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# Biological Analysis of Three Ponds at Peterson AFB, Colorado Springs CO

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A series of three man-made ponds on the golf course at Peterson AFB, Colorado Springs CO were analyzed to determine their current ecological status and future potential for recreational fishing. Biological analysis consisted of collection, enumeration and identification of organisms from the water column and sediment from three sampling sites at each pond. The ponds were evaluated on the basis of species diversity and the types of species present. Chemical analysis of water and sediments for toxicants was also performed.

The results indicated that ponds 1 and 2 are in excellent ecological condition and should be able to maintain stocked game fish which are safe for human consumption. Pond 3 cannot be recommended for stocking with fish in its current condition. Low species diversity suggests that this pond is being stressed by an unknown pollutant. The most likely source is a storm drain which may be a chronic source of pollutants for this pond. Keywords:


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We wish to extend our personal thanks to some specific individuals at AFOEHL who made this research effort rewarding and enjoyable. Lt Col Bob Binovi provided leadership, support, encouragement and some funny stories. The assistance of Lt Becky Bartine and Sgts Rolon and Hernandez was invaluable in solving many problems. A special thanks and salute to Sgt Carol Wilson who worked and put up with us on a day-to-day basis. She was an unending source of assistance, support and supplies. Thanks also to the Biology Department at the Air Force Academy and the Colorado Fish and Game Department for their timely response to our needs for equipment when our shipment from AFOEHL became lost.

## Contents

## Illustrations

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## I. INTRODUCTION

A series of three man-made, 1- to 2-acre ponds at Peterson AFB in Colorado Springs CO have been impacted by the introduction of pollutants from the flightline area through the storm drainage system resulting in fish kills and an apparent decrease in the invertebrate and plant populations in one of the ponds, designated pond 3. The remaining two ponds (ponds 1 and 2) have been impacted to a lesser extent because of pumping of water from pond 3 into these two ponds. Base personnel were particularly concerned about the ecological health of pond 3 because they would like to utilize the pond as a recreational fishing pond and as a source of water for the base golf course. USAF Clinic/SGPB requested AFOEHL conduct a survey of the ponds in June 1989. The survey was conducted by Gregory Zagursky, William (Jeff) Jefferson, University of South Carolina, Lt Col Robert D. Binovi, 2Lt Rebecca Bartine, and SSgt Carole Wilson.

The objectives of this survey were to (1) determine the physical factors or toxicant responsible for the original biological impact, (2) determine if the ponds are now capable of maintaining a fish population and (3) determine if fish taken from these ponds are and will be safe for human consumption. Also from a long-term perspective, findings of this survey could suggest preventive measures that will maintain the water quality of the ponds for game fish stocking and golf course irrigation and suggest ways to restore the ponds to a natural ecological state with a self-sustaining population of game fish.

## II. DISCUSSION

### A. Sampling Strategy

The initial approach to accomplish the objectives was wide-ranging because of the unknown nature of the toxicants. The fire suppressant material, Ansulite Aqueous Film Forming Foam (AFFF), which was accidentally spilled into pond 3 shortly before the first fish kill, was initially suspected as the toxicant. Unfortunately, it could not be proven for certain that the chemical was the source of the problem because AFFF would not persist very long in the environment and yet a subsequent restocking resulted in a second fish kill, and pond 3 receives drainage from areas on base subject to spills and discharges of other potentially toxic chemicals, complicating the problem of targeting for a specific toxicant.

All sampling was conducted during the period 6-8 June 1989. Three sampling sites were established in each pond: station C was near the deepest point of each pond; station B was located where the water depth equaled the depth of the photic zone; station A was approximately 1 meter from the shoreline. The biological health of all three ponds was evaluated at the population level (Warren, 1971) by qualitatively and quantitatively sampling the water column and the benthos (bottom sediment) for invertebrates, vertebrates and plants. The water column was sampled for plants and animals with plankton nets, seines and water bottles. Benthic samples were taken along transects with grab samplers for macrobenthos and cores for meiobenthos and the infauna preserved in the field. Since there is a gradient to the impact, with pond 2 being slightly impacted and pond 1 apparently not having been impacted at all, pond 1 was used as a control for comparing species position. The usual set of physical measurements (temperature, pH, secchi disk depth, nutrient levels) was taken at each pond.

