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Fish Population Dynamics During the Establishment Phase of a Constructed Wetland

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Abstract

The Wetlands Park Nature Preserve in Clark County Nevada is a constructed wetland that is home to several species of fish. The purpose of this study is to report on the fluctuations of the fish populations during the first 20 months of monitoring at the Wetlands Park Nature Preserve. This thesis analyzes the fish monitoring data in order to assess the behavior of the fish population of the Wetlands Preserve. As the environment at the Wetland has changed during its initial establishment, so has the fish population. Using data collected during the monthly monitoring protocol from June 2001 to January of 2003, I will describe fluctuations in fish trap numbers in order to reveal behaviors in fish such as predator-prey relationships, species mating patterns, and the general behavior of the fish population at the WPNP. This research will be useful for WPNP managers and future authors, as there is very little information about the dynamics of fish populations in constructed wetlands in arid regions.

I. Introduction

The purpose of this study is to report on the fluctuations of the Wetland Park Nature Preserve (WPNP) fish populations during the initial 20 month establishment phase of the system. The Clark County Wetlands Park Nature Preserve is a 130 acre constructed wetland located in the west portion of the Clark County Wetlands Park (CCWP). The Preserve consists of a series of five ponds which receive water from urban runoff, flooding, and shallow groundwater sources (USBOR 1999). The Preserve is important for water quality treatment of non-point sources of pollution as well as a recreation site for the citizens of the Las Vegas Valley.

This study will provide information to Wetlands Park managers for use in managing the current fishery, developing plans for the stocking of native fish and for determining the extent of public use and recreation in the Nature Preserve, which may include fishing. Population information about the wetland fish can also be used in assessing current activity levels, predicting growth rates, predicting future populations trends, and for determining when to implement control measures (Dent, 1991). Information about the population dynamics of the existing fish in the ponds will also aid wetland managers in controlling the mosquito population, which may be growing with the creation of ponds. Because the Wetlands Park Nature Preserve is a recreational area, the control of the mosquito population is important, not only for nuisance reasons, but also to eliminate and control possible disease vectors. Although, *Gambusia* (mosquito fish) currently inhabit the ponds, managers of the Wetlands Park Nature Preserve, would prefer native fish species for the control of mosquitoes, as the *Gambusia* are an exotic, not native to the U.S. (USBOR, 1999). Previous studies have also shown that the wetlands are suitable for the survival of native Nevadan fish that may help to control the mosquito population (Pollard & Sheppe, 2001). In November of 2001, two native fish species were introduced to the ponds. This was also important in order to allow native fish to thrive in their native habitat in order to keep their populations at a sustainable level. The introduction of these native fish also helps to establish a diverse sustainable fishery that controls mosquitoes. In order to set-up a healthy ecosystem it is necessary for us to know the dynamics of the fish population at the Wetlands Park Nature Preserve.

This study is part of a larger study funded by the U.S. Bureau of Reclamation to monitor changes in the WPNP ecosystem and conduct public outreach activities. The overall study is being conducted by Jim Pollard of the UNLV Harry Reid Center and Krystyna Stave of the Environmental Studies Department at UNLV under agreements 1425-00-FG-0073 and 1425-00-FG-30-0074. This study will interpret fish monitoring data which has been collected starting in June of 2001. Information will be provided about the fish population growth patterns for each species and changes in total population and population dynamics over the initial two years after the ponds were constructed in January of 2001. Figure 2 shows how the Wetlands Park Nature Preserve has changed.

Figure 2:
View of the Upper Pond (north). The photo on the left was taken during the Winter of 2001 and the photo on the right was taken during the Spring of 2002

The Monson Channel inflow plus periodic overflow from the Las Vegas Wash during flood event, have allowed a variety of mature fish and their eggs to enter the Nature Preserve ponds (Pollard, 2001). Water enters the Nature Preserve at the Northwest corner via the Monson Channel and travels through the Upper Pond (North), through the Middle Ponds, and leaves the Nature Preserve through the Lower Pond (South) at the Southeast corner of the WPNP where water enters the Las Vegas Wash. Figure 1 shows the layout of the five ponds.

Figure 1- Map of Wetland Park Nature Preserve

A study done by the Bureau of Reclamation and Clark County Department of Parks and Recreation in December of 1998 identified the types of fish living in the Las Vegas Wash (USBOR ,1998). The results of this study also showed that many of the fish in the main wash channel are exotic species. Another study conducted by Jim Pollard with assistance from UNLV Environmental Studies students identified the different fish species of the Las Vegas Wash, their relative abundances, and health (Eguchi et al., 2001). The study also examined whether fish could be used for mosquito population control. A preliminary study has shown that the fish species that inhabit the Las Vegas Wash are the same species that inhabit the Wetlands Park Nature Preserve ponds (Elgin & Snyder, 2001 Not Published). Initial Monitoring of the fish population in The Wetland ponds in February of 2001 yielded no fish (Pollard, 2002). However, flooding that occurred late February of 2001 may have been the initial source of fish colonization which occurred when overflow from the Las Vegas Wash flooded the wetland ponds, bring fish and eggs into the system (Pollard & Sheppe, 2001). Monitoring since early 2001 has shown an established fish population. This report will analyze fluctuations in the population in the system for the 18 months for which the populations were monitored.

Jim Pollard, Valerie Sheppe, Krystyna Stave, John Hutchins and UNLV students conducted a preliminary fish survey of the Las Vegas Wash in the spring of 2001 (Pollard, 2001). Information from this study and knowledge about the composition of these fish populations led to the latter study which determined the species found in the Wetlands Park Nature Preserve. Initially, fish in the Nature Preserve included common carp (*Cyprinus carpio*), green sunfish (*Lepomis Cyanellus*), red shiner (*Cyprinella lutrensis*), mosquito fish (*Gambusia affinis*) and red swamp crawfish (*Procambarus Clarkii*) (Elgin & Snyder, 2001). In addition to these species, two native fish species, the desert sucker (*Catostomus clarki*) and the speckled dace (*Rhinichths osculus*), also inhabit the Wetlands via transplant in November of 2001.

The final results of this study will provide information about the fish populations and their dynamics at the WPNP. By graphing fish population data collected during the two years that the protocol has been implemented, we can examine how fish population numbers and characteristics have changed in relation to the development of the wetland ponds. We can also examine species interactions by comparing graphed data of individual species. I will examine research literature to determine fish characteristics.

In order understand the fish dynamics in the wetland ponds, we must answer a number of sub-questions. First, the individual characteristics of each species which inhabit the Wetlands must be studied. Species characteristics will help identify possible behaviors such as how the different species react to the traps used, as well as fish population characteristics concerning spawning, birth rates, lifespan, and schooling behavior. We must also determine how the numbers of the individual species population have changed over time. This information will show how individual species trends change over time, which can be compared to the population changes in other populations over time in order to give insight into how the different species are related. Additionally, to examine the fish population dynamics in correlation with the establishment of the Wetlands pond, fluctuations in trap data must be examined. Because there is very little information about fish development in constructed wetlands, this research will be useful in further studies at the WPNP as well as in future construction of wetlands.

