The Effects of Bear Hollow Mine Seep on the Water Quality and Biota of Cooks Run, Clinton County, Pennsylvania

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Abstract

Acid mine drainage (AMD) is a major problem in Pennsylvania today. A study was completed in summer, 2008 to determine the effects of a mine seep on the Cooks Run watershed. The Bear Hollow mine seep is producing a toxic discharge with a pH of 2.9 that is causing harm to the stream. The seep was diverted away from the stream in 2001 by Pennsylvania Fish and Boat Commission to eliminate the amount of metals entering the stream. The present study was conducted to determine whether the seep still has an impact on the water quality and aquatic life of Cooks Run. The study consisted of fish, macroinvertebrate, and water sampling. The stream was sampled at one site above and one site below the discharge. Data from 1993 were also analyzed at to determine the success of the diversion. From the study it was determined that the Bear Hollow does have an adverse impact on Cooks Run. All sampling showed a decrease in biotic integrity from above to below. It is not as severe as first determined, and the diversion is helping to protect the stream from total loss of aquatic life. It was also determined that the diversion was successful in reducing metal concentrations and raising the pH.

A study was conducted in the summer of 2008 on Cooks Run in Clinton County, Pennsylvania to determine whether the Bear Hollow mine seep is affecting water quality, macroinvertebrates, and trout populations. Bear Hollow mine seep is producing a discharge that is highly toxic to fish. Acid mine drainage (AMD) is a major problem from coal mining that has caused major damage to streams. Over 2,400 miles of streams in Pennsylvania are polluted by AMD (Arway 1988). Acid mine drainage is formed when pyrite and coal refuse is exposed to air and water. A chemical reaction occurs forming hydroxide and sulfuric acid. Acid mine drainage contains high levels of metals; such as, iron, aluminum, and manganese, which precipitate out and can cause harm to aquatic life (Skousen no date). Iron can coat gills of fish and aquatic insects, disrupt growth, and cause mortality (Arway 1988). According to Pennsylvania Fish and Boat Commission, Aluminum is toxic to aquatic life at levels as low as 0.5 mg/l. The purpose of the present study was to determine what affect the Bear Hollow mine seep has on Cooks Run, and how AMD impacts the aquatic life.

The study consisted of benthic macroinvertebrate, fish, and water quality sampling. The project was conducted by Trout Unlimited (TU), Clinton County Conservation District (CCCD) in cooperation with Pennsylvania Fish and Boat Commission (PFBC), and Department of Environmental Protection; Bureau of Abandoned Mine Reclamation (DEP)(BAMR). Cooks Run is a tributary to the West Branch Susquehanna River, and is located in the Sproul State Forest in Clinton County. The Cooks Run watershed has 11.6 miles of stream (Shaw, 1984). About 5.5 miles of stream are polluted by AMD, and it is a contributor to the pollution of the West Branch Susquehanna River.

According to Pennsylvania Fish and Boat Commission, Cooks Run tributaries, Camp Run, Rock Run, and Crowley Run all have AMD impact and cause a major depletion of aquatic life to Cooks Run. The pollution on Rock and Camp is impacted by the same 37 acre mine site that was not filled in properly. The area was mined in late 1970's by Fran Contracting Incorporated. A study on Camp and Rock Run was also completed in summer 2008 and can be found in another report done my Megan Kepler. The area was originally inhabited by both stocked and wild trout, and widely used for recreational purposes. In 1978 it was determined that over 1000 fish were killed in Cooks Run due to AMD impact from the Fran mine site. According to PFBC recreational loss data it was estimated to be around $105,000 that number today is considered over $300,000.

Due to shallow covering of the mine, surface water is collecting in the mine, and is causing the AMD impact on Cooks Run. From the data collected this summer it was determined that Bear Hollow mine seep contains high levels of aluminum, iron, and magnesium. The pH from the water collected from the mine seep was 2.9, highly toxic to aquatic life. This was determined by data collected from PFBC. In summer 2001 a stream diversion and an alkaline addition project was constructed by PFBC to divert the stream away from the mine seep and to improve overall water quality. Some of the metals are able to drop out before making it to the stream, but there is still some AMD reaching the stream. Water quality data from 1993 provided by PFBC was analyzed to determine whether the project in 2001 has improved the stream below the Bear Hollow discharge.

Methods/ Materials

Cooks Run was sampled above and below Bear Hollow to evaluate changes in the benthic macroinvertebrate population, fish populations, and water quality. Macroinvertebrates were sampled at two sites using a D-frame kick net for semi-quantitative analysis. One site was above the discharges and one below. Samples were conducted in riffle areas and kicks were done 1 square meter upstream of net (Anonymous no date). The total area kicked was 1/3m x 1m. Two samples from each site were taken. Samples were then placed into a plastic bag with isopropyl alcohol and tagged. Site 1 was above all discharges, and site 2 was below bear hollow. The macroinvertebrates were then brought back to the CCCD office and identified down to lowest possible taxonomic level using the books Aquatic Entomology and An Introduction to the Aquatic Insects of North America. The data were then analyzed using Stream survey 99, which is a computer program provided by PFBC. Five different metrics were calculated to evaluate macroinvertebrates; total population, taxa richness, EPT, %EPT vs. chironomidae, and Shannon diversity.

Taxa richness shows the total number of taxa in a sample. This number usually decreases when stress is added to the stream (Anonymous no date). Good indicators of water quality are the families; Ephemeroptera, Plecoptera, and Trichoptera (EPT), which are the mayflies, stoneflies, and caddisflies. These three orders are usually identified as pollution intolerant, therefore they are normally found in larger numbers in good quality streams. The family Chironimidae is another good indicator of water quality. Chironomidae are pollution tolerant and can stand poor water quality. Unlike EPT, Chironomidae are normally found in larger numbers in AMD impacted streams. Percent

EPT versus Chironomidae can be a good indication of water quality. A larger percent EPT usually means water quality is better. Shannon diversity is a metric used to measure the richness and evenness of individuals in the sample. This number decreases as pollution increases. The number depends on number of pollution sensitive taxa versus pollution tolerant (Anonymous no date).

Fish populations were sampled using a backpack electrofisher. 200 meter sections were fished and one pass was completed at each site. The same sites were sampled that were done for macroinvertebrates. Only brook trout and brown trout were collected for population estimates. Other species were noted. Stream widths were taken at 5 different locations in the sampling area and then an average width was calculated. Fish were weighed and measured and all the data were used to calculate biomass and fish per hectare.

Water samples were taken with the help of BAMR. Three samples were taken from each site. Samples were collected in one 500ml bottle and two 100ml bottles. 2ml of HNO_3 was added to one of the 100ml bottles, and 2ml of HCl was added to the other. The samples were then put in ice and transported to the DEP lab in Harrisburg for analysis. From the samples; pH, alkalinity, iron, and aluminum were measured. Results were provided by DEP.

Results

Macroinvertebrates are a good indicator of water quality. A total of 414 macroinvertebrates was found at site 1, above all discharges. Below Bear Hollow (site 2) had a total of 111 (Fig 2).

