Final Project Report

TITLE: Introduced Fishes in Short-Hydroperiod Wetlands: Evaluation of Sampling, Status, and Potential Effects

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EXECUTIVE SUMMARY

Hydrological changes resulting from canal and levee construction in South Florida have been implicated in the broad-scale decline of the Everglades ecosystem. In particular, the Rocky Glades region in eastern Everglades National Park (Figure 1) has been adversely affected by water diversions. Outside the park, this habitat has been converted to agricultural and urban land uses. However, inside the Park, the geologic structure of the habitat remains intact. Its highly eroded landscape was thought to offer dry-season refuge to aquatic animals in groundwater within solution holes (Loftus et al. 1992, Kobza et al. 2004). This report presents the results of a three-year study focusing on the environment of Rocky Glades habitats, use of these habitats by fishes and aquatic macro-invertebrates, and effects of introduced fishes on native fauna within this region. Several questions led to the development of this ambitious study. These included:

- How do hydrological and physico-chemical parameters differ between study habitats?
- How does composition, recruitment, and size-structure of aquatic animals change during the flooded period?
- What sampling biases may be associated with the drift-fence array/ minnow trap method on the marsh surface?
- Are there diel patterns to fish catches on the marsh surface?
- How do fish communities vary in solution holes throughout the dry season?
- What factors contribute to changes in species compositions in solution holes?
- What sampling biases may be associated with using minnow traps in solution holes?
- What is the seasonal diet of the non-indigenous African jewelfish (*Hemichromis letourneuxi*) in the Rocky Glades?
- What are the potential effects of the recently introduced African jewelfish on native fishes?

This project is a continuation of work we began in 2000. Our former project focused on describing the ecology and ichthyofauna of the Rocky Glades region. The current study expands on information we gathered through our previous work, particularly with respect to introduced fishes in the Rocky Glades. This project combines field monitoring with implementation of controlled experiments to identify impacts of introduced species on native fishes in the Rocky Glades. In the first year, we conducted monthly monitoring of fish communities on the marsh surface. Upon dry-down of the marsh, we monitored fish communities in solution holes during the dry-season of 2004-05. In the second and third years (2005 – August 2006), we conducted experiments to learn about the survival of native and introduced fishes in solution holes, efficiency of minnow traps in solution hole and surface water environments, nesting behaviors of

native fishes in the presence of introduced competitors, prey selectivity by introduced predators, and anti-predator behaviors by native fishes. We also continued monitoring the drift-fence arrays, both exhaustively during the first two weeks of marsh flooding and than monthly for the duration of the flooded period. In addition to regular array sampling, we performed a 24-hour catch survey to investigate diel patterns in fish movements on the marsh surface. We collected quarterly samples of *H. letourneuxi* for gut content analysis so we could document the prey preferences of that species in Rocky Glades marshes. Lastly, we continued monitoring water quality (pH, dissolved oxygen, specific conductance, and water temperature) in surface water and solution-hole environments.

This study continued the inventory of the aquatic animals in the Rocky Glades and provided a baseline dataset for the wetland surface and solution holes that will be useful for comparison with future monitoring data during restoration of this region. It is important to define the characteristics of the animal communities utilizing this area before restoration activities begin to interpret the effects of those actions as they are implemented. The ecological relationship between surface and groundwater habitats illustrates how water management has affected this region. This series of investigations has particular relevance to the Comprehensive Everglades Restoration Plan (CERP) program in predicting the effects of restoration activities on this region. Quantitative descriptions of aquatic-animal use of the Rocky Glades landscape, including solution holes, are needed under different water conditions. By incorporating those data and relationships into models, it should be possible to simulate the success of various management alternatives in providing a restored aquatic community. The basic inventory data and ecological information can be applied in planning and evaluating restoration actions that include developing performance measures, describing aquatic animal dispersal as related to hydrological conditions, and predicting impacts of introduced species to natives within this system.

KEY FINDINGS:

- Wet season rains events drove hydropatterns on the marsh surface. Water depths and hydroperiods varied on the marsh surface, but tended to be low during the study period except in the western-most study sites. Water flowed from the east to the west for most of the wet season, and flow velocities were greatest during periods of greatest inundation. Solution-hole water depths decreased throughout the dry season. Shallow solution holes dried within five months. However, deeper solution holes contained water throughout the dry season.

- Water-quality parameters in surface-water were more variable than ground-water. Water temperatures remained stable (>20 $^{\circ}$C) in solution holes, providing thermal refuge for aquatic animals during winter cold spells. Dissolved oxygen concentrations declined in solution holes during the dry season, creating harsh conditions for aquatic in habitats. On the marsh surface, oxygen was variable and ranged from low concentrations to supersaturation. Specific conductance in groundwater increased during the dry season as are a result of the concentration of aquatic life in those environments. pH was the least variant of the physico-chemical parameters measured in surface and ground water habitats.

- Collections from the drift-fence arrays showed that the short-hydroperiod wetlands of the Rocky Glades support a rich assemblage of species, despite long, annual periods of drying. The assemblage of native species continues to be supplemented by new introduced species.

- *Hemichromis letourneuxi* (African jewelfish) was the third most abundant species collected in drift-fence arrays during the wet seasons of this study. Their abundance was greatest in 2005 following intense flooding from Hurricane Katrina. Over 20 inches of rain fell during that storm. This flood event caused drainage canals to the east of Everglades National Park to overflow, facilitating the migration of *Hemichromis* westward through the Rocky Glades.

- Temporal changes in fish community structure were observed during the wet seasons of 2004, 2005, and 2006. Spatial differences in community structure between array sites were only observed in 2004 and 2005. Fish communities on the marsh surface were primarily characterized by *Gambusia holbrooki* (eastern mosquitofish), *Fundulus confluentus* (marsh killifish), *Jordanella floridae* (flagfish), and *Lepomis marginatus* (dollar sunfish). *Hemichromis* was the non-indigenous taxa that contributed most to differences in community structure.

- Array location and water depth were the abiotic parameters with the greatest influence on catch patterns of non-indigenous fishes.

- Catch patterns of common species were influenced by temporal (month of flooding) and spatial (location) variables.

- Most fishes collected during the first month of flooding on the marsh surface were adults that immediately began reproducing. Trap-vulnerable juveniles were often collected toward the beginning of the wet season, and larger individuals were more prevalent towards the end of the flooded period.

- Non-indigenous fishes were collected in low abundances during early wet season samples and did not contribute to differences in community structure at that time.

- Fishes exhibited mass directional dispersal during the early wet season; this occurred, but was less marked, late in the wet seasons.

- There may be biases associate with the drift-fence method for monitoring marsh fishes. This method collected greater abundances of fishes than 1-m^2 throw traps, and samples from both methods described different community structures.

- In general, small native fishes on the marsh surface were more active during the day than in the evening. Fishes were also more active during a full moon than a new moon. In contrast, *Hemichromis* was most active after dark.

- Samples of fishes from solution holes showed a temporal difference in community structure of resident fishes to those habitats. By the end of the dry season, many solution holes had dried, resulting in mass mortality of aquatic inhabitants. The deepest holes that retained water through the dry season were left with mainly non-native fishes and native catfish.

- Size structure of fishes in solution holes increased during the dry season, likely indicating that small natives were being preyed upon by larger native and non-indigenous fishes.

- Results of the solution-hole monitoring indicated that this habitat is not a viable dry-season refuge for most fishes. It is likely that, under today's water management, the fish fauna of the Rocky Glades depends on connections with more permanent waters from which the fishes disperse as waters re-flood the region.

- Minnow traps in solution holes do not capture all resident fishes. In an experiment, we found that fish commonly moved in and out of minnow traps in this habitat. However, despite these movements, there were no priority effects in fishes captured with minnow traps in solution holes.

- *Hemichromis* preyed heavily on native eastern mosquitofish in solution holes, based on both monitoring and experimental data.

- Results of gut-contents analysis demonstrated that *Hemichromis* in the Rocky Glades are primarily carnivorous, feeding on small fishes, shrimp and other crustaceans, and insects. Diets varied according to prey availability which is mediated by water levels and season. Heaviest feeding occurred when marshes began to dry and prey concentrated. Eastern mosquitofish were major prey. Energy storage in fat bodies enables these fish to survive lean times during the rest of the dry season.

- *Hemichromis* in the Rocky Glades are reproductively active from late spring to early fall.

- In another experiment, *H. letourneuxi* preferred small shrimp over fish prey, whereas a *Lepomis gulosus* (a native predator) was more of a generalist predator, taking small numbers of multiple species. Results of this experiment suggest that *Hemichromis* may have large effects on lower trophic-level prey.

- Small, ubiquitous native fishes do not appear to exhibit strong behavioral responses to predators, perhaps because few native predatory fishes inhabit the Rocky Glades. Small native fishes may not be adapted to avoid predation by introduced predators.

- Dollar sunfish and *Hemichromis* selected hard substrates on which to attach their adhesive eggs. In an interspecific nesting-interaction experiment, dollar sunfish successfully nested only in treatments in which *Hemichromis* were absent; *Hemichromis* were able to nest in the presence of dollar sunfish, as well as with conspecific pairs.

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INTRODUCTION

The Rocky Glades region of the Everglades ecosystem is a harsh environment for aquatic organisms. To survive there, species must avoid desiccation and increased depredation during seasonal dry-downs. Since the Everglades formed approximately 5000 years ago, native fauna have had the opportunity to adapt to these conditions. Within the last century, however, dramatic anthropomorphic alternations to the Everglades have resulted in losses of wetland habitats, decreases in hydroperiods, and introductions of invasive species. Native Everglades fauna have not had sufficient time to adapt to these added challenges, and their ability to survive in this changing landscape may be compromised**.**

Aquatic animals in the seasonally flooded wetlands of the Everglades have developed a variety of means by which to cope with environmental variability. These include movements among habitats to find refuge from drying in winter and spring, and dispersal away from those refuges with the onset of the wet season (Kushlan 1974, Loftus and Kushlan 1987). Freshwater refuge habitats in southern Florida include natural sites such as alligator holes (Craighead 1968, Kushlan 1974) and solution holes in the Rocky Glades (Loftus et al. 1992). Canals and ditches offer a relatively recent but spatially extensive form of artificial refuge for aquatic animals on the landscape (Loftus and Kushlan 1987). This pattern of movements among habitats with fluctuating water depths is a general one common to seasonal wetlands in the tropics (Lowe-McConnell 1987, Machado-Allison 1993).

Human-induced changes have affected the natural variability of environmental conditions through the construction of canals and levees that can either drain or flood wetlands (Gunderson and Loftus 1993). Several programs to restore lost structure and function to the south Florida landscape are now being planned. To have the ability to detect changes in natural and artificial habitats resulting from these restoration programs, we need to collect baseline data on the constituent aquatic communities and their ecology before the restoration actions.

The Rocky Glades region of Everglades National Park (ENP) (Figure 1) has been adversely affected by water diversions and has been reduced in aerial extent by land conversion for agriculture and urban development. This area represents an endangered landscape of the south Florida ecosystem that remains structurally intact only within the boundaries of ENP. This region has a high priority for restoration in the Comprehensive Everglades Restoration Plan (CERP) because it is the largest remnant short-hydroperiod wetland in the eastern Everglades, representing an aquatic habitat that has been disproportionately lost from the ecosystem. It is widely accepted that the quality of this habitat has been greatly altered by water diversions. This region once may have provided important summer and early dry-season feeding sites for wading birds and good habitat for alligators before it was affected by drainage. Knowledge about fishes and aquatic invertebrates there is especially important because the loss of short-hydroperiod wetlands has been implicated in the decline of nesting wading birds in the Everglades (Fleming et al. 1994).

In the Rocky Glades as well as other south Florida wetlands, fishes support many of the predatory animals, especially alligators and wading birds. Fishes and aquatic invertebrates are recognized as indicators of wetland health. Because of the hydrological changes wrought by

drainage and impoundment, and the loss of spatial extent and functioning of former wetlands to development (Gunderson and Loftus 1993), there can be little doubt that fish standing crops and overall numbers have declined. Those changes to the original system have also altered the timing and the areas of fish availability to predators. Indirectly, the fishes have been detrimentally impacted by hydropattern alteration through effects on alligators, which provide them dry-season refuge in their ponds, and through impacts on wading birds, which transfer energy from the marshes to other habitats through predation.

In addition to the effects of habitat alternations, non-indigenous species introductions have also been a concern in ENP. Non-indigenous species have been colonizing natural and disturbed habitats during the past three decades. Introduced fishes appear to establish and prosper readily in disturbed habitats, such as the Rocky Glades. Trexler et al. (2000) found that this region had higher relative abundances of introduced fishes compared to other Everglades regions. Their data also indicated that some species have a rapid expansion phase, followed by a crash in numbers, after which they persist at low levels. Persistence at low levels probably poses a small degree of impact to native species, but in areas where high population levels are maintained, there is a possibility for adverse effects. Impacts on native species can include predation, nest-site competition, and habitat disturbance. Non-native fishes may also divert food-web energy into biomass unavailable to many top-level predators (Taylor et al. 1984). The climate and geography of south Florida make it conducive to the survival and establishment of non-indigenous organisms (Loftus and Kushlan 1987). The eventual extent of invasion, geographically and numerically, is uncertain. It seems likely that more species will invade and extend their ranges within the region, with unknown ecological consequences. To date, several species of introduced fishes, particularly the African jewelfish (*Hemichromis letourneuxi*), Mayan cichlid (*Cichlasoma urophthalmus*), black acara *(Cichlasoma bimaculatum*), jaguar guapote cichlid (*Cichlasoma managuense*), blue tilapia (*Oreochromis aureus*), spotted tilapia (*Tilapia mariae*), oscar (*Astronotus ocellatus*), walking catfish (*Clarias batrachus*), brown holplo (*Hoplosternum littorale*), pike killifish (*Belonesox belizanus*), and spotfin spiny eel (*Macrognathus siamensis)* have been collected from the Rocky Glades region of ENP (Loftus et al. 1992, Kline et al. 2004, Loftus et al. 2005).

We have collected more that 30 species of native fishes in the Rocky Glades of ENP (Appendix 1). Fishes and invertebrates appear on the wetland surface of the Rocky Glades wetlands as soon as the rains re-flood the area in the early summer (Loftus et al. 1992). However, despite recent investigations into the patterns of fish colonization, questions remain about the source of those colonists (Loftus et al. 1992, Kobza et al. 2004). Are solution-hole refuges spatially and physically adequate to provide the large number of re-colonizing aquatic animals that appear on the surface, or are these animals the result of rapid dispersal from flooded sloughs to the east and west? Little has been published about the species composition of the animals that survive below ground through the dry season, their dispersal and recruitment patterns once above-ground, and their movements back into solution holes as water recedes in autumn. While the role of alligator ponds as dry-season refuges had been documented (Kushlan 1974; Nelson and Loftus 1996), the possibility of groundwater refuge in the highly eroded Rocky Glades in solution holes has only recently been studied (Kobza et al. 2004, Loftus et al. 2005).

From 2000 – 2004, we conducted an extensive research project that investigated how fishes and aquatic invertebrates utilized habitats within the Rocky Glades (Loftus et al. 2005). Through this work, we collected baseline information about the physical environment and community composition of species inhabiting wetland surfaces, solution holes, and subterranean habitats. The following describes some of the major results of this past study.

Water-quality parameters in surface waters fluctuated on a diel basis. Species collections from surface waters showed that the short-hydroperiod wetlands of the Rocky Glades support a rich assemblage of native species, despite long, annual periods of drying. The assemblage of native species is being supplemented by new introductions of non-indigenous species. Fishes and crayfish often appeared on the surface the same day that the wetlands flooded, demonstrating either the existence of local subterranean refuges or rapid colonization from more distant refuges. Large catches of several species occurred within a few days of flooding. Fishes tended to exhibit mass directional dispersals as the wetlands flooded. Although flow velocities were relatively slow in the shallow wetlands, animals appeared to respond to the flow of water. Individuals of some species appeared to follow the flow, although other species, particularly the Everglades crayfish (*Procambarus alleni*), dollar sunfish (*Lepomis marginatus*), and flagfish *(Jordanella floridae*), often moved against the flow. The majority of species appeared at each array within one week of flooding, and the assemblage was numerically dominated by small-bodied livebearers, killifish, and the dollar sunfish. The Everglades crayfish was also abundant in catches immediately after re-flooding, but declined in catch over time. Most fishes collected on the marsh surface were adults that began reproducing within one or two weeks of colonization. Samples collected later during the wet seasons provided data on community-succession patterns as new species appeared and relative abundances changed. Non-native and larger-bodied native fishes were slower to appear on the wetland surface, indicating dispersal from more distant refuges.

The physical environment of solution holes remained more constant than surface waters. However, dissolved oxygen in solution holes tended to be very low, especially as water levels declined towards the end of the dry season. Fishes in these holes were subjected to near anoxic conditions. Samples of fishes from solution holes showed a steady decline in numbers of species and individuals the longer fishes were confined to those habitats. By the end of the dry season, most solution holes had dried completely, resulting in mass mortality of aquatic inhabitants. The deepest holes that retained water through the dry season were left with mainly non-native fishes and native ictalurid catfish that could survive the low dissolved-oxygen conditions. Solution holes remained warmer than surface waters during the winter, potentially providing thermal refuge to introduced fishes that otherwise may not have survived the cooler temperatures on the surface. Our results indicated that this habitat is not a viable dry-season refuge for most fishes. Our comparison of fish species that survived in holes with those that first colonized the wetlands after re-flooding showed little resemblance. These results suggested that under today's water management, the fish fauna of the Rocky Glades depends on connections with more permanent waters from which fishes disperse as the Rocky Glades re-flood. Historical groundwater levels may have provided better quality solution-hole refuges, but under today's conditions, our study indicated that the numbers of solution holes available as refuges and their habitat quality are low.

During the study by Loftus et al. (2005), several new species of non-indigenous fishes were found in the Rocky Glades. Introduced fishes have long been a concern in ENP. Introduced species appear to establish and prosper in disturbed habitats, as is the case for the Rocky Glades. Trexler et al. (2000) found that this region had a high relative abundance of introduced fishes compared to other Everglades environments. However their data also indicated that some species have a rapid expansion phase, followed by a crash in numbers, after which they persist at low levels. Our recent collections, and those by Jeff Kline (ENP biologist), produced new records for several introduced species that are expanding ranges and numbers in this area. One in particular, the African jewelfish (*Hemichromis letourneuxi*), became abundant and widely distributed in samples in 2003-2004. This is a small, aggressive predator that appears well adapted to Rocky Glades conditions. A second predatory species, the brown hoplo catfish (*Hoplosternum littorale*) has also moved into the area where we expect it to spread and become numerous. We proposed to use the existing sampling network to find whether these species continue to expand and multiply. In this study, we also proposed to use field and mesocosm experiments in combination with monthly field sampling to further our understanding of the ecology of freshwater communities in the Rocky Glades, specifically focusing on potential interactions between introduced and native fishes (Appendices 2a and 2b). There remains much controversy about whether introduced fishes are benign invaders or whether they are affecting native species detrimentally.

Our main objectives were to:

- Continue collecting physical and biological data for surface-water and solution hole environments within the karst landscape of the Rocky Glades.
- Continue documenting patterns in seasonal movements, species composition, and size structures of fishes on the wetland surface.
- Collect data on seasonal changes in native and introduced fishes from solution holes in the dry season, as related to water level.
- Test experimentally for effects by African jewelfish (*H. letourneuxi*) on native fishes in field and mesocosm situations.
- Determine sampling biases of the drift-fence and minnow-trap methods to understand their potential as monitoring methods in this habitat.

I. STUDY ENVIRONMENTS

Description of the Physical Environment

The study area is located in Miami-Dade County in extreme southeastern Florida, including eastern ENP (Figure 1). The Florida Everglades is an extensive subtropical wetland ecosystem that formed during the past 5,000 years when peat and marl were deposited within a pre-existing limestone depression in the southern Florida peninsula (Gleason and Stone 1994). Karst

limestone underlies the peat and marl throughout much of the Everglades, (Fish and Stewart 1991). In the southern Everglades, limestone of the Miami Limestone and Fort Thompson Formation form the Biscayne aquifer in the upper part of the surficial aquifer. The Fort Thompson Formation is 3-17 m deep, and it thickens slightly to the east, where it underlies the Miami Limestone (Fish and Stewart 1991). The high porosity of the limestone of the Biscayne aquifer (Fish and Stewart 1991) in south Florida allows for considerable interchange between surface water and ground water. The Fort Thompson Formation generally is riddled with solution cavities called vugs that are usually six cm or less in diameter, but are so abundant that much of the limestone resembles a sponge. As a consequence, this formation is highly permeable (Fish and Stewart 1991). The Miami Limestone emerges at the surface along the eastern margin of ENP, giving rise to the landscape known locally as "the Rocky Glades" (Figure 1). In general, it does not appear that the Miami Limestone has a network of open cavities as well developed as the Fort Thompson Formation. In many areas, the cavities are at least partly clogged with lime mud and sand, reducing the average hydraulic conductivity to much less than the underlying limestone of the Fort Thompson Formation (Fish and Stewart 1991).

Under today's drained conditions, areas of the Rocky Glades are inundated between three to seven months each year. This hydroperiod has been reduced from historical conditions prior to the construction of the drainage canals to the east (Loftus et al.1992; Renken et al. 2000). They found that the region once had higher maximum and minimum water levels, and longer flooding periods, which agreed with output from the South Florida Water Management District's Natural System Model. Today, surface-water generally appears in early June, with the onset of the wet season, providing aquatic animals with conditions for dispersal and re-colonization. When the dry season commences, typically in mid-October or November, the wetland quickly dries. The karst topography of the Rocky Glades is typified by thousands of shallow depressions in the form of solution holes. The holes often occur in complexes, a few of which appear to be connected by an underground net of small channels. Deeper holes penetrate the shallow aquifer of south Florida where groundwater has the potential to provide refuge for organisms during the dry season.

The Atlantic Coastal Ridge was a historically drier and higher elevation area of southern Florida. The ridge ranges from 1.5 to 6 m above sea level in the study area and bounds the Everglades marshes on the east. The ridge is about 5 to 8 km wide throughout most of its length, widening to about 16 km at its southernmost terminus. The ridge is a natural barrier to eastward-flowing surface drainage, except in its southern part, where it is breached by low-elevation sloughs oriented perpendicular to the trend of the ridge. Surface water on the ridge during the wet season occurred mainly in the transverse glades that cut across the ridge. However, the ridge harbored both solution holes and subterranean cavities that held groundwater throughout the year. Most of these solution holes now dry each year because of the reductions in ground-water levels, but deeper cavities in the Biscayne aquifer remain perennially flooded.

Methods:

How do hydrological and physico-chemical parameters differ between study habitats?

Surface-water. Environmental data were collected from fixed locations in the Rocky Glades. During the wet season, we used six drift-fence arrays within the Rocky Glades to collect aquatic animals, and all physical data from the surface water environment were collected at these sites (Figures 2 and 3, arrays #1-6). Staff gauges were installed to measure water depths at each drift-fence array (Appendix 3). We also installed plastic rain gauges at four drift fences (Appendix 4). We measured flow on the marsh surface by averaging three measurements of the time needed for a neutrally buoyant glass vial to move across a 15-cm distance of the wetland. Water temperatures were collected at each array with a thermometer. Data were collected each time we sampled (Appendix 3). We used five YSI 600 devices to continuously measure physico-chemical conditions for one-week periods to collect seasonal data at the drift-fence sites (Table 1). These units collected continuous readings of water temperature, specific conductance, pH, and dissolved oxygen. The units were calibrated prior to each deployment. After retrieving the units, we uploaded data to a PC, then used EcoWatch©, a compatible software program to generate graphs and arrange the raw data into a spreadsheet. YSI units were deployed at arrays #1, 4 and 5 (Appendix 5), and data were collected during August and October of 2004 and September of 2005 (Table 1).

Ground water. The groundwater environment was assessed during dry-season samples of solution holes from September 2004 through May 2005 (Figures 4 and 5). We installed staff gauges to measure water depths at each solution-hole site (Appendix 6). We used a hand-held YSI-556 unit to collect discrete readings of temperature, specific conductance, pH, and dissolved oxygen in the solution holes (Appendix 7). We also occasionally deployed YSI 600 devices in solution holes to continuously measure these same physico-chemical parameters for one-week periods (Tables 2). YSI units were generally deployed at Bluebag D, MR11 D and 3WR D (Appendices 6 and 8). Samples in these solution holes were collected during January and May 2005.

Data Analysis:

Surface Water. Rain accumulations and water depths at the arrays were plotted to illustrate surface-water hydropatterns (Figures 6 and 7). Hydroperiods from 2004 – 2005 were averaged, and significant differences between array sites were determined using one-way analysis of variance (ANOVA) in SYSTAT 10 ® (Figure 8). We did not include hydroperiod data from 2006 because this study ended prior to the dry-down of all sites. We assessed flow patterns on the marsh surface by calculating the percentage of samples that had flow as well as the direction of flow (i.e. no flow, east to west, west to east, other) (Figure 9). We ran ANOVAs to determine if flow velocities differed temporally during the wet season or spatially between study sites (Figure 10). We analyzed surface water temperatures using this same method (Figure 11). Summer and winter profiles of surface water temperature, dissolved oxygen percentage, specific conductance, and pH were plotted using data from deployable YSI 600s (Figures 12-15).

Ground Water. Water depth and physico-chemical parameters were organized into the following variables: depth category, location, and month. Depth categories included shallow (0 – 40 cm), medium (41-80 cm), and deep (>80 cm) solution holes. Solution-hole locations included Hidden Lake, Wilderness Road, Main Park Road – East, and Main Park Road – West (Figure 4). Mean water depths were plotted to demonstrate temporal changes in water depth for solution holes in

each depth category (Figure 16). Using discrete measurements collected with the YSI 556, we plotted mean temperatures, dissolved oxygen concentrations, specific conductance, and pH for solution holes for the depth category, location, and month variables (Figures 17-20). We ran ANOVAs on water depth and the physico-chemical variables to test for significant differences and investigate abiotic patterns in the groundwater environment (Tables 3 and 4). Lastly, we plotted summer and winter profiles of ground-water temperatures, dissolved oxygen percentages, specific conductance, and pH using data from the YSI 600s (Figures 21-24).

Results & Discussion:

Surface Water. As observed in past studies (Loftus et al. 2005), rainfall appeared to drive hydrological conditions in Rocky Glades marshes (Figure 6). Surface water levels responded by rapidly rising with the onset of seasonal rainfall, but fell quickly when precipitation ceased (Figures 6 and 7). Rainfall typically caused water levels to rise and flood the wetland surface in June. Ground-surface elevations between the westernmost and easternmost arrays (arrays 4 and 1) increase by about 80 cm so that the westernmost array, Array 4, had the longest hydroperiod (Figure 8; $P < 0.05$ in Tukey's pairwise comparisons with all other array sites). Array 4 is on the eastern periphery of Shark River Slough (Figure 2) and, during this study, appeared to be influenced by water-management in that basin. The higher elevations of the easternmost arrays, 1 and 2, resulted in the shortest flooded periods (Figures 7 and 8). Water management along the eastern ENP boundary also influenced their flooding and drying. Hydroperiod at these arrays averaged less than two months despite tropical rain events during the late wet seasons of 2004 and 2005. The short hydroperiods at these arrays was likely the result of pre-storm drawdowns to reduce flooding in the urban and agricultural areas east of ENP. Water flow at Array 1 was often west to east towards Taylor Slough, while flow at the other arrays was generally from east to west toward Shark River Slough. During this study, there was no discernable flow for about one third of the samples (Figure 9). Flow velocities were not significantly different between the arrays, although flows significantly decreased as the wet season progressed (Figure 10; $F_{10,30} = 6.841$, $P = 0.00$, $R^2 = 0.688$), presumably as water levels decreased (Figure 7). As expected, surface water temperatures also significantly declined from summer to late fall and early winter (Figure 11; $F_{16,48} = 32.324$, $P = 0.00$, $R^2 = 0.915$). Water temperatures, however, did not vary significantly between arrays (Figure 11).

In general, surface-water conditions at the arrays were more variable than groundwater. Physico-chemical measurements from the arrays during summer showed water temperatures ranging between 26-36 °C, with winter temperatures ranging from 15-26 °C (Figure 12). Dissolved-oxygen percentages showed wide diel fluctuations from very low levels to supersaturation (Figure 13). Percent saturation averaged higher in winter because of the lower water temperatures. Specific conductance was also relatively invariant, but higher in winter (~0.58 mS/cm) than in summer (~0.2 mS/cm), perhaps as the result of drying, concentrating, dissolved minerals (Figure 14). Finally, measurements for pH were relatively stable and slightly above neutral (Figure 15). Again, pH was higher in winter than summer. The wetland surface is the site of intense photosynthetic activity by periphyton and emergent macrophytes that results in greater fluxes compared with ground-water environments. These extremes in water chemistry, especially dissolved oxygen saturation, certainly influence fish and invertebrate behavior and should be considered in interpretations of faunal movement and survivorship.

Ground water. As in previous years (Loftus et al. 2005), water levels significantly declined in solution holes throughout the dry season (Figure 16, Table 3; $P < 0.05$ for all Tukey's pairwise comparisons from September through March). In the dry season of 2004-05, most medium and deep holes remained inundated until wet season precipitation flooded all of the holes. However, all shallow solution holes dried by February 2005. ANOVAs of the YSI 556 measurements of temperature, dissolved oxygen, specific conductance, and pH indicated significant differences in the physical environments of solution holes for the following variables: depth category, location, and month (Table 4, Figures 17 -20). Temperatures were significantly different for all variables ($P < 0.05$) and were coolest in shallow holes (Figure 17). Mean ground-water temperatures in medium and deep holes did not fall below 20 $^{\circ}$C during the dry season of 2004-05. Those holes likely provide thermal refuge for aquatic animals, especially non-indigenous species that might otherwise be affected adversely by colder temperatures in surface waters. Dissolved-oxygen concentrations also varied significantly as the dry season progressed (Figure 18; $P < 0.001$ for all Tukey's pairwise comparisons within all variables). Dissolved-oxygen concentrations were lowest in the deep solution holes in the Wilderness Road region. This region has some of the deepest solution holes in the Rocky Glades, and holes there tended to remain inundated even during long dry seasons (Loftus et al. 2005). Specific conductance in solution holes was significantly different for location and month ($P < 0.05$), but not for depth category (Figure 19). Specific conductance was highest in Hidden Lake and Wilderness Road. Measurements of specific conductance were lowest in November, but steadily increased as the dry season progressed. pH only differed significantly by month (Figure 20; $P < 0.001$), and increased throughout the dry season. However, our results for pH were based on fewer samples than were collected for the other physiochemical parameters. The pH probe on the YSI 556 unit was removed and sent back to the manufacturer for repair during most of the dry season.

Physico-chemical measurements from the solution holes varied little during our seven-day profiles collected with YSI 600s (Figures 21- 24). As expected, dissolved-oxygen values in deep solution holes were critically low during the winter sample (Figure 22). Summer measurements were slightly more variable for temperature, pH, and specific conductance, but dissolved-oxygen measurements were higher as a result of early wet-season rains and connections with the marsh surface (Figures 21 -24).

The physico-chemical environment of solution holes in the Rocky Glades is not as variable as surface habitats of the Everglades (Loftus and Kushlan 1987). However, conditions do vary on a diel basis, and likely result from differences in the physical and biological characteristics of individual holes (Appendix 8). Water temperatures varied less than 10° C throughout the year and were relatively stable through the diel cycle (Figure 17). Specific conductance in the holes increased from late fall through spring (Figure 19). This pattern was expected because high numbers of aquatic animals excreting in these small-volume holes with little exchange of water leads to a rise in specific conductance. The highest levels of specific conductance in Everglades freshwaters was reported by Loftus and Kushlan (1987) from dry-season alligator holes in which large numbers of fishes and other animals sought refuge from drying. Measurements of pH were higher during the winter dry-season than during the summer (Figure 24). We attribute this to production of CO_2 and other metabolites by the fishes and other aquatic animals confined to the holes at that season, which would lower the pH. Coincident with the drop in pH in the summer, dissolved-oxygen levels also fall from autumn through spring (Figure 18), again the result of

poor water exchange and high bio-load of aquatic animals in the solution holes. The dissolved-oxygen concentration recorded in this environment was very low in the late dry-season (Figures 18 and 22), suggesting that animals must be tolerant of low dissolved-oxygen tensions to survive. Additionally, ammonia levels are often very high in solution holes in the dry season (Liston et al. unpublished data), further stressing aquatic organisms. The extreme variations in depth and water chemistry that occur on a seasonal to daily basis create a challenging situation for aquatic animals in solution holes.

II. SURFACE WATER: DRIFT-FENCE ARRAY TRAPS

Drift-fence array sampling

How do the composition, recruitment, and size structure of aquatic animals change during the flooded period?

Methods:

Six drift-fence arrays were constructed on the marsh surface to measure the dispersal and relative abundance of fishes and macroinvertebrates with the arrival of the wet season (Loftus et al. 2005; Figure 2, Appendix 5). Sites were located along the Main Park Road, two east (Arrays 1 & 2), and two west (Arrays 3 & 4) of the Pineland Trail, and two were built within the interior of the marsh, away from the Main Park Road (Arrays 5 & 6; Figure 2). Arrays were constructed using heavy black, nursery-greenhouse ground-cloth, tied with plastic-coated wire to iron rebar driven into the limestone substrate. Each array had four arms that intersected at the center to form an X, creating four quadrants, which were oriented so that the central apex of each quadrant faced one of the four cardinal compass directions. Each arm of the array was 12-m long and 0.7 to 1.5-m high (depending on anticipated water depths). Where the arms intersected at the center of the array, we used additional cloth to form an approximately one- by one-meter square area with a hole in each quadrant large enough to insert a minnow trap (Figure 3).

To sample fishes in drift-fence arrays, we inserted a three-mm, wire-mesh, Gee©minnow trap (mouth diameter = 2.5 cm) into each quadrant of the array. One trap mouth faced into the quadrant, and the other (facing the center of the array) was plugged so that animals could enter the trap only from the quadrant it faced. Minnow traps were set at the array for 24 hours. An animal moving across the marsh would be intercepted by the array's arms and directed to the center of the array into the trap that faced the direction from which the animal was moving. The inverted funnel of the minnow trap opening prevented movement of animals out of the trap. Minnow-trap mouths were 8-cm high (from the substrate) which limited the depth of water at which we could begin collecting animals. Roads served as borders to the south end of arrays 1-4 (Main Park Road for arrays 1-3 and Pa-Hay-Okee Road for Array 4), so the south quadrant was not sampled for those arrays. When the initial rise in the water table inundated the arrays, we soaked the minnow traps for 24-hour periods every day for two weeks to gather data on early colonization patterns (Tables 5a and 5b, Appendix 9). Later, as the wet season progressed, we reduced the frequency of sampling to once a month for the duration of the wet season (Tables 6a and 6b, Appendix 10).

Fishes and macroinvertebrates were either processed in the field (identified and enumerated) or in the lab (identified, enumerated, standard length (SL) or carapace length (CL) and total species mass). In the wet season of 2004-05, we processed all samples in the lab to obtain size information. Beginning in the wet season of 2005, we processed all native fishes in the field, but retained and froze all non-indigenous species for lab processing. When releasing animals after field processing, we placed them far from the array to avoid recapturing the same animals. In addition to non-indigenous fishes, unusual species were retained as vouchers. Reptiles, amphibians, aquatic insects and other by-catch were identified and enumerated in the field, then released alive away from the arrays (Table 7).

Data Analysis:

Community composition of fishes on the marsh surface. To describe the composition of fishes on the marsh surface, we calculated the relative abundance and total catch-per-unit-effort (CPUE) of each species collected between August 2004 and September 2006 (Table 8). We constructed pie charts to display differences in relative abundances between study years (Figure 25). We also constructed pie charts to illustrate differences in relative abundance before and after the significant flood event from Hurricane Katrina in 2005 (Figure 26). We used monthly monitoring data for these calculations.

Factors influencing fish community structure on the marsh surface. We used PRIMER® 5.2.9 to construct Bray-Curtis dissimilarity matrices of our standardized, ln (observed value + 1) - transformed catch per unit effort data (CPUE) from our monthly monitoring in the wet seasons of 2004, 2005, and 2006. Using these matrices, we conducted multivariate tests including analysis of similarity (ANOSIM), similarity percentage (SIMPER), and multi-dimensional scaling (NMDS) on the community compositions of fishes collected at the arrays during each year. ANOSIM tests produce Global R statistics with values ranging between 1 and -1. Values closer to 1 indicate greater community dissimilarity among groups than within, while values closer to -1 indicate less dissimilarity among groups than within. We followed ANOSIM analyses with similarities percentage breakdown analyses (SIMPER) to determine which taxa contributed most to groupings observed among samples. We then constructed non-metric multi-dimensional scaling (NMDS) plots to illustrate dissimilarity among groups. In these plots, the distance between data points is proportional to the degree of similarity between samples (Clarke and Warwick 2001). ANOSIM tests allowed us to determine if there were significant temporal and spatial differences in community structure of fishes on the marsh surface. These analyses attributed differences in community structure to three variables: location, month of sample, and trap orientation, and were run separately for the wet seasons of 2004, 2005, and 2006. To illustrate temporal differences in community structure, we plotted the NMDS results for "month of sample" (Figure 27). For these analyses, we used an incidence level of 3% to eliminate rare taxa. The following taxa were included: *G. holbrooki, P. latipinna, F. confluentus, J. floridae, Heterandria formosa* (least killifish), *Lucania goodei* (bluefin killifish), *F. chrysotus, Lepomis gulosus* (warmouth), *Lepomis punctatus* (spotted sunfish), *L. marginatus, Enneacanthus gloriosus* (blue-spotted sunfish), *C. bimaculatum, C. urophthalmus, Belonesox belizanus* (pike killifish), and *H. letourneuxi*.

In addition to the multivariate analyses described above, we investigated the influence of abiotic parameters on catch patterns using univariate techniques in SYSTAT 10 ®. We calculated the total CPUE of fishes and the CPUE of non-indigenous fishes for each monthly monitoring sample from August 2004 through September 2006. We ran one-way ANOVAs using generalized linear models of these CPUE data with the following independent variables: year, month of sample, location, trap orientation, and flow direction (Table 9). CPUE data were log+1 transformed to meet assumptions of normality prior to running the ANOVAs. We also ran linear regressions of the CPUEs with continuous variables including hydroperiod (days flooded in 2004 and 2005), water depth (cm), water temperature (°C), flow velocity (seconds/ cm), and rain accumulation (inches/ month). Hydroperiods were only compared with mean CPUE data from arrays for 2004 and 2005 because the 2006 wet season was still underway at the conclusion of this study. All other regressions included data from all years. ANOVA results from the linear regressions were tabulated (Table 10), and significant results plotted to illustrate the influence of those variables on catch patterns (Figures 28 and 29).

Catch patterns of abundant species. We examined the influence of spatial and temporal variables on catch patterns of common species in our monthly monitoring samples. We ran one-way ANOVAs using generalized linear models in SYSTAT 10® to test effects of "Array Location", "Month Flooded", and "Year" on CPUE. The common native taxa included in these analyses were *G. holbrooki, L. marginatus,* and *J. floridae* (Table 8). We also tested these variables with the most common non-indigenous taxa in the monitoring samples: *H. letourneuxi, B. belizanus,* and *C. urophthalmus.* In addition, we tested the effect of these variables on the CPUE of the Everglades crayfish, *Procambarus alleni*. This species is the most common macro-invertebrate in Rocky Glades habitats. ANOVA results were tabulated (Tables 11a-c), and significant results were plotted to visualize effects of these spatial and temporal variables on catch patterns of common Rocky Glades species (Figures 30, 31, and 32).

Temporal changes in the size structure of marsh fishes. We analyzed the standard lengths of all fishes collected during the 2004-05 wet season to investigate temporal changes in size structure. We log-transformed these data to meet assumptions of normality and ran a one-way ANOVA to test if the general size structure of fishes on the marsh surface differed with respect to "month post-flood" (Figure 33). We also conducted this test to investigate differences in the size structure of *P. alleni*. (Figure 34). Pairwise comparisons of significant results were performed using Tukey's adjustment.

Using the two most abundant native (*G. holbrooki and L. marginatus*) and non-indigenous (*H. letourneuxi and B. belizanus*) species, we plotted frequency distributions of standard lengths to further examine patterns in size structure of marsh fishes. Frequency distribution of standard lengths for these species were plotted for the "early wet season" (first and second months post-flood), "mid-wet season" (third and fourth months post-flood), and "late-wet season" ($\geq$ five months post-flood) (Figures 35-38). One-way ANOVAs were performed to test if sizes of these taxa differed during the beginning, middle, and end of the 2004-05 wet season.

Early colonization of fishes to the marsh surface. In addition to examining patterns in community structure throughout the wet season, we studied the composition of early fish colonizers to the marsh surface. We calculated the relative abundance and total catch-per-unit-

effort (CPUE) of fishes collected at the onset of the 2005 and 2006 wet seasons in daily drift-fence array samples (Table 12). Results from the daily array sampling in 2004 were reported in Loftus el al. 2005. We constructed pie charts to display differences in the relative abundances of early marsh colonizers in 2005 and 2006 (Figure 39).

In our previous study of fish colonization to Rocky Glades marshes, we observed mass directional dispersals of fishes as soon as the wet season began (Loftus et al. 2005). To test the effect of "direction" on catch patterns of early colonizers in this study, we ran one-way ANOVAs to learn how trap orientation affected total CPUE (Table 13). Mean CPUEs were plotted to illustrate significant relationships (Figures 40 and 41). We used array location and time period as our independent variables in these analyses. Time period was divided into: beginning (days 1-4), middle (days 5-10), and end (days 11 - $\geq$ 14).

We used PRIMER® 5.2.9 to construct Bray-Curtis dissimilarity matrices of our standardized, ln (observed value + 1) - transformed catch per unit effort data (CPUE) from our daily samples in 2005 and 2006. Using these matrices, we conducted ANOSIM and SIMPER tests to determine how the community structure of early colonizers differed spatially and temporally at the beginning of each wet season. We used multi-dimensional scaling (NMDS) to illustrate significant differences (Figure 42). Only taxa with an incidence of 3% in our 14-day samples were used during these analyses. These species included: *G. holbrooki, P. latipinna, F. confluentus, J. floridae, H. formosa, L. goodei, F. chrysotus, L. gulosus, L. punctatus, L. marginatus, C. bimaculatum, B. belizanus*, and *H. letourneuxi*.

Lastly, we constructed a species-area-curve of species collected at Array 4 in 2005 (Figure 43) to illustrate fish recruitment to the Rocky Glades. We used Array 4 because this was the array site with the longest hydroperiod (Figure 8). We used data from the 2005 wet season because this was the only year during this study that included the entire wet season.

Results and Discussion:

Community composition of fishes on the marsh surface. Excluding samples taken during the first 14 days of re-flooding, which are discussed below, from July 2004 through September 2006, we sampled the drift-fence arrays 78 times during monthly monitoring. This resulted in catches from 261 minnow traps (Tables 6a and 6b). As well as catching fish on the marsh surface, the drift fences also frequently captured reptiles, amphibians, and aquatic invertebrates (Table 7). Through our monitoring efforts, 7,072 fishes were identified at the six drift-fence arrays (Table 8). Twenty-eight species were collected, of which eight were non-indigenous. These included African jewelfish (*Hemichromis letourneuxi* – 11.1%), Mayan cichlid (*Cichlasoma urophthalmus* – 0.8%), pike killifish (*Belonesox belizanus* – 0.7%), black acara (*Cichlasoma bimaculatum* – 0.2%), jaguar guapote cichlids (*Cichlasoma managuense* – <0.1%), spotted tilapia (*Tilapia mariae* - <0.1%), blue tilapia (*Oreochromis aureus* - <0.1%), and brown hoplo (*Hoplosterum littorale* - <0.1%). All non-indigenous species were collected at relatively low numbers in the arrays, except for *H. letourneuxi*, which was the third most abundant species collected. The most abundant native species were eastern mosquitofish (*Gambusia holbrooki* – 37.1%), dollar sunfish (*Lepomis marginatus* – 26.5%), flagfish (*Jordanella floridae* – 8.3%), and marsh killifish (*Fundulus confluentus* – 8.2%). Together, those native species comprised

approximately 80% of the fishes collected during the monthly samples. During the 2004 wet season, few non-indigenous fishes were collected at the arrays (Figure 25). However, in 2005, non-indigenous fish catches vastly increased in August following the heavy rains (~50 cm) from Hurricane Katrina. During the August sample, *H. letourneuxi* comprised ~75% of the array catches (Figure 26). We observed large numbers of that species swimming westward along the park road in the weeks following Katrina. The significant flooding caused by that hurricane seemed to foster the colonization of habitats on the eastern edge of Shark River Slough by this species. Prior to the storm, we had taken only a few specimens in that area. One month after Katrina, our catches of *H. letourneuxi* decreased, perhaps indicating that these fish had already dispersed through the Rocky Glades and continued farther west. In 2006, relative abundances of non-indigenous fishes were far less than 2005, comprising less than 10% of the total catch for that year. Still, the relative abundances of non-indigenous fishes were higher in 2006 than they were when this project began in 2004 (Figure 25).

Factors influencing fish community structure on the marsh surface. Temporal differences in fish-community structure were identified during all years of this study (Figure 27). A one-way crossed ANOSIM of "Month of Sample" indicated that this factor was a significant contributor to variation in the fish communities during 2004 (Global R = 0.138, P = 0.003), 2005 (Global R = 0.257, P = 0.001), and 2006 (Global R = 0.112, P = 0.001). During 2004, SIMPER indicated that fish communities were dominated by *G. holbrooki, F. confluentus,* and *J. floridae* (contribution >90%) during the first and last months of the wet season. Larger species such as *L. marginatus, L. gulosus, and C. urophthalmus* contributed more than 50% to community composition during the middle months of the wet season when water levels were highest. In 2005, the fish communities were dominated by *L. marginatus, G. holbrooki*, and *J, floridae* (cumulative contribution >90%) during June and July, but in August, *H. letourneuxi* comprised 76% of the community composition following Hurricane Katrina. During the wet season of 2006, fish communities at the arrays were dominated by *G. holbrooki, F. confluentus, and L. marginatus* (cumulative contribution >90%). In 2006, *H. letourneuxi* decreased in abundance and contributed less than 15% to the community composition at the arrays, but this species did account for ~12 % of the difference in community structure between the western-most array (Array 4) and the other array sites. Spatial influences on fish community structure were observed in 2004 and 2006. Array location contributed to significant differences in the community composition of fishes during the 2004 (Global R = 0.147, P = 0.001) and 2006 (Global R = 0.098, P = 0.02) wet seasons. There were no significant differences in community structure attributable to "location" in 2005. In 2004, the pairwise comparisons indicated that the fish community captured by Array 5 significantly differed from the communities at all other arrays (Global R $\geq$ 0.144, P $\leq$ 0.021 for all pairwise comparisons). *L. marginatus* contributed most to the fish community at Array 5 (66.85%). This species is extremely common in that location and may be observed spawning within the array boundaries each year (Loftus and Dunker, personal observations). In 2006, the fish community at Array 2 differed most from other arrays. The community there was characterized by *L. marginatus* (29.83%), *F. confluentus* (23.81%), *G. holbrooki* (19.73%), *B. belizanus* (13.01%), and *H. letourneuxi* (6.9%). Trap orientation had a weak, but significant influence on fish-community structure in 2004 (Global R = 0.056, P = 0.033), but was not significant in 2005 or 2006.

The abiotic variables in our ANOVA model did not account for much of the variation in the CPUEs of all fishes collected on the marsh surface during the monthly monitoring ($R^2 = 0.094$; Table 9). There were no significant differences in total fish CPUE for any of the variables. Non-indigenous CPUE differed significantly with array location ($R^2 = 0.379$, $F_{5,74} = 3.395$, $P = 0.008$; Figure 28). Tukey's pairwise comparisons showed that the CPUE of non-indigenous fishes at Array 4 differed from all other array sites ($P<0.05$). This difference results from the large abundance of *H. letourneuxi* collected from Array 4 following Hurricane Katrina in 2005 (Figure 26). CPUE of non-indigenous fishes did not significantly differ for any of the other variables in our ANOVA model (Table 9). Similarly, the linear regressions of total and non-indigenous CPUEs did not illustrate significant relationships with most continuous physical variables. There was no relationship between total fish CPUE and hydroperiod, depth, water temperature, flow velocity, or rain accumulation (Table 10). Non-indigenous CPUE differed significantly with water depth ($R^2 = 0.129$, $F_{1,93} = 13.828$, $P = 0.008$; Figure 29). Non-indigenous fishes tend to be larger-bodied than most natives and require deeper water connections to disperse through the marsh. The regression, however, is dependent on outliers that, again, relate to the flood event from Hurricane Katrina. None of the other continuous variables had a significant relationship with non-indigenous fish CPUE. It is not surprising that variables such as water temperature and rain accumulation did not affect patterns in catch. Temperatures during the wet season do not drop low enough to be biologically limiting to non-indigenous fishes. Rain accumulations directly influence water depths, but have a more indirect influence on fish abundances. It is curious, however, that flow velocity and flow direction did not yield significant results. In our previous studies of marsh fishes in the Rocky Glades (Loftus et al. 2005), we did identify significant relationships between fish abundance and flow. During this study, however, there were many samples with imperceptible flow at the arrays (Figure 9). This likely influenced the relationships between catch and flow during this current study.

Catch patterns of abundant species. The most common native fish species on the marsh surface during the wet seasons of 2004, 2005, and 2006 were *G. holbrooki*, *L. marginatus*, and *J. floridae* (Table 8). *P. alleni* was the most common macro-invertebrate. Temporal differences in catch patterns of common native species were observed. CPUE of *G. holbrooki* was significantly higher in the last months of the wet seasons (Table 11a, Figure 30). CPUEs of *J. floridae* and *P. alleni* were also higher in the late wet season, peaking after six and seven months of flooding respectively (Figures 30 and 31). These results likely illustrate greater abundances of these ubiquitous species after spawning has occurred for several months on the marsh surface. Aquatic animals become concentrated on the marsh surface as water levels decline in the autumn and early winter. This may also partially explain why CPUEs of *G. holbrooki*, *J. floridae*, and *P. alleni* were significantly higher in the late months of the wet season. Spatial differences in CPUE were not observed for these species. Neither "month of flooding" nor "array location" had significant effects on *L. marginatus* CPUE.

Catch patterns of common non-indigenous species were influenced by spatial and temporal variables. The mean CPUE of *H. letourneuxi*, the most common non-indigenous species (Table 8), was extremely low during the first two months of flooding (mean CPUE <1). The CPUE of this species significantly increased during the third month of flooding (Table 11c, Figure 32), strongly indicating that *H. letourneuxi* colonizes Rocky Glades marshes from more distant refuges. CPUE of *C. urophthalmus* was not influenced by temporal variables, but "array

location" did significantly influence catch patterns of this species. The CPUE of *C. urophthalmus* was highest at Array 4 (Figure 32). Water depths there are deeper than at other arrays (Figure 7), making this location conducive to larger-bodied cichlids. In contrast, there were no significant differences in catch patterns of *B. belizanus* accounted for by the spatial and temporal variables in our ANOVA models (Table 11c).

Temporal changes in the size structure of marsh fishes. Patterns in the size structure of marsh fishes during the wet season of 2004-05 resembled patterns we had observed in the past (Loftus et al. 2005). Collective standard lengths for all marsh fishes were significantly higher during the first month of flooding then they were during the second, third, and fourth months ($F_{5,2350}$ = 53.935, P = 0.000, R^2 = 0.103; Figure 33). The same trend was observed for the size structure of *P. alleni* ($F_{5,167}$ = 4.954, P = 0.000, R^2 = 0.129; Figure 34). Aquatic animals initially disperse onto the marsh as adults. They begin spawning soon after colonizing, and their off-spring are detected in drift-fence samples within the first few months of sampling (Loftus and Dunker, personal observations).

Individual species patterns resembled those of the entire fish community. Standard lengths of the ubiquitous *G. holbrooki* were significantly shorter during the early wet-season then in the late wet season (P<0.05; Figure 35). Lengths of *L. marginatus* were also significantly smaller during the early wet season. The larger sizes of these species collected in the late wet season probably illustrate the growth of offspring during the course of the flooded period. This trend was also illustrated by the non-indigenous *H. letourneuxi* (Figure 37). We collected significantly larger individuals of this species in the mid- and late wet season than in the beginning. Juvenile *Gambusia* and other juvenile poecilids and cyprinodontids likely provide an abundant food source for voracious predators like *Hemichromis*. Therefore, we would expect to observe larger individuals of this species in the late wet season. The same is expected for *B. belizanus*, although the ANOVA results for this species were only marginally significant (P = 0.057; Figure 38). Abundances of all other non-indigenous species were too low to illustrate substantial size patterns.

Early colonization of fishes to the marsh surface. Trends in the community composition of natives fishes in the first weeks of flooding were similar to those observed during monthly monitoring, but non-indigenous fishes were far less prevalent at this time. Overall, 15,633 fishes were collected from the six drift-fence arrays during the 14 days of consecutive sampling (Tables 5a, 5b, and 12) at the onset of the 2005 and 2006 wet seasons. Twenty-nine species were documented during these samples, and seven were non-indigenous. Non-indigenous species included *C. bimaculatum* (0.4%), *B. belizanus* (0.4%), *H. letourneuxi* (0.2%), *C. urophthalmus* (0.1%), *H. littorale* (0.1%), *C. batrachus* (<0.1%) and *O. aureus* (<0.1%). Cumulatively, these species composed less than 1.5% of the fishes collected during the daily samples (Table 12, Figure 39). Similar to the monthly samples described earlier, the three most abundant native species were *G. holbrooki (*37.2%), *L. marginatus (*25.7%), and *J. floridae* (12.0%). However, *Heterandria formosa* was also abundant in these initial samples (7.2%). By mid-wet season this species is rarely collected, perhaps because its small size makes it susceptible to predation by late-recruiting non-indigenous species and larger-bodied natives.

Total CPUE significantly varied by trap orientation in all arrays except Array 5 during early colonization (Table 13, Figure 40). Temporal differences were also observed with the largest catches occurring during the middle days of the 14-day sampling periods ($R^2 = 0.023$, $F_{2,486} = 5.821$, $P = 0.003$; Figure 41). A one-way crossed ANOSIM of the daily samples indicated that trap orientation also had a weak, but significant influence in describing variation in the developing fish communities in the early wet season (Global R = 0.034, P = 0.006). As previously discussed, trap orientation did not affect catch patterns during the later months of the wet seasons (Table 9) except in August of 2005 when a second wave of fish colonists arrived after flooding from Hurricane Katrina. Minnow traps catches in the beginning of the wet season are indicative of direction because mass migrations of fish are funneled by the array wings. Later during the wet season, direction does not explain catch patterns because dispersal decreases, and fish typically utilize the marsh for spawning and establishing territories, therefore moving little.

A one-way crossed ANOSIM of the daily samples indicated that "Time Period" had a weak, but significant influence in describing variation in the developing fish communities in the early wet season of 2005 (Global R = 0.085, P = 0.001), but not in 2006. However, "Array Location" did influence early fish communities during both years (Global R = 0.147, P = 0.001 in 2005 and Global R = 0.138, P = 0.001 in 2006; Figure 42). Pairwise tests indicated significant differences among all array comparisons in both years ($P \leq 0.01$). SIMPER showed that the early communities at the arrays in both 2005 and 2006 tended to be dominated by *G. holbrooki, J. floridae, L. marginatus, a*nd *F. confluentus* (cumulative contributions > 90%). The only non-indigenous species contributing to dissimilarities in community structure between arrays was *B. belizanus*. This species contributed to ~ 5% of the dissimilarity between arrays in 2005 and ~10% of the dissimilarity in 2006. Non-indigenous fishes were collected in such low abundances at the arrays during the early wet seasons that they did not greatly influence community structure in these early samples.

Recruitment to Array 4 in the wet season of 2005 was similar to what we had observed in the past (Loftus et al. 2005). Common species were collected within a few days of flooding (Figure 43). Non-indigenous species such as *C. urophthalmus* and *H. letourneuxi* and uncommon species such as *E. gloriosus* and *Aphredoderus sayanus* (pirate perch) were collected after the daily sampling ended.

Evaluation of minnow-trap sampling efficiency

What sampling biases are associated with the drift-fence/ minnow trap method?

A. Quantitative density estimation

Methods:

We used a 1-m^2 throw-trap to obtain quantitative density estimates of fish on the marsh surface and compared these to drift-fence array samples to learn if the arrays captured similar species and abundances as other gear types. We set minnow traps in Array 4 on 12 January

2006, and fished them for 24 hours. On 13 January 2006, we sampled the surrounding marsh with a 1-m^2 throw-trap. The throw trap was tossed outside the array boundary, with five tosses in each of cardinal directions sampled by the minnow traps (north, east, and west) (Appendix 11).

We intended to expand this portion of the project to include throw-trap comparisons at all arrays. Additionally, we hoped to compare drift-fence data with data collected from a backpack electroshocker. Our plan was to complete this work in the summer and fall of 2005. However, due to interruptions and park closures from Hurricanes Katrina, Rita, and Wilma, this work was postponed. All six arrays were severely damaged by the storms, and extensive repairs were made in September and in late November 2005. In January, 2006, we were able to complete the throw-trap comparison at Array #4 as described above. However, the marsh dried before we could complete these comparisons at the other arrays. We hoped to complete these samples during the 2006 wet season. However, in the early summer of 2006, all key field personnel accepted employment outside ENP. Our backpack electroshocker also malfunctioned, and funds for replacement were not available. Lack of staff and equipment made it impossible to complete the throw trap, electroshock, and drift-fence array comparisons within the time frame of this study. We analyzed our data from the Array 4 sample and have described preliminary results below. We will continue this work by incorporating additional data from Trexler's more extensive network of throw trap and drift fence data from around the park, and have discussed collaboration with ENP Project Manager, Jeff Kline, in this research. At the end of this section, we present our ideas on the research approach for this investigation.

Data Analysis:

We calculated the relative abundance of species collected with minnow traps and throw traps (Table 14). We then used PRIMER® 5.2.9 to construct Bray-Curtis dissimilarity matrices of the standardized, ln (observed value + 1) - transformed catch per unit effort data (CPUE) from these samples. Using these matrices, we conducted ANOSIM and SIMPER tests to investigate if data from both methods described similar community compositions. We used multi-dimensional scaling (NMDS) to visualize results from the ANOSIM test (Figure 44). All taxa collected in our samples were used during these analyses. These species included: *G. holbrooki, P. latipinna, F. confluentus, J. floridae, H. formosa, L. goodei, F. chrysotus, L. gulosus, L. punctatus, L. marginatus, C. urophthalmus, B. belizanus,* and *H. letourneuxi*. We looked for variation in the CPUEs of these species for both methods by running one-way ANOVAs in SYSTAT 10 ®. Log-transformed CPUE data and "method" were our dependent and independent variables, respectively, for this analysis (Table 15).