In order to determine possible toxic chemical levels in all 3 ponds, both water and sediment samples were analyzed for a series of possible toxicants (hydrocarbons, heavy metals, pesticides, herbicides). Fish tissue was similarly evaluated for toxic chemicals to determine if it was safe for human consumption.

B. Physical Characteristics

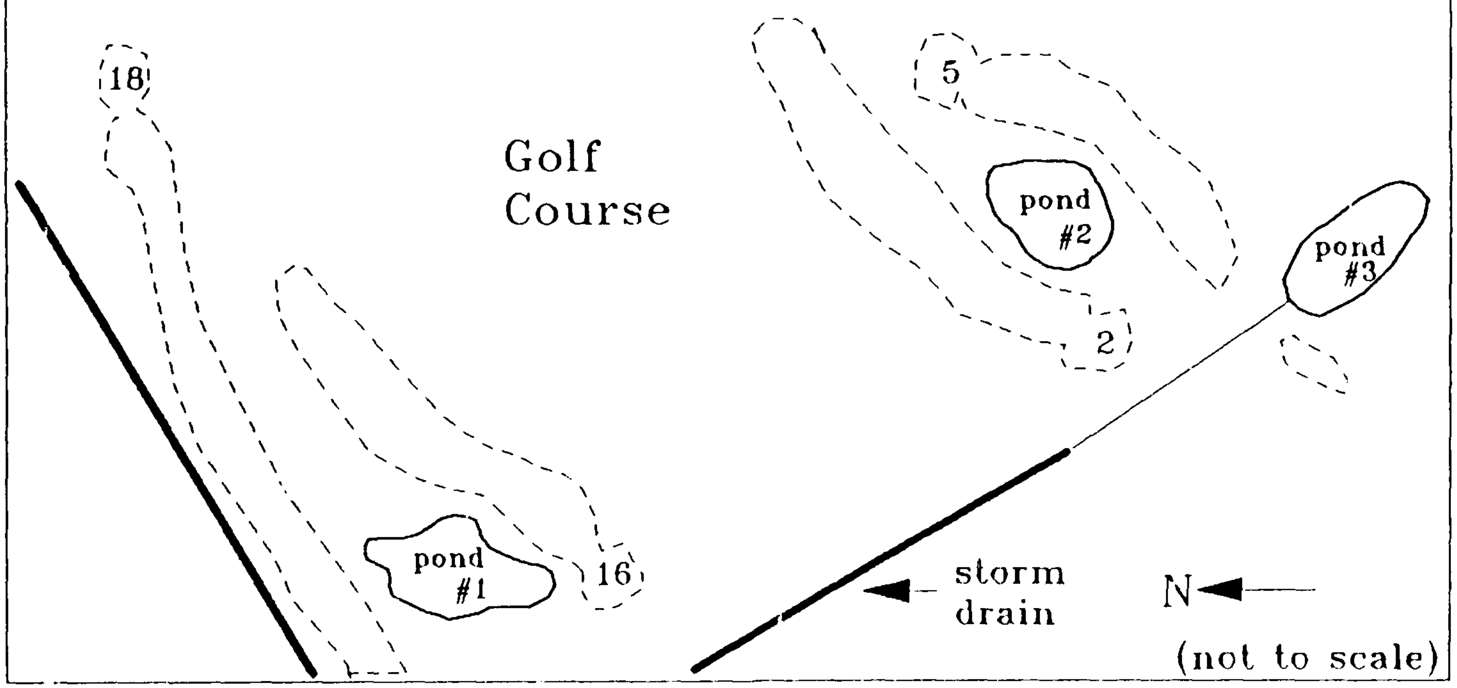
All three ponds were located on the golf course at Peterson AFB, Colorado Springs CO. Figure 1 shows the relative locations of the three ponds and photos of each. The circumference of each pond was measured with a tape and the volumes computed. The pH, temperature and dissolved oxygen levels were measured at various locations and depths with probes. The depth was measured by using a weighted rope and the photic zone (depth of light penetration) measured by using a white, water sampling bottle. The results are summarized in Table 1.

