WRD Resource Room

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Final Report to

United States Department of the Interior
National Park Service
Padre Island National Seashore
Corpus Christi, Texas 78418

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A BASELINE STUDY OF THREE PONDS WITHIN THE PADRE ISLAND NATIONAL PARK

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TABLE OF CONTENTS

INTRODUCTION

When one sets out to make a base-line study of an ecosystem it becomes imperative that all available knowledge about that ecosystem must be assembled and evaluated. Since the Padre Island National Seashore was established, a number of very impressive studies have been made associated with certain aspects of defining the park. An excellent account of Padre Island's history has been summarized by James Sheire (1971). In his study he mentions the availabity of fresh water beginning with the needs of the Karankawa indians and extending through the Dunn Ranch era where "wells were dug" into the fresh ground water lens. Rechanthin and Passey (1973) wrote on the vegetation of Padre Island. This was reported to me as unpublished and no longer available so is not included in the references. Higginbotham (1972) prepared a paper on the vegetation of the Padre Island National Seashore as a part of a course in which he was enrolled at Texas A & I University. He mentions seven species of plants I feel sure were around Pond A, but his locations were unclear. In 1972 a high school student, M. Keller, prepared a small paper on some ponds that he studied. Unfortunately the pond locations were not described sufficiently to be identified with any of those in this study. He was the first to report the possible use of the ponds as water sources for

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construction. Baccus (1979) mentions ponds but presents only general information about them.

There were two studies that definitely have information on two of the three ponds in this study. Serota (1971) prepared a study of primary productivity and chlorophyll standing crop of two ponds on Padre Island. An almost identical study was made by Perez (1971). These two unpublished theses provided some information useful in this study. Hannan (1978) while defining the limits of the drainfield of the ranger station sewage system conducted some chemical tests on the pond nearest the ranger station.

A computer search of the literature revealed that in the last 30 years no papers have been published in regular journals on barrier island ponds. The small number of pieces of literature available on these ponds of Padre Island are found in government or private sources.

As with the beginning of any ecological study a defining of the elements of an ecosystem occurs in the baseline concept. This study investigates the many aspects of these three ponds in order to establish a foundation, or baseline, or a beginning point, for further studies. Some of those studies have already begun in the preparation of two theses; one by Mr. Christopher Caudle on the dynamics of the fish population of the three

ponds and another by Ms. Florence Oxley on the decay organisms of the three ponds. These should be finished by 1992.

METHODS

The original experimental design for this study called for our research team to visit the three ponds on a monthly basis from September of 1989 through August of 1990. We visited the ponds near the 15th day of each of those months to collect data. Five additional trips were made for various reasons and three of the trips were extended visits of two days.

Mapping of Ponds

All three ponds were surveyed by a licensed surveyer, Mr. Jim Barber, during our first visit in September of 1989. At that time the water levels were low from the summer dry-down, making the surveying task much easier than if they had been full. The average full water level was diagnosed on the basis of the obvious change in vegetation types. This is the level where aquatic vegetation gives way to terrestrial vegetation. During floods, such as the heavy rains of March, the ponds increase in depth approximately two feet, resulting in increased volumes and surface areas. As the island dries this excess water "wicks" out through the surrounding sands and the water level returns to that configuration depicted in the maps.

Chemical Methods

During the September trip extensive samplings were made to investigate the possibility of undesirable contaminants. These samples were returned to the Edwards Aquifer Research and Data Center for analysis. The samples were analyzed for the following materials using the methods proposed by the Environmental Protection Agency.

Inorganic Nutrients The nitrate nitrogen was analyzed using the nitrate electrode screening method, No. 418 B, described in "The Standard Methods for the Examination of Water and Waste Water."

The total nitrogen analysis was performed by the standard Kjeldahl method.

The total phosphates were analyzed by the Environmental Protection Agency Method 365.2. This analysis is a colorimetric, ascorbic acid, single reagent method.

Heavy Metals Each of the heavy metals were analyzed using various Environmental Protection Agency methods and they are as follows:

Arsenic	EPA 206.2 (AA, Furnace Technique)
Iron	EPA 236.1 (AA, Direct Aspiration)
Mercury	EPA 245.1 (Manual Cold Vapor Technique)
Lead	EPA 239.2 (AA, Furnace Technique)

a quantitative standpoint the preserved sample was subsampled 10 times using a Sedwich-Rafter counting chamber with a Whipple eyepiece under 100X magnification. Averages were obtained for the 10cc subsamples and the figures adjusted to the number/liter of pond water. Because the numbers within each genera ranged from a few hundred to many million per liter, the data was converted to their logarithms. The data for the Chlorophyta, Cyanophyta, Chrysophyta, Protozoa, Rotifera, Crustacea and Nematoda were summarized for each month. During the month of June 1990 the plankton data is missing. After the collection was made we discovered a plankton net failure and the data was so low that the decision was made to leave it out rather than include faulty data. There is no reason to believe that the data would not have been similar to that of either May or July. In some months no diatoms, rotifers, protozoa, crustacea and nematodes were found.

Fish The fish population was sampled using a 1/4 inch mesh 15 foot seine. In each pond at each sampling period three 3-minute hauls were made. The fish were preserved and returned to the laboratory for analysis. Mr. Christopher Caudle is using the data from October of 1989 through October of 1990 for his Master's thesis. A copy of his thesis will be made for the National Park Service when it is completed. The preliminary data

is included in this report.

Fungi The fungi populations for all three ponds are being studied by Mrs. Florence Oxley. Samples of foam, decaying and living plant material, feathers and other organic debris were returned to the laboratory where they were submitted to fungal analysis on specialized media used for fungal identification. This study will form the basis of her Master's thesis. Her collection period is from June 1990 through July 1991 and a copy of her study will be made available to the National Park Service.

POND A MORPHOLOGY

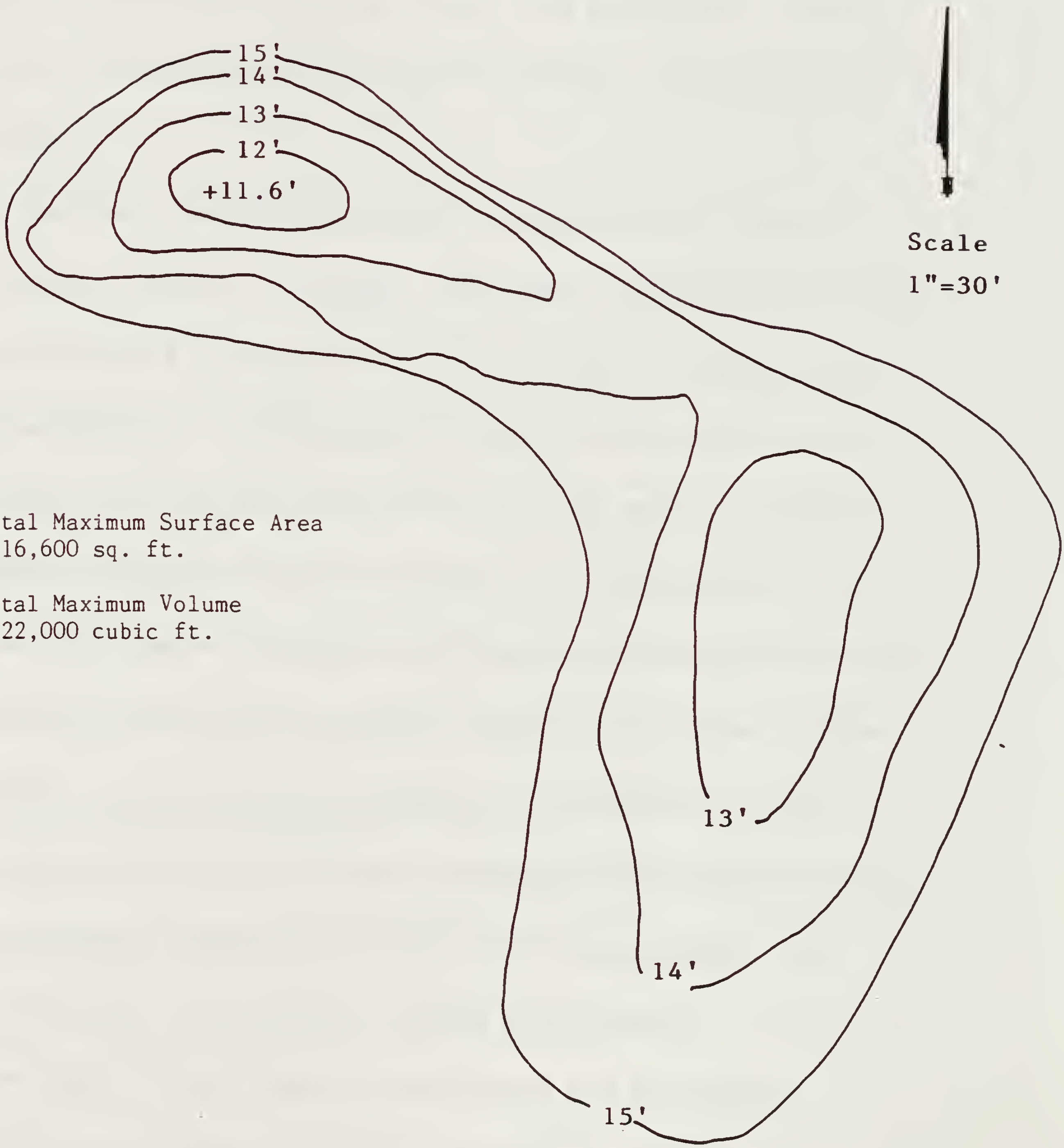
From looking at the map following page 12 we see that this pond, having a surface area of 16,000 feet is characterized by being actually two ponds separated by a shallow sill. The pond on the left, or more westerly, is the deeper of the two, having a water depth approximately 4 feet. The pond on the right, or more easterly , has a depth of approximately 3 feet. The floors of both ponds are covered with approximately 18 inches of a soft watery gel-like muck, making traversing the pond when it is full somewhat dangerous to small people or children unaccustomed to walking in the sludge-like material. In the summer of 1990, Pond A dried down to the point that the more easterly pond's floor could be walked on with safety. Pond A during flood time has another very shallow sill (with water depth less than 6 inches) , heavily covered with vegetation on its most southern edge. This sill connects Pond A with a very large deflation trough covering several acres.

