

Evaluation of the Use of Treated Mine Water for Rainbow Trout Production

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Background

- Preliminary studies have established mine water as a potential source of water for aquaculture operations in the state of West Virginia.
- A site was established just downstream of a mine water treatment facility to investigate the chemical and physical properties of the treated mine water and assess its suitability for further development as an aquaculture production facility.



- Recommendations were made to proceed with the study following extensive chemical analyses and bioassay studies. Temperature was identified as a limiting factor, and though some metals exceeded recommended limits, the bioassays exhibited no physiological signs of stress and experienced no bioaccumulation of metals.

Investigative Approach

- Construction of a novel honeycomb fiber reinforced polymer raceway system was completed in September 2002.
- 8000 Rainbow Trout (135 g; 0.30 lb) were stocked in the system, and production studies began October 16, 2002.

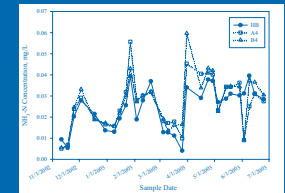


- The fish were fed *Zeigler Brothers, Inc* Finfish Gold 42/16 (Channel A) and WV GR6 43/12 (Channel B) daily to satiation.
- Water quality was monitored monthly for:
 - Nutrients (TAN, NO₂, NO₃, TP)
 - Dissolved Ions (Fe, Al, Mn, Ca, Mg, Ni, Zn, Cu, and SO₄)
 - Alkalinity and Acidity
 - pH, Water Temp., Specific Conductance, Salinity
 - Dissolved Oxygen
 - 5 Day Biochemical Demand (BOD₅) and Total Suspended Solids (TSS)
- Random samples of fish were measured individually monthly for weight and length (50+ from each segment).

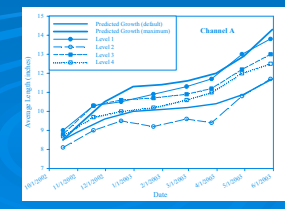
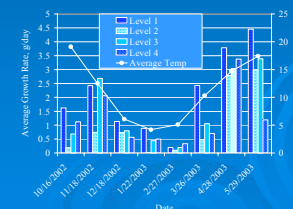
Results and Discussion

- Water quality results were typical of the previous investigation; however ammonia was added as an analyte of concern due to its increase in concentration, identified through routine monthly sampling.
- Dissolved iron, aluminum, calcium, magnesium, and sulfate were present throughout the study at concentrations at or exceeding recommended limits.
- Fish production results:
 - Net Production: 3,657 kg (8,045 lb)
 - Feed Conversion Rate (FCR): 1.4
 - Average Absolute Growth Rate: 1.55 g/day (0.00341 lb/day)
 - Mortality Rate: 1.4%
 - Average Loading Rate: 0.2 kg/L/m (1.67 lb/gal/min)
- Chemical concepts (activity and speciation) help to explain why treated mine water does not adversely affect fish health. CHEMICAL EQUILIBRIA FOR AQUATIC SYSTEMS (CHEAQs) and the Güntelberg approximation of the Debye-Hückel equation were used to determine speciation and calculate active concentrations of limiting ions.

Contaminant	Recommended Limit (mg/L)	Aqueous Phase Species Present (%)	Average C _{total} (mg/L)	C _{total} (mg/L)	Active C _{total} (mg/L)
Iron	0.1	Fe ²⁺	0	0.1	0
		Fe(OH) ₂	2		
		Fe(OH) ₃	28		
		Fe(OH) ₄ ⁻	70		
			[0.04 - 0.31]		
Aluminum	0.01	Al ³⁺	0	0.06	0
		Al(OH) ₃	1		
		Al(OH) ₄ ⁻	99		
			[0.05 - 0.2]		
Calcium	160	Ca ²⁺	47	370	174
		CaSO ₄	53		
		CaHCO ₃ ⁺	80		
			[308 - 452]		
Magnesium	15	Mg ²⁺	53	108	57
		MgSO ₄	47		
		MgHCO ₃ ⁺	47		
			[47 - 72]		
Sulfate	850	SO ₄ ²⁻	80	3,390	2,710
		CaSO ₄	14		
		MgSO ₄	6		
			[1,784 - 3,366]		
			[571 - 1,075]		



- Though un-ionized ammonia concentrations measured at the site may be high for freshwater systems (recommended criteria for no effect on growth: 0.0166 mg/L NH₃-N), there were several mitigating factors at the site: dissolved oxygen close to saturation, high salinity (3.6 ppt), high ionic strength (0.101), and high calcium concentration (56 mg/L as free active Ca²⁺)
- Temperature was identified as the major limiting factor. A temperature curve plotted versus date closely follows growth rate trends observed at the site over the same time frame.



- Growth at the site was nearly normal: the identified limiting factors were temperature, feeding, and theft; this year a warmer tolerant species is being tried and demand feeders were installed to increase feeding opportunities and potentially improve FCR