Flambeau River Monitoring at the Flambeau Mine: Crayfish

A Summary of the Parejko Crayfish Report [1]
Provided by Wisconsin Resources Protection Council – June 2009

Flambeau Mining Company (FMC), a subsidiary of Kennecott Minerals of Salt Lake City, Utah constructed an open pit copper sulfide mine on the banks of the Flambeau River near Ladysmith, WI in the mid 1990s. The river formed the western boundary of the project area, and the pit itself was constructed to within 150 feet of the river. The Flambeau Mine was operational for four years. It ceased production in 1997 and has since been partially reclaimed.

Between 1991 and 2008, FMC carried out a series of studies to determine if the Flambeau Mine might be impacting the Flambeau River ecosystem. River sediment, crayfish and walleye were tested upstream and downstream of the mine site for metal content. In addition, surveys were done to track the kinds of insects, worms, leeches and clams (macroinvertebrates) living along the river bottom.

Dr. Ken Parejko, Professor Emeritus, Department of Biology, University of Wisconsin-Stout, did an independent analysis of FMC's river monitoring data for the Wisconsin Resources Protection Council (WRPC). He generated four separate reports dealing with the company's sediment, macroinvertebrate, crayfish and walleye studies. This summary outlines his findings with regard to FMC's crayfish study; separate summaries are provided for his other reports.

To view any or all of the Parejko reports in their entirety, please go to the WRPC web page: www.wrpc.net

Flambeau River Crayfish: Four major points emerge from Dr. Parejko's Crayfish Report:

1. While Flambeau Mining Company was required to monitor crayfish in the Flambeau River as a condition for receiving its mine permit, Parejko explains that the studies performed by FMC between 1991 and 2008 were flawed. To start, he cites problems with the company's baseline data collection:

   Though some preliminary crayfish monitoring was undertaken by FMC in 1988, ambiguous recording [of the data] made the results uninterpretable. In addition, "background" data from 1991 and 1992 may have been affected by preliminary work at the mine site already underway in 1991.[2]

   He adds: ***Iron and manganese were not added to the crayfish test panel until 2007. As a result, interpretation of current test results showing measurable concentrations of these metals in crayfish has been impeded.***[2]

   Perhaps the most important study design flaw discussed by Parejko is what he calls FMC's "lack of in-year replication."[3] In other words, there were too few crayfish samples tested in any given year to draw meaningful conclusions, from a statistical viewpoint, for that year's data. He explains that while FMC collected about 25 crayfish on an annual basis from one upstream and two downstream sampling sites, the crayfish were not tested individually for metal content. Rather, the crayfish from each site were "composited" (i.e., combined into a single sample) for analysis.[3] Instead of 75 crayfish samples being tested (25 from each site), that meant only three samples (an upstream composite and two downstream composites) were tested each year. Parejko explains:

   The theory behind compositing is that the concentration in a composite of crayfish [e.g.., 25 crayfish blended into a single sample] is roughly equal to the mean for those crayfish had individual samples been analyzed. Compositing is often done to save money and may sometimes be necessary if individual samples do not provide enough tissue for analysis.[4]

   The problem with composite samples, however, as Parejko explains, is that: "***… variations among individual crayfish are not known."***[4] In the case of the FMC study, this, in turn, ***"limited the ability to do statistical analyses and draw meaningful conclusions regarding the level of potential risk to crayfish or organisms feeding on those crayfish."***[4]

   Parejko includes an example to illustrate his point: ***In 1993 copper concentrations in crayfish collected upstream [from the mine site] were higher than in those collected at the [downstream] site (15 mg/kg vs. 12 mg/kg). But in 1994 those differences had reversed themselves (9.9 mg/kg vs. 18 mg/kg). This nearly double***

concentration downstream vs. upstream is quite striking; but without replication we can't know anything about the statistical significance of that difference. In other words, without in-year replication, we have to wait for a number of years' data to make statistical inferences about the differences observed.[4]

Parejko adds: ***An important goal of monitoring is to provide current information about the status of an ecosystem, so management decisions can be made in a timely fashion, based on reliable statistical analyses. As it is, without in-year replication, these decisions require waiting for multi-year sampling results which only allow statements such as "Yes, there WAS a difference in parameter X between sampling sites," rather than "Yes, there IS a difference in parameter X between sampling sites."***[4]

2. Despite FMC's poor study design, Parejko's review of the data still suggests that the Flambeau Mine might be having an impact on crayfish in the Flambeau River. He also points out that, on first glance, it might appear otherwise. Parejko explains: ***Crayfish whole-body copper appears to have been consistently higher at both downstream locations even prior to mining and to have risen at all three locations (including the upstream sampling site) during the mine operation. … [However, a statistical analysis of the data] indicates that the gap between upstream and downstream copper concentrations [in crayfish] appears to have increased during operation of the mine, and has been sustained in the post-mining years with significantly higher copper levels reported in the downstream crayfish. This suggests a possible mining effect.***[5]

3. Parejko also challenges FMC's assessment of its own data by quoting from the company's 2006 annual report. He states the following: ***[Statistical analysis of FMC's crayfish data] indicates that copper concentrations in the crayfish changed significantly over the years of testing, and specimens collected at the two sampling sites located downstream from the mine had significantly higher levels of copper than the upstream crayfish. … While it is not possible to prove a mining effect on crayfish copper concentrations, the FMC 2006 annual report statement that:*** **"Based on all data collected, including that which was collected in 2006, there are no impacts to crayfish relative to metal uptake whether we are looking at upstream/downstream effects or effects due to time (active mining phase, mine site reclamation, or post-reclamation"** ***should be considered over-reaching.*** [6]

4. Parejko includes a comprehensive list of recommendations in his report for how to improve FMC's monitoring program at the Flambeau Mine site, and how to design better monitoring programs in the future.[7] He also cites a memo written in December 2001 by Elisabeth Harrahy, an environmental toxicologist with the Wisconsin Department of Natural Resources, to bolster his argument that enhanced monitoring is needed at the Flambeau Mine site. As Harrahy states, with regard to copper levels measured by FMC in Flambeau River crayfish:

"Without more in-depth monitoring it is difficult to draw any conclusions on the effects of this copper on these crayfish. … [Because] metals are expected to continue moving from the mine pit to the river, and because metals can build up in sediments over time and bioaccumulate in organisms (with potential for moving up the food chain), continued monitoring could yield important information." [8]

Summary: Parejko provides the following summary of his findings:

Copper was the element of interest that showed the clearest pattern during the period of monitoring crayfish whole-body metal concentrations. While levels of copper in the crayfish showed an overall increase both upstream and downstream from the mining activity, it was significantly higher at both downstream sites than upstream, and the gap between downstream and upstream sites widened over time, suggesting a possible mine effect. Copper levels did not appear to reach toxic or otherwise harmful levels in this organism during the time period in question (1991-2008), although one's confidence in that inference is lessened by the monitoring protocols used. Monitoring should continue and procedures be improved to strengthen any inferences made regarding the effect, if any, of mining activities on the benthic invertebrates such as crayfish.[9]

References:

1. Flambeau River Monitoring at the Flambeau Mine, Rusk County, Wisconsin: 3. Crayfish – Analysis, Comments and Recommendations. Ken Parejko, Ph.D., Professor Emeritus, University of Wisconsin-Stout, April 10, 2009. To view the complete report, go to www.wrpc.net
2. ibid, p. 10; 3. ibid, p. 2 4. ibid, p. 3 5. ibid, pp. 7-8 6.ibid, p. 9 7. ibid, pp. 10-12 8. ibid, p. 11
9. ibid, p.p. 12-13