Technical Report WAS04-002

Assessment of Opalite Mine on Macroinvertebrate communities of Mine, Hot and McDermitt Creeks

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Introduction

The Oregon Department of Environmental Quality (ODEQ) Watershed Assessment Section was asked to perform a biological assessment on the benthic community of the Mine, Hot and McDermitt Creek as part of a Site Investigation for Opalite Mine – an inactive mercury mine located in southern Malheur County, Oregon. The Opalite mine is located approximately 15 miles northwest of McDermitt, Nevada. The site is approximately 342 acres in size and consists of a mine pit, shaft, and at least one adit, several small exploratory prospect excavations, several waste rock piles, remains of processing facilities, and two large piles of processed ore. Mine Creek flows in a southerly direction along the south side of the site. Adjacent land use mainly consists of livestock grazing. There are no residences or other structures within 4 miles of the site. Access to the site is unrestricted.

The Opalite deposit was discovered by William Bretz in 1924. The Opalite Mine produced a total of 12,367 flasks of mercury (a flask is equivalent to 76 pounds) between 1927 and 1961, with the vast majority of the production occurring before 1943. Only spotty production was recorded between 1944 and 1961.

To assess the impact on the benthic community a set of six sites were sampled upstream, downstream, and in an adjacent watershed (Cottonwood Creek) of the mine site. Our primary objective was to document the macroinvertebrate community composition and determine if biological impairment due to the mine was apparent. Lahontan Cutthroat trout occur in the McDermitt Creek drainage and are listed as sensitive by the Oregon Dept. of Fish and Wildlife(check). Fish tissue samples of were also collected at each site and those samples were turned over to the DEQ contractor E&E. Chemical water quality samples were also collected as part of this assessment.

Sample sites

The following table lists the sample site locations. Sites were selected based on suitable riffle habitat, relatively easy access, and previously established sampling locations. Site locations were as follows; Mine Creek upstream of the mine, Mine Creek downstream of the mine, Hot Creek near road culvert (downstream of mine), McDermitt Creek at Zimmerman's Ranch (upstream of mine), McDermitt Creek just D/S of Hot Creek (downstream of mine), and Cottonwood Creek downstream of Little Indian Creek (adjacent watershed). The upstream Mine Creek, McDermitt Creek at Zimmermans, and Cottonwood Creek were selected to approximate a less impacted or background conditions. Three sites downstream were chosen to document any near field impact from the mine, as well as, the extent of any far field impact downstream.

Table 1- Opalite Sampling Sites for Macroinvertebrates & WQ – June 8th, 2004

Station_Key	Site	Location (to mine)
31529	Mine Creek upstream of the mine	upstream of mine
31530	Mine Creek downstream of the mine	downstream of mine
31531	Hot Creek near road culvert	downstream of mine
31532	McDermitt Creek at Zimmerman's Ranch	upstream of mine
31533	McDermitt Creek just D/S of Hot Creek	downstream of mine
31534	Cottonwood Creek d/s Little Indian Cr.	adjacent watershed

Methods and Analysis

We sampled all sites on 8 June 2004 between 0900 and 1715 hours. Macroinvertebrate samples were collected from riffles at each site according to standardized ODEQ protocols (ODEQ 2003). Samples were collected from a one-foot by one-foot substrate area using a 500-micron D-frame kick net. Eight randomly selected areas were sampled at each stream site. The eight samples were composited in a single container and preserved with 95% ethanol. Macroinvertebrates (target of 500 specimens) were sorted from each sample at the contract laboratory, and all organisms were identified to the lowest possible taxon (usually genus).

RIVPACS - We scored the macroinvertebrate samples using RIVPACS predictive model that the Watershed Assessment section has recently developed for the state. A RIVPACS score is calculated by dividing the observed number of taxa from the sample by the expected number of taxa modeled from a set of regional reference sites (Moss et al, 1987; Hawkins et al, 2000). The model predicts the expected taxa using non-anthropogenic factors so that every 'test' site is compared to an appropriate reference set of taxa. RIVPACS Scores within the 10th or 90th percentile of all reference sites would be considered not impaired (comparable to reference), scores beyond these cut points would be considered impaired.