While the reason for the construction of Pond A appears to be lost in history it is my theory that the more easterly pond (shallowest) was dug first and probably for the purpose of providing fresh water for construction or livestock. From the map it is plain that the easterly pond is older with widely sloping banks produced by the invasion of surrounding

sands. When in time this pond went dry during periods of drought, a second pond (the westerly pond) was dug. It is deeper and its banks are steep in keeping with its relative youth.

Of the three ponds studied, Pond A is the most ideal for wildlife.

PADRE ISLAND NATIONAL SEASHORE
POND A



Scale
1"=30'

Total Maximum Surface Area
16,600 sq. ft.

Total Maximum Volume
22,000 cubic ft.

POND A CHEMICAL AND PHYSICAL PARAMETERS

Initial September Analysis

It is difficult to apply normal lake parameters to small ponds that are subject to rapid heating, cooling, dilution, and evaporation. Pond A would have to be classified hypereutrophic according to the description by Wetzel (1983).

He described nitrate concentrations in hypereutrophic lakes as having a range of .500 to 15.0 mgs/l. The nitrate concentrations in Table I were found in Pond A to range from 9.6 to 4.11 mgs/l in September and February respectively. In September the water level was low from the summer drought and the pond was filled with a vast amount of decaying plant material comprised mostly of members of the Chlorophyta. The water level rose between September and February and the reduction in the concentration of nitrate may have been a result of both dilution and the revival of the algal population. In February a measurement of total nitrogen was made using the Kjeldahl method which converts all nitrogen within the sample to ammonia. A value of 7.0 mgs/l indicated that nitrogen compounds other than just nitrates were present.

From Table I Pond A metal analysis shows that the arsenic, cadmium, chromium, copper, zinc, lead, strontium, iron, and mercury

concentrations are all well below the standards set by the Texas Department of Health. Probably these ions play no part in restricting the life in Pond A.

When the water from Pond A was analyzed for organic materials no pesticides, PCB's or hydrocarbon contaminants were found other than 29.37 mgs/l of oil and grease. This is not a significant amount and probably originated from the close position of the pond to the Bird Island road.

Monthly Chemical and Physical Analyses: Pond A

Temperature The water temperature at mid-day was measured with a standard centigrade thermometer and from the information in Table II we calculated the average water temperature to be 25.125^0 for the year's study. The average water temperatures for the seasons were 28.3^0 for the spring, 31.8^0 for the summer, 27.3^0 for the fall, and 14^0 for the winter. The highest temperature measured was 33^0 in September and the lowest was 14^0 in February. However, the Padre Island National Park data for the severe freeze occuring December 22 and 23 of 1989 was not available and information taken from the Corpus Christi Weather Station indicated that the air temperature reached a low of 13^0. Padre Island National Park

personnel reported that considerable ice formed on all three ponds.

Turbidity The turbidity, as measured in Formazin units in Table II, showed a yearly average of 27.5. Seasonal averages were determined to be 59.1 for the spring, 24.3 for the summer, 19.6 for the fall and 16.6 for the winter. The highest turbidity of 70 Formazin units occured in April and the lowest value of 12 Formazin units occured in September. The water color varied from clear in September to a very light brownish cast in those months with high Formazin unit values. The relatively low but steady increase in turbidity in the months of September, October and November resulted from recovery of pond life from the summer dry-down. The turbidity was low during the months of December and January, when algal growth was retarded by the low temperatures in December. By February, March, April, and May, the spring bloom of algae increased the turbidity to the all year high in April. From May through August the pond gradually cleared with the summer dry-down.

Oxygen The data from the monthly oxygen analysis showed that at no time during the study year was oxygen totally limiting to life within the pond. The yearly average was 7.5 ppm/l and the seasonal averages were: for the spring months 8.4 ppm, summer months 6.0 ppm, fall months 8.7 ppm and winter months 7.2 ppm. The highest oxygen value was in April

when it was 12.0 ppm. April is the month with the highest spring peak of photosynthetic activity and 12.0 ppm would represent a super-saturation value. The lowest oxygen analysis of 3.6 ppm was in August 1989 when the pond had dried down to about 1 foot of depth in the deepest basin closest to the bay. During the August analysis the 3 species of rainwater fish were observed to be swimming very near the surface and were "playing" with the water-air interface. Many fish died during August from the lack of habitat and the nocturnal anoxia produced by the decay of the heavy algal bloom of the spring and summer.

Salinity Of the three ponds in this study Pond A was consistently the freshest of the three. The average salinity for the year was 0.33 ppt with seasonal average values for the spring of 0.23 ppt, for the summer months 0.21 ppt, for the fall months 0.37 ppt, and for the winter months 0.30 ppt. The freshness of this pond is responsible for the large variety of animal life that use this pond as a watering place.

Alkalinity and pH Baccus (1979) states that the soils of Padre Island are derived primarily from the rivers bringing sand grains from the calcareous rocks of the mainland and from the calcium rich shells of the marine molluscan fauna living within and offshore of the beaches, principally Big and Little Shell beaches. Wetzel (1983) states that as

water enters soil it infuses that soil with carbon dioxide. The CO_2 is produced from plant and microbial respiration and forms carbonic acid which dissolves the calcium from the sand and increases the bicarbonate ion. The high values of alkalinity (measured as total $CaCO_3$ in mgs/l in Table II) result from this process. Since a high total alkalinity results in high pH values, the monthly data supports this concept. Alkalinity during the study period ranged from a low of 120 ppt in July to 298 ppt in October with a yearly average of 236.45 ppt. Seasonal averages were: spring 239.66 ppt, summer 168.00 ppt, fall 275.00 ppt, and winter 276.00 ppt. The pH values averaged 8.35 for the year, and seasonally they were: spring 8.43, summer 8.36, fall 8.46, and winter 8.13. These figures are supported by the high numbers of algal, fungal and terrestrial plants within and around Pond A.

LIFE AROUND POND A

Vascular Plants

The Vascular Plant Species Inventory, Table III, prepared by Dr. Lemke, shows some 50 species of vascular plants within 200 feet of the three ponds. In Pond A we find 19 species distributed in 11 families, and of those 11 families, 5 are found only at Pond A. The 5 families unique to Pond A are: Apiaceae, Polygalaceae, Solanaceae, Typhaceae and the Verbenaceae. These 5 families have a single species each. Therefore on the familial level this pond has a greater variety than does either Pond B or Pond C. The other 6 families have 14 species unique to Pond A. For a complete listing of the species found at Pond A see Appendix I where they are listed by species, common names and by families.

Animal Life

The data in Table IV indicates Pond A is a more desirable watering place than is either Pond B or Pond C. Pond A had the greatest variety of wildlife as indicated by the observation of 46 species of vertebrates and miscellaneous Arthropoda. They are described by taxon.

Amphibia. During the October study period we found a few tadpoles. Since amphibians fall prey to many predators it was not possible to determine the speciation. No other amphibians were discovered in any of

the ponds.

Reptilia. A dead massauga rattlesnake was discovered near the edge of the pond and the only other snake seen at Pond A was a western cottonmouth. The red-eared pond slider population was very large at the beginning of our study but the turtles disappeared by July. Many were found dead around the pond edge and the population numbers may have become so low that we missed them.

Mammalia. The Texas pocket gopher, black-tailed jackrabbit and a single coyote were observed visiting the pond. Three other species are believed to visit Pond A. They were identified from tracks and were badger, raccoon, and whitetailed deer.

Aves. Of the 3 ponds studied the bird life visiting Pond A was the largest. Twenty-six of the 72 species reported to be found around ponds in the Padre Island National Seashore bird check list were observed. This list of birds we observed can be found in Table IV. One interesting note was the sighting of a pair of whooping cranes flying over Pond A. This sighting was reported to the Aransas Wildlife Refuge.

Miscellaneous Arthropoda. An assortment of obvious arthropoda were found including grass shrimp, dragonflies, damselflies, mosquitoes, spotted camel crickets, fire ants and the Texas spotted tick.

LIFE WITHIN POND A

Pond A is characterized by Wetzel (1983) as hypereutropic with a dominance of Chlorophyta (green algae). Along with the greens a large amount of Cynanophyta (blue-green) and Chrysophyta (diatoms) produce an algal population almost too large at times to drag a plankton net or a 1/4 inch seine through the water. Because of this the numbers of algal species are lumped together in their respective divisions and the genera in each division can be found in Table V-A.

Cyanophyta The blue-green numbers increased from the beginning of our study in September 1989 from 3.96 to 5.00 in November. Their numbers decreased sharply to 4.22 in January. All algal taxons decreased during the winter low when the temperature dropped to freezing and below in late December. The blue-greens began to recover in February and in March to a high for the year of 5.52. Because of the winter low temperatures a large amount of the pond life was killed and their disintegrating bodies added nutrients to the water column, laying the foundation for the spring bloom. In April the blue-greens decreased to 3.36 and as warmer weather approached their numbers began to clumb to a high of 5.22 in August. The lower figure for April of 3.36 could be a result of dilution from the large rains of March.

Chlorophyta The green algae followed a similar pattern as the blue-greens in that the first sampling in September of 1989 showed a log of 3.97. A small autumn pulse occurred in October, November and December. The cold temperatures of January reduced green algae growth to a low of 3.57 in February. By March the spring pulse had begun with a high of 4.36. The small dip in April of 3.77 is probably from rain water dilution. The planktonic algae hovered between 4.30 to 4.55 the rest of the study period. It should be noted that the filamentous green algae were excluded from the plankton net collection procedure. The dominant filamentous greens were Zygnema and Spirogyra. In late March and early April the filamentous algae began to develop around the shore of Pond A and proceeded to increase to enormous floating mats during the months of April, May and June. These mats were so dense that small birds were observed walking upon them looking for small creatures to feed upon.

Chrysophyta The diatoms represent the "pasture of the pond", providing along with other unicellular life, sustenance for minute crustaceans and rotifers which constitute the body of first herbivore trophic level. The diatom populations were measured in September with a log of 4.29, decreased to 4.14 in October, rose to a high of 4.86 in November and steadily decreased through December and January to a

February low of 4.12. A spring pulse of 5.11 will be noted in March. The population decreased in April to 4.27 and they ranged from 4.44 to 4.66 in May, July and August.