**TABLE 1 - PHYSICAL CHARACTERISTICS OF 3 PONDS**

| | POND 1 | POND 2 | POND 3 |
|---|---|---|---|
| TEMPERATURE ( C) | 14 | 14 | 15 |
| pH (range) | 7.8-8.2 | 7.1-7.6 | 6.2-6.5 |
| Dissolved Oxygen (surface/depth) | 9.0/9.7 | 9.6/10.0 | 6.7/6.9 |
| Circumference (m) | 384.6 | 303.9 | 360.0 |
| Deepest Point (m) | 3.9 | 1.8 | 1.65 |
| Depth of Photic Zone (m) | 1.35 | 0.67 | 0.90 |
| Estimated Shoreline Plant Cover (%) | 80 | 70 | 0 |

Ponds 1 and 2 had mechanical aerators in operation at the time of sampling and water was being pumped into each. Ponds 1 and 2 also had moderate amounts of vascular plant detritus (mainly tree leaves) along the shoreline. The general water quality of ponds 1 and 2 appeared to be good to excellent. Pond 3 had no aerator and was receiving an inflow of 242,000 gallons/day from an open channel storm drain as measured by an ISCO 2780 flow meter (Lt Col Binovi, pers. comm.). The decaying, floating bodies of 30-50 Necturus sp. (mudpuppies) were observed along the shoreline of pond 3. Also, pond 3 had no observable submerged aquatic vegetation and no aquatic shoreline macrophytes. General water quality of pond 3 was poor.

FIG. 1 RELATIVE LOCATION OF THE THREE STUDY PONDS PETERSON AFB, COLORADO SPRINGS, CO



Pond 1

Pond 2

Pond 3

Figure 1 cont'd

C. Phytoplankton Composition

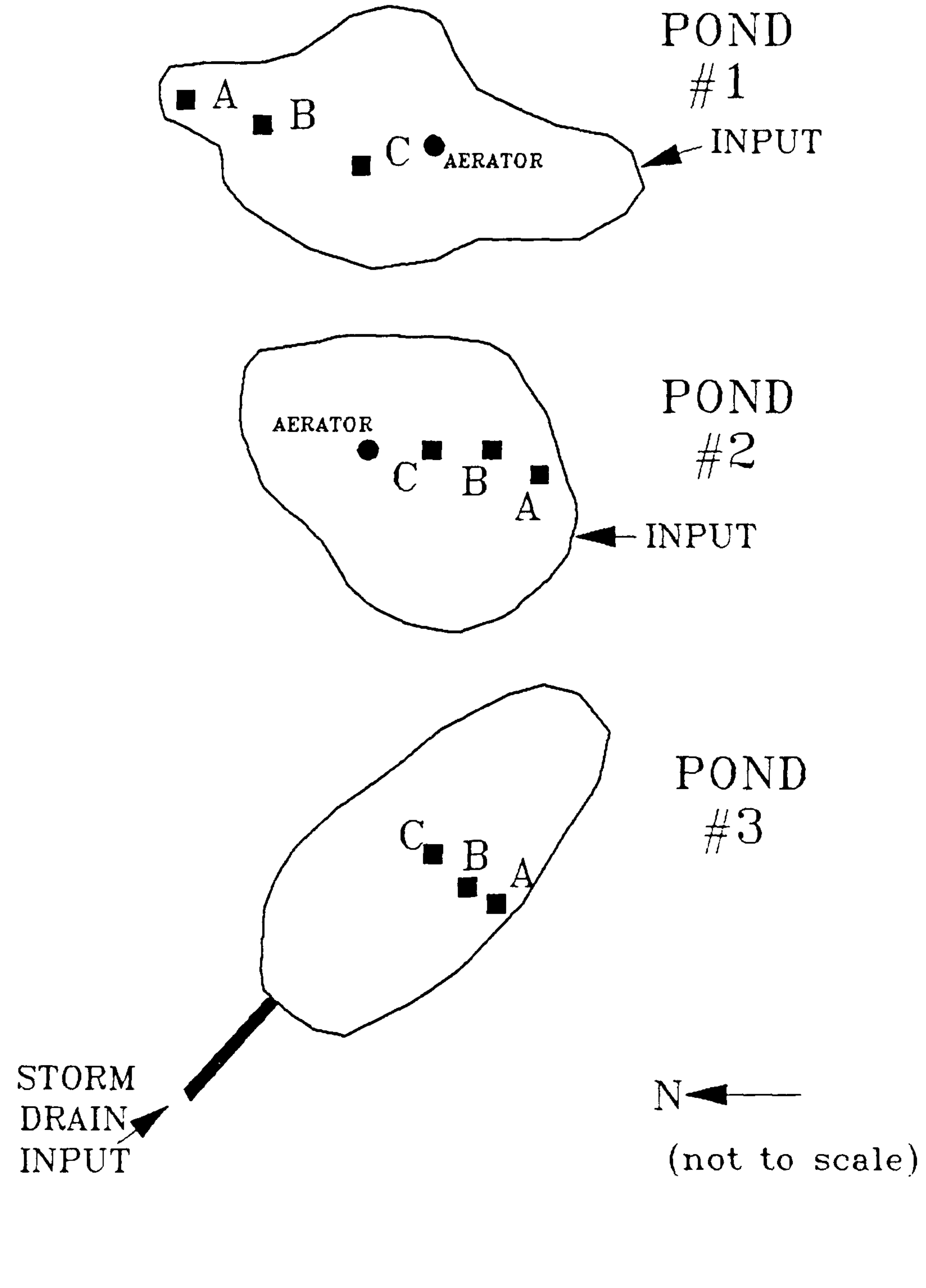
Replicate phytoplankton samples were collected at stations C and B in all ponds by filling a 2-liter bottle with water, 0.5 meters under the water surface. Figure 2 locates the sampling sites. The samples were immediately preserved with Lugol's fixative (Wetzel and Likens, 1979). Three 1 ml subsamples were counted from each sample using a Sedgwick-Rafter counting cell under 100X magnification. The phytoplankton were identified to the genus level and the results summarized in Table 2. The diversity of species at each station in each pond was calculated by using the Shannon-Wiener species diversity index (H') (Shannon and Wiener, 1963).

