IOWA'S WATER
Ambient Monitoring Program

Floods of 2008: How Did Aquatic Life in Streams Fare?

Many of Iowa's river corridors experienced major flooding in June of 2008. With property damages estimated at $10 billion, this event ranks as Iowa's costliest natural disaster. To address water quality concerns, the Iowa Department of Natural Resources (DNR) and University Hygienic Laboratory (UHL) conducted special monitoring during and after the floods. One such project sought to determine the effects of flooding on aquatic life in Iowa's streams.

Iowa River at Columbus Junction, Iowa. June 18, 2008

Sampling of benthic macroinvertebrates (aquatic insects, leeches, snails, worms) and fish was conducted at several locations during fall 2008 using consistent methods. The objective was to compare post-flood sampling results with "baseline" results from previous non-flood years. The sampling data are used to calculate the Benthic Macroinvertebrate Index of Biotic Integrity (BMIBI) and the Fish Index of Biotic Integrity (FIBI), which measure the biological health of Iowa's streams on a scale ranging from 0 (poor) -100 (excellent). Each index includes several individual metrics that quantify different attributes of the aquatic community; for example: numbers (richness) of species, abundances of tolerant and intolerant organisms, and occurrences of organisms representing specialized feeding modes or habitat types.

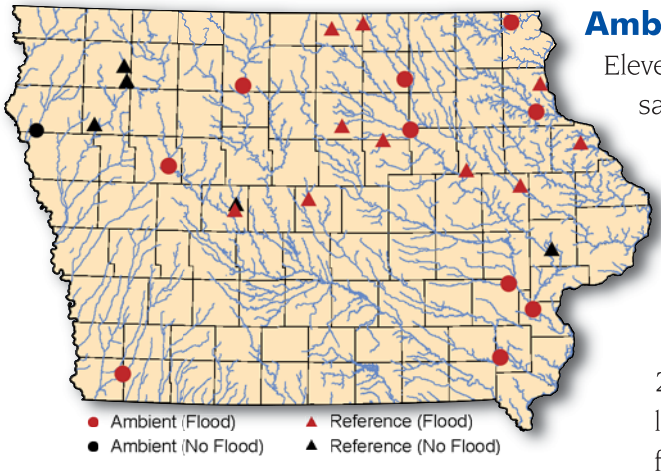

Figure 1. 2008 *biological assemblage sampling locations.*

Ambient Monitoring Sites

Eleven ambient monitoring stations (Figure 1) were sampled for benthic macroinvertebrates in 2008 and previously from 2000-2002. These sites are part of a statewide network used to characterize water quality conditions in medium-to-large streams across Iowa. Pre-flood fish sampling data were not available; therefore, fish sampling was not conducted at these sites in 2008. Each site is located at or near a U.S. Geological Survey stream gage, which allowed 2008 flood levels to be compared with historic levels.

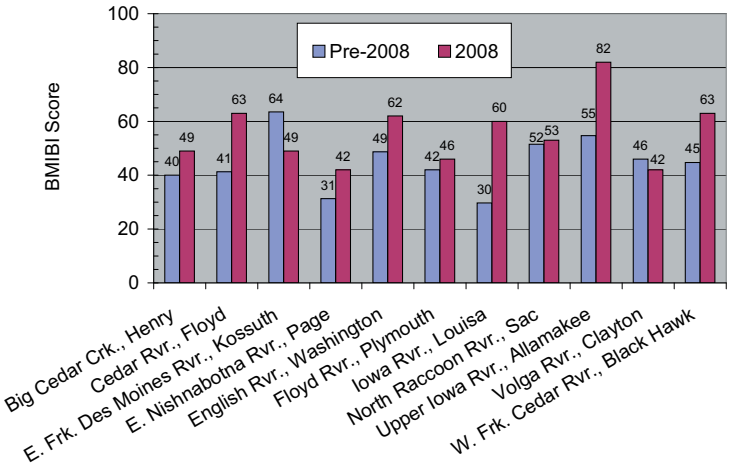

Figure 2. *Benthic Macroinvertebrate Index of Biotic Integrity* (BMIBI) *sampling results from ambient monitoring locations (stream name, county).*

Of the eleven sites, only the Floyd River in Plymouth County did not experience major (out-of-bank) flooding in 2008.