Approach:

To understand the fish population dynamics, Jim Pollard of the UNLV Harry Reid Center for Environmental Studies designed a fish monitoring protocol that was implemented in June of 2001. Monitoring has been conducted monthly since then by student research assistants on the Wetland Park Nature Preserve Monitoring and Public Outreach project run by Krystyna Stave (Environmental Studies Department, University of Nevada Las Vegas). This study analyzes approximately the first 20 months of data collected.

Fish are monitored at each of the five wetland ponds at the Clark County Wetlands Park Nature Preserve. Fish are trapped for three consecutive nights per month at several locations in each pond. For each fish, total length, fork length, and weight are recorded. Internal biomarker analysis of some of the fish caught were also taken to determine the health of the fish. This report does not include biomarker data. It reports the dynamics of trap data. Edge (2002) defines *population dynamics* as the study of changes in the number of fish of different species in a population, and the factors that influence those changes. The populations include all of the species of fish in the wetland ponds.

II. Hypothesis

During the first two years since the creation of the wetlands the vegetation, soil, and overall activity at the wetlands has changed. Overall, I expected to find that the fish population had grown as the environment of the Wetlands had developed. Specifically, I expected to find that the fish population as a whole as well as each species has followed a pattern of rapid growth during this initial establishment period followed by a leveling out at a dynamic equilibrium. Further, I thought that a dynamic equilibrium would signify the completion of the establishment period at the WPNP.

I expected to find that the dynamics of different fish species were related. For example, the diet of juvenile green sunfish consists of small, water insects as the diet of adult green sunfish consists primarily of active invertebrates and small fish which includes *Gambusia* (Buchanan & Robinson, 1992). I expected graphed data to show a lagged oscillating population curve between *Gambusia* and green sunfish populations which would suggest a predator-prey relationship between the two species. Further, I expected that this will be seen primarily in the months following green sunfish mating events when the green sunfish are large enough to consume *Gambusia*. This is also based on my own observations which have shown that traps that yield high green sunfish numbers yield small *Gambusia* numbers. I assume that green sunfish are eating smaller *Gambusia* while the traps are submerged in the ponds. Based on preliminary analysis of fish trapping data, I also expected graphed data to show fluctuations that correspond with species mating patterns, depending on whether a particular species has seasonal or year long mating behaviors. Both *Gambusia* and green sunfish are highly adaptable and have both been shown to transform aquatic communities and crowd out native and lower populated species (Moyle, 1976); (Page & Burr, 1991); (Hawaii Biological Survey,2002). I predicted that green sunfish and *Gambusia* numbers would be much larger than the Red Shiner numbers. It appears that red shiners are not as adaptable or competitive as green sunfish and *Gambusia*.

Some species of fish, such as *Gambusia* and Red shiners, gather in schools for protection and I expect that monthly trap numbers in one pond may be high as trap numbers in another pond may be small. Because Green sunfish are aggressively territorial, I expect that their trap numbers may be evenly distributed throughout the ponds (Moyle, 1976).

Assumptions:

One of the key assumptions in this report is that the fluctuations in the dynamics of trap data are similar to the fluctuations in the fish populations as a whole. Outside influences, such as weather, water quality and plant density are not taken into account when analyzing the collected data. This report also assumes that the ponds at the Wetlands Park Nature Preserve are not abnormal as far as chemical content that may cause mutations in individual fish, their behavior, or their populations. It is assumed that the different fish species are all equally attracted to the traps. Also, fish that are too large to fit into the traps, larger than 3-4 inches from the base of the dorsal fin to the base of the caudal fin, are not represented in the data. The presence of any large predators that may severely or significantly affect the populations of the fish or their population dynamics will not be accounted for or explored in this report. Although Red Swamp Crayfish are found in the wetland ponds, their populations were also not accounted for in the data analysis nor will their predatory impact on the fish in the traps be examined.

Field Data Collection:

I analyzed data collected at the Wetlands Park Nature Preserve over the period from June 2001 to January 2003. The data was collected using procedures outlined in "Fish Sampling and Processing Protocol" (Snyder, 2002) (see Appendix A). Each month for three consecutive nights, minnow traps were set for 12 hour increments. Each night one pond system was set with traps. The ponds systems include the Upper (north) pond, the middle ponds, and the Lower (south) pond. Fifteen traps were set at each site for each night. The next morning, traps were pulled and fish were counted for each individual trap, and recorded. Fish were then released back into the pond and the traps were set at the next site. All data collected during trappings has been recorded on data sheets (Appendix B) as well as in Microsoft Excel (Appendix C). Although there are five ponds in the Wetlands Park Nature Preserve, the three middle ponds are treated as one pond system and are referred to as the middle ponds. The Northern pond is shown on maps as NP-1 and will be referred to as the Upper pond. The Middle ponds are shown on maps as NP-3, NP-4, and NP-5 and are all considered one pond system. These ponds will be referred to as the Middle ponds. The Southern pond is seen on maps as NP-8 and will be referred to as the Lower pond.

For the purposes of this study, I examined only the data that pertain to the number of fish caught during trapping events for each month. I was also only concerned with the number of fish caught at each pond and their relative species. Populations of native fish species, the desert sucker and speckled dace, will not be examined; however, their numbers will be included in the summary of the total fish population. In addition to total numbers of fish, I also graphed Green sunfish, *Gambusia*, and Red Shiner trap data separately.

III. Methods

To compare population characteristics of the different species at the Wetlands ponds, I graphed the data in Microsoft Excel for multiple parameters over the 18 month record of data. Additionally, each pond system is monitored one night per month, with a total of three nights per month for the monitoring of all the ponds. Multiple graphs were created and included total fish catch for all ponds, individual fish species catch for all ponds, total fish catch per pond and individual fish species catch per pond. I compared the graphs to see if there were any connections or correlations between the populations of the separate fish species or total populations of fish in each of the ponds.

Secondary sources including previous literature and research pertaining to the subject, will be used to explain the relationships between the behavior of the graphs and the behavior of the fish and their populations and answer any questions about fish behavioral characteristics that may explain their population behaviors seen in the graphs. Any relationships or characteristics identified from the graphs were then examined further to explain why they are occurring and to identify any questions for further research concerning the fish population.

IV. Results

Data from the first 18 months of monthly trap data are summarized in the figures below. Overall, populations show a distinct pattern with high populations from August through January and low populations from January through May. All ponds show similar behaviors in species, but with significant differences.

Figure 3 shows the monthly fluctuations in the total fish population, which includes all fish species and all ponds. Each point on the graph represents the total number of fish caught at all three pond systems for each three-night trapping event per month.

