INDIAN CREEK WATERSHED DIAGNOSTIC STUDY

Indian Creek is one of the largest tributaries (watershed area of 111 square miles) of the Tippecanoe River in northwestern Indiana (Fig.1). The Pulaski, Cass, Fulton, and White County SWCDs received funding from the Indiana Lake and River Enhancement program of IDNR in December 2001 to conduct a Watershed Diagnostic Study to help identify water quality problems and solutions in the watershed.

Figure 1. Tippecanoe River and Indian Creek Area

RESULTS AND IDENTIFICATION OF PROBLEM AREAS

Instream chemical parameters measured at each site indicate that dissolved oxygen (D.O.), pH, temperature, and conductivity fell within acceptable ranges for most forms of aquatic life. Abundant algal growth (stimulated by high nutrient inputs) is usually indicated by pH readings significantly higher than 8.0. This was the case at sites 4 (upper Indian Creek) and 8 (Frederick Ditch) during the dry weather sampling. High algal growth rates are also indicated at sites where dissolved oxygen is much higher than the saturation level. This was especially true at site 8 (Frederick Ditch) and 9 (upper Little Indian Creek), where the D.O. level was much higher than saturation during the dry weather sampling. Because algae also use oxygen when light is not present, sites with abundant algae typically have large variations in D.O. During the night or on cloudy days the D.O. at such sites may drop below the 5 mg/l minimum required for healthy aquatic communities.

Nutrient and suspended solids concentrations were relatively low at most sites in Indian Creek, compared to other streams in Indiana flowing through areas with primarily agricultural land uses. A single grab sample from Rans Ditch in the upper Grassy Creek watershed was an exception. The orthophosphorus concentration at this site on October 30, 2002 was 2 mg/l (at least 20 times higher than other sites).

A total of 41 macroinvertebrate genera were collected at the twelve sites. The most commonly collected groups were midge larvae, aquatic beetles, snails, and net-spinning caddisflies. The pollution intolerant groups Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies) were abundant at most sites but noticeably absent at sites 8 and 9 in the Little Indian Creek sub-watershed. Many of the sites contained “cool water” forms such as *Brachycentrus numerosus* and *Ceratopsyche sparna*. These species are only found where abundant groundwater contributions keep the water relatively cool in the summer months.

Table 4 shows how the aquatic communities at the eleven study sites compared to that of the reference site. Impacted sites are shown graphically in Figure 9. The site with the highest biotic index and habitat value was on Indian Creek just upstream with its confluence with the Tippecanoe River. This means that Indian Creek is probably not having a negative effect on water quality of the Tippecanoe River. Its habitat and biota are similar to that of a “reference” stream. All upstream sites in the Indian Creek watershed were slightly or moderately impacted. This means that improvements can be made there.

Figure 10 shows the normal relationship of biotic index scores to habitat values (a linear relationship according to [10]). The figure also shows a range of plus or minus 10% to account for a certain amount of measurement variability. When biotic index values fall outside this range, the site typically has degraded water quality. Fig.10 indicates that seven of the eleven study sites had biotic values outside the range expected from their measured habitat value. Therefore, these sites are impacted by both water quality and habitat degradation. The largest deviation from the expected value occurred at sites 4 and 10. Efforts to improve water quality in the watershed should be focused on these areas (Fig. 11) in the upper Grassy Creek and upper Indian Creek sub-watersheds.

In contrast, the biotic index of some streams will not improve until aquatic habitat is improved. These areas are shown in Fig. 12. Habitat improvements include establishing shading trees, decreased channelization, and streambank stabilization.

Figure 9.
Degrees of Impairment in the Indian Creek Watershed
Yellow = Moderate Impairment
Blue = Slight Impairment
Green = No Impairment