Stressor Inference Model - We also scored the sites with a newly developed macroinvertebrate diagnostic stressor tool for sediment and temperature(Huff et al, In Prep) that is based on established approaches used in other ecological applications (need cites here Dave!). Our section has already used a component of this method to calculate the realized niche (optima) for temperature in stream vertebrates (Huff et al, In Press). The approach calculates the realized niche for individual taxa using a weighted average approach for temperature (seasonal maximum) and substrate quality (proportion of coarse gravel and larger/proportion of fines). The realized niche value for each taxon in a sample can then be summed to generate a weighted average score for temperature or sediment at each site. Sites that are beyond the Northern Basin and Range ecoregion (Omernik et al, 2004) reference distribution cut points of the 10th or 90th percentile of the ecoregion reference sites for temperature or sediment would be considered stressed for that parameter. Reference sites for a given ecoregion is used because the stressor score approach does not model the factors as in RIVPACS, therefore comparing to set of ecoregional reference sites is appropriate (SH cites?). In building the stressor tool tests of model performance for both temperature and sediment was considerably better than similar tests for the RIVPACS model, therefore we consider them to be potentially more sensitive.

Metals Tolerance Index - A metals tolerance metric score was also calculated using macroinvertebrate tolerance index scores developed by Montana Dept. of Environmental Quality (McGuire 1992,1993,1994). Much like the stressor tool, this score is a relative abundance weighted value of individual taxa's metal tolerance index (MTI). The MTI is calculated as the sum of proportional abundance of a taxon in the sample multiplied by tolerance values specified by [Montana] DEQ for that taxon, for all the taxa in the sample. Values range from 0 to10. To be consistent with the stressor tool approach, cut points were established using the reference sites in the Northern Basin and Range. No model performance test are possible with this metric, therefore relative sensitivity is unknown at this point.

Water Quality Index - Finally a Water Quality Index score was calculated (Cude, 1999?) for every site. This score is based strictly on the water chemistry results. Dissolved oxygen, pH, Temperature, BOD, total suspended solids, Total phosphate and Ammonia+Nitrate Nitrogen are scored from 0 to 100 and then a harmonic mean is taken of these sub-index scores. Water Quality Index scores that are less than 60 are considered very poor; 60-79 poor; 80-84 fair; 85-89 good; and 90-100 excellent.

Results

The characteristics of the stream habitats varied. While grazing impacts were evident at all sites, the intensity of the impacts ranged from light to moderate. The discharge also varied from very small (>1-3 cfs) to almost un-wadeable. The quality of the riparian zone also ranged from little or no vegetative cover to moderate amounts. Given the variety of stream habitat condition this is a summary of our best professional ranking (from best to worst) of habitat quality with comments.

- Cottonwood Creek – Light grazing, good discharge, and best riparian of sites.
- Mine Creek u/s mine – Light grazing, smallest discharge, decent riparian.
- Hot Creek – Some grazing, close to road, good-but slow discharge, decent riparian.
- Mine Creek d/s mine - Light to moderate grazing, small discharge, decent riparian.
- McDermitt @ Zimmerman's – Moderate grazing, close to ranch, high discharge, moderate riparian
- McDermitt just d/s Hot Cr. - Moderate grazing, eroding banks, high discharge, poor to moderate riparian

The RIVPACS and stressor scores are summarized in Table 2 and in Figures 1-4 below.