Results & Discussion:

In our method comparison with Array 4, we collected twelve species with throw traps and nine species with minnow traps (Table 14). The most abundant species in the throw traps were *G. holbrooki* (30.6 %) and *F. chrysotus* (24.5 %). In the minnow traps, *L. marginatus* (39.5%) and *F. confluentus* (24.4%) were the most abundant. Our one-way ANOSIM indicated that there were significant differences in the fish communities captured by each method (Global R = 0.561, P = 0.011; Figure 44). SIMPER showed that there was an average dissimilarity of 74.74 between these two methods, and this was largely due to the differences in catches of *L.*

marginatus and *F. confluentus* (cumulative contribution > 30%). Minnow Trap CPUEs were significantly higher for the following taxa: *G. holbrooki*, *F. confluentus*, *L. marginatus*, and *H. letourneuxi* ($P < 0.05$, Table 15). Total CPUE was also significantly higher in minnow traps than in throw traps ($P = 0.00$, Table 15). Though based on only one comparison, these results probably reflect true differences in catches between these methods. Because drift-fence arrays are activity traps that depend on fish movements to encounter the fences and move into the traps, it is understandable that actively moving fishes would be more easily taken in the minnow traps. Alternatively, fishes that are sedentary or territorial are more likely to be collected by the throw trap. In general, employing a variety of sampling techniques is recommended for future monitoring of marsh fishes because all sampling gears tend to be biased to some degree (Pot et al. 1984, Layman and Smith 2001).

Research Approach for Future Study

Additional work is required to understand and interpret data collected by the drift fences and minnow traps. Data from minnow-trap and drift-fence sampling are catch-per-unit-effort (CPUE) data. Those sampling methods catch animals that encounter the traps, enter them, and are assumed to be retained in the trap until removed by the collector. In analyses of those data, we treated the data as encounter rates, defined as the number of animals per unit time that enter the trap, similar to the capture rate of a sit-and-wait predator. Foraging theory calculates encounter rate (ENC) as:

$$ENC = D \times M \times B \times L$$

where D is density of the animals collected (by another sampling gear) in the area of the trap (number per unit area), M is movement rate (distance traveled per unit time), B is bias from attraction (excessive proportion of animals captured $B > 1.0$) or avoidance (deficient proportion of animals captured $B < 1.0$) of the trap when encountered, and L is loss of animals due to consumption by other captured animals or escape (proportion of animals captured that are lost, L # 1.0). The units of ENC are number of animals per unit time (in our case, 24 hours). When an estimate of density is available, as might be gathered by simultaneously sampling with a throw trap, it should be possible to estimate movement rate from ENC with bias from B and L.

The net direction and magnitude of bias is unclear from the current literature, except that it will be species- and context-specific (Pot et al. 1984; He and Lodge 1990; Kubecka 1996; Layman and Smith 2001). This is also clear from our mesocosm experiment described in the following section of this report. Layman and Smith (2001) reviewed bias in minnow-trap collections and noted that some fish were attracted to minnow traps as habitat structure, while others were under-sampled when compared to estimates from seining. Our work in ENP indicates bias in captures consistent with well-known patterns of use of the water column: at relatively deep sites, eastern mosquitofish are more likely to be caught in traps set at the surface, while juvenile sunfish are more likely to be caught by traps set at the bottom. One reason for attraction or repulsion of fishes to traps is the response by at-large fishes to animals already present inside when they approach the trap. Friesen and Chivers (2006) demonstrated that avoidance of traps by cyprinids might be a response to chemical alarm cues (Schreckstoff). Work documenting behavioral responses to alarm cues is gaining in sophistication (reviewed in

Friesen and Chivers (2006), and there is growing evidence that a diversity of fishes express such cues both to intraspecific and interspecific chemicals. However, within the Everglades ichthyofauna, members of the Cypriniformes [minnows and allies] and Siluriformes [catfishes] are the groups best known for such cues. Other groups thought to express communication via alarm cues are cyprinodontids, poeciliids, percids, and cichlids (Smith 1992; Chivers and Smith 1998). Though the potential of chemically mediated avoidance or attraction to traps is clear, predicting the net magnitude of B in any particular case is difficult. The response to chemical cues is context dependent, and will vary among species and environmental context (potential for cues to be dispersed by currents (Hazlett et al. 2006), effects of specimens in trap when encountered, etc. Chemical attraction, for example, is balanced by the interaction of food acquisition and predator avoidance in complex ways that depend on flow regimes (Weissburg et al. 2002). However, the literature suggests that the net direction of bias will lead to an underestimate of the product of D and M in many cases, i.e., both B and L are mostly likely less than 1. In addition, visual cues probably play a major role in the Everglades sampling owing to the clarity of the water.

The density of fishes in a trap may play a major role in the magnitude of both B and L. Kneib and Craig (2001) found that mummichogs (*Fundulus heteroclitus*) entered traps less frequently as the density of conspecifics inside increased. Furthermore, the rate of escape showed a positive relationship with density inside a trap. The densities of fish they studied were high relative to numbers commonly collected in a 24-hour sample in the Everglades; the baseline density used was 30 fish, with effects noted at 60 and 120 fish; samples with 60 or more fish are relatively uncommon from the Everglades, except during mass dispersal periods. They recommended limiting trap sampling times to 60 minutes, primarily to keep density in the trap relatively low. Minimizing sampling time seems to be a prudent recommendation to limit B and L, even in when low capture rates are expected. However, the low captures typical of a 60-minute sample time in most Everglades conditions present a statistical-power limitation that could only be overcome by increasing the number of traps sampled. It may also limit the potential of obtaining data on rarer species or those with specific diel activity periods.

In the absence of density estimates, we refer to ENC as activity density. There is precedence for this term in describing data from drift fences and pit-fall traps, particularly in applied entomology (e.g., Carmona and Landis 1999), and it accurately represents the data as a product of activity level (movement rate) and density. This term is probably imperfect for Everglades data, however. 'Activity' suggests that the movement rate is indicative of local movements, those within a proscribed area (a population or neighborhood), and animals are captured while making routine foraging or predator avoidance movements. As such, it implies that the data gathered are representative of the abundance of a local population, weighted by activity levels of its members. Since activity level may vary as a function of predation risk and food level, affecting capture rates even when density is held constant, activity density is a prudent term to use for sampling in habitats considered 'closed' (all animals susceptible to capture have some minimal probability of encountering each other and interacting in their life span). In the Everglades, and probably many other habitats, the notion of 'closed' populations is inappropriate; members of local communities are moving in species-specific ways over different spatial scales as a function of seasonal water-level fluctuation, the magnitude of which varies annually. Species-specific pulses of immigration into local areas of the Everglades occur as a

function of drying (animals moving from some distant site into an area that remains inundated) and rewetting (animals actively moving into a formerly dry area that has recently re-wetted). These long-distance movements are properly called migrations (directed movement from one habitat area to another) and should be contrasted with more routine movements within a local habitat. Thus, four variables influence drift-fence capture rate: local density, local activity, long-distance movements (immigration to the area sampling or emigration out of the area), and trap bias. Low movement rates yield drift-fence data most indicative of local density variation; increases of local activity level will increase CPUE, even if local density is held constant; while pulses of immigration have the potential to swamp either of the two previous factors. Responses of a fish, either through attraction or repulsion, to animals already in the trap will also affect capture rate. We use CPUE and activity density interchangeably when referring to capture of fish by the drift fences to avoid tedious repetition.

Our experience in Everglades research helps in practical interpretation of CPUE data from the drift fences. Animals taken from areas recently re-flooded are almost certainly immigrating into the site because past work has largely eliminated the alternative explanation of aquatic animals emerging from local refuges in solution holes (Kobza et al. 2004; Loftus et al. 2005). The timeframe during which the immigration signal is swamped by locally moving fishes (days or weeks post flooding) is a topic requiring research, leaving current interpretation of data largely to the judgment of the researchers. Recent analyses of data from Everglades National Park suggest that species-specific pulses of immigrating fishes (particularly eastern mosquitofish) dominate drift-fence collections from the first one to three weeks following re-flooding; however, the data also suggest that the severity of regional drying affects the level and duration of post-flooding immigration (Goss 2006). Evidence of pulses in captures, in particular when linked to fluctuating water levels, and when observed in species known to migrate in large numbers, can be interpreted as evidence of migration. In other situations, we are left using activity density to be indicative of some combination of two or three parameters: local density; local movement; and, possibly, migration (regional-scale movement). Addition of independent estimates of local density by throw-trap sampling may aid in interpreting drift-fence data by permitting correction for variation in density, leaving movement as the primary source of temporal variation (assuming B and L are roughly constant or relatively small).

Is it reasonable to assume that B and L are constant in drift-fence data? Though certainly not true in practice, can we assume that temporal variation in B is small compared to other sources of variability in density and movement? Two factors to help evaluate this are the time scale over which data are collected and number of traps sampled at a time (both of which contribute to total sample size). An estimate of minimum sample size needed to dilute idiosyncratic effects of interactions in specific samples would be useful to address this issue. This will require an estimate of inter-sample variation created solely by these effects. This could be provided by a study that clears traps hourly, for comparison of the total collection (sum of 24 separate estimates) to those from similar traps left in place for 24 hours (or some shorter total time). Replacement traps should be soaked in a solvent, possibly alcohol, to remove any residual chemical cues from past residents. The difference in collections from the cumulative hourly captures and 24 hour captures would be indicative of L and some, though not all, aspects of B. Alternatively, traps stocked with marked fish could be placed the drift fences and left for different intervals of time; missing specimens would be indicative of L, and the difference

between unmarked fishes in the trap and fishes collected in empty traps fished simultaneously provides an estimate of B. Our data reported in the section following in this report on the evaluation of trap biases in solution holes provides some insights into L. A second study might involve stocking enclosures with known densities of fish and documenting captures to evaluate species-specific attraction to the traps as shelter, similar to work reported by Dorn et al. (2005); unfortunately, this study may not be feasible because enclosing an entire drift fence may be impractical. A related effort is needed to evaluate a minimum effect size required to document ecological processes of interest. Together, these efforts can be used to identify the proper balance of sampling effort (sampling time and number of traps) and effect sizes required to be detected if present for optimal use of drift fences. We plan further work on this topic during FY07.

B. Diel-catch patterns

Are there diel catch patterns to fish catches?

Methods:

In a previous study using the drift-fence arrays in the Rocky Glades (Loftus et al. 2005), we found evidence for diel patterns in fish catches and wished to investigate this further. Three 24-hour sampling runs were conducted in July and October of 2005. Minnow traps were set at arrays #1, 2 and 3. We sampled the arrays every six hours to look at diel catch patterns (Appendix 12). We began these samples by setting the minnow traps at 0600 h. The traps were then sampled at 1200 h, 1800 h, 2400 h, and 0600 h. During each collection, all specimens were collected and brought back to the lab for length and mass measurements. Samples were taken during a full moon in July 2005, and during both the full and new moon phases in October 2005. Fishes from these samples were processed in the lab. Unfortunately, many of our samples from the July event were lost when the lab freezer in which they had been stored lost power after Hurricane Katrina. We have focused on the intact October samples for our analyses of these data.

Data Analysis:

CPUE data were organized by time and lunar phase (Table 16). We ran one-way ANOVAs in SYSTAT 10 ® to test if CPUE varied by sample time (0600 h, 1200 h, 1800 h, and 2400 h) and lunar phase (new moon, full moon, and daylight) (Figure 45). ANOVAs were also run for common taxa in these samples. Taxa included *G. holbrooki, L. marginatus, H. letourneuxi, B. belizanus,* and *P. alleni*. Pie charts were constructed to visualize differences in relative abundances of marsh fishes in the diel samples (Figure 46). As mentioned earlier, minnow traps are “activity traps”. Fishes only encounter traps when they are actively swimming on the marsh surface. We used multivariate analyses including ANOSIM and SIMPER in PRIMER 5.2.9 ® to discover which species were active during the sample times and lunar phases. Significant differences were displayed using NMDS (Figure 47).

Results & Discussion:

More fish were active on the marsh surface during daylight hours than at night (Table 16). The CPUE of marsh fishes was significantly higher in the 1200 h and 1800 h samples than in samples collected after dark. Tukey's pairwise comparisons showed that, in addition to being significantly higher during daylight hours, CPUE was also significantly higher during the full moon than the new moon ($P < 0.05$; Figure 45). ANOVAs of individual species CPUE did not yield significant results. The ANOSIM results showed that there was a weak, but significant difference in community composition with respect to time (Global R = .081, P = 0.044), and a stronger difference with respect to lunar phase (Global R = 0.176, P = 0.022). The greatest difference as indicated by the comparisons was between daylight and new moon conditions (Global R = 0.304, P = 0.011; Figure 46). *G. holbrooki*, *H. letourneuxi*, *L. gulosus*, and *L. marginatus* were the predominant taxa accounting for this difference with a cumulative contribution of 73.36% to the dissimilarity between daylight and new-moon species compositions. The most abundant species, *G. holbrooki*, had highest relative abundances during the day, indicating that this species was most active diurnally (Figure 47). During the new moon, *G. holbrooki* was absent from the 0600-h samples but prevalent at this same time during the full moon (Figure 47). Relative abundances of *H. letourneuxi* suggest that this species is most active after dark (Figure 47), although it has not been reported to be nocturnal in the scientific literature. The activity of predaceous species like *H. letourneuxi* during the evening hours may partially explain the inactivity of small, common natives like *G. holbrooki*. However, behavioral studies would be needed to test this idea.

III. SHALLOW SUB-SURFACE REFUGIA: SOLUTION-HOLE SAMPLING

Monthly sampling

How do fish communities vary in solution holes throughout the dry season?
What factors contribute to this variation?

Methods:

Solution-hole samples were collected monthly during the dry season of 2004-05, and sampling protocols matched those used in our previous research (Loftus et al. 2005). Solution-hole study sites were located in the Rocky Glades near the Main Park Road (both east and west of the Pinelands), Hidden Lake, and Wilderness Road of ENP (Figure 4, Appendix 6). One minnow trap was deployed in each solution hole and fished for 24 hours. Upon retrieval of the traps, we identified and enumerated all fishes, and recorded the standard length (SL), mass, and gender. All fishes were returned alive to the hole in which they were captured.

Marshes surrounding solution holes began drying in September 2004, so we initiated sampling at that time (Table 17). Solution holes were not sampled in October 2004 because of rain events that flooded the marshes. Sampling resumed in November, and continued once each month through May 2005. Shallow solution holes (0-40 cm) were not sampled as often as medium (41-80 cm) or deep holes (>80 cm) because they dried by February 2005. In total, 183

minnow-trap samples were taken in the solution holes during this study (Appendix 13). Fishes observed in solution holes, but not collected in the minnow traps, were recorded to document the presence or absence of those species (Table 18).

Data analysis:

Patterns in fish community structure and abundance. We calculated the relative abundances of species in solution holes to identify which species were most common (Table 19), and observe how patterns differed with depth category (shallow, medium, deep; Table 20). We also calculated mean CPUE, incidence of presence, and incidence of capture for each species (Table 21). The incidence of presence was the percentage of site visits in whch the species was observed and/ or captured, and the incidence of capture was the percentage of samples in which the species was captured with minnow traps. Relative abundances were plotted to visualize temporal differences in native and non-indigenous species compositions (Figures 48 - 50).

We used PRIMER 5.2.9 ® to construct a Bray-Curtis dissimilarity matrix of our standardized and square root- transformed catch-per-unit-effort data (CPUE). Using this matrix, we conducted multivariate tests including analysis of similarity (ANOSIM), similarity percentage (SIMPER), and multi-dimensional scaling (NMDS) on the community compositions of fishes within solution holes (Figure 51). In these analyses, we used an incidence level of 5% to eliminate rare taxa.

We used univariate tests to assess temporal differences in CPUE and size structure of fishes in solution holes. CPUE of all species, native species, and non-indigenous species were calculated, and ANOVAs were run to determine if variation was caused by time and/ or depth category. In addition, we performed one-way ANOVAs to investigate if variation in fish sizes (mass and standard length) could be explained temporally (Figure 52). We used "dry-season period" as the independent variable in this analysis. Dry season time periods were divided as follows: early (September – November), middle (December – February), and Late (March – May). ANOVAs were run separately for common taxa in solution holes. These species included: *P. latipinna, G. holbrooki, L. marginatus, L. gulosus, H. letourneuxi,* and *C. bimaculatum.*

Impact of physiochemical conditions on fishes in solution holes. We employed univariate techniques to investigate how the abiotic information we collected during our monitoring contributed to variation in the CPUE of the five most abundant fish species in solution holes. In these preliminary analyses, we used generalized linear models in SYSTAT 10.0 ® to construct one-way ANOVAs on the following categorical variables: category (shallow: 0-40 cm, medium: 41-80 cm, deep: >80 cm), month, and location (Figure 4), and the following continuous variables: water depth, dissolved oxygen, temperature, and specific conductance. Continuous variables were normally distributed and did not require transformation. We normalized the species CPUEs by square-root transforming these data. We ran backward stepwise ANCOVAs for each species to determine which of the variables were most important in describing the variation in CPUE of that species. For significant results of the categorical variables, we plotted the means and standard errors, and we ran Tukey's tests for pairwise comparisons. For

significant results of our continuous variables, we ran linear regressions of the transformed CPUEs with that variable and presented the associated scatter plots (Figures 53-57).

Results & Discussion:

Patterns in fish community structure and abundance. Non-indigenous fishes were consistently sampled and/or observed during the dry season of 2004-05 (Table 18). Overall, the top five most abundant species collected in solution holes were *P. latipinna* (27.7%), *G. holbrooki* (20.8%), *H. letourneuxi* (14.6%), *L. marginatus* (7.9%), and *L. gulosus* (5.8%) (Table 19). Non-indigenous fishes comprised rather small percentages of the fish communities in shallow solution holes (Table 20, Figure 48). Those communities tended to be dominated by smaller fishes such as *G. holbrooki*, *P. latipinna, F. confluentus,* and juvenile sunfishes such as *L. gulosus, L. punctatus,* and *L. marginatus* (Tables 20 and 21). These habitats were often highly vegetated (Appendix 8) and provided more cover for vulnerable species when compared to deeper, open solution holes. Deeper holes appeared more suited to mixed-species assemblages containing larger fishes, such as adult *L. marginatus* and *P. latipinna,* juvenile *Ameiurus natalis* and *L. gulosus,* as well as non-indigenous cichlids (*H. letourneuxi, C. bimaculatum, Oreochromis aureus, and C. urophthalmus*), catfishes (*Clarias batrachus and Hoplosternum littorale*), and livebearers (*B. belizanus)* (Tables 20 and 21).

Non-indigenous species often comprised a high proportion of the fish communities in both medium and deep holes, especially in the latter months of the dry season (Figures 48 and 49**).** *H. letourneuxi* persisted at relative abundances approximating 15 - 20% of the catches in medium and deep solution holes (Table 20, Figure 50). Non-indigenous species, in general, tended to increase in relative abundance towards the end of the dry season (Figures 48 and 49). To further investigate temporal changes in community composition of fishes in solution holes, we ran a one-way analysis of similarity (ANOSIM) on species ($\geq$ 5% incidence) and time period during the 2004-05 dry season. The months of the dry season were divided into "early", "middle" and "late". The results of the ANOSIM were only marginally significant ($R^2 = 0.063$, $P = 0.05$) (Figure 51). SIMPER results indicated that fish-community composition in solution holes was dominated by *G. holbrooki, L. marginatus, H. letourneuxi,* and *P. latipinna* for both the early and middle months of the dry season (cumulative contributions of 95.07% and 94.81% for the early and middle months, respectively). In the late months of the dry season, the non-indigenous *C. bimaculatum* replaced *G. holbrooki* as one of the species that contributed to greater than 90% of the community. During those months, the communities were dominated by adult *P. latipinna* (38.65%), *H. letourneuxi* (29.12%), *L. marginatus* (16.99%) and *C. bimaculatum* (8.10%), with a cumulative species contribution of 92.9%. The contribution of *H. letourneuxi* increased from 15.66% in the early months of the dry season to 24.42% and 29.12% in the middle and late months, respectively. Overall differences in the community structure of fishes in solution holes between the early and late months of the dry season were largely due to changes in the contributions by the non-indigenous cichlids, *H. letourneuxi* and *C. bimaculatum*. *H. letourneuxi* contributed to 20.7%, and *C. bimaculatum* contributed to 11.6% of the dissimilarity between the early and late months of the dry season. Non-indigenous fish species appear to tolerate harsh conditions in these habitats (Kobza et al. 2004), and by doing so, their persistence may further affect the survival of native fishes there.

Despite the ANOSIM results described above, our univariate tests did not detect significant variation in CPUE patterns in solution holes. However, size structure of fishes differed temporally within solution holes. The collective mass and standard length of all fishes increased significantly between the early and late dry season ($P < 0.001$; Figure 52). ANOVAs of mass and lengths of individual species, however, did not yield significant results, possibly because their sample sizes were too small. Over-all size structure of fishes increased in the late dry season because small fishes were collected less frequently, illustrating, perhaps the effect of predation by larger fishes on small native species in solution holes.

Impact of physiochemical conditions on fishes in solution holes. The harsh environments of solution holes likely contribute to the survival, and, therefore, community structure of fishes residing within them. As we will discuss later, we have addressed this question experimentally. However, because we found significant differences in the physical data collected during our monitoring (Tables 3 and 4, Figures 17 - 20), we were interested in investigating which variables contributed most to changes in species compositions in solution holes. We used the five most abundant species in solution holes for our analyses (Table 19). Our results indicated that variation in each of our taxa was described by different factors, and for all five species, less than 25% of the variation in CPUE could be accounted for using our categorical (depth category, location, month) and continuous variables (water depth, dissolved oxygen, temperature, specific conductance). *P. latipinna* was the most abundant species in solution holes. The backward stepwise ANCOVA for *P. latipinna* identified category, location, and water depth as the variables to include in the ANOVA model for this species (Figure 53). All variables were significant (category: $F_{2,167} = 3.923$, $P = 0.022$; location: $F_{3,167} = 7.223$, $P = 0.000$, water depth: $F_{1,167} = 8.377$, $P = 0.004$). However, the linear regression for water depth did not yield significant ANOVA results. All together, the aforementioned variables accounted for only 20% of the variation in *P. latipinna* CPUE ($R^2 = 0.207$). The backward stepwise ANCOVA for *G. holbrooki*, the second most abundant species, only identified temperature and dissolved oxygen (DO) as significant variables (temperature: $F_{1,170} = 11.394$, $P = 0.001$; DO%: $F_{1,170} = 4.291$, $P = 0.040$; $R^2 = 0.217$) (Figure 54). Linear regressions of both variables yielded significant ANOVA results (temperature: $F_{1,181} = 8.910$, $P = 0.003$, $R^2 = 0.042$; DO%: $F_{1,181} = 5.312$, $P = 0.022$, $R^2 = 0.023$). Despite the weakness in the regressions, the significant results for temperature and DO for *G. holbrooki* are curious. *G. holbrooki* is native, therefore not adversely affected by cold temperature stress and is morphologically adapted to employ aerial surface respiration. This result may reflect the ability of piscivorous, non-indigenous fishes to thrive in harsh environmental conditions, and thereby reduce the abundance of small natives such as *G. holbrooki*. Surprisingly, the backward stepwise ANCOVA omitted all variables except location from the ANOVA model for *H. letourneuxi* (Figure 55). Location was significant ($F_{3,178} = 3.011$, $P = 0.032$; $R^2 = 0.051$), but this variable only accounted for ~5% of the variation in *H. letourneuxi* CPUE. The pairwise comparisons only identified a marginally significant difference between main road – east and wilderness road ($P = 0.066$) for this species. Both location ($F_{3,170} = 7.950$, $P = 0.000$) and month ($F_{3,170} = 2.681$, $P = 0.012$) were significant for *L. marginatus*, the fourth most abundant species (Figure 56). These variables accounted for ~18% of the variation in *L. marginatus* CPUE ($R^2 = 0.179$). The pairwise comparisons for month indicated that the greatest differences were between the first and last month of sampling (September vs. May: $P = 0.018$). Finally, the fifth most abundant species, *L. gulosus*, was most influenced by location ($F_{3,178} = 6.031$, $P = 0.001$) and temperature ($F_{3,178} = 8.729$, $P = 0.004$) according to the backward

stepwise ANCOVA for this species (Figure 57). 17% of the variation in catch was described by these variables ($R^2 = 0.17$). The linear regression for temperature was also weak, but significant ($F_{1,181} = 16.905$, $P = 0.000$, $R^2 = 0.080$).

In combination with our previous work (Loftus et al. 2005), these analyses have identified interesting trends. Our general conclusion regarding the function of solution holes is that they no longer provide quality dry-season refuges for native fishes. Under today's water-management practices, solution holes remain isolated from the wetland surface for longer periods of time than they did historically (Loftus et al. 1992). Over time, water quality in solution holes declines (Kobza et al. 2004, Loftus et al. 2005). Specifically, oxygen is depleted, and ammonia levels increase. Fish in solution holes are subjected to these harsh conditions for much longer than they were prior to hydrologic changes to the Rocky Glades. This abiotic challenge for native fishes is compounded by introductions of highly predatory, non-indigenous species that are better adapted to survive in harsh environments. Because of current water management practices and the presence of non-indigenous fishes, solution holes do not function well as refuges for native fishes during the dry season (Figure 58). Specific experiments designed to address this dynamic are further explained in the "Introduced Fishes" section of this report.

Evaluation of minnow-trap sampling efficiency in solution holes

What sampling biases may be associated with the minnow-trap method in holes?

A. Priority effects/depletion study

Methods:

We conducted a trap efficiency/depletion study in Rocky Glades solution holes from 31 January to 07 February 2006. We selected 10 solution holes large enough to encompass three minnow traps, and that had varied fish communities, along the eastern Park-boundary L-31W road and along the Main Park Road (Table 22). We then conducted a 24-h priority effects study, followed by seven days of continuous sampling to deplete the fish community. On 30 January 2006, we placed three minnow traps in each solution hole: one control (empty trap), one prey treatment (stocked with 10 *G. holbrooki*), and one predator treatment (stocked with two *H. letourneuxi*) (Figure 59). *G. holbrooki* and *H. letourneuxi* were fin-clipped prior to being stocked into cages to allow identification upon recapture. Fish were removed from traps on 31 January 2006, and all three empty traps were redeployed. Minnow traps remained in solution holes through 7 February 2006. We made daily visits to holes to collect fish from traps and to collect water depth and temperature data. Additionally, beginning on 3 February 2006, we baited each trap daily with one frozen shrimp to increase catches.

Data Analysis:

We used a combination of multivariate and univariate techniques to detect patterns in fish-community structure and catch, respectively. Prior to analyses, the number of fish captured in

each trap (catch) was sqrt (x+1) transformed to meet assumptions of normality. Analyses focused on common fish species (those present in ≥ 5 % of samples). To examine variation in community structure across priority-effect treatments, we used one-way ANOSIM on a standardized Bray-Curtis dissimilarity matrix. We then performed one-way ANOVAs to examine patterns in the catch of individual species and total fish catch across priority effect treatments. Additionally, we performed multivariate (one-way ANOSIM) and univariate (2-way crossed ANOVAs) analyses to determine the effect of baiting on the community structure and catch of fish.

Results & Discussion:

We recovered 17% of the *G. holbrooki* and 70% of the *H. letourneuxi* stocked into traps in our priority-effects experiment (Table 23). In one case (solution hole 02), all fish stocked into cages were recovered dead, presumably from low dissolved-oxygen conditions associated with deep solution holes (all dead fish were intact). We found surprisingly strong evidence that many fish are able to move freely in and out of minnow traps. While we assumed that most *G. holbrooki* stocked into traps were consumed by predators, 75% of the stocked *G. holbrooki* that were captured alive were captured in a trap other than the one they were placed in. Similarly, we found that 70% of the stocked *H. letourneuxi* moved out of their respective traps: 35% were recovered in a different trap, 5% were not captured until a subsequent day, and 30% were never recovered. After the 24-h experiment, only 1% of *G. holbrooki* (one fish) and 20% of *H. letourneuxi* (seven fish) were recovered alive in the trap into which they had been stocked.
In the priority-effects experiment (day 1 of study), we collected 324 fish (excluding stocked fish; 41% non-indigenous species) and 17 *Procambarus alleni* (Everglades crayfish) (Table 24A). Ignoring the issues associated with fishes staying in their respective traps, we still found no significant priority effects on community structure or catch. Community structure did not vary among the three treatments (Global R = -0.059, P = 0.900), nor did catch of the five common fish species or total fish catch (*A. natalis*: $P = 0.917$; *C. bimaculatum*: $P = 0.931$; *H. letourneuxi*: $P = 0.454$; *L. gulosus*: $P = 0.849$; *P. latipinna*: $P = 0.777$; total fish: $P = 0.995$).

In eight consecutive days of trapping in the ten solution holes, we collected 687 fish (excluding stocked fish), 85 *P. alleni*, two *Amphiuma means* (two-toed amphiuma), one *Pomacea paludosa* (Florida apple snail), and one *Rana utricularia* (southern leopard frog) (Table 24B). Overall, 63% of the fish collected were non-indigenous species. Additionally, at one of our holes on Wilderness Road, we captured the first *Macrognathus siamensis* (spotfin spiny eel) from the Rocky Glades region of Everglades National Park.

On average, 52% of the fish collected in this study were collected during the first 24 h. We are currently working on developing statistical techniques to determine whether the community structure of the fish collected on Day 1 is representative of the total community caught. We saw significant decreases in daily catch throughout the 8 days of sampling (Figure 60). Although catches had significantly diminished, on the final day of sampling visual observations were made of numerous large and small fish in six of the 10 holes (Table 25). The minnow-trap catch is limited to fishes that can fit into the approximately 2.54-cm diameter mouth, so larger fishes would be excluded; however, that does not explain why smaller fishes remained in the holes unless they had been captured but escaped and became trap-wise.

This study also provided the opportunity to examine the effect of baiting minnow traps. We compared the community structure of fish captured February 3 (last day prior to baiting) with those captured February 4 (first day of baiting) and found no significant variation (Global R = 0.020, P = 0.228). Univariate analyses of the most common species, however, indicated the catch of *A. natalis* increased 5.3X and total fish catch increased 2.2X with baiting (Table 26).

B. Mesocosm study

Methods:

We conducted mesocosm experiments to test the efficiency of minnow traps for sampling fish in relatively small basins with little substrate or habitat structure (e.g., solution holes). Density experiments addressed whether the numbers of fish caught in minnow traps (CPUE) reflect ambient environmental densities (number/m^2 or number/m^3). These mesocosm studies were conducted at the Daniel Beard Center in ENP in outdoor 80 x 220 cm concrete crypts filled with 35 cm of water. Immediately after being filled with water, crypts were covered with 2-mm mesh nylon shade cloth (≈ 30% shade) to reduce egg deposition by predatory flying insects. Fishes were collected from several areas throughout the southern Everglades and held in outdoor tanks prior to experiments.

Density experiments were designed for three native species commonly collected in solution holes: *G. holbrooki*, *P. latipinna*, and *L. marginatus*. Monocultures of each species were stocked at six densities (*G. holbrooki* and *P. latipinna*: 5, 10, 15, 20, 30 and 40 fish/crypt, equivalent to 2.85-22.86 fish/m^2; *L. marginatus*: 3, 6, 9, 12, 15 and 18 fish/crypt, equivalent to 1.71-10.29/m^2). Fish were stocked in mesocosm tanks and allowed 24 hours to acclimate. Efforts were made to insure that fish spanned a broad size range to detect any size limitations that minnow traps may have. Any fish that died during the acclimation period was replaced prior to the experiment. One unbaited, 3-mm mesh, wire minnow trap was then deployed for 24 hours in the center of each mesocosm. At the end of the experiment, water depth and temperature were recorded, and standard lengths were obtained for all fish (those in traps and outside of traps). Additionally, mass and sex were recorded for each *G. holbrooki* and *P. latipinna*.

Data Analysis:

Water depth, water temperature, standard length (SL), and mass were ln(y+1) transformed, and the proportion of fish caught in each mesocosm was arcsine (sqrt(y))-transformed for analyses to meet assumptions of normality. One-way analysis of variance (ANOVA) was used to test for significant variation between blocked replicates for water depth and temperature. We used linear regression to correlate the number of fish stocked in the mesocosm tanks with the number of fish captured in minnow traps. Lastly, ANOVAs were performed to identify significant differences in average standard length, mass and condition factor (Fulton-type: K = (mass/SL^3)*100,000 of *G. holbrooki* in minnow traps ("trapped") compared to the averages of those that failed to enter minnow traps ("not-trapped") for each sex (two-way crossed analyses: location x sex).

Results & Discussion:

We conducted the density experiment using *G. holbrooki* on 02-04 May 2005. Three replicates of each of six densities were used for a total of 18 mesocosms. Replicates were arranged in blocks to detect any local environmental gradients or edge effects that may have existed within the mesocosm facility (Figure 61). One-way analyses of variance (ANOVA) revealed significant variation between blocked replicates in both water depth and temperature (depth: $F_{2,15} = 4.416$, $P = 0.031$, $R^2 = 0.371$; temperature: $F_{2,15} = 17.850$, $P < 0.001$, $R^2 = 0.704$). Tukey's pairwise comparisons indicated that variation in each case was driven by one or two pairwise differences, but the small relative magnitude of variation makes it unlikely that observed differences are biologically meaningful (depth (cm): $\overline{X}_A = 35.250 \pm 0.250$, $\overline{X}_B = 36.167 \pm 0.477$, $\overline{X}_C = 34.833 \pm 0.167$; temperature (C): $\overline{X}_A = 25.612 \pm 0.049$, $\overline{X}_B = 25.908 \pm 0.030$, $\overline{X}_C = 25.855 \pm 0.030$). Water temperature was not significantly correlated with water depth ($P = 0.531$).

A total of 360 *G. holbrooki* were used in this experiment (36.4% male, 63.3% female, 0.3% juvenile (< 17mm SL)). Linear regression indicated a strong positive correlation between the density of *G. holbrooki* stocked in mesocosm tanks (no./m^2) and the number captured in minnow traps (catch per unit effort (CPUE)) ($P < 0.001$, $R^2 = 0.897$, y = 1.362x – 2.791; Figure 62). ANOVA indicated no variation between replicates in the proportion of fish captured in minnow traps ($P = 0.512$). Linear regression revealed no correlation between water temperature and proportion of fish captured in traps ($P = 0.240$). While a significant linear relationship was observed between water depth and proportion of fish captured in traps ($P = 0.029$, $R^2 = 0.265$), this relationship was weak and was strongly dependent on one data point (when that data point was removed, no correlation was observed).

We used ANOVA to identify significant differences in average SL, mass and condition factor (Fulton-type: K = (mass/SL^3)*100,000; Anderson and Gutreuter 1983) of *G. holbrooki* in minnow traps ("trapped") compared to the averages of those that failed to enter minnow traps ("not-trapped") for each sex (two-way crossed analyses: location x sex) (Figure 63). The juvenile fish (one individual) was excluded from these analyses. Female *G. holbrooki* were observed to have greater SL (20.7%), mass (100.4%), and K (6.1%) than males, and K of not-trapped fish was 5.1% greater than that of trapped fish. No interactions between location and sex were detected in SL, mass or K (Table 27 (A)). We repeated these analyses, restricting them to small fish (SL ≤ 19.0 mm), and found no significant differences between sexes ($P > 0.05$), but did find that fish with greater masses and condition factors were trapped preferentially (Table 27 (B)).

A density trial with *P. latipinna* was conducted 01-03 December 2005. Again, three replicates of each of six densities were blocked to detect local environmental gradients or edge effects (Figure 64). We found no significant variation between blocked replicates in water depth or temperature (depth: $P = 0.667$; temperature: $P = 0.225$). As was expected, however, we did observe a significant correlation between water depth and temperature ($P = 0.008$, $R^2 = 0.367$).

A total of 360 *P. latipinna* were used in this experiment (11% male, 89% female). Linear regression indicated a strong positive correlation between the density of *P. latipinna* stocked in

mesocosm tanks (no./m^2) and the number captured in minnow traps (catch per unit effort (CPUE)) ($P < 0.001$, $R^2 = 0.865$, y = 1.747x – 4.739; Figure 65). ANOVA indicated no variation between replicates in the proportion of fish captured in minnow traps ($P = 0.941$). Linear regression revealed no correlation between water temperature or depth and proportion of fish captured in traps (temperature: $P = 0.299$; depth: $P = 0.254$).

We used ANOVA to identify significant differences in average SL, mass, and K of *P. latipinna* in minnow traps ("trapped") compared to the averages of those that failed to enter minnow traps ("not-trapped") for each sex (two-way crossed analyses: location x sex) (Figure 66). Significant variation in SL and mass of fish with location (trapped v. not-trapped) and location x sex was observed (Table 28). Trapped fish had 9% greater SL and 29% greater mass than not-trapped fish. Examination of location x sex interactions revealed no significant variation in female *P. latipinna* ($P > 0.05$), while trapped males had 20% greater SL and 71% greater mass (Tukey's pairwise comparisons; SL: $P < 0.001$; mass: $P < 0.001$). No significant variation was observed in K.

Experimental manipulations of *L. marginatus* densities were conducted from 11-13 May 2005. Replicates were blocked, as in the two trials previously discussed (Figure 67). One-way analyses of variance (ANOVA) indicated no variation in water depth among blocked replicates ($P = 0.808$), yet significant variation in water temperature ($F_{2,15} = 4.192$, $P = 0.036$). Temperature differences were subtle, and are likely not biologically relevant ($\overline{X}_A = 24.383 \pm 0.293$, $\overline{X}_B = 23.983 \pm 0.031$, $\overline{X}_C = 23.683 \pm 0.065$). Water temperature was not significantly correlated with water depth ($P = 0.596$).

A total of 189 *L. marginatus* were used in this experiment. Linear regression indicated a significant, yet weak positive correlation between the density of *L. marginatus* stocked in mesocosm tanks (no./m^2) and the number captured in minnow traps (catch per unit effort (CPUE)) ($P = 0.015$, $R^2 = 0.317$, y = 0.333x + 0.333; Figure 68). ANOVA indicated no variation between replicates in the proportion of fish captured in minnow traps ($P = 0.174$). Linear regression revealed no correlations between water depth or temperature and the proportion of fish captured in traps (depth: $P = 0.112$; temperature: $P = 0.688$).

One-way ANOVA indicated the SL of trapped L. marginatus averaged 8.4% greater than those of fish not retained in traps ($F_{1,185} = 8.450$, $P = 0.004$, $R^2 = 0.044$; $\overline{X}_T = 38.036 \pm 0.884$, $\overline{X}_{NT} = 35.104 \pm 0.475$; Figure 69).

IV. INTRODUCED-FISH EFFECTS

What are the potential effects of H. letourneuxi on native fishes?

A. Predation vs. physiological stress experiment

Methods:

We have observed that *G. holbrooki* disappeared from most solution holes over the course of the dry season. To examine the relative effect of predation by *H. letourneuxi* and/or abiotic

stress (including desiccation) to *G. holbrooki* survivorship in solution holes, we conducted a predator inclusion/exclusion cage experiment (14 Feb – 8 June 2005) in deep solution holes (approximately > 80 cm) in the Rocky Glades. Beginning in January, we spent several weeks visiting sites throughout the Rocky Glades (along the L-31W levee road between S-175 and S-332, along the Main Park Road, and along Wilderness Road) to locate deep solution holes that would be naturally disconnected from surface flow by the start of the experiment. Five holes were selected in each of three geographic regions of the Rocky Glades (along the eastern boundary road (BR), the Main Park Road (MR) and Wilderness Road (WR); Table 29). Three cages were placed in each solution hole and stocked with either *G. holbrooki* only (cages A and B) or with *G. holbrooki* + *H. letourneuxi* (cage C)(Figure 70 B). We designed this study as two interrelated sub-experiments: an abiotic stress experiment focusing on the survival of *G. holbrooki* throughout the dry-season in the absence of predators, and four predation trials examining the predation rate of *H. letourneuxi* on *G. holbrooki* throughout this period.

Cage design. We constructed 45 cages for use in the abiotic-stress experiment and predation trials (Figure 70 (A)). Cylindrical cages (18-cm diameter, 1-m high) were constructed from 3-mm black plastic mesh (2-cm black plastic mesh was wrapped around the cylinder for structural support). Solid plastic, beige, outdoor canvas was wrapped around the base of each cylinder (overlap ≈ 5 cm) and was gathered and tied to create a solid cage bottom. Artificial vegetation was constructed by tethering 4- 1.5 x 34 cm strips of 6-mil plastic sheeting to a 1-inch aluminum washer. Two bundles of artificial vegetation were placed in each cage. Between predation trials, cages were removed from holes and artificial vegetation was rinsed in a weak (10%) bleach solution to reduce algal build-up.

Water-Quality Monitoring. Water-quality measurements (YSI 556: temperature, pH, specific conductivity, dissolved oxygen (DO); Hanna Instruments: [NH_3-N] (value adjusted to [NH_3])) were made weekly through the study. Each week all sites were visited prior to 1100 h to capture low, diel DO levels.

Abiotic-Stress Experiment. We installed one cage in each experimental solution hole on 08 February 2005. Ten *G. holbrooki* were measured (SL), sexed, and stocked into each cage on 14 February 2005. Sites were re-visited after 48 h and censused to determine initial mortality due to acclimation (= "Day 1"). Dead fish observed were removed from the cages and recorded, but not replaced. Each week during water-quality monitoring visits, we removed each cage and placed it in a 5-gal bucket filled with water taken from that solution hole. We removed the artificial vegetation from the cage and took a visual count of the *G. holbrooki*, recording the presence of both live and dead fish. Dead fish were not removed from cages. We returned the cage to its solution hole within five minutes of its removal. The experiment continued until we recorded either 100% mortality of *G. holbrooki* or the re-flooding of hole to marsh surface (Table 30).

Predation Trials. We conducted four predation trials (T_1: 02/16/05; T_2: 03/03/05; T_3: 03/17/05; T_4: 04/06/05) through the course of this experiment. Two additional cages were installed in each solution hole for each trial (cages were removed from holes between trials to reduce algal growth). In each trial, we placed 10 *G. holbrooki* in one cage, and 10 *G. holbrooki* and one *H. letourneuxi* in the second cage. All fish were measured (SL) and *G. holbrooki* were sexed prior to cage stocking. Sites were re-visited 24 h after stocking, cages removed from holes, placed in

5-gallon buckets, and censused. We removed dead *H. letourneuxi* from the cages and replaced them; we noted *G. holbrooki* mortality but did not replace those fish. Fish remained in cages for seven days, after which all were removed, sacrificed, and preserved in 10% formalin. In the laboratory, fish were processed to obtain SL, mass, and sex. *H. letourneuxi* were archived for gut-content analyses.

Data Analysis:

The proportion of *G. holbrooki* mortality in each cage during each trial was arcsine (sqrt(y))-transformed prior to analyses to fulfill assumptions of normality, and a 3-way factorial ANOVA (Region (BR, MR, WR) x Predator (present, absent) x Trial (T_1, T_2, T_3, T_4)) was performed on the proportion of *G. holbrooki* mortality. We used ANOSIM and NMDS in Primer 5.2.9 ® to compare community compositions across treatments. We also used principal-components analysis (PCA) of environmental data collected in our weekly water-quality monitoring to produce factor scores to use as covariates in analyses of data for both studies.

Results and Discussion:

Analysis of Resident Fish Communities in Experimental Solution Holes. Prior to the start of experiments, we set one 3-mm mesh wire minnow trap in each experimental solution hole for 24 hours (08-10 Feb 2005) to census the resident community. Fish collected in each trap were identified, enumerated, and released into the hole of origin (Appendix 14 and 15). One-way analysis of similarities (ANOSIM; from standardized Bray-Curtis dissimilarity matrix) indicated no significant variation in community composition of resident fish communities among our three geographic regions ($P = 0.091$). Non-metric multidimensional scaling (NMDS) was used to illustrate these relationships (Figure 71).

Water-Quality Monitoring. In each of our experimental solution holes, water depth, cage depth, water temperature, dissolved oxygen (concentration and %), specific conductance, pH, and ammonia concentration ([NH_3]) were recorded weekly (Figures 72 -79).

Abiotic-Stress Experiment. Mortality of *G. holbrooki* in our long-term cages was greatest within the first 30 days of the experiment, decreasing only gradually from this point (Figure 80). *G. holbrooki* in this experiment were able to survive at low water levels, often with extremely low levels of dissolved oxygen. Of our 15 experimental solution holes, there was only one case in which *G. holbrooki* suffered 100% mortality for reasons other than total dry-down (four cages dried completely during the experiment, causing 100% mortality). We suspect that their ability to use aquatic surface respiration aided their survival in the face of low DO (Lewis 1970). Prior to the re-flooding event that ultimately led to the conclusion of this experiment, average *G. holbrooki* survival was 11.2%.

Predation Trials. Because of decreasing water levels, 14 of our 15 experimental solution holes were available for the first predation trial (T_1), 14 were available for the second trial (T_2), 13 for the third trial (T_3), and 12 for the fourth trial (T_4) (Table 30). In several cases, *H. letourneuxi* died before the end of the experiment (six cases in T_1, three cases in T_3), and those solution holes were excluded from data analyses for these trials. As expected, ANOVA indicated a

significantly higher mortality of *G. holbrooki* in the presence of *H. letourneuxi* (66.8%) than when the predator was absent (18.1%) (Table 31, Figure 81). We also saw a significantly higher mortality rate at WR sites (51.0% (± 6.1)) compared to MR and BR (35.6% (± 4.1)). ANOVA also indicated a significant Region x Trial interaction, although Tukey's pairwise comparisons revealed no significant within-trial regional effects, or within-region trial effects.

B. Response of prey fish to native and introduced predators

Methods:

We conducted a prey-selectivity experiment to understand the susceptibility of Everglades fishes and macroinvertebrates to predation by the non-indigenous jewel cichlid, *H. letourneuxi* (Figure 82). Identifying how susceptible native aquatic organisms are to predation by *H. letourneuxi* and the factors underlying such susceptibility allows us to gain insights on the potential for impact by non-indigenous species on aquatic communities of the Everglades. We examined whether the susceptibility of small fish and macroinvertebrates to predation by *H. letourneuxi* was similar to their susceptibility to native predation. In outdoor mesocosms, we compared predation rates and preferences of jewels to those of an abundant native predator, the warmouth, *Lepomis gulosus* (Figure 82). Stomach-content analyses show that *L. gulosus* is a generalist predator, whose diet is composed of decapods (shrimp and crayfish), aquatic insects, and fish, particularly during the dry season (Loftus 2000). Results from the caged study (see section A above), and from gut contents (see section C below) showed that *H. letourneuxi* may be an important predator of mosquitofish, *G. holbrooki*, but whether *H. letourneuxi* may preferentially prey on them or another species was not known.

Experimental design:

We quantified the survivorship of six prey species in the presence and absence of *L. gulosus* and *H. letourneuxi* (three treatments: no predator; native predator; introduced predator). The experiment was conducted at the Daniel Beard Center in ENP in outdoor 80 x 220 cm concrete tanks (three treatments x nine replicates = 27 experimental units). Tanks were stocked with an assemblage of prey species at equal densities (six prey species x eight individuals per species = 48 prey items). The prey included small-bodied prey species that dominate prey abundance across Everglades marshes: eastern mosquitofish *G. holbrooki*, sailfin molly *Poecilia latipinna*, Florida flagfish *Jordanella floridae*, least killifish *Heterandria formosa*, bluefin killifish *Lucania goodei*, and riverine grass shrimp *Palaemonetes paludosus*. Mesocosm tanks were provided with a standardized amount of refuge in the form of artificial vegetation. Three vegetation clumps were constructed with 40 black plastic strips (40 cm x 2 cm) attached to two one-inch stainless-steel washers. These clumps were placed separately along the midline of each tank, comprising about 10% of the surface area (Figure 83). Over the course of the experiment, water level was maintained at 28.5 cm (equivalent to a 502-L volume), and water temperature averaged 24.0 C (minimum was 21.8 and maximum was 26.3 C).

The experiment was conducted in mid-November 2005. On November 18, prey were stocked in all tanks and allowed to acclimate for 24 h (six species x eight individuals per species x nine replicates = 1296 total prey). Prey animals were added randomly to tanks and in two

batches to minimize size biases. Both predators and prey were collected in late October and early November from a variety of sites throughout ENP and the Water Conservation Areas. On November 19, we checked and replaced prey mortalities (only 19 mortalities were found). After mortalities were replaced, we added predators to predation treatments (one predator per tank x nine replicates per treatment x two predator types = 18 predators used in the experiment), and the predation trial ran for 48 hours. Prior to their addition, predators were measured (Table 32) and starved for a 40-h period. On November 21, the trial was stopped, and predators and prey were recovered from tanks by carefully draining them completely and catching all organisms in dip nets below drains. All prey animals were preserved in 10% formalin to be counted and measured later (see Table 32 for mean prey sizes). Those samples were processed in January 2006.

Data Analyses:

We first examined variation in predation rates between native and non-native predators by comparing total prey mortality in the three treatments with a one-way ANOVA. We then examined variation in individual predation rates and preferences in a two-way ANOVA that examined the effect of treatment, prey identity, and the interaction. To satisfy normality assumptions, mortality counts were square-root transformed prior to analysis. Post-hoc pairwise comparisons were performed using Tukey's adjustment. All analyses were performed in February 2006 using SYSTAT® Version 8.01.

Results & Discussion:

Total prey mortality varied significantly among the treatments ($F_{2,24} = 15.4$, $p = 0.0001$). As may be expected, total mortality was higher in the predator-present than in the predator-absent treatments (Figure 83, $p < 0.0001$). Total mortality of prey was similar between *L. gulosus* and *H. letourneuxi* (seven vs. eight total prey), demonstrating that native and non-native predation rates were comparable. Mortality of individual prey species, however, differed between the two predator treatments, suggesting that predator preferences varied (Figure 84; significant treatment x prey type interaction: $F_{10, 144} = 2.3$, $p = 0.016$). Both predators had significant and equal mortality effects on *L. goodei* and *P. latipinna*, and exhibited a trend for a similar predatory effect on *H. formosa*. Neither predator preyed on *G. holbrooki*. *L. gulosus* had a higher mortality effect on *J. floridae* than did *H. letourneuxi*. In contrast, *H. letourneuxi* had a stronger mortality effect on *P. paludosus* than did *L. gulosus*.

Overall, *H. letourneuxi* strongly preferred *P. paludosus*, whereas *L. gulosus* behaved as a generalist predator, consuming most prey species indiscriminatingly, except for *G. holbrooki*. These results are somewhat surprising given the strong predation effect seen by *H. letourneuxi* on *G. holbrooki* (see sections A and C). In our experiment, we suspect the reason that both predators avoided *G. holbrooki* relates to the lack of overlap in microhabitat use by both predators and *G. holbrooki*. *G. holbrooki* is a surface-dweller, whereas both *H. letourneuxi* and *L. gulosus* are typically occur low in the water column. These results show that while native and non-native predators may have equal predation rates, their prey preferences can differ, suggesting that their overall impact on lower trophic levels may be quite distinct. Thus, native and non-native predators may not be functionally redundant in aquatic communities of the Everglades ecosystem.

C. Food Habits of *Hemichromis letourneuxi*

Methods:

We collected specimens with unbaited minnow traps or by dip netting four times during 2005-06. When minnow traps were used, we emptied them every 10-15 min to reduce chances of intra-trap predation by *Hemichromis*. Our target was 30 fish from each sampling date. We recorded the lengths and wet mass of all specimens before removing the stomachs by cutting on the left side at the esophageal sphincter and at the pyloric caecae. Each stomach was dissected, flushed of contents, and the contents examined with a Wild®5A dissecting microscope. Stomach contents were recorded to the lowest possible taxon. Fragmented or highly digested remains of insects, fishes, and crustaceans were termed "unidentifiable". Insect taxa listed in Table 33 are larval forms, unless otherwise indicated. Stomach contents were quantified using the numerical, volumetric, and frequency of occurrence analyses (Bowen 1983). We measured the volumetric displacement of the items with a McNaught and MacKay-Shevsky-Stafford sedimentation tube with demarcations to 0.001 ml.

Results & Discussion:

The diet of African jewelfish in the Rocky Glades was quite varied and was greatly affected by the seasonal change in water levels in these temporary wetlands (Table 33). In August 2005, we collected the first sample for diet analysis during the flooding period immediately following Hurricane Katrina. We found that thousands of jewelfish (and other species) dispersing westward towards Pa-Hay-Okee along the flooded road shoulder. We netted samples by dip net from the mass of dispersing fish. The fish contained a variety of prey animals, including aquatic crustaceans, insects, and fishes. Fish scales, small cyprinodontoids, and fishes too digested to be positively identified to species comprised the bulk of the diet by number and volume (Table 33). Those prey types were also consumed by most fish in the sample (Figure 85). Average number and volume of prey per fish were moderate compared to subsequent samples. The state of digestion of prey in these fish, taken in late morning, indicated that feeding occurred in the night or early morning. This result correlates with the results of the 24-h sampling at the arrays, in which we learned that *H. letourneuxi* actively moves about the wetland at night (See Section II of this report). Because most cichlids are active diurnally, this finding was unexpected.

The next sample was taken in January 2006 from solution holes in the wetland west of L-31W canal, one of the last remaining areas of the Rocky Glades with water and *Hemichromis*. Stomachs from the late morning sample were dominated by eastern mosquitofish and unidentifiable fishes (Table 33; Figure 85), again indicative of nocturnal or early morning feeding by *Hemichromis*. A few riverine grass shrimp and Everglades crayfish were in the stomachs, along with microcrustaceans and chironomid larvae. Most fish contained food and the mean number of prey and mean prey volume per fish were in the moderate range.

Towards the end of the dry season, we took the May 2006 sample in one of the few remaining pools of water, a culvert in Taylor Slough. Fish had been confined to this pool for many weeks at the time of sampling. Food resources were scarce, as evidenced by the low

average prey number and volume per fish, low stomach fullness, and because more than half of the 27 fish collected had empty stomachs (Table 33). Interperitoneal fat bodies had disappeared, demonstrating depletion of that energy source during the dry season. Food items at this time included eastern mosquitofish, bluefin killifish, and a few riverine grass shrimp.

Unlike the wet 2005 summer following Hurricane Katrina, summer 2006 was relatively dry. We collected the sample of *Hemichromis* from a drying pool along Research Road in which predators and prey had been concentrated from the surrounding wetlands. The *Hemichromis* were feeding heavily and frequently in this concentration of prey. Only one of 30 fish in the sample was empty and most other had very full gasterointestinal tracts. Eastern mosquitofish were abundant in the pool as well as in the guts (Table 33, Figure 85). A few Everglades crayfish and other crustaceans and insects were also taken. Mean prey number and volume per fish were the highest of any sample. This pattern of heavy predation during the transition from wet to dry season has been noted for the Everglades (Loftus 2000) and elsewhere in the tropics (Lowe-McConnell 1987, Winemiller and Jepsen 1998). Predators are able to build energy stores as fat bodies which enable them to survive the lean times of the dry season.

Based on the diet breadth of Everglades *Hemichromis*, it is a generalist mini-predator that opportunistically feeds on a variety of available prey. The heaviest feeding was found in specimens taken at the beginning of a drying period in the summer of 2006. In our samples, the majority of the diet was aquatic-animal based, particularly small fishes characteristic of the Rocky Glades. The importance of small fishes in the diet at the beginning of the dry season, when predators and prey are forced into proximity in remnant water bodies by declining water levels in the wetlands, correlated well with the results of both the solution-hole predation experiment and routine sampling of holes discussed above. In that experiment, eastern mosquitofish were preyed upon by *Hemichromis* as water levels fell in the holes, and the routine sampling found that small fishes disappeared from the samples as the holes became shallower. In other work presented in the next section of the report, experimental work on prey selection by *Hemichromis* at 30-cm depth showed a preference by the predator for riverine grass shrimp, rather than for eastern mosquitofish, a surface dweller. Riverine grass shrimp are relatively rare in the Rocky Glades, while eastern mosquitofish are the most abundant species, so it is not surprising that the guts of the opportunistic *Hemichromis* from the wild contained few shrimp but many fish, particularly as waters receded.

However, data from other systems indicates flexibility in the diet. In Miami canals, Hogg (1976) examined the diets of a small number of *Hemichromis*, called *bimaculatus* then, but almost certainly the same species with which we are working, because the true *H. bimaculatus* is rare and infrequently imported (Lamboj 2004). The fish from urban canals fed predominantly on algae, young of other introduced cichlids, and insects. Although algae were available to the fish we examined from the Everglades, little was found in the stomachs at any season. Hickley and Bailey (1987) studied the diet of *H. letourneuxi* in the Sudd swamps of Sudan in Africa where it is a browsing predator in aquatic vegetation that feeds on small shrimp, aquatic insects, and some plant/algae material. Lauzanne (1988), not distinguishing among nominal species of *Hemichromis*, stated that, in African waters, they are mini-carnivores, preying on a variety of insect larvae, small shrimp, and larval fishes. Larger individuals become increasingly

piscivorous. Bailey (1994) reaffirmed the diet of *H. letourneuxi* in the Nile basin as feeding on insects and shrimp.

At low water, the sample of *Hemichromis* had many fish with empty stomachs, a characteristic pattern seen in many Everglades fishes (Loftus 2000), and in other tropical wetlands (Lowe-McConnell 1987, Arrington et al. 2004). The remaining water holes towards the end of the dry season have been depleted of prey by the native and non-indigenous predators that are adapted for survival under poor water conditions and can survive using fat reserves laid down during times of plenty. *Hemichromis letourneuxi* is pre-adapted to surviving in remnant Everglades pools which are similar to the savannah pools it inhabits in Africa. Recent research by Schofield and Loftus (unpublished manuscript) has demonstrated the ability of Everglades Hemichromis to survive extremely hypoxic conditions; that, in combination with their small body size, allows them to find refuge in relatively small pockets of water.

We had intended to document the reproductive status of wild-caught Hemichromis from the Rocky Glades from the same specimens taken for gut analysis. However it became apparent that sampling four times a year was not frequent enough to delineate the reproductive cycle adequately, and the dissection for the gut contents usually disrupted the gonads too severely. After discussion with ENP project manager Jeff Kline, we decided to work cooperatively with Jeff to analyze his more frequently collected samples in 2007 to obtain better data on reproductive phenology. From our samples, we observed that the fish were beginning to produce yolked eggs in May, were ripest during the summer samples of July and August, and were reproductively quiescent in January.

D. Behavioral response of prey to native and introduced predators

Methods:

We examined whether differences in prey preferences observed in the mesocosm experiment (Section B) were related to the prey's anti-predator behavior. Non-native predators may prey opportunistically on naive prey that have no common evolutionary history with the non-indigenous predator, and thus lack anti-predator responses or show behavioral responses that are ineffective against novel predation (e.g., Gamradt and Kats 1996). In laboratory aquaria, we investigated whether native and non-native predator foraging preferences could be explained by how the prey behaviorally responded to both types of predation risk. In order words, are prey susceptible to predation by *H. letourneuxi* because they do not perceive predation risk from *H. letourneuxi*? We compared the activity, refuge use, and microhabitat use of a prey assemblage in the presence and absence of *H. letourneuxi* and the native *L. gulosus*.