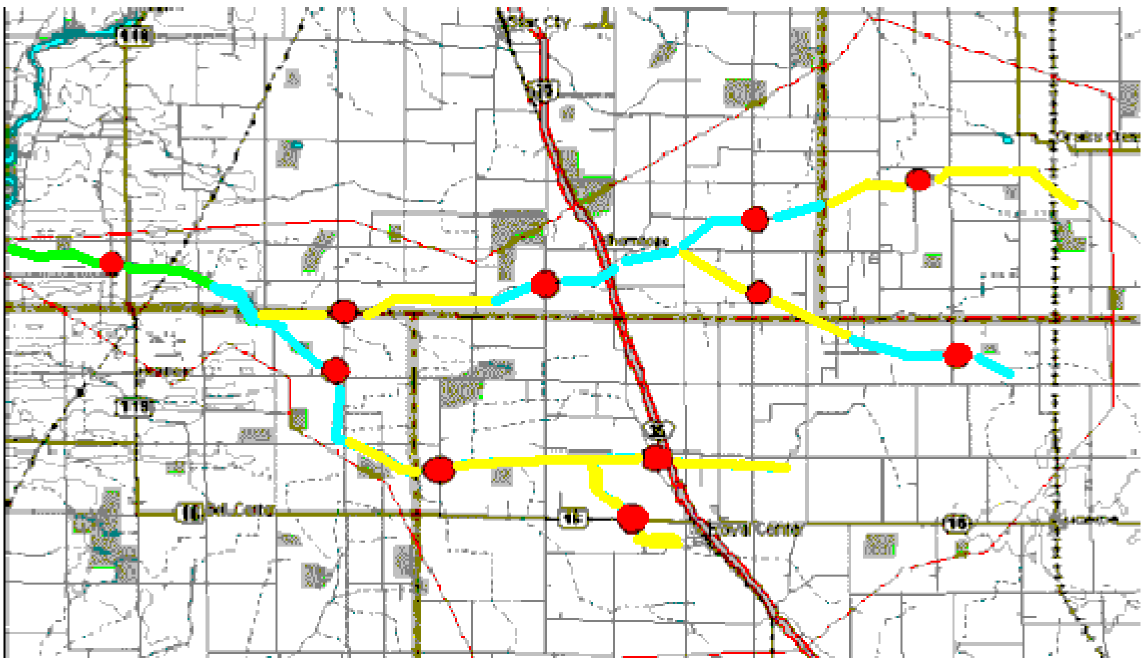


Figure 10.

The normal relationship between habitat and biotic index score is shown below.
Sites falling outside the normal relationship (plus or minus 10%)
are probably affected by degraded water quality.