Table 2 – Summary of Macroinvertebrate RIVPACS, Stressor and WQ Index Scores Opalite Mine survey– June 8th, 2004

Site	RIVPACS Score	Temperature Score	Sediment Score	Metals Score	WQ Index Score
Mine Creek upstream of the mine	0.96	22.1	20.2	3.6	91.6
Mine Creek downstream of the mine	0.85	21.3	20.0	4.0	87.4
Hot Creek near road culvert	0.96	20.5	19.6	4.2	87.3
McDermitt Creek at Zimmerman's Ranch	0.75	22.1	21.0	3.9	80.2
McDermitt Creek just D/S of Hot Creek	0.96	25.3	18.2	4.0	76.7
Cottonwood Creek d/s Little Indian Cr.	0.96	20.4	21.7	3.6	85.0
Cut points (10th or 90th percentile of reference sites)	0.73 (10th,values below are impaired)	20.3 (90th,values above are stressed)	25.9 (10th,values below are stressed)	3.5 (90th,values above are stressed)	*Very Poor: 0-59, Poor: 60-79, Fair: 80-84, Good: 85-89, Excellent: 90-100*

RIVPACS score All of the Opalite sites had RIVPACS scores that indicate no impairment (Figure 1). Two sites did have lower scores and they were Mine Creek downstream of the mine (the site closest to the mine) and McDermitt Creek at Zimmerman's Ranch (a site with agricultural degradation); both downstream of the mine as well.