Experimental design:

We examined the anti-predator behavior of prey in 64-L aquaria in which the predator was caged but the prey was able to perceive visual and chemical cues from each individual predator (Figure 86). Prey species included: *G. holbrooki, P. latipinna, J. floridae, H. formosa, L. goodei, and P. paludosus.* Repeated 5-min trials were conducted on groups of four individual fish (of the

same size classes as in the prey-selectivity experiment) of each of six species. Trials were conducted over a period of three days. Each day, the group experienced each of the three treatments: no predator; native predator; and non-native predator. The sequence of the treatments was randomized for each species. During the five-minute trials, we conducted visual scans every minute (six data points) to quantify the activity of the prey, its refuge use, and location in tank (i.e., close or far from the predator). Six replicates of each species were used in the experiment (Four individuals per group x six species x six replicates = total sample size of 144 organisms). Tanks were provided with a transparent and perforated partition that allowed prey to see and smell predators. Both the predator and prey were provided with refuges. For the prey, refuges consisted of transparent plastic strips (40 cm x 2 cm) attached to two, 2.5-cm stainless-steel washers that were placed away from the predator (Figures 86 and 87b). For the predators, refuges consisted of clear plastic cylinders (10-cm long and 6-cm diameter). To minimize disturbance of the fish and not alter their behavior, all observations were conducted using a mirror suspended above the tank at a 40-45º angle (Figure 87a). The mirror permitted a clear, top view of the prey and predator (Figure 87b). Tank sides were covered with white, plastic sheeting to prevent further disturbance to the prey and predator. Trials were conducted in two three-day blocks in July 25-Aug. 2nd 2006. Between trials, to standardize hunger levels and particularly predator motivation, prey were fed flake food *ad libitum*, and predators were fed a single earthworm. Water changes were conducted after every trial to prevent alarm chemical cues from affecting the behavior of fish in the next trial.

Data Analysis:

The response variables were the proportion of fish (out of the four fish in the group) active, in refuge, or in close proximity of the predator. We examined variation between the three treatments with one-way ANOVAs. Post-hoc pairwise comparisons were performed using Tukey's adjustment. All analyses were performed using Systat® Version 8.01.

Results & Discussion:

In response to predation risk, prey typically decrease their activity and foraging behavior, and alter their habitat use (i.e., increasing refuge use or use of predator-free microhabitats) (Sih 1987; Lima and Dill 1990). Those responses are adaptive because they often reduce conspicuousness, encounter rates, and thus vulnerability to predators (Lawler 1989). However in our study, we documented relatively weak anti-predator responses to predation risk; both towards the native and the non-native predator. Prey did not reduce activity levels in the presence of either predator (Treatment by species interaction: $F_{10, 60} = 0.9$, $p = 0.92$). This was true for all six prey species. Instead, most of the variation in activity was among prey (Figure 88). Individuals of most prey species were very active in the presence and absence of predation risk. On average, 90 % of fish prey individuals were active throughout trials despite of the presence of predators. In contrast, 60 % of the *P. paludosus* tested were active in all treatments (Species: $F_{3, 30} = 38.2$, $p = 0.0001$).

Prey differed in their response to predation risk in their refuge use (Treatment by species interaction: $F_{10, 60} = 2.0$, $p = 0.04$). Four of the six prey species exhibit no response (Figure 89). For *G. holbrooki, J. floridae, L. goodei,* and *P. latipinna*, the time spent in refuge was similar in the presence and absence of native and non-native predation. *H. formosa* responded

appropriately to the native *L. gulosus*, and there was a trend for a similar response to the non-native predator ($p < 0.10$). *P. paludosus*, surprisingly, responded inappropriately to the native predator; they spent more time out of refuge in the presence of *L. gulosus*. They exhibited a similar response in the presence of *H. letourneuxi* by spending more time out of refuge in the presence of this non-native predator.

Results for microhabitat use were similar to those from refuge use (Treatment by species interaction: $F_{10, 60} = 2.0$, $p = 0.05$). *G. holbrooki, J. floridae, L. goodei,* and *P. latipinna* spent similar proportions of time in close proximity of the enclosure whether or not a predator was present. *H. formosa* was less often found in close proximity to the partition if the native predator was present; but exhibited no differences from the no-predator control when the predator was *H. letourneuxi* (Figure 90). *P. paludosus* were most often found in close proximity of the partition when both the native and non-native predators were present.

The lack of an anti-predator response to the native predator is surprising. Most species did not respond to predation risk from *L. gulosus*. This lack of response may be explained by the fact that *G. holbrooki, P. latipinna, J. floridae,* and *H. formosa* may not be as susceptible to predation by *L. gulosus* as *H. formosa*. *P. paludosus*, interestingly, responded inappropriately to predation risk from both native and non-native predators. The reason for this is unknown, but it may explain the strong preference of *H. letourneuxi* for *P. paludosus* detected in the mesocosm experiment (See Section B).

Behaviorally, prey responses to predation risk appeared to be species-specific; yet most species exhibited little response to either native or non-native predators. This lack of response may be specific to *L. gulosus*, if predation by *L. gulosus* is not an important source of prey mortality. Further testing with a large suite of predators is needed to assess how anti-predator response differs between native and non-native predators, and if prey naiveté to novel non-native predation is a major mechanism of impact by fish invasion in the Everglades.

E. Nesting Experiment: Intra- and Inter-specific interactions of native and non-indigenous fishes in the Everglades

Justification:

The introduction of a new animal species into an ecosystem may result in its interactions with the established inhabitants through detrimental effects on reproduction, habitat use, and feeding, by predation, and by habitat disruption. Fishes of the cichlid family have been widely introduced in southern Florida where they are the most speciose non-indigenous fish family (Courtenay 1997). They are generally thought of as aggressive towards conspecifics and other fishes (Sterba 1967). Cichlids have highly developed strategies for pair-bonding, guarding territories, and protecting their young. They may also have prolonged breeding seasons, multiple clutches, and be less prone to nest desertion when faced with disturbance or nest predation than native centrarchids (Taylor et al. 1984). Interspecific competition mediated by aggression or territoriality, when numbers of the non-indigenous species are high, may lead to displacement of less-aggressive native species from nesting sites (Taylor et al. 1984).

During the last six years, a small species of cichlid, the African jewelfish (*Hemichromis letourneuxi*), has dispersed from the canal system of Miami-Dade County, from which it was recorded more than 30 years ago (Loftus and Kushlan 1987), into the Everglades and Big Cypress wetlands. In the Rocky Glades, this non-indigenous fish has rapidly increased in numbers (Figure 91) and range. Those wetlands are seasonally flooded in summer and early fall. When they flood, a variety of native fishes and aquatic invertebrates rapidly colonize them by dispersing from other water bodies, such as sloughs, creeks, and canals. The most numerous perciform fish in those wetlands is the dollar sunfish, *Lepomis marginatus* (Loftus et al. 2005), with a maximum length of 65 mm standard length (SL). *L. marginatus* appears in the wetlands within a few days of re-flooding, and males quickly establish territories on the marl substrates, creating circular nests with diameters from about 80-120 mm. Nesting males tend to be solitary, rather than colonial like other centrarchid species. Males attract several females to the nest for spawning and are solely responsible for guarding the nest and the free-swimming fry. Spawning behavior in *L. marginatus* in captivity has been described by Rice (2005) and Wolff (1999), and a field experiment investigating *L. marginatus* reproduction under threat of predation was done by Winkelman 1996).

Although we have not observed *H. letourneuxi* spawning in the Rocky Glades or other Everglades wetlands, our catches of juveniles, and the rapid growth of its population demonstrates that it reproduces there. Literature accounts show all *Hemichromis* species to be biparental substrate spawners (Noble and Curtis 1939, Loiselle 2000), unlike sunfishes which, although substrate spawners, offer parental care only by the male. *H. letourneuxi* is regarded as highly aggressive (Fuller et al. 1999; personal observations). As its numbers increase in the Everglades wetlands, the potential for interactions with native species of similar size and habitat requirements deserves study. While native fish and invertebrate predators are known to disrupt sunfish nesting and prey on eggs and fry (Popiel et al. 1996, Dorn and Mittelbach 2004), little is known about the effects on reproduction of native fishes by introduced fishes in southern Florida.

In this project, we wished to investigate the intra- and inter-specific interactions of *L. marginatus* and *H. letourneuxi* when reproducing. To observe those interactions, we brought both species into captivity and performed the experiment in mesocosm tanks at the Daniel Beard Center with a variety of available nesting substrates and protective cover. Three experiments were planned: a test of preferred nesting substrate by each species; a pilot study of nesting interactions; and a larger nesting-interaction study with additional replication.

By observing and analyzing proposed response variables of territorial behavior, spawning, and number of fry produced, we hoped to test several null hypotheses regarding potential interactions:

Ho1: no difference in establishment of territories among treatments.
Ho2: no difference in spawning occurrences among treatments.
Ho3: If spawning occurs, no difference in numbers of late-stage sac-fry produced among treatments.

Methods:

We collected wild *L. marginatus* and *H. letourneuxi* from the Rocky Glades using 3-mm-mesh, wire minnow traps several weeks prior to the experiments. Each species was maintained in separate white, 1200-l fiberglass tanks. We fed them daily with frozen and freeze-dried chironomid larvae (bloodworms) and brine shrimp, and commercial flake food. Water was supplied from a groundwater well, although the well ran dry during the initial phase of the study in June 2005. When water was available, we performed weekly water changes by siphoning each tank. We began the experiments when the wet season began in June 2005. All experiments were conducted in 80 x 220-cm concrete tanks at the ENP Beard Center Mesocosm Facility. The tanks were filled with 30 cm of well water, covered with 2-mm black nylon shadecloth (30% shade) to exclude egg deposition and colonization by dragonflies, aquatic beetles, and bugs.

Experimental Designs:

Nesting-substrate study. This was the first study conducted, from 03-23 June 2005. Each of three concrete mesocosm tanks was stocked with one male and female pair of either *H. letourneuxi* or *L. marginatus*, for a total of six tanks. Tanks were allocated to species randomly. We did not know on what type of substrate the sunfish and cichlid would prefer to attach their adhesive eggs so we offered four choices. In each concrete tank, four different substrate options were offered to the fish by placing the substrates into 30-cm wide by 8-cm deep plastic planting bowls. The substrates were: 1) sections of 4-cm diameter PVC pipe to simulate caves; 2) limestone rubble with one large rock; 3) limestone rubble with a 10-cm square piece of smooth, white ceramic tile; and 4) silica sand. The outdoor tanks were exposed to ambient air temperatures and photoperiods. The fish were fed in the stock tanks at 1600h on 3 June 2005, then caught, sexed, and introduced to their respective tanks by acclimating them using gradual water replacement in plastic bags. Six *Poecilia latipinna* were added to each tank to serve as "dither fish" to make the fish feel secure. We fed the fish twice daily, in early morning and late afternoon. Before each feeding, we monitored the tanks to look for signs of spawning or guarding behavior. On 7 June 2005, we added an additional pair of fish to each tank because the single pair of fish appeared shy and hid most of the time. The addition of other fishes, conspecific or not, is known to increase the activity of shy fish. On 17 June, the shade cloth was removed to enable better observation of the fish. The fish were removed from the tanks and returned to the stock tanks on 23 June 2005.

Pilot Study. On 4 July 2005, we set up nine concrete tanks with 30-cm high plastic strips as artificial vegetation cover, and a tile-sand selected as a result of the first study (Figure 92). We placed two white ceramic tiles (10-cm square) surrounded by sand in each tank, separated by artificial vegetation clumps (V) and a limestone rock (R) for visual isolation. At each end of the tank, we placed a thicket of artificial plastic vegetation, and a rock for additional cover. Tanks were left uncovered by shade cloth for ease of observation.

In this experiment, we had three treatments to allow us to measure any intra- and/or inter-specific reproductive effects:

1. One *Lepomis marginatus* male and two females (Control)

2. Two *Lepomis marginatus* males and four females (Intraspecific effect)
3. One *Lepomis marginatus* male and two females, and one male and two females of *Hemichromis letourneuxi* (Interspecific effect).

We used three replicates of each treatment for a total of nine tanks. Treatments were randomly assigned to the nine tanks (Figure 93). We marked each tank's treatment by tying colored strips of flagging on tank water spigots.

We measured the standard lengths (SL) of all experimental fishes placed into crypts, then floated them in plastic bags in crypts prior to release. The fish were fed twice daily, as in the substrate experiment. If a fish died during the experiment, we replaced it with a conspecific of similar size. To observe the behavior of the fish, we sat on a 1.5-m high stepladder set 2m away from the tank, and observed the fish using binoculars for one minute. Observations were made between 1000h and 1400h each day, usually two days apart. Data were recorded on data sheet for each day; the same sheet was used in the second experiment described below (Appendix 16). If a male fish exhibited territoriality over a cleared area of bottom and was very site faithful, we examined the site carefully for eggs or fry. If fry were present, we used a turkey baster to remove and count eggs or fry in a white dish, after which we carefully returned them to the nest site. During the experiment, we placed a YSI-600 unit in three randomly selected tanks representing each treatment to measure conditions over a one-week period. This experiment ran until 2 August 2005.

Full Experiment. Following the pilot experiment, we had planned to perform a larger experiment with the same three treatments but more replication. We planned to use a blocked design in which the three treatments would be randomly assigned to a tank within each of the nine blocks (see Figure 94). Unfortunately, the passage of Hurricane Katrina affected our plans by causing mortality of many stock animals. The high water levels following the storm made it difficult to collect the numbers of centrarchids and cichlids needed for the full experiment, so we did not have enough fish to fulfill that design. We could wait no longer to run the experiment because the seasonal window for spawning by *L. marginatus* was drawing to a close. Therefore, faced with these issues, we chose to run a smaller experiment in which the treatment design in the tanks was the same as in the pilot experiment (Figure 95). However, the treatments differed from the pilot study in that there was no control for the *L. marginatus*, which would have been uninformative. Instead, we included two intraspecific and one interspecific treatment:

1. Two trios (one male/two females) of *H. letourneuxi* (Intraspecific exotic)
2. Two trios (one male and two females) of *L. marginatus* (Intraspecific native)
3. One trio of *L. marginatus* and one trio of *H. letourneuxi* (Interspecific effect).

As in the pilot study, we used three replicates of each treatment for a total of nine tanks. Treatments were randomly assigned to the nine tanks (Figure 95). Each tank was marked as to treatment by tying colored strips of flagging on spigots. Tank water levels were maintained at 30 cm by addition of well water; a 30-cm high standpipe in each tank allowed excess rainwater to drain from the tanks. The set up of each tank was the same as shown in Figure 92, and the tanks were not covered. The fishes were measured and carefully introduced into the concrete tanks on 1 September 2005. We fed them in the morning and afternoon with frozen and dried foods. As

before, we observed each tank from a stepladder perch set away from the tank with binoculars for one minute, between 1000h and 1400h. We made observations every other day, and recorded them on a data sheet for each day (Appendix 16). If we saw a fish exhibiting territoriality being site faithful, we examined the site carefully for eggs or fry. If fry were present, we used a turkey baster to remove them for counting in a white dish before carefully returning them to the nest. This experiment ran until 23 September 2005. However, the tanks were not emptied of water until mid-October.

Results & Discussion:

More than 400 separate observations of the fishes in the tanks were made during the three experiments. During the first test of substrate preference for spawning, the sailfin mollies introduced as activity fishes disappeared from the African jewelfish tanks by the fourth day, but remained through the test in the dollar sunfish tank – an indication of the piscivorous abilities of the cichlids. Four days after introducing the pairs of fishes to the tanks, it was obvious that the dollar sunfish were more timid than the cichlids. The addition of another pair of conspecifics to the appropriate tanks eased that timidity. By 13 June 2005, one pair of African jewelfish in each tank had spawned and guarded eggs or sac-fry. The other pair of cichlids in those tanks huddled in the opposite corner of the tank. Spawning site was either the side of the plastic pot or on the tank floor. The dollar sunfish had set up territories in two of the three tanks; one with one male and the other with both males sparring over their respective territories. Males assume a dark base body color when territorial. All males choose the pot containing limestone rubble with the ceramic tile. By 17 June, two African jewelfish were guarding free-swimming fry and the remaining pair, sac fry. One pair had killed the male of the other pair in its tank. The two tanks with territorial dollar sunfish remained so but the females did not seem interested in joining the males on the territories to spawn. By 22 June, one pair of African jewelfish in each tank guarded free-swimming young around the tank while the young foraged. The other cichlids in each tank held territories at the opposite end. Dollar sunfish males in two of the three tanks had become shy and did not hold territories, while in the third tank, the two males continued their territorial displays.

At the termination of the test, the results were that the cichlids used hard, vertical or horizontal surfaces for spawning, while the dollar sunfish held territories in the vicinity of limestone rubble with a hard, horizontal surface. In the Rocky Glades, we often observed dollar sunfish nesting in open, marl marshes in which the male brushed aside the loose marl to produce a shallow depression on firmer rock or marl substrates. We have observed African jewelfish on nests in canals, where they spawn on limestone surfaces along the canal bank. Both species require firm substrates onto which to anchor their adhesive eggs.

Following this test, we were prepared to offer the fishes spawning sites on the tank sides and floor, along with squares of ceramic tile surrounded by rubble and sand. Although the dollar sunfish did not select sand in the test, we thought that they might need the stimulus of clearing material to reach firm substrate on which to spawn. We next ran a pilot study of the intra-and interspecific nest interaction experiment (Figure 93) to insure that our design would work before embarking on the larger study. We set up the experiment on 4 July 2005, after collecting and conditioning the fishes. A few days into the experiment, we removed some of the artificial

vegetation to make observations of the fishes easier. After the first week of observations, we noted that mortality of female dollar sunfish was higher than anticipated, both in the intra- and inter-specific treatment tanks. We replaced dead females with fresh females to maintain the experimental ratios in the tanks. In inter-specific tanks, dollar sunfish appeared more active than in tanks than when housed with conspecifics. The fishes seemed to swim together indiscriminately, with no obvious aggression. Occasionally, a *Hemichromis* would displace a male dollar in a refuge. However, the number of interactions seen over the course of the observation period was relatively low.

By the end of the first week, the first instances of territorial behavior occurred in one of the interspecific tanks by *Hemichromis*, in intraspecific tank #32, and in control tank #3. The behavior was evidenced by lateral displaying and sparring by the males. There also was an instance of mating/courting behavior in control tank #9. Through the second week, some of the territories observed previously persisted while others did not. Mortalities of female dollar sunfish continued, often in the same tanks. We began to suspect the presence of aggressive male dollar sunfish or *Hemichromis*. Females were replaced as needed. By the third week, no spawning had been observed, but activity levels seemed to be increasing. Mortality of female dollar sunfish continued. We continued to quantify the behaviors of the fishes in all tanks, particularly those that would cause the focal fish to leave the territory to display to or chase another fish.

We terminated the experiment at the end of the third week because of the high mortality of sunfish and the absence of spawning. Because we had been successful in encouraging *Hemichromis* to spawn in the substrate test, we suspected that we had not fed the fishes adequately in the current experiment to bring them into spawning condition. The majority of mortalities occurred in the interspecific treatments (#3) with 14 female dollar sunfish killed; however we have no way of knowing if they were killed by conspecific or heterospecific fish. The control treatment (#1) had seven mortalities of female dollar sunfish, followed by the intraspecific dollar sunfish treatment (#2) with only two mortalities. We also thought that the reason for the high female sunfish mortalities may have been the lack of sufficient refuge in which the females could shelter from the aggressive males or from *Hemichromis*. The behavioral observations demonstrated that we could remotely observe and quantify the fishes' activities using binoculars. The majority of chases by both male dollar sunfish and *Hemichromis* were directed towards male and female sunfish (Figure 96). Dollar sunfish rarely chased *Hemichromis*. Displays by *Hemichromis* were aimed at male and female dollar sunfish that entered the male's territory, as well as at female *Hemichromis* in attempts to attract them to the territory (Figure 96). Male sunfish displayed towards both conspecifics of both genders, towards both genders of *Hemichromis*, and towards non-discernible targets (Figure 96). Although the results of the pilot study were disappointing from the standpoint of achieving spawning, we learned lessons about conditioning and aggression.

The reduced scope of the final experiment allowed us to put into practice the lessons we had learned, as well as to test a different treatment than we had planned originally, that of intraspecific *Hemichromis* effects (Figure 95). We conditioned the fish very heavily during August 2005 and obtained an adequate number of specimens despite interruptions from tropical storms and Hurricane Katrina. In the first observation period following the commencement of

the experiment, the fishes in the three treatments were rather inactive, although male dollar sunfish in Treatment 2 darkened and became territorial, as did *Hemichromis* in Treatment 1 (Table 34). In all subsequent observation periods, territoriality increased, along with increased frequencies of chases and displays (Figure 97). Interestingly, male dollar sunfish in the interspecific treatment exhibited some level of territoriality throughout the trial, yet were not able to spawn in that treatment. Female dollar sunfish in the intraspecific and interspecific treatments spent the majority of their time in cover.

Results of the treatments showed spawning success in the intraspecific treatments, but success by only the non-indigenous species in the interspecific treatment. In the intraspecific (*Hemichromis*) treatment (I), a pair of fish in each of the three replicate tanks spawned (Table 34). In one tank, there were three spawns produced over three weeks, but the first two spawns disappeared. In the intraspecific (Dollar sunfish) treatment (2), a pair in all three replicate tanks also spawned and produced fry (Table 34). The fry were small and difficult to observe; however, several weeks after the end of the experiment while emptying the tanks, we found large juvenile dollar sunfish in the tanks, indicating that intraspecific predation were not too severe. In the interspecific treatment (3), only *Hemichromis* produced eggs and young – in two of the tanks. In the third tank, neither species spawned (Table 34). Male dollar sunfish displayed and chased mainly the conspecific females. Hemichromis did less chasing and displaying, but those behaviors were mainly directed towards the sunfish (Figure 97).

Our attempts to decrease mortality of female dollar sunfish were successful in that we lost only 8 fish versus 23 fish in this experiment compared to the previous one. The majority of fish were lost in the intraspecific (Dollar sunfish) trial. Two female *Hemichromis* were lost in the intraspecific trial this time. Usually it is females that are not ready to spawn that are harassed and sometimes killed by the males.

The results of this experiment indicate that conditions we provided were suitable for inducing spawning by both species in the intraspecific treatments. When housed alone, both species spawning in all three replicate tanks. However, it seems that *Hemichromis* may suppress spawning by the native dollar sunfish, when housed together, as in Treatment 3. We also demonstrated that in the intraspecific treatments that conspecifics are able to repress spawning by other fish, particularly when spawning occurs in a limited space. Only one pair of either species, in either the interspecific or intraspecific treatments, spawned and guarded young at any time. When successive spawnings occurred in the same tank, we were unable to tell whether it was the same pair or a different pair. Despite what we considered to be the relatively large area of these tanks, *Hemichromis*, when spawning and guarding young, took over more than half of the tank area, forcing the other fish into the far end of the tank. Such territoriality appeared to intimidate the other fish from attempting to set up and maintain a spawning area. The results of this experiment would be more robust had we been able to run the full experiment, as planned. However, the data we collected support the contention that the more aggressive, non-indigenous species is able to suppress the native species in some situations.

PROJECT SYNTHESIS

The study of ecological interrelations between native and non-native fishes will help in the understanding of the effects of the invaders on the Rocky Glades region. These studies will also help to define how water management has affected this region by aiding in the invasion and the success of those fishes. The temporal dynamics of the use of Rocky Glades habitats in relation to hydrology have just begun to be described. Through our previous work and this current study, we are providing the first description of the aquatic fauna that inhabits this short-hydroperiod environment. Results from this project further confirmed that solution holes in the Rockland presently function as sinks for native fishes because of extended dry-downs and introduced-species effects. These data will be available for use in simulation models that assist in planning management actions in Everglades National Park.

The environmental monitoring data contributed to our understanding of basic physiological tolerances of species that inhabit groundwater environments in the Rocky Glades. Interpretation of these data indicated that solution-hole environments generally offer a very low dissolved-oxygen habitat, while the marsh habitat is generally saturated with dissolved oxygen and varies diurnally with respect to temperature, and to a lesser degree, pH. It appears that fishes and other aquatic organisms inhabiting the Rocky Glades require the possession of several adaptations to successfully survive and reproduce in this region. The most critical survival period is during the frequent and prolonged drying of the wetland surface, when organisms are either forced to migrate or move below ground to space-limited habitats in the company of predacious native and introduced species. Although solution holes may be challenging solely because of their chemical variability and space limitations, the difficulty of survival there by native species is now compounded by the presence of non-indigenous predators often better adapted to survive hypoxic conditions.

Survival of fishes in solution holes depends on the characteristics of the individual hole, the minimum groundwater depth in a particular year relative to hole depth, and the cohabiting fishes in the hole. Many introduced species have adaptations that enhance their survival in solution holes. The physicochemical data demonstrate that the holes that retain water longest under today's drained conditions are also the most difficult habitats in terms of low dissolved oxygen. They also house the largest numbers of introduced predatory fishes, which are tolerant of those conditions and use the holes as a thermal refuge. Our study demonstrated that native fishes do not appear to exhibit strong anti-predator behaviors. Monitoring and experimental data showed that prolonged coexistence with introduced species in solution holes ultimately resulted in large losses or local extinctions of small native fishes that are apparently easy prey for introduced predators.

Yearly rainfall patterns played a major role in determining the timing and duration of surface flooding, and the extent to which groundwater levels fall in the Rocky Glades. Those patterns in turn affect the appearance and catch rates of fishes on the wetland surface, and probably also affect the interannual species composition. Our water-depth data from each array and solution hole demonstrated that surface and ground water conditions were dependent upon, and highly responsive to, rainfall. In addition to long-term reductions in water levels in the Rocky Glades, the data set for the easternmost arrays suggested that pumping and drainage operations during

IOP affected hydropattern as well as fish survival in those arrays. In contrast, water remained longest on the surface of the westernmost array, #4, and we assume that hydrology at this site responded to operations that affected Shark Slough rather than the Rocky Glades/Taylor Slough area.

Fish catches and relative abundances varied temporally on the marsh surface. In general, there was greater recruitment of fishes to sites with longer hydroperiods and deeper water. Hydroperiods at the eastern-most array sites range from short to moderate, but were shorter than those predicted by the Natural Systems model for the area. Arrays 4 and 5, with the longest hydroperiods, usually had the greatest richness of species.

At the beginning of our first study in 2000 (Loftus et al. 2005), seven species of introduced fishes bred in ENP, and two species (including the butterfly peacock bass, *Cichla ocellaris*) had not yet established (Loftus 2000). In addition, Loftus (2000) noted several species of exotic fishes that occurred in bordering canals but had not yet been observed or collected in ENP. Prior to the summer of 2000, no new exotic species had been observed within ENP for many years. Since then, in cooperation with Jeff Kline of ENP, we have recorded three new species in the array and solution-hole samples, and three additional species in Taylor Slough including the recently discovered spotfin spiny eel, *Macrognathus siamensis*. Recent water-management changes may have directly contributed to the introduction of, or the redistribution of, new non-native fishes in ENP.

Our data showed that one species in particular, the African jewelfish (*Hemichromis letourneuxi*), has proliferated and expanded its range in the park since this latest study began. We attribute the flooding associated with Hurricane Katrina as an agent that assisted in this expansion. In the Rocky Glades, *Hemichromis* was the most common non-indigenous species in our array collections on the wetland surface, and was also common in solution-hole samples. Experiments confirmed that the continuous loss of small native species in solution holes during the dry season could be explained by a combination of poor water quality or drying and predation by *Hemichromis*. Predation appeared to be the predominant factor in explaining that decline, however. Prey-selectivity experiments showed that *Hemichromis* would feed on a variety of aquatic animals, and should be considered opportunistic. Although it did not feed on eastern mosquitofish in the experimental tanks, we believe that was the result of the water levels used in the experiment. At deeper depths, the surface-dwelling mosquitofish and the bottom-dwelling *Hemichromis* do not encounter one another. This was confirmed by an examination of wild *Hemichromis* guts from the Rocky Glades in which mosquitofish were not preyed upon too heavily in the wet season, but were the dominant prey during the beginning of the dry season.

Hemichromis, besides being an opportunistic predator on small aquatic animals in the Rocky Glades, may also have the ability to suppress spawning in native fishes because of its territorial, aggressive demeanor. Our nesting experiments in mesocosms tanks showed that while both species could spawn successfully when housed alone, only *Hemichromis* was successful when housed with dollar sunfish. We believe that this species has the potential to affect native fish communities in southern Florida and that it deserved further study.

The Rocky Glades region serves as a seasonal home to almost forty species of fishes, many invertebrates, amphibians, and aquatically associated reptiles. We concluded that, while some species like the Everglades crayfish, can survive in the wetlands by burrowing, the fishes must recolonize the region every wet season from permanent waters elsewhere. Some regional solution holes offer dry-season refuge, but the majority of holes in the Rocky Glades are too dry under today's conditions to maintain water through the dry season. If groundwater levels were higher, as in the past before drainage, a higher percentage of holes would remain wet, providing higher quality refuges and more local recolonization of the surface.

POTENTIAL IMPACTS AND PRODUCTS

This project has expanded our previous work and provided baseline ecological data for the aquatic fauna of the Rocky Glades region of ENP. Sampling at fixed sites that combined solution-hole complexes with surrounding wetlands was performed before restoration began so that a large amount of baseline data are now available. Future monitoring in the region during the restoration process may be able to test for faunal changes. Now, with this project's conclusion, the study sites are available to the Everglades National Park monitoring staff for incorporation into the long-term monitoring program.

The benefits to restoration include more confidence in improved tools, like the ATLSS models, that are used to evaluate alternatives for ecological effects of the Central and Southern Florida Project Restudy, C-111 Project, and Modified Water Deliveries (Modwaters) Plan to Shark Slough. A number of Performance Measures and Success Criteria have been developed to assess Restudy actions that relate directly to the Rocky Glades. These Measures are referable to the Conceptual Models developed for CERP to illustrate stressors and response variables in each major habitat affected by restoration actions. Data from the present study are available to examine the responses of aquatic communities to restored hydrological patterns. The data, and the models that incorporate them, may contribute to defining the reasons behind wading-bird decline as relates to prey availability and abundance.

In addition to the application of these data to modeling, the data collected during these studies represent new information about the composition and adaptations of the surface-water and groundwater communities,and impacts to native fauna from non-indigenous species. The interactions of groundwater and surface-water habitats demonstrate the critical and delicate ecosystem linkages that occur on this karstic landscape. The relationships we describe, and the information we collect, may help managers of other karstic wetlands, as in Mexico, Belize and the Bahamas, better protect their resources.

Though the Rocky Glades have been our focus in this study, introductions of non-indigenous species are a global concern. New introductions of non-natives continue, and in many places, little is being done to understand and counter-act this problem. Invasive species biology is just emerging as a new field of study in Ecology, with new research being reported continuously. In the United States, Florida has one the most species of invasive fishes, second only to California. Research such as this current project brings us closer to understanding the magnitude of ecological damage caused by non-indigenous species. In the Everglades, this topic has economic

considerations as well because restoration funds are prioritized to focus on areas where successful restoration is likely. Restoring the natural hydrology is only part of the overall restoration picture. Understanding the ecological dynamic to which Everglades fauna are currently subjected allows us to make informed decisions and plan restoration activities that ultimately assist native fauna with the challenge of surviving within the harsh Everglades environment.

DATA PRESENTATIONS

Results from several pieces of work supported by this project were presented at three scientific meetings: the International Conference on Aquatic Invasive Species held in Miami in May 2006, the Greater Everglades Ecosystem Restoration meeting in Orlando in June 2006, and the Ecological Society of America Annual Meeting in Memphis in August 2006. The following abstracts were published and presented at those meetings:

Assessing the potential impact of jewel fish *Hemichromis letourneuxi* (Cichlidae) in Everglades marshes: prey selectivity and antipredator response by naïve prey

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Predation is often a major mechanism underlying effects by non-indigenous (NI) fishes. In this study, we examined the susceptibility of Everglades fishes to predation by a recent invader, the jewelfish *Hemichromis letourneuxi*. Little is known about the susceptibility of small-bodied fishes to predation by NI fishes, and whether this susceptibility differs from the predation risk these fishes experience from native predators. Prey susceptibility to predation should intimately relate to the predator's foraging preferences or to the prey's antipredator response. In the case of invasions, several studies show that predation by NI species is strongly affected by the degree of naiveté of the prey species. NI species may prey opportunistically on naive prey that have no common evolutionary history with the non-indigenous predator, and thus lack antipredator responses or show behavioral responses that are ineffective against novel predation.

To examine these questions, we conducted a prey-choice experiment in outdoor mesocosms, and behavioral assays of antipredator response in the laboratory. Mesocosms containing a standardized amount of refuge were stocked with an assemblage of prey species. Prey species included three abundant fish species in Everglades habitats: *Gambusia holbrooki, Poecilia latipinna,* and *Jordanella floridae*. Survivorship of these fishes was quantified in the presence and absence of a native predator, the warmouth *Lepomis gulosus,* and the introduced jewel fish (3 treatments: no predator, native predator, introduced predator). We then quantified antipredator response (i.e., activity, refuge use, and foraging) individually by the three prey species to the jewel fishes and warmouth in timed trials conducted in aquaria. Results showed that predation by jewels was intense and dissimilar from predation by native warmouth and correlated to the degree of antipredator response exhibited by the prey species.

Solution holes in the Rocky Glades region of Everglades National Park: sources or sinks for non-indigenous fishes?

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The Rocky Glades region of Everglades National Park is the only intact remnant of a karstic, short-hydroperiod habitat separating Shark River and Taylor Sloughs. Historically, solution holes throughout this region provided dry-season refuge for aquatic animals, and likely served as the source of fish colonists upon re-flooding of the marsh. Compartmentalization of the Everglades ecosystem through the construction of canals and levees has had a significant impact on Everglades hydrology, decreasing sheet flow and reducing hydroperiods in the Rocky Glades region. In recent years, the incidence and relative abundance of non-indigenous fishes in the Rocky Glades' dry-season refuges have increased, especially *Hemichromis letourneuxi* (African jewelfish), *Cichlasoma bimaculatum* (black acara), and *C. urophthalmus* (Mayan cichlids). These cichlids, however, are notably less common on the marsh surface after re-flooding. It is unclear whether under current water management practices, solution holes serve as sources of marsh colonists upon wet-season re-flooding, and thus, the potential impact of non-indigenous fishes in wet-season Rocky Glades marshes.

We compared the community structure and abundance of fishes in solution holes at the end of the dry season with those of fishes on the surface of adjacent marshes upon wet-season re-flooding. Communities were sampled weekly in 2002-2004: in solution holes throughout the dry season using 3-mm wire mesh minnow traps, and on the marsh surface throughout the wet season in 100-m drift fences with embedded 3-mm mesh wire minnow traps. While the community structure of shallow ($\leq$ 40 cm max. depth) and medium (41-80 cm max. depth) solution holes at the beginning of the dry season is similar to the community found on the marsh surface (dominated by native species, i.e., *Gambusia holbrooki*, *Lepomis marginatus*, *Fundulus confluentus*), these holes dried annually, resulting in 100% mortality. During the dry season, as water levels receded, dissolved oxygen levels decreased dramatically providing an increasingly adverse environment for fishes. Communities surviving until the end of the dry season in deep solution holes ($\geq$ 80 cm max. depth) were dominated by *H. letourneuxi* and *C. urophthalmus*. Comparisons of fish community structure in solution holes and marsh habitats indicate significant inter-annual variation, likely resulting from inter-annual hydrological variation. In the 2002-2003 dry season, water levels remained higher than the 2003-2004 dry season, resulting in similar community structure in dry-season solution hole and wet-season marsh communities. In contrast, the 2003-2004 dry season was more severe and had significantly lower water levels and all but 2 solution holes dried completely. The community structure of these solution holes at the end of the dry season was significantly different from that on the marsh surface upon re-flooding. Although solution holes in the Rocky Glades are dominated by non-indigenous species, they currently serve as sinks for fish communities. Since current Everglades restoration plans include increased water deliveries to this region, it is unclear whether increased hydroperiod will change the function of solution holes, and what impact non-indigenous fishes will have on marsh habitats.

Relative impact of non-indigenous African jewelfish (*Hemichromis letourneuxi* (Cichlidae)) on native Everglades fishes in subterranean dry-season refuges

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The abundance of non-indigenous fishes in the Rocky Glades region of Everglades National Park (ENP) has increased dramatically in the past few years. The Rocky Glades is a short-hydroperiod karst wetland with numerous solution holes that vary from shallow, isolated depressions to deep, interconnected complexes. Solution holes provide refuges for fishes during seasonal dry-downs, and may serve as important sources of marsh colonists upon re-flooding of the marsh surface. Non-indigenous *Hemichromis letourneuxi* (African jewelfish) were first collected in Everglades solution holes in 2000; subsequently, their relative abundances have increased rapidly, especially in medium (41 - 80 cm max. depth) and deep (> 80 cm max. depth) holes. Data collected from fish-community monitoring efforts in 2003 - 2004 indicated native fishes (e.g., *Gambusia holbrooki*, *Fundulus confluentus*, *Jordanella floridae*) were abundant in shallow solution holes (≤ 40 cm max. depth), but were uncommon and often absent in deep solution holes where *H. letourneuxi* was common (comprised ≈ 30% of total CPUE).

In this study, we conducted a predator inclusion/exclusion cage experiment in medium to deep solution holes in ENP to discern whether the absence of small native fishes in deep solution holes is a result of poor physicochemical conditions (e.g., low dissolved oxygen, high ammonia, etc.) or predator-induced mortality by *H. letourneuxi*. We installed two 18-cm diameter cylindrical 2-mm mesh cages containing artificial vegetation in each of 15 solution holes. We then conducted four predation trials through the course of the dry season, as abiotic conditions deteriorated. For each trial, we placed 10 *G. holbrooki* (eastern mosquitofish) in one cage and 10 *G. holbrooki* + 1 *H. letourneuxi* in the second cage. Trials ran for 7 d at which time cages were removed and fish were censused. Physicochemical data (water temperature, pH, conductivity, DO, ammonia) were collected at the beginning and end of each trial. We saw significantly higher mortality of *G. holbrooki* in the presence of *H. letourneuxi* than when the predator was absent, and saw no consistent impact of deteriorating physicochemical conditions on either predator-induced mortality of *G. holbrooki* or on *H. letourneuxi* survival during trials. Additionally, we present a survival analysis of *G. holbrooki* in solution holes through the course of the dry season. Those data were collected from a third cage installed in each solution hole, stocked with 10 *G. holbrooki* (no predator present), and censused weekly until either the hole re-flooded to the marsh surface or there was 100% mortality. Our data suggest that predator-induced mortality by non-indigenous fishes may have a deleterious impact on native fishes in refuges in this system.

Relative Roles of Abiotic Stress and Predation by Non-Indigenous African Jewelfish (*Hemichromis letourneuxi*) on Native Fishes in Rocky Glades Solution Holes

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The abundance of non-indigenous fishes in the Rocky Glades region of Everglades National Park (ENP) has increased markedly in recent years. The Rocky Glades is a short-hydroperiod karst wetland with numerous solution holes that vary from shallow, isolated depressions to deep, interconnected complexes. Solution holes provide refuges for fishes during seasonal drying events, and may serve as a source of marsh colonists upon re-flooding of the marsh surface. The non-indigenous African jewelfish (*Hemichromis letourneuxi*) was first collected in Everglades solution holes in 2000; subsequently, its relative abundance has increased rapidly. This increase was especially apparent in intermediate (41 to 80-cm max. depth) and deep (> 80-cm max. depth) solution holes. Data collected from fish-community monitoring efforts in 2003-04 indicated native fishes (e.g., *Gambusia holbrooki*, *Fundulus confluentus*, *Jordanella floridae*) were abundant in shallow solution holes (≤ 40-cm max. depth), but were uncommon and often absent in deep solution holes where *H. letourneuxi* was common (comprising ≈ 30% of total catch).

In this study, we conducted a predator inclusion/exclusion cage experiment in medium to deep solution holes in ENP to discern whether the absence of small native fishes in deep solution holes is a result of poor physicochemical conditions (e.g., low dissolved oxygen, high ammonia, etc.) or predator-induced mortality by *H. letourneuxi*. We installed two cages in each of 15 solution holes and conducted four predation trials through the course of the dry season as abiotic conditions deteriorated. For each trial, we placed 10 *G. holbrooki* (eastern mosquitofish) in one cage, and 10 *G. holbrooki* and 1 *H. letourneuxi* in the second cage; trials were run for 7 days. Physicochemical data were collected at the beginning and end of each trial. We found significantly higher mortality of *G. holbrooki* in the presence of *H. letourneuxi* than when the predator was absent. There was no consistent impact of deteriorating physicochemical conditions on either predator-induced mortality of *G. holbrooki*, or on *H. letourneuxi* survival during the trials.

We also performed a survival analysis of *G. holbrooki* in solution holes through the course of the dry season. Those data were collected from a third cage installed in each solution hole, stocked with 10 *G. holbrooki* (no predator present), and censused weekly until either the hole re-flooded to the marsh surface or there was 100% mortality. Our data suggest that predator-induced mortality by non-indigenous fishes may be deleterious to native fishes in refuges in southern Florida, and may be more limiting to native fish survival than concomitant abiotic stress.

Assessing the potential impact of African jewelfish *Hemichromis letourneuxi* in Everglades marshes: prey selectivity and antipredator response by native prey

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Predation is often a major mechanism underlying impact by non-indigenous species. We examined the susceptibility of Everglades fishes and macroinvertebrates to predation by a recent invader, the African jewelfish Hemichromis letourneuxi. Susceptibility to predation should intimately relate to predator foraging preferences, as well as to prey antipredator responses. Non-indigenous species may predate opportunistically on naive prey that have no common evolutionary history with the non-indigenous predator, and thus lack antipredator responses or show behavioral responses that are ineffective against novel predation. We conducted a prey-selectivity experiment in outdoor mesocosms, followed by behavioral assays of antipredator response in aquaria. Survivorship of several species was quantified in the presence of a native predator, warmouth, of the non-indigenous jewelfish, and in the absence of predators. The prey included species abundant across a variety of Everglades habitats, stocked in equal densities: eastern mosquitofish, sailfin molly, Florida flagfish, least killifish, bluefin killifish, and grass shrimp. We then quantified foraging behavior, activity, and refuge use of each prey species in the absence and presence of the two predators in timed trials. Predators had similar predation rates but different preferences. Both predators avoided mosquitofish, jewels preferentially consumed shrimp and avoided flagfish. Warmouth behaved as diet generalists, and exhibited no preferences. Antipredator responses differed among prey and in response to predator type. These results suggest that the role jewels may play in the community may be distinct from that of native predators and deserving further attention.

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Table 1. Dates and locations of samples collected in drift-fenced arrays with YSI 600s. Samples include measurements of water temperature, dissolved oxygen, specific conductance, and pH.

Surface Samples	Deployment Dates
Array 2	8/2/04 – 8/9/04
Array 3	8/2/04 – 8/9/04
Array 4	8/2/04 – 8/9/04
Array 5	8/2/04 – 8/9/04
Array 1	10/28/04 – 11/4/04
Array 4	10/28/04 – 11/4/04
Array 1	9/29/05 – 10/06/05
Array 2	9/29/05 – 10/06/05
Array 3	9/29/05 – 10/06/05
Array 4	9/29/05 – 10/06/05
Array 5	9/29/05 – 10/06/05
Total Samples	11

Table 2. Dates and locations of samples collected in solution holes with YSI 600s. Samples include measurements of water temperature, dissolved oxygen, specific conductance, and pH.

Solution Hole Samples	Deployment Dates
Bluebag D	1/27/05 – 2/3/05
3WR D1	1/27/05 – 2/3/05
Bluebag D	5/25/05 – 6/2/05
3HL D	5/25/05 – 6/2/05
MR11 D	5/25/05 – 6/2/05
	5

Table 3. ANOVA results of water depths in the solution holes during the dry season of 2004-05.

Dependent Variable	R^2	Independent Variables	F-Ratio	P
Water Depth	0.710	Depth Category	$F_{2,169} = 89.835$	0.000
		Location	$F_{3,169} = 20.574$	0.000
		Month	$F_{7,169} = 39.010$	0.000

Table 4. ANOVA results of YSI 556 data collected in solution holes during the dry season of 2004-05. YSI samples include measurements of water temperature (°C), dissolved oxygen concentration (mg/l), specific conductance (mS/cm), and pH.

Dependent Variable	R^2	Independent Variables	F-Ratio	P
Temperature	0.780	Depth Category	$F_{2,169}$ = 7.282	0.001
		Location	$F_{3,169}$ = 16.912	0.000
		Month	$F_{7,169}$ = 67.639	0.000
DO Concentration	0.584	Depth Category	$F_{2,169}$ = 12.850	0.000
		Location	$F_{3,169}$ = 21.991	0.000
		Month	$F_{7,169}$ = 12.058	0.000
Specific Conductance	0.571	Depth Category	$F_{2,169}$ = 0.405	0.667
		Location	$F_{3,169}$ = 10.927	0.000
		Month	$F_{7,169}$ = 18.333	0.000
pH	0.689	Depth Category	$F_{1,47}$ = 1.413	0.241
		Location	$F_{3,47}$ = 2.641	0.060
		Month	$F_{2,47}$ = 33.586	0.000

Table 5a. Schedule of 14-day array samples at the onset of flooding in 2005. Array 3 re-flooded prematurely and dried prior to wet-season re-flooding. Daily sampling started over on June 20 when the marsh re-flooded. All other arrays remained flooded throughout the 14-day sample periods.

Arrays	14 - Day Sample Dates
1	June 21 – July 4
2	June 21 – July 4
3	June 4 – June 15; June 20 – July 3
4	June 8 – June 21
5	June 11 – June 24
6	June 20 – July 3

Table 5b. Schedule of daily array samples at the onset of flooding in 2006. The arrays began drying down near the end of the 14-day sampling. Sampling was extended 2-4 days at most arrays to account for sampling days missed due to temporary drying.

Arrays	14 - Day Sample Dates
1	July 15 – July 31
2	July 15 – July 28
3	May 26 – June 13
4	May 26 – June 11
5	May 27 – June 11
6	May 26 – June 13

Table 6a. Monthly array samples collected from July 2004 – October 2005. October 2005 samples were not collected because the park was closed by Hurricane Wilma.

Arrays	July 7/30/04	August 8/31/04	September 9/30/04	October 10/29/04	November 11/29/04	December 12/30/04	January 1/27/05	June 6/24/05	July 7/28/05	August 8/31/05	September 9/29/05
1	X	X		X				X		X	X
2	X	X		X				X		X	X
3	X	X	X	X				X	X	X	X
4	X	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X			X	X	X	X
6	X	X	X	X				X	X	X	X

Table 6b. Monthly array samples collected from November 2005 – September 2006.

Arrays	November 11/30/05	December 12/30/05	January 1/27/06	February 2/28/06	May 5/31/06	June 6/30/06	July 7/28/06	August 8/31/06	September 9/29/06
1							X	X	X
2							X	X	X
3					X	X	X	X	X
4	X	X	X	X	X	X	X	X	X
5					X	X	X	X	X
6					X	X	X	X	X

Table 7. Percent incidence of bycatch species greater than 0.1% collected within the drift-fence arrays from 2004-2006.

Group	Species		Incidence (%)
Amphibians	*Amphiuma means*	Amphiuma	2.3
	Siren lacertina	Greater siren	2.0
	Eumeces inexpectatus	Southern 5-lined skink	0.2
	Acris gryllus	Cricket frog	0.0
	Hyla cinerea	Green tree frog	0.2
	Rana sphenocephala	Southern leopard frog	1.6
	Rana grylio	Pig frog (adults)	0.0
	Bufo quercicus	Oak toad	1.4
	Gastrophryne carolinensis	Eastern narrow-mouthed toad	0.2
	Batrachian larvae	Tadpoles	23.1
Reptiles	*Nerodia taxispilota*	Brown water snake	1.4
	Nerodia fasciata pictiventis	Florida water snake	2.7
	Nerodia fasciata	Banded water snake	3.2
	Nerodia floridana	Florida green water snake	2.3
	Thamnophis sirtalis	Garter snake	0.9
	Thamnophis sauritus	Ribbon snake	1.8
	Coluber constrictor	Black racer	0.2
	Regina alleni	Crayfish Snake	0.7
	Agkistrodon piscivorus	Cottonmouth	0.2
Invertebrates	Dytiscidae	Predaceous diving beetle	33.2
	Cybister sp .larva	Predaceous diving beetle	1.1
	Gyrinid sp.	Whirligig beetle	3.0
	Palemonetes paludosus	Grass shrimp	4.0
	Procambarus alleni	Everglades crayfish	49.0
	Procambarus fallax	Slough crayfish	0.0
	Pelocoris sp.	Alligator flea	3.8
	Belostoma sp.	Giant water bug	17.0
	Lethocerus sp.	Toe biter	35.7
	Dolomedes sp.	Fishing spider	4.1
	Anisopteran naiads	Dragonfly larvae	1.6
	Ranatra sp.	Water scorpion	0.5
	Planorbella duryi	Seminole snail	7.5
	Pomacea paludosus	Apple snail	2.5

Table 8. Total number and relative abundance of fish species collected in the monthly arrays samples from July 2004 – September 2006.

Species	Number of Fishes Collected	Relative Abundance
Gambusia holbrooki	2681	37.1%
Lepomis marginatus	1872	26.5%
Hemichromis letourneuxi	786	11.1%
Jordanella floridae	587	8.3%
Fundulus confluentus	581	8.2%
Poecilia latipinna	91	1.3%
Fundulus chrysotus	91	1.3%
Lepomis gulosus	84	1.2%
Enneacanthus gloriosus	77	1.1%
Cichlasoma urophthalmus	55	0.8%
Belonesox belizanus	52	0.7%
Heterandria formosa	38	0.5%
Lucania goodei	24	0.3%
Cichlasoma bimaculatum	14	0.2%
Lepomis punctatus	10	0.1%
Cyprinodon variegatus	4	<0.1%
Cichlasoma managuense	4	<0.1%
Aphredoderus sayanus	4	<0.1%
Esox americanus	4	<0.1%
Elassoma evergladei	3	<0.1%
Noturus gyrinus	2	<0.1%
Lepomis microlophus	2	<0.1%
Ameiurus natalis	1	<0.1%
Lepisosteus platyrhincus	1	<0.1%
Lucania parva	1	<0.1%
Tilapia mariae	1	<0.1%
Oreochromis aureus	1	<0.1%
Hoplosternum littorale	1	<0.1%
Total	7072	100.0%

Non-indigenous species

Table 9. ANOVA results comparing total fish CPUE and Non-indigenous fish CPUE with physical variables at the drift-fence arrays during monthly monitoring.

Dependent Variable	R^2	Independent Variables	F-Ratio	P
Total Fish CPUE	0.940	Year	$F_{2,190}$ = 0.536	0.586
		Month of Sample	$F_{7,190}$ = 1.248	0.279
		Location	$F_{5,190}$ = 0.912	0.474
		Trap Orientation	$F_{3,190}$ = 1.620	0.186
		Flow Direction	$F_{4,190}$ = 1.790	0.656
Non-Indigenous CPUE	0.379	Year	$F_{2,74}$ = 1.673	0.195
		Month of Sample	$F_{7,74}$ = 1.235	0.295
		Location	**$F_{5,74}$ = 3.395**	**0.008**
		Trap Orientation	$F_{3,74}$ = 0.184	0.907
		Flow Direction	$F_{3,74}$ = 1.322	0.274

*** Bold variables were significant**

Table 10. Linear Regression and associated ANOVA results comparing total fish CPUE and Non-indigenous fish CPUE with continuous variables (hydroperiod (days flooded in 2004 and 2006), water depth (cm), water temperature (°C), flow velocity (s/cm), and rain accumulation (inches)) at the drift-fence arrays during monthly monitoring.

Dependent Variable	R^2	Independent Variables	F-Ratio	P
Total Fish CPUE	0.003	Hydroperiod	$F_{1,10}$ = 0.027	0.87
	0.001	Water Depth	$F_{1,210}$ = 0.232	0.63
	0.005	Water Temperature	$F_{1,206}$ = 1.086	0.29
	0.010	Flow Velocity	$F_{1,159}$ = 1.594	0.20
	0.011	Rain Accumulation	$F_{1,123}$ = 1.318	0.25
Non-Indigenous CPUE	0.068	Hydroperiod	$F_{1,10}$ = 0.732	0.41
	0.129	**Water Depth**	**$F_{1,93}$ = 13.828**	**0.00**
	0.026	Water Temperature	$F_{1,91}$ = 2.476	0.11
	0.010	Flow Velocity	$F_{1,64}$ = 0.663	0.41
	0.001	Rain Accumulation	$F_{1,54}$ = 0.005	0.94

*** Bold variables were significant**

Table 11a. ANOVA results testing the influence of spatial (array location) and temporal (month of flooding and year) variables on the CPUE of common native species.

Dependent Variable	R^2	Independent Variables	F-Ratio	P
G. holbrooki	0.212	Array Location	$F_{5,137}$ = 1.195	0.315
		Month Flooded	**$F_{7,137}$ = 3.968**	**0.001**
		Year	$F_{2,137}$ = 1.288	0.279
L. marginatus	0.133	Array Location	$F_{5,126}$ = 0.976	0.435
		Month Flooded	$F_{7,126}$ = 1.379	0.220
		Year	$F_{2,126}$ = 1.172	0.313
J. floridae	0.251	Array Location	$F_{5,80}$ = 1.990	0.890
		Month Flooded	**$F_{7,80}$ = 2.085**	**0.050**
		Year	$F_{2,80}$ = 2.701	0.073

Table 11b. ANOVA results testing the influence of spatial (array location) and temporal (month of flooding and year) variables on the CPUE of the Everglades crayfish (*Procambarus alleni*).

Dependent Variable	R^2	Independent Variables	F-Ratio	P
Procambarus alleni	0.183	Array Location	$F_{5,112}$ = 1.234	0.298
		Month Flooded	**$F_{7,112}$ = 1.957**	**0.053**
		Year	$F_{2,112}$ = 0.239	0.788

Table 11c. ANOVA results testing the influence of spatial (array location) and temporal (month of flooding and year) variables on the CPUE of common non-indigenous species.

Dependent Variable	R^2	Independent Variables	F-Ratio	P
H. letourneuxi	0.427	Array Location	$F_{5,44}$ = 1.923	0.110
		Month Flooded	**$F_{7,44}$ = 2.977**	**0.012**
		Year	$F_{2,44}$ = 0.014	0.986
B. belizanus	0.285	Array Location	$F_{4,11}$ = 0.527	0.719
		Month Flooded	$F_{6,11}$ = 0.150	0.985
		Year	$F_{2,11}$ = 0.596	0.568
C. urophthalmus	0.550	Array Location	**$F_{4,20}$ = 3.002**	**0.043**
		Month Flooded	$F_{6,20}$ = 1.838	0.142
		Year	$F_{2,20}$ = 0.541	0.590

*** Bold variables were significant**

Table 12. Total number and relative abundance of fish species collected in the daily arrays from July 2005 – September 2006 (Note: 2004 daily data were reported in Loftus et al 2004.)

Species	Number of Fishes Collected	Relative Abundance
Gambusia holbrooki	5822	37.2%
Lepomis marginatus	4012	25.7%
Jordanella floridae	1882	12.0%
Heterandria formosa	1125	7.2%
Fundulus confluentus	1021	6.5%
Poecilia latipinna	577	3.7%
Lucania goodei	405	2.6%
Fundulus chrysotus	256	1.6%
Cyprinodon variegatus	118	0.8%
Lepomis gulosus	94	0.6%
Enneacanthus gloriosus	78	0.5%
Cichlasoma bimaculatum	68	0.4%
Belonesox belizanus	64	0.4%
Hemichromis letourneuxi	30	0.2%
Elassoma evergladei	24	0.2%
Cichlasoma urophthalmus	12	0.1%
Hoplosternum littorale	8	0.1%
Lepomis punctatus	7	<0.1%
Ameiurus natalis	5	<0.1%
Micropterus salmoides	4	<0.1%
Notropis maculatus	4	<0.1%
Noturus gyrinus	4	<0.1%
Labidesthes sicculus	4	<0.1%
Lepomis microlophus	3	<0.1%
Clarias batrachus	2	<0.1%
Lepisosteus platyrhincus	1	<0.1%
Lepomis macrochirus	1	<0.1%
Esox americanus	1	<0.1%
Oreochromis aureus	1	<0.1%
Total	15,633	100%

Non-indigenous species

Table 13. ANOVA Results for trap orientation and Mean CPUE at the drift-fence arrays during the daily samples in 2005 and 2006.

Location	***F***	***P***	$\mathbf{R^2}$
Array 1	$F_{2,57}$ = 8.655	0.001	0.233
Array 2	$F_{2,78}$ = 17.599	0.000	0.311
Array 3	$F_{2,69}$ = 9.932	0.000	0.224
Array 4	$F_{2,72}$ = 13.823	0.000	0.277
Array 5	$F_{3,104}$ = 1.473	0.226	0.041
Array 6	$F_{3,89}$ = 3.863	0.012	0.115
All Locations	$\mathbf{F_{3,485}}$ **= 12.142**	**0.000**	**0.07**

Table 14. Relative abundances of fishes sampled with throw traps vs. drift-fence array minnow traps. Sampling occurred at array #4 on January 13, 2006.

Throw Traps	RA	Array Minnow Traps	RA
Gambusia holbrooki	30.6%	*Lepomis marginatus*	39.5%
Fundulus chrysotus	24.5%	*Fundulus confluentus*	24.4%
Lepomis marginatus	10.2%	*Gambusia holbrooki*	14.0%
Fundulus confluentus	8.2%	*Jordanella floridae*	5.8%
Lucania goodei	8.2%	*Hemichromis letourneuxi*	5.8%
Heterandria formosa	4.1%	*Poecilia latipinna*	4.7%
Hemichromis letourneuxi	4.1%	*Cichlasoma urophthalmus*	2.9%
Poecilia latipinna	2.0%	*Fundulus chrysotus*	1.8%
Jordanella floridae	2.0%	*Belonesox belizanus*	1.2%
Lepomis gulosus	2.0%		
Lepomis punctatus	2.0%		
Belonesox belizanus	2.0%		

Table 15. ANOVA results showing variation in the CPUE of fishes sampled with throw traps vs. drift-fence array minnow traps. Sampling occurred at array #4 on January 13, 2006.

	R^2	F	P
Gambusia holbrooki	**0.424**	**$F_{1,9}$ = 6.20**	**0.030**
Poecilia latipinna			
Fundulus confluentus	**0.867**	**$F_{1,4}$ = 26.115**	**0.007**
Jordanella floridae	0.299	$F_{1,2}$ = 0.853	0.453
Heterandria formosa			
Lucania goodei			
Fundulus chrysotus	0.001	$F_{1,8}$ = 0.010	0.922
Lepomis gulosus			
Lepomis punctatus			
Lepomis marginatus	**0.917**	**$F_{1,5}$ = 55.035**	**0.001**
Cichlasoma urophthalmus			
Belonesox belizanus			
Hemichromis letourneuxi	**0.785**	**$F_{1,3}$ = 10.974**	**0.045**
Total CPUE	**0.814**	**$F_{1,15}$ = 65.716**	**0.000**

*** Significant results are in bold**

* *P. latipinna, H. formosa, L. goodei, F. gulosus, L. punctatus, C. urophthalmus,* and *B. belizanus* were only collected once. Therefore, ANOVAs were not performed.

Table 16. Catch Per Unit Effort (CPUE) of fishes collected during the diel drift-fence array samples in October 2005.

Time	October 3-4, 2005 (New Moon)	October 17-18, 2005 (Full Moon)
1200 h	590	485
1800 h	718	529
2400 h	78	60
0600 h	9	78

Table 17. Monthly solution-hole samples collected from November 2004 – May 2005.