Figure 3

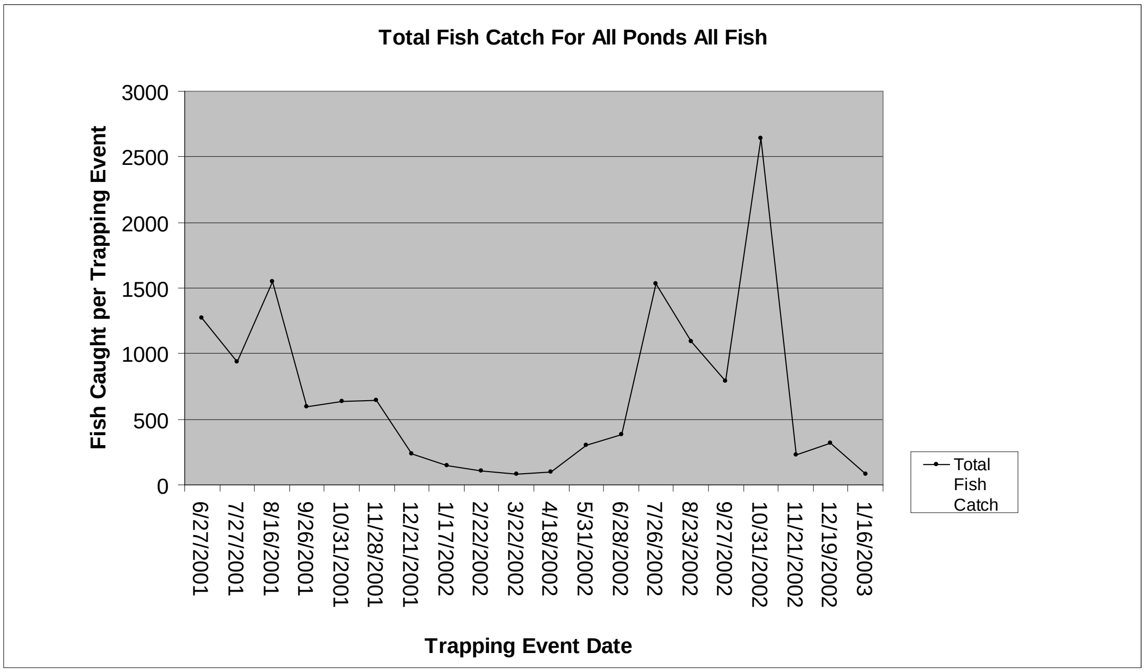


Figure 4 shows monthly fluctuations in the total fish population, separated by pond system. The total fish caught includes all fish caught during the trap night for each pond.

Figure 4

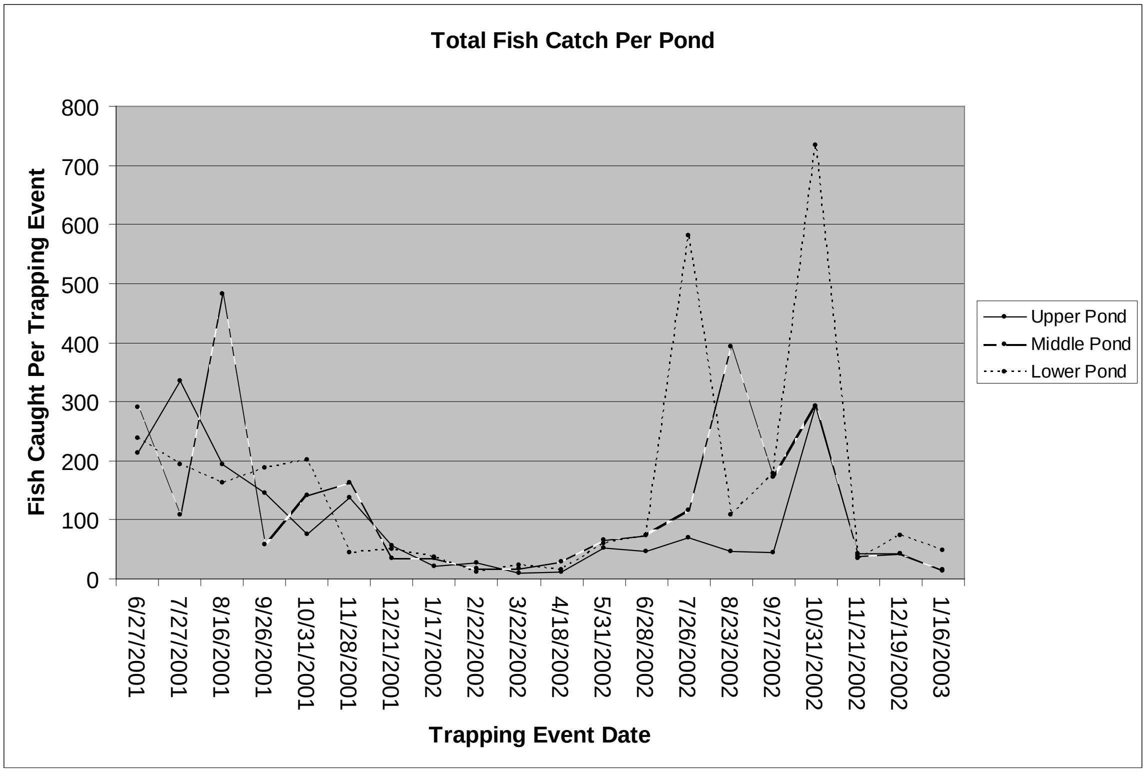


Figure 5 illustrates the fish population fluctuations per month separated by species. Each graph line shows the total number of fish caught for a given species for all ponds combined.