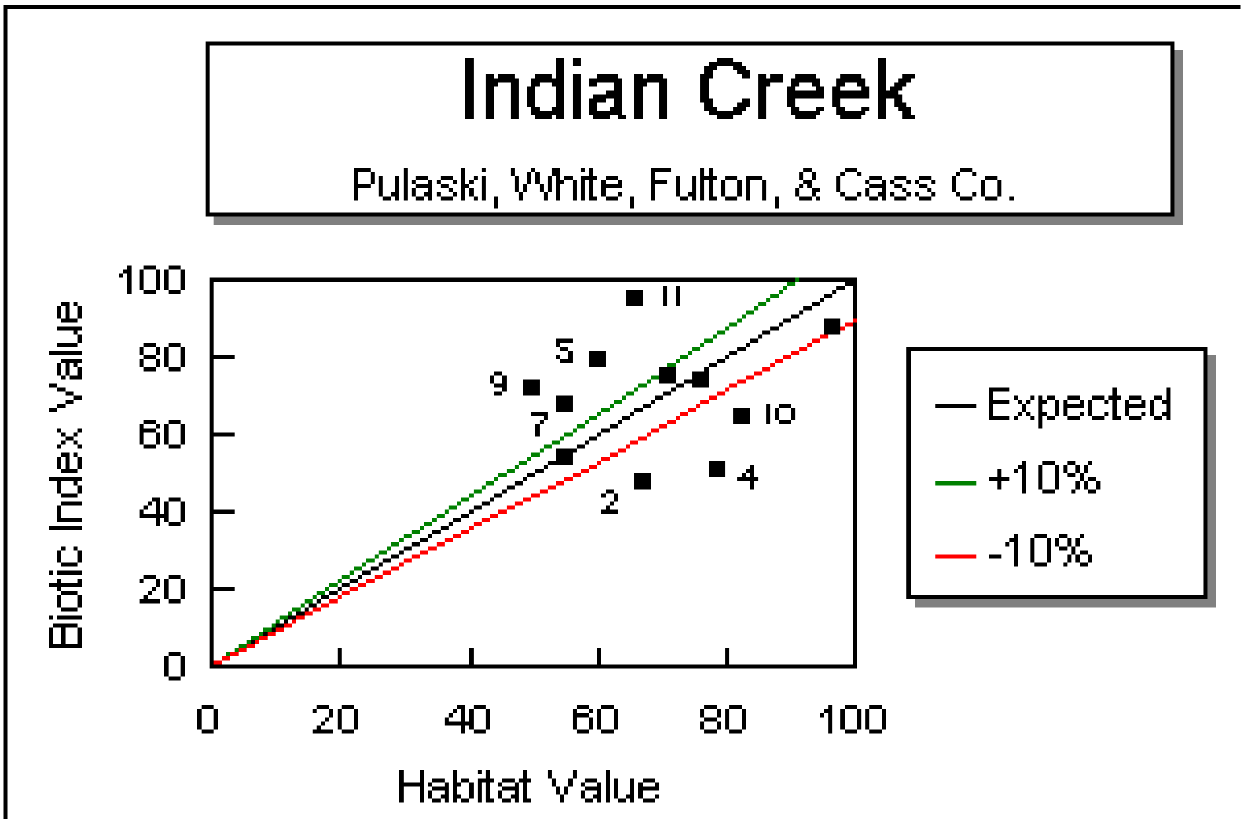


Fig.11. Sub-watersheds with highest potential for water quality improvement and with highest priority for BMPs (highlighted in green)

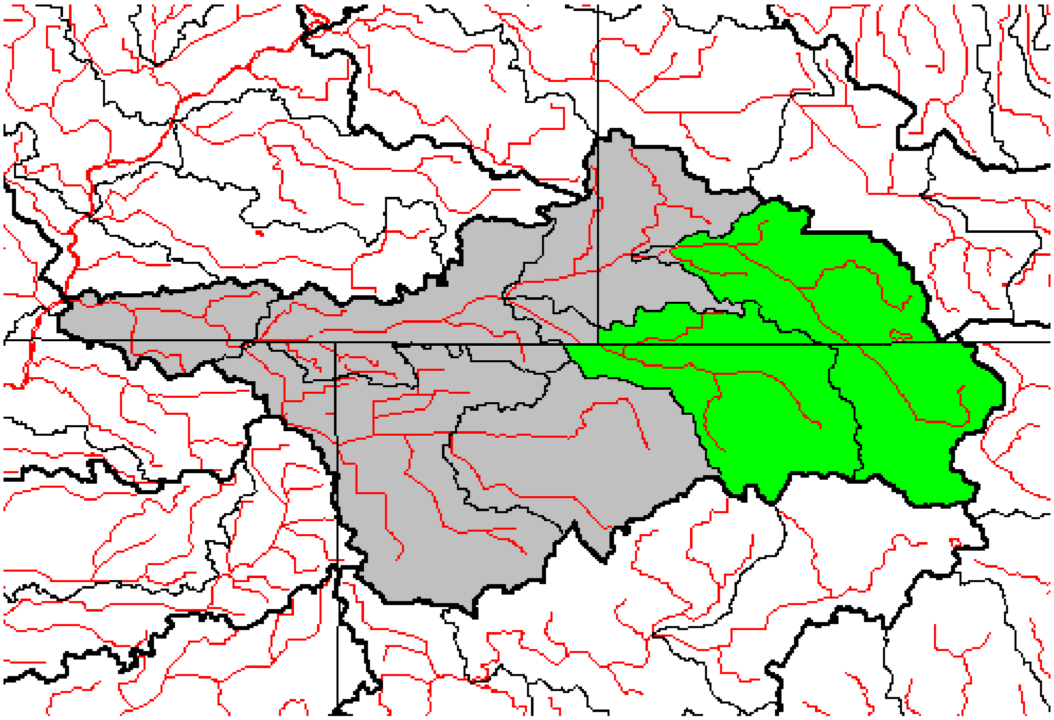
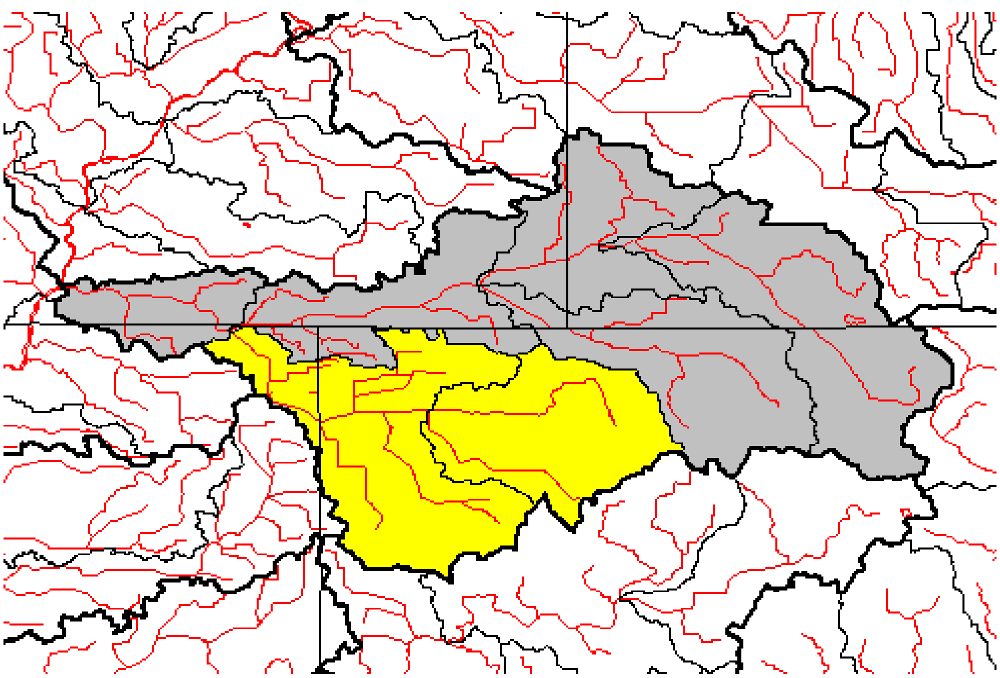