This data clearly indicates that pond 3 was unable to support a phytoplankton community. This lack of primary producers is strong evidence that this pond was stressed. Comparison of the Shannon-Wiener diversity indices also indicates that ponds 1 and 2 have healthy, diverse and large phytoplankton communities which probably result in a fairly high primary productivity which can support higher trophic levels. The differences in species composition between ponds 1 and 2 may be due in part because of the greater depth of pond 1 and the deeper photic zone. The generally reduced numbers of organisms collected at station C can be attributed to the aerators which probably reduced the number of delicate species.

**Table 2 - Phytoplankton Species Composition (mean number/ml)**

| | POND 1 | | POND 2 | | POND 3 | |
|---|---|---|---|---|---|---|
| Genus | Sta. B | Sta. C | Sta. B | Sta. C | Sta. B. | Sta. C |
| Anacystis | 4.5 | 0.25 | 11.25 | 3.5 | 0.0 | 0.0 |
| Acanthocystis | 4.4 | 1.5 | 1.24 | 0.75 | 0.0 | 0.0 |
| Asterionella | 4.7 | 0.75 | 21.5 | 12.0 | 0.0 | 0.0 |
| Ceratium | 0.25 | 0.5 | 1.0 | 1.0 | 0.0 | 0.0 |
| Closterium | 0.25 | 0.0 | 0.25 | 0.0 | 0.0 | 0.0 |
| Cocconeis | 19.4 | 11.25 | 16.5 | 5.25 | 0.0 | 0.0 |
| Coelastrum | 0.25 | 12.88 | 14.5 | 20.25 | 0.0 | 0.0 |
| Cosmarium | 1.5 | 5.0 | 69.5 | 69.0 | 0.0 | 0.0 |
| Cymbella | 31.0 | 9.0 | 39.63 | 4.75 | 0.0 | 0.0 |
| Dictyosphaerium | 147.5 | 78.8 | 419.75 | 337.5 | 0.0 | 0.0 |
| Fragilaria | 355.4 | 195.0 | 525.25 | 416.75 | 1.25 | 1.75 |
| Gloeobotrys | 12.0 | 7.0 | 24.75 | 20.5 | 0.0 | 0.0 |
| Nephrocytium | 69.75 | 18.5 | 287.0 | 379.25 | 1.25 | 0.25 |
| Oocystis | 6.0 | 2.0 | 7.0 | 9.75 | 0.0 | 0.0 |
| Pediastrum | 36.75 | 6.0 | 116.75 | 84.25 | 0.0 | 0.0 |
| Scenedesmus | 168.25 | 83.25 | 177.5 | 149.25 | 0.0 | 0.0 |
| Sphaerocystis | 58.75 | 125.25 | 119.75 | 190.75 | 0.0 | 0.25 |
| Staurastrum | 341.75 | 341.75 | 276.5 | 239.5 | 1.0 | 0.75 |
| Synedra | 32.75 | 56.25 | 6.75 | 0.5 | 0.0 | 0.0 |
| Unknown diatoms | 254.75 | 63.0 | 54.25 | 17.3 | 1.5 | 1.75 |
| Shannon-Wiener Diversity Index | 2.12 | 2.07 | 2.21 | 2.12 | 1.37 | 0.67 |