The taxa richness at site 1 had a taxa richness of 28, while site 2 bared a taxa richness of 23. Site 3 had taxa richness of 19 (Fig. 3). The EPT at site 1 had an EPT of 16 and site 2 had EPT of 8 (Fig. 4). Percent EPT versus Chironomidae at site 1 the percent EPT was 61.1 and percent chironomidae was 19.6. At site 2 percent EPT was 21.6 and chironomidae 48.6% (Fig. 5). Shannon diversity at site 1 Shannon diversity was 2.61 and site 2 was 2.01 (Fig. 6).

The fish populations showed similar decreases from above and to below. For sites 1 and 2 the total kilograms per hectare of trout 12.3 and 5.7respectively. The numbers of fish per hectare were estimated at 558 and 420 for total trout at site 1 and 2 (Fig. 7).

Water samples were collected from each site. The pH at sites 1 and 2 were 6.8 and 6.2 respectively. Site 1 had an alkalinity of 12.6 mg/l and site 2 had an alkalinity of 11.6 mg/l. Aluminum at Site 1 and 2 was the same at less than 0.2 mg/l. At site 1 iron was 0.06 mg/l and site 2 was 0.11 mg/l. The data collected in 1993 was similar from site 1 2008; however site 2 has shown some changes. The pH at site 2 in 1993 were 5.4, alkalinity was 16 mg/l, hot acidity was 0.00, aluminum was less than 0.2mg/l, and iron was 1.72 mg/l (Fig. 8).

Discussion/ Conclusion

From the data collected in the summer of 2008 was determined that the discharge from Bear Hollow does have an adverse effect on aquatic life in Cooks Run. Statistical analysis could not be completed on the data due to not enough replicates, but the data shows that fish population, water quality, and macroinvertebrates have decreased from above the discharge to below.

From the collection of macroinvertebrates it was determined that the mine seep does have an effect on the stream. Although numbers decrease in the new stream channel, the numbers are even lower below the seep. Percent Chironomidae is higher then EPT, which indicates water quality is not as good as above.

The fish populations are a good indication of the affects that AMD has on Cooks Run. The number of fish per hectare and kilograms per hectare were both larger above the Bear Hollow seep, which means that the discharge is affecting trout populations.

The water chemistry data show that the stream diversion that was built in 2001 has improved the water quality. Data below the discharge is only slightly lower than above. The water quality has improved drastically since before the stream was diverted. The pH of a trout stream should be between 6-9. Fish can survive in pH as low as 5, but can cause stress. Alkalinity should be above 20mg/L, however, Cooks Run is a freestone stream and it does not have a good buffering capacity which is why the sites have low alkalinity values. Iron, unlike aluminum is not directly toxic to fish, but can be harmful. Aluminum is toxic at 0.5mg/L.

From the data collected the stream diversion put in place on 2001 was a success at improving overall water quality in Cooks Run. There is a slight decrease in trout and macroinvertebrate population, but it is not an impact that needs immediate response. Diverting the stream was a successful way to eliminate stream population on Cooks Run. Further recommendations would be to try and divert the seep way from the stream so that it can not enter the stream at all. If the study is done again more replicates should be done. The stream should be looked at in early spring to determine if a rise in water levels has an effect results.

References

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Figure 1-Map of the Cooks Run watershed with all tributaries in Clinton County, Pennsylvania.

Figure 2- Total number of macroinvertebrates collected in duplicate samples above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

Figure 3- Taxa Richness of macroinvertebrates collected in duplicate samples above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

Figure 4- Number EPT of macroinvertebrates collected in duplicate samples above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

Figure 5- Percent EPT versus Percent Chironoimidae of macroinvertebrates collected in duplicate samples above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

Figure 6- Shannon Diversity of macroinvertebrates collected in duplicate samples above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

Figure 7- Biomass of total trout collected electrofishing in one, 200 meter pass above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

Figure 8- Fish/ Hectare collected electrofishing in one, 200 meter pass above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

Figure 9- Average pH collected in water samples above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

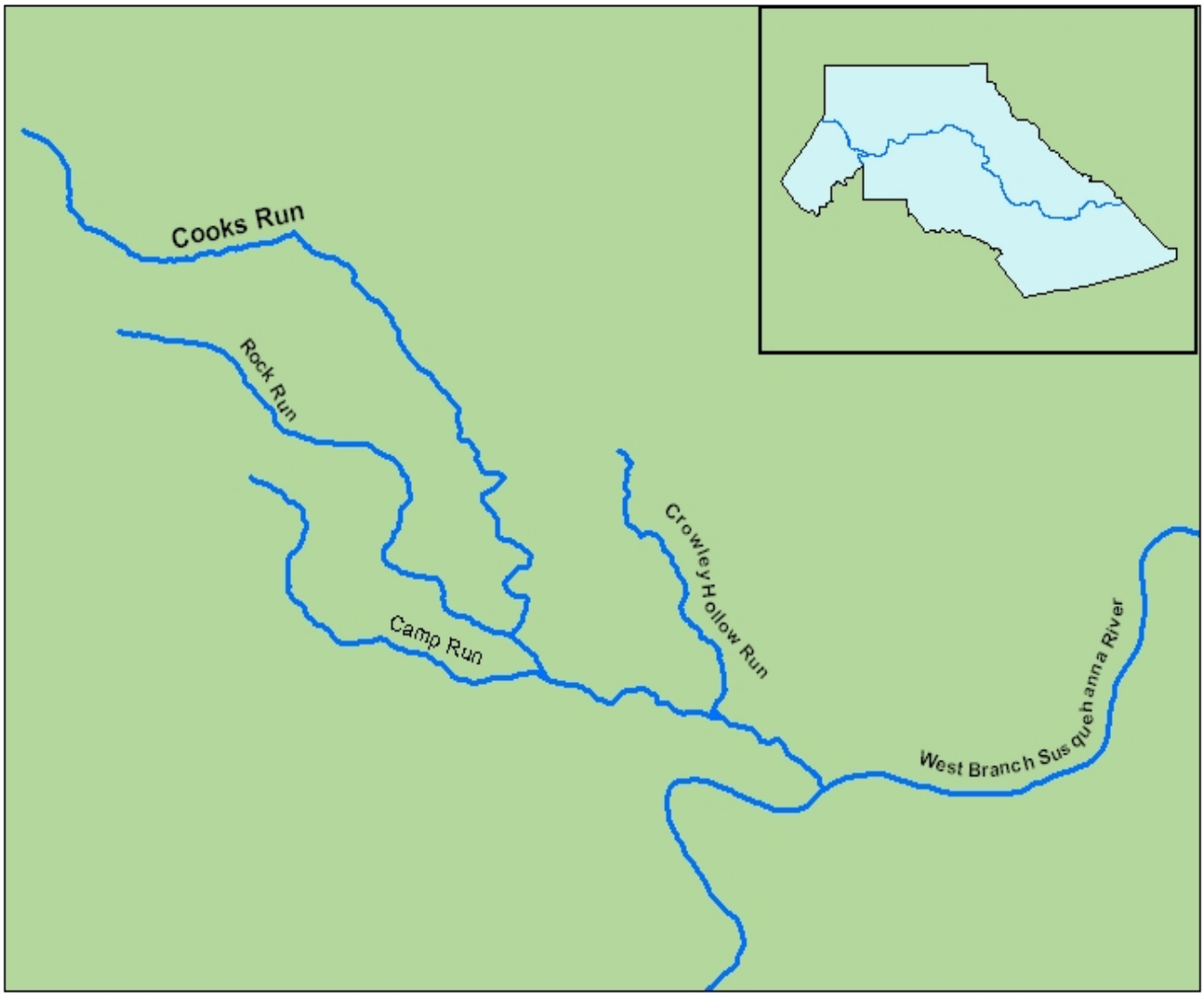
Figure 10- Average alkalinity content collected in water samples above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