Fig. 12. Sub-watersheds impaired most by habitat degradation and which need riparian vegetation and channel restoration (highlighted in yellow)



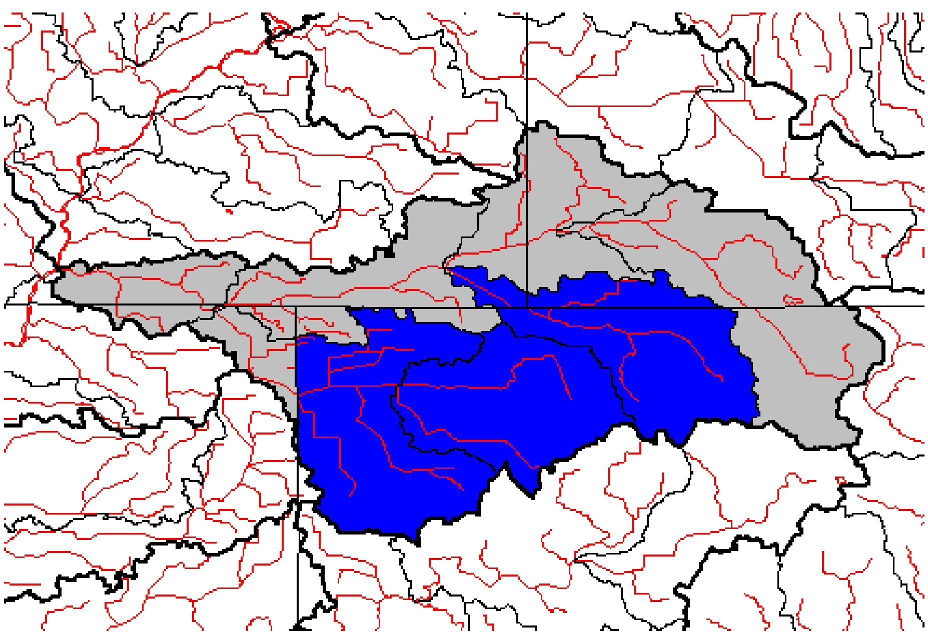
What kinds of water quality problems are contributing to impairment? Table 5 shows sediment-tolerance values for many of the commonly collected animals in these streams. The proportion of sediment and turbidity-intolerant forms was significantly higher at the reference site than sites 4, 5, 7, 8, and 9. These results indicate that sediment-related impairment may be contributing to the water quality problems in the Indian Creek watershed, especially in the upper Indian Creek and Little Indian Creek sub-watersheds.

