Channel-Bank Conditions and Accumulations of Large Woody Debris along White River between Anderson and Indianapolis, Indiana, 2002

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Introduction

In December 1999, a fish kill occurred along the reach of White River between Anderson and Indianapolis, Indiana. As a result of that fish kill, two trust funds--the White River Restoration Funds--were established to help rehabilitate and restore natural resources along White River.

In support of these rehabilitation and restoration efforts, the U.S. Geological Survey (USGS), working in cooperation with the Indiana Department of Environmental Management (IDEM), the Indiana Department of Natural Resources (IDNR), and the U.S. Fish and Wildlife Service (USFWS), completed a project to map channel-bank conditions and accumulations of large woody debris along White River between Anderson and Indianapolis (see Index Map).

This web site has been developed to provide a description of that project and display the resultant maps.

Background

In any river system, excessive loads of suspended sediment can be one of the primary degraders of aquatic habitat. In the case of White River, the problem of excessive suspended-sediment load is brought about by several factors. In most locations within the study area, the White River Watershed is underlain by fine-grained glacial deposits and agriculture is the dominant land use. These two characteristics combine to produce a river system that often is subjected to excessive loads of fine-grained sediment as runoff from enters the river. Further compounding the suspended-sediment problem is the fact that natural channel meandering may lead to bank erosion that contributes additional fine-grained sediment to the river.

In early 2002, the IDEM, IDNR, and the USGS performed a reconnaisance investigation of channel-bank conditions and accumulations of large woody debris along White River between Anderson and Indianapolis. During this tour, reaches with stable channel banks were observed, but there were also many reaches where moderate to severe bank erosion was adding fine-grained sediment to the river. Many trees growing along the river banks were being undermined and lost to bank-erosion processes.

Tree trunks, large tree limbs, and root boles sloughed into the river tend to collect as accumulations of large woody debris (LWD) at sites where a channel feature acts as an obstruction to flow. These LWD accumulations can pose a threat to public safety and cause further bank erosion by redirecting streamflow toward a vulnerable stream bank.

As a first step toward restoration and rehabilitation, the USGS, IDEM, IDNR, and USFWS entered into a cooperative project to map channel-bank conditions and accumulations of LWD along White River between Anderson and Indianapolis.

Study Objective

The objective of this study was to map channel-bank conditions and accumulations of LWD along a 58-mile reach of White River in Indiana. The study reach (see Index Map) began at Madison Avenue in Anderson, Indiana, and continued downstream to the 16th Street Dam in Indianapolis. Bank conditions were mapped in terms of erosion and stability along the entire study reach. The maps produced from this study show the location of accumulations of LWD and contain links to photographs that depict channel conditions at the time field observations were made (August-October 2002).

Acknowledgments

Members of the White River Citizens Advisory Council provided input regarding the direction and scope of this investigation. Leslie Arihood, of the USGS Indiana District, developed software tools to process the field observations and generate the bank-condition maps. Mark Hopkins, also of the USGS Indiana District, was instrumental in the development of this web site. The author thanks these individuals for their support of this investigation.

Study Methods

During August-October 2002, the USGS surveyed the entire length of the study reach by canoe. Bank-condition observations were recorded on 7.5-minute quadrangle USGS topographic maps and digital photographs were taken to document channel-bank conditions and the location of LWD accumulations.

Channel-bank conditions were evaluated following the general method outlined by Bhowmik and others (1997) working in the upper Mississippi River Watershed and by Bhowmik and others (2001) as they mapped and described bank conditions along the Kankakee River in Indiana and Illinois. The bank-assessment criteria used to categorize bank conditions for White River included bank angle, bank height, bank material, vegetative conditions, and other signs of bank erosion or sediment deposition.

Bank conditions were inspected visually and from these observations the banks were mapped using one of six descriptive categories: 1) stable, 2) slight erosion, 3) moderate erosion, 4) severe erosion, 5) depositional, or 6) hardened. Further description of these bank-condition categories is provided on the Bank-Condition Categories page. A seventh category--no information--was used where bank-condition information could not be collected because of the small size of some islands not shown on the USGS topographic maps used in the field.

Bank Assessment

Several channel features can be observed in the field to evaluate bank-erosion conditions. In general, bank stability is promoted by cohesive bank materials--bank materials with a significant silt and/or clay component--and relatively low bank angles. At sites of accelerated bank erosion, one expects to encounter bank materials that lack significant cohesion--bank materials dominated by sands and gravels--and relatively steep bank angles.