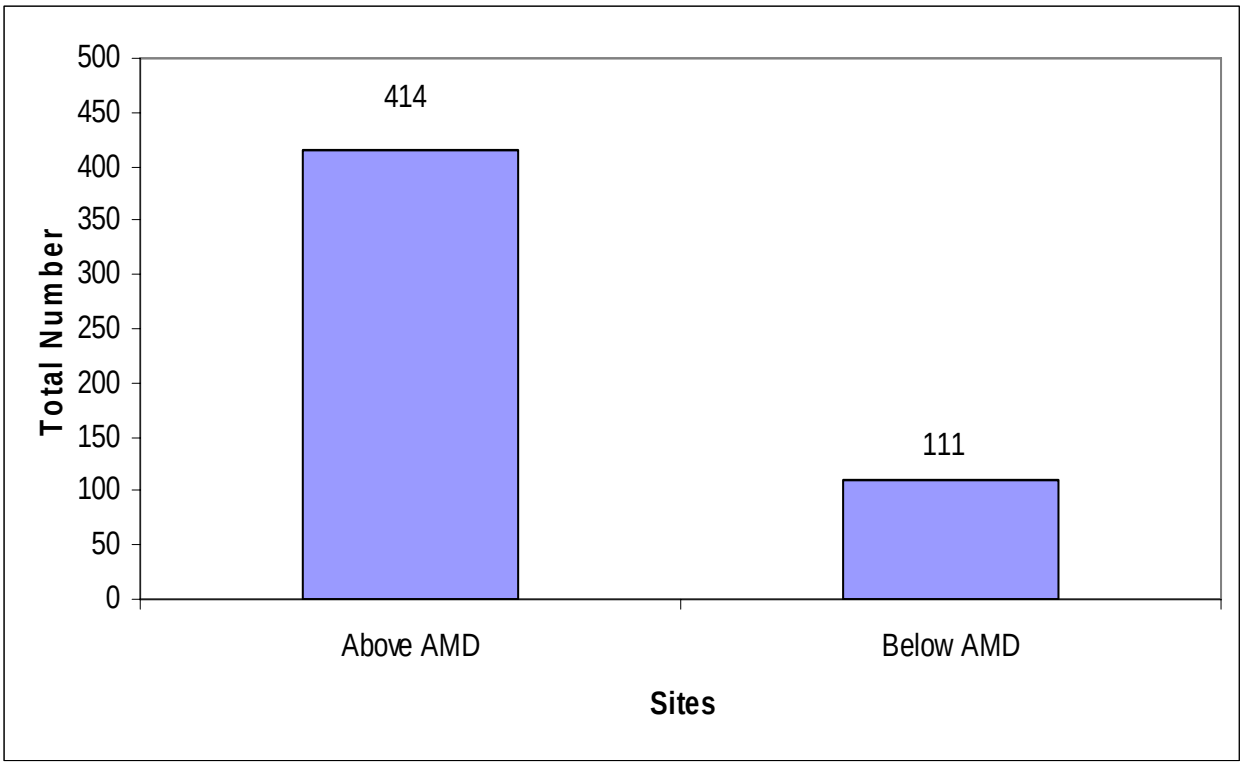
Figure 11- Average iron content collected in water samples above and below Bear Hollow mine seep on Cooks Run, Clinton County, Pennsylvania in 2008

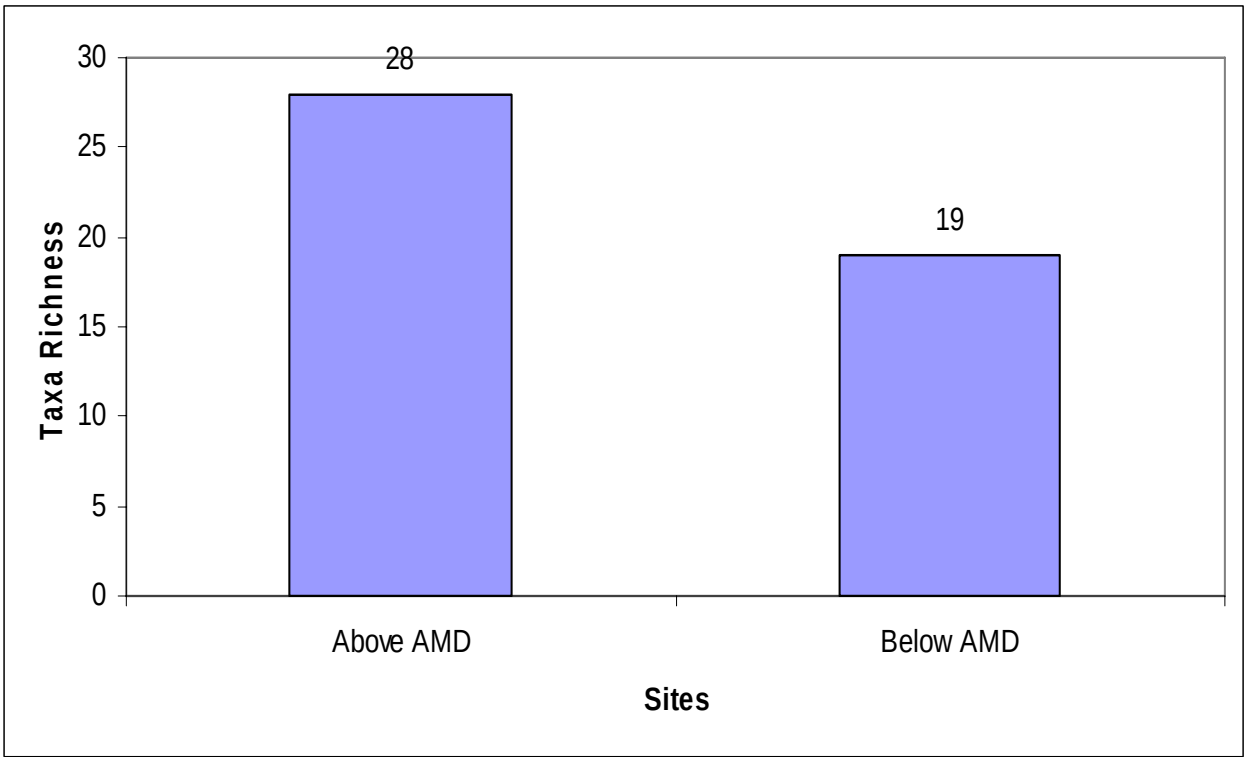
Figure 12- Comparison of pH from water samples in1993 and 2008 below Bear Hollow Cooks Run, Clinton County, Pennsylvania