<u>Protozoa</u> The protozoans were dominated by dinoflagellates, a few ciliates and fewer amoeboids. The data in Table V-A show a range of 3.47 in April to 4.14 during the spring pulse in March. There is a constancy in the protozoa populations that does not occur in the photosynthetic organisms. The data indicate that there is an excess of food available throughout the year, and it should be noted that the figures represent the pelagic forms and do not include the sessile forms and those that are found living upon the substrate whether it be bottom mud or other filamentous or higher plants.

<u>Rotifera</u> The rotifer populations are lower than one would expect in a pond so filled with life. No rotifers were found in the October, November and August samples. They seemed to flourish in December and January, with figures of 3.78 and 3.84 respectively. The other months ranged from a low of 2.82 in September of 1989 to 3.60 in May of 1990. A low spring pulse can be noted for March (3.08), April (3.08) and May (3.60).

<u>Crustacea</u> The crustacean population is considerably more healthy than the populations of either rotifer or protozoa. They are restricted to

mostly cyclopoid copepods with a few cladocera. Occasionally there appeared an ostracod exuvia. Their populations appear erratic in Table V-A. A high of 4.33 was found in September of 1989; the number declined in October and November, reaching a low of 3.65 in December, then increased again in January only to decrease to 3.82 in February. Higher numbers were found in March, May and July and low numbers in April and August. Why the pupulation should vary in this fashion is not known. The low of 3.30 in April may be a product of dilution from rain and the August low could be produced by the summer dry-down. In August the pond was small from the summer dry-down and the fish population (predation) large for the pond volume. Whatever brought about this pattern, the yearly average was 4.04 within a range of 4.33 to 3.30, indicating a rather healthy zooplankton population.

Nematoda The nematodes were observed on only two occasions, November and July. On both occasions their numbers were low and not considered important.

Fish *Cyprinodon veriegatus* is the dominant fish in Pond A; with few exceptions healthy populations were found all year long. In the cold winter months of December, January, and February we were able to collect very few specimens per trip. Wading birds rely heavily on Pond A for a

food source, and the migratory fowl plus the cold temperatures may have reduced the population. During March and April the filamentous algae were so dense that we were not able to operate a seine. With the decline of the spring bloom and subsequent clearing of the pond the numbers of fish captured per collection returned to a normal of approximately 100 fish.

Gambusia affinis was collected in December and March. Fundulus grandis was found in the months of Movember, May, June, and July. We suspect that Gambusia affinis and Fundulus grandis occur in the pond year around but with very low populations numbers. It should be noted that of the three ponds Pond A experiences the largest extremes. By being shallow, Pond A has more rapid temperature shifts, and in combination with the heavy algal growth and decomposition becomes near anoxic, especially at night during the hotter months. The summer dry-down kills many fish and those that remain in the summer months may be found "gulping" at the surface of a very much smaller pond.

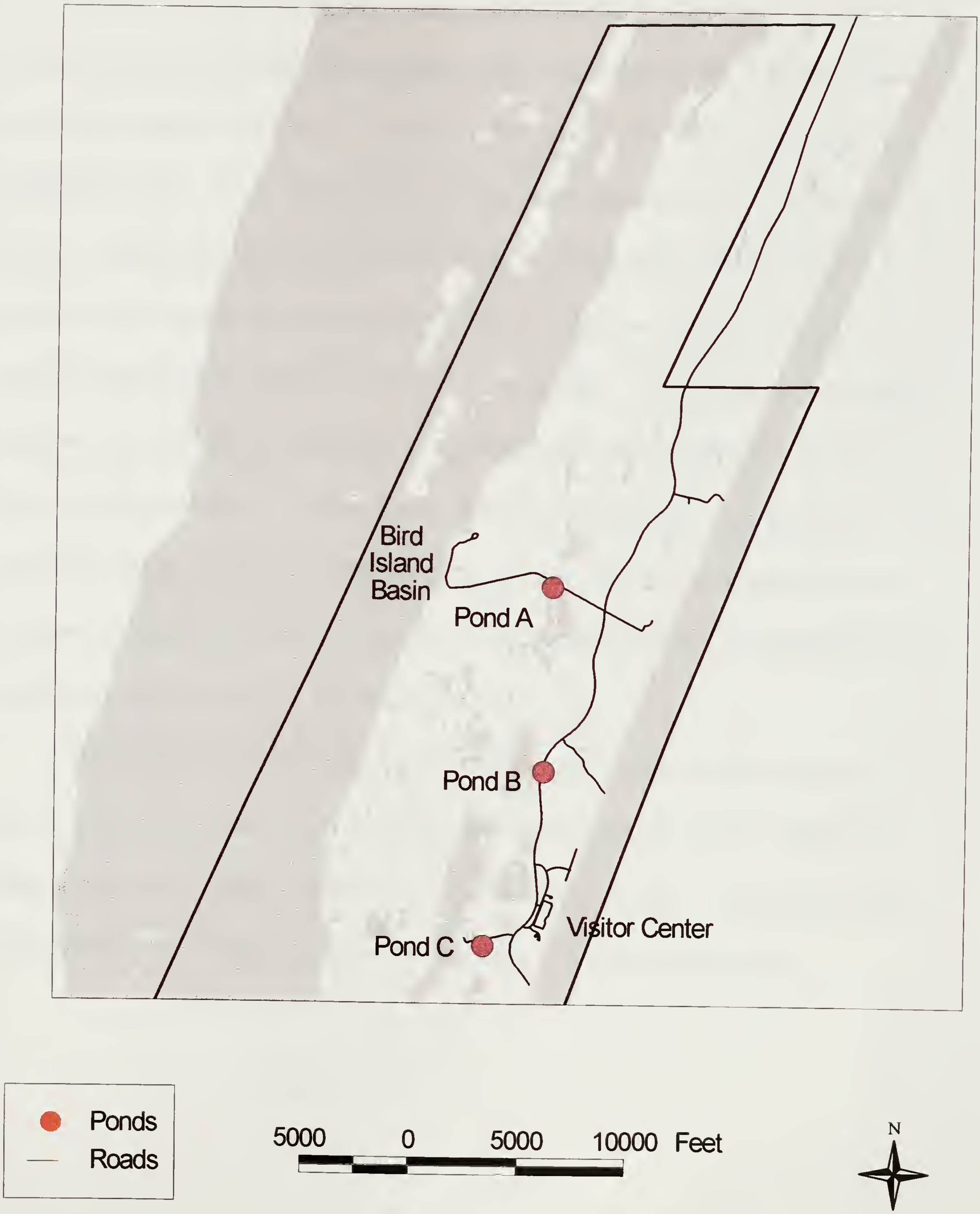
Fungi In the ecosystem organic materials must return to the inorganic state to complete the carbon cycle. Both bacteria and fungi perform this function. Mrs. Oxley's fungal list is found in table VII. Her isolations have come from foam, water, living and dead plant material and feathers. Her collection period ends in September of 1992 and a copy of

feathers. Her collection period ends in September of 1992 and a copy of her thesis will be made available to the Padre Island National Seashore Park.

RECOMMENDATIONS FOR POND A

Of the three ponds studied, Pond A is the one that presents the most interesting parameters as far as the public is concerned. It is teeming with life of all kinds and Pond A could be an excellent location to observe nature from a "nature trail" standpoint. From a blind one can observe a very large list of the bird population of Padre Island, especially during those months when the migratory birds are available. However, Pond A is slowly filling with sand and will be eventually converted to a marsh. Even a marsh can present some interesting concepts of Padre Island. With a minimum of cleaning of material from the floor of the pond it can retain much of its enjoyable qualities and its life can be extended many years.

Locations of Three Freshwater Ponds at Padre Island National Seashore



POND B MORPHOLOGY

Pond B on the main Park Road is characterized in the map on the following page by being approximately eight feet deep with a surface area of 34,100 square feet and a volume of 160,000 cubic feet. It is roughly rectangular with rather steep sides. The southeastern side is beginning to show a shallowing from the sands moving in, producing a wider slope. A pond of this shape is better for storing water and also may be a place where material was obtained for road construction. The floor of Pond B is covered with about six inches of a gel-like muck that overlays a more solid clay-like bottom. A pond with this type bottom is desirable for retaining water. During the March rain of 1990 this pond flooded with an increase of depth of about 18 inches. The summer dry-down decreased the water level only to about six feet.