Figure 5

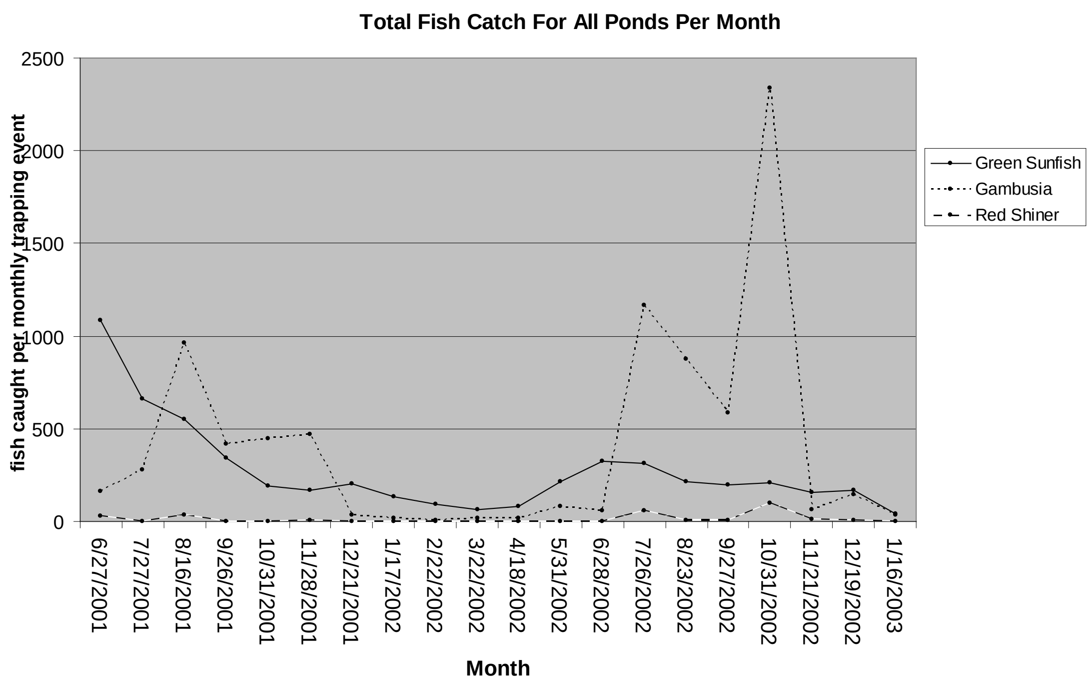
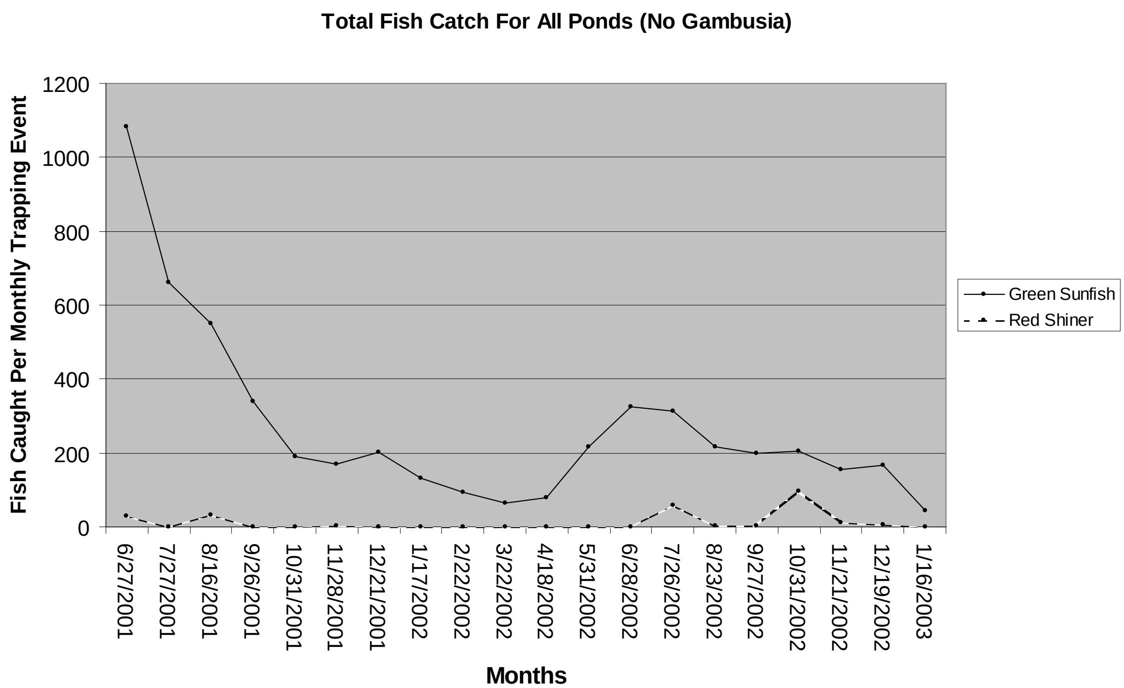


Figure 6 is the same graph as figure 5 without the Gambusia data in order to get a better representation of the Green sunfish patterns.

Figure 6



Figures 7, 8 and 9 show the monthly fluctuations of each of the three fish species separately by pond.