Solution Holes	Depth Category	September 9/30/04	November 11/30/04	December 12/30/04	January 1/27/05	February 2/25/05	March 3/31/05	April 4/28/05	May 5/25/05
1HL	M1			X	X	X		X	X
1HL	M2			X	X	X	X	X	X
1WR	S								
1WR	D	X	X	X	X	X	X	X	X
2HL	S			X	X				
2MB	D	X		X	X	X	X	X	X
2MB	M	X		X	X				
2WR	D	X	X	X	X	X	X	X	X
2WR	M	X	X	X					
3HL	D2			X	X	X	X	X	X
3HL	M			X	X	X	X	X	
3HL	D1			X	X	X	X	X	X
3HL	S			X	X				
3MB	M1	X		X					
3MB	M2	X		X	X				
3SB	M	X		X					
3WR	D1	X	X	X	X	X	X	X	
3WR	D2	X	X	X	X	X	X	X	X
4MA	M1	X	X	X	X				
4MA	M2	X	X	X	X				
4MB	D1	X	X	X	X				
4MB	D2	X	X	X	X				
4WR	M	X	X						
4WR	D	X	X	X	X	X	X	X	X
5SA	S1		X						
5SA	S2		X						
5SB	D		X	X	X				

(TABLE 17 continued…)

Solution Holes	Depth Category	September 9/30/04	November 11/30/04	December 12/30/04	January 1/27/05	February 2/25/05	March 3/31/05	April 4/28/05	May 5/25/05
5SB	M		X	X					
BLUEBAG	M	X	X	X	X				
BLUEBAG	D	X	X	X	X	X	X	X	
MR10	M		X	X	X				
MR10	D		X	X	X				
MR11	D		X	X	X	X	X	X	X
MR11	M		X	X					
MR7	D	X	X	X	X		X	X	
MR7	M	X	X	X		X			
MR8	D1	X	X	X	X	X	X	X	X
MR8	D2	X	X	X	X	X	X		
MR9	D1	X	X	X	X	X	X	X	
MR9	M	X	X	X	X				

Table 18. Presence/absence from trap data and observations of fish species in solution holes for each month of sampling.

Month	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosternum littorale*
September	Shallow																						
	Medium	X	X	X		X				X			X	X		X				X	X	X	
	Deep	X	X			X				X			X							X		X	
November	Shallow	X	X										X										
	Medium	X	X			X	X	X	X	X			X			X				X		X	
	Deep	X	X			X		X		X	X		X		X	X	X		X	X		X	X
December	Shallow	X	X		X					X		X							X	X		X	
	Medium	X	X		X	X	X			X	X	X	X		X				X	X		X	
	Deep	X	X			X		X	X	X		X	X		X	X		X	X	X		X	X
January	Shallow	X	X							X													
	Medium	X								X		X	X				X					X	
	Deep	X	X					X		X	X	X	X		X		X	X		X		X	
February	Shallow																						
	Medium	X						X		X			X		X				X		X	X	
	Deep	X	X					X		X			X		X	X		X		X		X	
March	Shallow																						
	Medium							X		X			X		X				X	X		X	
	Deep		X					X		X			X		X			X	X	X		X	
April	Shallow																						
	Medium	X	X										X						X			X	
	Deep		X							X			X		X	X	X	X	X	X	X	X	
May	Shallow																						
	Medium																						
	Deep	X	X					X		X					X	X		X					

Table 19. Relative abundance of fish species collected in all solution holes during the dry season of 2004-05.

Species	RA
Poecilia latipinna	27.7%
Gambusia holbrooki	20.8%
Hemichromis letourneuxi	14.6%
Lepomis marginatus	7.9%
Lepomis gulosus	5.8%
Jordanella floridae	4.3%
Cichlasoma bimaculatum	3.5%
Ameiurus natalis	3.4%
Cichlasoma urophthalmus	2.6%
Belonesox belizanus	2.4%
Oreochromis aureus	1.9%
Clarias batrachus	1.1%
Fundulus confluentus	0.8%
Lepomis microlophus	0.5%
Lepomis punctatus	0.5%
Tilapia mariae	0.5%
Fundulus chrysotus	0.4%
Cyprinodon variegatus	0.3%
Cichlasoma managuense	0.3%
Hoplosternum littorale	0.3%
Noturus gyrinus	0.2%
Enneacanthus gloriosus	0.1%

Table 20. Relative abundances of species collected in deep (> 80 cm), medium (41 – 80 cm), and shallow (0-40 cm) solution holes during the dry season of 2004-05 (September – April).

Deep Solution Holes	RA	Medium Solution Holes	RA	Shallow Solution Holes	RA
Poecilia latipinna	33.0%	*Gambusia holbrooki*	30.0%	*Gambusia holbrooki*	45.8%
Hemichromis letourneuxi	15.5%	*Poecilia latipinna*	19.0%	*Poecilia latipinna*	27.1%
Gambusia holbrooki	13.1%	*Hemichromis letourneuxi*	15.0%	*Lepomis gulosus*	10.4%
Lepomis marginatus	7.6%	*Lepomis marginatus*	9.2%	*Fundulus confluentus*	4.2%
Lepomis gulosus	5.9%	*Jordanella floridae*	6.7%	*Cichlasoma urophthalmus*	4.2%
Ameiurus natalis	5.0%	*Lepomis gulosus*	4.9%	*Lepomis punctatus*	2.1%
Cichlasoma bimaculatum	5.0%	*Cichlasoma urophthalmus*	4.0%	*Lepomis marginatus*	2.1%
Jordanella floridae	3.1%	*Belonesox belizanus*	1.8%	*Belonesox belizanus*	2.1%
Oreochromis aureus	3.1%	*Fundulus confluentus*	1.5%	*Hemichromis letourneuxi*	2.1%
Belonesox belizanus	2.8%	*Cichlasoma bimaculatum*	1.5%	*Cyprinodon variegatus*	0.0%
Clarias batrachus	1.7%	*Fundulus chrysotus*	1.2%	*Jordanella floridae*	0.0%
Cichlasoma urophthalmus	1.7%	*Ameiurus natalis*	1.2%	*Fundulus chrysotus*	0.0%
Lepomis microlophus	0.7%	*Cyprinodon variegatus*	0.9%	*Ameiurus natalis*	0.0%
Tilapia mariae	0.7%	*Cichlasoma managuense*	0.9%	*Noturus gyrinus*	0.0%
Hoplosternum littorale	0.6%	*Lepomis punctatus*	0.6%	*Lepomis microlophus*	0.0%
Lepomis punctatus	0.4%	*Noturus gyrinus*	0.3%	*Enneacanthus gloriosus*	0.0%
Noturus gyrinus	0.2%	*Lepomis microlophus*	0.3%	*Cichlasoma bimaculatum*	0.0%
Cyprinodon variegatus	0.0%	*Enneacanthus gloriosus*	0.3%	*Clarias batrachus*	0.0%
Fundulus confluentus	0.0%	*Clarias batrachus*	0.3%	*Tilapia mariae*	0.0%
Fundulus chrysotus	0.0%	*Tilapia mariae*	0.3%	*Oreochromis aureus*	0.0%
Enneacanthus gloriosus	0.0%	*Oreochromis aureus*	0.0%	*Cichlasoma managuense*	0.0%
Cichlasoma managuense	0.0%	*Hoplosternum littorale*	0.0%	*Hoplosternum littorale*	0.0%

Table 21. Fish in shallow, medium, and deep solution holes in the 2004-2005 dry-season. Average abundance (±standard error (SE)) per hole is based on minnow trap CPUE (24 h soak time). Incidence of presence (I_p) is percentage of site visits where species was observed and/or captured. Incidence of capture (I_c) is percentage of site visits where species was captured with minnow traps. Number of samples (N) is indicated for each depth category.

	Shallow (N = 24)			Medium (N = 197)			Deep (N = 261)		
Species	$\overline{X}$ (±SE)	I_p	I_c	$\overline{X}$ (±SE)	I_p	I_c	$\overline{X}$ (±SE)	I_p	I_c
Ameiurus natalis		0	0	0.03 (±0.02)	2.4	2.4	0.18 (±0.05)	13.3	8.7
Belonesox belizanus	0.02 (±0.02)	2.2	2.2	0.05 (±0.03)	3.9	3.1	0.10 (±0.04)	10.0	5.3
Cichlasoma bimaculatum		0	0	0.04 (±0.02)	3.9	3.1	0.18 (±0.06)	16.7	10.0
Cichlasoma managuense		0	0	0.02 (±0.02)	1.6	1.6		0	0
Cichlasoma urophthalmus	0.04 (±0.04)	2.2	2.2	0.10 (±0.05)	3.9	3.9	0.06 (±0.03)	4.0	2.7
Clarias batrachus		0	0	<0.00(± <0.00)	1.6	0.8	0.06 (±0.03)	7.3	3.3
Cyprinodon variegatus		0	0	0.02 (±0.02)	0.8	0.8		0	0
Elassoma evergladei		0	0		0	0		0	0
Enneacanthus gloriosus		0	0	<0.00(± <0.00)	0.8	0.8		0	0
Fundulus chrysotus		0	0	0.03 (±0.02)	2.4	2.4		0	0
Fundulus confluentus	0.04 (±0.03)	4.4	4.4	0.04 (±0.02)	3.1	3.1		0	0
Gambusia holbrooki	0.47 (±0.29)	8.9	8.9	0.77 (±0.20)	20.5	18.1	0.47 (±0.15)	19.3	11.3
Hemichromis letourneuxi	0.02 (±0.02)	2.2	2.2	0.38 (±0.12)	13.4	13.4	0.56 (±0.19)	18.0	16.0
Heterandria formosa		0	0		0	0		0	0
Hoplosternum littorale		0	0		0	0	0.02 (±0.01)	2.0	2.0
Jordanella floridae		0	0	0.17 (±0.10)	3.9	3.9	0.11 (±0.06)	4.0	4.0
Lepomis gulosus	0.11 (±0.06)	6.7	6.7	0.13 (±0.04)	8.7	8.7	0.21 (±0.06)	13.3	12.7
Lepomis macrochirus		0	0		0	0		0	0
Lepomis marginatus	0.02 (±0.02)	2.2	2.2	0.23 (±0.05)	16.5	15.7	0.27 (±0.07)	15.3	14.0
Lepomis microlophus		0	0	<0.00(± <0.00)	0.8	0.8	0.02 (±0.02)	1.3	1.3
Lepisosteus platyrhincus		0	0		0	0		0	0
Lepomis punctatus	0.02 (±0.02)	2.2	2.2	0.02 (±0.01)	1.6	1.6	0.01 (±0.01)	2.0	1.3
Lepomis spp.		0	0		0	0		0	0
Lucania goodie		0	0		0	0		0	0
Micropterus salmoides		0	0		0	0		0	0
Noturus gyrinus		0	0	<0.00(± <0.00)	0.8	0.8	<0.00(± <0.00)	0.7	0.7
Oreochromis aureus		0	0		0	0	0.11 (±0.05)	5.3	4.7
Poecilia latipinna	0.28 (±0.17)	6.7	6.7	0.48 (±0.22)	9.4	8.7	1.19 (±0.33)	18.7	16.7
Tilapia mariae		0	0	<0.00(± <0.00)	0.8	0.8	0.03 (±0.02)	4.0	1.3
Total Fish	1.02 (±0.56)			3.47 (±0.50)			3.61 (±0.51)		

Table 22. Coordinates, average water depth, and average water temperature of solution holes used in the priority effects/depletion study conducted 31 January to 07 February 2006. Water depths and temperatures represent averages of daily measurements.

Solution Hole	Latitude (N)	Longitude (W)	Average Water Depth (cm ± SE)	Average Water Temperature (°C ± SE)
01	25° 25.0866’	80° 34.7220’	65.4 ± 1.4	19.5 ± 0.6
02	25° 25.0758’	80° 34.7892’	123.4 ± 2.5	19.5 ± 0.3
03	25° 25.0752’	80° 34.8348’	104.4 ± 1.4	21.6 ± 0.5
04	25° 24.4350’	80° 36.9996’	34.1 ± 2.1	21.6 ± 0.4
05	25° 24.4332’	80° 36.9996’	58.1 ± 0.6	19.3 ± 0.4
06	25° 25.4514’	80° 39.2544’	55.9 ± 3.8	20.5 ± 0.3
07	25° 25.5018’	80° 39.3168’	53.3 ± 4.2	19.5 ± 0.2
08	25° 26.1384’	80° 41.7534’	25.2 ± 5.1	22.4 ± 0.6
09	25° 26.1774’	80° 41.7306’	35.6 ± 5.1	20.6 ± 0.6
10	25° 26.0154’	80° 44.1006’	57.3 ± 3.8	20.0 ± 0.4

Table 23. Number of stocked *G. holbrooki* and *H. letourneuxi* from priority effects experiment recovered in minnow traps.

Solution Hole	*G. holbrooki* Recovered (10 stocked)	*H. letourneuxi* Recovered (2 stocked)
01	0	2[a]
02	10[b]	2[b]
03	0	2
04	1	2[c]
05	1	1[d]
06	0	1[e]
07	1	1
08	4[f]	1[g]
09	0	0
10	0	2[h]

[a] recovered in control trap
[b] recovered dead
[c] 1 recovered in control trap, 1 in prey trap
[d] recovered in prey trap
[e] recovered in control trap
[f] 2 recovered in control trap, 1 in prey trap, 1 in predator trap
[g] recovered in predator trap on 02/01/06 (day 2)
[h] 1 recovered in predator trap, 1 in control trap

Table 24. Number, relative abundance, and rank of fish captured on Day 1 (priority effects experiment) (A) and across all days (B).

	A. Day 1 (Priority Effects Experiment)			B. All Days		
Species	N	Relative Abundance (%)	Rank	N	Relative Abundance (%)	Rank
Ameiurus natalis	81	25.0	1	118	17.2	3
*Belonesox belizanus**	13	4.0	7	32	4.7	6
*Cichlasoma bimaculatum**	34	10.5	4	145	21.1	2
*Cichlasoma managuense**	8	2.5	9	16	2.3	10
*Cichlasoma urophthalmus**	8	2.5	9	28	4.1	8
*Clarias batrachus**	12	3.7	8	29	4.2	7
Enneacanthus gloriosus	1	0.3	11	2	0.3	15
Esox americanus	0			1	0.1	16
Gambusia holbrooki	1	0.3	11	1	0.1	16
*Hemichromis letourneuxi**	80	24.7	2	168	24.5	1
*Hoplosternum littorale**	0			5	0.7	12
Lepomis gulosus	38	11.7	3	65	9.5	4
Lepomis marginatus	14	4.3	6	26	3.8	9
Lepomis punctatus	1	0.3	11	10	1.5	11
Lepomis spp.	0			1	0.1	16
*Macrognathus siamensis***	0			3	0.4	14
Poecilia latipinna	30	9.3	5	33	4.8	5
*Tilapia mariae**	3	0.9	10	4	0.6	13
Total fish	354			687		

* Non-indigenous

** First recorded capture in the Rocky Glades region of Everglades National Park (non-indigenous)

Table 25. Visual observations of fish in solution holes on the last day of the priority effects/depletion study (fish observed remaining after 8 days of continuous trapping).

Solution Hole	Fish observed	Notes
01	None	
02	None	
03	*C. bimaculatum* (numerous), *B. belizanus* (numerous), *L. gulosus* (numerous), *L. punctatus*, *C. urophthalmus*, *A. natalis*, *C. managuense*, *O. aureus*	Numerous large cichlids, sunfish, and catfish
04	*C. bimaculatum* (numerous), *L. marginatus*, *L. gulosus*, *T. mariae*, *C. managuense*, *C. urophthalmus*	
05	*B. belizanus*	
06	*C. bimaculatum*, *L. punctatus*, *C. urophthalmus*	Numerous fish in hole- many are too large to enter traps
07	*C. bimaculatum*	
08	None	
09	*G. holbrooki*, *L. marginatus*	
10	*C. bimaculatum*, sunfish	

Table 26. Results of ANOVA conducted on fish collected in priority effects/depletion study 02/03/06 (no bait) and 02/04/06 (baited).

	Hole		Bait		Hole x Bait	
Species	$F_{9,59}$	P	$F_{1,59}$	P	P	R^2
Ameiurus natalis	2.19	**0.043**	7.88	**0.008**	0.855	0.447
Cichlasoma bimaculatum	2.44	**0.026**		0.098	0.263	0.478
Hemichromis letourneuxi	2.26	**0.038**		0.733	0.993	0.357
Lepomis gulosus	2.20	**0.042**		0.279	0.505	0.424
Total fish	4.52	**<0.001**	12.50	**0.001**	0.684	0.599

Table 27. Two-way crossed analyses of variance (location (trapped (T), not-trapped (NT) x sex (M, F)) of standard lengths (SL), masses, and condition factors (K) of *G. holbrooki* in trap efficiency experiment. Analyses exclude one juvenile individual (< 17.0 mm), and were conducted on all size classes (A) and small fish (SL ≤ 19.0 mm) only (B).

	Metric	*Factor*	*P*	*F*	R^2	$\overline{X} \pm SE$
A. All Size Classes	SL (mm)	Location	0.831		0.246	
		Sex	**<0.001**	$F_{1,344}$=104.13		$\overline{X}_M$= 21.452±0.193; $\overline{X}_F$= 25.895±0.313
		Location * Sex	0.595			
	mass (g)	Location	0.283		0.245	
		Sex	**<0.001**	$F_{1,341}$=100.97		$\overline{X}_M$= 0.241±0.008; $\overline{X}_F$= 0.483±0.018
		Location * Sex	0.680			
	K	Location	**0.051**	$F_{1,341}$=3.848	0.026	$\overline{X}_T$= 2.453±0.043; $\overline{X}_{NT}$= 2.578±0.038
		Sex	**0.040**	$F_{1,341}$=4.258		$\overline{X}_M$= 2.402±0.064; $\overline{X}_F$= 2.549±0.033
		Location * Sex	0.711			
B. Small Fish Only	SL (mm)	Location	0.171			
		Sex	0.334			
		Location * Sex	0.775			
	mass (g)	Location	**0.007**	$F_{1,20}$=8.882	0.390	$\overline{X}_T$= 0.116±0.006; $\overline{X}_{NT}$= 0.180±0.018
		Sex	0.704			
		Location * Sex	0.609			
	K	Location	**0.012**	$F_{1,20}$=7.596	0.379	$\overline{X}_T$= 1.941±0.116; $\overline{X}_{NT}$= 2.847±0.249
		Sex	0.973			
		Location * Sex	0.451			

Table 28. Two-way crossed analyses of variance (location (trapped (T), not-trapped (NT) x sex (M, F)) of standard lengths (SL), masses, and condition factors (K) of *P. latipinna* in trap efficiency experiment.

Metric	*Factor*	*P*	*F*	R^2
SL (mm)	Location	**< 0.001**	$F_{1,355}$=16.41	0.065
	Sex	0.695		
	Location * Sex	**< 0.001**	$F_{1,355}$=17.98	
Mass (g)	Location	**< 0.001**	$F_{1,355}$=12.79	0.064
	Sex	0.368		
	Location * Sex	**< 0.001**	$F_{1,355}$=16.28	
K	Location	0.398		
	Sex	0.757		
	Location * Sex	0.362		

Table 29. Location and physical description of solution holes used in predator inclusion/exclusion study. Geologic complexity was estimated on a relative scale.

Region	Hole	UTM (E)	UTM (N)	Max. Hole Depth (cm)	Geologic Complexity (1=min, 5=max)	Circ. (cm)	Max. Length (cm)	Max. Width (cm)	Substrate Depth (cm)	Veg. Cover (%)	Macrophyte species present
	01	542367	2811315	90	3	388	196	82	27	5	*Proserpinaca* spp.
	02	542257	2811303	135	4	589	138	99	21	0	
BR	03	542166	2811302	124	4	1208	149	196	6	15	*Ludwigia repens, Cladium jamaicense*
	04	542040	2811324	79	2	390	140	130	9	0	
	05	541895	2811275	88	3	344	84	85	60	0	
	06	538635	2810041	91	3	505	132	98	5	0	
	07	538622	2809977	70	1	584	170	100	40	0	
MR	08	538596	2810036	96	4	470	125	97	5	0	
	09	538554	2810024	74	3	558	130	74	15	0	
	10	538556	2810097	82	3	556	151	110	13	0	
	11	534009	2811486	147	2	584	150	146	18.5	0	
	12	535344	2811848	160	4	305	81	78	26	0	
WR	13	534771	2811962	118	2	573	150	139	43	0	
	14	534669	2812047	149	3	709	172	104	20	65	*Sagittaria lancifolia*
	15	534572	2812323	200	4	375	90	83	*	0	

* could not be determined due to hole depth

Table 30. The duration that experimental solution holes remained in abiotic-stress experiment, and reasons for ending experiment in each case. Water level in each hole also determined whether holes were available for predation trials (predation trials were also discontinued in holes whose long-term cage suffered 100% *G. holbrooki* mortality). Holes that were used for predation trials (T_1 (16-23 Feb 05), T_2 (03-10 Mar 05), T_3 (17-24 Mar 05), T_4 (06-13 Apr 05)) are indicated with an "X".

		Abiotic Stress Experiment		Predation Trials			
Region	Hole	'Day' Study Ended	Reason for ending	T_1	T_2	T_3	T_4
BR	01	115	**	X	X	X	X
	02	115	re-flooded	X	X	X	X
	03	115	re-flooded	X	X	X	X
	04	38	re-flooded*	X	X	X	
	05	115	re-flooded	X	X	X	X
MR	06	80	dry-down	X	X	X	X
	07	115	**	X	X	X	X
	08	115	re-flooded	X	X	X	X
	09	17	dry-down				
	10	115	**	X	X	X	X
WR	11	115	**	X	X	X	X
	12	115	**	X	X	X	X
	13	101	dry-down	X	X	X	X
	14	73	dry-down	X	X	X	X
	15	31	100% mortality	X	X		

* Rain event caused solution hole to overflow briefly and fish were able to escape from cage.

** Experiment was ended with re-flooding of most sites. These sites did not re-flood completely, but most were expected to re-flood during the following week with the beginning of heavy summer rains.

Table 31. Three-way factorial analysis of variance (Region (Boundary Road, Main Park Road, Wilderness Road) x Predator (*H. letourneuxi* present, *H. letourneuxi* absent) x Trial (T_1 (16-23 Feb 05), T_2 (03-10 Mar 05), T_3 (17-24 Mar 05), T_4 (06-13 Apr 05))) of proportion of *G. holbrooki* mortality in predation trials. Cases where *H. letourneuxi* died prior to the end of the trial were excluded from analyses.

		Model $R^2 = 0.718$
Factor	*P*	*F*
Region	0.006	$F_{2,71} = 5.440$
Predator	< 0.001	$F_{1,71} = 119.938$
Trial	0.079	
Region x Predator	0.837	
Region x Trial	0.015	$F_{6,71} = 2.847$
Predator x Trial	0.500	
Region x Predator x Trial	0.107	

Table 32. Mean predator and prey sizes and weights of animals used in the experiment. Mean prey measurements are estimated from prey recovered at end of trial.

	Species	Size (mm)	Weight (g)
Prey			
	Mosquitofish	16.15 ± 0.14*	0.084 ± 0.005
	Sailfin molly	19.37 ± 0.24	0.19 ± 0.007
	Bluefin killifish	20.87 ± 0.24	0.14 ± 0.005
	Least killifish	12.79 ± 0.12	0.049 ± 0.004
	Florida flagfish	20.58 ± 0.13	0.28 ± 0.006
	Grass shrimp	6.31 ± 0.08**	0.079 ± 0.003
Predator			
	Jewel cichlid	57.06 ± 2.0	6.50 ± 0.58
	Warmouth	55.69 ± 0.2	6.39 ± 0.79

* Fish sizes correspond to standard length
** Shrimp sizes correspond to carapace length

Table 33. Rocky Glades *Hemichromis letourneuxi* diet data from four seasons, based on gut-content analysis (N=fish sampled). Volume and numerical prey percentages greater than 5 % are **emboldened**. N/A for prey number indicates an item that cannot be counted. Mean per fish is the average volume or number of a prey taxon in an individual fish in that sample.

	% Prey Volume				% Prey Number			
	Aug-05	Jan-06	May-06	Jul-06	Aug-05	Jan-06	May-06	Jul-06
Plants								
Algae			1.05%				N/A	
Detrital/Algal Mix	0.0%	0.01%			N/A	N/A		
Crustaceans								
Decapoda Parts	1.6%				N/A			
Ostracoda	0.04%	0.01%	0.02%	0.00%	3.85%	3.00%	**11.11%**	2.33%
Hyalella azteca		0.17%				**6.10%**		
Cladocera	0.04%	0.01%		0.00%	3.8%	3.00%		2.33%
Procambarus alleni		**10.28%**		2.56%		3.00%		**14.0%**
Palaemonetes paludosus		1.51%	0.84%	0.12%		3.00%	**11.11%**	2.3%
Insects								
Insecta Parts	0.1%				N/A			
Anisoptera	1.15%			0.33%	3.8%			2.3%
Coleoptera	2.08%			0.13%	3.8%			2.33%
Chironominae		0.07%		0.00%		3.00%		2.3%
Tanypodinae		0.10%				**6.10%**		
Fishes								
Unidentified Fish	**55.26%**	**32.22%**		1.09%	**30.77%**	**30.30%**		4.65%
Fish Scales	0.77%	0.22%	3.59%	0.02%	**38.46%**	**18.20%**	**11.11%**	**6.98%**
Jordanella floridae	**11.54%**			3.97%	3.8%			**6.98%**
Lucania goodei			**23.10%**				**33.33%**	
Gambusia holbrooki	**15.38%**	**76.93%**	**71.40%**	**91.76%**	3.8%	**24.20%**	**33.33%**	**51.16%**
Lepomis marginatus	**9.2%**				3.8%			
Miscellaneous								
Unidentifiable Animals	3.85%				3.8%			
Hydracarina								2.3%
Mean per fish	0.05	0.05	0.04	0.31	0.96	1.18	0.82	1.48
N	30	30	27	30	30	30	27	30

Table 34. Full nesting experiment data for the three treatments, based on male behavior.. Treatment 1 = Intraspecific, African Jewelfish (J); Treatment 2 = Intraspecific, Dollar sunfish (D); Treatment 3 = Interspecific, African Jewelfish (J) and Dollar sunfish (D). T = territorial; R = refuge; E = Guarding eggs; S = Guarding sac fry; F = Guarding free-swimming fry; - = No activity. Dates of Observation are sequentially numbered, with #1 on 3 September 2005, and subsequent dates every two days thereafter until 23 September 2005, when the experiment ended.

			Date of Observation									
Tank	**Trtmt**	**Spp**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**E,S,F?**
34	**3**	**D**	**-**	**T**	**-**	**T**	**-**	**T**	**T**	**T**	**T**	**No**
34	**3**	**J**	**-**	**T**	**E**	**S**	**F**	**F**	**F**	**F**	**F**	**Yes**
30	**3**	**D**	**-**	**-**	**-**	**T**	**T**	**T**	**T**	**-**	**T**	**No**
30	**3**	**J**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**No**
28	**3**	**D**	**-**	**-**	**T**	**-**	**T**	**T**	**-**	**-**	**-**	**No**
28	**3**	**J**	**-**	**-**	**T**	**-**	**E**	**S**	**F**	**?**	**F**	**Yes**
32	**2**	**D1**	**T**	**-**	**T**	**-**	**-**	**-**	**-**	**-**	**-**	**No**
32	**2**	**D2**	**-**	**T**	**-**	**T**	**T**	**E**	**S**	**?**	**T**	**Yes**
1	**2**	**D1**	**-**	**-**	**-**	**-**	**E**	**S**	**T**	**-**	**T**	**Yes**
1	**2**	**D2**	**-**	**-**	**T**	**T**	**T**	**-**	**-**	**-**	**-**	**No**
3	**2**	**D1**	**-**	**-**	**-**	**T**	**T**	**T**	**-**	**T**	**T**	**No**
3	**2**	**D2**	**-**	**-**	**-**	**T**	**E**	**F**	**T**	**T**	**T**	**Yes**
5	**1**	**J1**	**-**	**-**	**-**	**T**	**E**	**S**	**F**	**F**	**F**	**Yes**
5	**1**	**J2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**No**
7	**1**	**J1**	**-**	**-**	**-**	**-**	**T**	**T**	**E**	**S**	**-**	**Yes**
7	**1**	**J2**	**-**	**-**	**T**	**T**	**T**	**T**	**T**	**?**	**S**	**Yes**
9	**1**	**J1**	**T**	**-**	**-**	**-**	**T**	**T**	**-**	**-**	**T**	**No**
9	**1**	**J2**	**T**	**-**	**E**	**T**	**E**	**T**	**T**	**T**	**E**	**Yes**

Location of the Rocky Glades in South Florida

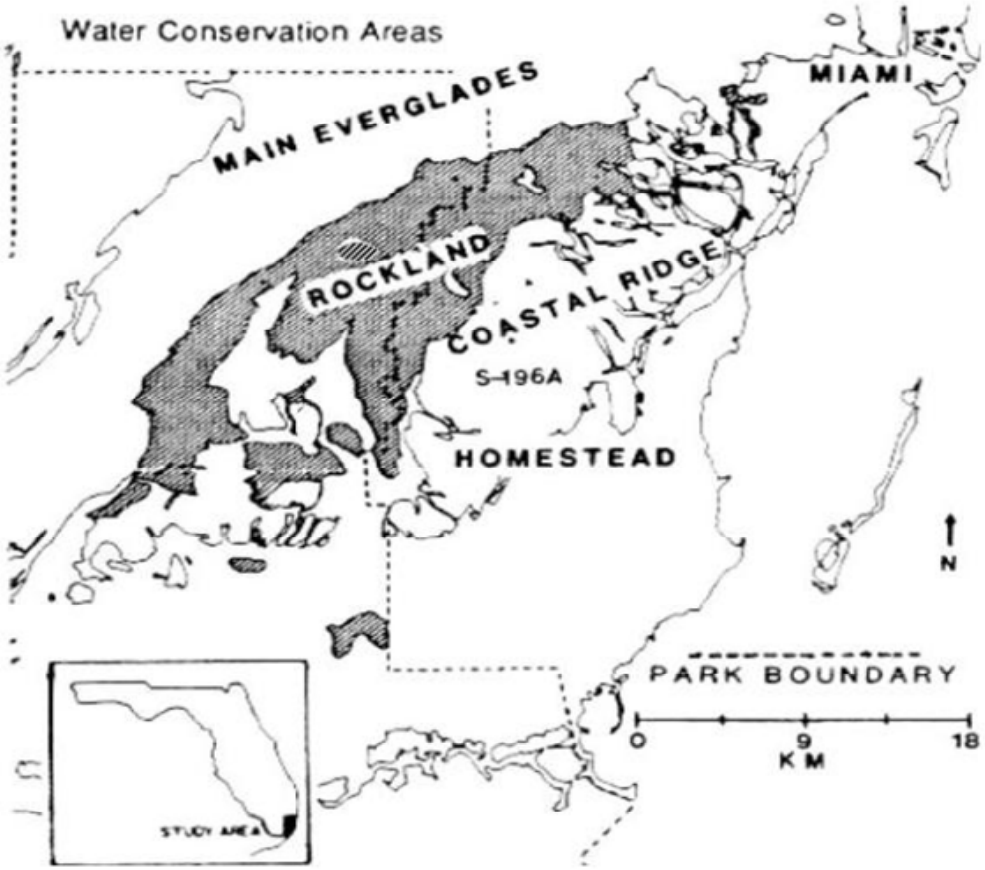


Figure 1

Location of Drift Fence Arrays in the Rocky Glades

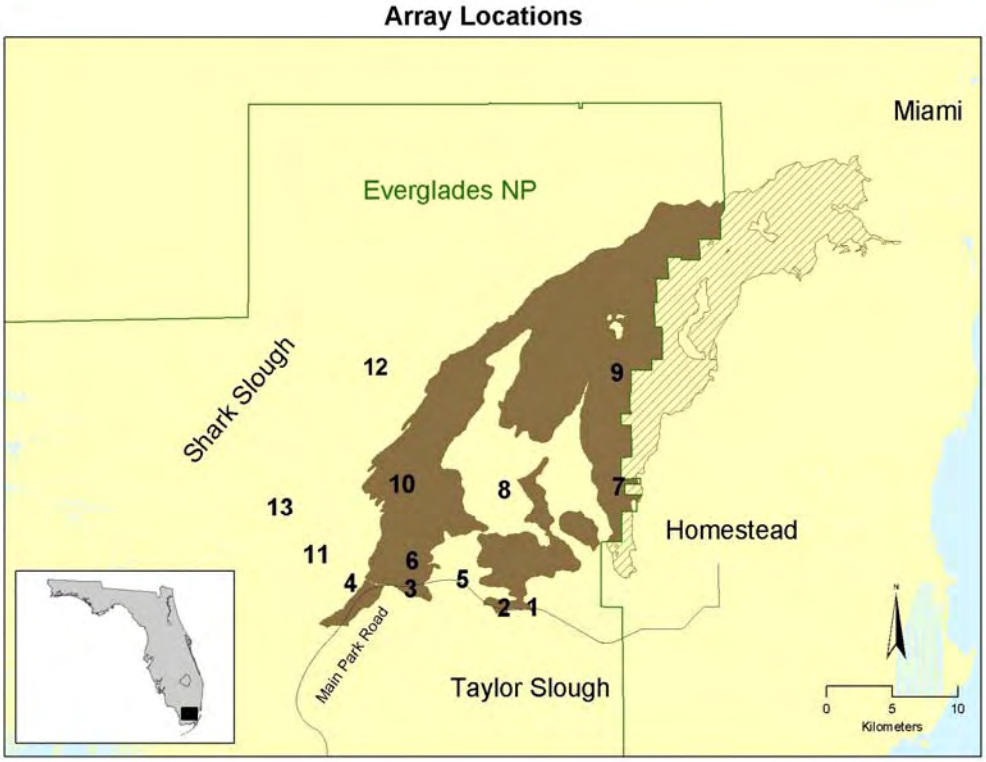


Figure 2

Minnow Traps in a Drift-Fence Array in the Rocky Glades

Figure 3

Solution Hole Study Locations in the Rocky Glades

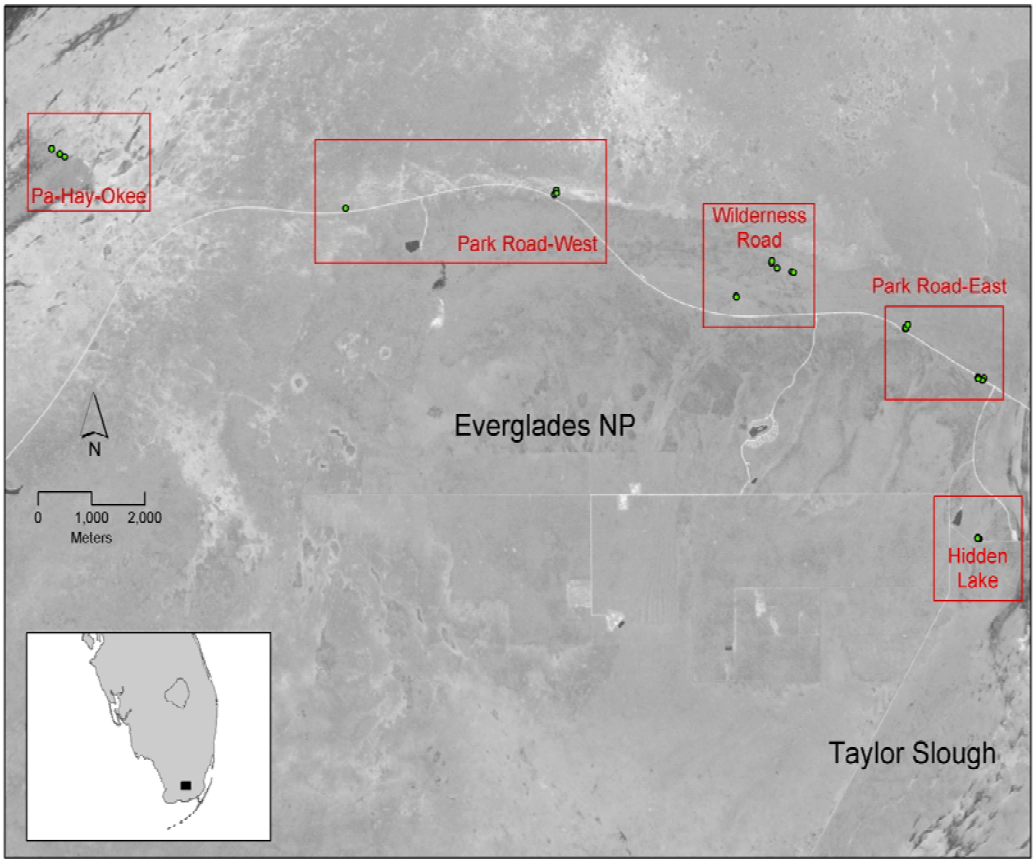


Figure 4

Solution Hole in the Rocky Glades

Figure 5

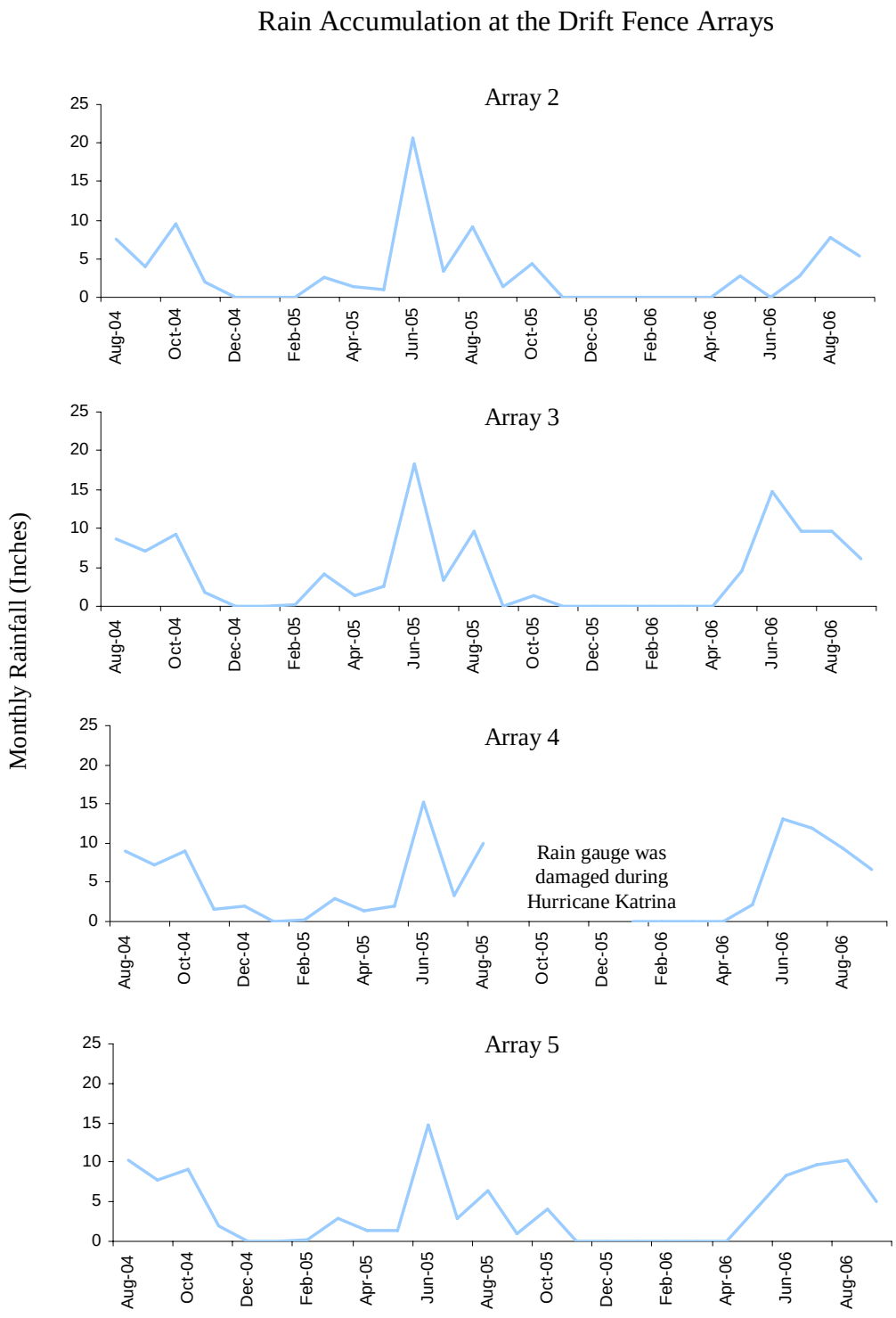

Rain Accumulation at the Drift Fence Arrays
Array 2
Array 3
Array 4
Array 5
Monthly Rainfall (Inches)
Rain gauge was damaged during Hurricane Katrina
0
5
10
15
20
25
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06

Figure 6

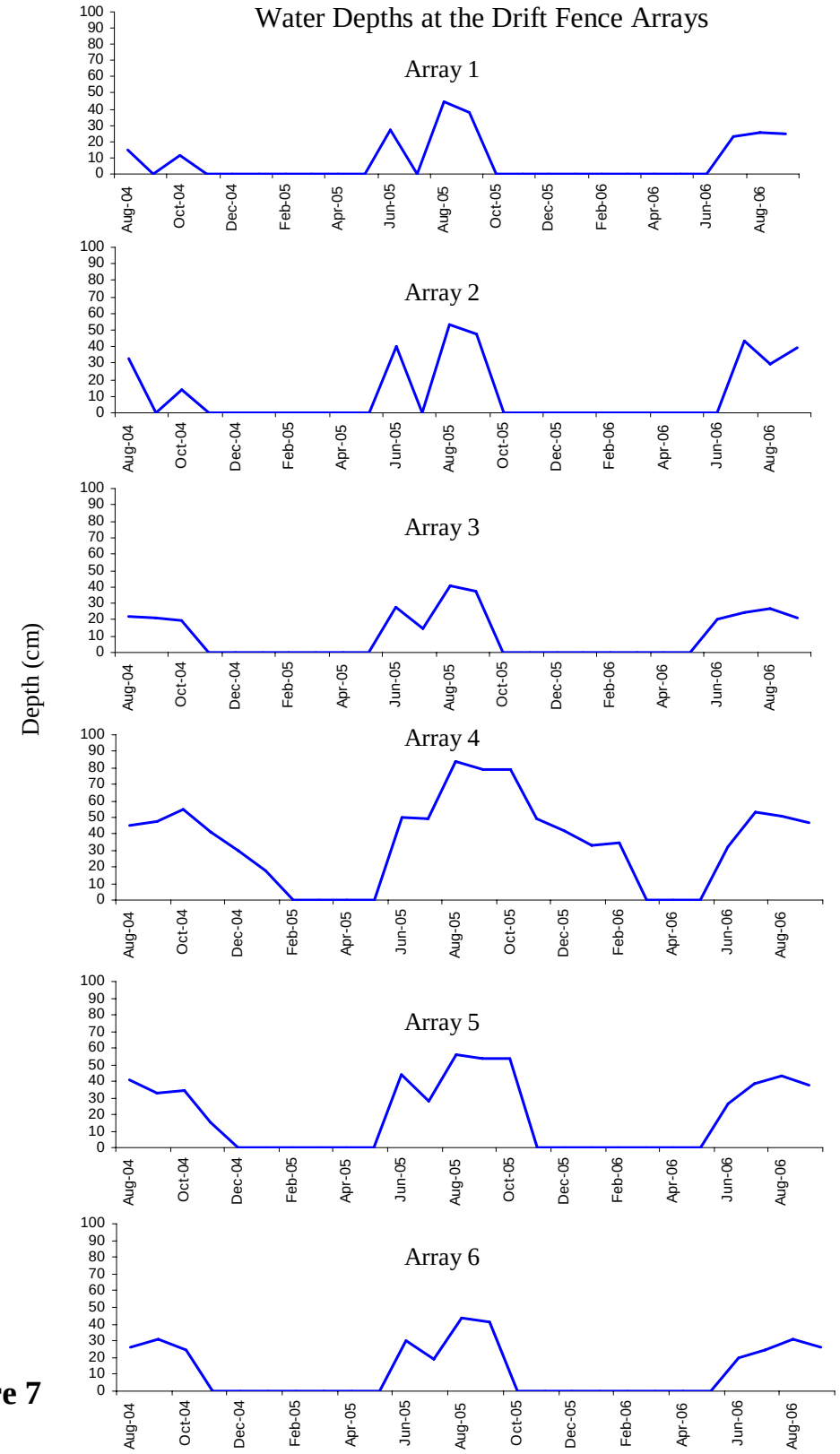
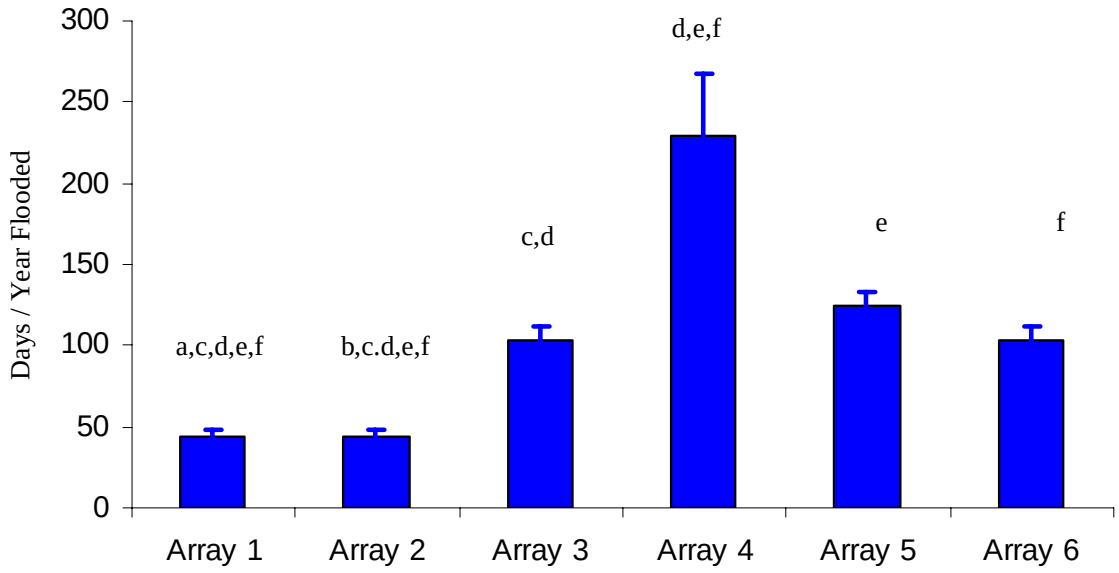

Water Depths at the Drift Fence Arrays
Array 1
Array 2
Array 3
Array 4
Array 5
Array 6
Depth (cm)
0
10
20
30
40
50
60
70
80
90
100
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06

Figure 7

Mean Hydroperiod



* Letter indicates significant differences at P < 0.05

Figure 8

Flow Directions during Monthly Array Samples

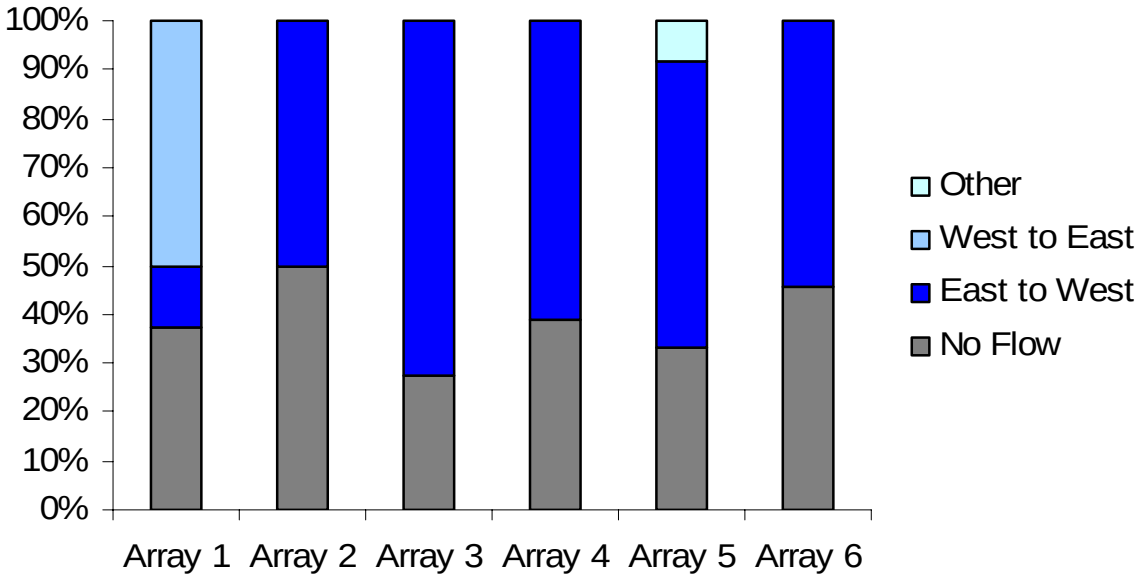
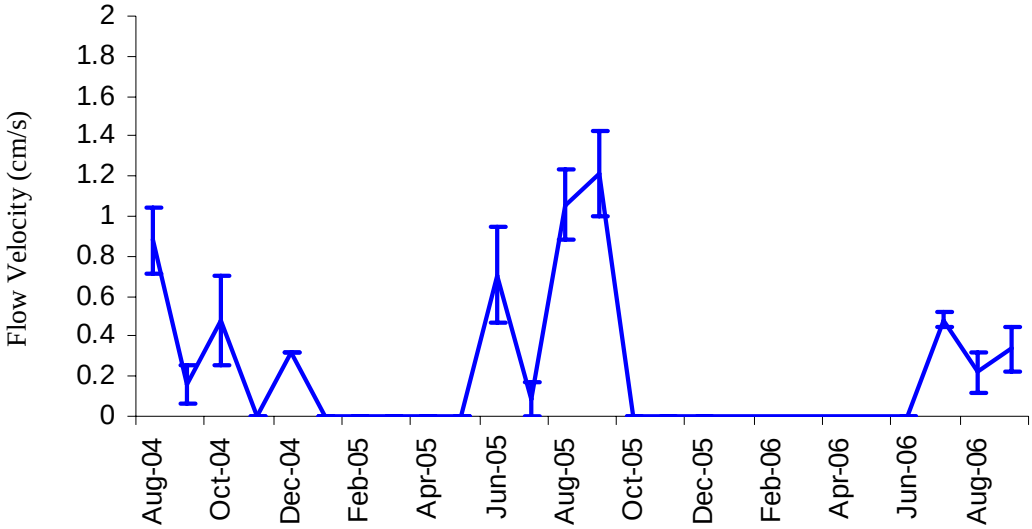
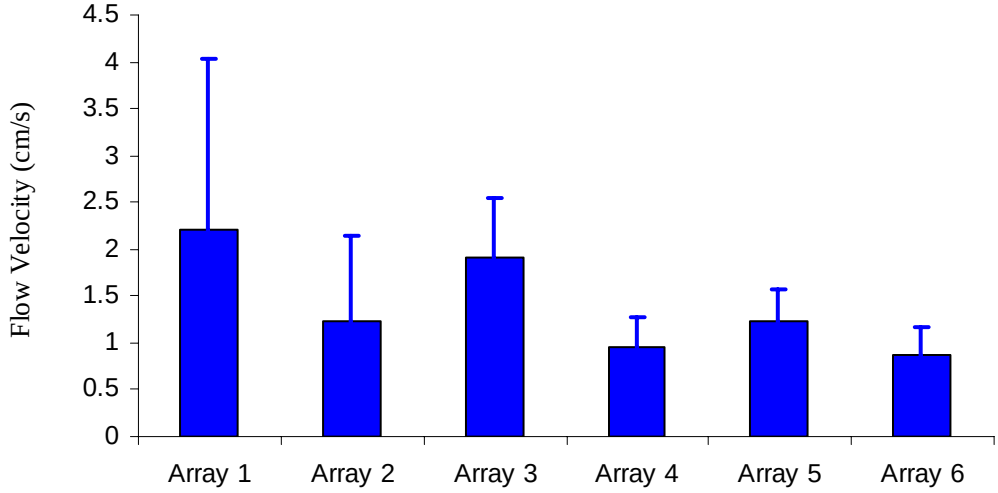


Figure 9

Mean Flow Velocity



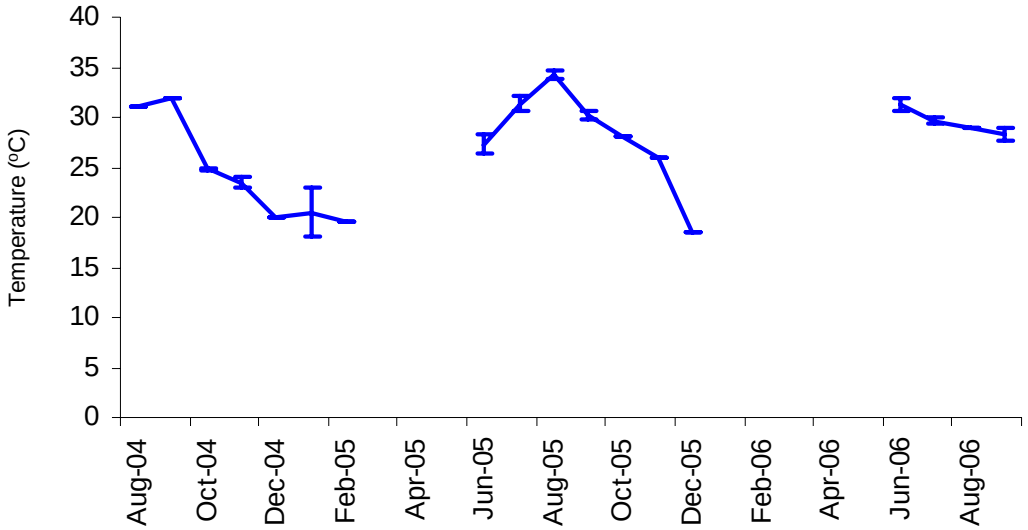
$F_{10,30} = 6.841$; $P = 0.00$, $R^2 = 0.688$



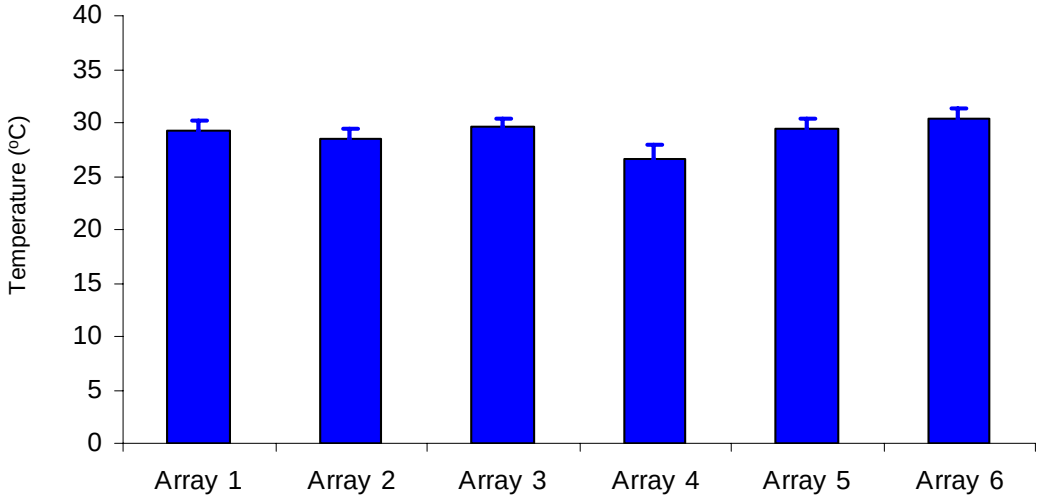
* No significant differences at P <0.05

Figure 10

Mean Temperature



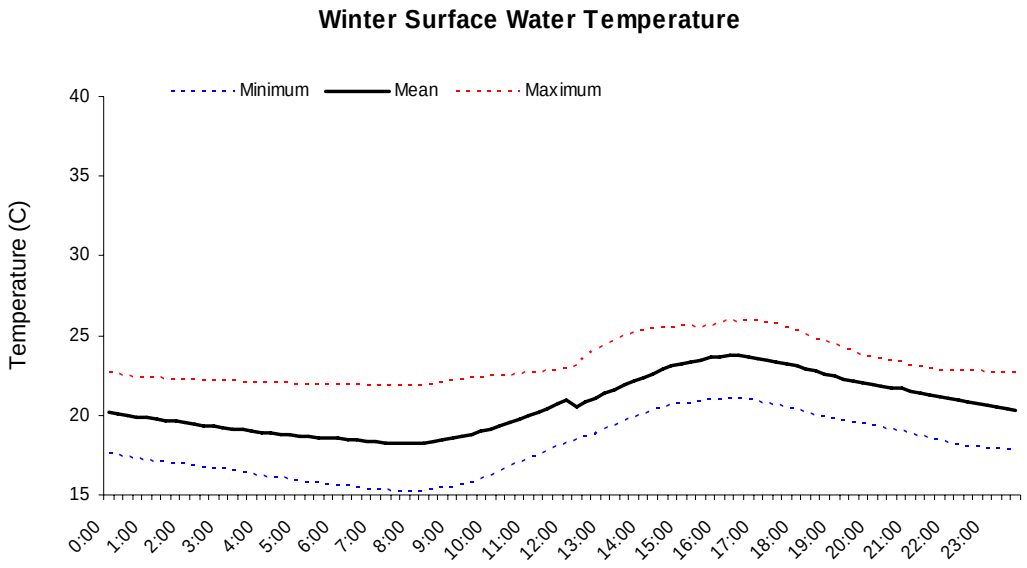
$F_{16,48} = 32.324$; $P = 0.00$, $R^2 = 0.915$



* No significant differences at P <0.05

Figure 11

Surface Temperature Profiles



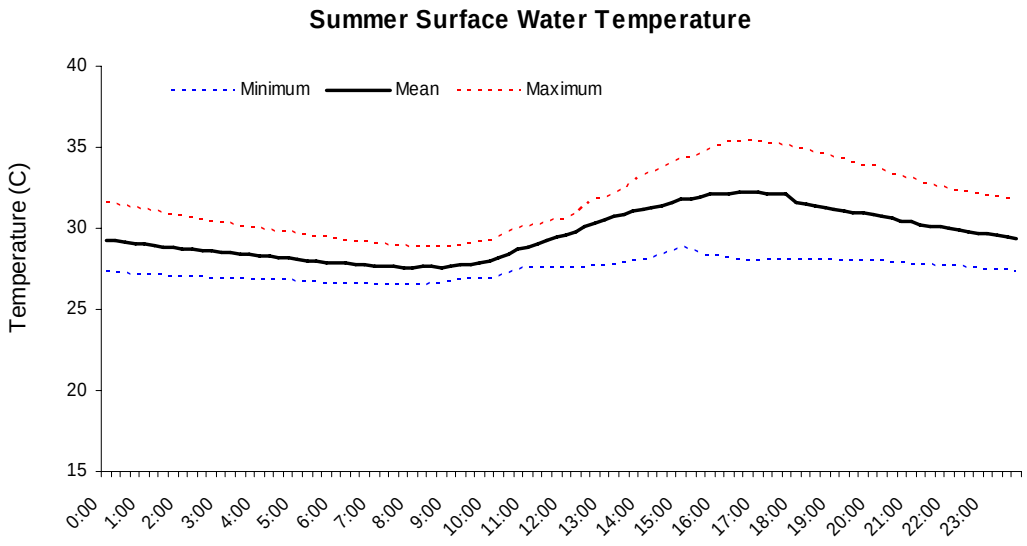
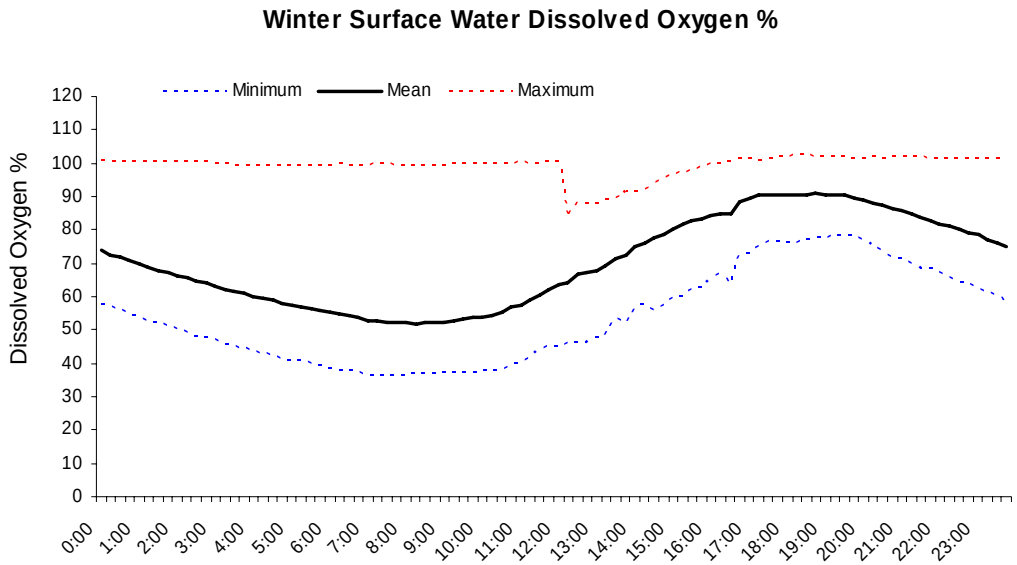