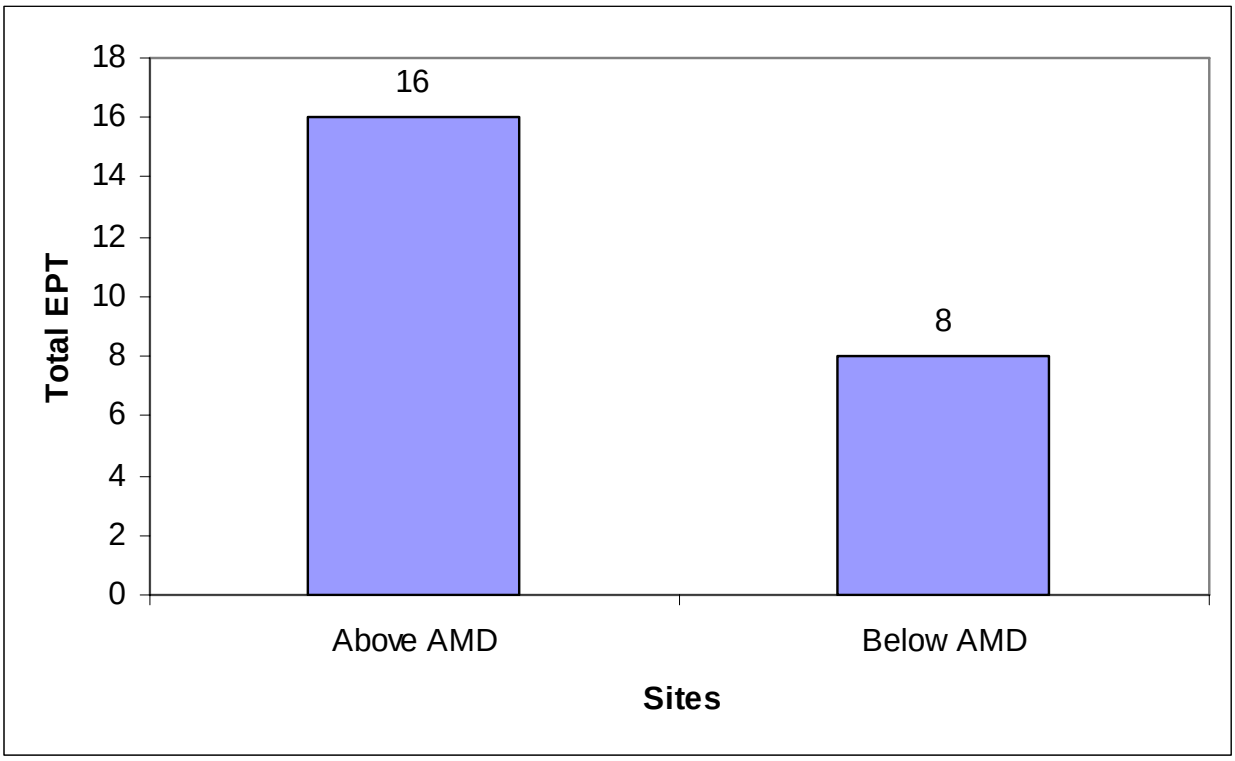
Figure 13- Comparison of Iron from water samples in 1993 and 2008 below Bear Hollow Cooks Run, Clinton County, Pennsylvania

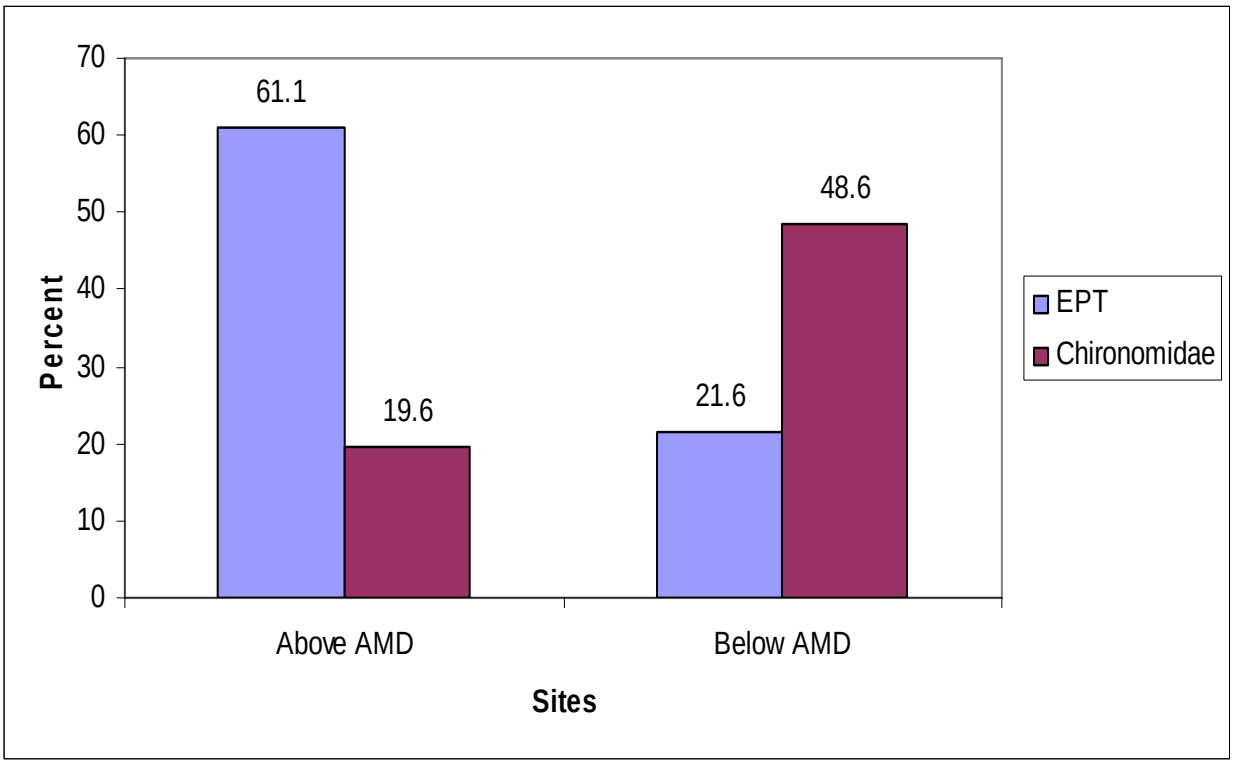
Figure 14- Comparison of Alkalinity from water samples in 1993 and 2008 below Bear Hollow Cooks Run, Clinton County, Pennsylvania