Figure 7

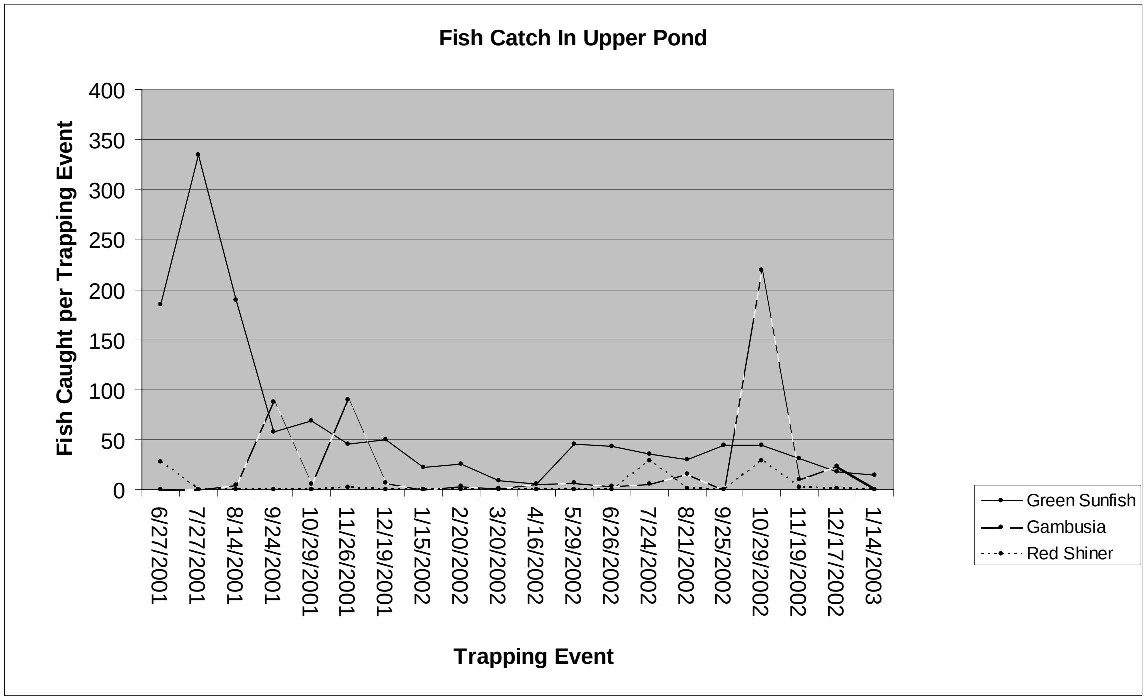


Figure 8

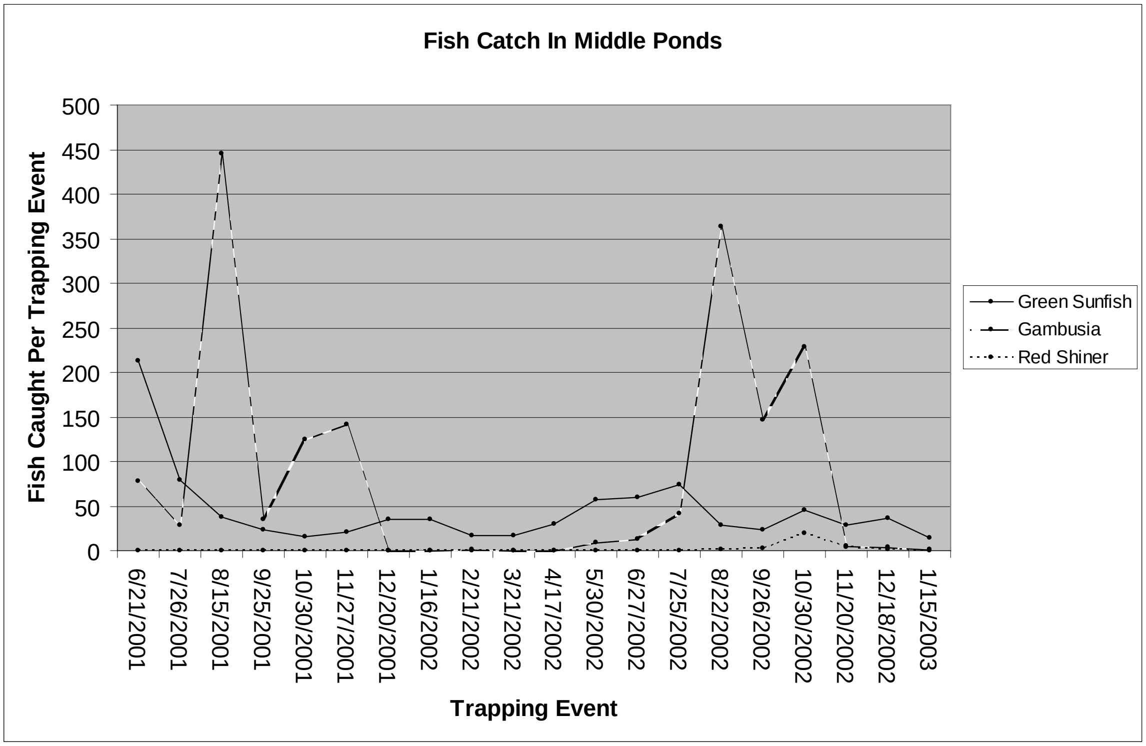
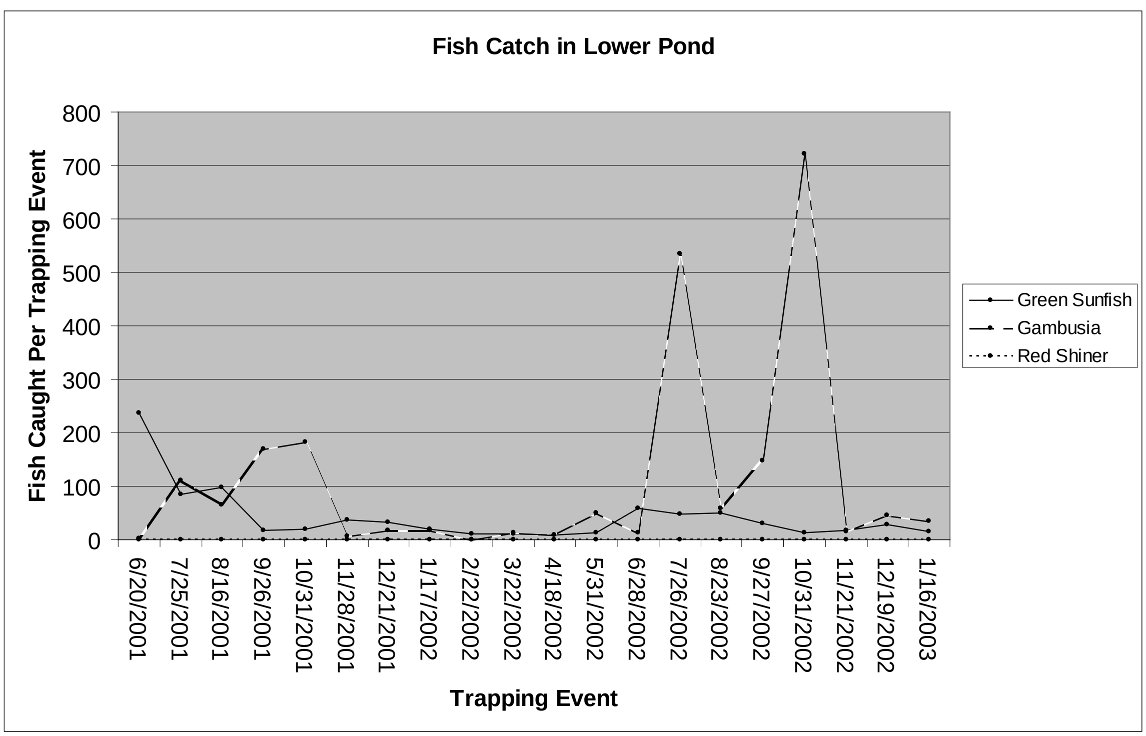


Figure 9



V. Discussion

The results show that the total fish population has a definite seasonal fluctuation. As shown in Figure 3, the total fish population peaks from August through December, where it reaches the lowest points of the year from December through August and then rises again through November and sharply drops again. Figure 5 shows that *Gambusia* have the most distinct seasonal pattern which peaks from August to December and is apparent both in 2001 and 2002. The distinct peaks of *Gambusia* are also shown clearly in Figures 7, 8, and 9.

The green sunfish population shows a different pattern. The population starts at a high value in the beginning of the data record and falls steadily over the 20 month period. The green sunfish population may be approaching a dynamic equilibrium which could signify the end of an establishment period in their population. Figure 6 indicates that after an initial decline during the first month of trapping, their trap numbers begin to stabilize with minor monthly fluctuations. The high numbers of Green sunfish during the first few months of trapping may be attributed to the lack of constraints, such as competition for food and space. However, as the populations of fish in the wetland ponds began to compete and meet limitations in the system, the numbers of Green sunfish may have dropped and leveled out at a sustainable level. There is little to say about the population of Red shiners as the numbers trapped are so low that no patterns or behaviors are visible.

The graphs show that the WPNP is starting to show signs of consistency. This may mean that the system is approaching a dynamic equilibrium. Graphs showing the monthly fluctuations of the fish populations do not show a clearly reoccurring pattern in the fish trap numbers, and as such is contrary to my hypothesis. However, the results shown in the graphs illustrate the beginning of seasonal fluctuations in total fish numbers for the pond systems.

Seasonal fluctuations in fish can also be due to species mating patterns. I expected that graphed trap data would reflect the mating patterns of the individual species. Figures 7, 8, and 9 show the individual species monthly fluctuations for each of the three pond systems. *Gambusia* have a mating season that can range from April through September (Baird & Girard, 2003a) and according to Figures 7, 8, and 9, *Gambusia* numbers *Gambusia* numbers are very low in April and gradually grow until the number reach their peak in August to September, before the numbers drop. *Gambusia* also have a 21-28 day gestation period and then give live birth (Baird & Girard, 2003b). This suggests that trap numbers will show an increase in *Gambusia* numbers one month after the start of their mating season until one month after the end of their mating season. Although there may be alternative explanation for these fluctuations, *Gambusia* in the Wetlands Park Nature Preserve system appear to have mating cycles mainly between June and September, based on the fluctuations shown in Figure 5, which includes trap numbers for each species for all ponds. Green sunfish have a mating cycle in the Colorado region which starts in June and continues through mid-August. Once eggs are laid juvenile fish spend 15-20 days incubating, hatching, and swimming up the water column (University California Berkley, 2003). The Green sunfish in the Wetland Park show a slight increase in numbers in April which continues through July, where the numbers gradually begin to decline, as shown in Figure 5. These fluctuations suggest that the population of Green sunfish at the Wetlands Park Nature Preserve may have slightly different mating patterns than Green sunfish in Colorado. Further analysis of temperature differences may reveal more information about the mating patterns of Green sunfish, as they typically flourish between 20 and 28 degrees Celsius (University of California Berkley).The Red Shiner population at the Wetland Park is very small according to trap data, as shown in Figures 7, 8, 9, and 5, and as such there is little information that can be derived from this data. Baird and Girard state that the Red Shiner mating season is in June and July (Baird & Girard, 2003b). Trap data shows that Red Shiner numbers are so low, that they are not shown on graphs during some months or not at all as shown in Figure 9, where no Red shiners were caught at all. A caveat concerning the Red Shiner is the idea that the species may not enter the trap or may be eaten once in the trap. Hence, trap data may not reflect the population accurately. Figure 5 shows the highest numbers of Red shiners were caught in July and September of 2001 and August and November of 2002. Red shiners were not evenly distributed in traps during these months, but large numbers of Red shiners were caught in one trap or only in one pond system. Graphs may not necessarily show the mating pattern of the species, although months where their numbers are high are similar to the mating season of Red shiners Colorado region. Based on the trap data to this point, the monthly fluctuation of the Red shiners, as shown in the graphs, do not show the species mating season due to the small number of fish caught.