# FIG. 2 SAMPLING SITES



D. Zooplankton Composition

Replicate zooplankton samples were collected at stations C and B in all ponds (Fig 2) by taking vertical tows from the pond bottom to the pond surface using a 153-micron mesh, 0.5-m diameter plankton net. Since a flow meter was not available, these samples are not quantitative and species composition can only be compared on a relative basis. The samples were fixed with 5% buffered formalin and then stained with rose bengal to facilitate sample enumeration. A Hansen-Stempel pipet was used to withdraw three 1-ml subsamples from each replicate sample. The animals in the sample were enumerated using a dissecting microscope under 100X magnification. Identification was to the lowest taxonomic group using Pennack (1953) for species keys. Since these samples were qualitative, it was not possible to calculate a species diversity index.

These results (Table 3) show a similar trend to those seen in the phytoplankton composition table. Ponds 1 and 2 have a relatively greater species diversity than pond 3. The rotifer species are almost nonexistent in pond 3, probably because these species are sensitive to poor quality water conditions. The low diversity of species in pond 3 is typical of systems which are under stress from either physical conditions or pollutants. There is a shift in species dominance between ponds 1 and 2, but the relative diversity of species remains the same. The shift may be due to the decreased depth of pond 2 which results in a decrease in feeding area and increased competition amongst species.

**Table 3 - Zooplankton Species Composition (mean percentage of total)**

| | POND 1 | | POND 2 | | POND 3 | |
|---|---|---|---|---|---|---|
| Organism Name | Sta. B | Sta. C | Sta. B | Sta. C | Sta. B | Sta. C |
| CRUSTACEA: | | | | | | |
| *Bosmina coregoni* | 4.6 | 3.3 | 22.4 | 25.9 | 0.0 | 0.0 |
| *Bosmina longirostris* | 4.4 | 4.3 | 8.2 | 9.5 | 0.29 | 0.5 |
| *copepidites* | 4.4 | 3.8 | 2.4 | 1.4 | 1.2 | 1.4 |
| *Cyclops* sp. | 7.2 | 7.6 | 13.8 | 12.6 | 2.3 | 3.5 |
| *Daphnia pulex* | 10.4 | 10.0 | 7.1 | 6.3 | 18.6 | 17.3 |
| *Diaptomus* sp. | 0.23 | 0.11 | 0.0 | 0.3 | 0.0 | 0.0 |
| *nauplii* | 29.4 | 31.3 | 16.8 | 17.3 | 77.2 | 77.1 |
| ROTIFERA: | | | | | | |
| *Brachionus plicatilis* | 0.06 | 0.05 | 0.0 | 0.15 | 0.0 | 0.0 |
| *Keratella cochlearis* | 35.2 | 37.0 | 28.7 | 24.4 | 0.15 | 0.25 |
| *Keratella* | 3.9 | 2.8 | 1.3 | 1.9 | 0.29 | 0.0 |

Note: Totals do not equal 100 because of rounding.

## E. Benthos Composition

Replicate benthic samples were collected at stations A, B and C in all ponds (Fig 2). Meiobenthic infauna (defined as larger than 64 microns and smaller than 125 microns) were collected by taking 5.07 $cm^2$ cores of the sediment. Macrobenthic infauna were collected by taking a composite sample of three 5.07 $cm^2$ cores. All of these samples were preserved with 5% formalin and later stained with rose bengal to facilitate the counting of organisms. Before identification and enumeration, the meiofauna samples were sieved through a 125- and 64-micron sieve and the material retained on the 64-micron sieve was examined. Macrobenthic samples were only sieved through a 125-micron sieve. Organisms were identified to the lowest possible taxonomic group by use of a dissecting microscope with a magnification of 100X. Since these samples were quantitative, the diversity of species at each station in each pond was calculated by using the Shannon-Wiener species diversity index (H'). The results for the meiofauna are summarized in Tables 4, 5 and 6.