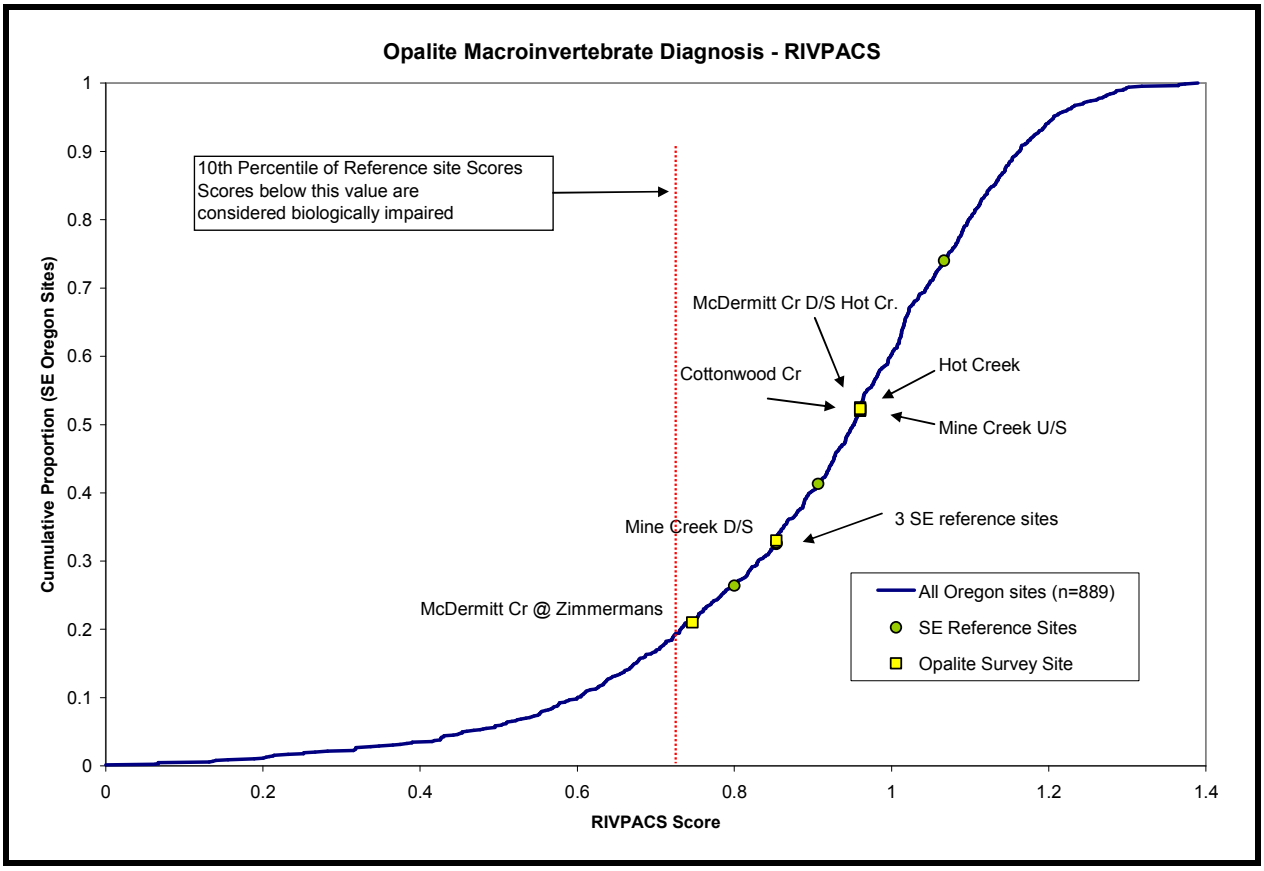

Figure 1 – Cumulative distribution plot of RIVPACS scores for all riffle samples in Oregon. The red dashed vertical line represents the 10th percentile of statewide reference sites. Scores below this cut point would be considered impaired. All of the Opalite and Southeast Oregon Reference sites are considered comparable to reference (not impaired).

It must be noted that the present RIVPACS model is under represented in terms of the number of reference sites in southeast Oregon (n=7). For this reason the Watershed Assessment section identified and sampled eight more reference sites in the Northern Basin and Range ecoregion this summer. While the results may not change, the overall sensitivity of the model should be improved with these additional sites.

Temperature score Temperature scores indicate that every Opalite site may be temperature stressed. The Southeast Oregon Reference sites, by definition, are below the cut points. It is interesting that the sites with the best habitat also had some of the best bug temperature scores

(Cottonwood and Hot Creeks), while the lower flow or habitat degraded sites show higher temperature stress scores.