The average BMIBI score for 2008 was 55.5 compared with 44.8 for the 2000-2002 non-flood years. BMIBI levels increased at eight of the ten sites affected by flooding (Figure 2); the average increase (11.4 pts.) was statistically significant ($p=0.03$; Wilcoxon Signed Rank). Levels of four BMIBI metrics were significantly higher in 2008 compared with average levels from non-flood years (Figure 3). Three of the metrics represent levels of taxa richness in composited multi-habitat samples: 1) total number of taxa; 2) number of generally sensitive EPT taxa (Ephemeroptera [mayfly], Plecoptera [stonefly], Trichoptera [caddisfly]); and 3) number of highly sensitive taxa. The percent abundance of mayflies in standard habitat samples also increased significantly in 2008 (Figure 4).

Reference Sites

Fourteen reference sites located on small-to-medium streams were sampled in 2008 and at least twice previously dating back to the 1990s (Figure 1). Reference sites were chosen prior to 2008 to represent "least disturbed" stream conditions from a contemporary standpoint. These locations do not have flow gages, so flooding levels could not be easily quantified. Instead, field staff were asked to note signs of flooding impacts, such as channel erosion and deposition of sediment or other debris on the flood plain. Recent deposits of sediment and/or debris on the flood plain were noted at about two-thirds (9) of the sites sampled in 2008. According to the DNR bioassessment protocol, sampling within the same calendar year of a major flood normally would not be acceptable because of concerns over disruption of the stream aquatic community.

Stream - County	*BMIBI*			*FIBI*		
	Pre-2008 Avg.	2008	Δ	Pre-2008 Avg.	2008	Δ
Bear Creek - Story	78.0	67	-11.0	54.5	55	0.5
Buffalo Creek - Linn	71.5	69	-2.5	76.5	77	0.5
Buttrick Creek - Greene	71.5	52	-19.5	41.5	59	17.5
Deer Creek - Mitchell	73.0	90	17.0	71.0	73	2.0
Lime Creek - Buchanan	73.3	83	9.8	75.5	69	-6.5
Little Maquoketa Rvr. - Dubuque	61.0	70	9.0	60.0	67	7.0
*Little Waterman Creek - O'Brien	49.0	54	5.0	48.5	62	13.5
Maynes Creek - Franklin	74.0	65	-9.0	57.0	71	14.0
North Cedar Creek - Clayton	71.7	75	3.3	58.7	51	-7.7
*Rock Creek - Cedar	66.5	74	7.5	71.0	61	10.0
South Beaver Creek - Grundy	69.5	-	-	47.5	52	4.5
*Waterman Creek - O'Brien	88.0	77	-11.0	48.0	48	0.0
*West Buttrick Creek - Greene	71.0	59	-12.0	62.0	79	17.0
*Willow Creek - Cherokee	55.0	10	-45.0	44.5	44	-0.5

Table 1. *Benthic macroinvertebrate index* (BMIBI) *and fish index* (FIBI) *sampling results from wadeable reference stream sites.*

Δ = *change*

*No observed evidence of out-of-bank flooding in 2008.

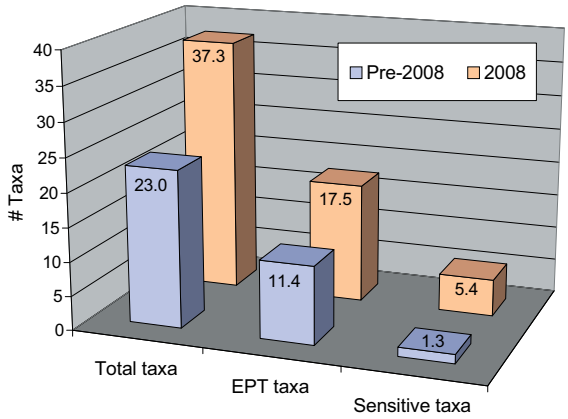

***Figure* 3.** *Average numbers of benthic macroinvertebrate taxa (distinct taxomomic groups) in multi-habitat samples collected from ambient monitoring stations where major flooding occurred in* 2008.

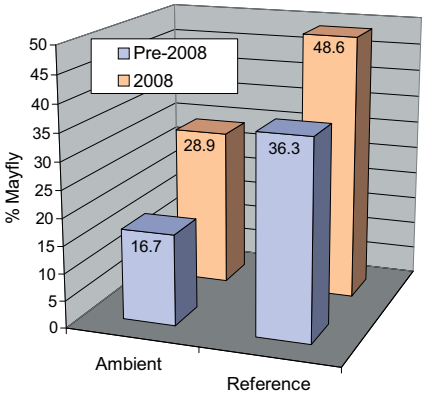

***Figure* 4.** *Average % mayfly taxa abundance sampled from ambient monitoring sites and reference sites where major flooding occurred in* 2008.