The low trap numbers of Red shiners in the Nature Preserve addresses another hypothesis concerning the adaptability and competitiveness of fish in the pond system. The abundance of Green sunfish and *Gambusia* as compared to the abundance of Red Shiner followed expected trends. Literature shows that both *Gambusia* and Green sunfish are highly adaptive and competitive for resources. I was unable to find any research which showed the same for Red shiners and there was not anything in the data that led to any conclusions concerning the red shiner population.

Figures 7, 8, and 9 show the monthly fluctuation of each fish species per pond system and illustrate how the individual species are distributed throughout the three pond systems. Although these graphs do not support my hypothesis which stated that these graphs would show schooling behavior of different species compared to others, it does show that Red shiners are much less abundant in the lower pond than in the upper and middle ponds.

Other possible reasons for seasonal changes aside from mating behavior may be predator prey relationships. In order to address the hypothesis stating that graphs will show a predator prey relationship between Green sunfish and *Gambusia*, figures 7, 8, 9, and 5 must be examined. Figures 7, 8, and 9 show the monthly fluctuation of individual species in the upper, middle and lower ponds respectively. I expected that green sunfish numbers would be high in the months following mating when juveniles would grow large enough to consume *Gambusia*. The *Gambusia* numbers would need to show a decline during the time that Green sunfish numbers are high in order to support the predator prey hypothesis. Figure 5, which shows trap numbers for each species for all ponds, shows that Green sunfish numbers increase in May 2002 and continue to increase until July 2002 when they start to decline. *Gambusia* numbers during this time frame increase rapidly from June 2002 to July 2002, when they drop sharply from July to October 2002. This supports the hypothesis that when Green sunfish are large enough to consume *Gambusia*, the *Gambusia* population will decline. However, from October 2002 to November 2002, *Gambusia* numbers increase and then drop sharply again from November 2002 to December 2002. Green sunfish numbers continue to gradually decrease during this time. Previous studies show that juvenile and adult *Gambusia* number decline drastically in the late fall due to lack of food and unfavorable temperature (Baird & Girard, 2003a). Therefore, perhaps the *Gambusia* numbers are declining due to factors other than the predatory behavior of Green sunfish. Baird and Girard (2003a) suggest that *Gambusia* embryos, carried by the female, require a much longer development time during colder months. Perhaps the temperature in September is cold enough to cause the longer gestation period in *Gambusia* causing an increase in the *Gambusia* in October. The increase in *Gambusia* numbers may then be offset by the number of *Gambusia*, which start to decrease in November and may have to forage for available food which causes *Gambusia* numbers to drop sharply in December. I have not found literature that supports this as the explanation for the behavior of the two species. Fluctuations shown in Figures 7, 8, and 9 show about the same behavior as shown in Figure 5.

Conclusion

Although graphed data shows fluctuations that may be evidence of species mating patterns and predator-prey relationships, I have not found literature that supports that these are the only explanations for these fluctuations nor have I found concrete evidence there are other factors affecting these fluctuations. Further, I have not been able to define the relationship between the abundance of fish caught in traps and the population of fish in the Wetland Park Nature Preserve. As such, these numbers do not lead to definitive conclusions about the exact behaviors of the fish in the ponds. It is unclear why the fish populations are different in different ponds. Although the fish population numbers in the separate ponds are similar, it is unclear why there are differences in the abundance of red shiners or why there are drops in one species in one pond and not in anther for the same month. These results do show the general behavior patterns of the fish in the ponds, including when they mate and their relative abundances as compared with each other. These findings also show that the fish population in the ponds is developing and has yet to show concrete patterns in fish population behavior. It is reasonable to use these results to evaluate trends in the fish population and compare future trends to the behavior of the fish during the establishment phase of the wetlands.

Based on correlations documented by Baird and Girard (2003a) between water temperature and fish behavior, I suggest further research be conducted into the temperature of the ponds in correlation with the effects temperature has on fish, their habitat, and their food supply. Also, to better determine the exact numbers of fish in the separate ponds as well as the effect that fish travel has on the trap numbers, mark and recapture studies should be conducted. To further support the hypothesis concerning the predator-prey relationship between green sunfish and *Gambusia*, I recommend that the weights and lengths of the fish should be analyzed in order to look for patterns in the size of green sunfish when *Gambusia* populations are low. Monitoring of the fish at the Preserve should continue in order to see more repeatable patterns in the behavior of the fish population as the fish in the ponds become established in their environment and exhibit concrete predictable behavior. A longer data record graphed over many years which showed repeating patterns and trends would be stronger support for the hypotheses in this report.

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Appendices

Apendix A

FISH SAMPLING AND PROCESSING PROTOCOL

2/02 by Erika Snyder

Purpose

The purpose of this protocol is to establish the requirements for monitoring and processing fish at the Wetlands Park Nature Preserve (WPNP). This is done under Jim Pollard and Dr. Stave's grants received through the Department of Wildlife, Clark County Parks and Recreation, and Bureau of Reclamation.

MATERIALS AND METHODS

<u>Setting Fish Traps</u>

The following materials are needed for each setting of fish traps, not including gill nets:

15 metal traps

Data sheets with maps of each pond and designated areas for data collection (see Appendix)

Gloves for each participant

Rope for trap anchoring

Clipboard

Writing utensils, 1-*Sharpie* marker, 1-ink pen

One pair of waders

Head lamp or flashlight, if dark outside

Harry Reid Center (HRC) building card and lab key (if needed)

University vehicle keys (if needed)

HRC building card and exposure lab keys must be checked-out from the Environmental Studies Lab at the White Hall Trailer #6. Sign this card out with your name and time out. In preparation for setting fish traps at the WPNP gather all materials and participants needed. If university vehicle is being used, acquire its keys from the HRC exposure/research lab on the 4th floor. Ensure that driver has permission to drive and has turned in a copy of their driver's license to the HRC. Load vehicle and return HRC card to the Environmental Studies Lab. Sign the keys back in.

Travel to the WPNP. Determine pond to be set and its location on map. Refer back to locations of previously set traps and approximate where to put the 15 traps. Take the time to find a trap location that is not easily visible, but not impossible to find if someone else will be collecting the traps the next day. The maps that we have are aerial views of the ponds as they existed in February 2000. Make sure that you identify and mark with a dot and a trap number (1-15) on the map where you have set the trap. It should be easy enough for one of us with the map to find the trap, but not so easy that someone walking by will take notice and investigate. The traps should also be set in favorable fish habitat. Out in the open water with no kind of coverage is not favorable fish habitat. Set the traps in the covered area of the reeds or under some type of vegetation providing shelter to the fish. Fish can also hide in and around rocks. Another good location is an inflow or outflow nestled in the rocks.