Also, in most locations, the presence and condition of woody vegetation growing on the channel bank can be used to evaluate relative bank stability. The photographs shown below and the accompanying discussion illustrate how this evaluation is accomplished.

A photograph of a failing bank lacking woody vegetation.
(http://in.water.usgs.gov/newreports/bankerosion/img10.jpg)

A photograph of tree roots providing some bank protection.
(http://in.water.usgs.gov/newreports/bankerosion/img11.jpg)

The rooting system of woody vegetation tends to bind and protect bank materials and promotes bank stability. The above two photographs show channel banks that have been eroding. The rates of bank erosion are undoubtedly quite different, however. The photograph on the left shows a bank devoid of woody vegetation, and field evidence indicates that the bank is retreating rapidly (mapped as severe erosion). The photograph on the right also shows a bank subjected to erosive forces; however, the root masses associated with the woody vegetation have helped to stabilize and protect the bank materials, thereby slowing the erosion process (mapped as slight or moderate erosion based upon a complete evaluation of all field evidence).

A photograph of bank failure causing a tree to lean toward the river.
(http://in.water.usgs.gov/newreports/bankerosion/img12.jpg)

A photograph of tree growth attempting to keep pace with bank erosion.
(http://in.water.usgs.gov/newreports/bankerosion/img13.jpg)

When banks covered by woody vegetation are unstable, the condition of the vegetation can provide the needed evidence to assess the relative rate of bank-material loss. In the photographs immediately above, the channel banks are unstable and the trees growing on these banks are impacted. However, the growth characteristics of the trees in each photograph indicate that these banks are failing at different rates. The photograph on the left shows rapid bank failure; since being tilted, the tree has not had a chance to grow into a more upright position. In contrast, the photograph on the right shows a tree that has been able to adjust gradually its growth form to compensate for the slow removal of bank material. Of the two photographs, the one on the left provides greater evidence of rapid and recent bank failure.

Bank-Condition Categories

The table below provides a list of the descriptive bank-condition categories used in the mapping process and a general description of the bank characteristics that were observed and evaluated to assign each bank segment to one of the bank-condition categories.

Map symbol	Bank-condition category	General channel-bank characteristics
(Blue)	Stable	Well vegetated banks, bank angles less than 40˚, no field evidence of active erosion
(Yellow)	Slight erosion	Vegetated banks with some root exposure, cohesive bank materials, bank angles less than 40˚
(Orange)	Moderate erosion	Partially denuded scarp less than 4 ft. high, bank angles greater than 30˚, erosional impacts to bank vegetation, cohesive bank materials
(Red)	Severe erosion	Denuded scarp 4 or more feet in height, non-cohesive bank materials, mass-wasting conditions, bank angles greater than 40˚
(Green)	Depositional	Recently deposited bar materials lacking vegetative cover, commonly point bars
(Gray)	Hardened	Bank protected by riprap, gabions, sheet pile, or sea walls

In this investigation, a total of 124.9 miles of channel bank were evaluated and assigned to one of the six bank-condition catergories listed above. Of these 124.9 miles, 53.6 miles (43 percent) were mapped into the slight-erosion category, 50.4 miles (40 percent) were mapped as stable, 9.3 miles (7 percent) were mapped into the moderate-erosion category, 4.6 miles (4 percent) were mapped as hardened, 4.2 miles (3 percent) were mapped as depositional, and 2.8 miles (2 percent) were mapped as showing signs of severe erosion.

References Cited

Bhowmik, Nani G., Soong, David T.W., 1997, Bank erosion field survey report on the Upper Mississippi River and Illinois Waterway: Interim Env Report #8 for the Upper Mississippi River - Illinois Waterway System Navigation Study: U.S. Army Corps of Engineers--St. Paul, Rock Island, and St. Louis Districts, accessed June 6, 2002, at http://www.mvr.usace.army.mil/pdw/nav_study/env_reports/ENVRPT8.htm

Bhowmik, N.G., Soong, D.T.W., Bauer, Erin, and Demissie, Misganaw, 2001, Bank erosion survey of the main stem of the Kankakee River in Illinois and Indiana: Illinois State Water Survey Contract Report 2001-01, 73 p.