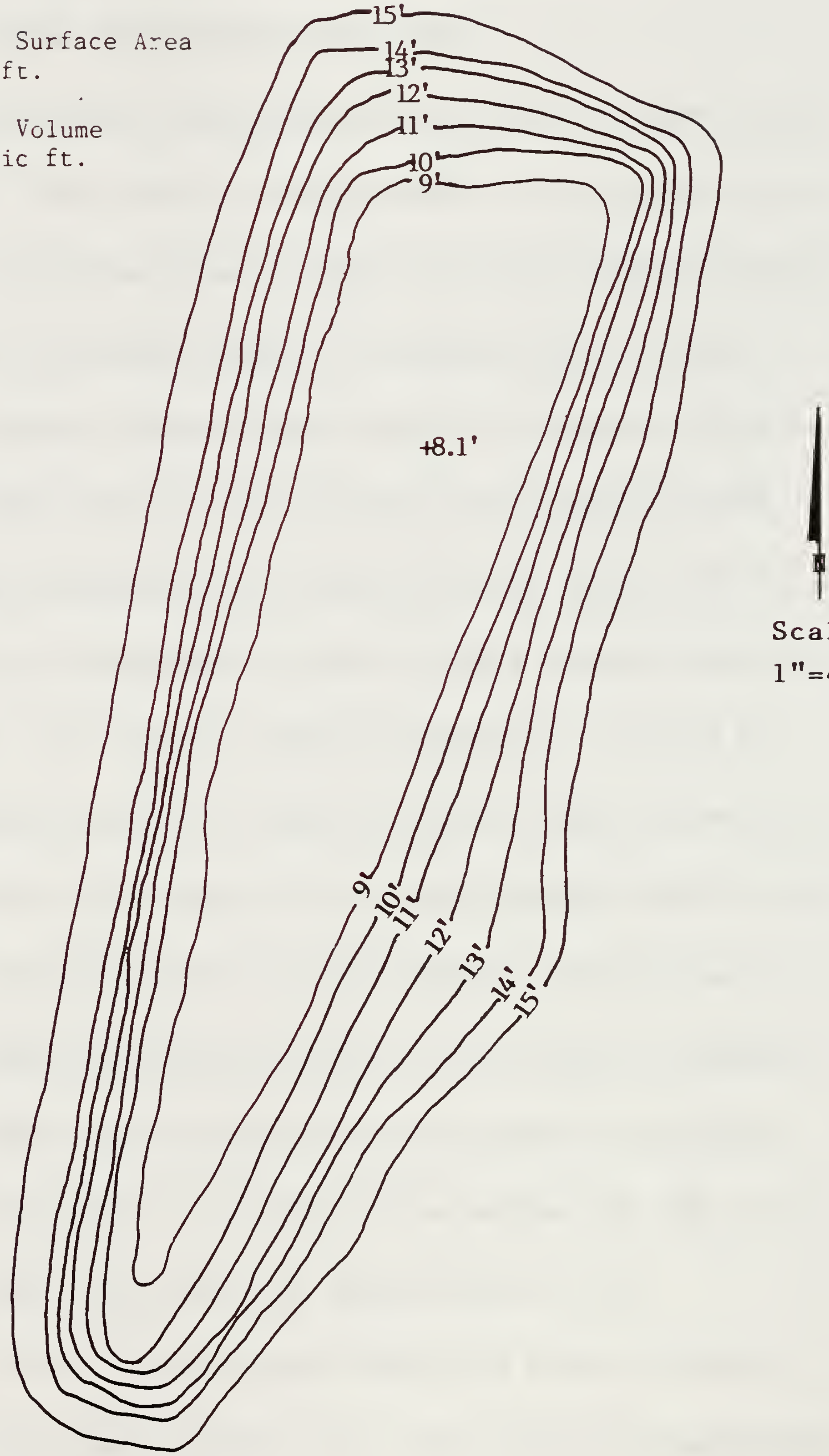
The studies prepared by Serota (1971) and Perez (1971) indicated that National Park personnel believed this pond was dug in the 1960s for both materials for road construction and for fresh water. This pond in not as desirable for wildlife as Pond A as there are few wading areas.

PADRE ISLAND NATIONAL SEASHORE

POND B

Total Maximum Surface Area
34'100 sq. ft.

Total Maximum Volume
160,000 cubic ft.



Scale
1"=40"

POND B CHEMICAL AND PHYSICAL PARAMETERS

INITIAL SEPTEMBER ANALYSIS

Wetzel (1983) described hypereutrophism as having two basic types of algal proliferation. While Pond A demonstrated the Chlorophyta type of hypereutrophism, Pond B clearly demonstrates the second type dominated by a huge population of blue-green algae. The chemical data in Table I consists of three different analyses beginning with the studies of Serota (1971) and Perez (1971); Hannan (1978); and our own analysis of 1989. Nitrates have steadily increased from a value of 0.6766 mg/l in 1971 to a high of 2.99 mg/l found in September of 1989. In 1978 Hannan found 2.2 mg Kjeldahl nitrogen. The Kjeldahl nitrogen increased to 13.0 mg/l by 1989. Since Kjeldahl nitrogen is a measure of total nitrogen converted to ammonia, there must be other nitrogen compounds available within Pond B.

Along with a steady increase of nitrogen Table I further shows a steady increase in total phosphate from 0.03 in 1978 to 0.48 in February 1989. The high nitrogen data and high phosphorus data indicate rather high values for natural systems. Our data did not support the high (111.0 mgs/l) phosphate data of the Serota and Perez studies of 1971.

From Table I Pond B metal analysis shows that arsenic, cadmium, chromium, copper, zinc, lead, strontium, iron, and mercury concentrations

are well below the standards set by the Texas Department of Health. However, copper and zinc concentrations may be limiting to some algal species and thereby limiting or inhibiting the production of a species diversity one would expect in this pond.

No pesticides, PCBs or hydrocarbons were noted except for one peak at 4.63 in Pond B. This peak does not correspond to any available hydrocarbon standard and is likely produced by a high ion concentration activating the flame ionization detector. The oil and grease analysis indicates a value of 17.82 mg/l. This quantity is not believed to be significant since this pond, like Pond A, is located near a heavily traveled public road.

Monthly Chemical and Physical Parameters of Pond B

Temperature The temperature of Pond B seen in Table II shows a similar pattern to that of Pond A. The yearly average was 25.54^0 and the seasonal averages were spring 28.16^0, summer 31.6^0, fall 27.3^0 and winter 15.0^0. The extremes occurred in August with a high of 35.0^0 and the low of 11.0^0 in December. It should be noted that the December low of 11.0^0 occurred before the cold spell of December 22 and 23 when ice formed on the pond.

Turbidity Pond B is as unique as Pond A in the heavy turbidity that is produced by the enormous ever-present blue-green algae population. The algae is so dense that the water appears to have a light olive tint. The turbidity averaged 121.3 formazin units and the pond experienced extremes of 25.0 formazin units in January, as a result of the December freeze, to a high of 190 formazin units in mid-December just before the freeze. The turbidity slowly rose from September to December, dropped dramatically in January and slowly rose from February through August.

Oxygen Our monthly oxygen analysis in Table II showed a yearly average of 8.0 ppm with seasonal averages of: 7.8 ppm for spring, 7.8 ppm for summer, 8.6 ppm for fall and 7.7 ppm for the winter months. At no time during the year did we find an anoxic situation within the pond. This pond more so than Pond A is almost constantly under the influence of the sea breeze and one can observe the heavy algal population roiling as microcurrents move to the down-wind side of the pond. Oxygen samples made in deeper water showed very little difference in deep water and shallow water, indicating a thoroughly mixed pond.

Salinity The data in Table II indicate that Pond B is almost as fresh as Pond A. The average salinity for the year's study was 0.258 ppt with extremes of 0.80 ppt in September and a low of 0.12 ppt in February. The

high salinity observed in August is probably a result of the summer dry -down. Even though the salinities observed are not significantly higher than Pond A, the number of species visiting this pond was not as great as that of Pond A. It is suspected that the presence of the heavy blue-green algae population may foul the water and make it less desirable as a watering hole for wildlife.

Alkalinity and pH The data in Table II show that the alkalinity and pH are as to be expected given the substrate composition and the heavy photosynthetic and decay activities associated with Pond B. Serota (1971) and Perez (1971) found alkalinities approximating those of this study. The alkalinity yearly average was 149.81 ppt and an average pH of 8.5. The extremes were a low of 120 ppt with a pH of 8.3 and a high of 210 with a pH of 8.6.

LIFE AROUND POND B

Vascular Plants

In the Vascular Plant Inventory, Table III, Pond B is shown with 21 species distributed in 11 families. There are 3 families unique to Pond B. These 3 families, with 1 species each, were the Asclepiadacea, Gentianaceae and the Iridaceae. The other 9 families contain 13 species unique to Pond B, 3 species common to Pond A and 2 species common to Pond C. This analysis shows a greater diversity on the species level. It is interesting to note that in Table III there are only 3 species, i.e. Heterotheca subaxillaris and Iva angustifolia in the Asteraceae family and Paspalum setaceum in the poaceae family, that are found at both Ponds A and B. Table III contains a complete listing of plants found around Pond B.

Animal Life

The data in Table IV indicates that Pond B is frequented by fewer vertebrates than Pond A. We observed 26 species visiting Pond B and the taxonomic groups are described below.

Reptilia. We observed the massauga rattlesnake one time in October and the Gulf salt marsh snake on several occasions. The red-eared pond slider was observed throughout the sampling period but the population seemed to decline as the study progressed. Many were found dead on the

shore in late fall and early spring.

Mammalia. Except for the Texas pocket gopher and the black-tailed jackrabbit, all other mammals were identified by their tracks. We observed cat tracks, too large for a house cat, one time; coyote tracks twice, and whitetailed deer tracks once during the course of this study. We propose that the heavy automobile traffic and the water, heavy with blue green algae, may be factors limiting visitation by mammals.

Aves. We observed 14 species of birds, mostly ducks, gulls and terns. The great blue heron was observed twice, a black skimmer once, and the short-billed wren once. For a complete listing, refer to Table II.

Miscellaneous Arthropoda. Ghost and fiddler crabs were identified by their burrows. We never found any alive and only rare evidence of their body parts. It is suspected that they migrate from the seashore, dig burrows and then die because of the freshness of the water in Pond B. Grass shrimp were numerous as were the ever-present mosquitoes. However, the mosquito population was never observed to be as large as the mosquito population at Pond A. We found a few fire ant mounds.

LIFE WITHIN POND B

In Wetzel's (1983) classification scheme Pond B is classified as hypereutrophic with a dominance of blue-green algae. In general we may say that Pond B has very few zooplankton and diatoms, a few green algae and an amazing blue-green algal population consisting primarily of Rhaphidiopsis. Note in Table V-B that blue-green algae for September 1989 was 7.19. The antilog of 7.19 is 15,786,900 cells or colonies/liter.

Cyanophyta The blue-green algae number was largest at the beginning of our study in September 1989 with a log of 7.19. Table V-B shows that there was a significant decrease in population numbers in October only to rise again in November to a value of 6.96. The population decreased from November to the low for the year of 5.30 in January. This decrease seems to be related to the onset of the colder weather of winter. In late February the blue-greens recovered to 6.92 but were diluted by the March rains to 6.28. From April to August they were between 6.56 and 6.78. These enormous numbers are primarily the result of Rhaphidiopsis and secondarily of Coelosphaerium. These two genera dominated the blue-greens throughout the study and no doubt produced the dark olive-brown stain in the water of Pond B. The filamentous blue-green algae were conspicuously absent. The studies of Fogg et. al. (1973) indicate that blue-

green algae often release metabolites into surface waters that render the water unpalatable to wildlife and in some cases poison the water, resulting in death for some wildlife. Pond B animal life is less than that of Pond A even though its salinity is nearly the same. This suggests a poorer water quality.