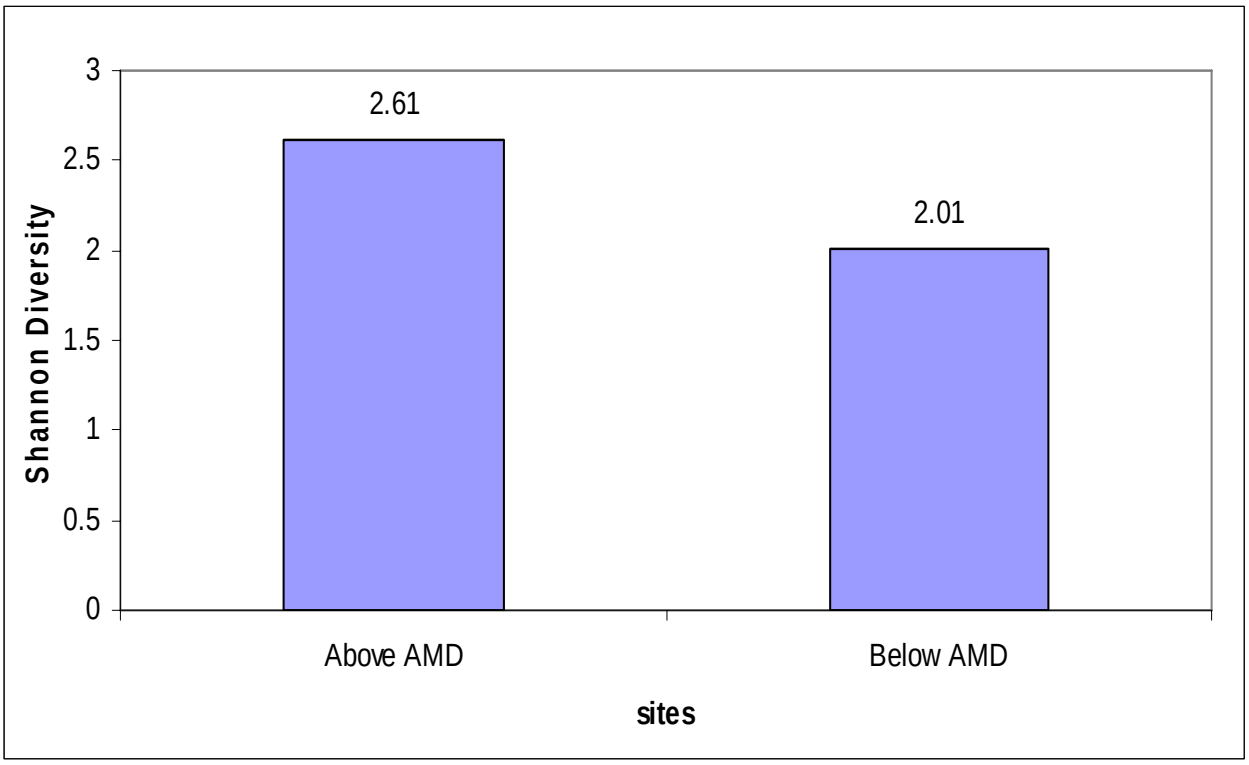

Cooks Run
Rock Run
Camp Run
Crowley Hollow Run
West Branch Susquehanna River

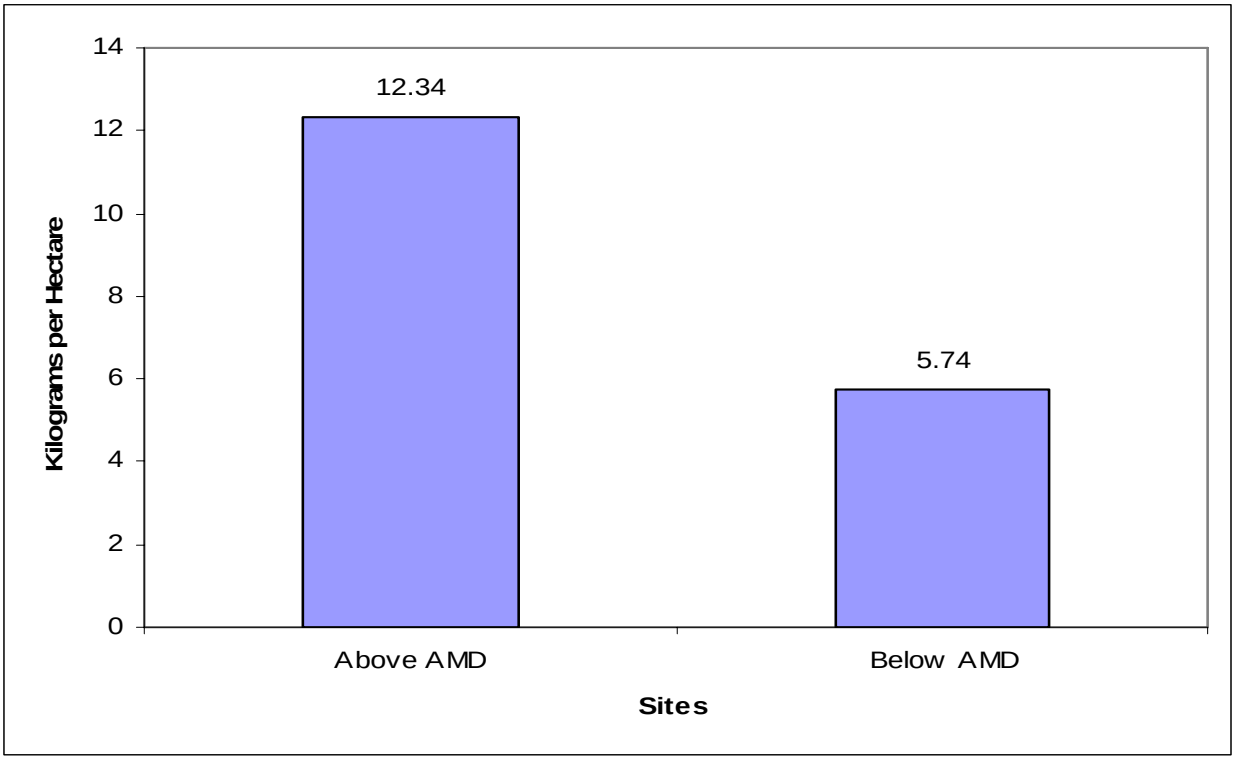

500
450
400
350
300
250
200
150
100
50
0
Total Number
414
111
Above AMD
Below AMD
Sites