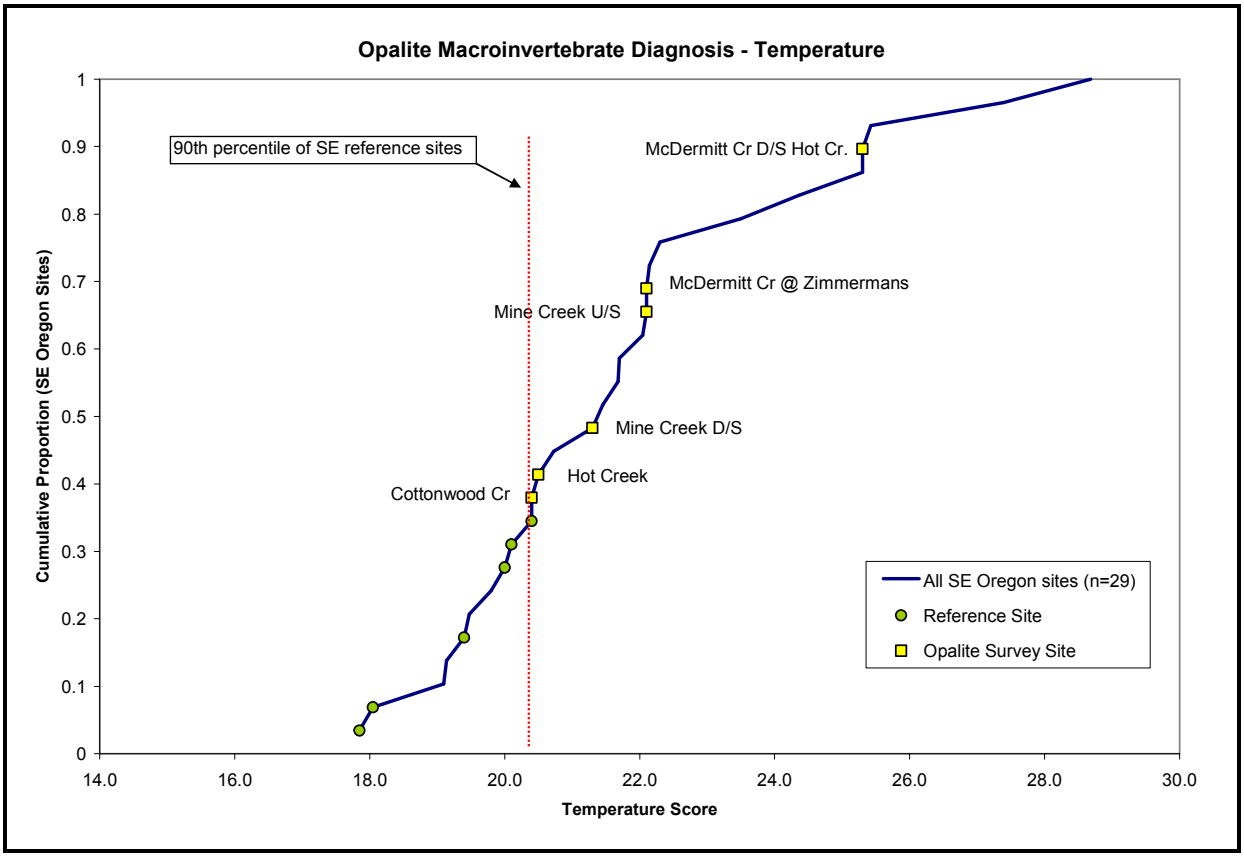

Figure 2 – Cumulative distribution plot of Temperature scores for all riffle samples in SE Oregon. The red dashed vertical line represents the 90th percentile of SE reference sites (n=7). Scores above this cut point would be considered stressed for temperature. All of the Opalite sites are stressed for temperature, especially the McDermitt Creek sites.

Sediment score Sediment scores indicate that every Opalite site may be stressed by sediment conditions. Reference sites, again by definition, are above the cut points.