Chlorophyta Where the blue-green algae was measured in millions of cells/liter the greens were measured in thousands to hundred thousands. Table V-B shows the green algal populations began in September with a value of 5.80 only to reduce in October to 4.94. They rose again in November to the yearly high of 5.92. They fell again in December (5.05) only to recover and actually exceed the blue-greens in January (5.53). These data suggest that either the inhibiting effect produced by the blue-greens was reduced in January or the green algae were stimulated to greater population numbers by the colder weather. The former is suspected since the dilution of the blue-green population by March rains produced an increase in the green algae population for March (5.85). The green algae became very much reduced in May (4.28) and continued to fall to an August low of 3.30. Again as with the blue-green algae the filamentous algae so very noticeable in Pond A is virtually absent in Pond B.

Chrysophyta The diatoms were in very low numbers compared to the blue-green and green algae. The data in Table V-B shows that in September they measured 3.9 and then decreased in October and November to a seasonal low of 3.26 in December. They increased in January and February (3.81) only to remain static in March through May. Why none appeared in the April, July and August samples is not known, but it is suspected that their numbers were so low that they escaped the counting procedure.

Protozoa Table VI-B, which lists the plankton in Pond B, lists only 2 genera, i.e., *Arcella* and *Difflugia*. Why there should be such a paucity of protozoan zooplankton is not known. It is poor not only in numbers/liter but also poor in diversity. A high of 4.13 was measured in the September sample and their numbers ranged from 3.75 in November to 3.26 in March. The lack of Protozoa in October is probably caused by counting error . induced by the unusually low population numbers. The dinoflagellates were conspicuously missing.

Rotifera While the rotifer populations are again small they are larger than the Protozoa. The list of genera in Table VI-B includes 3 genera, i.e., *Keretella*, *Filina* and *Rotaria*. Their numbers were measured at 4.21 in September and fell during October, November and December. The

winter cold apparently favored rotifers by there being a January figure of 4.21 and a February high of 4.24. Their numbers fell again during March and April only to rebound to an all year high of 4.38 in May. Their numbers fell during the summer and none were found in the August sample.

Crustacea The list of crustaceans in Table VI-B is, like the Rotifera and Protozoa, limited to a very few ostracods, copepods, and Naupilus larva. Their numbers as shown in Table V-B were high in September (4.03), February (4.04), March (4.04), April (4.22), and May (4.15), and only slightly lower in October (3.04), November (3.90), December (3.23), and January (3.70). None were observed in the July sample and again overall low numbers may have not shown up in the plankton sample count.

Nematoda The only nematodes to be noted were a very few (3.38) during the month of April. No significance is attached to so small a count.

Fish As Cyprinodon veriegatus dominated Pond A Gambusia affinis dominated Pond B. On the average 90% or more of the fish in our samples were Gambusia affinis. Cyprinodon veriegatus was always found in low numbers making up the remainder of l00%.

Our collections of Gambusia affinis and Cyprinodon veriegatus were low in January and February; perhaps this is the effect of low winter temperatures. No Fundulus grandis have been found in Pond B. Why this

species should be excluded from Pond B is not known. It may be that the heavy blue-green algal population fouls the water for _Fundulus_.

Fungi The fungi that Ms. Oxley has isolated from Pond B result in a more lengthy list than that of Pond A. Please refer to Table VII for an accounting of these fungi available as degraders in Pond B.

RECOMMENDATIONS

This baseline study has documented several unusual parameters characterizing this pond. The enormous blue-green algae population implies that the balance of life within the pond is skewed toward the characteristic polluted pond. While the nitrates and phosphates are indeed high, they are similar to the nitrate ahd phosphate values found in Pond A. Some as yet unknown factor or factors are limiting to the predatory fish, filamentous green algae, restricted diatom populations and low zooplankton numbers. The data on the rainwater fishes indicate that their numbers are high and it may be that the food chain is limited by these unknown factors, producing a two step food chain of fish and algae. The waste from the fish and visiting birds feed the algae, and the algae along with some zooplankton feed the fish. An interesting experiment might be accomplished by de-stabilizing this apparent tight food chain through the introduction of a predatory fish such as the large mouth bass. Because

Pond B has never been known to go dry and we never found it to be anoxic, Pond B might be corrected into a better balanced ecosystem.

At present no reason has been found to restrict the public from this pond, however, if the blue-green continue to increase it could in a few years become a public eyesore.

POND C MORPHOLOGY

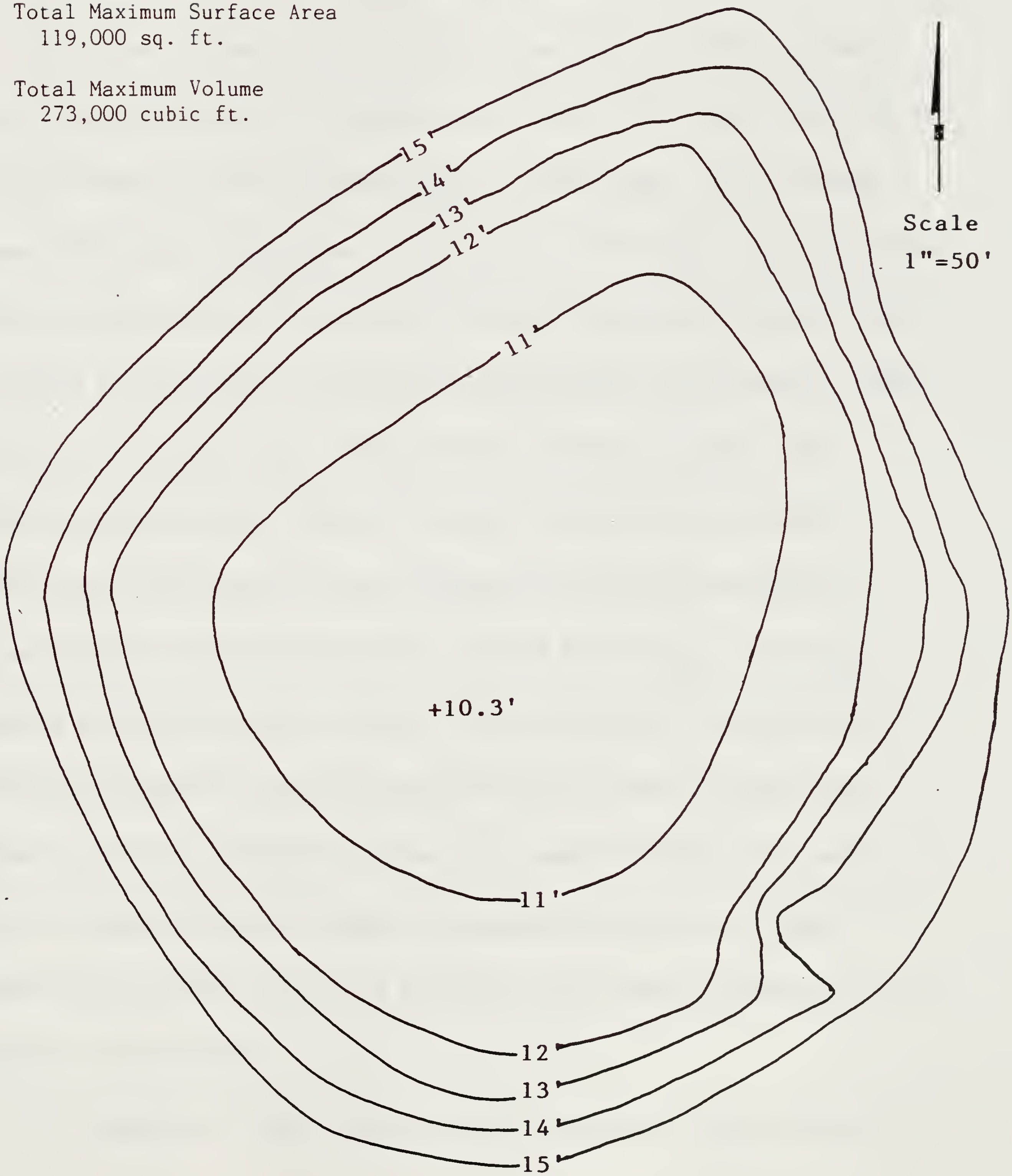
Pond C is located near the terminus of the park road leading to the hazardous waste dump. Serota (1971) and Perez (1971) reported that this pond was a source of fill for road construction in the 1960's. The stabilized dunes between the pond and the bay are fairly large and from their consistent and non-dune-like shape may actually be spoil banks from the construction of the pond. This pond depicted on the map on the following page is the largest of the three ponds in this study, having a surface area of 119,000 square feet and a volume of 273,000 cubic feet. It is roughly 5 feet deep except in flood times when the depth is increased to about 7 feet. The sides are gradual except on the southeast side where surface sand shows considerable migration. This migration is aided by the movement of subsurface water, primarily entering the pond from the northeast, east and southeast sides.

PADRE ISLAND NATIONAL SEASHORE

POND C

Total Maximum Surface Area
119,000 sq. ft.

Total Maximum Volume
273,000 cubic ft.



POND C CHEMICAL AND PHYSICAL PARAMETERS

Initial September Analysis

This pond located near the dump station is considerably different from Pond A and Pond B. From Table I the Perez (1971) and Serota (1971) studies indicate a nitrate concentration of 0.7567 mg/l. Our analysis shows 18.19 mg/l in September and 3.09 mg/l in February. The September figure was taken when the pond was low from the summer dry-down and the figure of 3.09 mg/l in February represents the rainfall dilution. Both figures for nitrate are high. Total Kjeldahl nitrogen is again high, indicating perhaps other types of nitrogen compounds are available. Unlike Pond A and Pond B, Pond C presents very low total phosphate concentrations of 0.04 in September and 0.05 in February. In marine systems phosphate may be limiting to the development of an expected plankton population. The metal analysis listed in Pond C shows that arsenic, cadmium, chromium, copper, zinc, lead, strontium, iron, and mercury concentrations are below the standards set by the Texas Department of Health. Again, as in Pond B, zinc could be limiting to some planktonic algal forms.

No pesticides, PCB's or hydrocarbons were noted and the figure of

7.49 mg/l of oil and grease plays no significant part in the health of Pond C. Again Pond C is near a well-traveled road.

Monthly Chemical and Physical Analysis

Temperature Pond C, as shown in the data from Table II, follows a pattern similar to Ponds A and B.