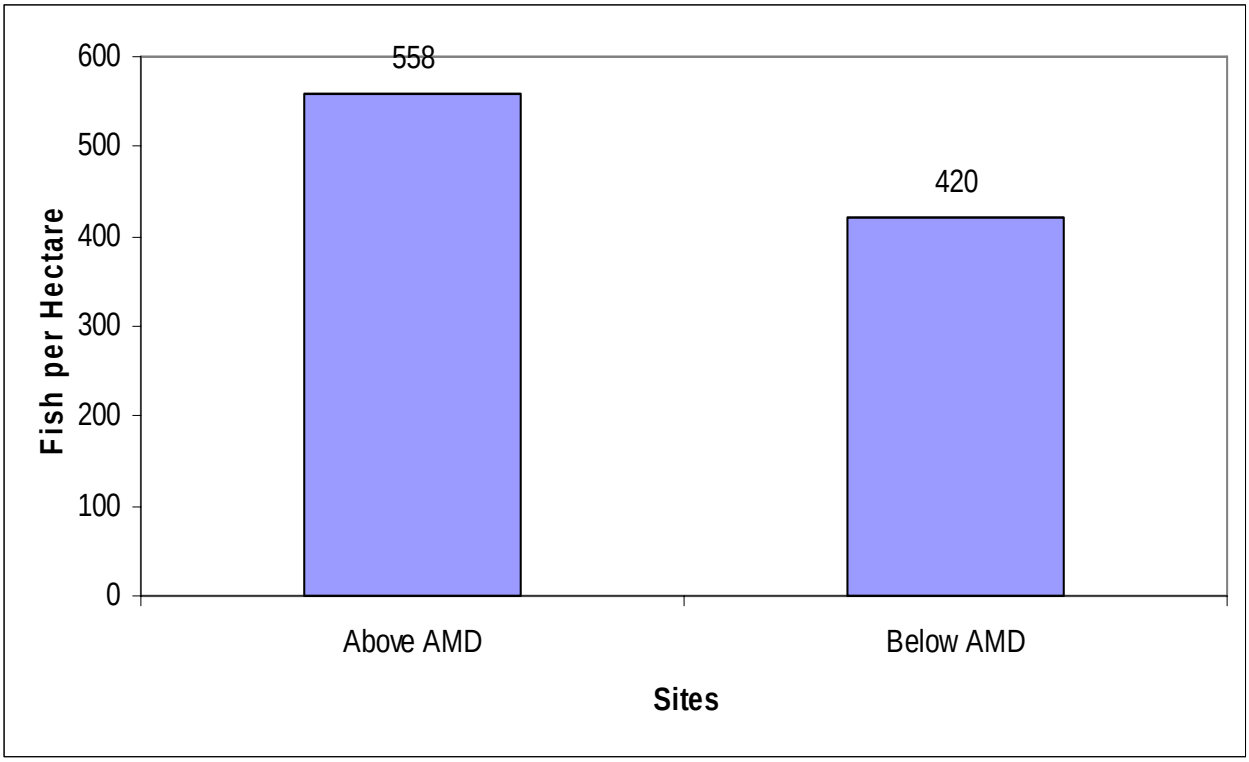

30
25
20
15
10
5
0
28
19
Taxa Richness
Above AMD
Below AMD
Sites

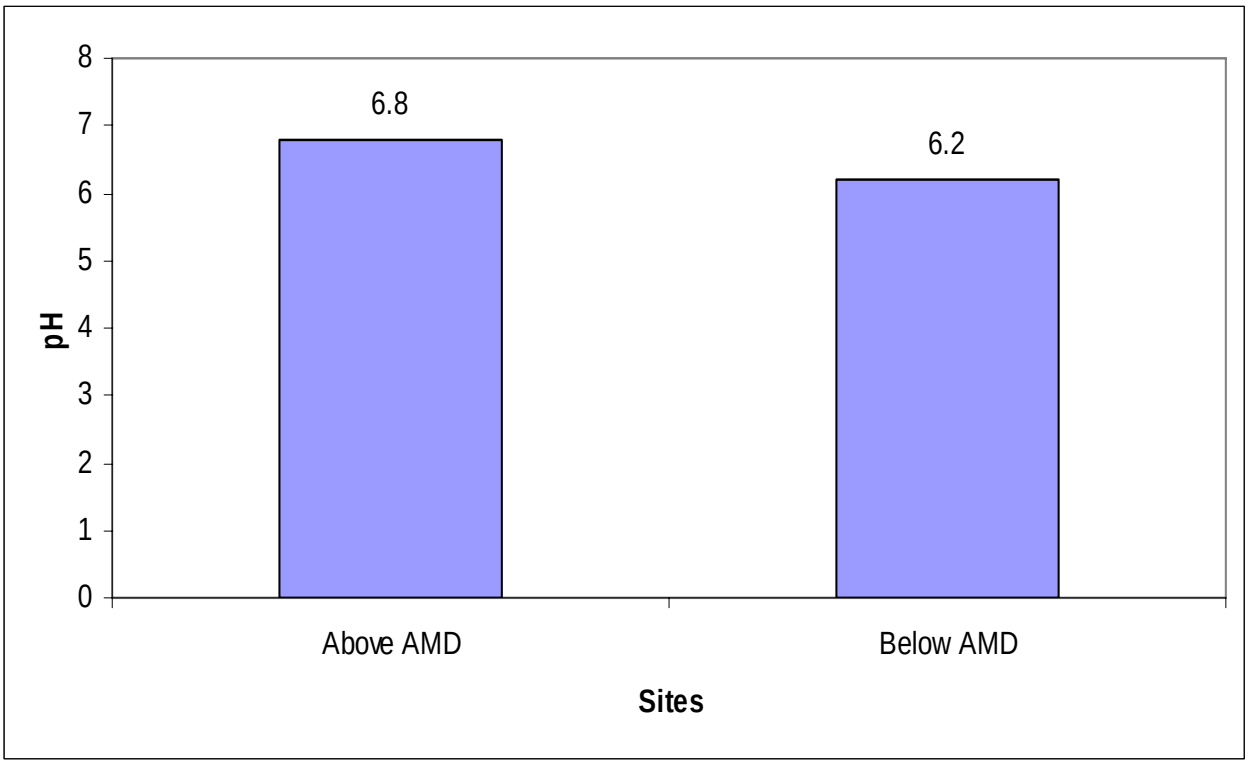

18
16
14
12
10
8
6
4
2
0
Total EPT
16
8
Above AMD
Below AMD
Sites

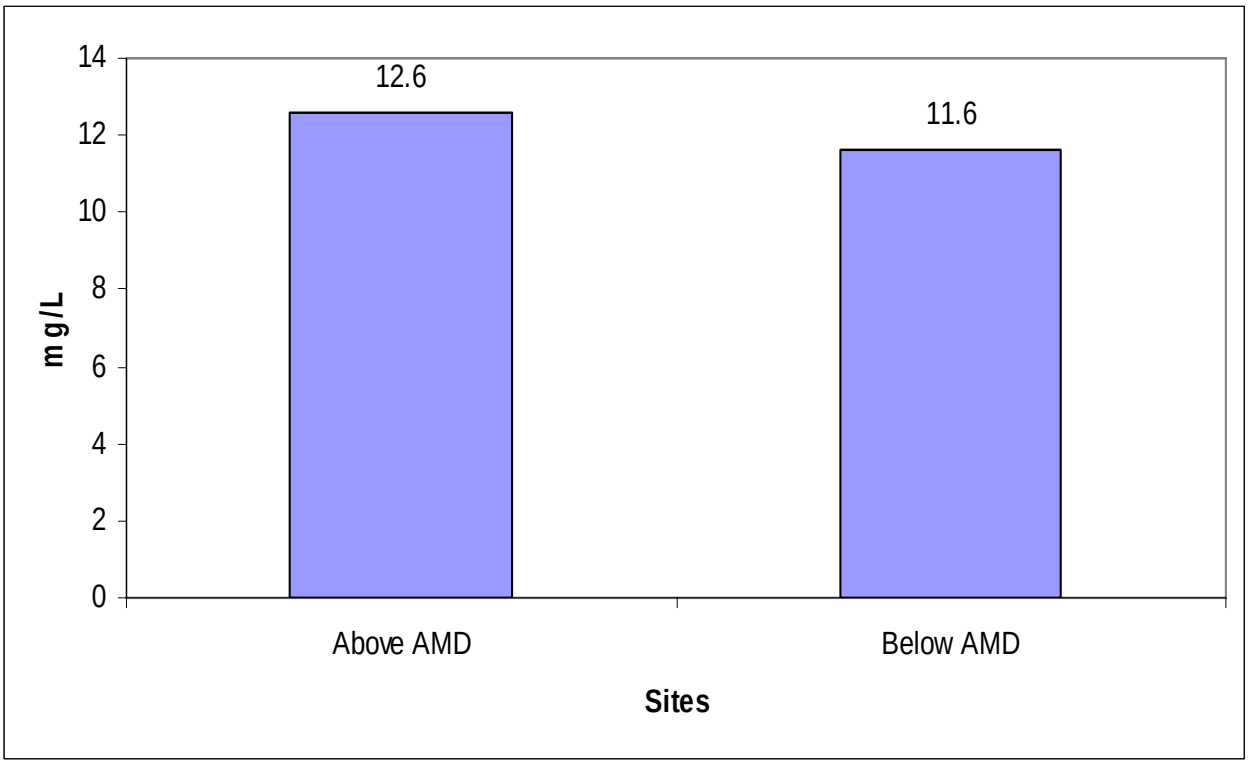

70
60
50
40
30
20
10
0
Percent
61.1
19.6
21.6
48.6
Above AMD
Below AMD
Sites
EPT
Chironomidae