Each participant must put on gloves and they must remain on the entire time in the field. Insure that knots are tight on each trap and each trap is closed properly. Set trap by holding the loose end of the rope and gently tossing the metal trap into the pond along the edge. If the trap does not end up in favorable fishing habitat after the first deployment attempt, move or reset it. Maintain a tight grip on the rope and tie the end to a secure object such as a rock, bush, or tree.

Gather all materials and load into vehicle. Ensure map is included with clipboard. Upon returning to UNLV Harry Reid Center, park university vehicle in front of the HRC north doors (not blocking the Marjorie Barrick Museum of Natural History entry or the CAT bus drop-off). Remove all materials from the bed of the truck, either placing them into the truck cab or the lab. If this is not the last day of trapping for the week, materials can be left in the backseat of the truck. If this is the last day of trapping, take the materials up to the exposure lab, make sure that they are clean enough to put away, and put them back in their proper location. Lock the truck. Keys must be returned to the student research desk drawer.

<u>Collecting Fish Traps</u>

The following materials are needed for collecting of fish traps at the WPNP, not including gill nets:

1 cooler, should be small enough to carry while collecting traps

About 4 lbs of dry ice for freezing specimens

15 metal traps, previously set the day before

2 dip nets

Data sheets with maps of each pond and designated areas for data collection

Gloves for each participant

Clipboard

Writing, utensils 1-Sharpie, 1-ink pen

One pair of waders

Head lamp or flashlight, if dark

Freezer-quality, resealable sandwich/snack bags; *Ziploc* bags: snack size and pint or quart size

Two buckets

If releasing fish back into the pond, you must also have a measuring board and scales along with data sheets for recording lengths/weights in the field

Before leaving for the park, make sure that everyone is dressed appropriately for the weather and has adequate water. With crew and materials, travel to the WPNP. When driving in the WPNP, be courteous to others using the park and to the ground you are driving on. Do not create your own trails and roads, and drive slowly. Lock the vehicle whenever you are away from it.

Refer back to the map of the traps set out the day before. Complete the data sheets in legible handwriting. Divide the tasks of collecting traps and recording data between the participants. While wearing gloves, the individual responsible for collecting the trap will untie the trap and bring it in from the water. The data recorder will be labeling a resealable bag. The number and size of the fish will determine the size of the bag used. With a *Sharpie* marker print clearly on the bag; the date, the pond location (NP_2, NP_3, NP_4, NP_5, or NP_8), and the trap number (refer to the map and the numbers given to the trap the day before). If the catch from the trap exceeds 10 fish from different species, dip one of the buckets into the pond and fill half-way with water. Empty the catch into the bucket to be counted. If the catch does not exceed 10 or the 10 fish are all from the same species, and the fish will not be out of the water for an inhumane amount of time (no more than five minutes), take the fish from the trap and while counting them, place them in the appropriately-labeled resealable bag. Now the fish should be placed in the cooler on the dry ice. Repeat this at each trap location, returning the trap to truck after each has been identified. Also, if any other creature, such as an aquatic insect, is located in the trap, place it in its individually labeled resealable bag and then on ice to be brought back to the lab for identification.

When completed with this site, move on to the next pond starting over with the trap setting. If this is the last day of setting traps, ensure that the 15 metal traps are free from excess debris or algae by cleaning/dipping them in a shallow area of the pond- some place you can kneel down next to the water and clean the traps. Survey the pond and its surrounding area, make sure that it looks just as good as or better than when you came. Do not leave a mess. Take an inventory of what you came with and what you have. If everything is correct, head back to campus. If for some reason you have lost a trap let someone at the WPNP information trailer or one of the Clark County Parks and Recreation workers know. They might find it and return it to us.

If this is not the last day of trapping for the week, materials can be left in the backseat of the truck. If this is the last day of trapping, take the materials up to the exposure lab, ensure that they are clean enough to put away, and put them back in their proper location. Lock the truck. Keys must be returned to the student research desk drawer.

Processing Fish Samples

The following materials are needed for processing the fish while inside the lab:

Dead fish; either thawed from the freezer or just brought in from the field

White measuring board

Scale, sensitive to the nearest 100^{th} of a gram for small fish, and to the nearest gram for large fish (weight over 200 grams)

Fitting latex gloves

Surgical scissors

Three small, lightweight, plastic dishes

Paper towels

Plastic container large enough to hold the day's catch

Freezer-quality, resealable bags, snack size and gallon or larger size

Data sheets from the setting/collecting effort as well as the fish processing data sheets (see Appendix)

Writing utensils, 1-*Sharpie* marker and 1-ink pen

Rolling, metal, NDOW cart

In preparation for the mess that will inevitably be created by the processing of the fish, lay down on the top shelf of the cart, three sheets of paper towels. For best coverage, make sure that the sheets are the same length as the shelf. Place the scale in the upper left-hand corner of the shelf. Turn the scale to on. Wait until it reads "0.00". Weigh the 200 gram standard weight and record as quality control, see the directions on the bottom of the scale. Set one of the lightweight plastic dishes on top of the scale and wait until it gives its final read, arrow will appear in bottom right-hand corner of screen of the scale. Push the “Tare” button to get a “0.00” reading while the dish is on top of the scale (this allows you to place the fish into the dish and not just on top of the scale). Place the measuring board at the base of the shelf, closest to you. Make sure that the board is placed so that the cm/mm side is the easiest to read. Place the other two lightweight, plastic dishes next to the scale.

Find a pair of latex gloves that fit your hands and put them on. Place the small, resealable bags of fish in the larger plastic container. Place them in numerical order (trap #1 first, all the way to trap #15 last). This allows you to work on each bag in order.

The data sheet to be used should be on the “Fish” clipboard and on the top shelf with all of the other instruments. If working alone, it is recommended that the data sheet be set off to the right at the end of the measuring board, as to not be in the way but to be close enough to record the information easily and accurately. If two people are processing fish, divide the tasks between cutting/weighing and data recording.

To begin, take the first bag of fish from the plastic container and dump the contents, the fish, onto one of the lightweight, plastic dishes. This dish should have a slight layer of water on the bottom. This ensures that the fish’s skin will not get stuck to the dry dish and keeps the fish from dehydrating. One at a time, take each fish, place them on the measuring board, mouth of fish on the zero reading and against the side of the board. By reading the millimeter measurements, find the total length of the fish (from mouth to end of tail) and find the fork length of the fish (from mouth to indentation of fork). Record both pieces of information in the corresponding places on the data sheets. Pick the fish up and set it in the scale. The final reading should be stable which is indicated by the arrow at the bottom right-hand side of the screen on the scale; record the weight on the data sheet. If at any time the scale appears empty but is not reading “0.00”, push the “Tare” button and wait for that reading to appear. Take note of any physical abnormalities that might be present on the fish. Finally, place the fish back into the resealable bag or place it in the empty, moistened, lightweight, third plastic dish. Proceed in the same manner with the other fish and the other bags. This process applies to both larger and smaller fish species.