The yearly average was 25.54^{0} c with seasonal averages of: spring 28.6^{0}, summer 31.5^{0}, fall 27.0^{0}, and winter 14.6^{0}. The extremes of 12.0^{0} and 33.0^{0} occurred in the months of August and December respectively. As in the data for Ponds A and B the extreme low that occurred in late December is not shown. Because of the higher salinities of Pond C it probably did not have as great an ice cover as the fresher Ponds A and B.

Turbidity The clarity of Pond C throughout the study period was amazing clear. The average yearly turbidity was 11.6 formazin units with seasonal averages of: spring 17.6, summer 6.0, fall 14.0, and winter 8.3. The extremes were 0.0 formazin units in the months of July and August and the highest turbidity occurring in April with a value of 30.0 formazin units. This highest reading was a function of the low spring algal pulse during the early spring months of February, March and April. The low values of 5.0 and 2.0 occurring in December and January are probably a

function of the December freeze.

Oxygen The oxygen values in Table II show less variation than those of Pond A and B. The yearly average was 7.2 ppm and the seasonal averages were: spring 6.7 ppm, summer 8.5 ppm, fall 7.5 ppm and winter 5.8 ppm. The extremes were 10.00 ppm in August and 5.40 ppm in June. Because of the relatively low populations of planktonic algae the data implies that the oxygen values probably result from two factors. The first of these is the rather large surface area to depth ratio allowing the ever-present turbulence from the sea breeze to bring about equilibrium with the atmosphere. The second factor is the large population of Chara that lines the floor of Pond C. The Chara is a major contributor to the oxygen value.

Salinity Pond C is very different from Ponds A and B in that it contains a very high salt content. Serota (1971) found the salinity to be less that 1 ppt. Our data shows considerable increase in the last 19 years. The yearly average was 14.79 ppt with seasonal averages of: spring II.43 ppt, summer 16.10 ppt, fall 13.53 ppt and winter 18.10 ppt. The extremes were 11.8 ppt in May and 19.80 ppt in February. The salinity values rise during the fall and winter and drop during the spring, as a result of spring rain dilution. They continue to fall during early summer and then rise

again in response to the late summer dry-down.

Just where the salt comes from remains a mystery, but three theories may be proposed. The first of these is that salt may have been added to create a redfish pond. National Park personnel indicated to me that at some time in the past there were redfish living in the pond. We found no evidence that there were any redfish present. However, were the population very low in numbers, it is possible that they avoided our seining efforts. The second theory is that the salt may be entering the pond from ground water coming in to the pond through the substrate from the bay. Pond C is closer to the bay than to the Gulf. However, Serota (1971) reports Pond C to be approximately two meters above sea level. While we did not survey to sea level, the floor of the pond does appear to be considerably higher than sea level. The third theory proposed is that the salt may be leaching from salt deposits within the subsurface structure of the island itself.

However the salt got there it is enough to modify the pond environment, producing a brackish water pond environment.

Alkalinity and pH The alkalinity and pH values of Pond C are similar to those of Pond B. The data on Table II show an alkalinity average for the year of 140.63 ppt and a pH value of 8.45. The seasonal averages are:

spring alkalinity 166.60 ppt and pH of 8.43 , summer alkalinity 144.00 ppt and pH of 8.36, fall alkalinity 114.00 ppt and pH of 8.66, winter alkalinity 129.66 ppt and pH of 8.36. The lowest alkalinity 90.0 ppt and pH of 8.5 occurred during the month of November and the highest alkalinity of 196.0 ppt and pH of 8.5 occurred in May. A similar value of alkalinity of 196.0 ppt and a pH of 8.3 occurred in August. All of these values are expected and there is nothing unusual about them.

LIFE AROUND POND C

Vascular Plants

The Vascular Plant Inventory, Table III, shows that Pond C has 15 species distributed in only 9 families. Of these 9 families 2 were unique to Pond C. They are the Plantaginacea and the Polygonacea with 1 species each. The other 7 families contain 11 species unique to Pond C. Two species, *Hypericum virginicum* and *Samolus ebracteatus* were also found at Pond B. The general types of plants found around Pond C are plants that are characteristic of disturbed soil. They may indicate that the construction of Pond C occurred more recently than Pond A and Pond B. A complete listing of plants found around Pond C is found in Table III.

Animal Life

The data in Table IV indicates that Pond C supports many of the same species found at Ponds A and B, but because of the high salinity visitations by vertebrates are fewer than at Pond A. Field observations indicate that most of the vertebrates are feeding on other vertebrates or are feeding on the surrounding plant life.

Reptilia. The reptiles were limited to two species. The red-eared pond slider was observed at the beginning of the study in the fall of 1989. These turtles were observed to be crawling out of the water and dying.

The population was not observed after December 1989. I suspect that the summer dry-down may have been the driving force causing their migration to Pond C in search of the proper habitat. All the turtles observed were very large. The other reptile we observed was a four-lined skink. It too was dead after being trapped in an old tire.

Mammalia. Of the six mammals observed at Pond C only the Texas pocket gopher and the black-tailed jackrabbit were actually observed. The other four mammals were identified from tracks. The bobcat tracks were more frequently found about gopher burrows and on one occasion the coyote tracks "followed" some jackrabbit tracks. Raccoon tracks were observed near water but the deer tracks were mostly in the outlying areas around Pond C.

Aves. Our field observations indicate a larger bird list for Pond C than Pond B. We observed 18 species of birds at Pond C and these are listed in Table IV. Because Pond C has very shallowly sloping edges we noted that more wading type birds were present in Pond C than Pond B with its steep banks. The terns, gulls, and ducks made up more than half of the bird fauna.

Mollusca. The only molluscs we observed during this study were found at Pond C. A rather large population of razor clams live in the

shallow areas of Pond C.

Miscellaneous Arthropoda. Among the 5 species of arthropodans the only species, other than the razor clams, that is usually considered to be "marine" was the discovery of one large dead blue crab in September. We were never able to observe others nor did they appear in the seine hauls. The grass shrimp population was very large and for the most part restricted to the large Chara beds that line the floor of Pond C. Mosquitoes, fire ants and spotted camel crickets complete the list.

LIFE WITHIN POND C

Pond C is too saline to be referred to as a fresh water pond. The salinity varies with its volume, producing a high salinity pond during the summer dry-down and a low salinity pond after the heavy rains that normally occur in March. Any creature that lives in this pond must be euryhaline in order to thrive in these extremes. The salinity excludes many of the life forms that were available in Ponds A and B. Pond C is very clear indicating low amounts of life within the water column. This clarity allows a macrophyte (Chara) to line the floor of the pond. The overall plankton community is low and these low plankton values may be a response to the low phosphate content. A listing of planktonic genera can be found in Table VI-C.

Cyanophyta Tables V-C and VI-C show the genera and population value. The blue-greens in September were 4.68; they fell to 3.33 in October only to rise in November to 4.28. The winter values were: 3.54 for December, 4.08 for January and 3.98 for February. The freeze of late December appeared to have a minimal effect. A small spring bloom occurred in March (4.15), April (4.66) and May (4.67). Their bloom was accompanied by an increase in water volume from the March rains that included a reduction of salinity. Throughout the summer months during

the dry-down the figures were May (4.67), July (4.18) and the yearly high of 5.15 in August 1990.

Chlorophyta The data in tables VI-C and V-C list the genera and population values. The green algae populations were highest in the fall of 1989 with values of 4.37 in September, 4.71 in October and 4.27 in November. The population numbers decreased in December (3.65) and increased in January to 3.91. They decreased through February (3.82), March (3.77), and April (3.56). There appeared to be no spring pulse as in Ponds A and B. In May the slight rise of 3.85 fell to 3.53 in July and 3.57 in August. From these data there appeared to be no appreciable effect produced from the cold weather of December or from the flooding in March.

Chrysophyta On the average the diatoms are more numerous both in number and kind than were the green algae. From Tables V-C and VI-C we see that there were 16 genera of diatoms and their population numbers were higher than the greens. In September they were 4.70 and their numbers basically declined through the fall and winter months to a low of 3.76 in the February sample. A spring pulse is noted to begin with 4.42 in March, increasing to 4.78 in April and decreasing to 4.59 in May. The values for July and August were 3.92 and 4.39 respectively. In marine systems the diatoms and green algae are the major primary producers and

the data from this study suggests that the primary production may be inhibited.

Protozoa The protozoa in Pond C are limited to one dinoflagellate and an amoeboid. Their numbers were never high. In August of 1990 the log was 3.97, the highest for the year. None were observed in the September and April samples. The values from Table V-C for the other months seem to fit no pattern.

Rotifera The rotifers consisted of only one genus and it appeared in the months of November (3.61), December (2.69), February (3.28), and March (3.07). The antilog of 3.61 in November translates into 4.1 rotifers/cc of water and it is easily seen how with such low numbers they could be missed in an analysis.

Crustacea The crustacean fauna consisted only of one cycloptic copepod, one ostracod, and mostly naupilus larvae. In Table V-C the logs of the samples appear higher for the crustaceans than for either the rotifers or the protozoans. Even so their numbers are not impressive. Note that the low (2.30) was in December and the high occurred in April during a small spring pulse.

Nematodes As shown in Table V-C the only nematodes obtained in our samples occurred in April of 1990.

Fish All three species, i.e., Cyprinodon veriegatus, Gambusia affinis, and Fundulus grandis, were found in Pond C. Cyprinidon veriegatus accounted for 95% of the fish fauna with the other 5% split about equally between Gambusia affinis and Fundulus grandis. Gambusia affinis was collected during November and April through July, and Fundulus grandis was found in January, June, and July. During the summer months with the water level so low all three species were taken in the seine collections. They are probably all three present throughout the year but G. affinis and F. grandis occur in such low numbers they may have escaped collection.

Mossusca Pond C has the only resident molluscs of the three ponds. In the shallower waters around the edges of Pond C reside a very large population of Tagelus plebeius. Every time the pond dries down many of the clams are killed. These clams lie buried in the mud and their population is likely to recover with an increase of water level to the average depth

Fungi Table VII lists 19 genera of fungi that were isolated mostly from foam, leaves and Chara.