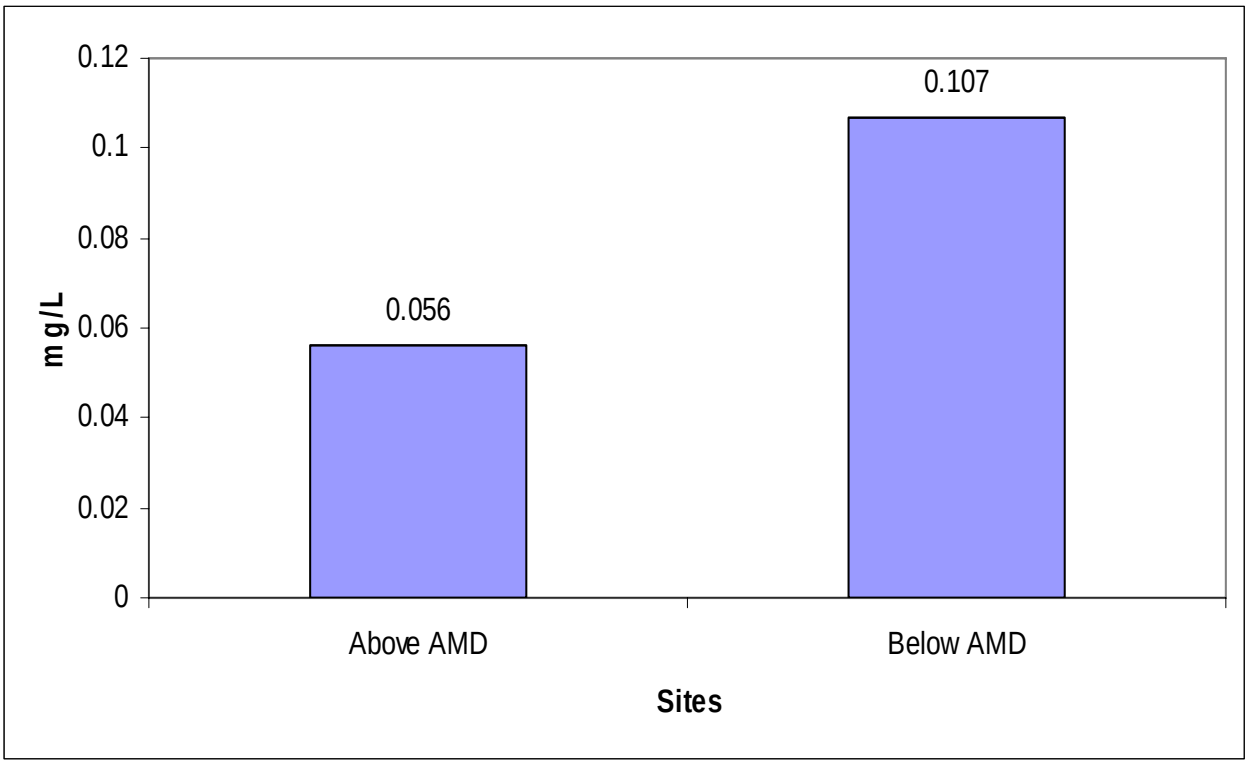

3
2.5
2
1.5
1
0.5
0
Shannon Diversity
2.61
2.01
Above AMD
Below AMD
sites

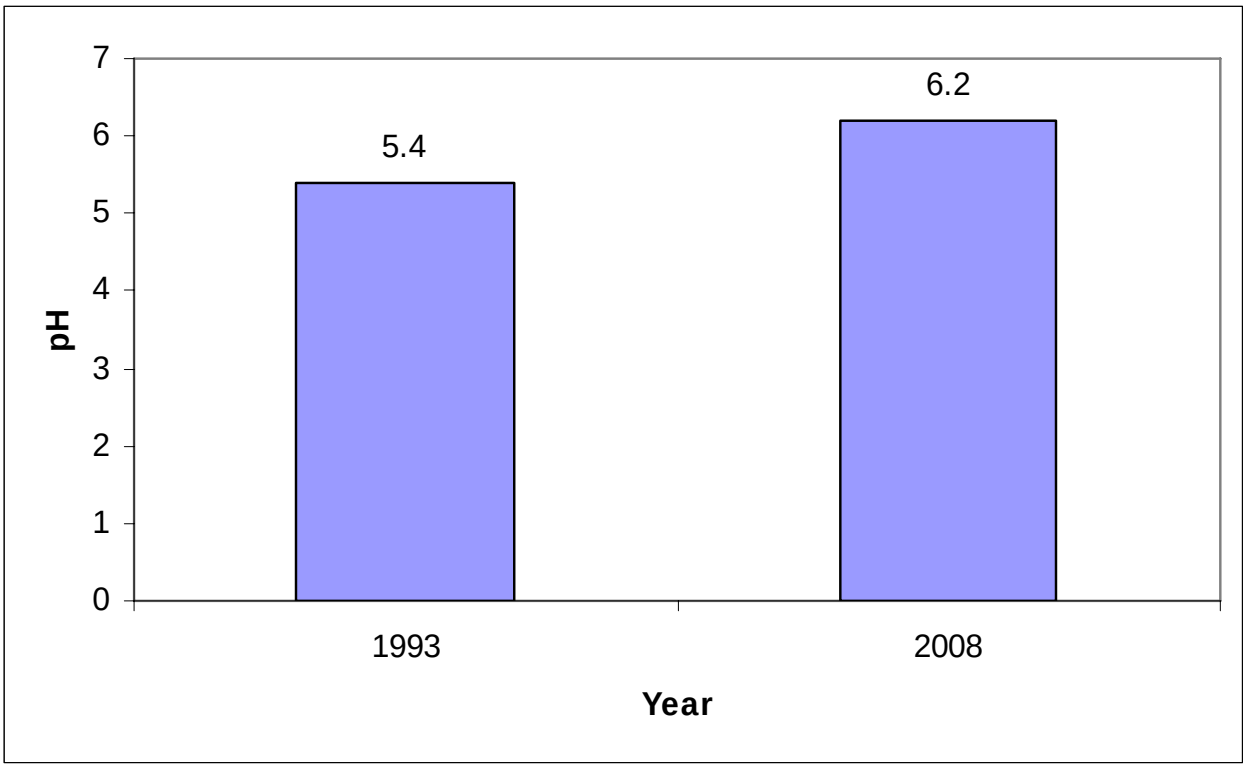

14
12
10
8
6
4
2
0
12.34
5.74
Kilograms per Hectare
Above AMD
Below AMD
Sites


600
500
400
300
200
100
0
Fish per Hectare
558
420
Above AMD
Below AMD
Sites


8
7
6
5
4
3
2
1
0
pH
6.8
6.2
Above AMD
Below AMD
Sites


14
12
10
8
6
4
2
0
mg/L
12.6
11.6
Above AMD