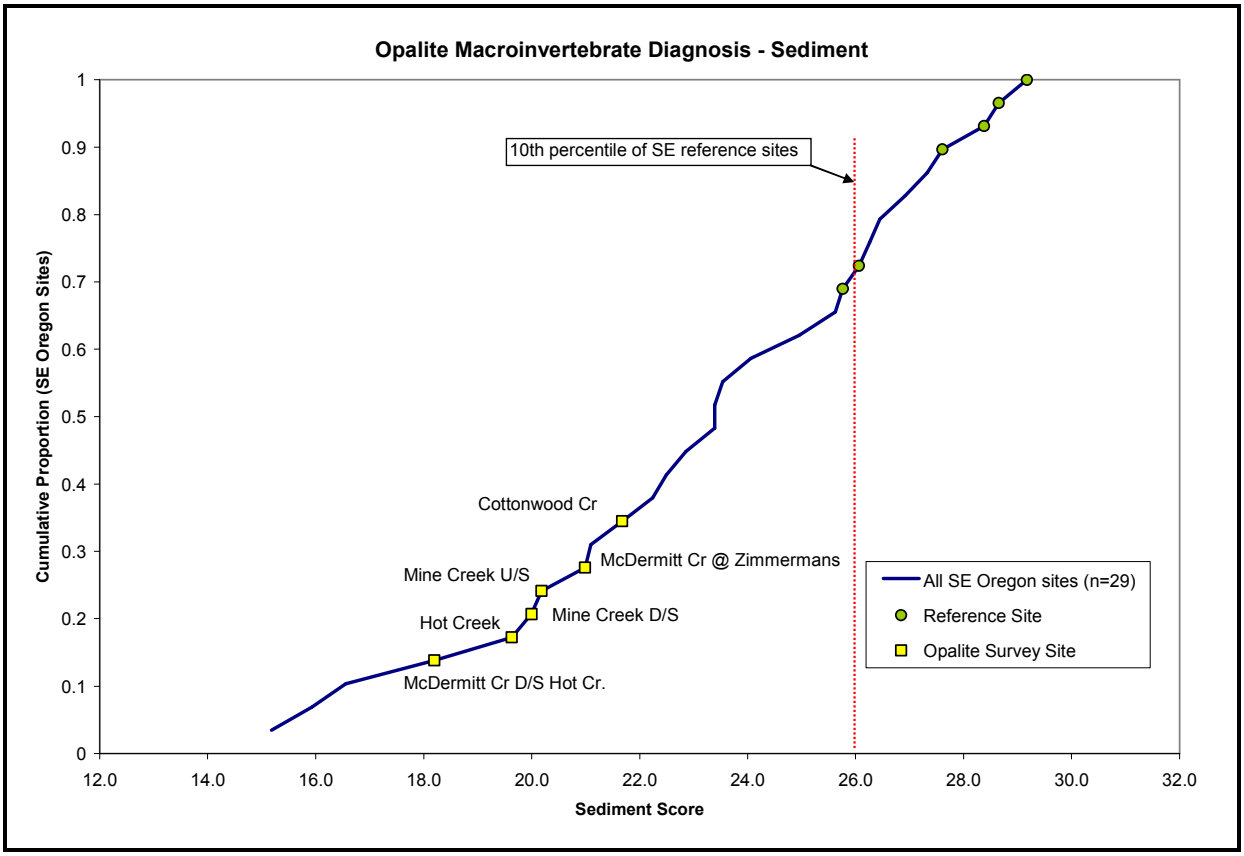

Figure 3 – Cumulative distribution plot of Sediment scores for all riffle samples in SE Oregon. The red dashed vertical line represents the 10th percentile of SE reference sites (n=7). Scores below this cut point would be considered stressed for sediment. All of the Opalite sites are stressed for temperature. The habitat condition for Cottonwood Cr.(best) and McDermitt (worst) Cr. are reflected in the sediment stress scores.

Metals Score Metals scores indicate that every Opalite site may be stressed by metals. Reference sites, again by definition, are above the cut points.