GENERAL RECOMMENDATIONS FOR POND C

With the exception of the fish, the other forms of life appear to be present in low numbers. The chemical data indicate that the usual level of

nutrients as compared to Pond A and B are not present. Especially low is the phosphate content. Again the role copper and zinc play in limiting the algal growth is poorly known and could play some part in its limitation. Green (1975) expressed the idea that zinc toxicity to green alga in bioassays is a function of phosphorus and/or ionic content. This implies that whether or not an ion is limiting depends on the ionic mix of other elements. An interesting experiment might be to mildly fertilize Pond C, particularly with phosphate, and see if the pond life is improved. If it is improved red fish might survive and grow.

I would further suggest that the dumping station on the south side of the road be moved to the north side of the road. We found on several occasions various containers near and in the water. What had been in them was not known. By moving the dump stations at least some of the materials could be prevented from entering the water. The policy of excluding the public from this area is a good one.

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TABLE I: SPECIAL CHEMICAL ANALYSIS, SEPTEMBER 1989
Nitrogen and Phosphorus (mgs/l)

	Nitrite	Nitrate	Ammonia	Kjeldahl Nitrogen	Organic Nitrogen	Total Phosphate	Dissolved Phosphate	Particulate Phosphate
Pond A								
1989								
Sept.		9.6				0.13		
Feb.		4.11		7.00		0.22		
Pond B								
1971	0.072	0.6766				111.0	67.0	44.0
1978	< 0.1	< 0.1	< 0.1	2.2	2.2	0.0		
1989								
Sept.		2.99				0.2		
Feb.		2.25		13		0.5		
Pond C								
1971	0.0154	0.7567				113.0	71.0	42.0
1989								
Sept.		18.19				0.0		
Feb.		3.09		13.0		< 0.05		

TABLE I CONTINUED

METALS (mgs/L)

	Pond A	Pond B	Pond C
As	< 0.01	< 0.01	< 0.01
Cd	< 0.01	< 0.01	0.02
Cr	< 0.01	< 0.01	0.02
Cu	< 0.02	0.02	< 0.02
Zn	0.03	0.32	0.10
Pb	0.002	< 0.002	0.008
Sr	1.36	0.206	3.96
Fe	0.38	0.16	0.20
Hg	0.00004	0.00007	0.00007

OIL AND GREASE (mgs/L)

	Pond A	Pond B	Pond C
	29.37	17.82	7.49

TABLE II: MONTHLY CHEMICAL AND PHYSICAL DATA

Turbidity in Formazin units; Oxygen, Salinity, Alkalinity in ppt.

Pond A	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Temperature	33o C	30o C	19o C	13o C	16o C	13o C	26o C	29o C	30o C	29.5o C	30o C	33o C
Turbidity	12	18	29	10	15	25	42.5	70	65	33	20	20
Oxygen	9.60	9.30	7.40	8.40	5.40	7.80	5.60	12.00	8.60	7.65	7.00	3.60
Salinity	0.48	0.64	0.64	0.32	0.32	0.36	0.24	0.24	0.2	0.2	0.12	0.3
pH	8.8	8.5	8.1	8.2	8	8.2	8.5	8.5	8.3	8.5	8.4	8.2
Alkalinity		298	252	246	288	294	252	263	204	246	120	138
Pond B												
Temperature	32o C	30o C	20o C	12o C	18o C	15o C	24.5o C	29o C	31o C	32o C	28o C	35o C
Turbidity	110.0	90.0	180.0	190.0	25.0	90.0	93.0	138.0	101.0	144.0	140.0	155.0
Oxygen	10.40	6.60	9.00	8.40	5.40	9.30	10.00	7.20	6.20	10.60	7.30	5.60
Salinity	0.80	0.40	0.20	0.22	0.20	0.12	0.18	0.20	0.18	0.20	0.15	2.50
pH	9.8	8.6	8.5	7.7	8.0	8.5	8.5	8.6	8.4	8.5	8.6	8.3
Alkalinity		122	136	140	192	160	144	140	150	134	210	120
Pond C												
Temperature	31o C	30o C	20o C	12o C	17o C	15o C	24o C	31o C	31o C	32.5o C	29o C	33o C
Turbidity	18.0	14.0	10.0	5.0	2.0	18.0	20.0	30.0	3.0	20.0	0.0	0.0
Oxygen	9.30	7.40	6.00	6.00	5.40	6.20	6.40	5.80	8.00	7.45	8.00	10.00
Salinity	14.60	12.00	14.00	16.50	18.00	19.80	10.50	12.00	11.80	14.00	15.30	19.00
pH	9.2	8.3	8.5	8.5	8.4	8.2	8.4	8.4	8.5	8.5	8.3	8.3
Alkalinity		138	90	125	132	132	160	142	196	126	110	196

TABLE III: VASCULAR PLANT SPECIES INVENTORY

SCIENTIFIC NAME	COMMON NAME	POND(S)
APIACEAE	PARSLEY FAMILY	
Hydrocotyle bonariensis	Water pennywort	A
ASCLEPIADACEAE	MILKWEED FAMILY	
Asclepias oenotheroides	Green Milkweed	B
ASTERACEAE	SUNFLOWER FAMILY	
Cirsium horridulum	Yellow bull thistle	A
Croptilon divaricatum	Scratch-leaf daisy	C
Erigeron procumbens	Fleabane	B
Eupatorium betonicifolium	Saltmarsh boneset	B
Gaillardia pulchella	Indian blanket	A
Heterotheca pilosa	Golden aster	C
Heterotheca subaxillaris	Golden aster	A, B
Iva angustifolia	Narrow-leaf sumpweed	A, B
Pluchea purpurascens	Marsh fleabane	B
CYPERACEAE	SEDGE FAMILY	
Cyperus rotundus	Flatsedge	B
Dichromena colorata	White-top sedge	B
Eleocharis montevidensis	Spike sedge	B
Fimbristylis castanea	Brown fimbristylis	C
Scirpus americanus	American bulrush	A
EUPHORBIACEAE	SPURGE FAMILY	
Croton capitatus	Woolly croton	C
Croton glandulosus	Tropical croton	C
Croton punctatus	Seaside Croton	A
Euphorbia cordifolia	Heart-leaf spurge	C
Euphorbia maculata	Spotted spurge	C
FABACEAE	PEA FAMILY	
Baptisia bracteata	Whitestem wild indigo	A
Chamaecrista fasciculata	Partridge Pea	B
Galactia canescens	Hoary milkpea	C
Indigofera miniata	Scarlet pea	A
Sesbania vesicaria	Bladder pod	A
GENTIANACEAE	GENTIAN FAMILY	
Eustoma exaltatum	Texas bluebells	B
HYPERICACEAE	ST. JOHN'S WORT FAMILY	
Hypericum virginicum	St. John's wort	B, C

TABLE III CONTINUED

IRIDACEAE	IRIS FAMILY	
Sisyrhinchium biforme	Blue-eyed grass	
PLANTAGINACEAE	PLANTAIN FAMILY	
Plantago rhodosperma	Red-seeded plantain	C
POACEAE	GRASS FAMILY	
Andropogon glomeratus	Bushy bluestem	B
Cenchrus ciliaris	Buffelgrass	A
Cenchrus incertus	Coast sandbur	C
Dactyloctenium aegyptium	Durban crowfootgrass	C
Eragrostis secundiflora	Red lovegrass	B
Eustachys petraea	Finger grass	B
Leptochloa fascicularis	Bearded sprangletop	A
Paspalum setaceum	Thin paspalum	A, B
Schizachyrium scoparium	Little bluestem	B
Setaria geniculata	Yellow bristlegrass	A
Sporobolus pyramidatus	Sand dropseed	C
POLYGALACEAE	MILKWORT FAMILY	
Polygala incarnata	Pink milkwort	A
POLYGONACEAE	KNOTWEED FAMILY	
Eriogonum multiflorum	Wild buckwheat	C
PRIMULACEAE	PRIMROSE FAMILY	
Samolus ebracteatus	Water pimpernel	B, C
SCROPHULARIACEAE	SNAPDRAGON FAMILY	
Agalinus maritima	Seaside gerardia	B
Bacopa monnieri	Coastal water hyssop	B
Buchnera floridana	American bluehearts	A
SOLANACEAE	NIGHTSHADE FAMILY	
Physalis viscosa	Ground cherry	A
TYPHACEAE	CAT TAIL FAMILY	
Typha domingensis	Narrow-leaf cat tail	A
VERBENACEAE	VERVAIN FAMILY	
Phyla nodiflora	Frog fruit	A

TABLE IV
VERTEBRATES AND MISCELLANEOUS ARTHROPODA

Common Name	Scientific Name	Pond A	Pond B	Pond C
	Osteichthyes			
Mosquito fish	Gambusia affinis	X	X	X
Pupfish	Cyprinodon veriegatus	X	X	X
Killifish	Fundulus grandis	X		X
	Amphibia			
Tadpoles	unknown	X		
	Reptilia			
Massauga rattlesnake	Sistrurus catenatus tergeminus	X	X	
Western cottonmouth	Agkistrodon discivorus leucostomia	X		
Gulf salt marsh snake	Natrix sipedon clarki		X	
Red-eared pond slider	Pseudemus scripta elegans	X	X	X
Four-lined skink	Eumeces tetragrammus			X
	Mammalia			
Bobcat (tracks)	Lynx rufus		X	X
Texas pocket gopher	Geomys personatus personatus	X	X	X
Raccoon (tracks)	Procyon lotor fusiceps	X		X
Black-tailed jackrabbit	Lepus californicus merriami	X	X	X
Coyote (tracks)	Canis latrans	X	X	X
Badger (tracks)	Taxidea taxus berlandieri	X		
Whitetailed deer (tracks)	Odocoileus virginianus	X	X	X
	Aves			
Eared grebe	Podiceps nigricollus			X
Great blue heron	Ardea herodias	X	X	X
American egret	Casmerodius albus	X		X
Black-necked stilt	Himantopus mexicanus			X
Willet	Catoptrophorus semipalmatus			X
Glossy ibis	Plegadis falcinellus	X		
Roseate spoonbill	Ajaia ajaja	X		
Whooping crane	Grus americana	X		
Sandhill crane	Grus canadensis	X		X
Long-billed curlew	Numenius americanus	X		X
Least sandpiper	Calidris minutilla	X		
Lesser yellow-legged sandpiper	Tringa flavipes	X		
Sanderling	Crocetheia alba	X		
Killdeer	Charadrius vociferus	X		
Black skimmer	Rynchops nigra		X	
Royal tern	Sterna maxima	X	X	X
Common tern	Sterna hirundo	X	X	