Sex Identification Process

If the fish weighs over six grams, it may be possible to identify the sex of the fish. Insert the sharpened end of the scissors into the circular anal opening of the fish. This is found at the base of its pectoral fins. With gentle, upward strokes, cut the underbelly of the fish open. While cutting, go around and not in between the pectoral fins. The cut should extend up to the base of the mouth of the fish. With your fingers open the incision and look inside, just below where you began to cut. The gonads are located on the upper back of the body cavity and are attached to the anal vents. If it is a female, two egg sacs will be evident. If it is a male, the testes will be creamy-white in color, long and almost triangular in shape, and are generally as big as the egg sacs. During the winter or non-breeding season the males’ testes will be smaller and similar in shape as to what was described before, but will be almost translucent with a reddish color indicative of vascular activity. If the gonads are too small to be identified and the fish is small, less than 10 grams, the fish’s sex can be labeled as "immature". If the gonads are hard to identify and the fish is larger, more than 10 grams, the fish's sex can be labeled as "unidentifiable".

Biomarker Analysis Methods

When a fish is over 20 grams a biomarker study is done on them. The information is recorded on the back of the laboratory processing data sheet. The information recorded is the eviscerated weight of the fish, the gut weight, the gut content and weight, the liver weight, and the gonad weight. Once again, all weights are recorded in hundredths of a gram. This is done beginning in the same manner as determining the sex of the fish. After making a clean cut up the underbelly of the fish, open the incision up with your fingers. Locate the liver and heart and cut in between them, careful not to cut the liver. The incision is made just below the heart and will sever the esophagus. This cut should allow for the organs and insides of the fish to loosen. To loosen even more and eventually detach this, gently snip away the sinewy fibers holding the internal organs of the fish to the interior of the body cavity. The internal organs should pull away from the inside of the body cavity towards the bottom of the fish. If the gonads do not come out with the initial internal organs removal they can be removed separately. With the organs in your hand, cut the liver away from the rest of the body. DO NOT cut the liver itself, but cut the fiber that holds it to the rest of the organs. Take note and record any anomalies found on any organ. Weigh the liver and place it in a clean, snack-size bag. Next cut open the stomach and remove onto the scale any contents from the stomach. Identify and record this data. With an empty gut and the rest of the fish's insides, weigh and record the information. Then place the guts into the same bag as the liver. Carefully remove the gonads from the fish. DO NOT cut the gonads, especially egg sacs.

Weigh the gonads and record the data. Then place them into the bag as well. Finally, place the eviscerated carcass of the fish onto the scale and record the eviscerated weight of the fish. Place the fish into an individual, snack-size bag. This bag should be labeled with the *Sharpie* with the date the fish was collected, the trap site, and the trap number, and the fish identification number (this is found on the data sheet). The corresponding bag of organs should be sealed and then placed inside the fish's individual bag. This bag will then go into the larger bag for the site it was located in. Seal all bags leaving little or no air in them. The air makes the bags bulkier than is needed and takes up unnecessary room in the freezer.

Final Processing Steps

When finished with one day's catch, place the larger bag in the freezer, trying to keep some chronological semblance of order. The cleanup is accomplished by washing everything that the fish have touched. Place washable items in the sink and wash thoroughly with soap and water. The scale and the cart you can be wiped down with soapy paper towels. After everything is clean, dry it all and return it to its proper location.

Data Handling

The data entry portion of the fish processing is done in the exposure lab at the computer on the S drive under "fish". It is all done in Excel and is simple to follow. Just enter the correct information taken from the data sheets recorded in the field and in the lab and apply them to the corresponding fields. Each month's data should be separate. Eventually, each species of fish is separated also. Any kind of graphing of data or data analysis should be done under the supervision of Jim Pollard.

Appendix B- Field Data Sheets

Nature Preserve Fisheries Data Sheet

Begin Date:__________ Begin Time: ___________ Crew Names____________________________
End Date:____________ End Time: _____________ Dissolved O^2/Temp.____________________
Weather:____________________________________ Sp. Cond / pH_________________________
Description of Activities:____
____
____

Middle Ponds Sites = NP_3,4&5

Nature Preserve Fisheries Data Sheet

Begin Date:__________ Begin Time: ___________ Crew Names____________________________
End Date:____________ End Time: _____________ Dissolved O^2/Temp.____________________
Weather:_____________________________________ Sp. Cond / pH__________________________
Description of Activities:____
____
____

Upper Pond Site = NP_2

Appendix C- Data in Excel Format

Date	Pond	Trap	Green sunfish	Gambusia	Crayfish	Red Shiner	Desert Sucker	Sp. Dace	All fish total per pond
7/25/2001	NP_8	1	0	0	0	0	0	0	
7/25/2001	NP_8	2	4				0	0	
7/25/2001	NP_8	3	1	46			0	0	
7/25/2001	NP_8	4	13	26			0	0	
7/25/2001	NP_8	5	19				0	0	
7/25/2001	NP_8	6	4				0	0	
7/25/2001	NP_8	7	4				0	0	
7/25/2001	NP_8	8	5				0	0	
7/25/2001	NP_8	9	6				0	0	
7/25/2001	NP_8	10	10				0	0	
7/25/2001	NP_8	11	5	7			0	0	
7/25/2001	NP_8	12	3	8			0	0	
7/25/2001	NP_8	13	7	2			0	0	
7/25/2001	NP_8	14	1	16			0	0	
7/25/2001	NP_8	15	2	5			0	0	
total for NP_8			84	110	0	0			194
7/26/2001	NP_3	1		1			0	0	
7/26/2001	NP_3	2	5				0	0	
7/26/2001	NP_3	3	17				0	0	
7/26/2001	NP_3	4	2				0	0	
7/26/2001	NP_3	5	0	0	0	0	0	0	
7/26/2001	NP_4	6	7	1			0	0	
7/26/2001	NP_4	7	3	3			0	0	
7/26/2001	NP_4	8					0	0	
7/26/2001	NP_4	9	3				0	0	
7/26/2001	NP_4	10		3			0	0	
7/26/2001	NP_5	11	6				0	0	

7/26/2001	NP_5	12	1				0	0	
7/26/2001	NP_5	13	13	8			0	0	
7/26/2001	NP_5	14	10				0	0	
7/26/2001	NP_5	15	12	13			0	0	
total for NP_3,4,5			79	29	0	0			108
7/27/2001	NP_2	1	18				0	0	
7/27/2001	NP_2	2	14		1		0	0	
7/27/2001	NP_2	3	22				0	0	
7/27/2001	NP_2	4	20		1		0	0	
7/27/2001	NP_2	5	3				0	0	
7/27/2001	NP_2	6	17		1		0	0	
7/27/2001	NP_2	7	2		1		0	0	
7/27/2001	NP_2	8	24				0	0	
7/27/2001	NP_2	9	4		1		0	0	
7/27/2001	NP_2	10	51				0	0	
7/27/2001	NP_2	11	2				0	0	
7/27/2001	NP_2	12	50				0	0	
7/27/2001	NP_2	13	61				0	0	
7/27/2001	NP_2	14	4				0	0	
7/27/2001	NP_2	15	43				0	0	
total for NP_2			335	0	5	0			340
TOTAL			661	278	5	0	0	0	944