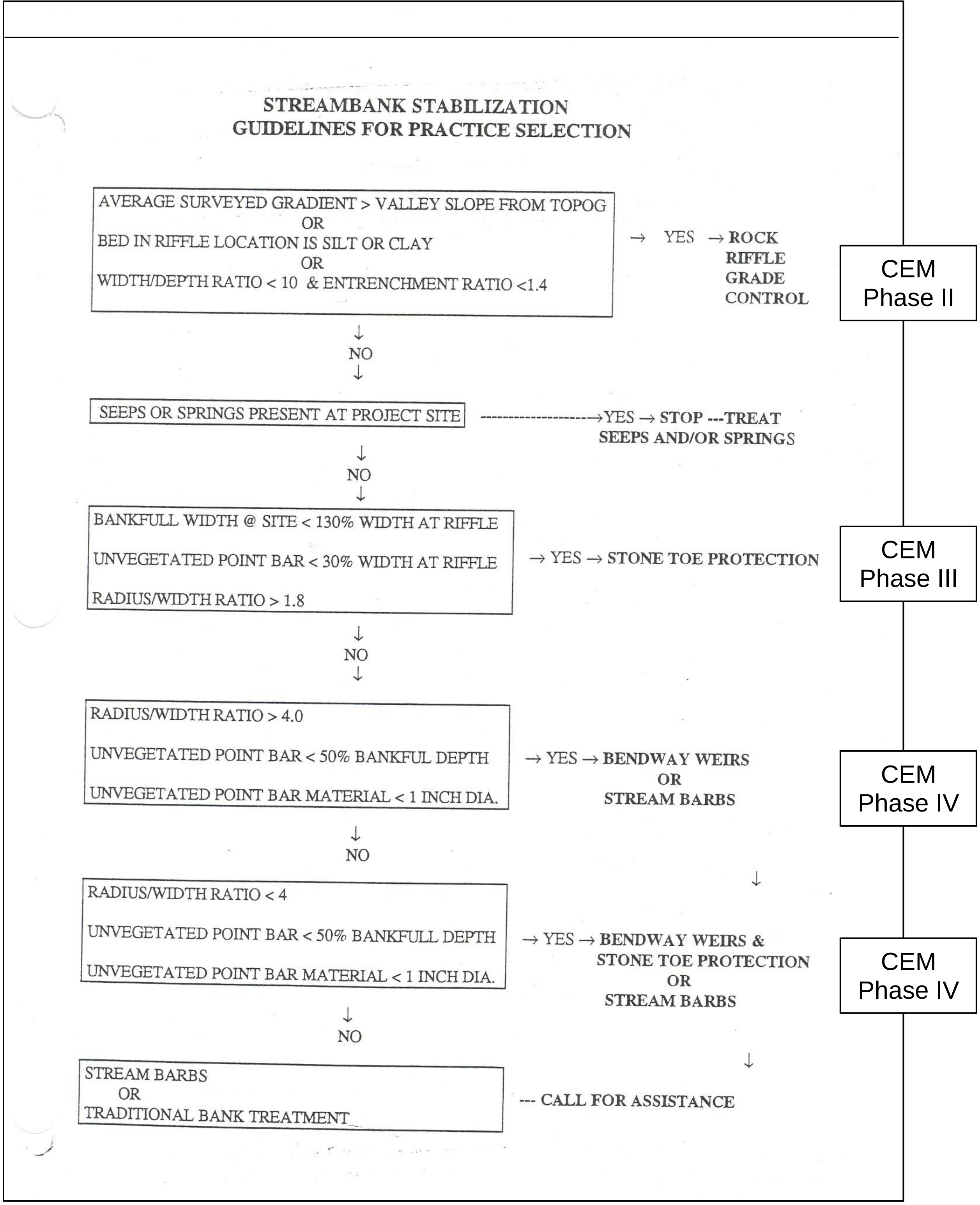


Figure 15

These guidelines were compared with the Kickapoo Creek survey data to formulate recommendations for channel stabilization. Below is a discussion for each of the six targeted sites:

Site 1

This site is located in the channelized and the upper most portion of the study area at Wildlife Prairie State Park. All the flow chart parameters indicative of **stone toe**

protection are true for this site indicating a CEM stage of III. At stage III the channel has undergone downcutting, likely due to channelization in this circumstance, and is now in the process of widening. The survey gradient for this site is slightly greater than the valley slope from the topographic map. It is possible that the channel is in a transitional state between CEM II and III; therefore, grade stabilization should also be considered.