Figure 12

Surface Dissolved Oxygen % Profiles



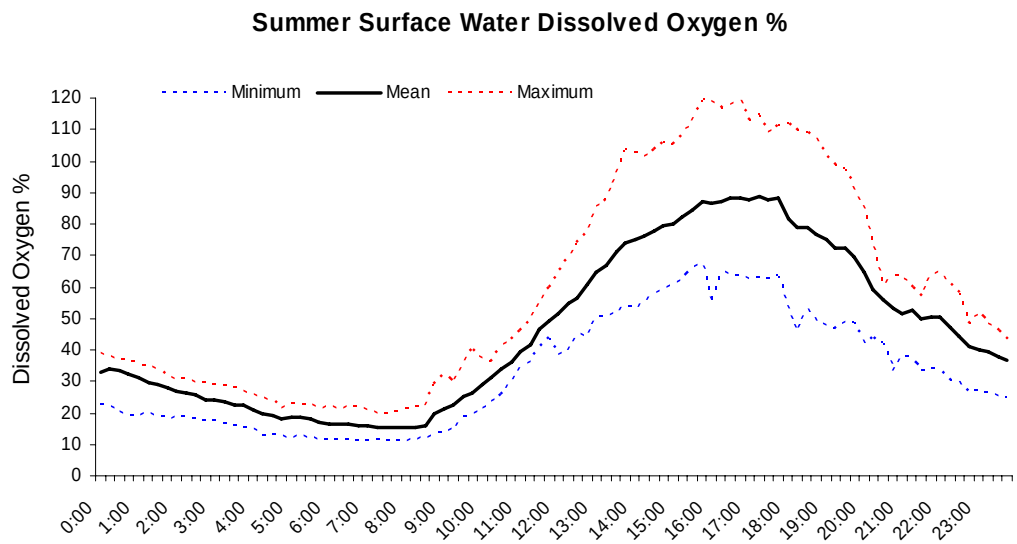
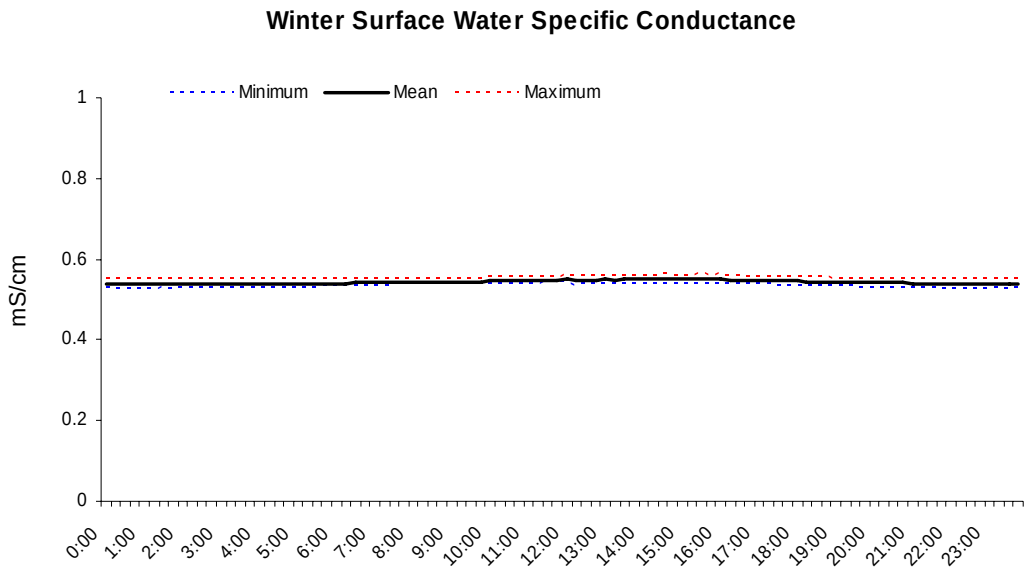


Figure 13

Surface Specific Conductance Profiles



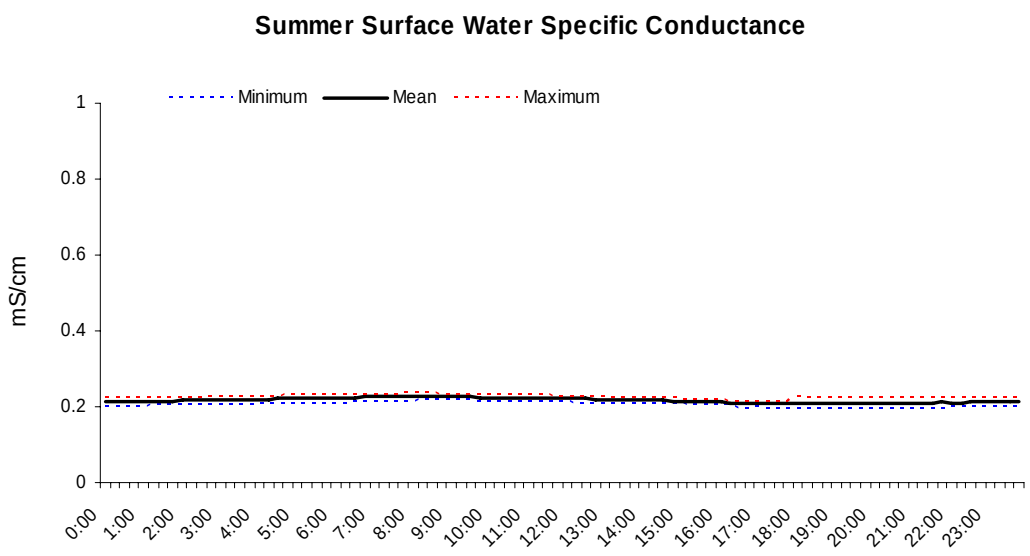
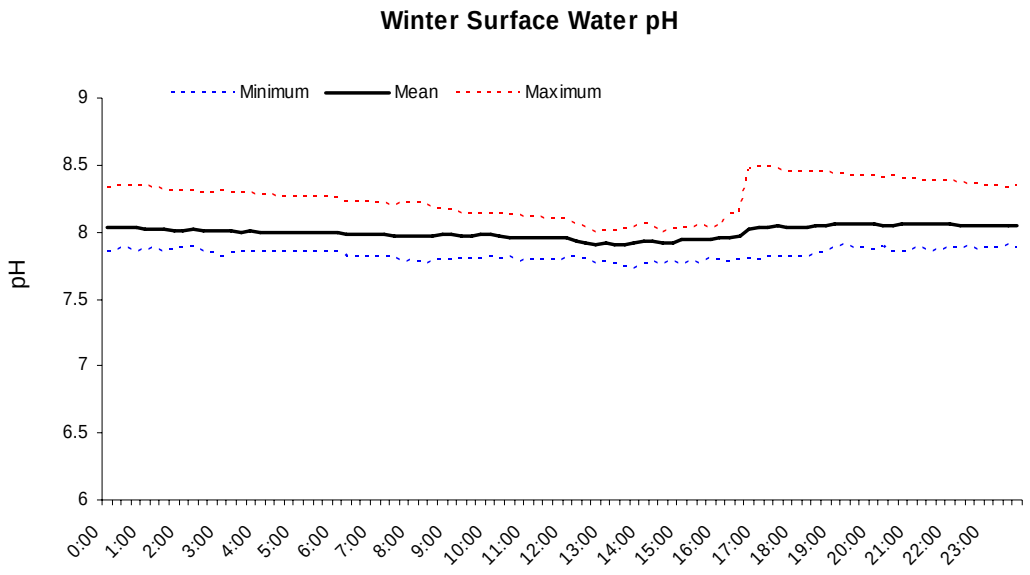


Figure 14

Surface pH Profiles



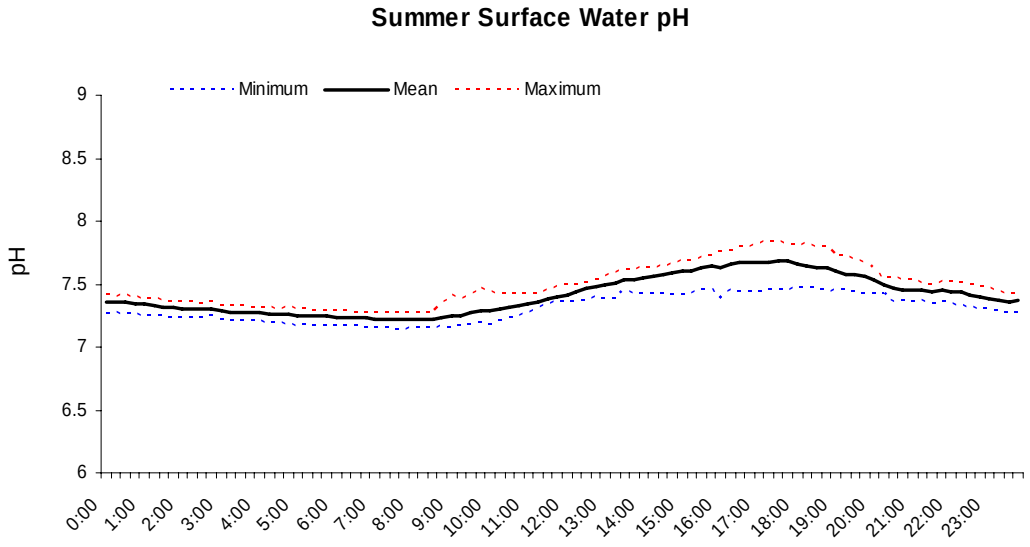


Figure 15

Mean Solution Hole Depths

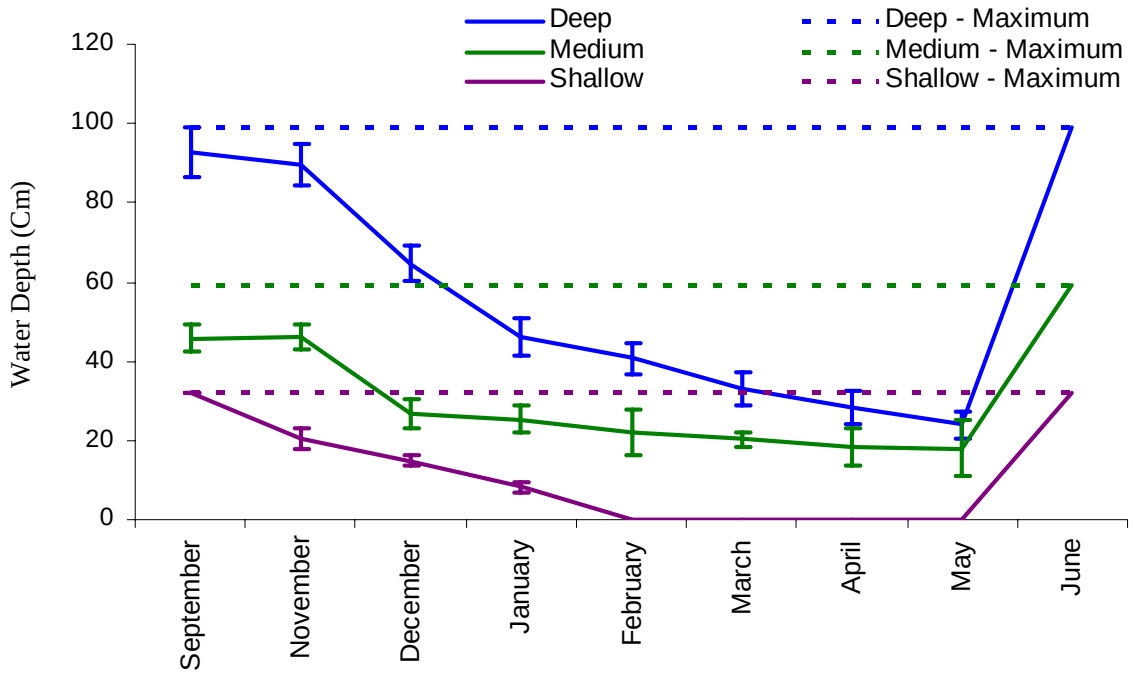


Figure 16

Solution Hole Temperatures

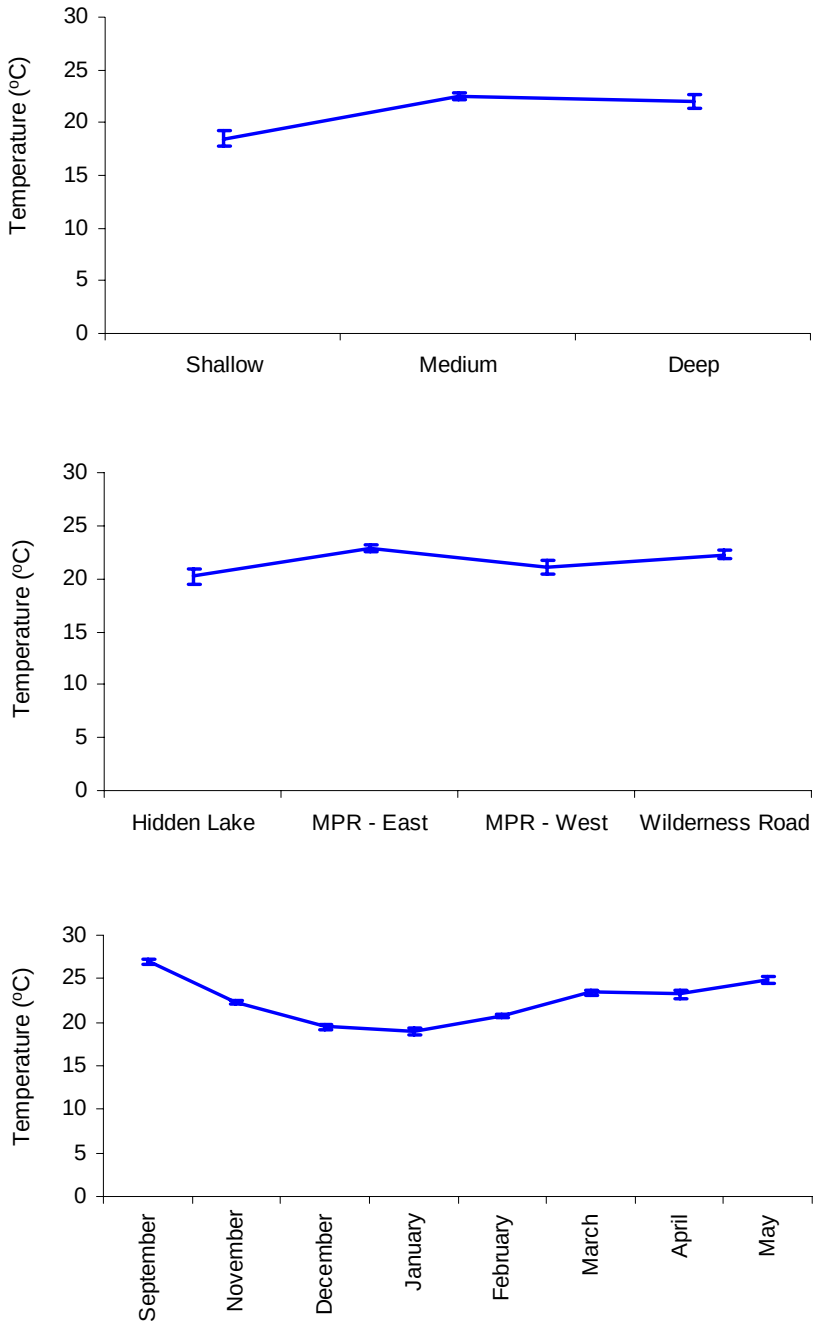


Figure 17

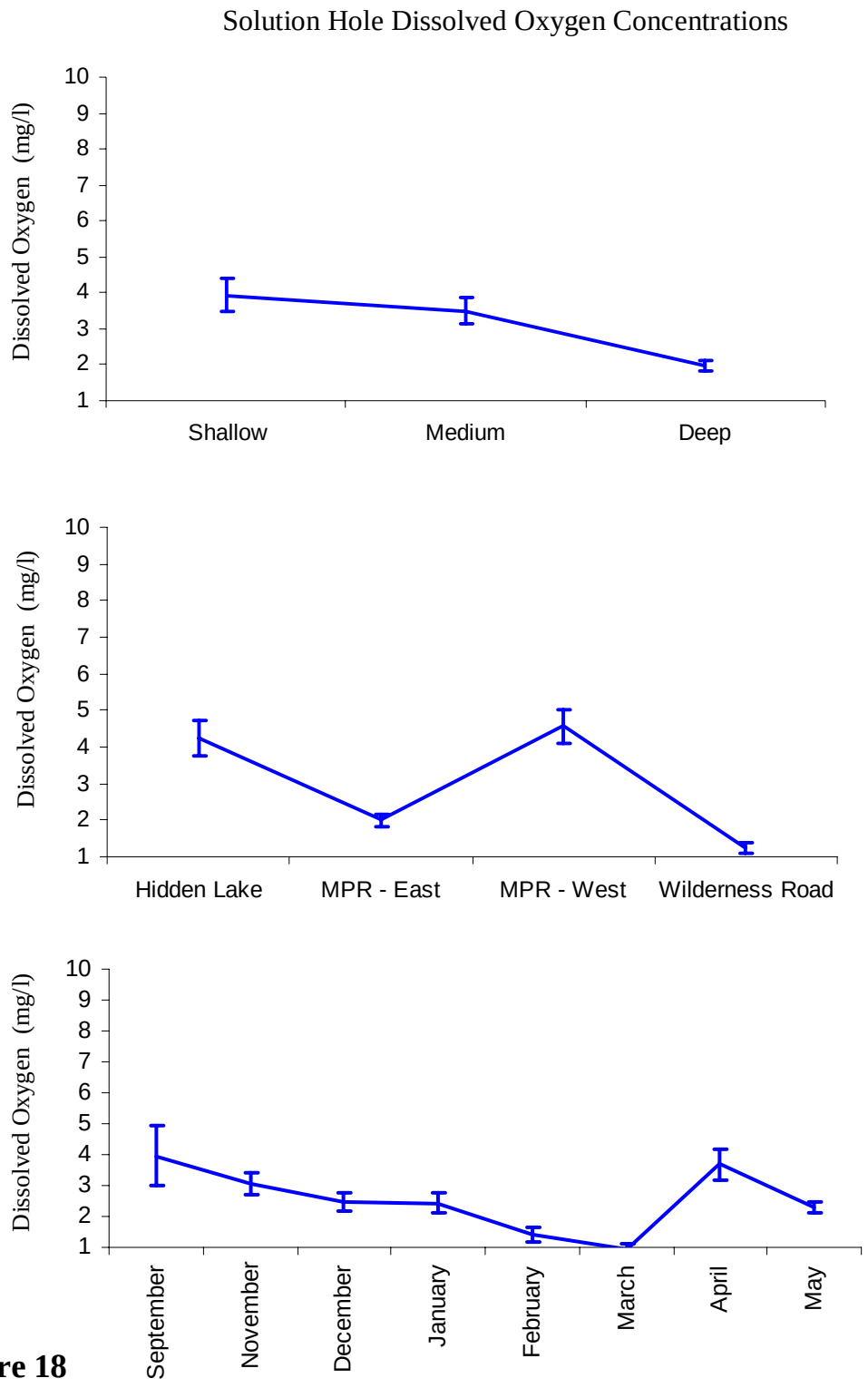

Solution Hole Dissolved Oxygen Concentrations
Dissolved Oxygen (mg/l)
10
9
8
7
6
5
4
3
2
1
Shallow
Medium
Deep
Dissolved Oxygen (mg/l)
Hidden Lake
MPR - East
MPR - West
Wilderness Road
Dissolved Oxygen (mg/l)
September
November
December
January
February
March
April
May

Figure 18

Solution Hole Specific Conductance

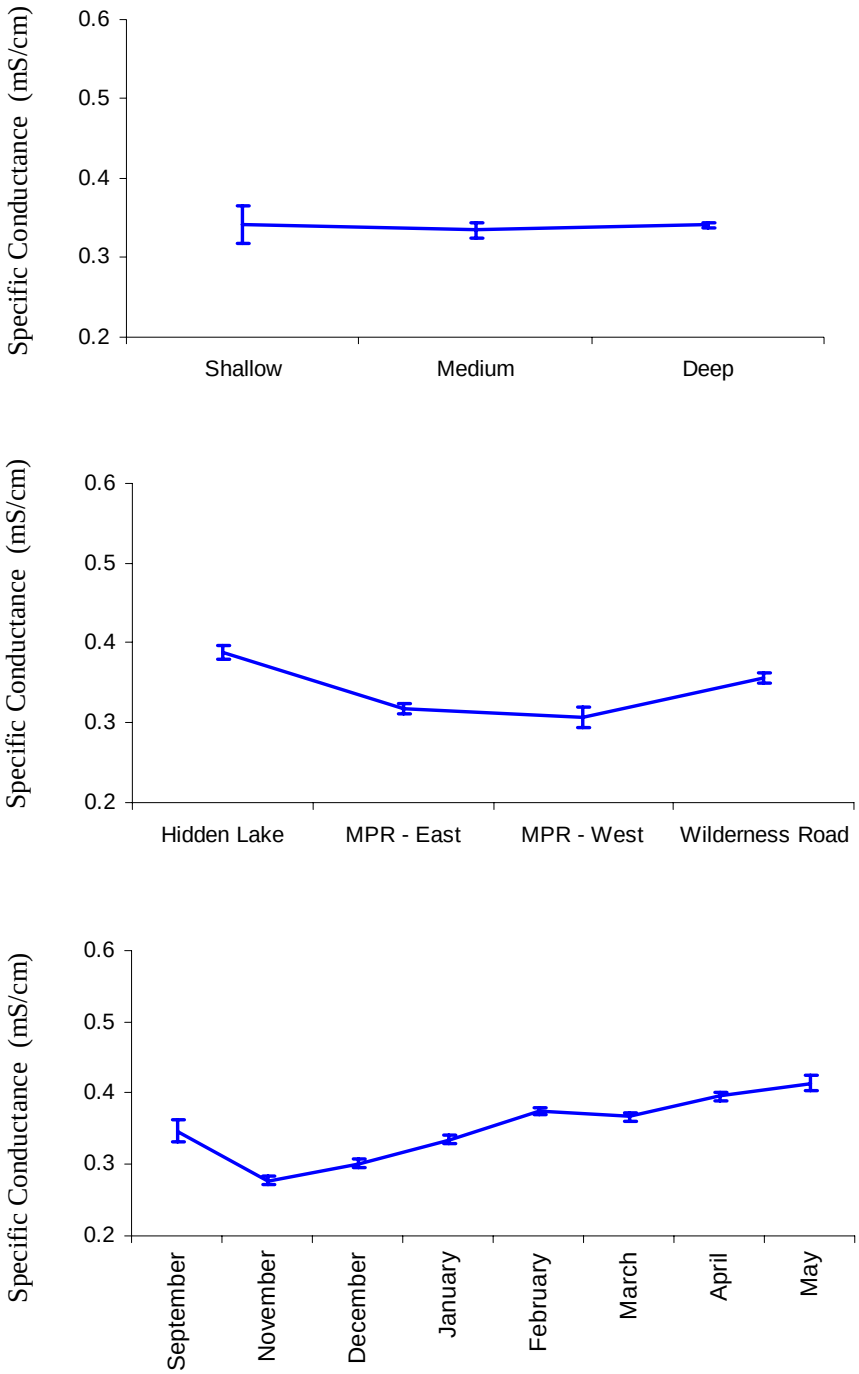


Figure 19

Solution Hole pH

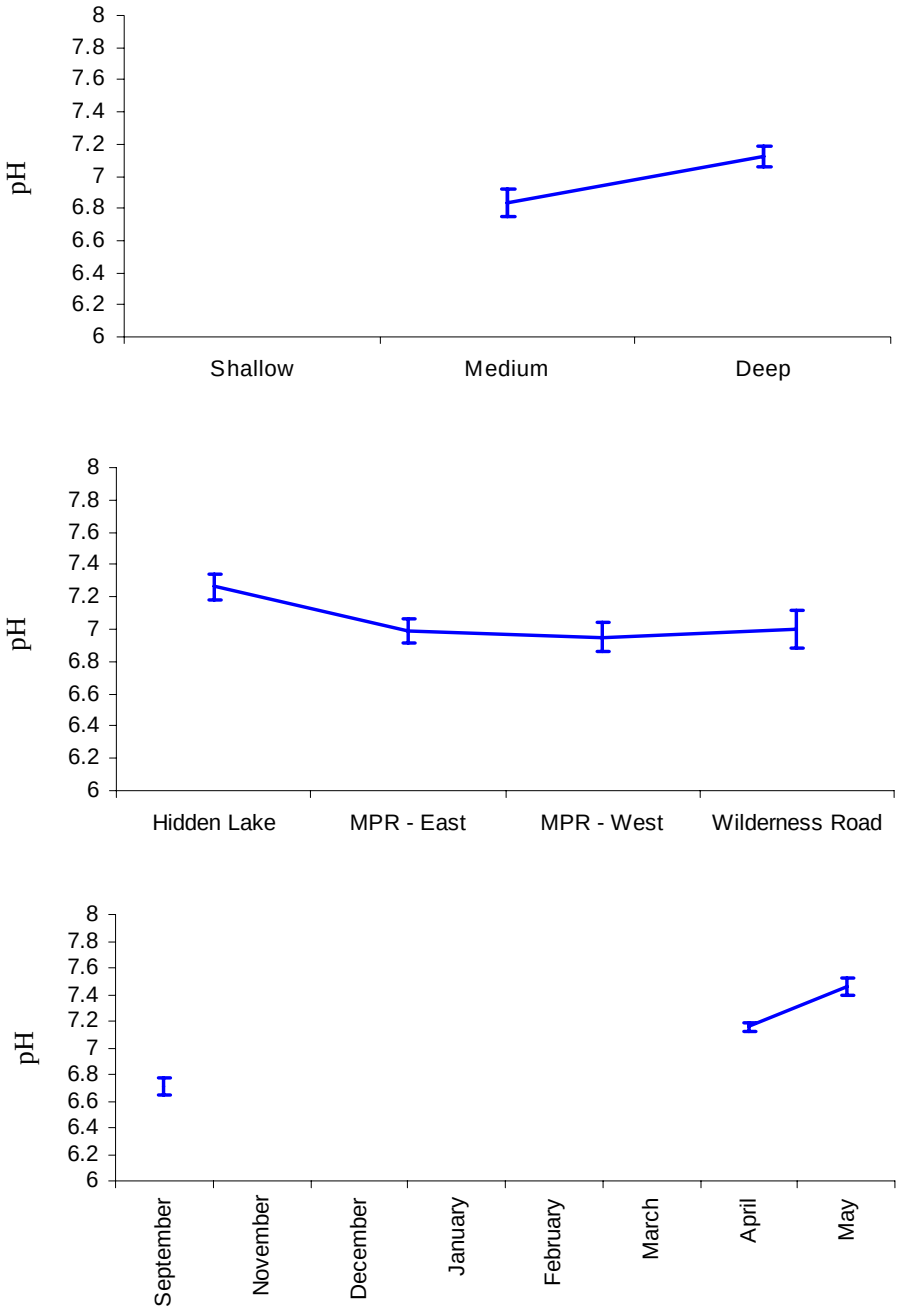
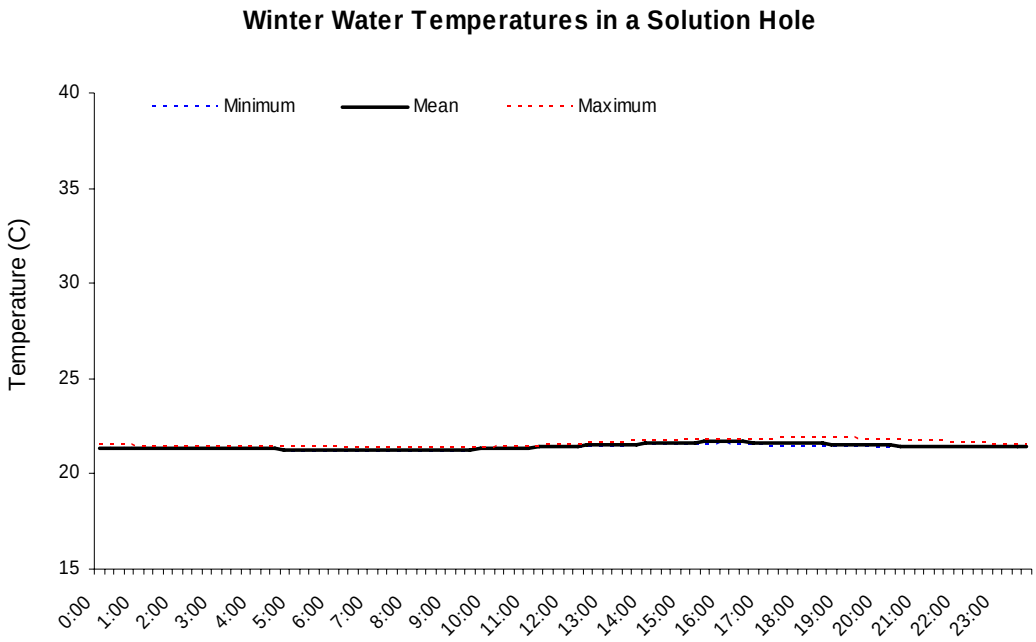


Figure 20

Ground Water Temperature Profiles



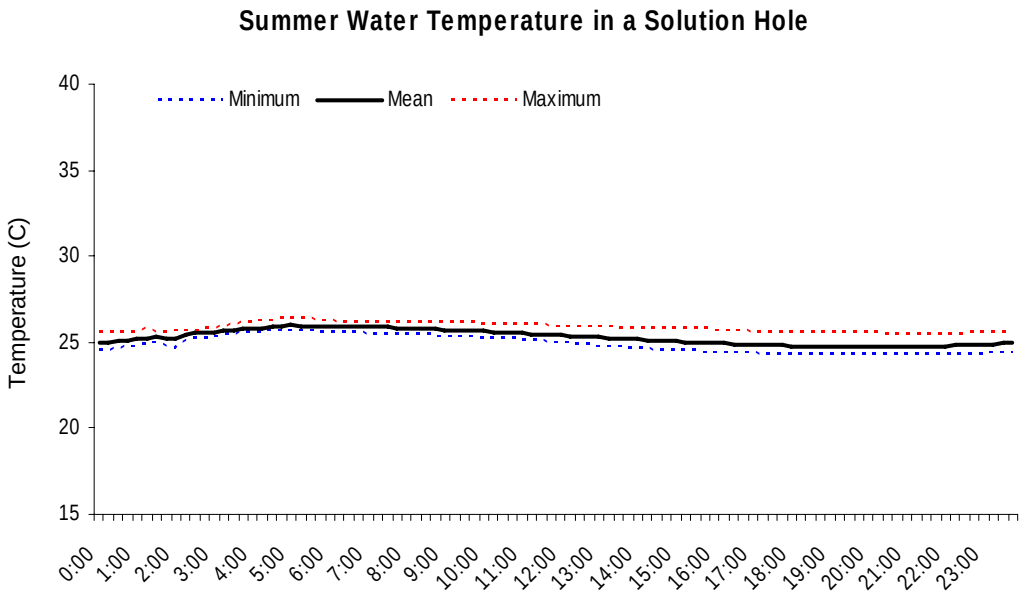
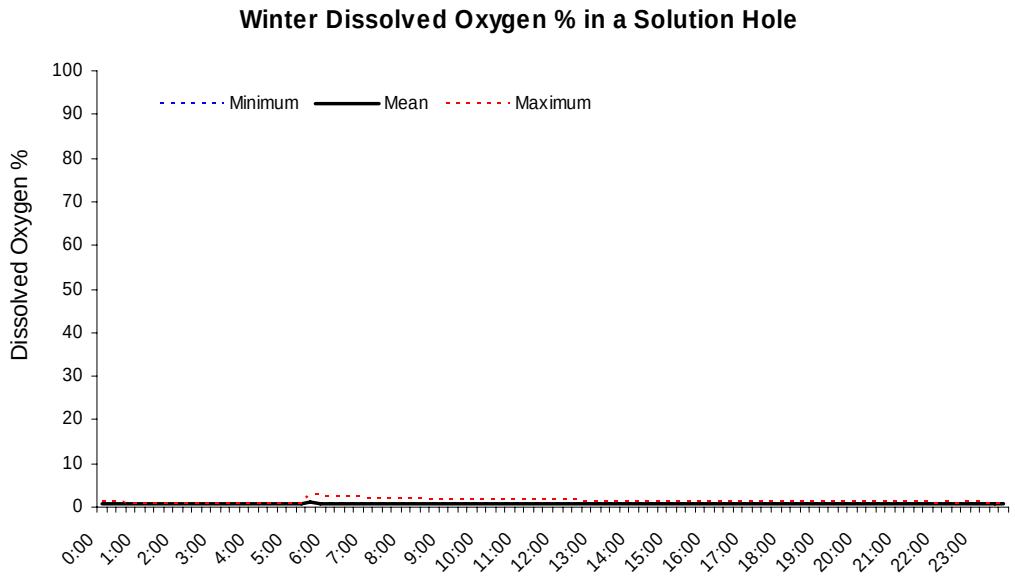


Figure 21

Ground Water Dissolved Oxygen % Profiles



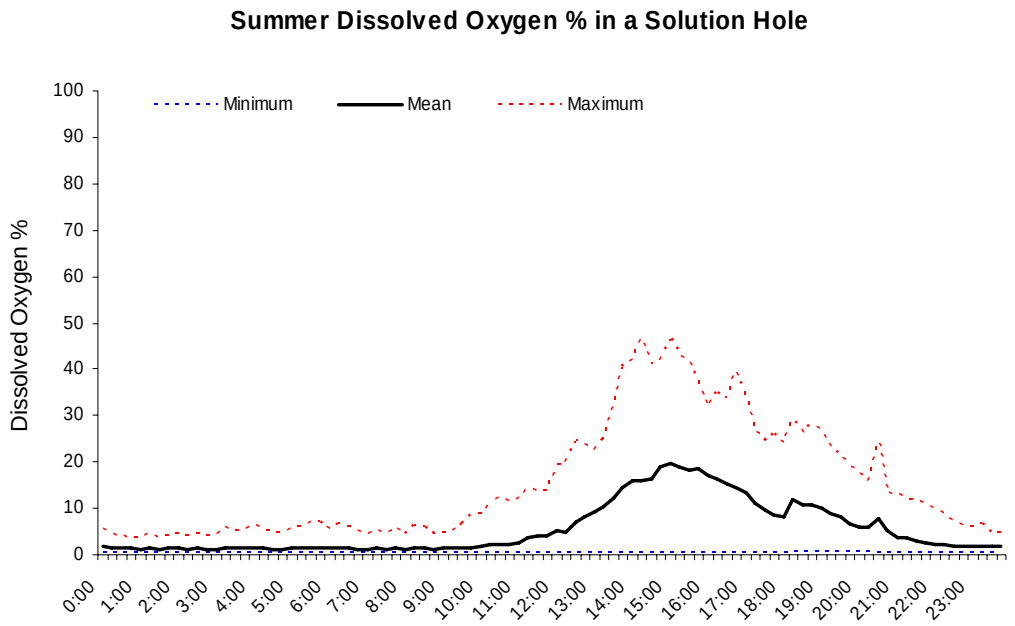
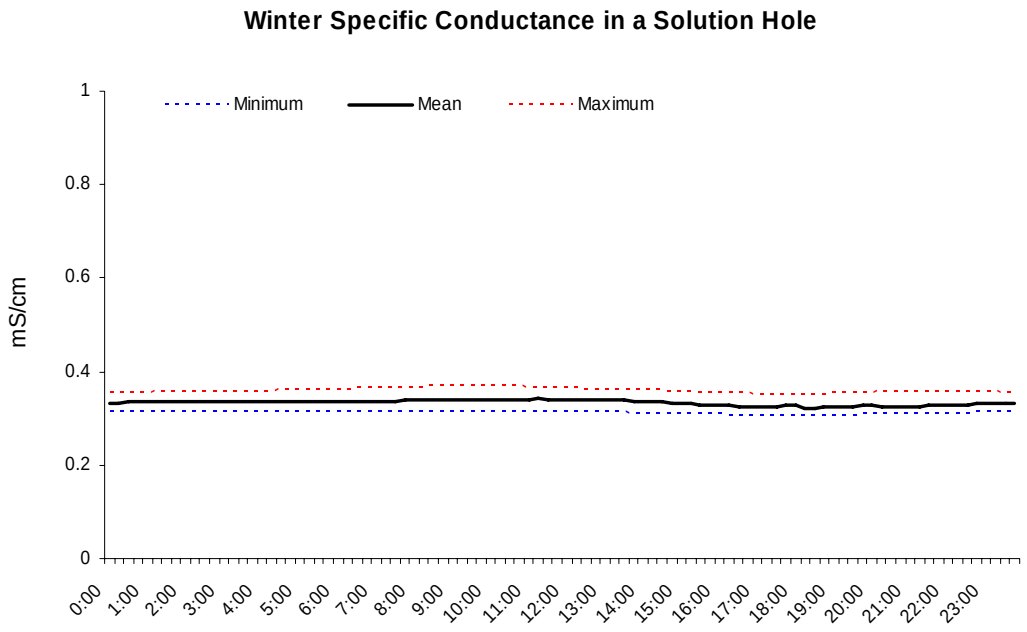


Figure 22

Ground Water Specific Conductance Profiles



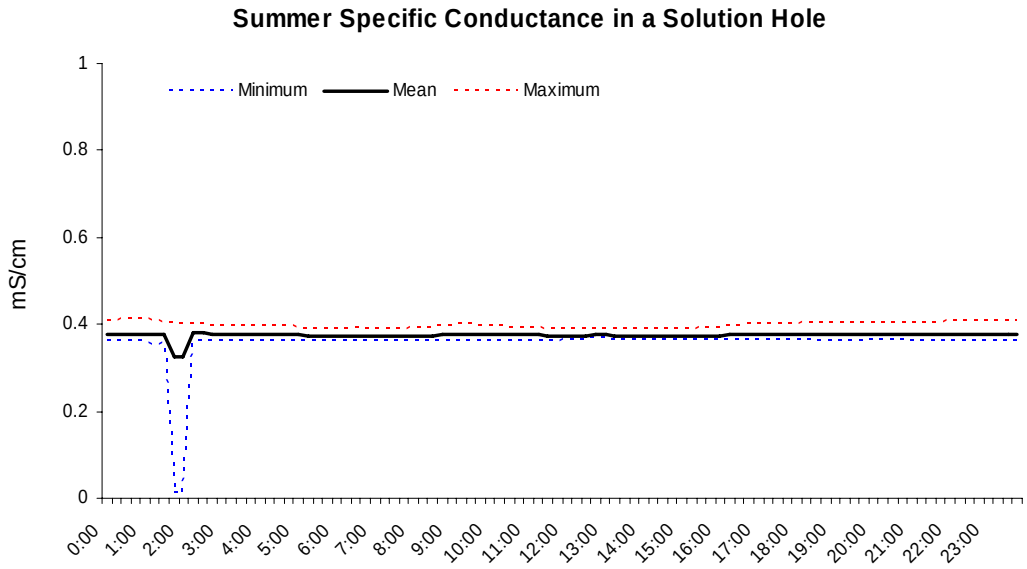
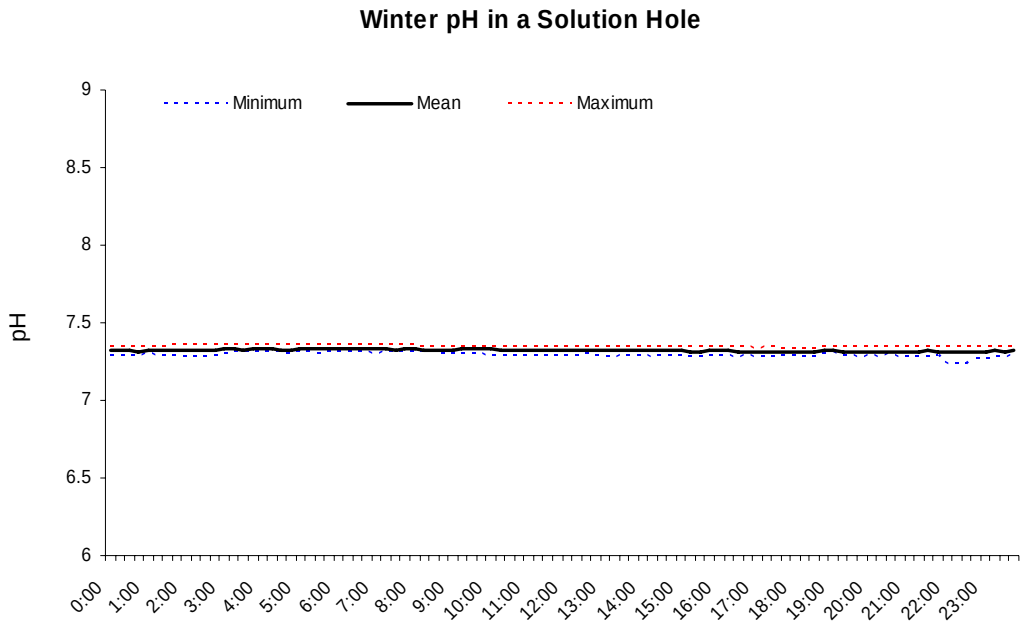


Figure 23

Ground Water pH Profiles



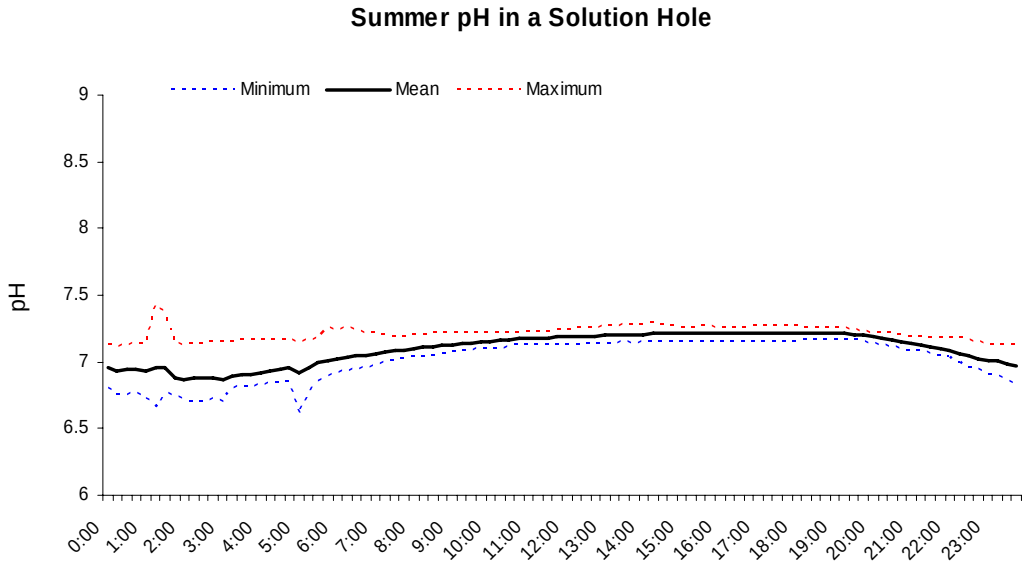


Figure 24

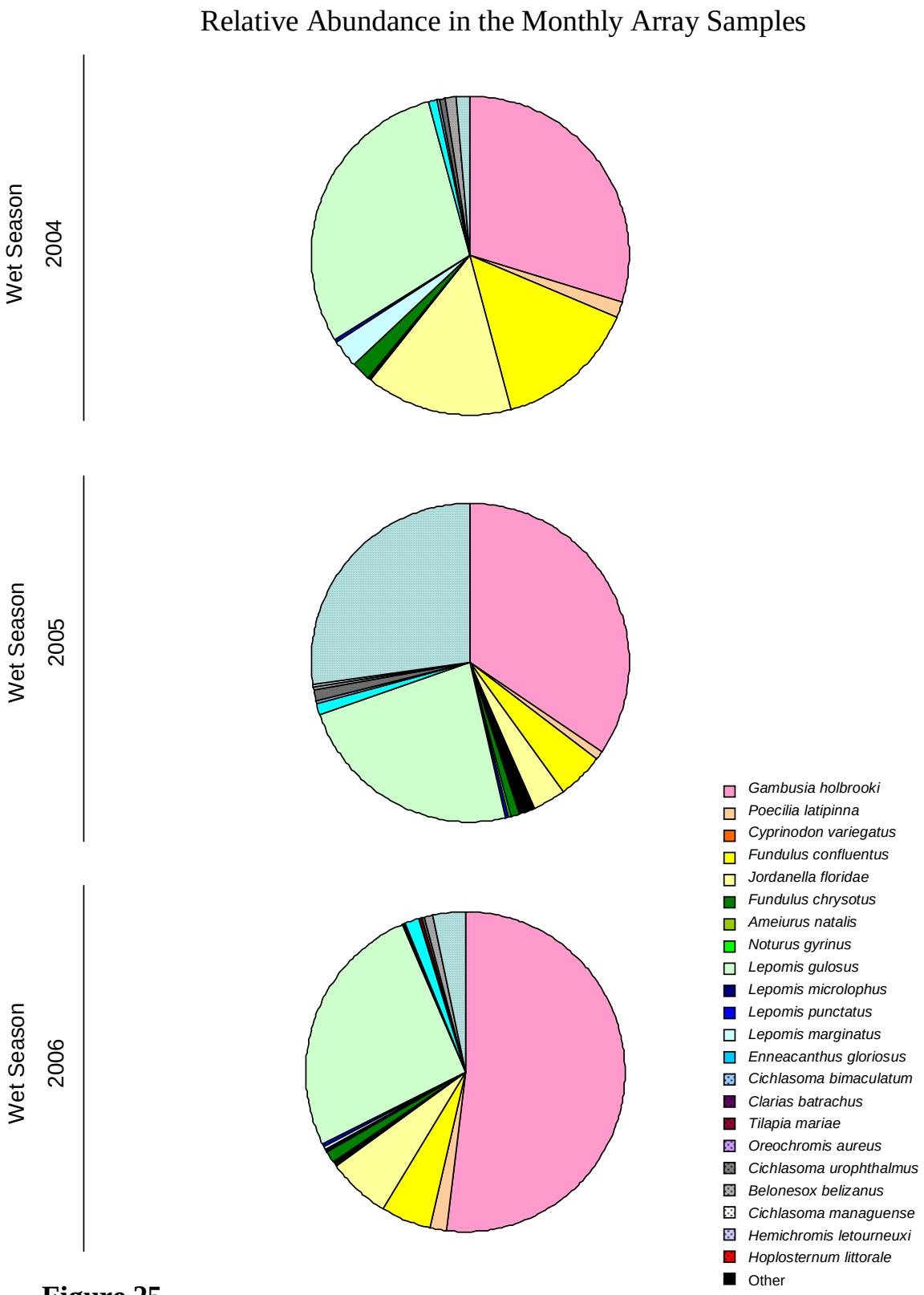

Relative Abundance in the Monthly Array Samples
Wet Season 2004
Wet Season 2005
Wet Season 2006
Gambusia holbrooki
Poecilia latipinna
Cyprinodon variegatus
Fundulus confluentus
Jordanella floridae
Fundulus chrysotus
Ameiurus natalis
Noturus gyrinus
Lepomis gulosus
Lepomis microlophus
Lepomis punctatus
Lepomis marginatus
Enneacanthus gloriosus
Cichlasoma bimaculatum
Clarias batrachus
Tilapia mariae
Oreochromis aureus
Cichlasoma urophthalmus
Belonesox belizanus
Cichlasoma managuense
Hemichromis letourneuxi
Hoplosternum littorale
Other

Figure 25

Relative Abundance Before and After Flooding from Hurricane Katrina

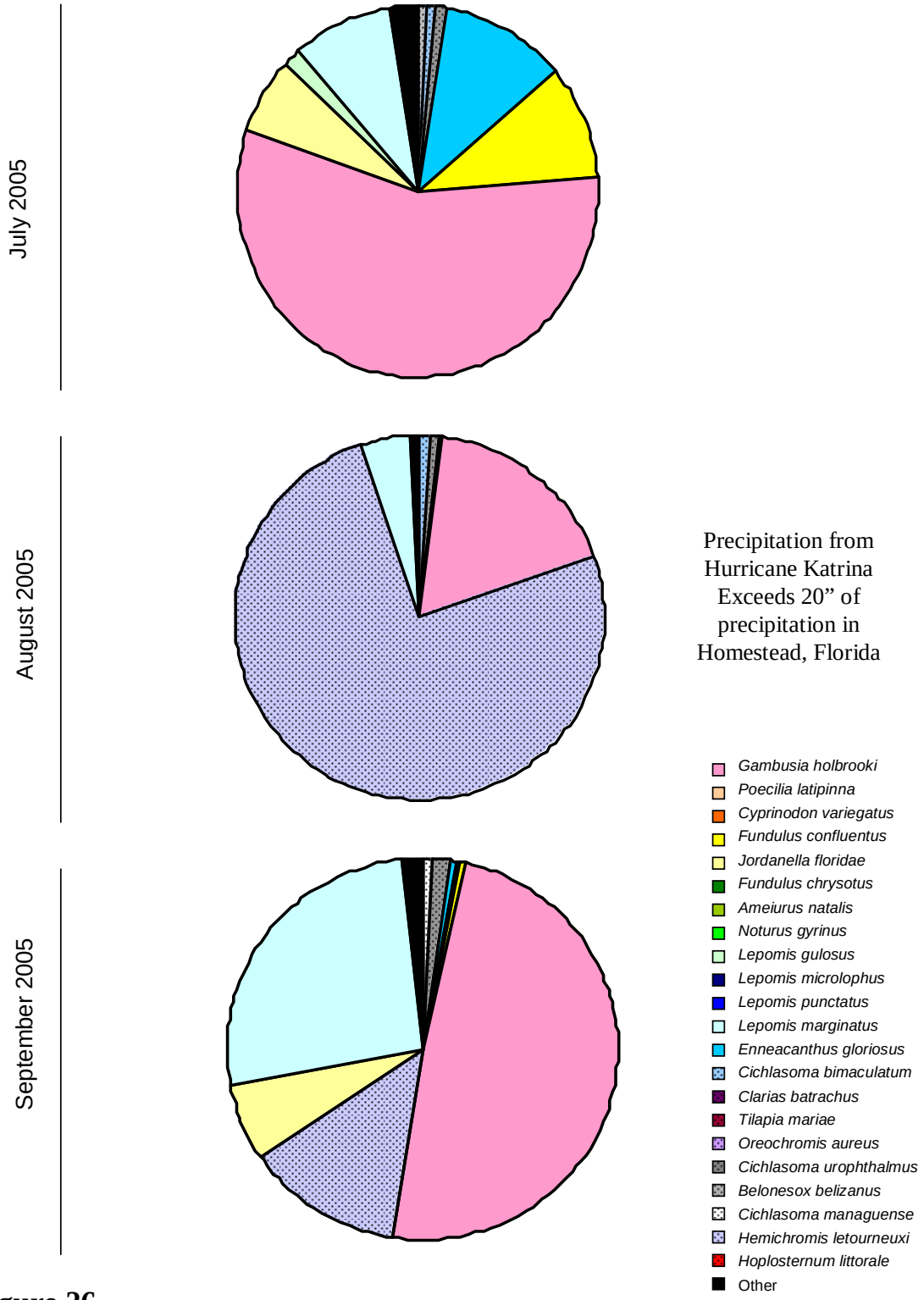
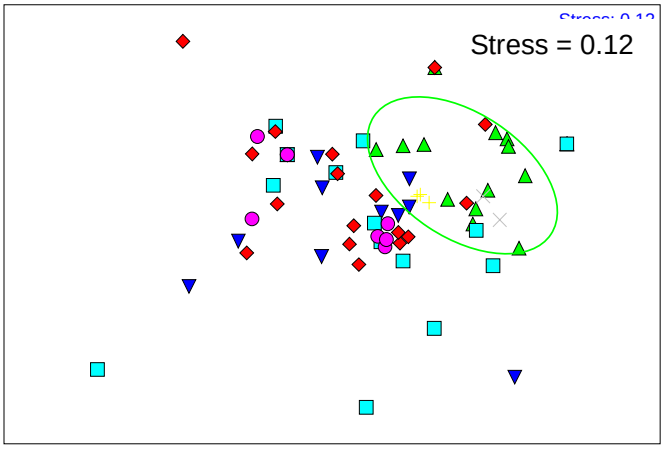
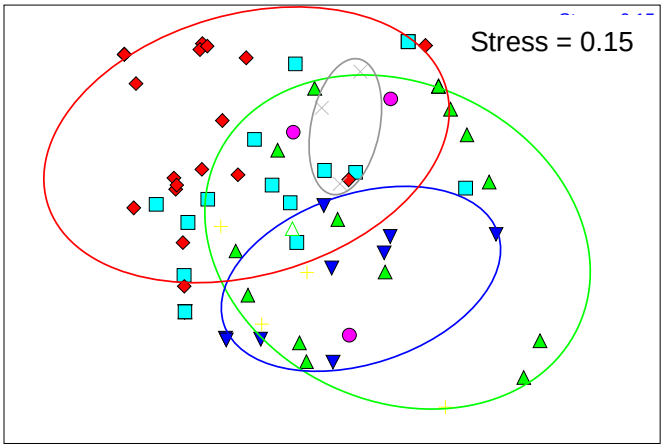


Figure 26

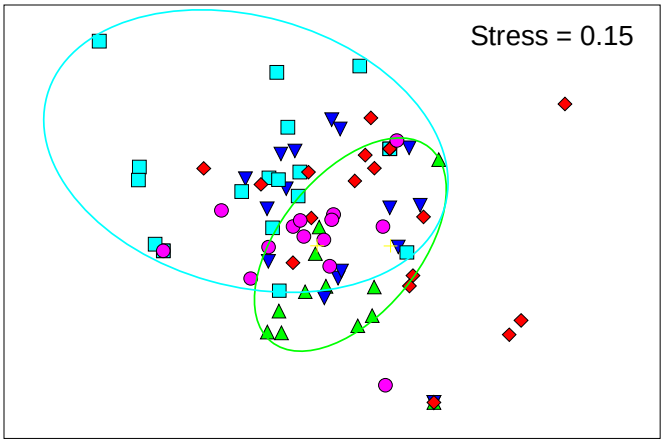
nMDS Plots Illustrating Temporal Differences in Community Structure Throughout the Wet Seasons



2004



2005

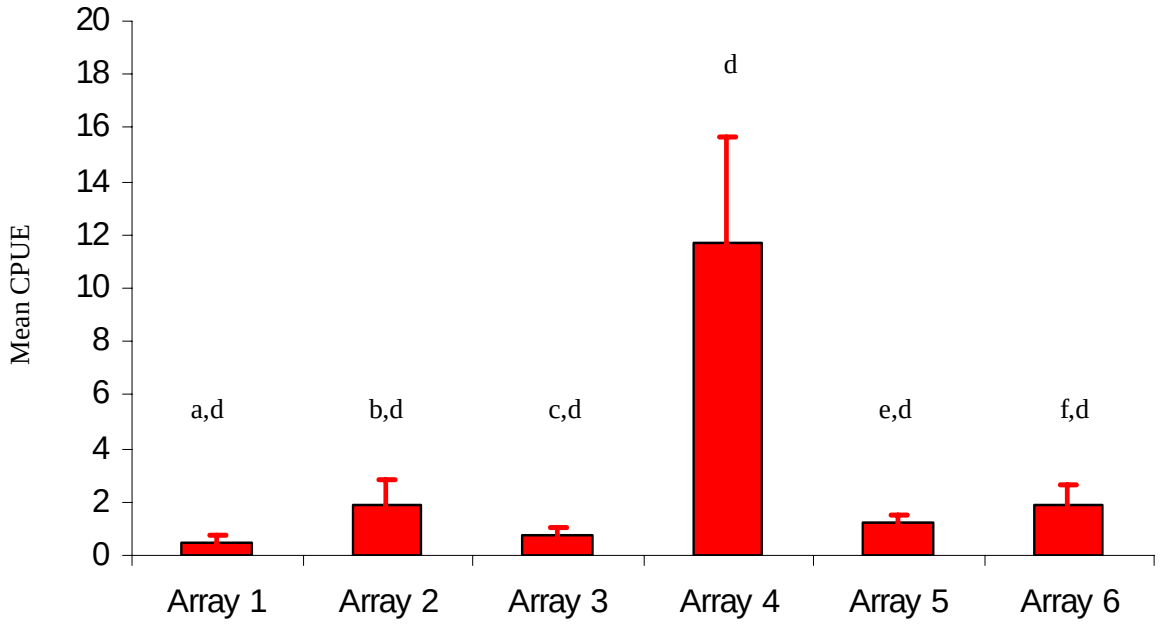


2006

Month 1
Month 2
Month 3
Month 4
Month 5
Month 6
Month 7

Figure 27

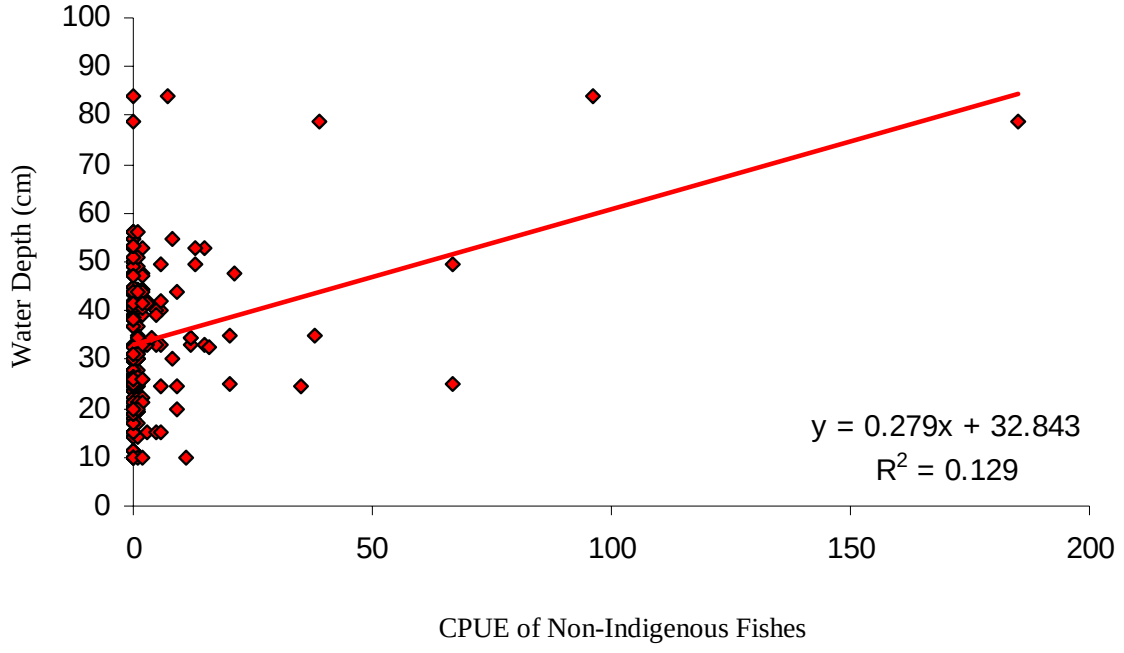
Mean CPUE of Non-Indigenous Fishes During Monthly Drift-Fence Array Monitoring