The Shannon-Wiener species diversity index for the meiofauna populations of ponds 1, 2 and 3 is 1.5, 1.4 and 1.1 respectively. Once again pond 3 has a lower species diversity, but the difference is not as great. This is somewhat expected since the sediment is a more stable environment and benthic populations are buffered against any rapid physical changes in the water column. The greatest difference in ponds is seen at station C where pond 3 has a sharply reduced number of organisms. Observations in the field indicated that the sediment at this site was almost completely anaerobic. The species composition and dominant species vary widely between the ponds. This again can be attributed to the relatively stable environment of the benthos which leads to the establishment of relatively constant biological communities with patchy distribution.

**Table 4 - Meiofauna Composition of Sampling Station A (mean number/core)**

| Organism Name | POND 1 | POND 2 | POND 3 |
|---|---|---|---|
| Tobrillus sp. (nematode) | 38.5 | 18.5 | 14.2 |
| Stauroneis sp. (benthic diatom) | 22.6 | 0.0 | 0.0 |
| Nitzchia sp. (benthic diatom) | 4.5 | 52.6 | 0.0 |
| Contracted Rotifera | 16.8 | 11.1 | 20.0 |
| Desmids (green algae) | 5.9 | 58.2 | 38.4 |
| Planaria sp. (flatworm) | 4.8 | 2.3 | 4.3 |
| Crustacea nauplii | 7.7 | 6.2 | 3.8 |
| Chaetonotus sp. (gastrotrich) | 0.0 | 2.9 | 0.0 |

**Table 5 - Meiofauna Composition of Sampling Station B (mean number/core)**

| Organism Name | POND 1 | POND 2 | POND 3 |
|---|---|---|---|
| Tobrillus sp. | 74.3 | 21.6 | 18.0 |
| Stauroneis sp. (benthic diatom) | 283.4 | 0.0 | 0.0 |
| Contracted Rotifera | 15.8 | 16.9 | 13.6 |
| Desmids | 4.8 | 3.3 | 17.3 |
| Bdelloidae rotifer | 0.0 | 1.2 | 3.5 |
| Planaria sp. | 1.7 | 10.9 | 0.8 |

**Table 6 - Meiofauna Composition of Sampling Station C (mean number/core)**

| Organism Name | POND 1 | POND 2 | POND 3 |
|---|---|---|---|
| Tobrillus sp. (nematode) | 12.6 | 110.4 | 5.9 |
| Stauroneis sp. (benthic diatom) | | 48.7 | 0.0 |
| Nitzchia sp. (benthic diatom) | 5.8 | 62.1 | 0.0 |
| Contracted Rotifera | 3.0 | 3.5 | 1.6 |
| Desmids (green algae) | 0.0 | 0.0 | 6.2 |
| Nematoda - unidentified | 8.1 | 19.0 | 4.5 |
| Chaetonotus sp. (gastrotrich) | 21.8 | 24.7 | 2.9 |
| Tardigrada | 5.2 | 17.3 | 2.1 |

The data collected for macrobenthic populations is summarized in Tables 7, 8 and 9. The Shannon-Wiener species diversity index for the macrobenthic populations of ponds 1, 2 and 3 is 1.75, 1.9 and 1.4

**Table 7 - Macrofauna Composition of Sampling Station A (mean number/core)**

| Organism Name | POND 1 | POND 2 | POND 3 |
|---|---|---|---|
| Actinolaiminiae sp. (nematode) | 13.4 | 8.5 | 1.3 |
| Tobrillus sp. (nematode) | 42.3 | 20.7 | 11.5 |
| Naidium breviseta (oligochaete) | 14.3 | 0.0 | 0.0 |
| Metriocnemus knobi (insect larva) | 14.6 | 12.8 | 0.0 |
| Chironomus tentans (insect larva) | 0.0 | 0.0 | 5.5 |
| Macrocyclops albidus (crustacean) | 2.3 | 2.9 | 6.6 |
| Pleuroxus aduncus (crustacean) | 0.0 | 0.0 | 43.1 |
| Musculium sp. (bivalve) | 1.2 | 3.2 | 0.0 |
| Candona sp. (ostracod) | 6.9 | 10.3 | 0.0 |
| Planaria sp. (flatworm) | 4.0 | 11.1 | 1.5 |
| Harpacticoid copepods | 0.0 | 0.0 | 6.2 |
| nauplii | 0.7 | 2.1 | 5.4 |
| Desmids (green algae) | 1.6 | 24.6 | 2.3 |