Table 5. Sediment-Intolerant Species Observed

% of Sediment-Intolerant Organisms at the Reference		11%
% of Sediment-Intolerant Organisms at the Study Sites		
	Site 1	12%
Sediment Intolerant Organisms	Site 2	50%
Ceratopsyche spp.	Site 3	12%
Chimarra obscura	Site 4	1%
Brachycentrus numerosus	Site 5	1%
Pseudostenophylax spp.	Site 6	4%
Stenonema vicarium	Site 7	0%
Stenonema terminatum	Site 8	0%
Isonychia sayi	Site 9	1%
	Site 10	6%
	Site 11	21%

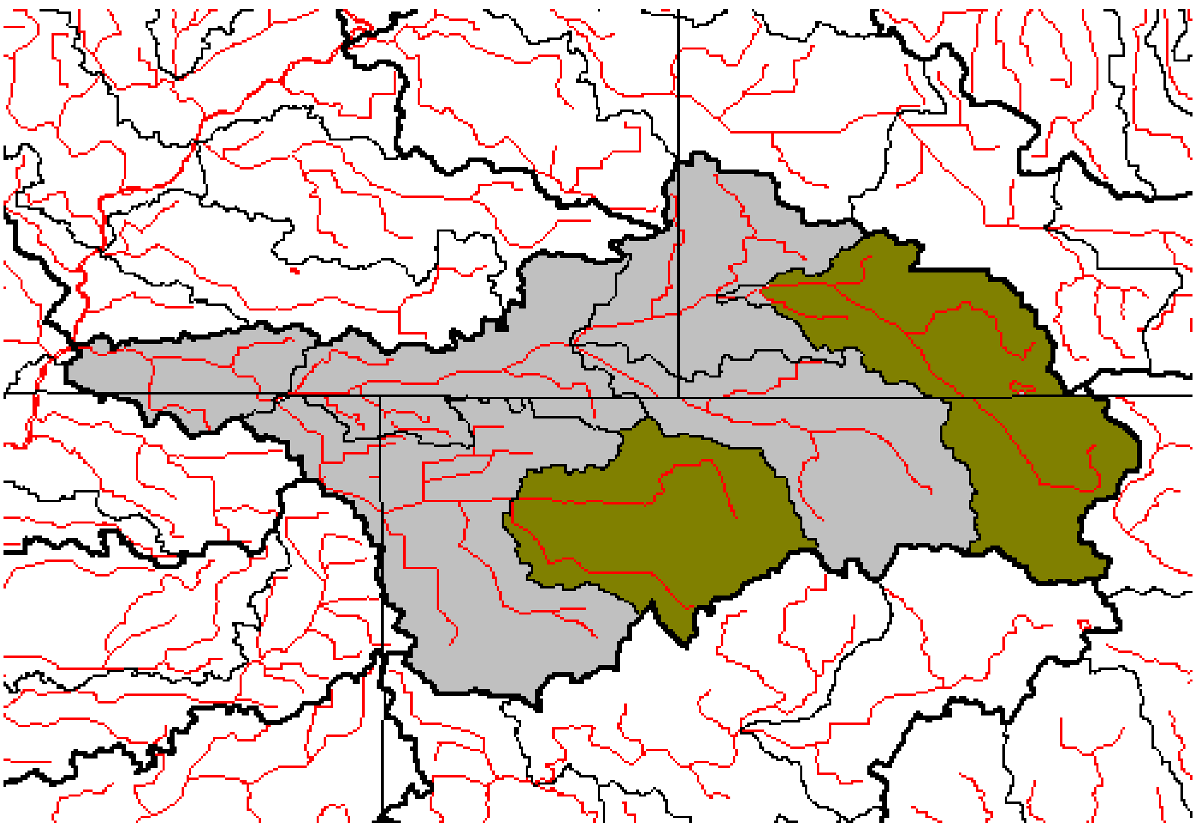
Best management practices which reduce soil erosion and increase streambank stability should be used in the sub-watersheds shown in Fig. 13.

Fig. 13. Sub-watersheds affected by sediment (need BMPs for sediment reduction) are highlighted in blue.



When the number of animals which eat algae attached to rocks (“scraper” organisms) become numerically dominant, excessive nutrient inputs are often the cause. Scrapers dominated at sites 7 and 9 in upper Little Indian Creek. The upper Grassy Creek sub-watershed is an interesting example of a stream with a biotic index much higher than its habitat value. According to [10], this type of effect also occurs where nutrient inputs are excessive. Best management practices to reduce nutrient inputs should be employed in these areas, shown in Fig. 14. Some nutrient BMPs, such as proper manure storage and land application, may also bring down the high concentrations of E.coli found in Grassy Creek..