* Letter indicates significant differences at P < 0.05

Figure 28

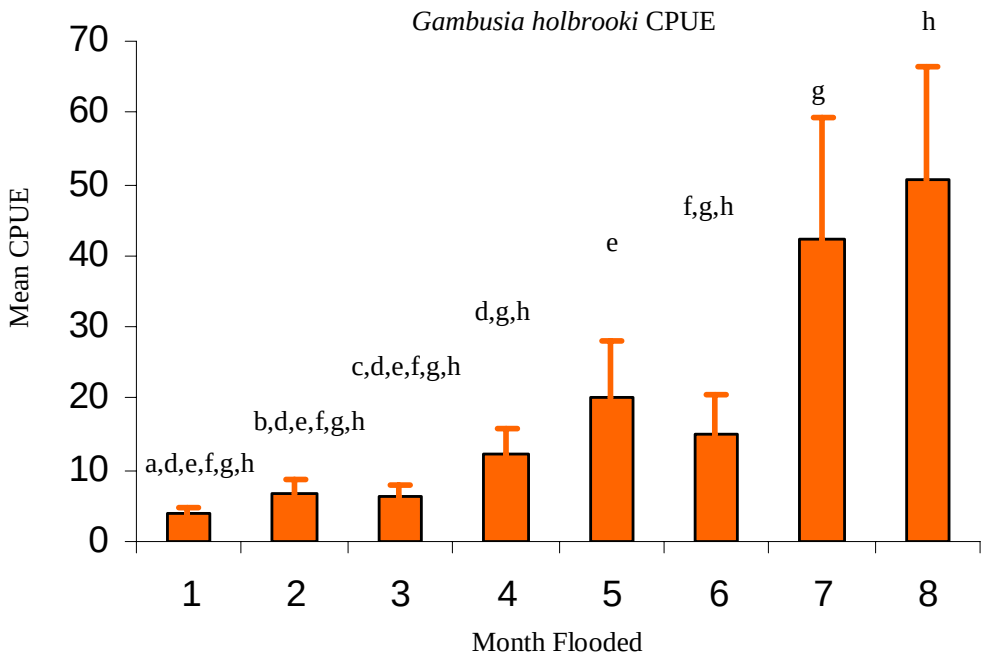
Significant Linear Regression of Non-Indigenous CPUE and Water Depth at the Drift-Fence Arrays During Monthly Monitoring

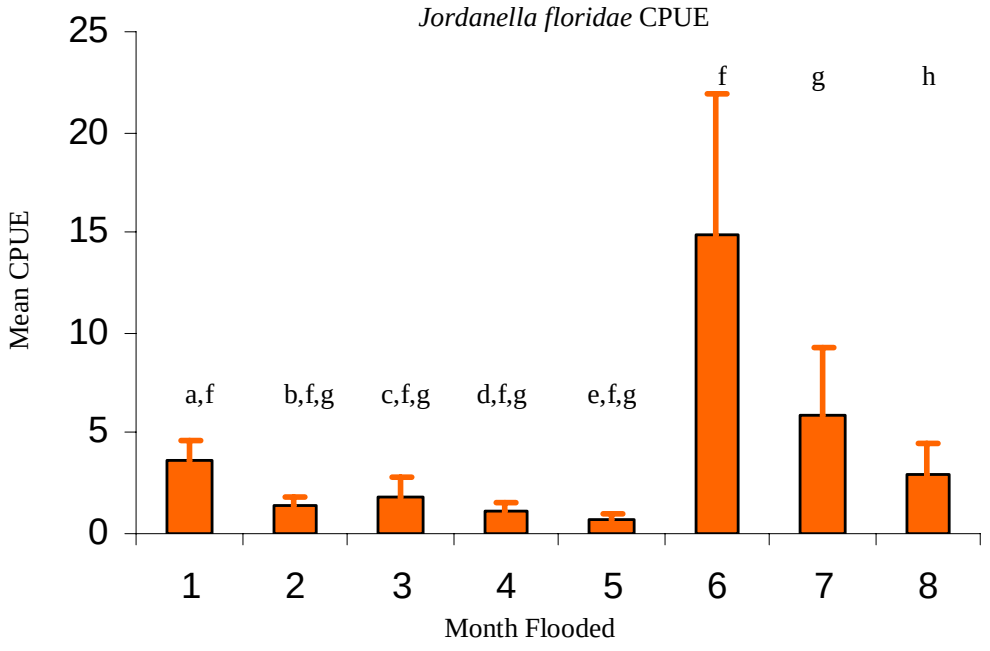


P = 0.000

Figure 29

Mean CPUE by Month Flooded for Common Native Species

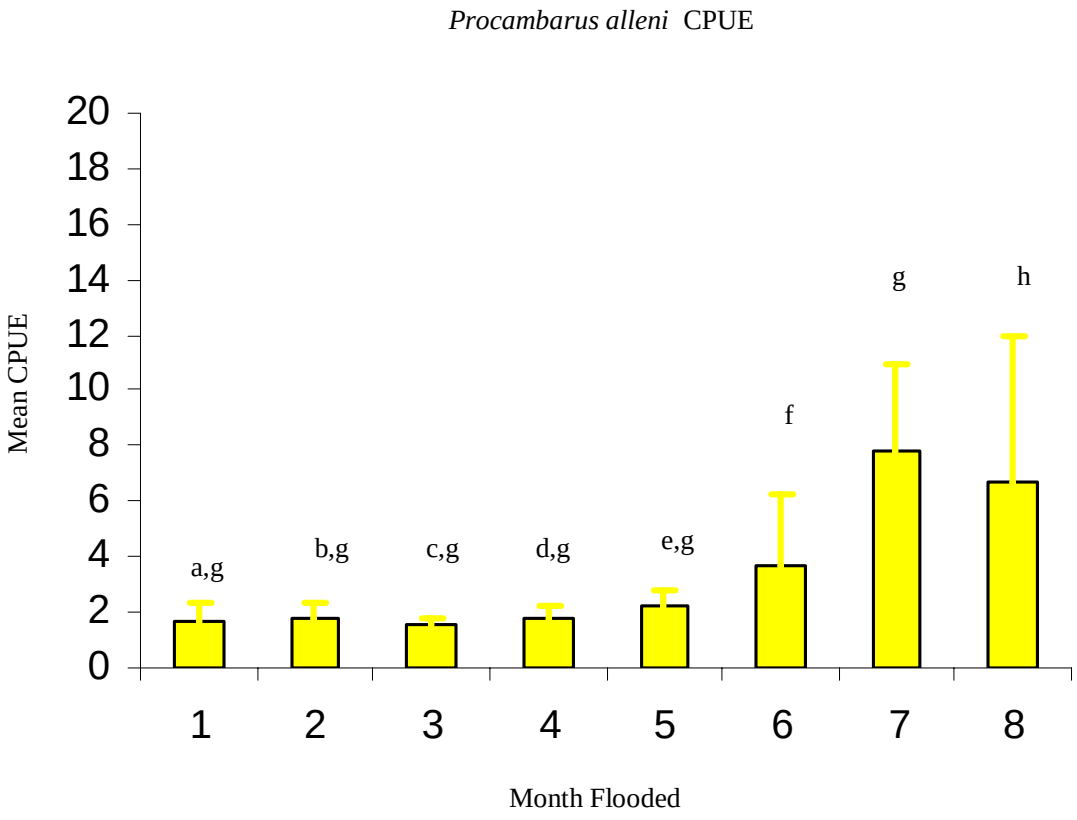




* Letter indicates significant differences at $P < 0.05$

Figure 30

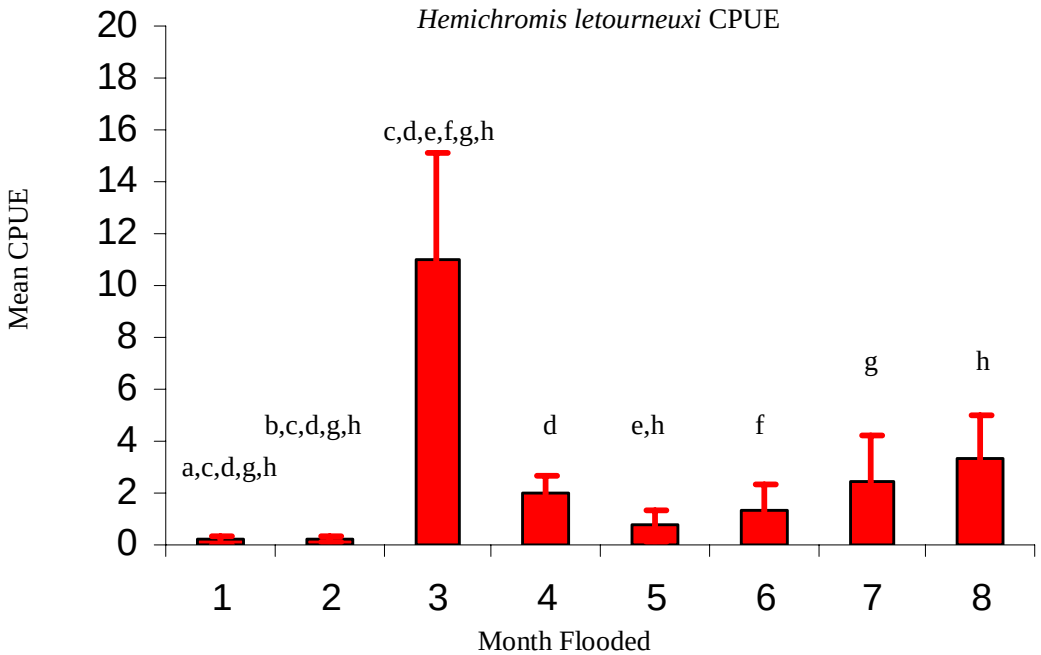
Mean CPUE by Month Flooded for the Everglades Crayfish

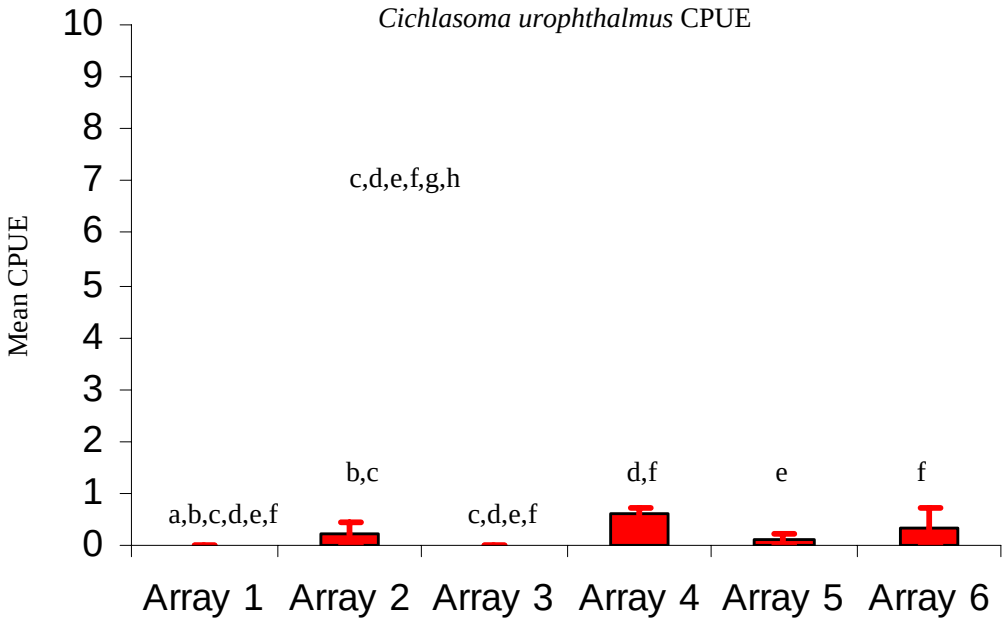


* Letter indicates significant differences at P < 0.05

Figure 31

Mean CPUE for Common Non-Indigenous Species



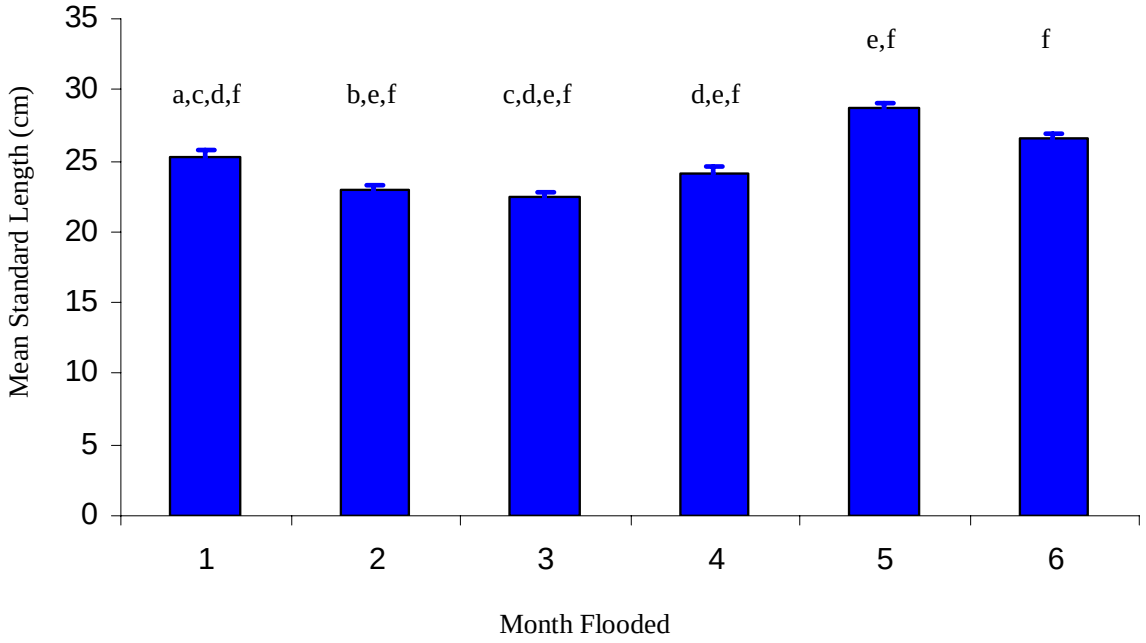


•Letter indicates significant differences at $P < 0.05$

•Note: Difference in Y-axis scale

Figure 32

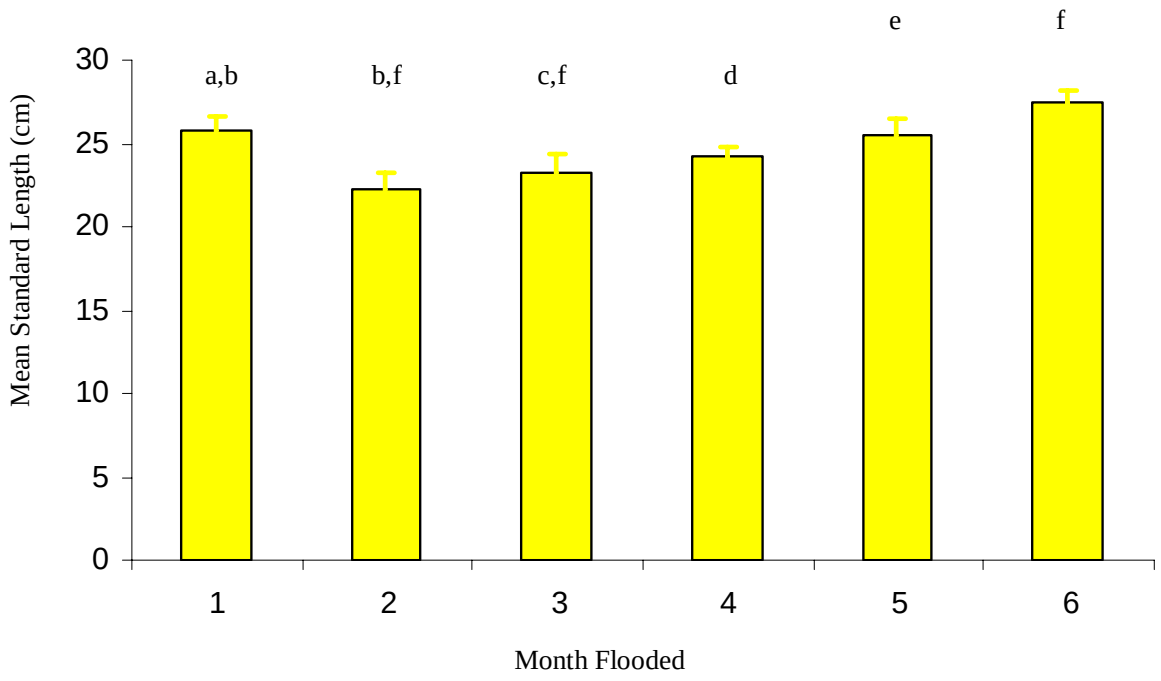
Temporal Change in Mean Standard Lengths of Fishes
During the 2004-05 Wet Season



* Letter indicates significant differences at P < 0.05

Figure 33

Temporal Change in Mean Standard Length of *P. alleni*
During the 2004-05 Wet Season

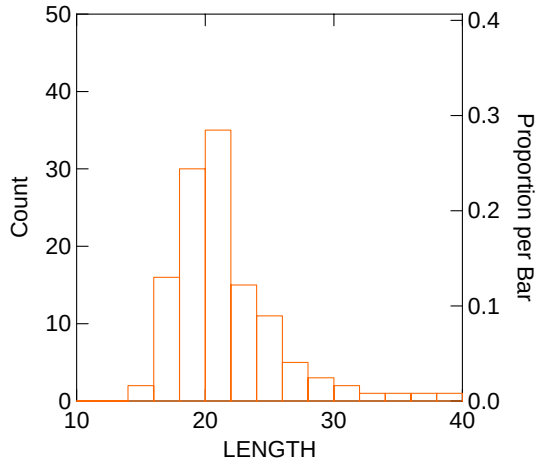


* Letter indicates significant differences at P < 0.05

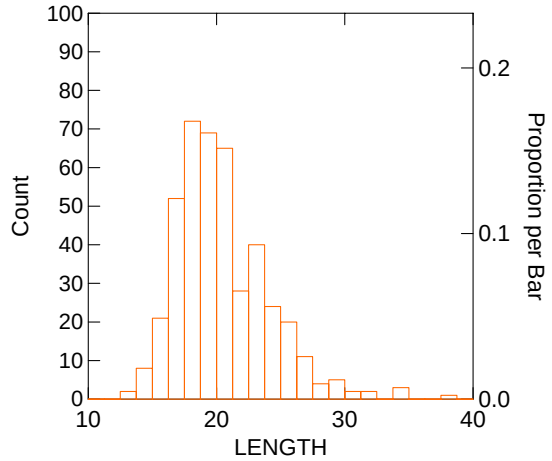
Figure 34

Frequency Distributions of *G. holbrooki* Standard Lengths (cm)

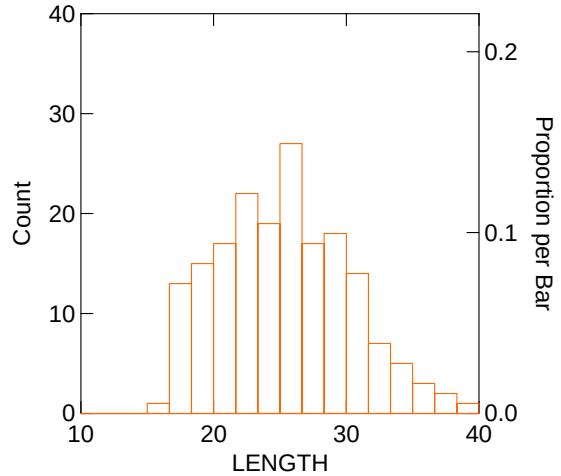
Early Wet Season



Mid -Wet Season



Late Wet Season

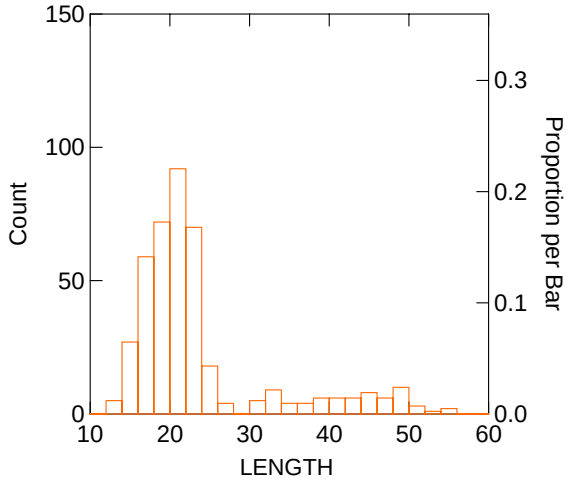


$F_{2,730} = 90.581$, $P = 0.000$, $R^2 = 0.199$

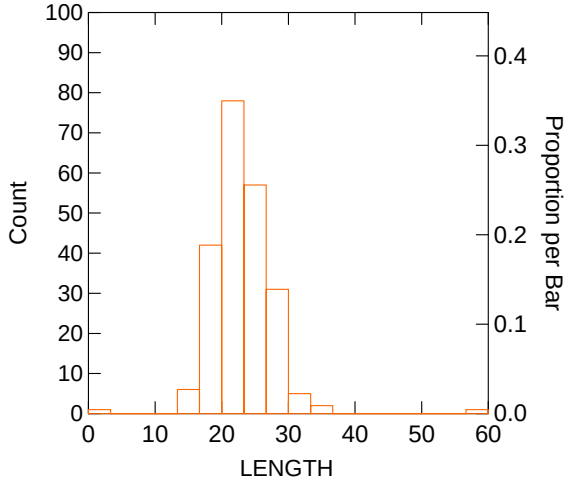
Figure 35

Frequency Distributions of *L. marginatus* Standard Lengths (cm)

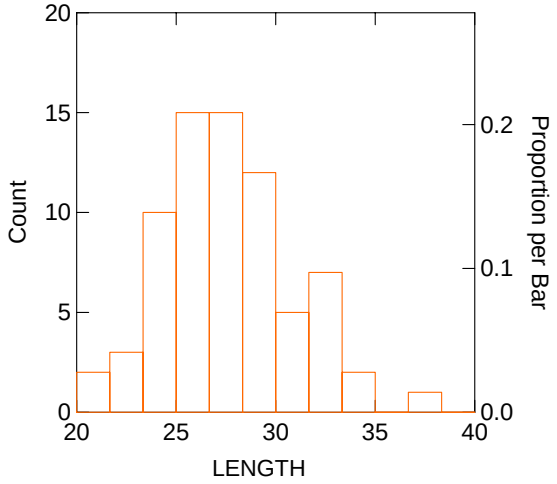
Early Wet Season



Mid -Wet Season



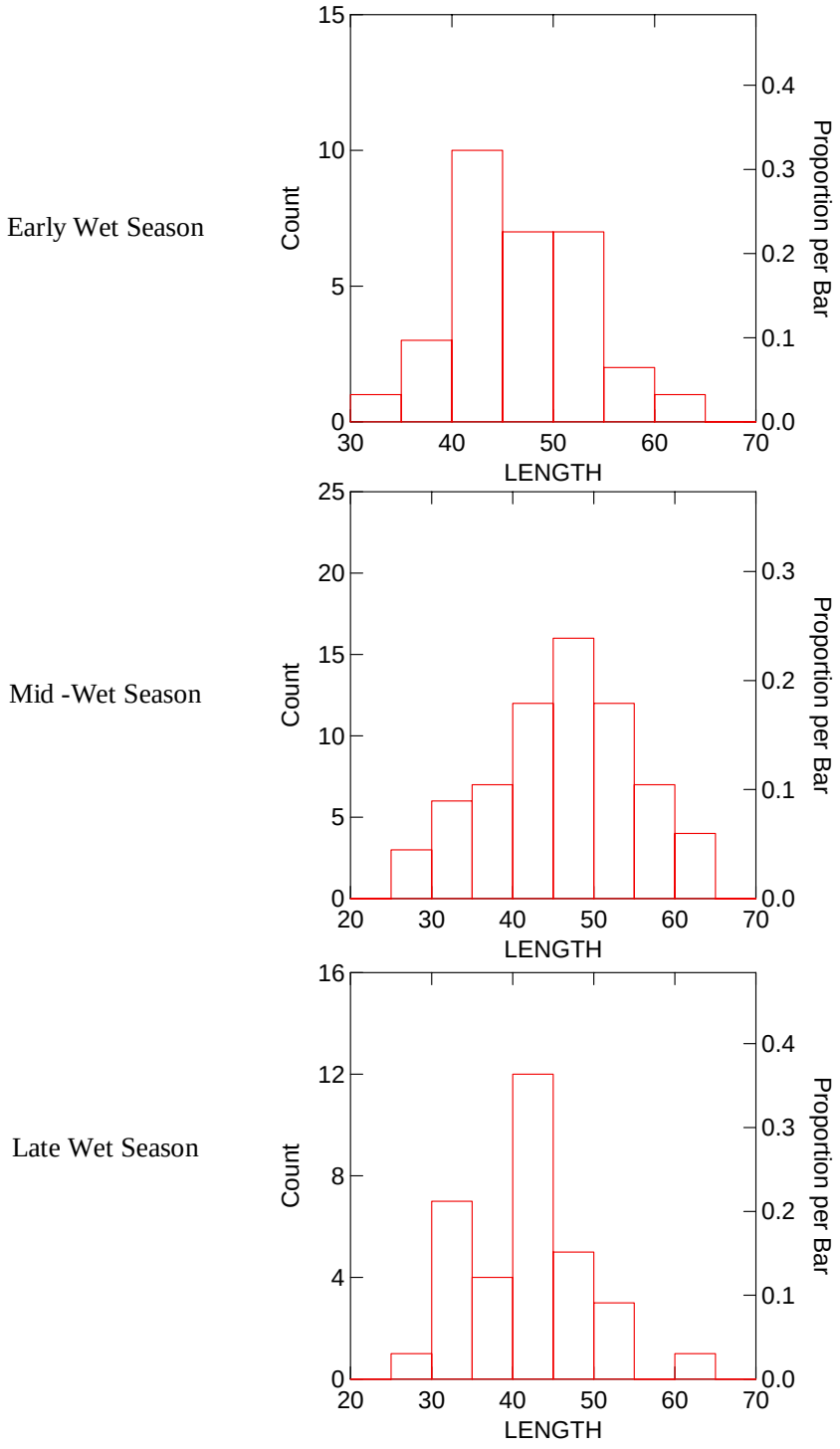
Late Wet Season



$F_{2,709} = 10.514$, $P = 0.000$, $R^2 = 0.029$

Figure 36

Frequency Distributions of *H. letourneuxi* Standard Lengths (cm)

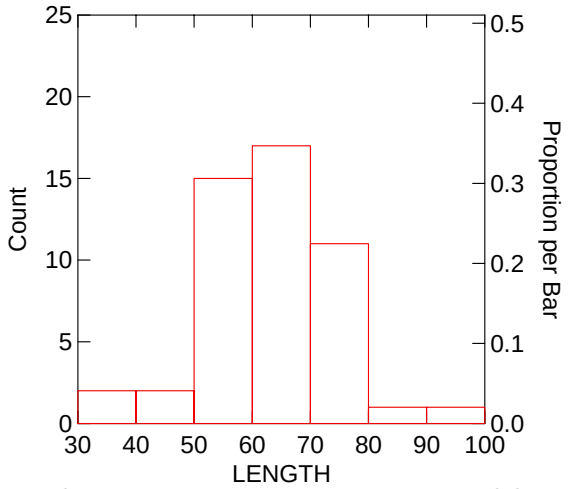


$F_{2,128} = 4.955$, $P = 0.008$, $R^2 = 0.072$

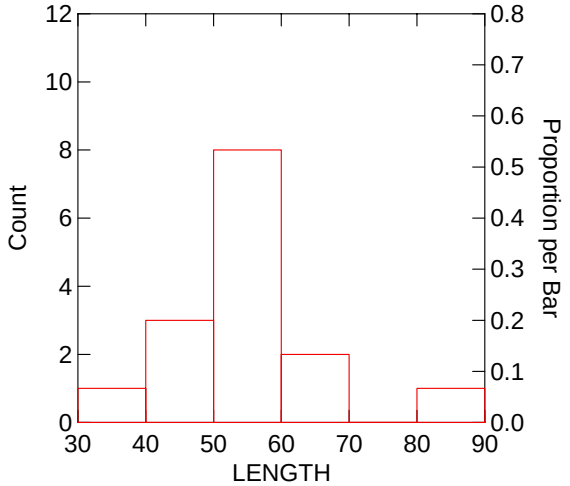
Figure 37

Frequency Distributions of *B. belizanus* Standard Lengths (cm)

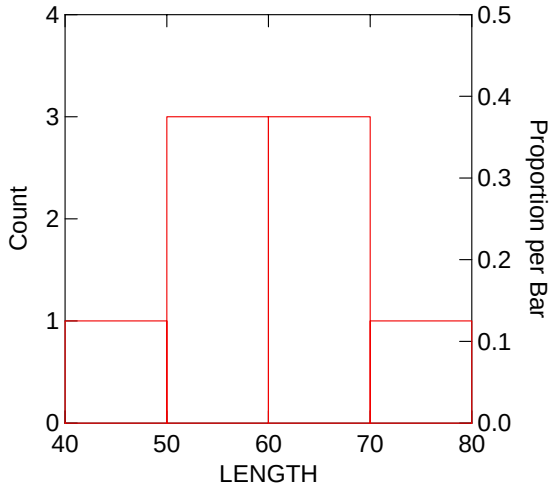
Early Wet Season



Mid -Wet Season



Late Wet Season



$F_{2,69} = 2.978$, $P = 0.057$, $R^2 = 0.079$

Figure 38

Relative Abundance in the Daily Array Samples at the Onset of Flooding in 2005 and 2006

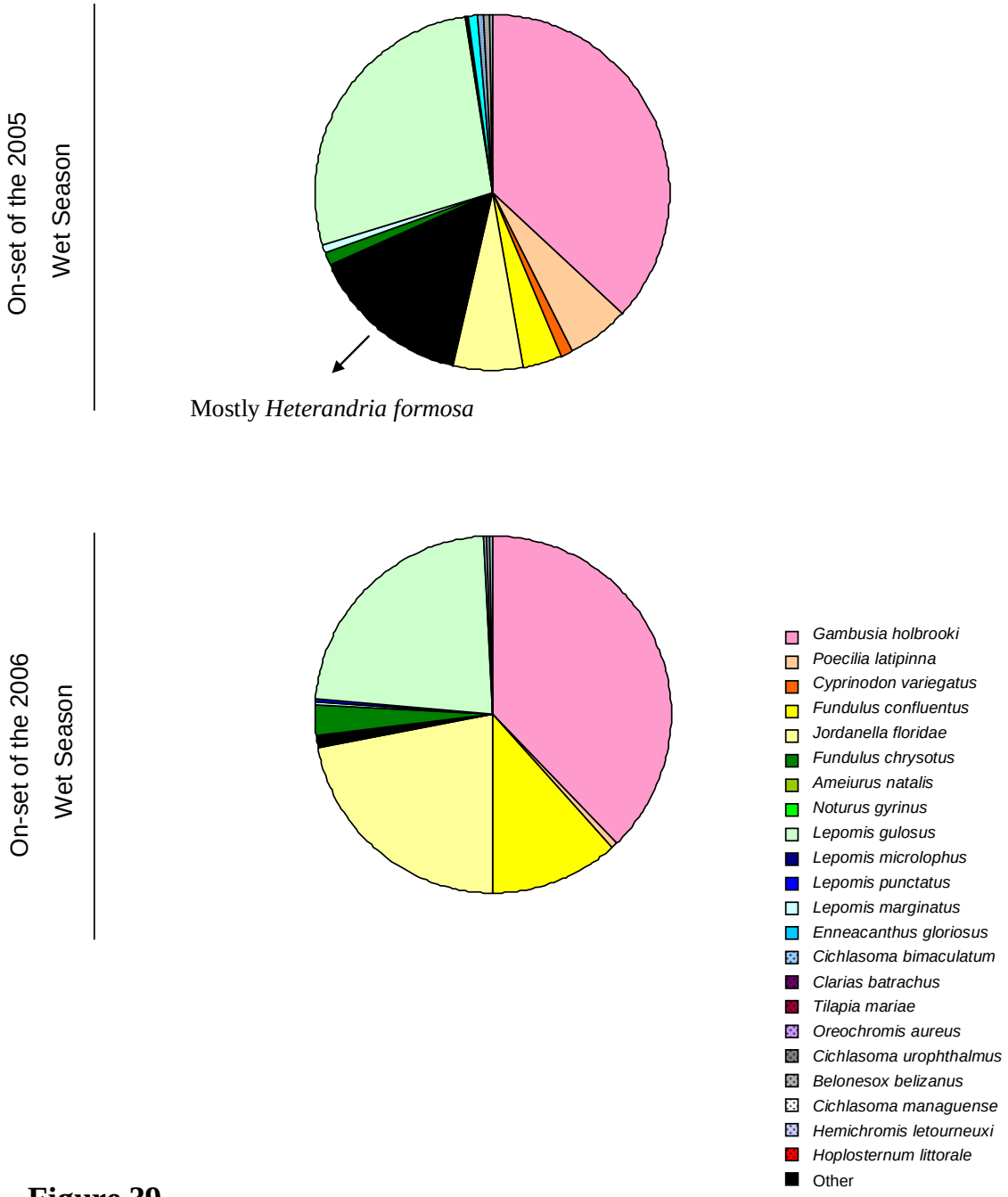
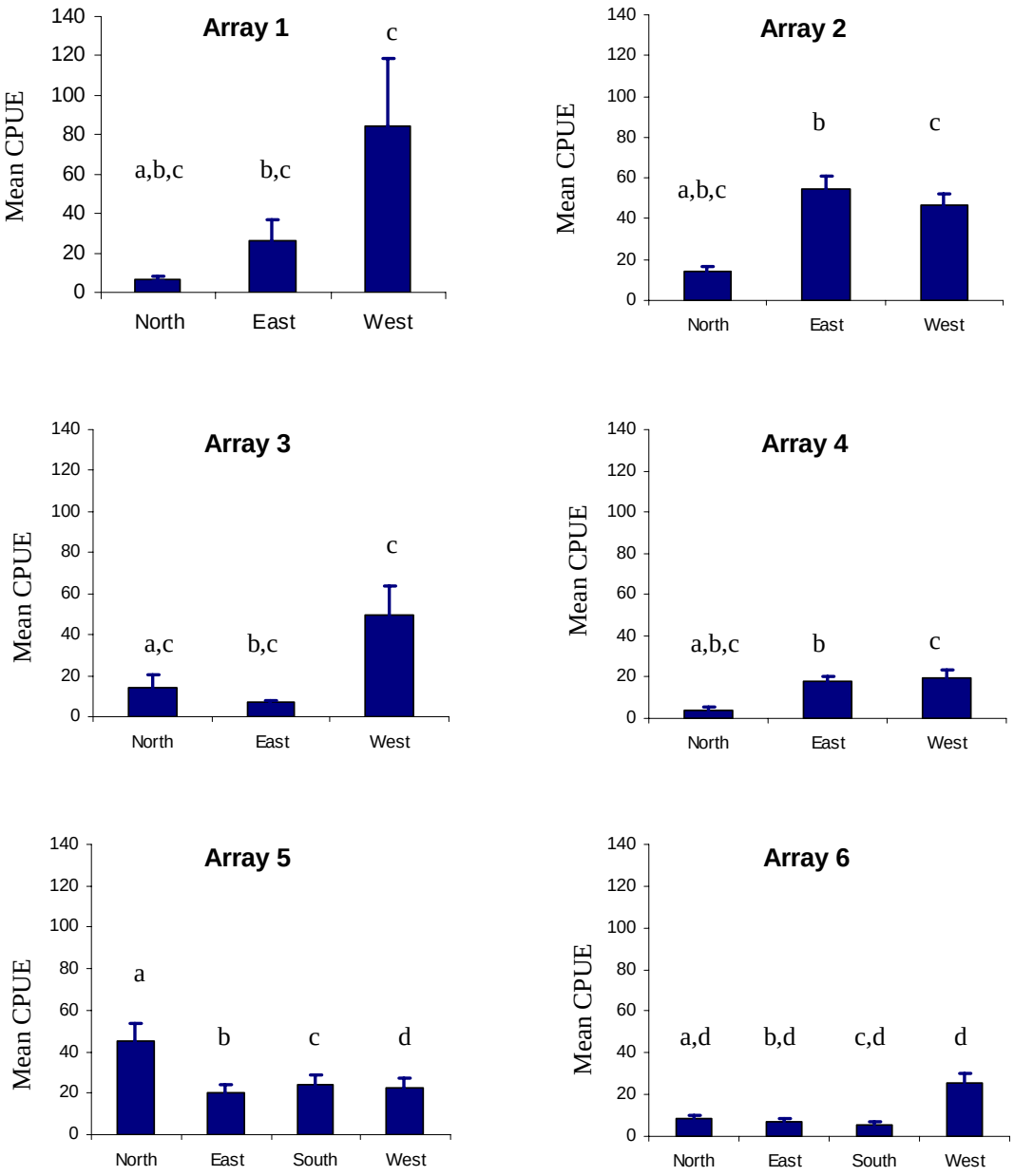


Figure 39

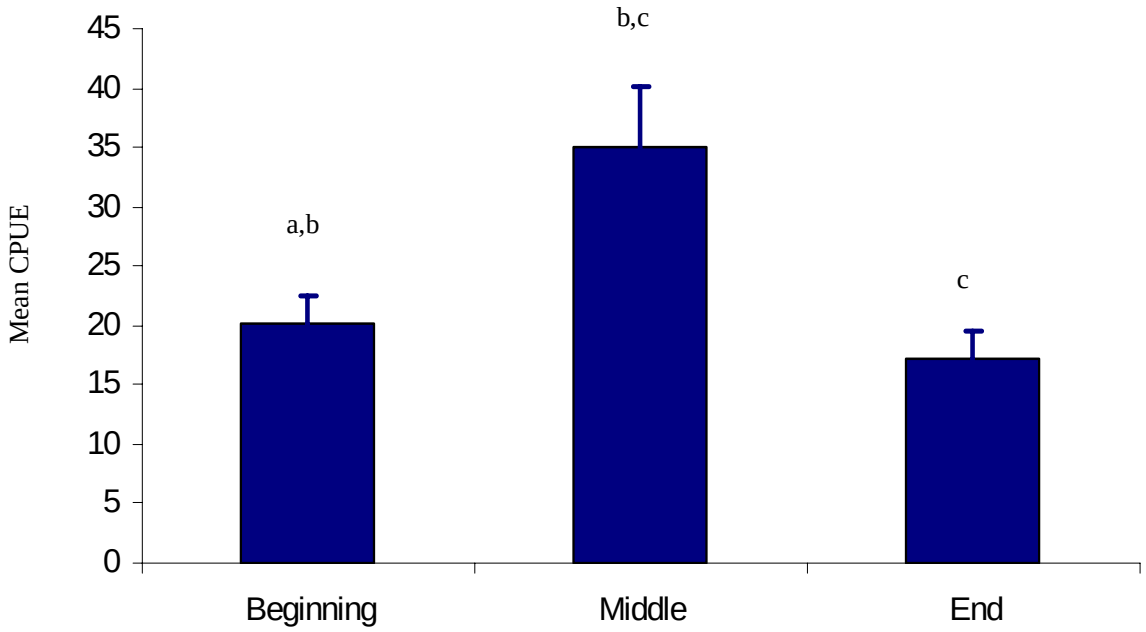
Mean CPUE by Minnow Trap Direction in the Drift-Fence Arrays During Daily Sampling



* Letter indicates significant differences at $P < 0.05$

Figure 40

Mean CPUE at the Beginning, Middle, and End of Daily Array Sampling



$F_{2,486} = 5.821$; $P = 0.003$, $R^2 = 0.023$

* Letter indicates significant differences at $P < 0.05$

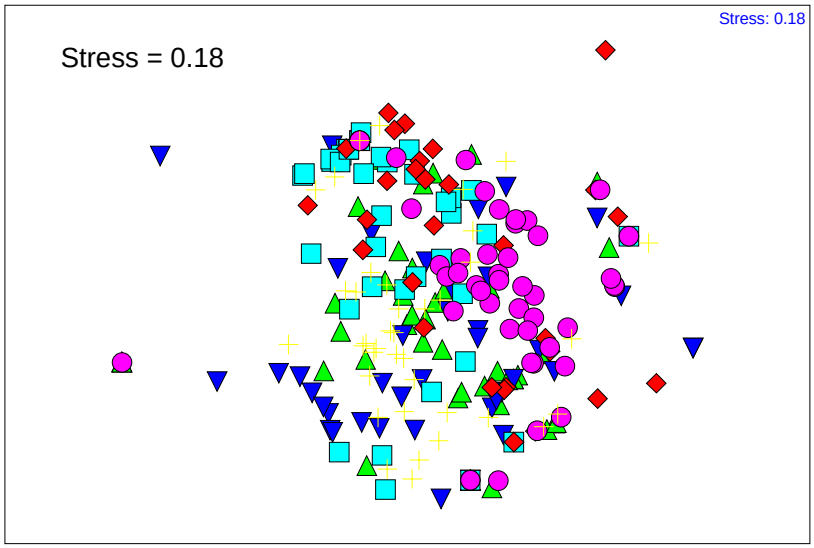
Beginning - Days #1 → 4

Middle - Days #5 → 10

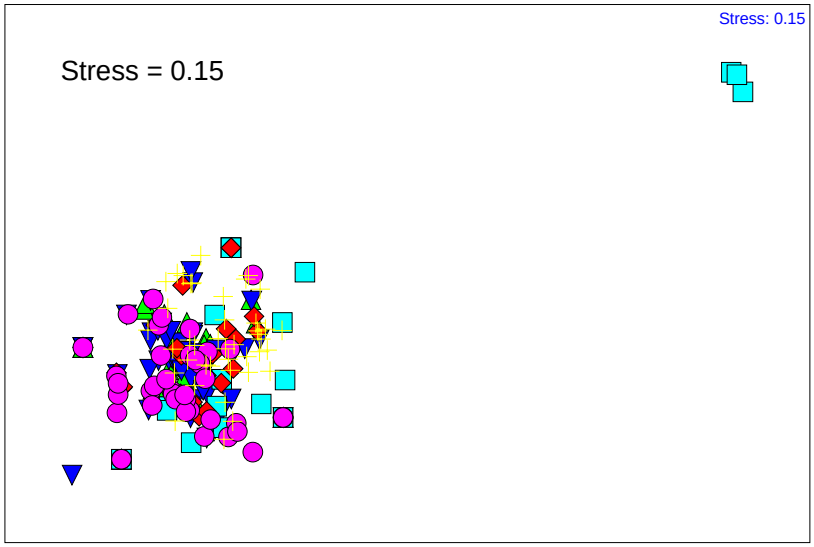
End - Days #11 → ≥14

Figure 41

nMDS Plots Illustrating Spatial Differences in Community Structure at the Beginning of the 2005 and 2006 Wet Seasons



2005



2006

Array 1
Array 2
Array 3
Array 4
Array 5
Array 6

Figure 42

Recruitment of Species to Array #4 During the 2005 Wet Season

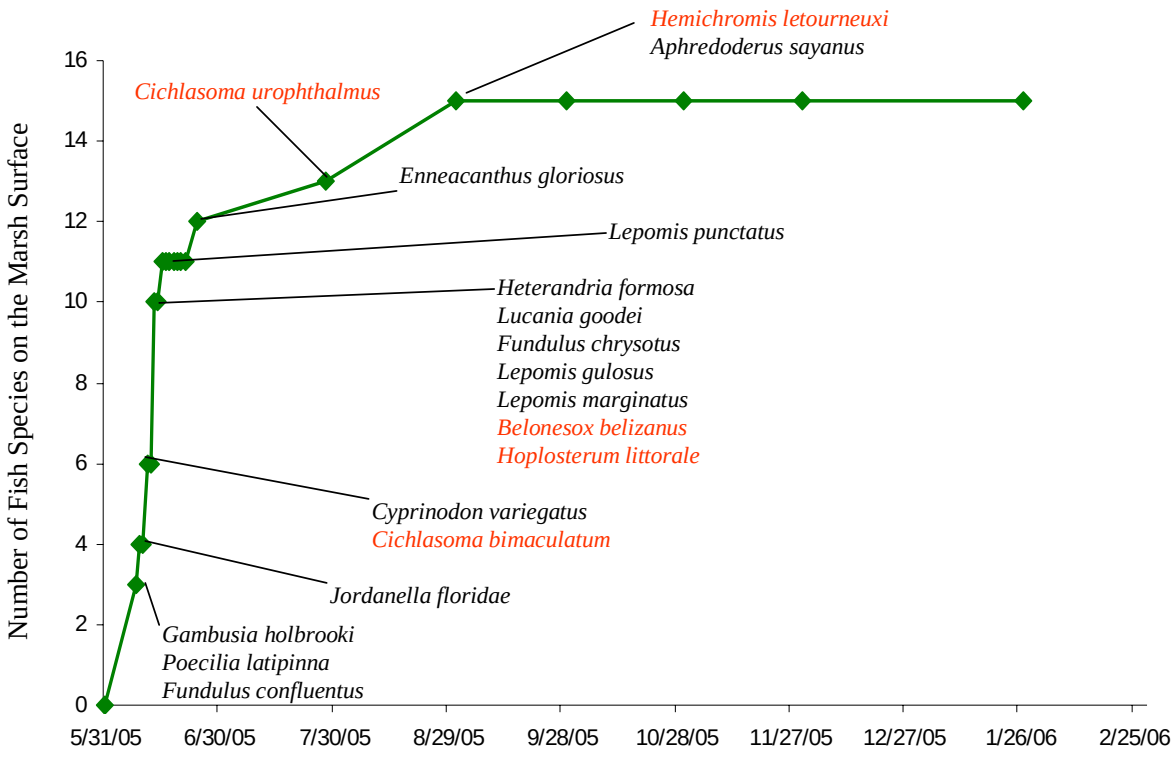


Figure 43

nMDS Plot Illustrating Differences in the Community Structure of Fishes Collected in Throw Traps and Drift-Fence Array Minnow Traps

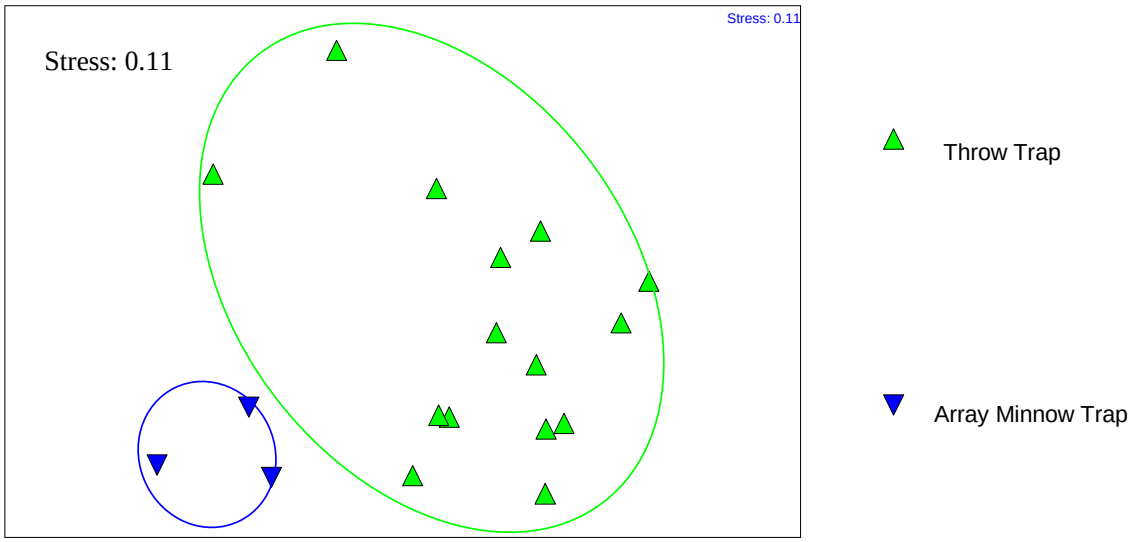
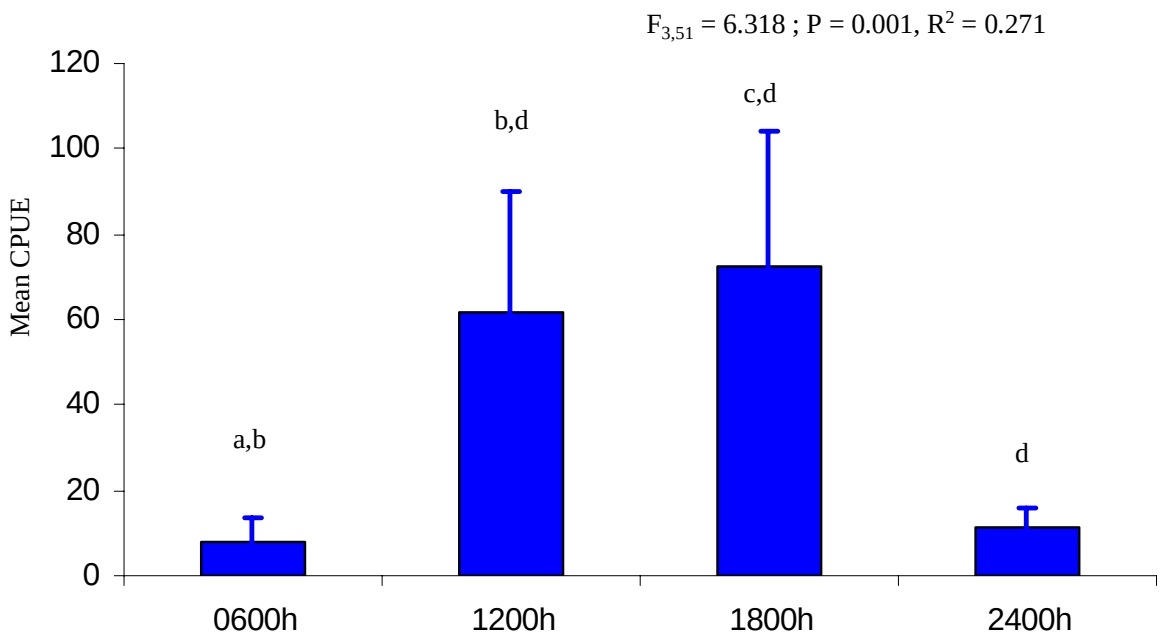
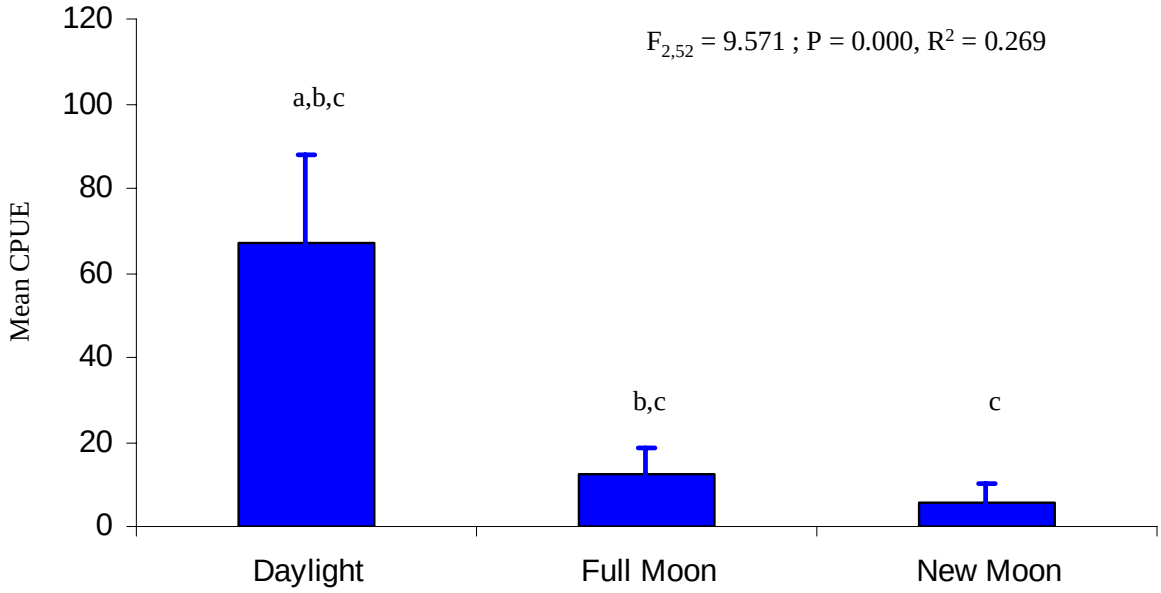


Figure 44

Mean CPUE During the Diel Drift-Fence Array Sampling





* Letter indicates significant differences at P < 0.05

Figure 45

nMDS Plot Illustrating Differences in the Community Structure of Fishes Collected During Different Lunar and Daylight Conditions

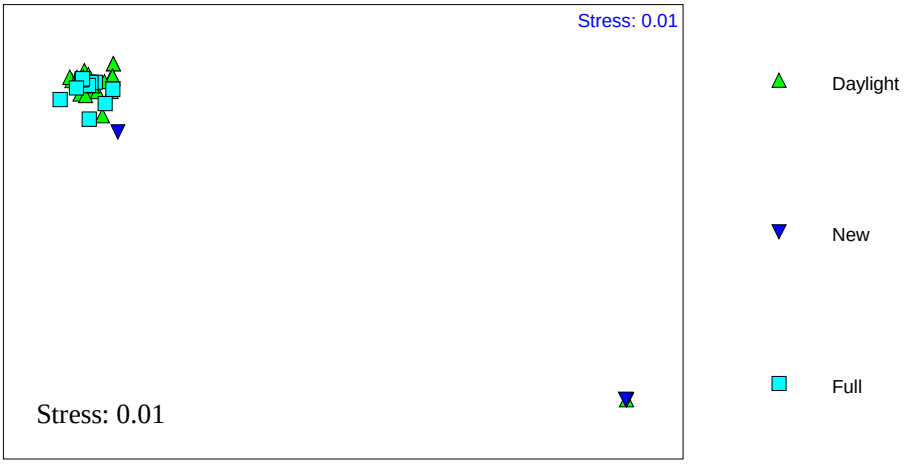


Figure 46

Pie Charts Depicting Differences in Diel Catches of Fishes on the Marsh Surface During 24-h Samples