**Table 8 - Macrofauna Composition of Sampling Station B (mean number/core)**

| Organism Name | POND 1 | POND 2 | POND 3 |
|---|---|---|---|
| *Actinolaiminiae* sp. (nematode) | 3.4 | 1.8 | 0.0 |
| *Tobrillus* sp. (nematode) | 29.4 | 18.3 | 45.8 |
| *Naidium breviseta* (oligochaete) | 8.9 | 9.1 | 0.0 |
| *Lumbriculus inconstans* (oligochaete) | 0.0 | 0.0 | 44.9 |
| *Metriocnemus knobi* (insect larva) | 4.1 | 8.9 | 0.0 |
| *Chironomus tentans* (insect larva) | 0.0 | 0.0 | 11.5 |
| *Macrocyclops albidus* (crustacean) | 0.0 | 0.0 | 4.1 |
| *Musculium* sp. (bivalve) | 2.7 | 3.2 | 0.0 |
| *Candona* sp. (ostracod) | 3.6 | 2.9 | 0.0 |
| *Planaria* sp. (flatworm) | 1.9 | 21.2 | 3.2 |
| *Attheyella* sp. (crustacea) | 1.6 | 1.1 | 0.0 |
| *Desmids* (green algae) | 0.0 | 2.6 | 3.5 |

**Table 9 - Macrofauna Composition of Sampling Station C (mean number/core)**

| Organism Name | POND 1 | POND 2 | POND 3 |
|---|---|---|---|
| *Actinolaiminiae* sp. (nematode) | 6.6 | 2.3 | 0.0 |
| *Tobrillus* sp. (nematode) | 78.9 | 98.2 | 49.1 |
| *Naidium breviseta* (oligochaete) | 16.5 | 8.4 | 0.0 |
| *Lumbriculus inconstans* (oligochaete) | 0.0 | 0.0 | 29.6 |
| *Metriocnemus knobi* (insect larva) | 0.0 | 3.7 | 0.0 |
| *Chironomus tentans* (insect larva) | 0.0 | 0.0 | 4.7 |
| *Macrocyclops albidus* (crustacean) | 0.0 | 0.0 | 6.4 |
| *Musculium* sp. (bivalve) | 1.2 | 2.3 | 0.0 |
| *Nematode* - unidentified | 16.8 | 3.8 | 4.3 |

Once again the species diversity of pond 3 is the lowest, indicating that the conditions of this pond are not as good as those of ponds 1 and 2. *N. breviseta*, *M. knobi* and *Musculium* are all organisms which occur only in well oxygenated, high quality aquatic systems. They are absent from pond 3 and replaced by low oxygen tolerant species (*L. inconstans* and *C. tentans*) which occupy the same niche.

F. Fish Composition

The fish and macroinvertebrate populations of the shoreline waters of all three ponds were sampled by pulling a 10-foot long, 0.5-inch mesh seine along the banks. The only fish caught by this method were *Pimephales promelas* (fathead minnows) from ponds 1 and 2; no fish were caught in pond 3. A total of 636 minnows were measured for their standard length and minnows from both ponds had similar length frequency distributions and mean standard length of 38.7 mm.

Also caught in ponds 1 and 2 were *Cambarus bartoni* (crayfish) which had a mean carapace length of 44.5 mm. The only organisms seined from pond 3 were leeches (Class: Hirundinea), snails and a large aquatic beetle (*Hydrophilus* sp.)

G. Chemical Analysis

Both water and sediment samples were taken from each pond and the storm drain input to pond 3 for chemical analysis by AFOEHL/SA for total organic carbon (TOC), nitrates, orthophosphates, oil and grease, and MBAS surfactants. An additional group analysis referred to as E.P. Toxicity was done on water and sediment samples for each pond. E.P. Toxicity analyzes for pesticides and a group of biologically active heavy metals. Also, trout (sampled by volunteers using long line sampling methods) and fathead minnows were analyzed for mercury and PCBs as recommended by the EPA. For the sake of brevity, only the significant results are reported.