Below AMD
Sites


0.12
0.1
0.08
0.06
0.04
0.02
0
mg/L
0.056
0.107
Above AMD
Below AMD
Sites


7
6
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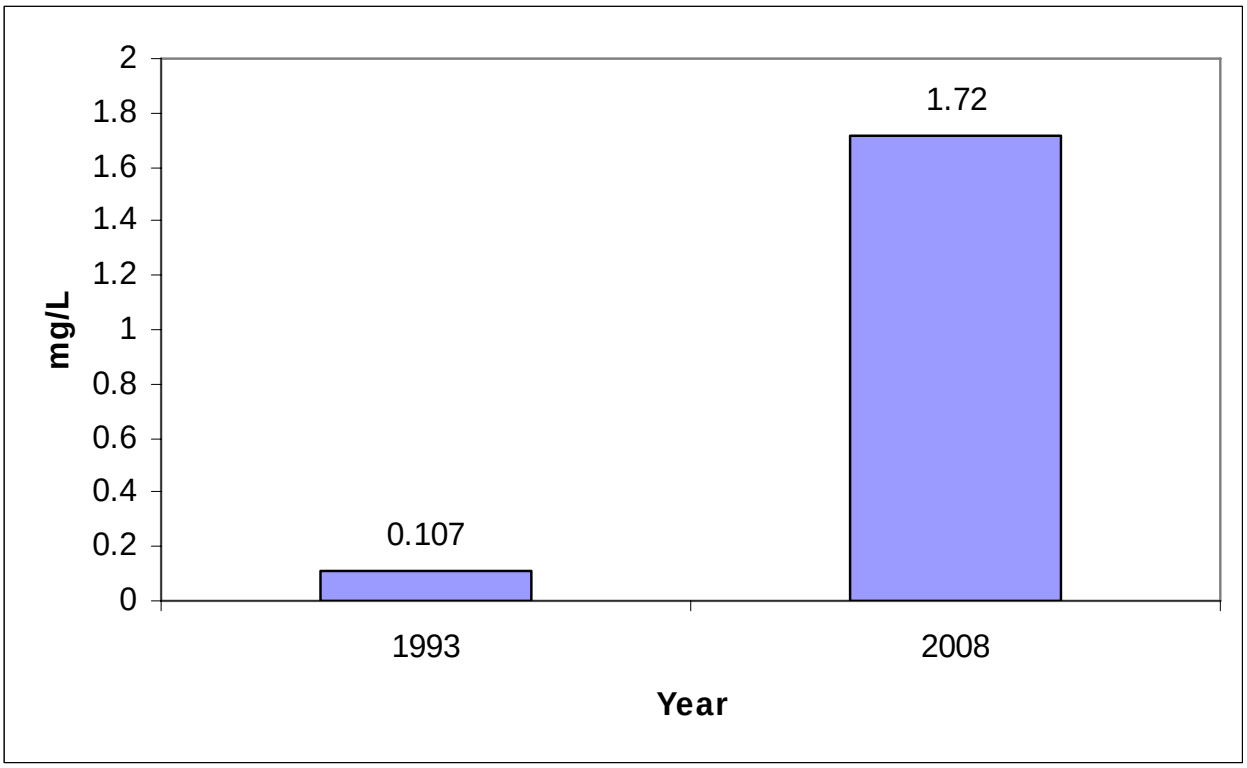
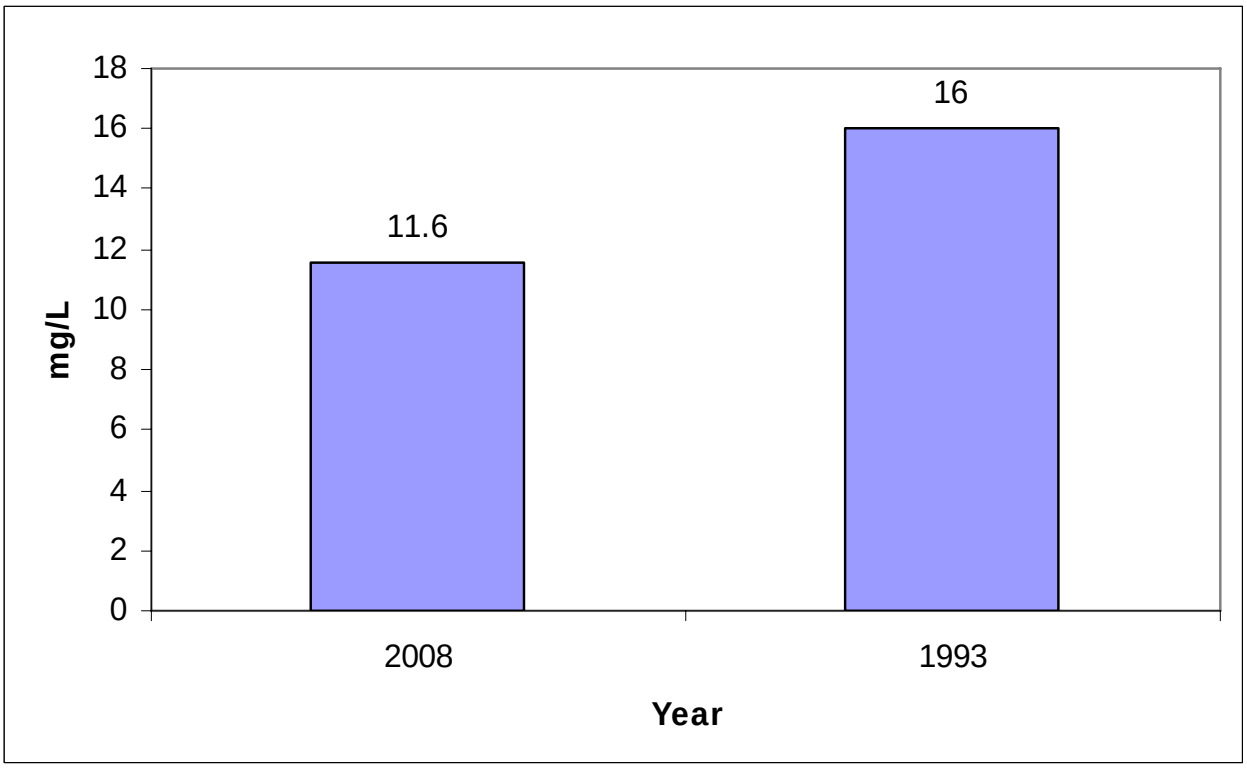
4
3
2
1
0
pH
5.4
6.2
1993
2008
Year


2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
mg/L
1.72
0.107
1993
2008
Year


18
16
14
12
10
8
6
4
2
0
mg/L
11.6
16
2008
1993
Year