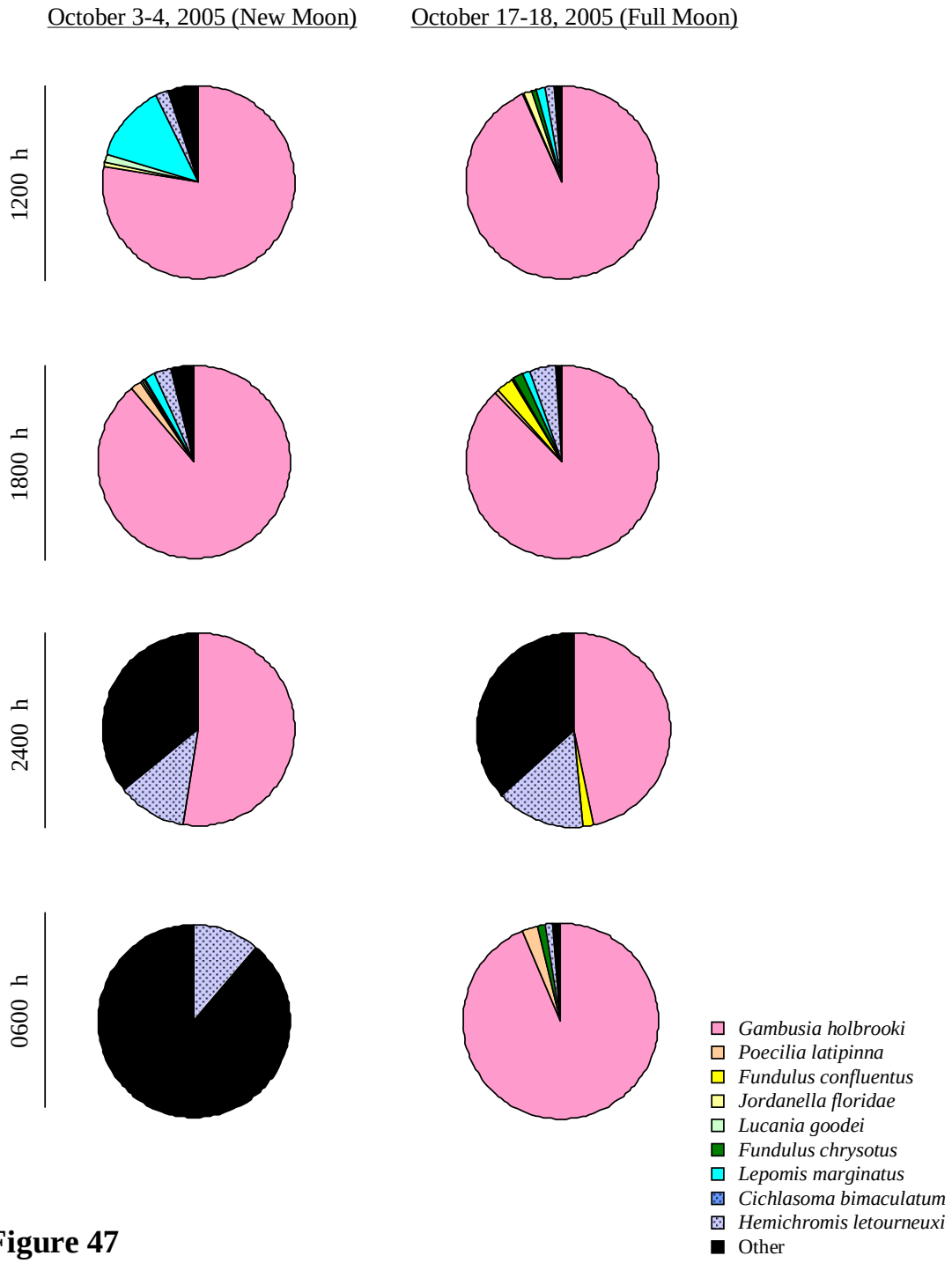


Figure 47

Pie Charts Showing Difference in Relative Abundances of Fishes in Solution Holes

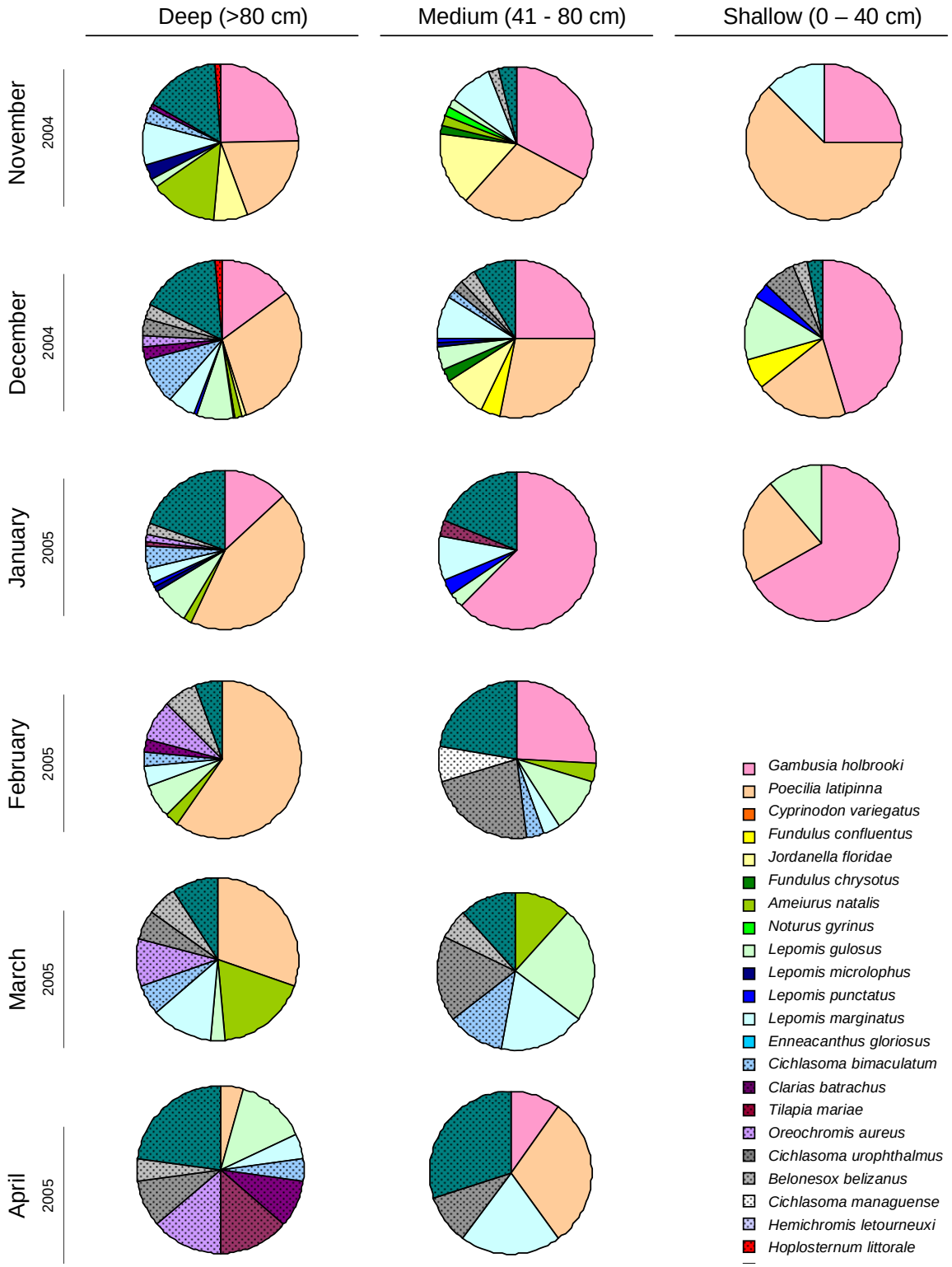


Figure 48

Relative Abundance of Non-Indigenous Fishes in Solution Holes

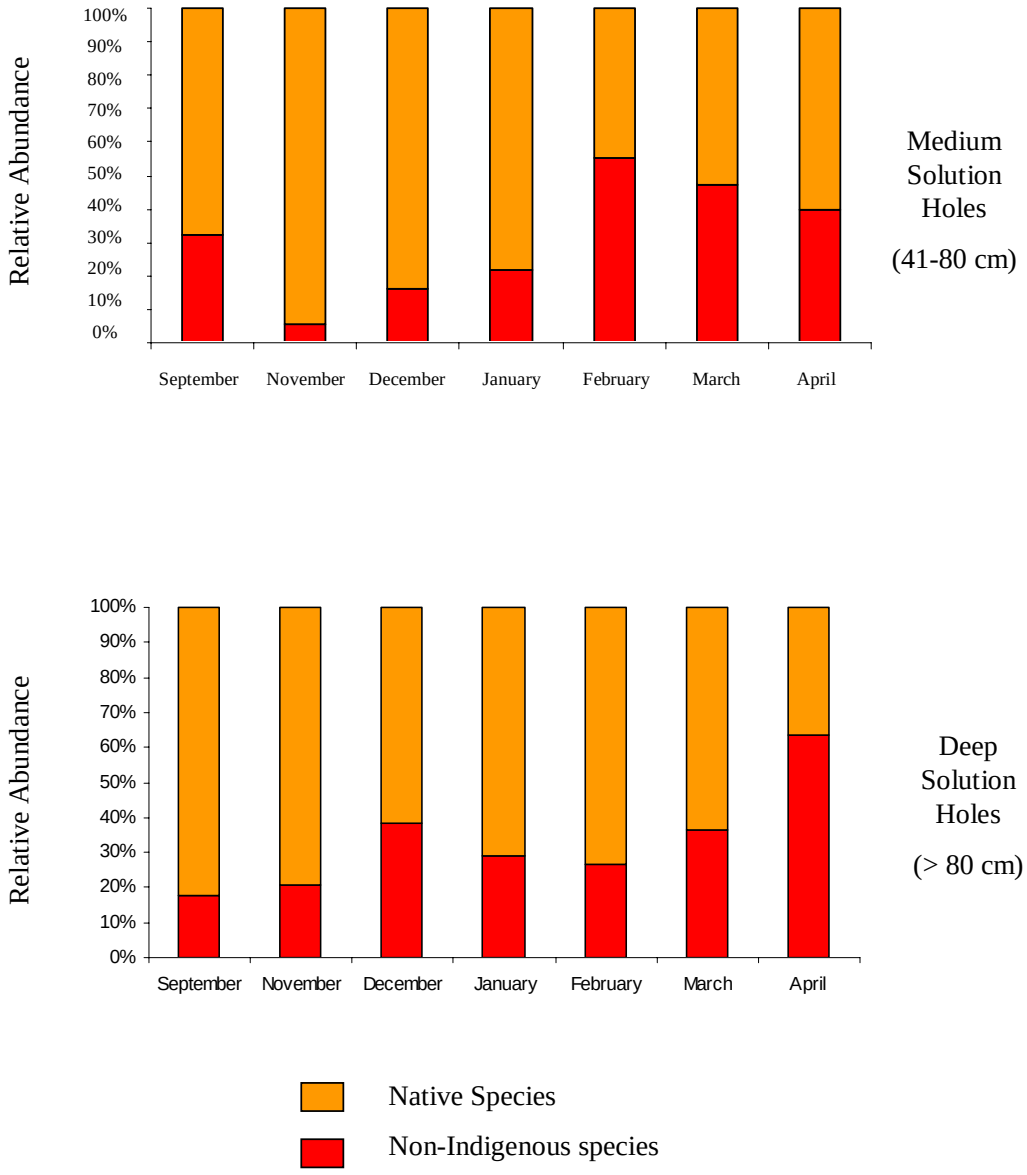


Figure 49

Relative Abundance of *Hemichromis letourneuxi* in Solution Holes

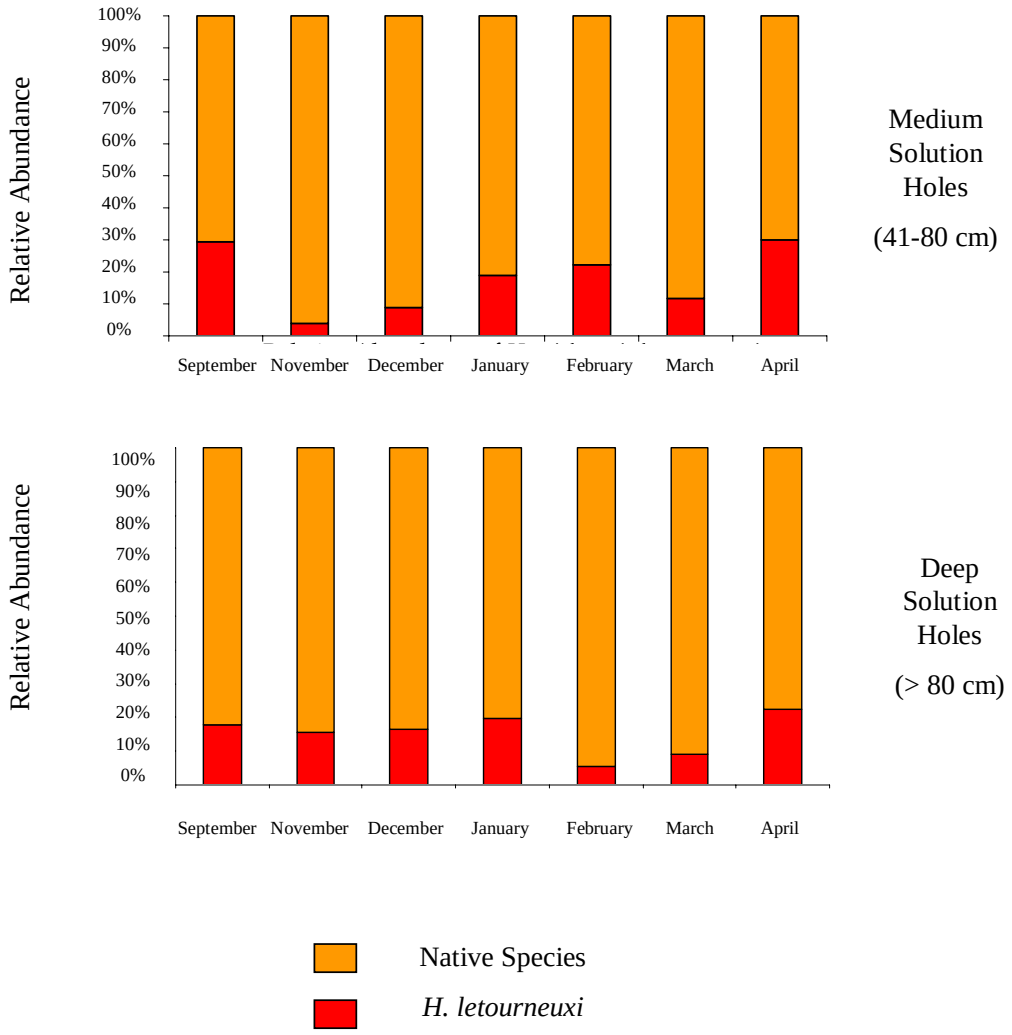


Figure 50

nMDS Plot Illustrating Differences in the Community Structure of Fishes in Solution Holes During the Dry Season of 2004-05

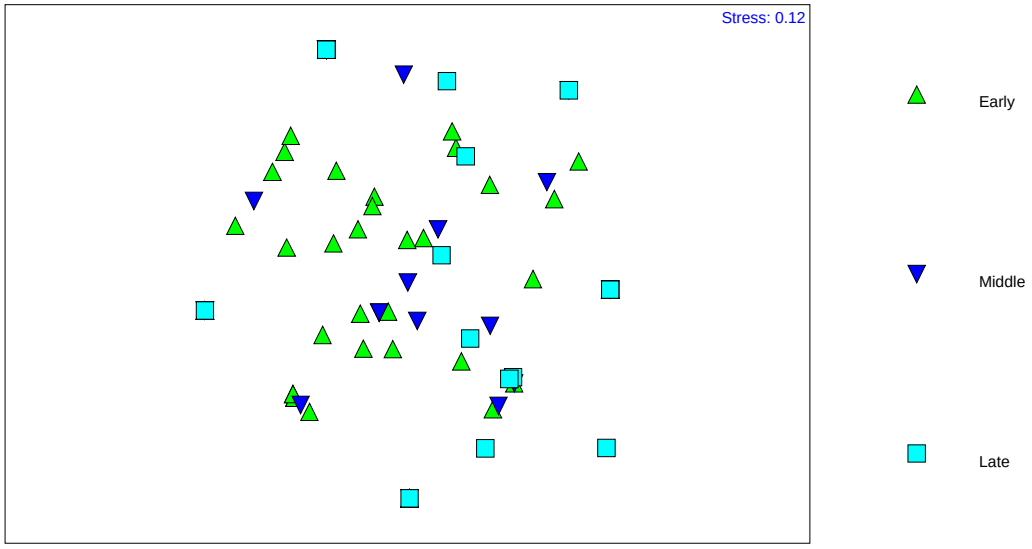
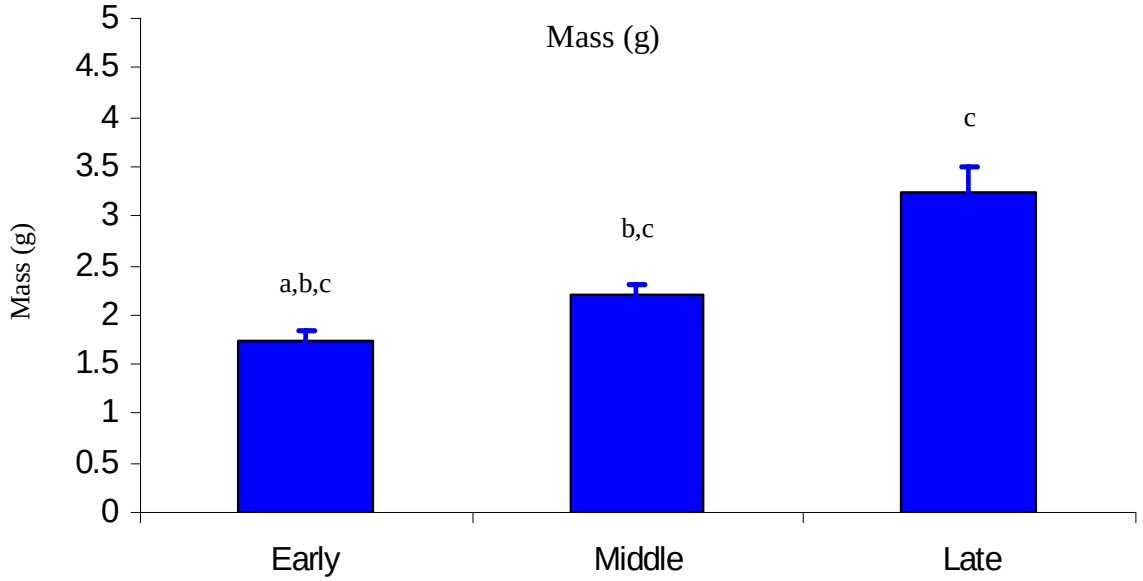
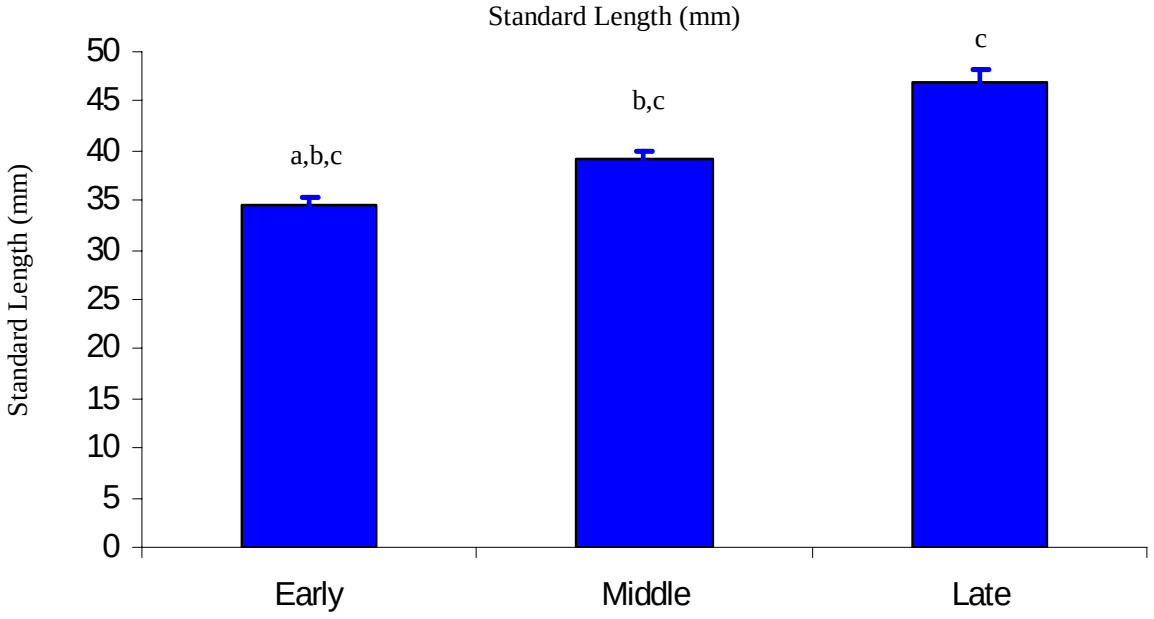


Figure 51

Mean Mass and Standard Length of Fishes Collected in Solution Holes at Different Times During the Dry Season of 2004-05



$F_{2,907} = 28.258$; $P = 0.000$, $R^2 = 0.059$



$F_{2,917} = 26.776$; $P = 0.000$, $R^2 = 0.055$

* Letter indicates significant differences at $P < 0.05$

Figure 52

Variables Contributing to Significant Differences in CPUE of *Poecilia latipinna* in Solution Holes

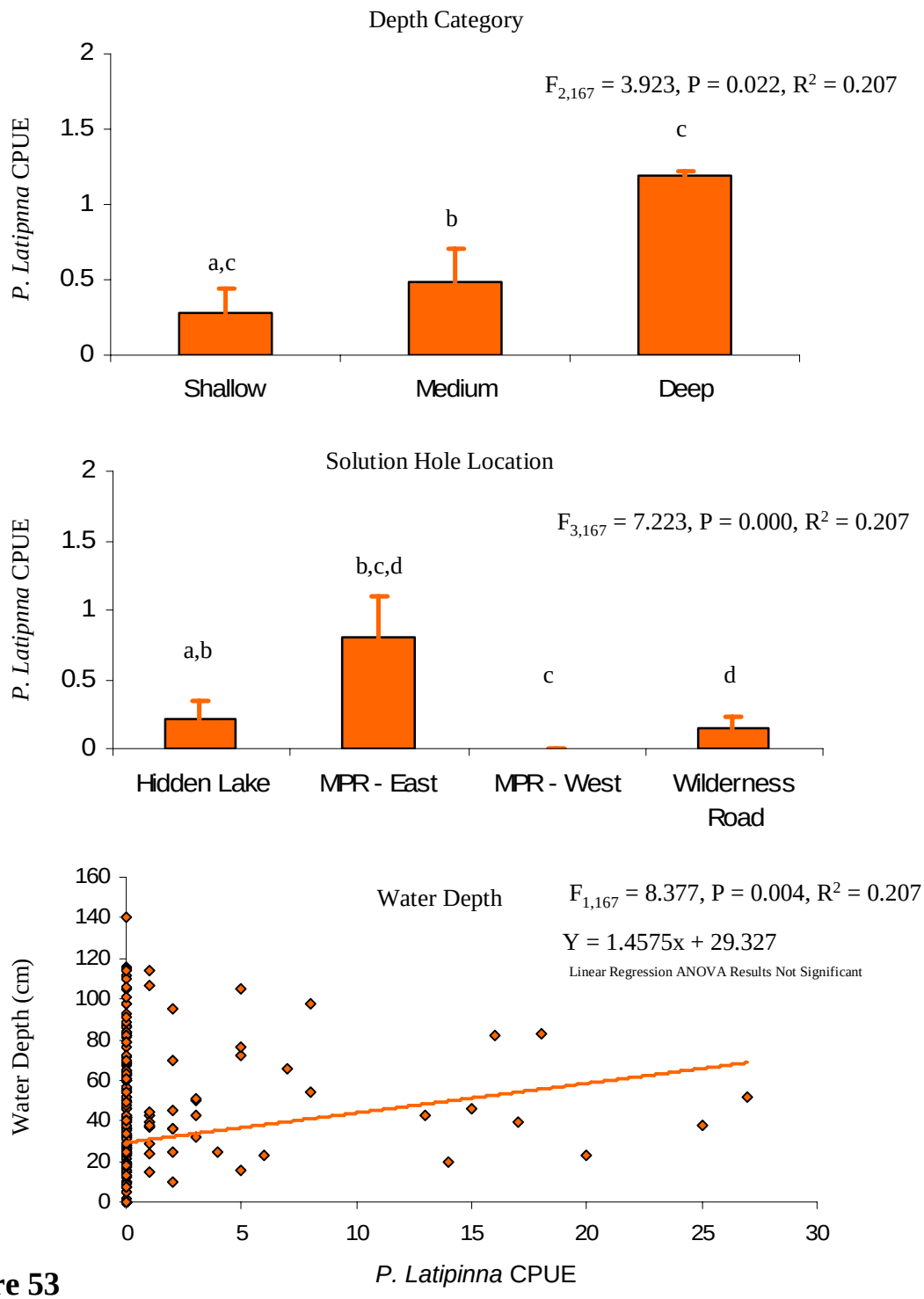
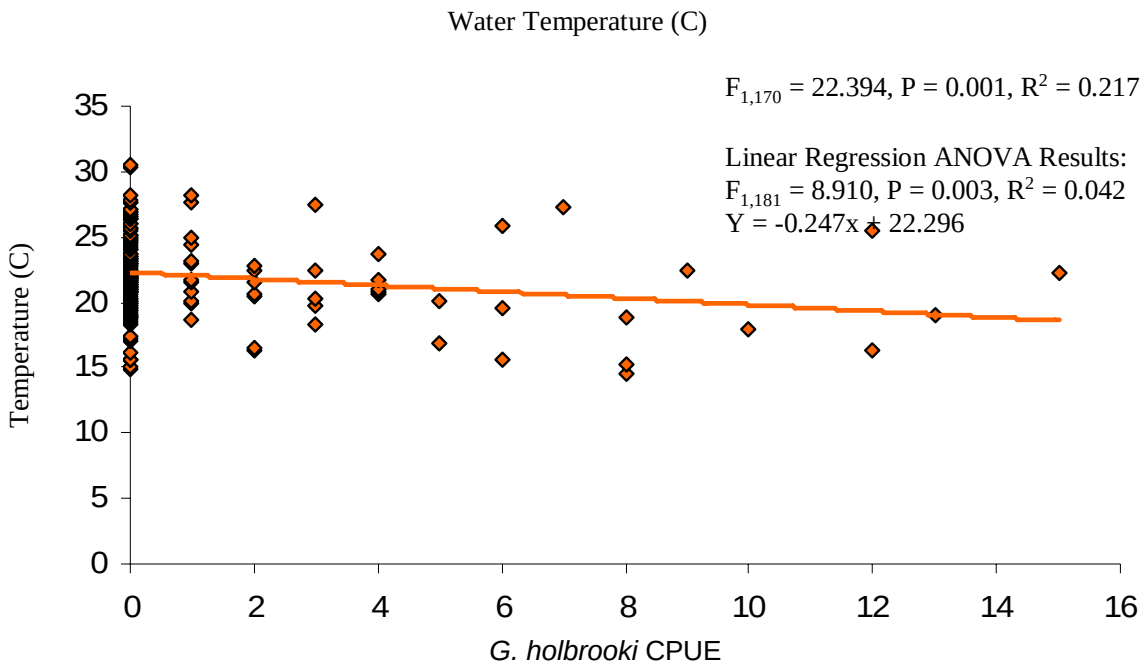


Figure 53

Variables Contributing to Significant Differences in CPUE of *Gambusia holbrooki* in Solution Holes



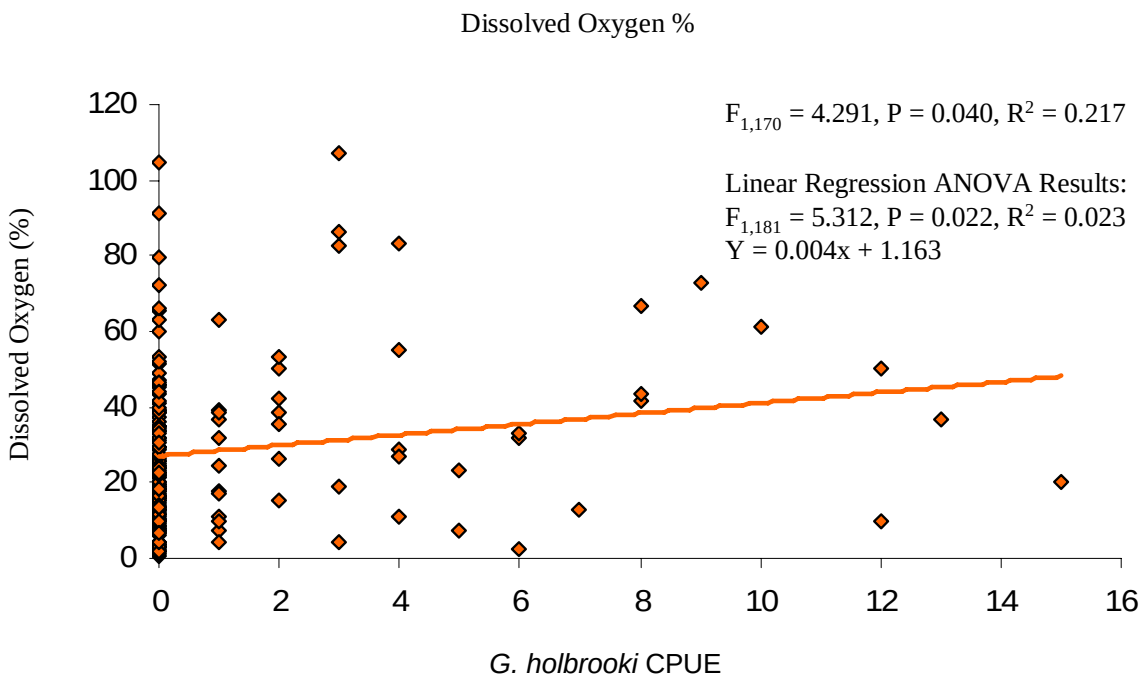


Figure 54

Variables Contributing to Significant Differences in CPUE of *Hemichromis letourneuxi* in Solution Holes

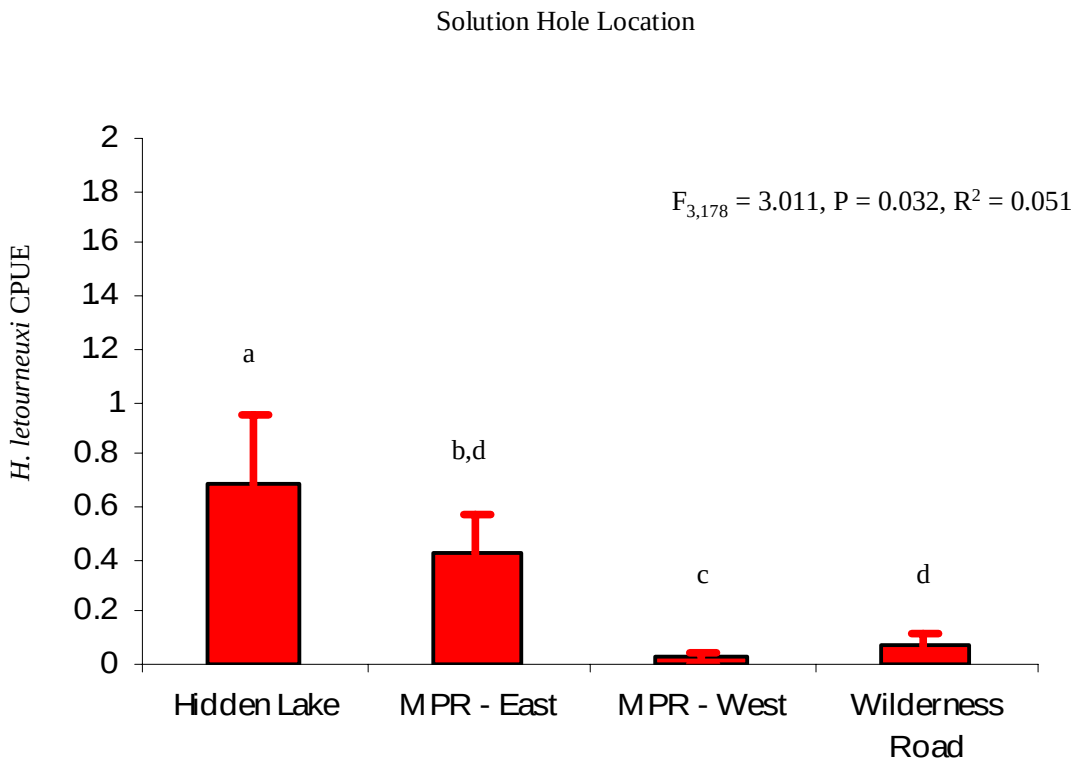
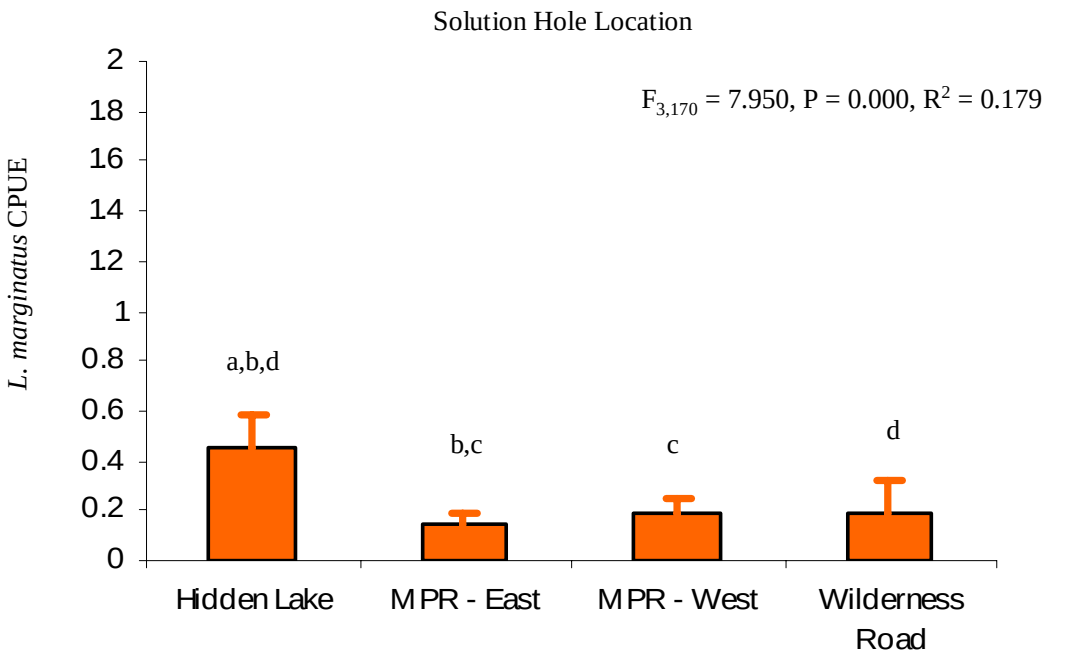


Figure 55

Variables Contributing to Significant Differences in CPUE of *Lepomis marginatus* in Solution Holes



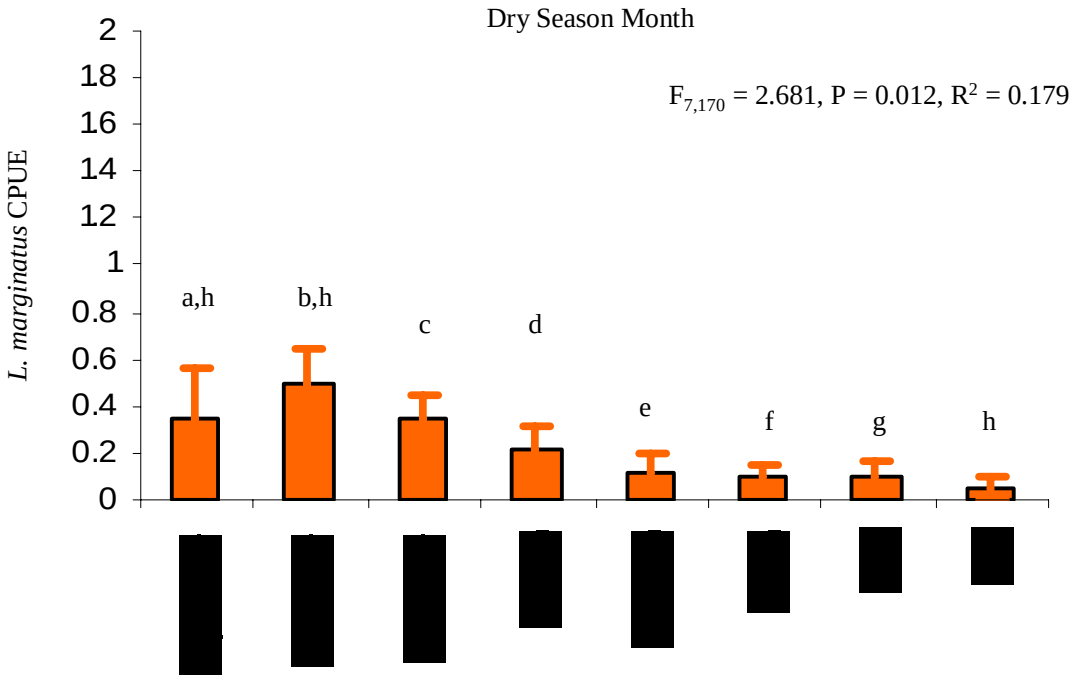


Figure 56

Variables Contributing to Significant Differences in CPUE of *Lepomis gulosus* in Solution Holes

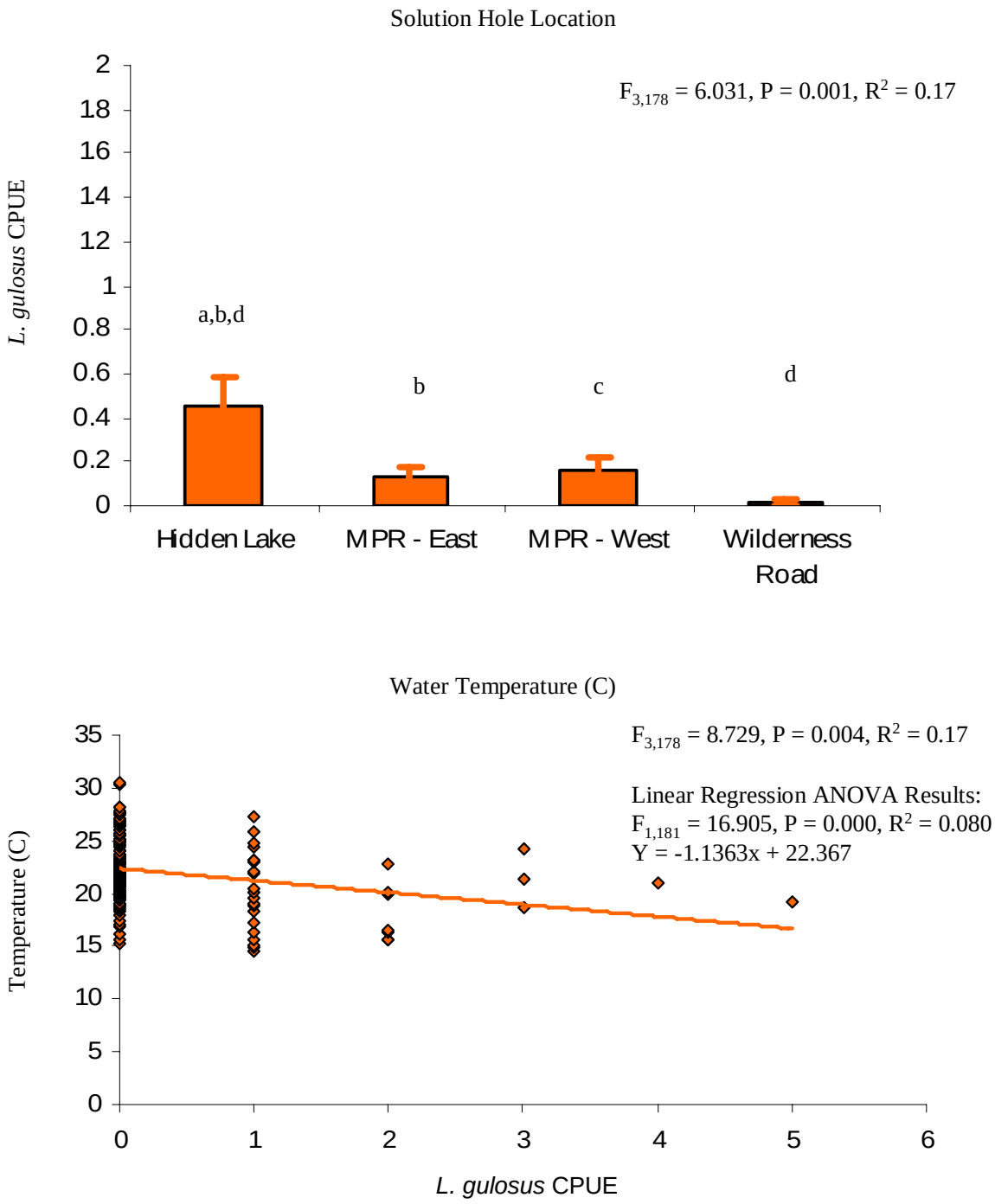


Figure 57

Proposed Conceptual Model of the Function of Solution Holes Under Historic and Present Water Management Practices

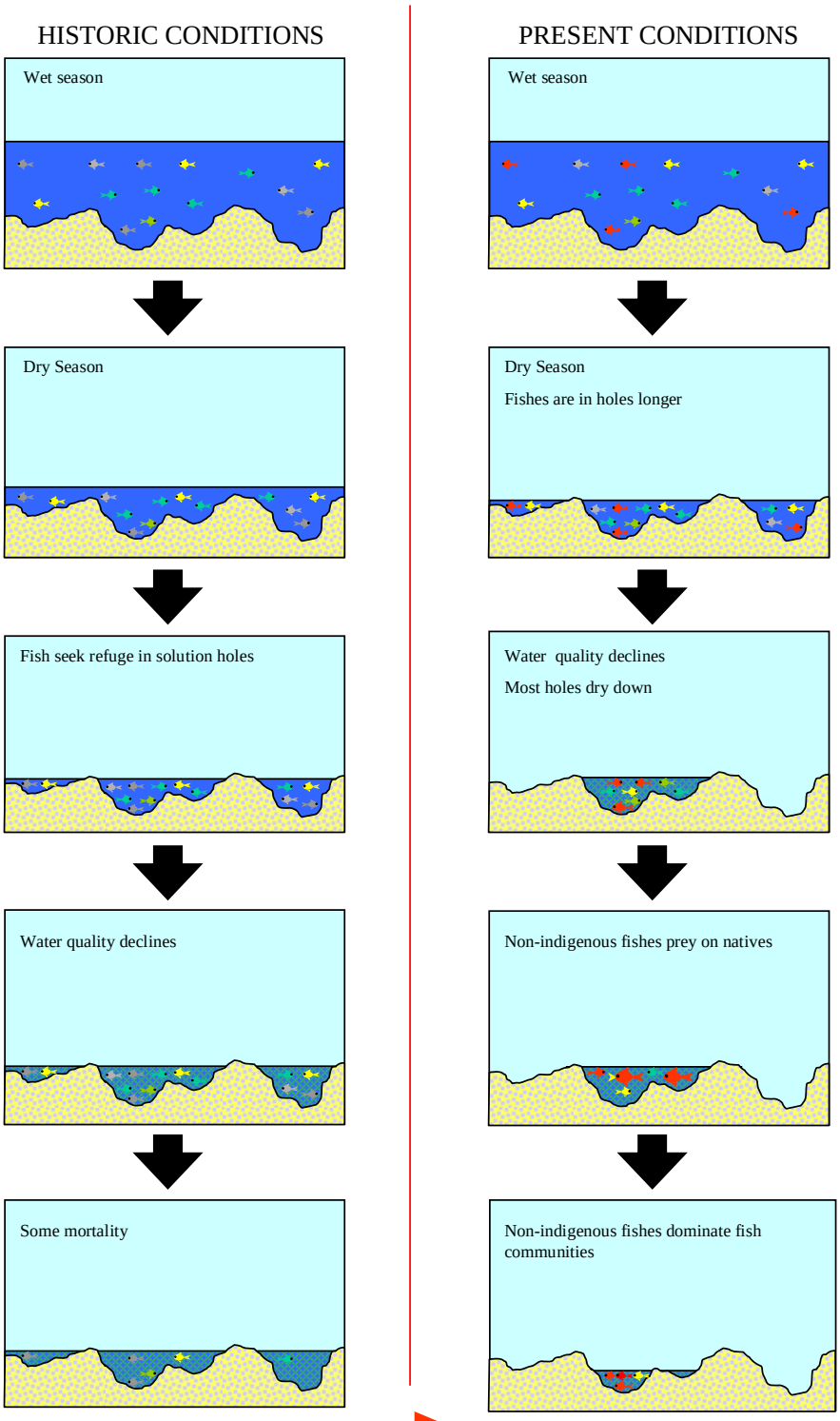


Figure 58

Non- Indigenous Fishes

Schematic Diagram of a Hypothetical Arrangement of Three Minnow Trap Treatments in a Solution Hole in the Priority Effects/Depletion Study

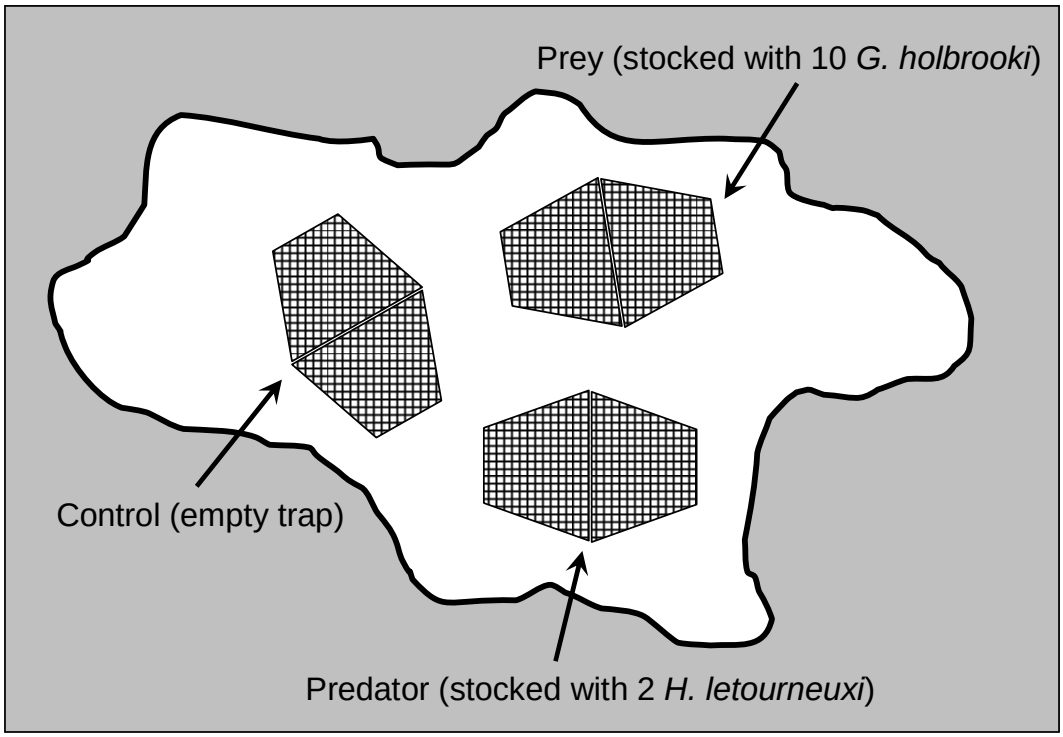


Figure 59

CPUE of Fish in Solution Holes During the Priority Effects/ Depletion Study.

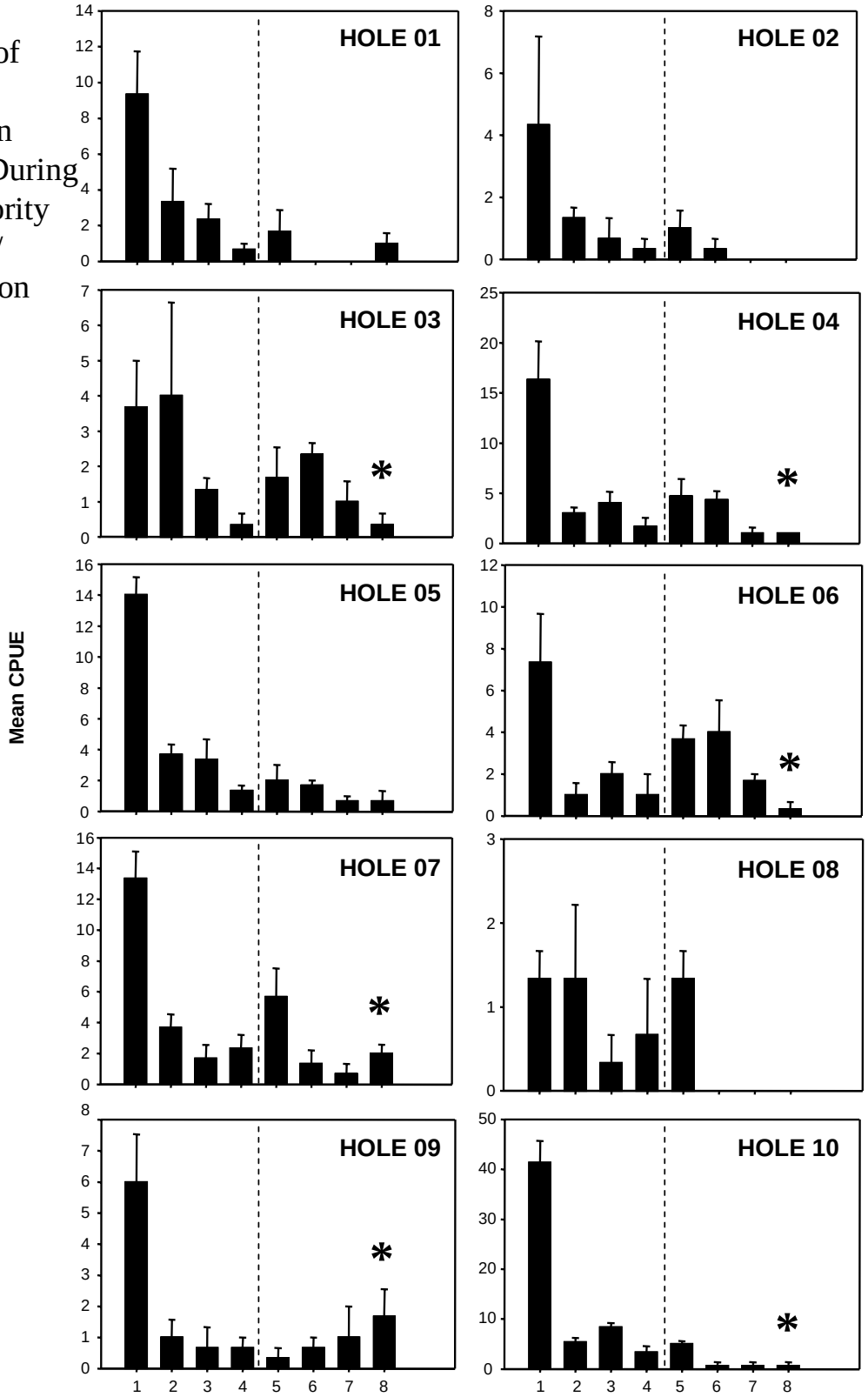


Figure 60

Schematic Diagram of *G. holbrooki* Minnow-Trap Efficiency MesocosmExperiment (02-04 May 2005)

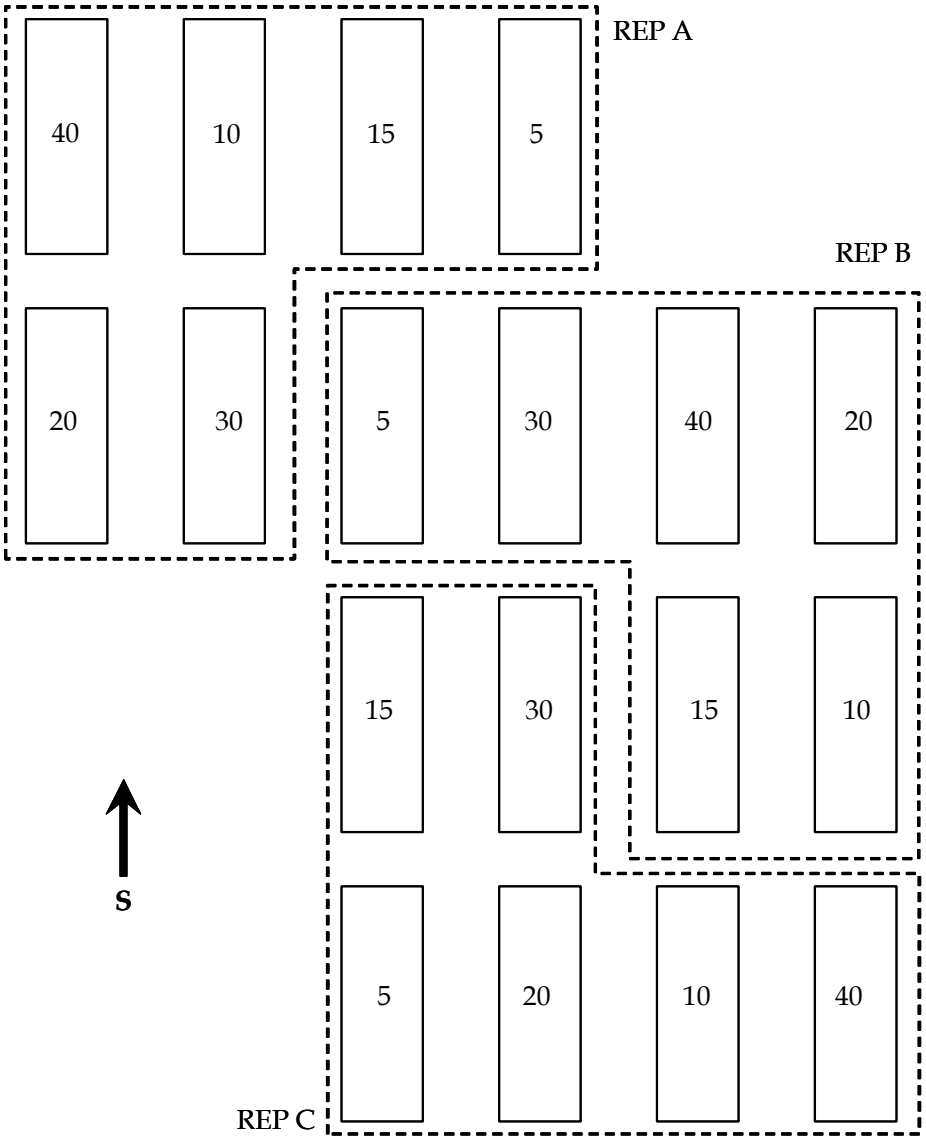


Figure 61

Linear Regression of the Density of *G. holbrooki* Stocked in Mesocosms Versus the Number Captured in Minnow Traps (24-h soak time) in During the Trap Efficiency Experiment

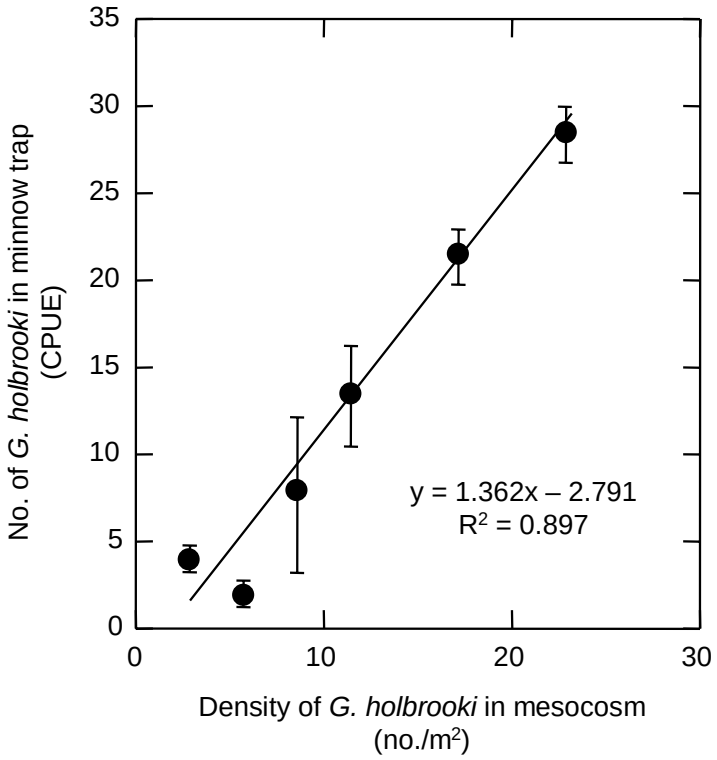


Figure 62

Distributions of Standard Lengths (mm) of *G. holbrooki* Captured in (black line) and Not Captured in (gray line) Minnow Traps

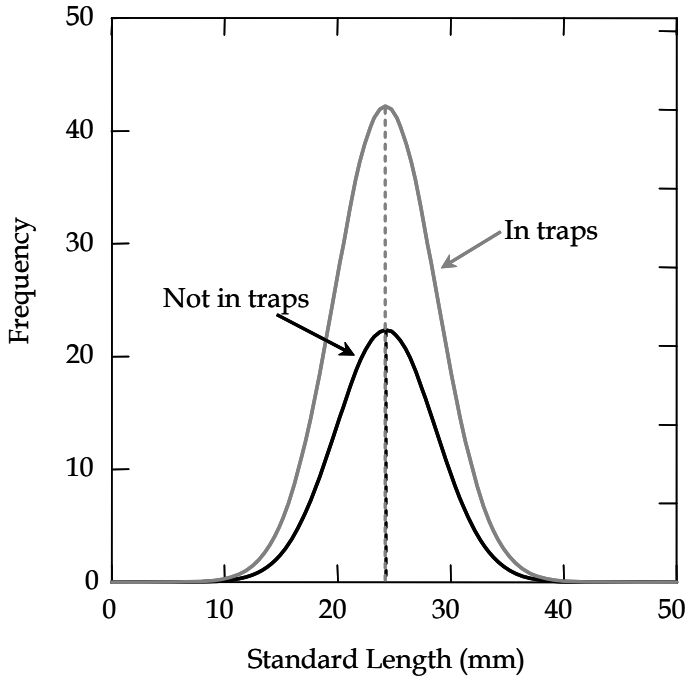


Figure 63

Schematic Diagram of *P. latipinna* in the Minnow Trap Efficiency Experiment

(01-03 December 2005)

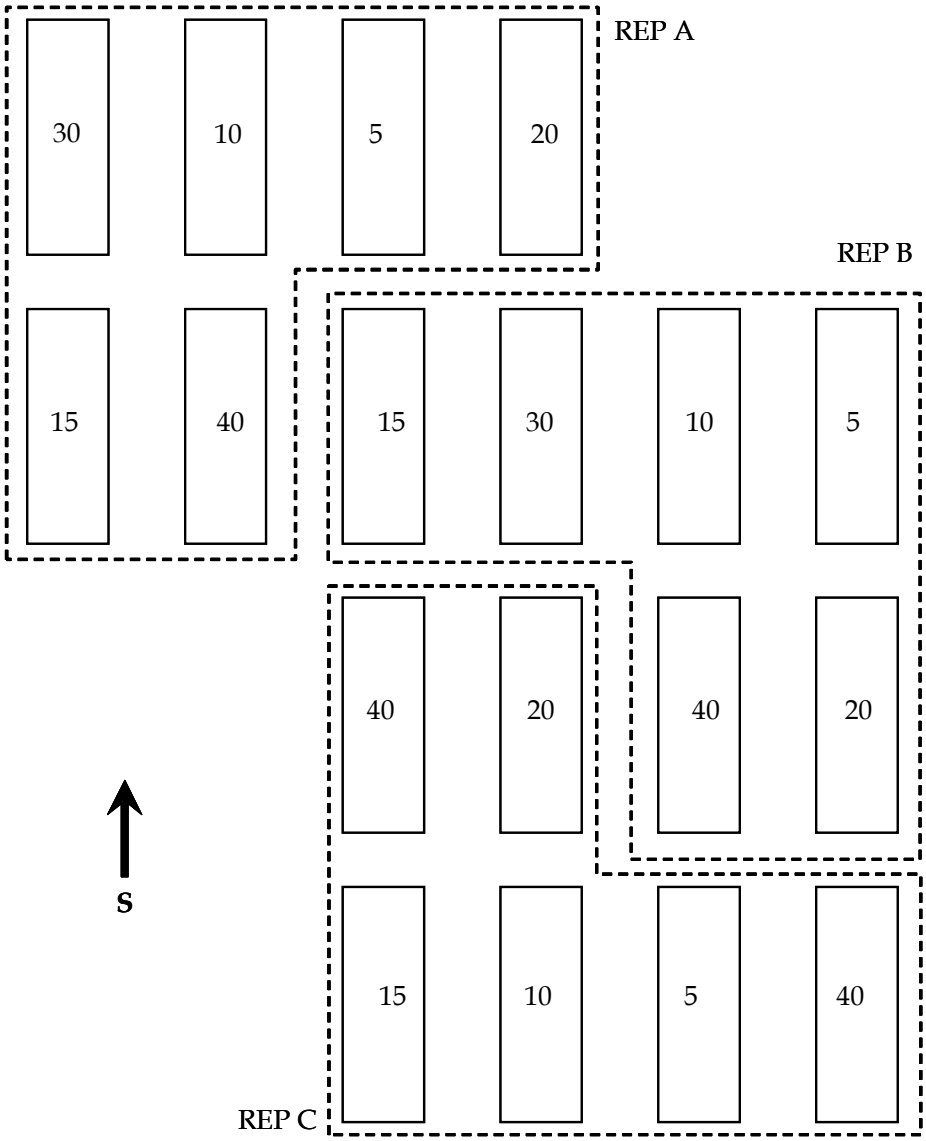


Figure 64

Linear Regression of the Density of *P. latipinna* Stocked in Mesocosms Versus the Number Captured in Minnow Traps (24-h soak time) in During the Trap Efficiency Experiment