The only analysis to produce detectable results in the fish flesh was for the PCB Aroclor 1254 which was present in 0.07 and 0.11 μg/gram concentrations in both the minnow and trout from pond 2. The E.P. Toxicity analysis of the sediments from pond 3 indicated the metals barium, cadmium, lead and selenium were all present in higher concentrations than ponds 1 and 2. While none of these levels are currently dangerous, there should be concern as to finding the source for these toxicants. The results of these analyses are given in Table 10.

## III. CONCLUSIONS

The ecological conditions of ponds 1 and 2 appear to be excellent based on these findings and they should continue to provide an excellent area to stock with game fish. Pond 3 should not be used for recreational fishing in its current condition. Its ecological condition is questionable as indicated by its low species diversity levels and the presence of pollution indicator species. The primary problem with utilizing pond 3 as a game fishing area is the continuous introduction of stormwater from the storm drain. The presence of the drain means that there is the constant potential for an ecological disaster on a small scale. The drain is a constant source of water of unknown quality. If any pollutant is accidentally spilled anywhere on the base, it has a good chance of entering this drain and pond 3. Also, the storm drain is a source of chronic pollution which may take years to manifest itself. Pesticides applied on the golf course or other areas of the base shortly before a downpour could affect acute toxicity in pond 3. Other chemicals which could conceivably cause acute toxicity problems would be fuels and oil spills, AFFF, and large solvent spills.

Applications of fertilizers anywhere along the storm drainage system would cuase chronic low oxygen conditions by stimulating algal bloom. The fact that low levels of some PCBs are detected in fish and the sediments have higher levels of some biologically active metals should cause concern. While these levels are not currently dangerous, the sources of these pollutants need to be determined and minimized before a problem arises.

One caveat of this study is that all of the samples analyzed (both chemical and biological) were collected over a 2-day period and may not reflect year round conditions. This study should be continued with periodic sampling so that any temporal variability can be observed. This is particularly true of any pollution study in which there may be a chronic, low-level addition of pollutants.

**TABLE 10 - E.P. TOXOCITY ANALYSIS FOR METALS**
**mean (std. dev.) in mg/l; n=2**

| | POND 1 | | POND 2 | | POND 3 | | STORM DRAIN |
|---|---|---|---|---|---|---|---|
| METAL | WATER | SEDIMENT | WATER | SEDIMENT | WATER | SEDIMENT | INPUT |
| ARSENIC | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 |
| BARIUM | 0.0245(0.0035) | 0.445(0.106) | 0.032(0.0) #1 | 0.32(0.057) | 0.32(0.057) | 0.78(.071) #2 | 0.04(0.0028) #4 |
| CADMIUM | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | 0.0125(0.0021) | <0.010 |
| CHROMIUM | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |
| LEAD | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | 0.0895(0.043) | <0.050 |
| MERCURY | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 | <0.0005 |
| SELENIUM | <0.050 | <0.050 | <0.050 | <0.050 | <0.050 | 0.11(0.0) #3 | <0.050 |
| SILVER | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 | <0.010 |

#1 significantly different from pond 3 (t-test alpha=0.05)
#2 significantly different from pond 2 (t-test alpha=0.05)
#3 significantly different from ponds 1 and 2 (t-test alpha=0.05)
#4 significantly different from ponds 1 and 3 (t-test alpha=0.05)

## IV. RECOMMENDATIONS

1. Pond 3 would benefit from mechanical aeration, as do ponds 1 and 2. Recommend capability to maintain a minimum of 5 mg/L during nighttime operation be provided to prevent stess to game fish population.

2. The current practice of using water from pond 3 to fill ponds 1 and 2 should also be curtailed in order to keep these ponds in top condition.

3. In order to utilize pond 3 for fishing, the storm drain should be diverted to some other area before the pond can be prepared to accept fish.

4. Prevent unweathered AFFF from entering the storm drainage system. Hangar fire suppressant systems should be provided with a holding pond to capture the release of AFFF and retain it sufficiently to affect its biodegradation before release into the stormwater system.

5. Aircraft washing, paint stripping, and other corrosion control activities should not be performed at locations such as the ramps where the rinsewater would enter the storm drainage system even after exiting an oil/water separator.

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