Fig. 14. Sub-watersheds affected by excessive nutrient inputs and need nutrient BMPs (highlighted in brown)



“Scraper Organisms”

Heptagenia spp.	Psephenus herricki
Stenacron spp.	Physella gyrina
Stenonema spp.	Elimia livescens
Stenelmis spp.	Ferrissia spp.
Dubiraphia spp.	Helisoma spp.
Optioservus spp.	Stagnicola spp.
Macronychus glabratus	Lymnaea spp.

D.. NUTRIENT LOADING PREDICTIONS BASED ON MODELING

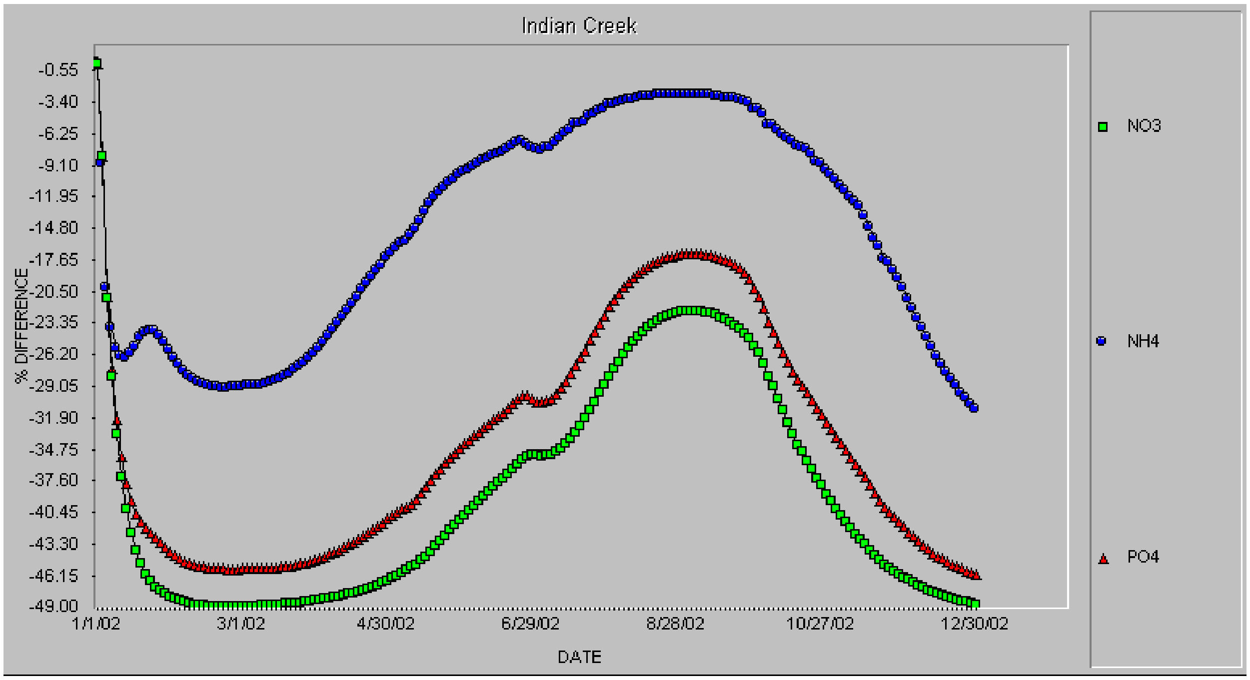
Computer models are sometimes useful for helping water resource managers visualize water quality and biological changes that could occur when changes in land use are made. U.S. EPA has recently released a new computer model called AQUATOX.[9] that combines water chemistry with aquatic ecology. The model allows a user to set up a model ecosystem (e.g. a stream with a given depth, length, flow, climate, and water chemistry) and observe how that ecosystem's chemistry and biology changes over time. The model also allows the user to change the ecosystem by increasing or decreasing the amount of pollutant loading that occurs. For example, the user could tell the model that Best Management Practices for agricultural land uses are going to be implemented in a watershed and that phosphorus, nitrogen, and suspended solids concentrations are going to be cut in half by these BMPs. AQUATOX tells the user how BMP implementation would affect the chemistry and biology of a stream in that watershed.