BMIBI samples were collected in 2008 from all reference sites except one where the sampling devices could not be located following the 4-6 week deployment period. 2008 BMIBI scores were compared to average scores from previous sampling years. The average difference (-4.4 pts.) obtained by comparing each site's 2008 BMIBI score against its average pre-2008 score was not statistically significant ($p>0.05$; Wilcoxon Signed Rank). Among the sites where major flooding occurred, 2008 BMIBI levels decreased at four sites and increased at four sites (Table 1). Results were similarly mixed for sites that did not flood in 2008. Of the twelve individual BMIBI metrics, only the standard-habitat percent abundance of mayfly taxa metric levels were significantly different in 2008 compared with pre-2008 levels. Among flooded sites, the average percent abundance of mayfly taxa was 48.6% in 2008 versus 36.3% in pre-2008 sample years (Figure 4).

Valid FIBI samples were collected from all 14 reference sites sampled in 2008 (Table 1). Among the nine sites that flooded in 2008, FIBI levels increased at seven sites and decreased at two sites in 2008. Although most FIBI scores increased, the average difference was relatively small (5.8 pts) and not statistically significant ($p=0.12$ Wilcoxon Signed Rank). However, it is possible the small number of samples hinders the ability to detect a significant change. Of the five sites where major flooding did not occur, 2008 FIBI levels increased at two sites, decreased at two sites, and one site did not vary. Average 2008 levels of the twelve individual FIBI metrics also were not significantly different from pre-2008 levels either for flooded or non-flooded sites.

Interpretation

Biological sampling conducted shortly after the floods of 2008 did not show negative impacts to aquatic communities in Iowa's streams. In fact, increases in benthic macroinvertebrate IBI levels at ambient monitoring sites can be attributed to increases in taxa richness and sensitivity. Possible explanations for the improved biological conditions include: a) increased dispersal (drift) of organisms from upstream sources; and/or b) increased availability of stable benthic habitats such as rock substrates, root mats, and woody debris. Flood processes such as scouring of fine sediments and accumulation of woody debris potentially might increase the quantity and quality of habitat available to benthic macroinvertebrates in Iowa's medium-to-large streams.

a. *August* 2001

b. *August* 2008

Figure 5. *Little Maquoketa River, Dubuque Co.* ***(a.)*** *Photo taken in non-flood year.* ***(b.)*** *Same general area. Notice the evidence of the June* 2008 *flood disturbance, including bank erosion, rock/sediment deposits, reduced streamside vegetation, and woody debris piles. Despite major flooding, the benthic macroinvertebrate and fish assemblages were rated in "good" condition two months afterward at this "least impacted" reference site. Sampling results from* 2008 *were equivalent to previous non-flood year results, thus demonstrating the resiliency of streams that have good riparian and instream habitat.*

Average IBI levels for benthic macroinvertebrates and fish sampled at the comparatively smaller reference sites did not differ significantly from pre-2008 to 2008. The diversity of habitat found at most reference sites might provide adequate refuge to prevent catastrophic losses of aquatic species during floods (see Figure 5). Consistent increases in mayfly abundance, both at ambient sites and reference sites, do suggest that movements by certain types of organisms can be triggered by floods. Such responses may cause shifts in species composition for an undetermined period of time afterward. Overall, the results of this project confirm the general belief that Iowa's native stream fauna are adapted to cope with natural hydrological cycles, including seasonal flooding of the magnitude seen in 2008.

Photo Credits

Iowa River at Columbus Junction, June 18, 2008; Little Maquoketa River, Dubuque Co., August 2001 and 2008 – courtesy of the University of Iowa Hygienic Laboratory.

Acknowledgements

The Iowa DNR would like to acknowledge the University of Iowa Hygienic Laboratory for the data collection and identification of benthic macroinvertebrates and fish as part of Iowa's statewide biological monitoring program.

Funding

Water monitoring activities of the Iowa Department of Natural Resources are funded by Iowa Infrastructure – Environment First Fund appropriations, as well as grants provided by the U.S. Environmental Protection Agency from Sections 106 and 319 of the Clean Water Act and the Regional Environmental Monitoring and Assessment Program.

Iowa Watershed Monitoring and Assessment Program Web Site – www.igsb.uiowa.edu/wqm/

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