The eroding bank is near vertical (figure 16) and while re-grading and vegetative stabilization is often utilized in conjunction with stone toe protection, the proximity to the bluff and limited accessibility to the site makes re-grading a challenge. Proper forest management including thinning invasive tree species, performing prescribed burns, and seeding would allow deep rooted vegetation to grow and improve the streambank ability to resist erosive forces.

Figure 16 Vertical bank adjacent to a forested bluff at Site 1

Summary Recommendation, Site 1: Grade stabilization, stone toe protection and forested bluff habitat management along the eroding bank.

Site 2

Unfortunately, limited data was available for Site 2 due to malfunctioning GPS towers. The important factor at this site was that a seep was observed from the base of the eroding bank to approximately 80 feet up the bluff. One source of the slope failure, in this case, is groundwater seeping from behind the bank; therefore, placing hard structures on the bank such as riprap would do little to stabilize the area. Further studies would be necessary to determine the appropriate procedure for treating the seep.

Summary Recommendation, Site 2: Check for and mitigate (if necessary) grade instability at the site. Investigate options to treat the groundwater seep on the bluff.

Site 3

All parameters in the flow chart indicative of stage IV CEM and **bendway weirs and stone toe protection or stream barbs** for stabilization are true. This site is approximately 5.5 miles downstream from Site 1. In system wide instabilities, such as that seen in Kickapoo Creek, it can be expected that the evolution of the channel is more advanced in the lower reaches than the upper, particularly since channel incision (the initial stage of an adjusting channel) migrates upstream. Re-grading the bank is feasible; however, trees would likely need removal and access is limited (figure 17).

Summary Recommendation, Site 3: Place bendway weirs and stone toe protection or stream barbs along the eroding bank. Shape slope to reduce failure hazard if feasible and seed with native trees and herbaceous vegetation.

Figure 17

Figure 18 Weirs placed within Kickapoo Creek by the USDA/NRCS upstream of the study corridor

Site 4

The characteristics of this site best match those listed for the **bendway weirs and stone toe protection or stream barbs** recommendation. All parameters listed for this recommendation are true; however, the bed material at the riffle is composed of silt, indicating grade instability; and the bank full width at the site is <130% of the width at the riffle, a characteristic of stage III channel evolution. These discrepancies may be related to channel failure that occurred 1,400 feet upstream were a structure redirecting the stream current was placed in the creek causing adjacent banks to erode and new sandbars to deposit (figure 19). The 1997 and 2003 aerial photographs of this site are seen in figure 20.

Figure 19 Streambank structure in the channel directly upstream of Site 4

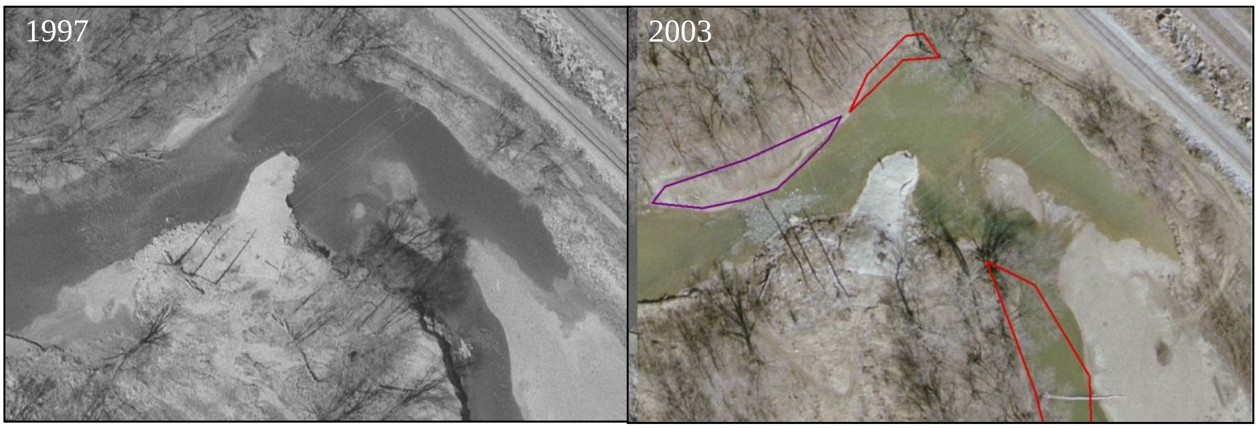


Figure 20 1997 and 2003 aerial view of Figure 19. Red polygons are areas of streambank erosion while the purple are point bar formations.