The AQUATOX model was used to predict changes in the Indian Creek watershed that could occur with BMP implementation. The model used the following assumptions, based on actual measurements in Indian Creek made as part of this study:

Physical Parameters	
Reach Length	40 km
Mean Depth	0.4 m
Surface Area	100,000 sq. m
Temperature Range	0 - 28 degrees C
Light	361 Ly/d
Latitude	41 degrees N
Initial Chemistry (average values presently observed in the watershed)	
Ammonia	0.05 mg/l
Nitrate	2 mg/l
Phosphate	0.1 mg/l
Oxygen	12 mg/l
TSS	5 mg/l

To measure the changes expected to occur with BMP implementation, a 50% reduction in nutrients and sediment (a reasonable goal for the watershed) was plugged into the model. The changes which could occur with BMP implementation are shown in Figures 15 -17 and listed in tablular form in Appendix A. The model predicts that nutrient values will decrease significantly, especially during spring and autumn. Physical and biological improvements associated with BMP implementation include an increase in water clarity and an increase in benthic biomass, especially in clean water forms such as mayflies and caddisflies.

Fig. 15. Reductions in nutrients during one year



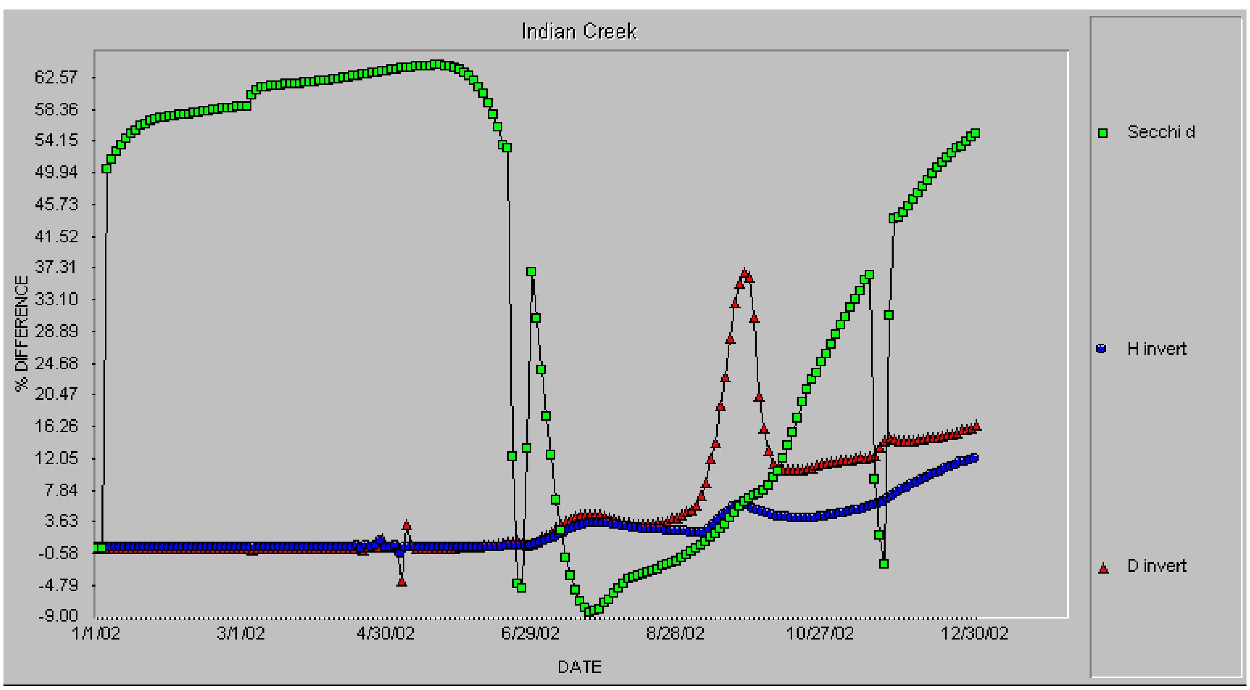
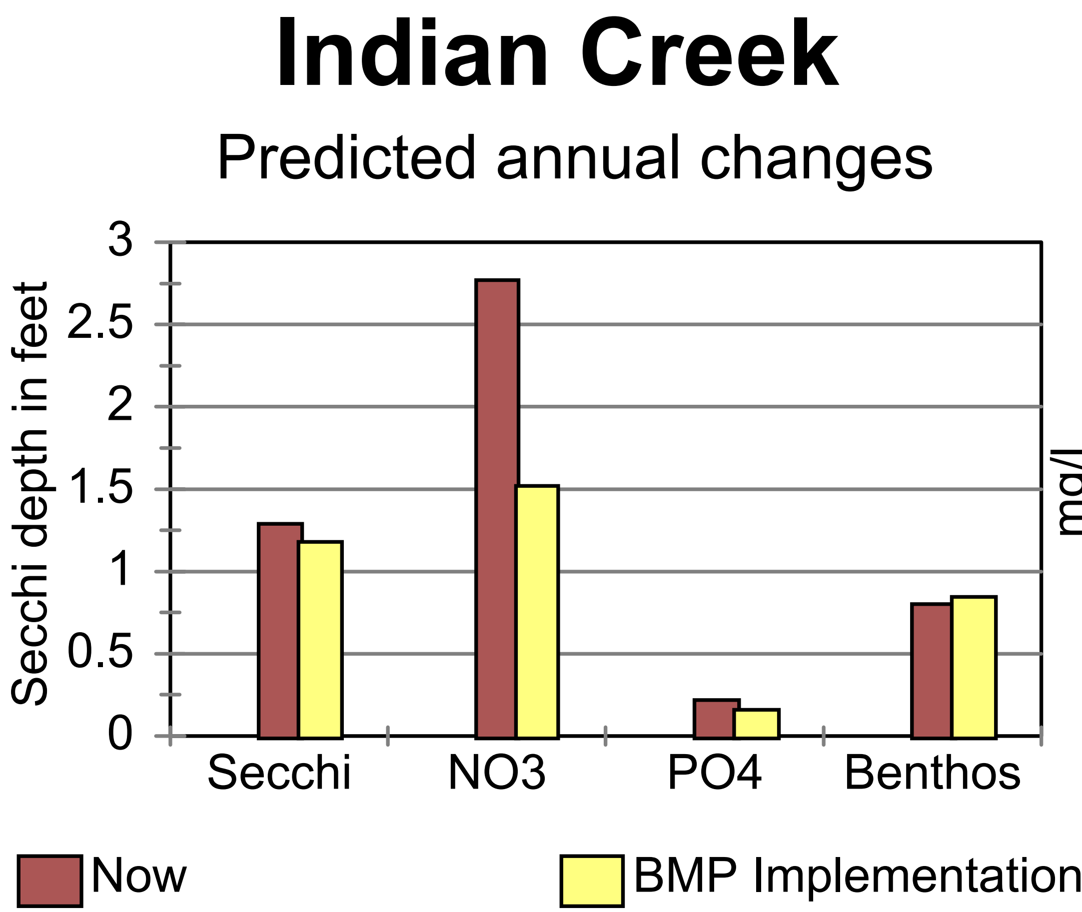