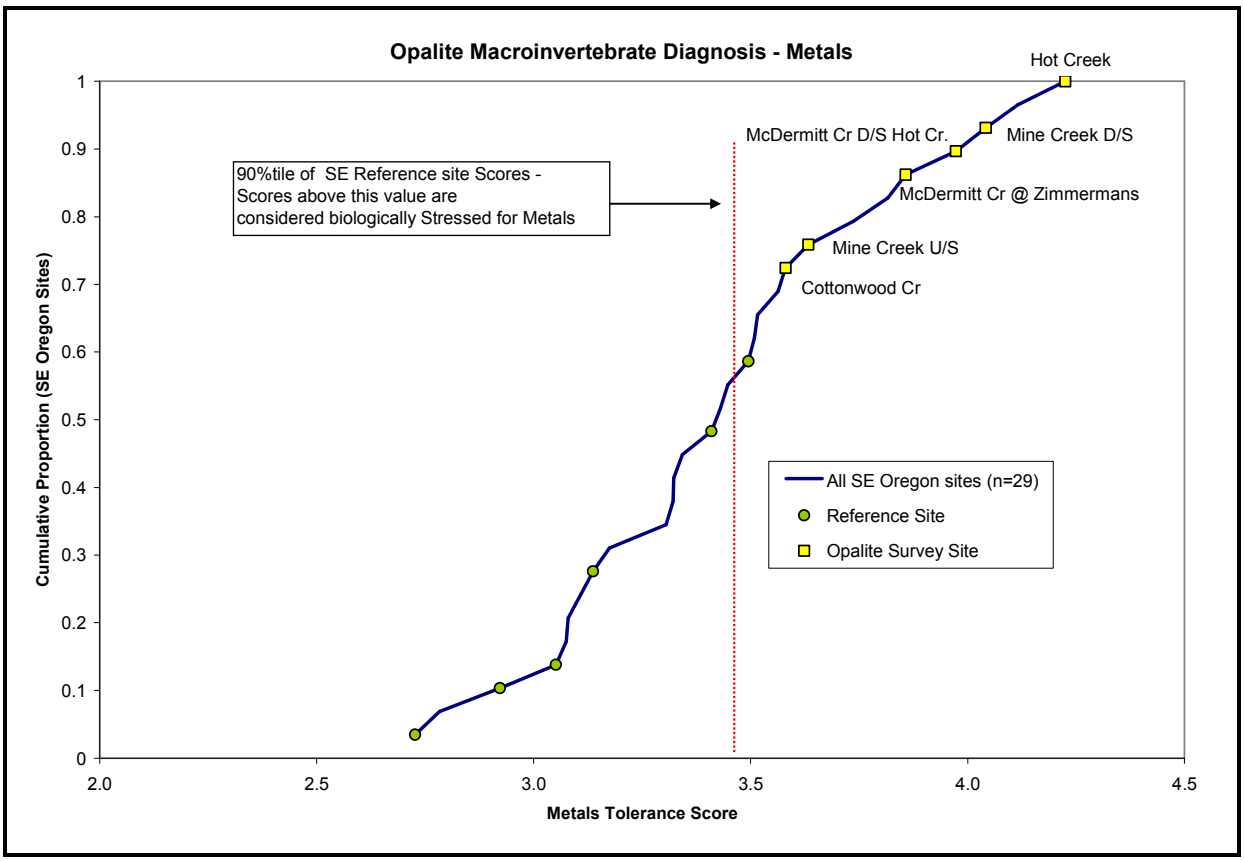

Figure 4– Cumulative distribution plot of Metals scores for all riffle samples in SE Oregon. The red dashed vertical line represents the 90th percentile of SE reference sites (n=7). Scores above this cut point would be considered stressed for metals. All of the Opalite sites maybe stressed for metals. The three highest scoring metals sites (Hot, Mine d/s of mine, and McDermitt d/s of Hot Creeks) are also the sites downstream of the mine.

Water Quality Index Scores The water chemistry samples reflect the habitat or land use. The least disturbed sites have the highest scores and the poorest habitat yielded the lowest WQ Index scores. This index is a general water quality measure and supports the habitat assessment but does not necessarily correspond to biological or toxicological conditions. For example, the WQI score for Mine Cr. d/s of mine had the second highest score (87.4 - good category), while it also had the second highest metals score (4.0).

Discussion

The streams surrounding the Opalite mine have degraded habitat due to cattle grazing and mining. In particular McDermitt Creek is more heavily disturbed and its habitat is the poorest of the sites sampled. The macroinvertebrate results confirm that the habitat and mining is stressing the community.

The benthic community at each site is not impaired when compared to reference, however, for every stressor we have diagnostic tool, every macroinvertebrate sample indicates varying levels of stress. Careful examination of each site and its subsequent stressor shows that

the level of habitat and proximity to the mine are reflected in the various stressor scores. The three highest metals scores (most stressed) were also the three closest to the mine. For temperature and sediment scores the best habitat site (Cottonwood Cr.) was consistently the least stressed according to the macroinvertebrate scores; while the poorest habitat (McDermitt Cr. d/s of Hot Cr.) was consistently the most stressed.

These results indicate that impacts from the mine do exist in Mine, Hot and McDermitt Creeks. So while the RIVPACS model doesn't seem to indicate biotic impairment due to loss of taxa, the temperature and sediment and metals diagnostic stressor tools indicate that there has been a noticeable shift in community structure that clearly implicates degraded biotic integrity which is caused by temperature, fine sediment pollution and the presence of toxic metals. Ultimately improvement in both stream habitat and toxic run-off from the mine will be beneficial to the benthic communities of Mine, Hot and McDermitt Creeks.

Acknowledgments

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