TABLE IV CONTINUED

Laughing gull	*Larus atricilla*	X	X	X
Franklin gull	*Larus pipixcan*	X	X	X
Cormorant	*Phalacrocorax olivaceus*			X
American widgeon	*Anas americana*	X		
Pintail duck	*Anas acuta*	X		
Blue-winged teal	*Anas discors*		X	
Mottled duck	*Anas fulvigula*		X	
Lesser scaup	*Aythya affinis*		X	X
Redhead duck	*Aythya americana*			X
Greater scaup	*Aythya marila*		X	
Canvas back duck	*Aythya valisineria*	X	X	
Bufflehead duck	*Bucephala albeola*		X	X
Ruddy duck	*Oxyura jamaicensis*			X
American coot	*Fulica americanus*	X	X	X
Bob-white quail	*Colinus virginianus*	X		
Redwinged blackbird	*Agelaius phoeniceus*	X		
Boat-tailed grackle	*Quiscalus major*	X		
Turkey vulture	*Catharies aura*	X		X
Northern harrier	*Circus cyaneus*	X		X
Inca dove	*Scardafella inca*			
Mourning dove	*Zenaida macroura*	X		
Short-billed marsh wren	*Cistothorus platensis*		X	
Chimney swift	*Chaetura pelagica*	X		
	Mollusca			
Razor clam	*Tagelus plebeius*			X
	Miscellaneous Arthropoda			
Blue crab (dead)	*Callinectes sapidus*			X
Grass shrimp	*Paleomonetes sp.*	X	X	X
Ghost crab (holes)	*Ocypoda quadrata*		X	
Fiddler crab (holes)	*Uca* sp.		X	
Dragonflies	Identification incomplete	X		
Damselflies	Identification incomplete	X		
Mosquitoes	Identification incomplete	X	X	X
Spotted camel cricket	*Ceuthophilus* sp.	X		X
Fire ants	*Solenopsis geminata*	X	X	X
Texas spotted tick	*Ambylomma texana*	X		

TABLE V-A: PLANKTON IN POND A

Log of Total Numbers/Taxon

	Cyanophyta	Chlorophyta	Chrysophyta	Protozoa	Rotifera	Crustacea	Nematoda
Sept.	3.96	3.97	4.29	3.51	2.82	4.33	
Oct	4.60	4.62	4.14	3.60	0.00	4.08	
Nov.	5.00	4.08	4.86	3.78	0.00	4.08	3.77
Dec.	4.75	4.35	4.61	3.65	3.78	3.65	
Jan.	4.42	4.38	4.37	3.84	3.84	4.05	
Feb.	4.58	3.57	4.12	3.57	2.97	3.82	
Mar.	5.52	4.36	5.11	4.14	3.08	4.26	
Apr.	3.36	3.77	4.27	3.47	3.30	3.30	
May	4.53	4.30	4.50	4.00	3.60	4.00	
June							
July	4.73	4.55	4.44	3.60	3.30	4.20	3.30
Aug.	5.22	4.00	4.66	3.60	0.00	3.77	

TABLE V-B: PLANKTON IN POND B

Log of Total Numbers/Taxon

	Cyanophyta	Chlorophyta	Chrysophyta	Protozoa	Rotifera	Crustacea	Nematoda
Sept.	7.19	5.80	3.90	4.13	4.21	4.03	
Oct.	6.79	4.94	3.34	0.00	3.64	3.04	
Nov.	6.96	5.92	3.65	3.75	3.74	3.90	
Dec.	5.89	5.05	3.23	3.53	3.77	3.23	
Jan.	5.30	5.53	3.40	3.40	4.21	3.70	
Feb.	6.92	5.02	3.81	3.34	4.24	4.04	
Mar.	6.28	5.85	3.60	3.26	3.80	4.04	
Apr.	6.78	5.52	0.00	3.68	3.68	4.22	3.38
May	6.56	4.28	3.68	3.68	4.38	4.15	
June							
July	6.76	4.20	0.00	3.30	3.77	0.00	
Aug.	6.68	3.30	0.00	3.30	0.00	3.60	

Table V-C: PLANKTON IN POND C

Log of Total Numbers/Taxon

	Cyanophyta	Chlorophyta	Chrysophyta	Protozoa	Rotifera	Crustacea	Nematoda
Sept.	4.68	4.37	4.7	0	0	3.57	
Oct.	3.33	4.71	4.4	3.33	0	3.93	
Nov.	4.28	4.27	4.45	3.44	3.61	3.44	
Dec.	3.54	3.65	4	2.69	2.69	2.3	
Jan.	4.08	3.91	4.08	3.13		3.73	
Feb.	3.98	3.82	3.76	2.98	3.28	3.58	
Mar.	4.15	3.77	4.42	3.07	3.07	3.77	
Apr.	4.66	3.56	4.78	0	0	4.21	3.26
May	4.67	3.85	4.59	3.55	0	3.73	
June							
July	4.18	3.53	3.83	3.92	0	3.7	
Aug.	5.15	3.57	4.39	3.97	0	3.75	

TABLE VI-A

LIST OF GENERA OF PLANKTON IN POND A

Cyanophyta

Polycystis
Oscillatoria
Coelosphaerium
Rhaphidiopsis
Merismopedia
Chroococcus
Spirulina

Protozoa

Peridinium
Arcella
Vorticella
Difflugia
Actinophrys
Gonium
Phacus
Chilodonella
Foraminifera sp.
Pleodorina
Euplores
Pandorina

Rotifera

Keratella
Filina
Kellicottia

Chlorophyta

Dictyosphaenium
Pediastrum
Protococcus
Crucigenia
Botryococcus
Spirogyra
Microspora
Zygnema
Tribonema
Selenastrum
Scenedesmus
Desmidium
Hydrocera
Staurastrum
Cosmarium
Closterium
Tetmemorus
Penium

Crustacea

Cladocera
Ostracoda
Copepoda
Naupilus larva

Chrysophyta

Diatoma
Amphora
Synedra
Cymbella
Navicula
Frustulia
Anomoeoneis
Plagiotropis
Bacillaria
Nitzchia
Fragilaria
Cyclotella
Campylodiscus
Epithemia
Melosira
Gyrosigma
Meridion
Asterionella
Exuviaella
Stylonychia

Nematoda

TABLE VI-B

LIST OF GENERA OF PLANKTON IN POND B

Cyanophyta
- Polycystis
- Oscillatoria
- Coelosphaerium
- Rhaphidiopsis
- Chroococcus
- Merismopedia
- Spirulina

Chlorophyta
- Protococcus
- Staurastrum
- Dictyosphaerium
- Crucigenia
- Botryococcus
- Selenastrum
- Pediastrum
- Ankestrodesmus
- Spirogyra
- Evastrum

Chrysophyta
- Diatoma
- Cymbella
- Navicula
- Amphora
- Synedra
- Chaetocerus

Protozoa
- Arcella
- Difflugia

Rotifera
- Keretella
- Filina
- Rotaria

Crustacea
- Ostracoda
- Naupilus larva
- Copepoda

TABLE VI-C

LIST OF GENERA OF PLANKTON IN POND C

Cyanophyta
- Polycystis
- Oscillatoria
- Coelosphaerium
- Rhaphidiopsis
- Chroococcus

Chlorophyta
- Closterium
- Protococcus
- Staurastrum
- Pediastrum
- Cosmarium
- Botryococcus

Chrysophyta
- Navicula
- Plagiotropis
- Mastogloia
- Cymbella
- Navicula
- Bacillaria
- Fragillaria
- Licmophora
- Cyclotella
- Halodiscus
- Chaetocoros
- Amphora
- Nitzschia
- Tabellaria
- Anomoeoneis
- Pleurosigma

Protozoa
- Peridinium
- Arcella

Rotifera
- Keretella

Crustacea
- Naupilus larva
- Ostracoda
- Copepoda

TABLE VII: FUNGI

POND A	POND B	POND C
Cladosporium	Cladosporium	Alternaria
Altenaria	Alternaria	Cladosporium
Cephalosporium	Curvularia	Aspergillus terius
Fusarium	Drechslera	Cephalosporium
Drechslera	Nigrospora	Fusarium
Nigrospora	Penicillium	Nigrospora
Aspergillus	Pithomyces	Curvularia
Phoma	Eurotiales	Humicola
Currularia	Rhizopus	Phoma
Penicillium	Aspergillus	Ascochyta
Drechslera	Cephalosporium	Curvularia turberculata
Ascochyta	Epicoccum	Pithomyces
Macrophoma	Furarium	Stachybotrys
Didymosphaenia maritima	Pestalotia	Aspergillus
Leptosphaeria discors	Tetraploa	Drechslera
Leptosphaeria oraemaris	Didymosphaeria enalia	Epicoccum
Phoma	Leptosphaeria marina	Penicillium
Leptosphaeria australiensis	Phoma	Postalotia
Epicoccum	Pleospora	Bipolaris
Pithornyces	Stagnospora	
Eurotiales	Myrothecium	
Pestalotia	Trichoderma	
	Macrophoma	
	Nigrospora	
	Aspergillus tarias	
	Candelabrella	
	Phoma	
	Fusarium	

TABLE VIII: WEATHER DATA

Temperature in Centigrade: Rainfall in Inches

	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
Total Rainfall	1.81	0.11	0.80	0.49	0.68	1.63	5.93	2.08	1.37	0.87	1.26	0.22
Date Max.Rain	22-0.69	6-0.07	19-0.70	4-0.28	7-0.23	21-1.33	10231	27-1.76	8-0.80	12-0.56	25-0.37	10-0.13
Temp.Ave	80.6	73.4	69.1	48.8	59.5	64	66.6	72.1	77.8	83.1	83.5	82.4
Temp. Min.	58.0	20.0	46.0	13.0	37.0	45.0	44.0	54.0	50.0	71.0	72.0	73.0
Temp. Max.	97.0	96.0	93.0	81.0	73.0	82.0	78.0	84.0	91.0	98.0	92.0	96.0