Fig. 16 Predicted changes in transparency (Secchi d) and benthos over 1 year.
H invert = herbivorous invertebrates. D invert = detritivorous invertebrates.

Fig. 17 Predicted changes in transparency, nutrients, and biology with BMP implementation. The results are averages for one year.



IV. SUMMARY OF PROBLEMS

	Problems	***Priority***
Upper Grassy Creek	Nutrients	High
Upper Indian Creek	Sediments	High
Upper Little Indian Creek	Degraded Habitat Nutrients	Low Medium

PROPOSED SOLUTIONS

This plan proposes to reduce nutrient loading in the Indian Creek watershed by 50% and to decrease sedimentation by 10%. The Cass County SWCD has already initiated 47 conservation-related projects in the watershed. Filterstrips and grassed waterways are the primary “best management practices” (BMPs) employed. Total government investment for BMPs in the Cass County portion of Indian Creek is over $900,000 to date ($200,000 for installation costs and $700,000 for conservation easements).

Water quality in the Indian Creek watershed would improve even more if additional implementation of BMPs was carried out. According to the priority summary in Section IV, these should be targeted especially for water quality problems in the upper Grassy Creek and upper Indian Creek watersheds in Fulton and Cass Counties. BMPs that are most effective for nutrient reductions are needed for upper Grassy Creek (and to a lesser extent in Little Indian Creek), while BMPs effective for sediment reductions are needed for upper Indian Creek.