Summary Recommendation, Site 4: Place bendway weirs and stone toe protection or stream barbs along the eroding bank at site. Shape slope to reduce failure hazard and seed with native trees and herbaceous vegetation. Investigate proper maintenance or possible removal of structure upstream to prevent further channel damage.

Site 5

Data for site 5 does not correlate with any complete set of characteristics in the flow chart. In this case, the discrepancies to the conditions of the flow chart may be due to the tributary, Dry Run, entering Kickapoo Creek at this location. Dry Run drains approximately 7,000 acres of highly urbanized areas within the City of Peoria. The tributary connects with the study corridor at the terminus of a channelized portion of Kickapoo Creek. It is evident from on-site analysis and aerial photographs that the channel of Dry Run directs flow perpendicular to the eroding bank of Kickapoo Creek (figure21). Further investigation should be given to the options to dissipate energy in Dry Run and minimize the erosive force of this water on the Kickapoo Creek bank. To protect the banks of Kickapoo Creek, **bendway weirs or stream barbs** may be the best option; however, the flow direction and discharge from Dry Run must be taken into account. The bank is easily accessible for re-grading to a gentler slope. This site is also located in the "steep slope" area defined by the stream profile and contains a greater survey gradient than the valley slope; therefore, grade stabilization should be considered here.

Summary Recommendation, Site 5: Place bendway weirs or stream barbs along the eroding bank accounting for flow from Dry Run. Shape slope to reduce failure hazard and seed with native trees and herbaceous vegetation. Stabilize the streambed with riffle pool or other appropriate structures. Investigate proper options to dissipate energy from Dry Run channel flow.

Site 6

All characteristics for the **bendway weirs and stone toe protection or stream barbs** recommendation are true. The site is accessible via row-crop agricultural field for re-grading. This site is also located in the "steep slope" area defined by the stream profile and contains a greater survey gradient than the valley slope; therefore, grade stabilization should be considered here.

Summary Recommendation, Site 6: Place bendway weirs and stone toe protection or stream barbs along the eroding bank. Shape slope to reduce failure hazard and seed with native trees and herbaceous vegetation. Consider grade stabilization techniques.

Conclusion

The trend of the above sites indicates that the study corridor of Kickapoo Creek currently ranges from phase III to phase IV with the channel becoming more advanced downstream. Steep slopes, however, particularly in the 2nd half of the corridor, indicate the possibility of a phase II movement simultaneously occurring with the phase IV segments. Further study would be needed to determine if these sites are truly downcutting or if the steep slopes are stable. Seeps and springs were noted in the study corridor; therefore, landowners should pay particularly attention to the presence or absence of springs before they begin any restoration project.

The purpose of this study was to provide a summary of the problems and potential solutions to stabilizing the banks of the lower reaches of Kickapoo Creek. The range of alternatives recommended in this report is limited and landowners wishing to implement streambank stabilization on their property should seek technical assistance from a professional consultant or streambank specialist to ensure the success of the project.

As noted, an estimated 1.3 million cubic feet of sediment from the study corridor has contaminated Kickapoo Creek over the past seven years. This sediment creates turbid waters limiting sunlight availability for photosynthetic organisms, raising water temperatures, and clogging gills of aquatic animals. Combining the practices of stream channel stabilization with riparian habitat restoration will have profound effect on the water quality of Kickapoo Creek by reducing the amount of sediment delivered to the stream system.

References

The Federal Interagency Stream Restoration Working Group. 1998. *Stream corridor restoration: principles, processes, and practices.*

Illinois Department of Natural Resources. 2002. 1999-2000 digital land cover.

Illinois Department of Natural Resources and University of Illinois at Urbana-Champaign. 1999. *Illinois Stream Information System.*

Kinney, Wayne. 2004. Connecting Illinois Watersheds Conference presentation. *Stream restoration in 2004: Illinois Department of Agriculture cooperating with Illinois Soil and Water Conservation Districts*.

Kinney, Wayne. 2003 USDA/ Natural Resource Conservation Service. *Streambank Manual*. Streams 201 course.

Peoria GIS Consortium. 1997 & 2003. digital ortho photography.

Peoria GIS Consortium. 1997. digital topographic data.

Petersen, Jr. Robert C. 1992. The RCE: a riparian, channel, and environmental inventory for small stream in the agricultural landscape. *Freshwater Biology*. **27**. 295-306.

United States Department of Agriculture. 1992. *Soil Survey of Peoria County, Illinois*. Illinois Agricultural Experiment Station Soils Report 132.