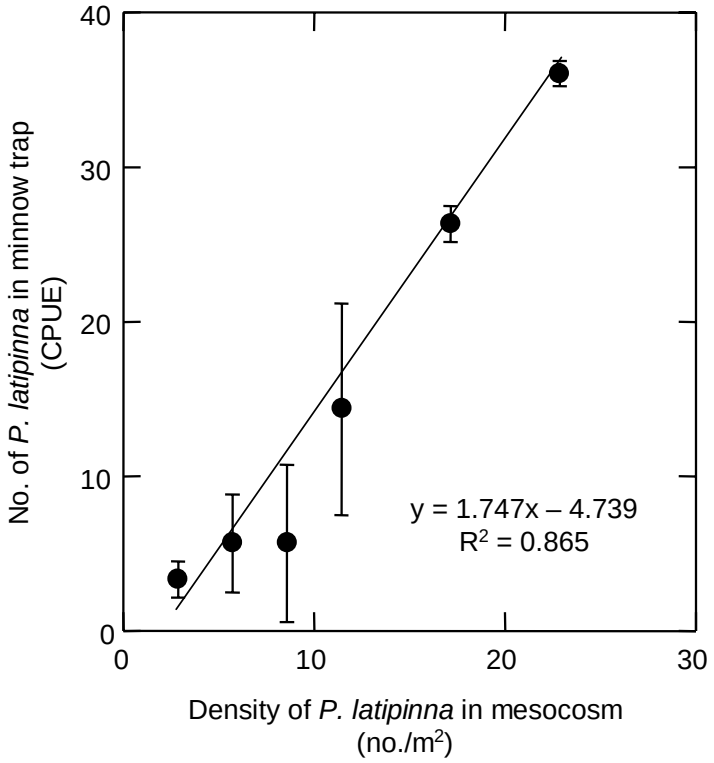


Figure 65

Distributions of Standard Lengths (mm) of *P. latipinna* Captured in (black line) and Not Captured in (gray line) Minnow Traps

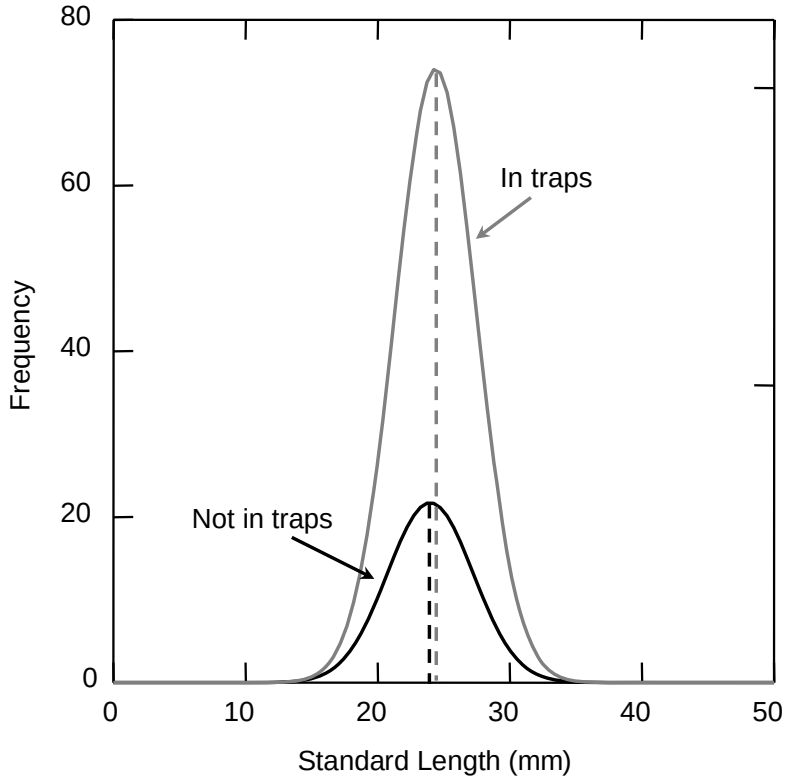


Figure 66

Schematic Diagram of *L. marginatus* in the Minnow Trap Efficiency Experiment (11-13 May 2005)

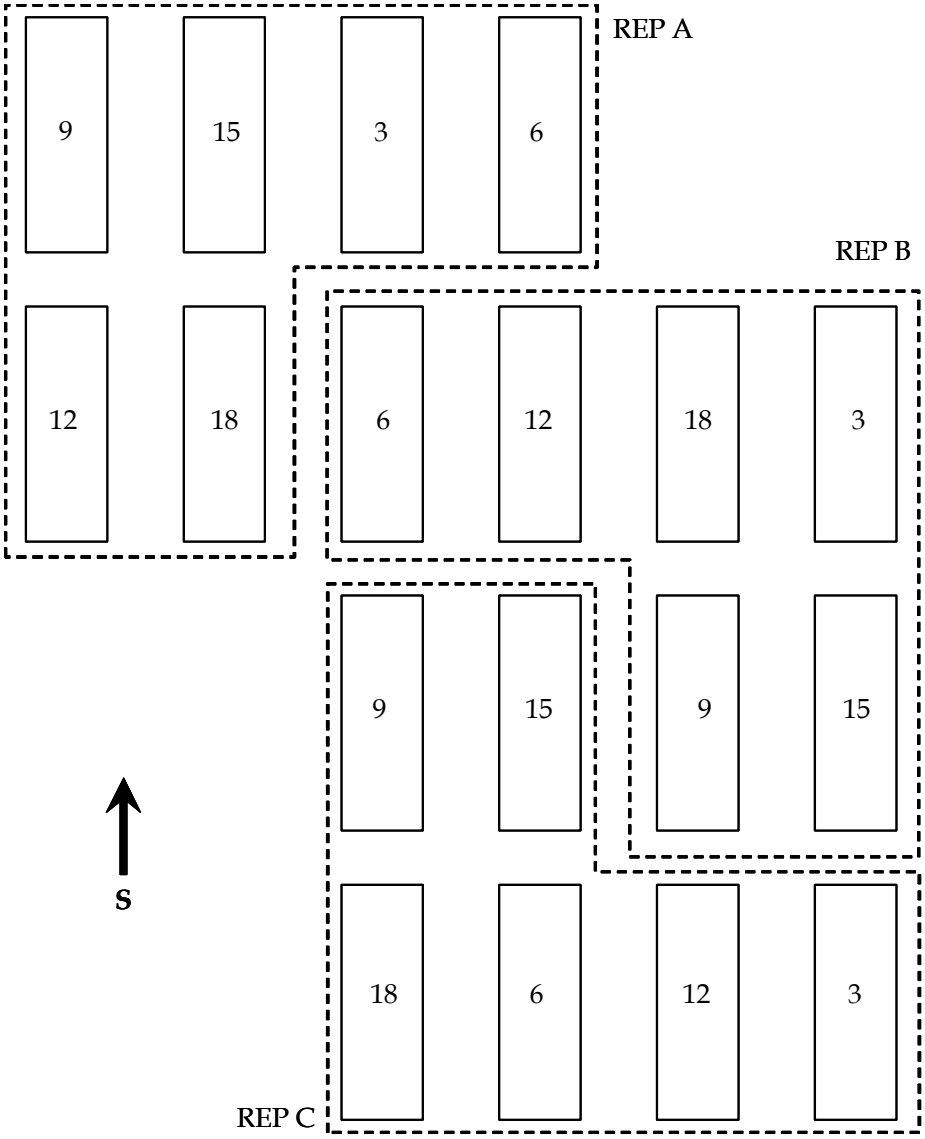


Figure 67

Linear Regression of the Density of *L. marginatus* Stocked in Mesocosms Versus the Number Captured in Minnow Traps (24-h soak time) in During the Trap Efficiency Experiment

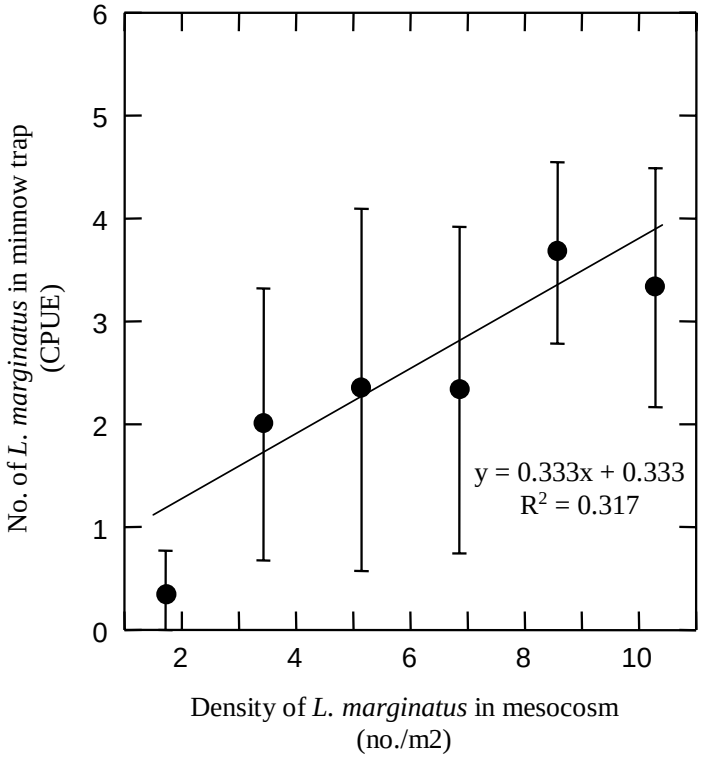


Figure 68

Distributions of Standard Lengths (mm) of *L. marginatus* Captured in (black line) and Not Captured in (gray line) Minnow Traps

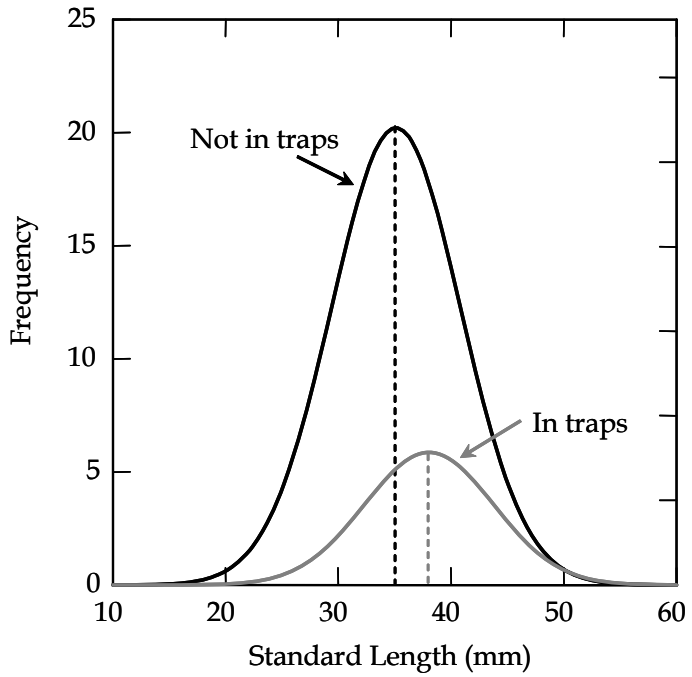


Figure 69

Schematic Diagrams of Cage Design (A) and Configuration in Solution Holes (B) in Experimental Predator Inclusion/Exclusion Field Experiment

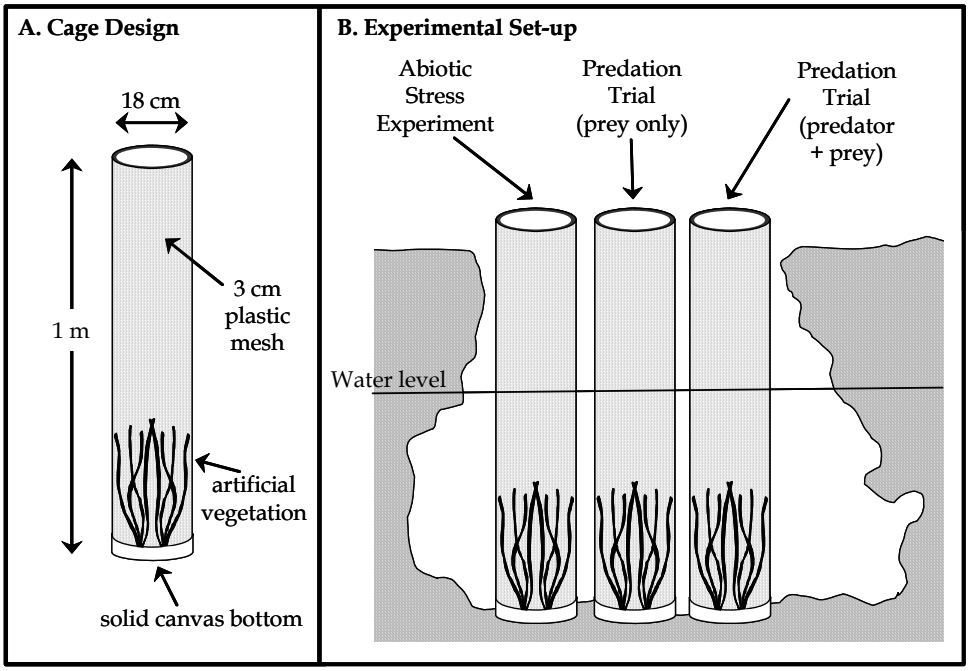


Figure 70

NMDS of Fish Species Collected in Solution Holes in Minnow Traps Prior to Predator Inclusion/Exclusion Trials

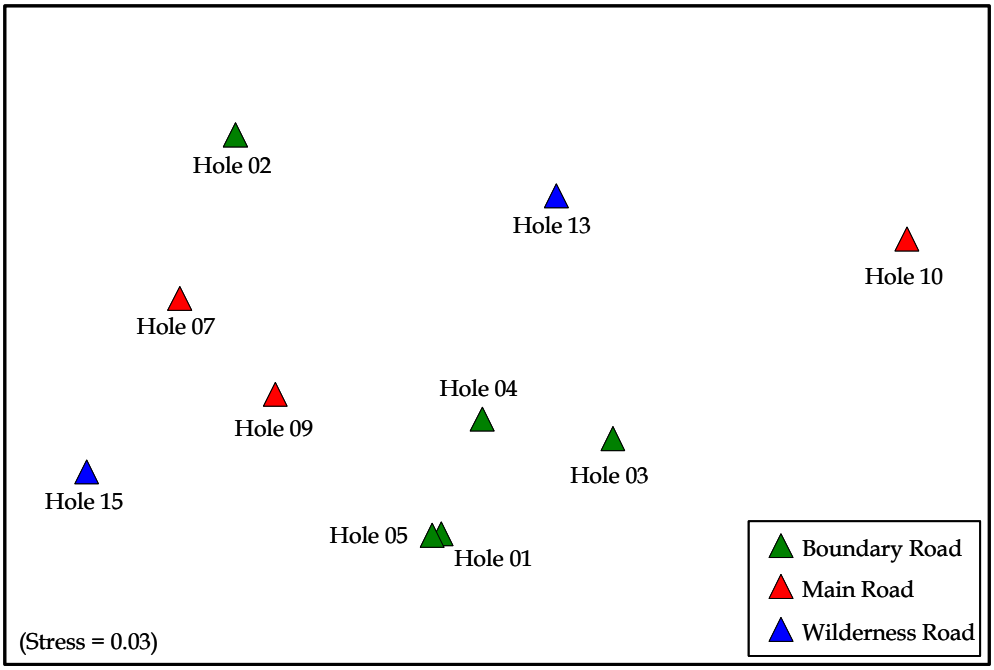


Figure 71

Average Water Depth in Experimental Cages in Solution Holes in Each Region
(BR=Eastern Boundary Road, MR=Main Park Road, WR=Wilderness Road)
During Weekly Censuses (Day 1 = 14 February 2005)

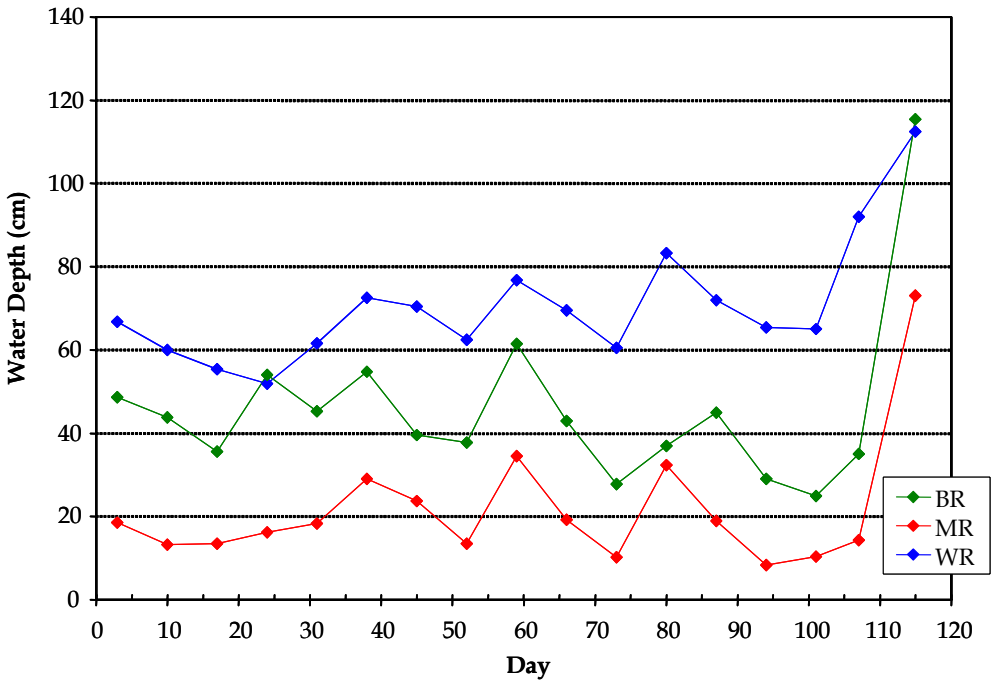


Figure 72

Average Water Depth in Experimental Cages in Solution Holes in Each Region
(BR=Eastern Boundary Road, MR=Main Park Road, WR=Wilderness Road)
During Weekly Censuses (Day 1 = 14 February 2005)

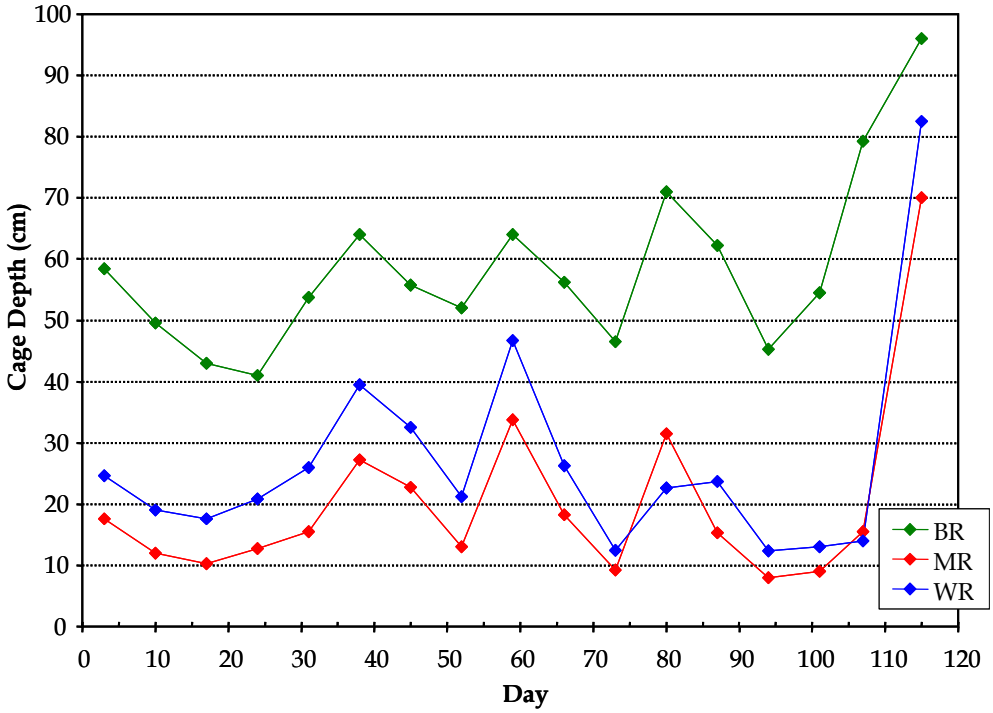


Figure 73

Average Water Temperature in Experimental Cages in Solution Holes in Each Region (BR=Eastern Boundary Road, MR=Main Park Road, WR=Wilderness Road) During Weekly Censuses (Day 1 = 14 February 2005)

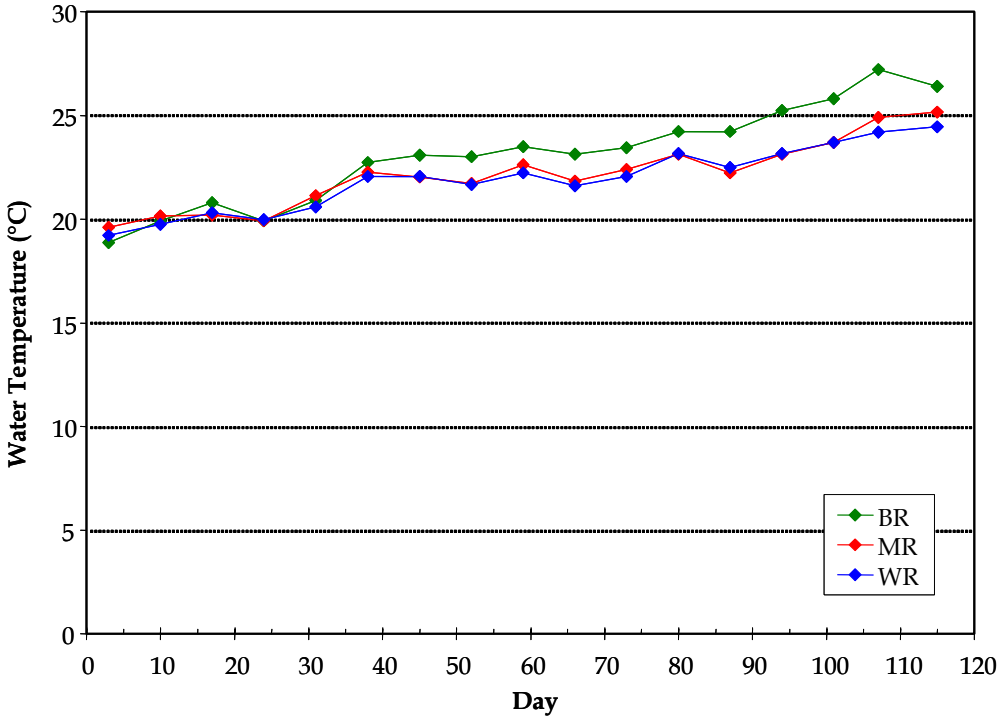


Figure 74

Average Dissolved Oxygen Concentration in Experimental Cages in Solution Holes in Each Region (BR=Eastern Boundary Road, MR=Main Park Road, WR=Wilderness Road) During Weekly Censuses (Day 1 = 14 February 2005)

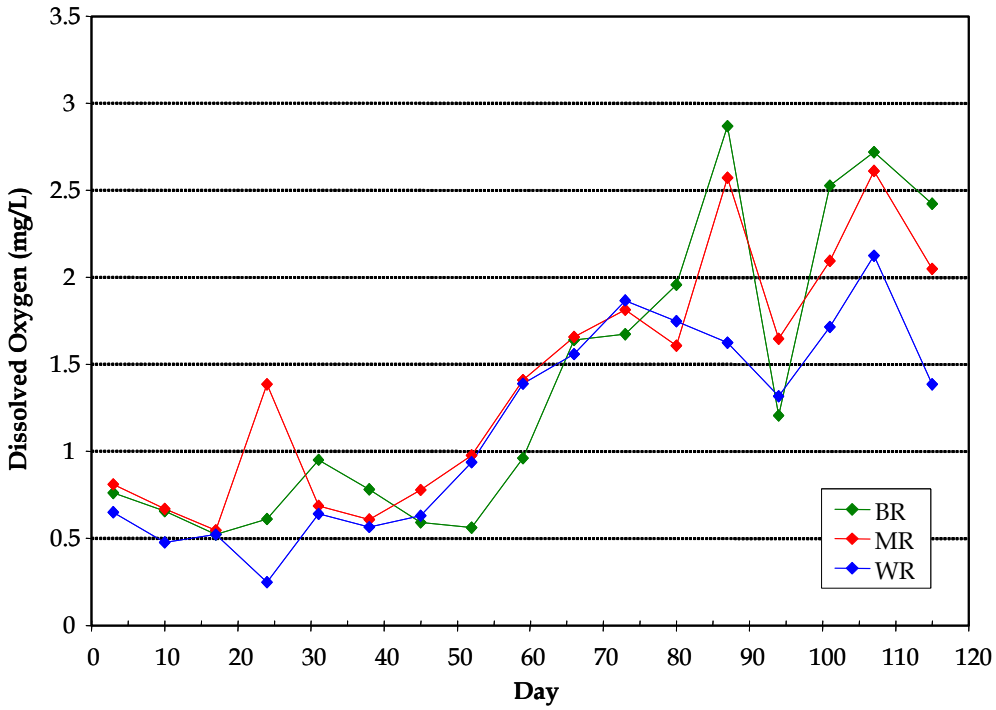


Figure 75

Average Dissolved Oxygen % in Experimental Cages in Solution Holes in Each Region (BR=Eastern Boundary Road, MR=Main Park Road, WR=Wilderness Road) During Weekly Censuses (Day 1 = 14 February 2005)

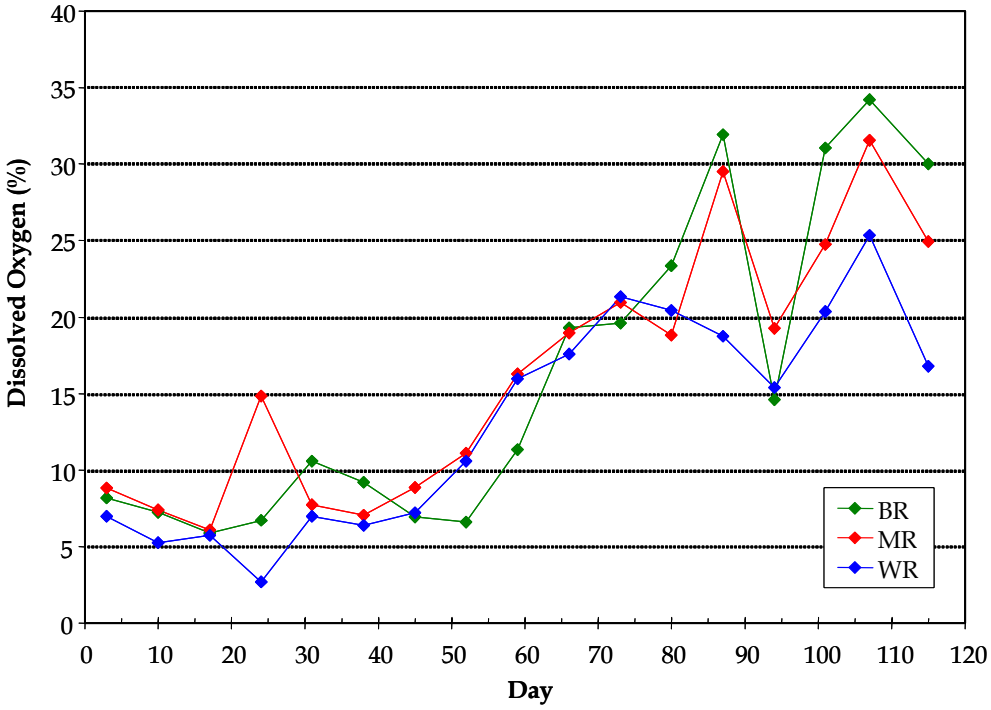


Figure 76

Average Specific Conductance in Experimental Cages in Solution Holes in Each Region (BR=Eastern Boundary Road, MR=Main Park Road, WR=Wilderness Road) During Weekly Censuses (Day 1 = 14 February 2005)

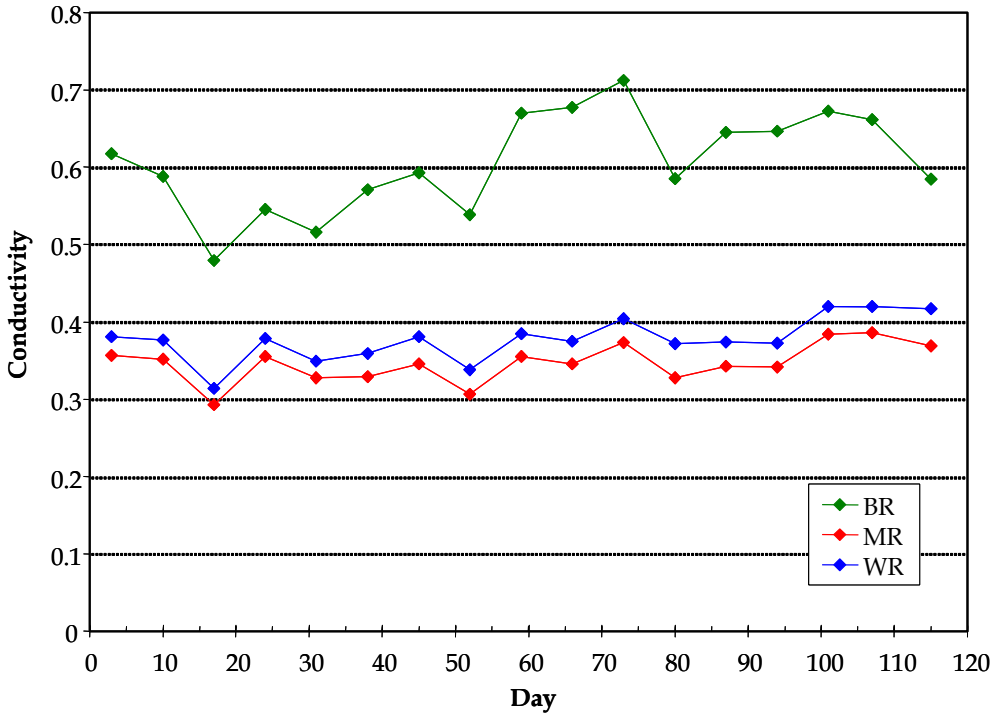


Figure 77

Average pH in Experimental Cages in Solution Holes in Each Region
(BR=Eastern Boundary Road, MR=Main Park Road, WR=Wilderness Road)
During Weekly Censuses (Day 1 = 14 February 2005)

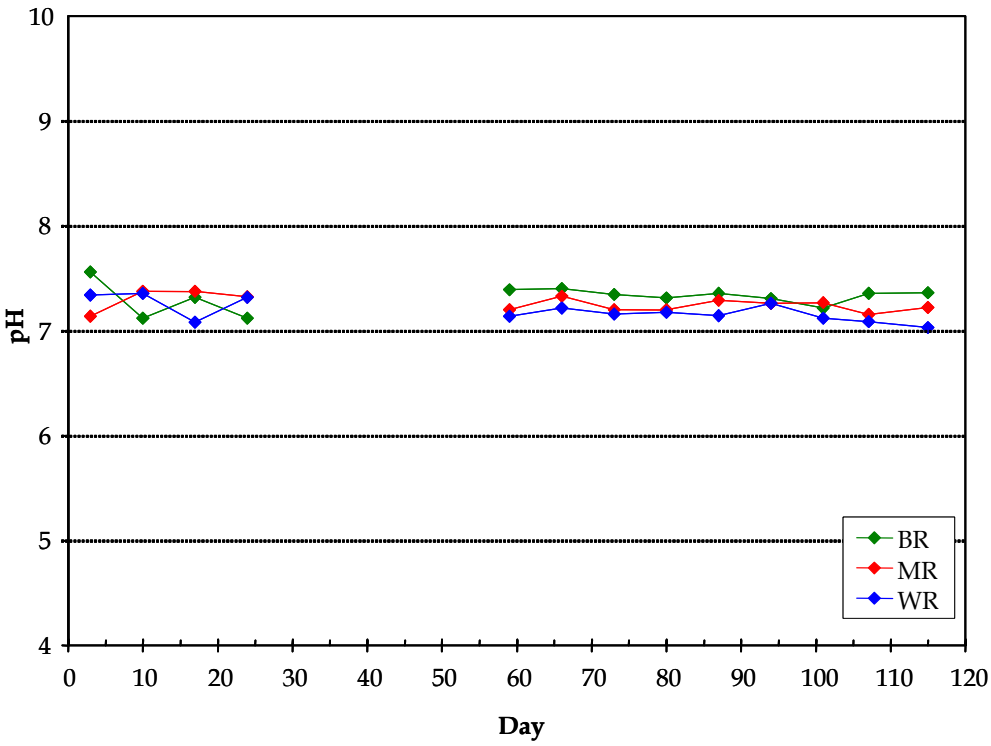


Figure 78

Average Ammonia Concentration in Experimental Cages in Solution Holes in Each Region (BR=Eastern Boundary Road, MR=Main Park Road, WR=Wilderness Road) During Weekly Censuses (Day 1 = 14 February 2005)

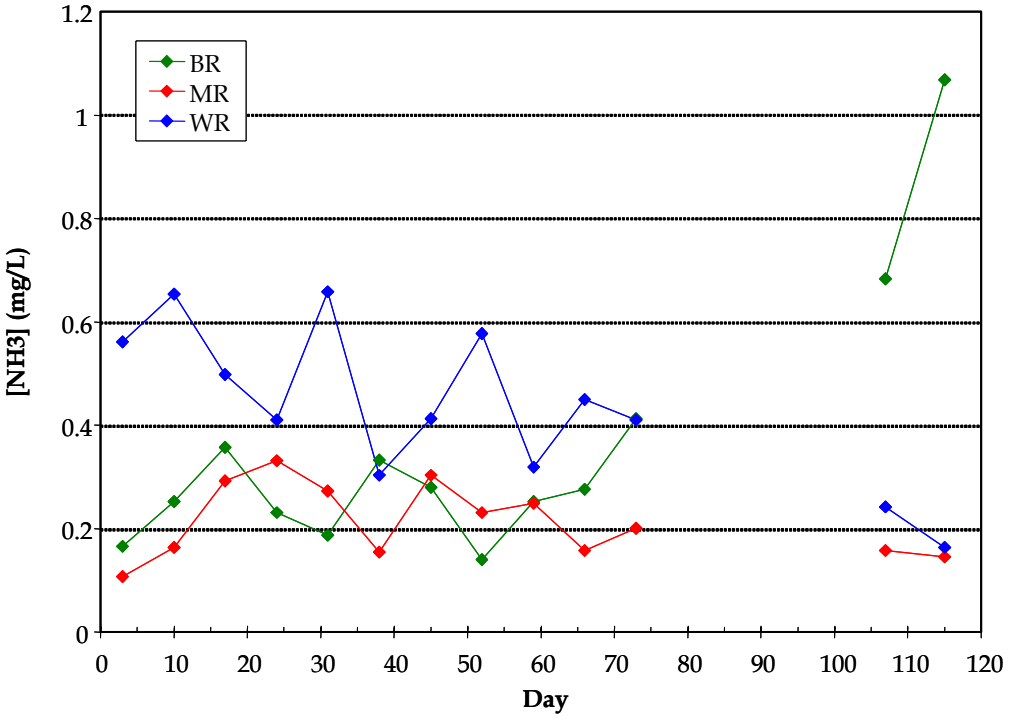


Figure 79

Average Percent Survival of *G. holbrooki* in Long-Term Cages Censused Throughout the Abiotic Stress Experiment

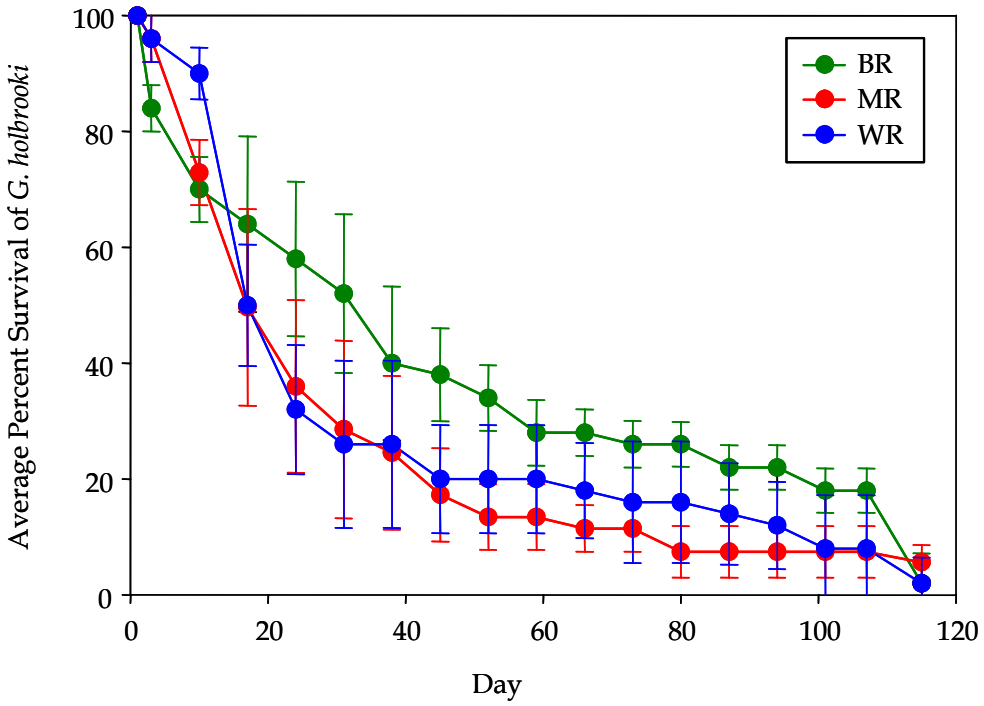


Figure 80

Percent Mortality of *G. holbrooki* in the Presence (solid bars) and Absence (striped bars) of *H. letourneuxi* in the 4 Predation Trials

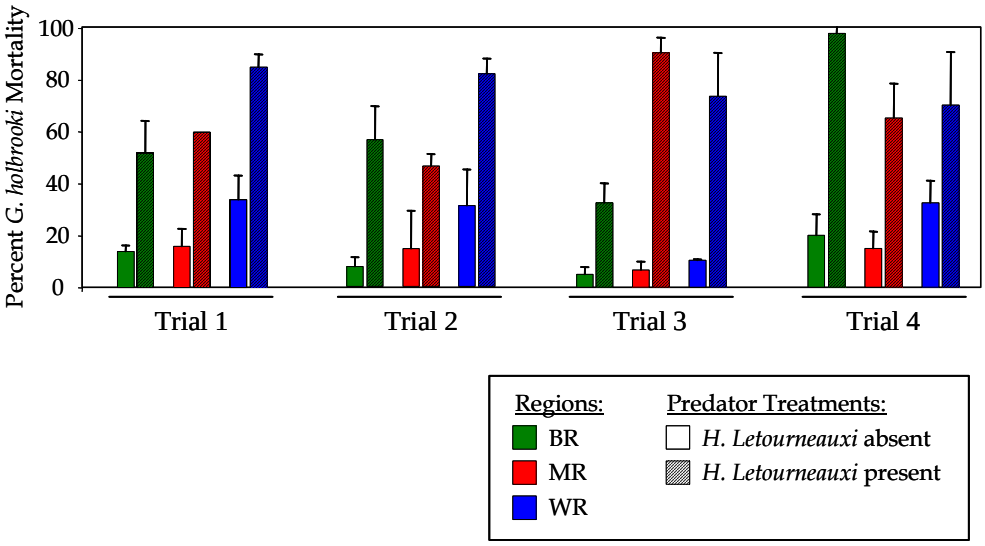


Figure 81

Images of (a) *H. letourneuxi* and (b) *L. gulosus* Used in the Experiment;(c) Image of Tanks Showing Artificial Vegetation Clumps

a

b

c

Figure 82

Total Prey Mortality in the 3 Treatments of the Experiment. Shown Below are Means ± 1 SE

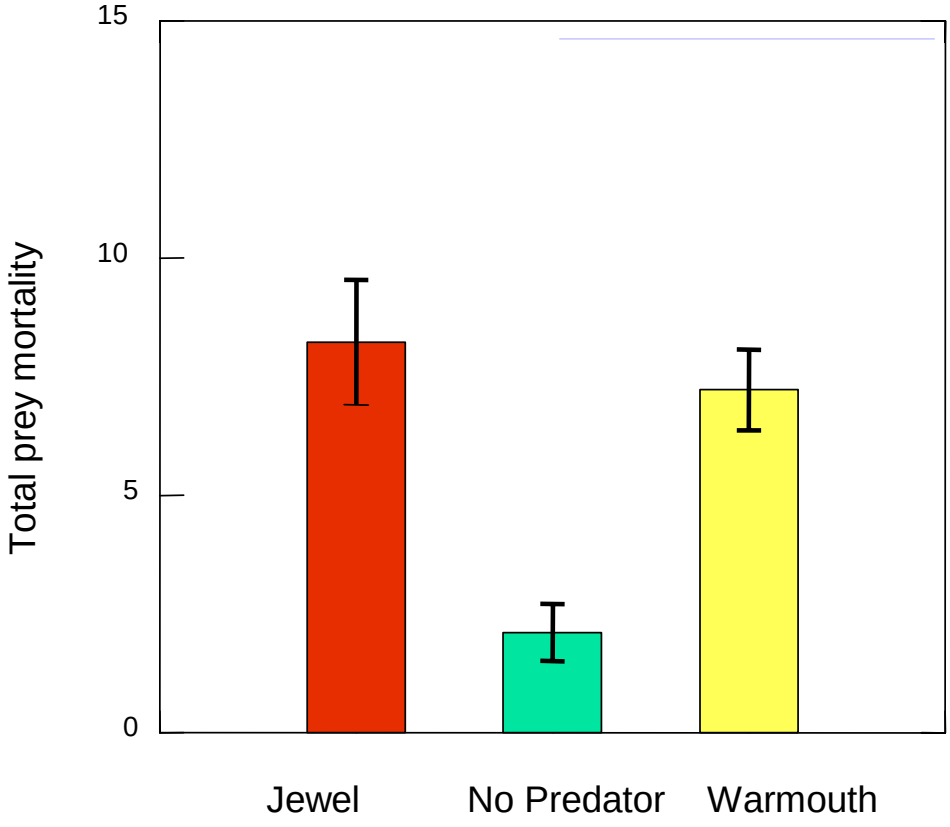


Figure 83

Mean Mortality (± 1 SE) Shown Separately by Prey Type and By Treatment Over the 48-h Predation Trial.

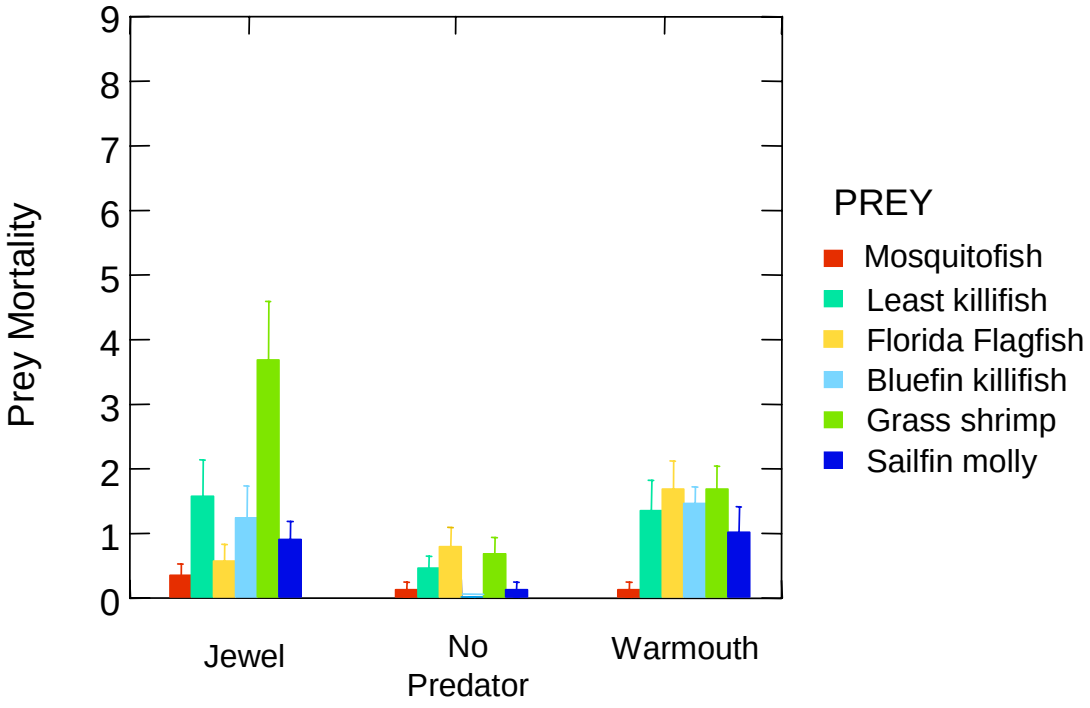


Figure 84

Figure 85. Percentage occurrence of prey in *Hemichromis letourneuxi* stomachs containing prey. Fish were collected during four time periods from 2005-06 in the Rocky Glades of ENP. N = 30 for all time periods, except for May 06, with 27.

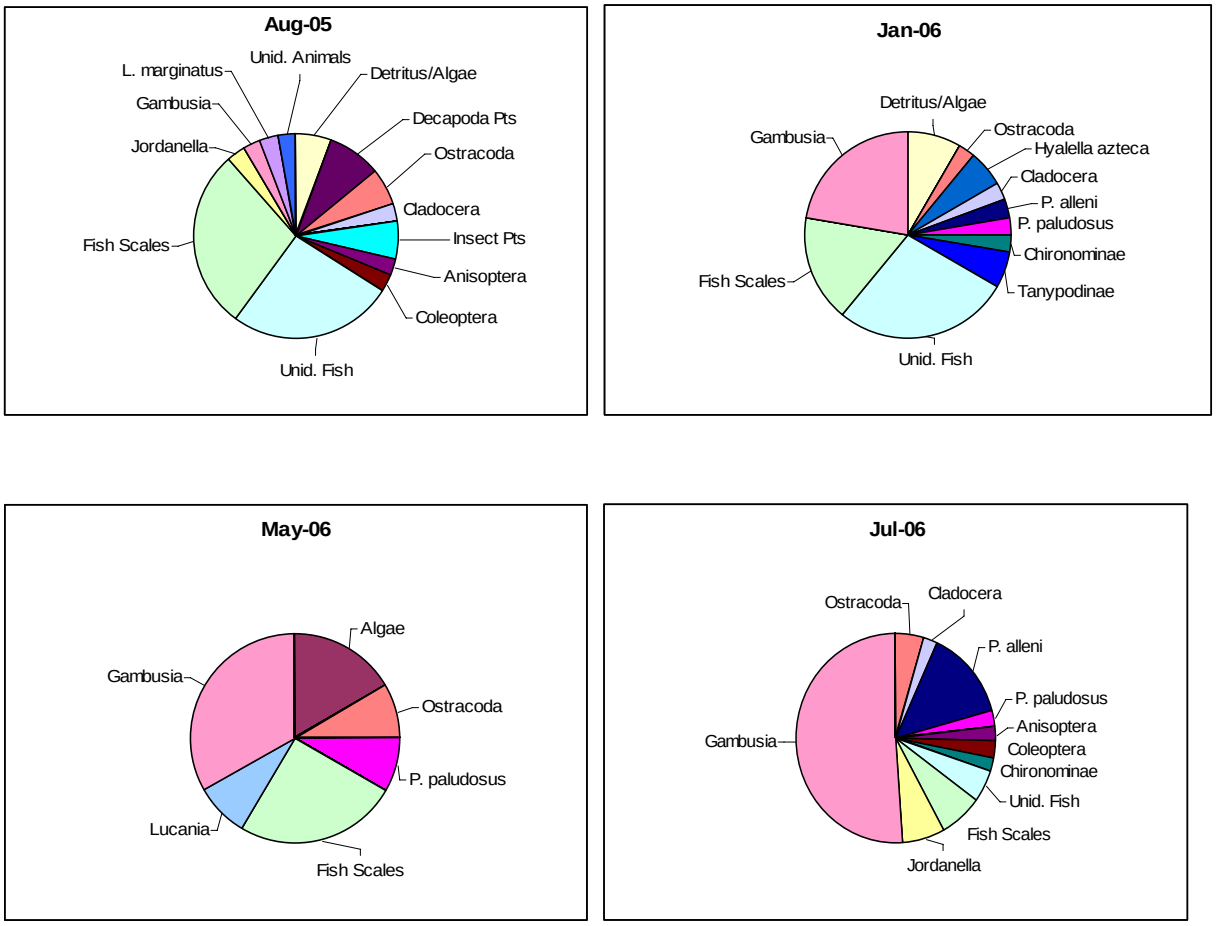


Diagram of the Experimental Setup for the Anti-Predator Behavior Experiment
With the Three Treatments (a,b and c)

a. *H.letourneuxi* b. *L. gulosus* c. No predator

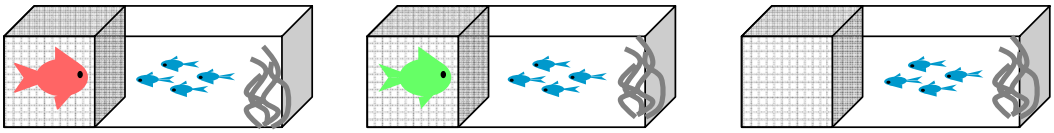


Figure 86

Images of Experimental Setup for the Anti-Predator Behavior Experiment Showing (a) the Three Tanks and Mirrors and (b) a Top View of the Tank Compartment as Seen Through the Mirror

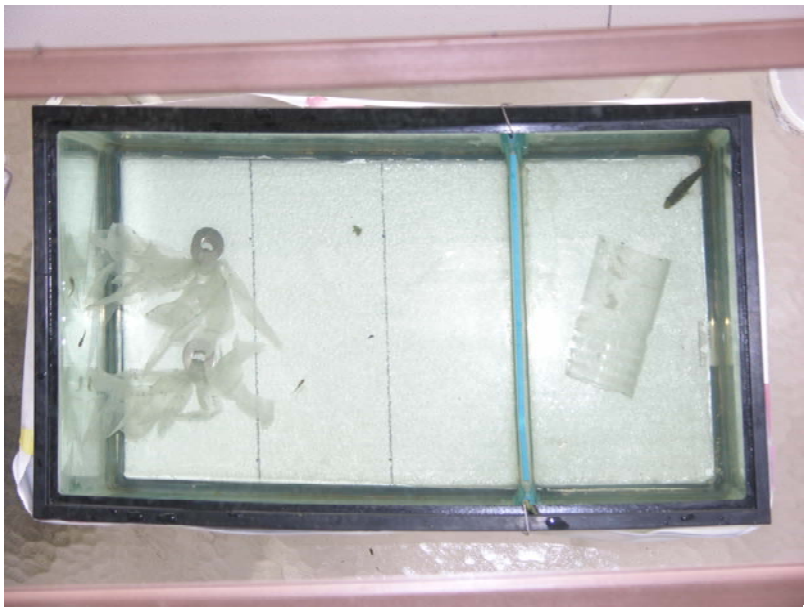


Figure 87

Mean Proportion of Prey (± 1 SE) Active Across Predation Treatments.

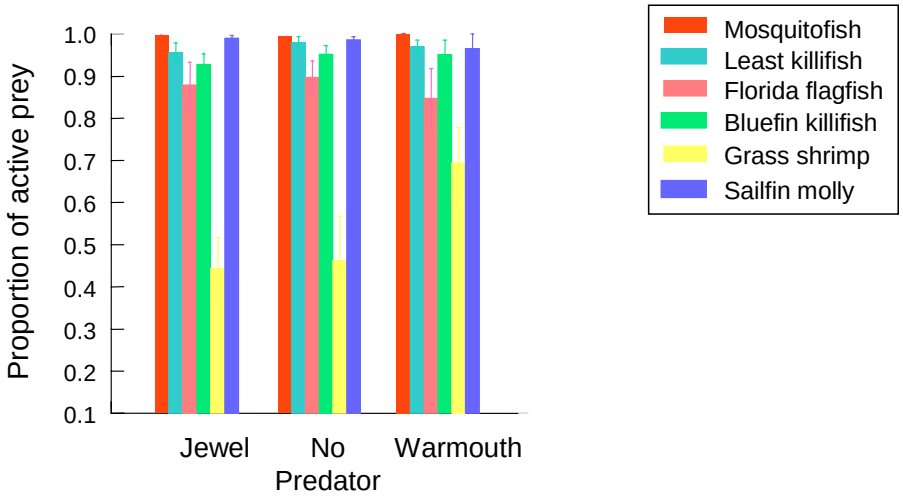


Figure 88

Mean Proportion of Prey (± 1 SE) in Refuge Across Predation Treatments

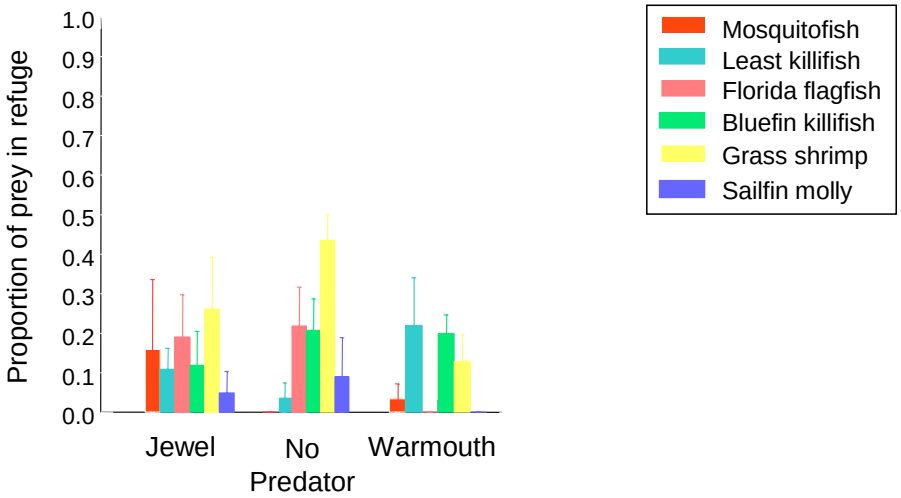


Figure 89

Mean proportion of Prey (±1 SE) in Close Proximity of the Predator Across Predation Treatments.

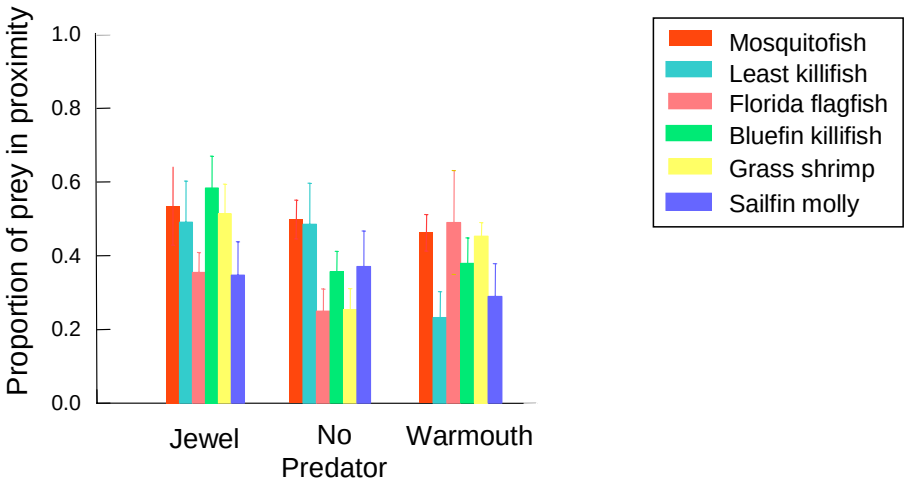
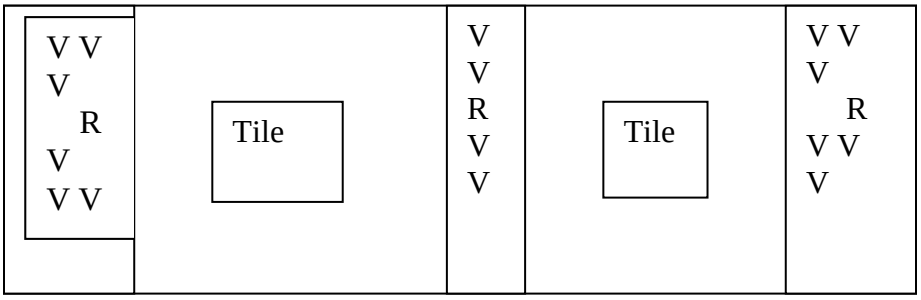


Figure 90

Catch of *H. letourneuxi* in a Drift-Fence Array Trap Near Pa-Hay-Okee Following the Passage of Hurricane Katrina.

Figure 91

Figure 92. Schematic of nesting substrates within concrete crypts for the nesting experiments, showing locations of ceramic tile on sand beds, and placement of artificial vegetation (V) and limestone rocks (R).



Design of Pilot Experiments Showing Treatments in Tanks.
Treatment 1 = Control; Treatment 2 = Intra-specific (*L. marginatus*);
Treatment 3 = Inter-specific.

Pilot Nesting Experiment – July 2005

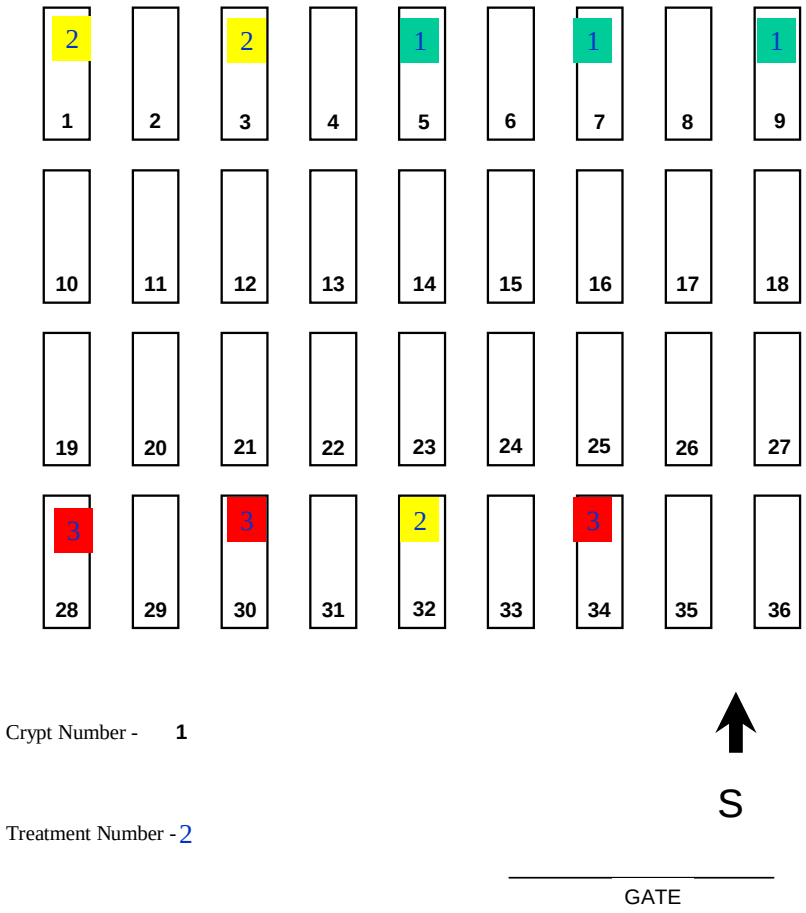
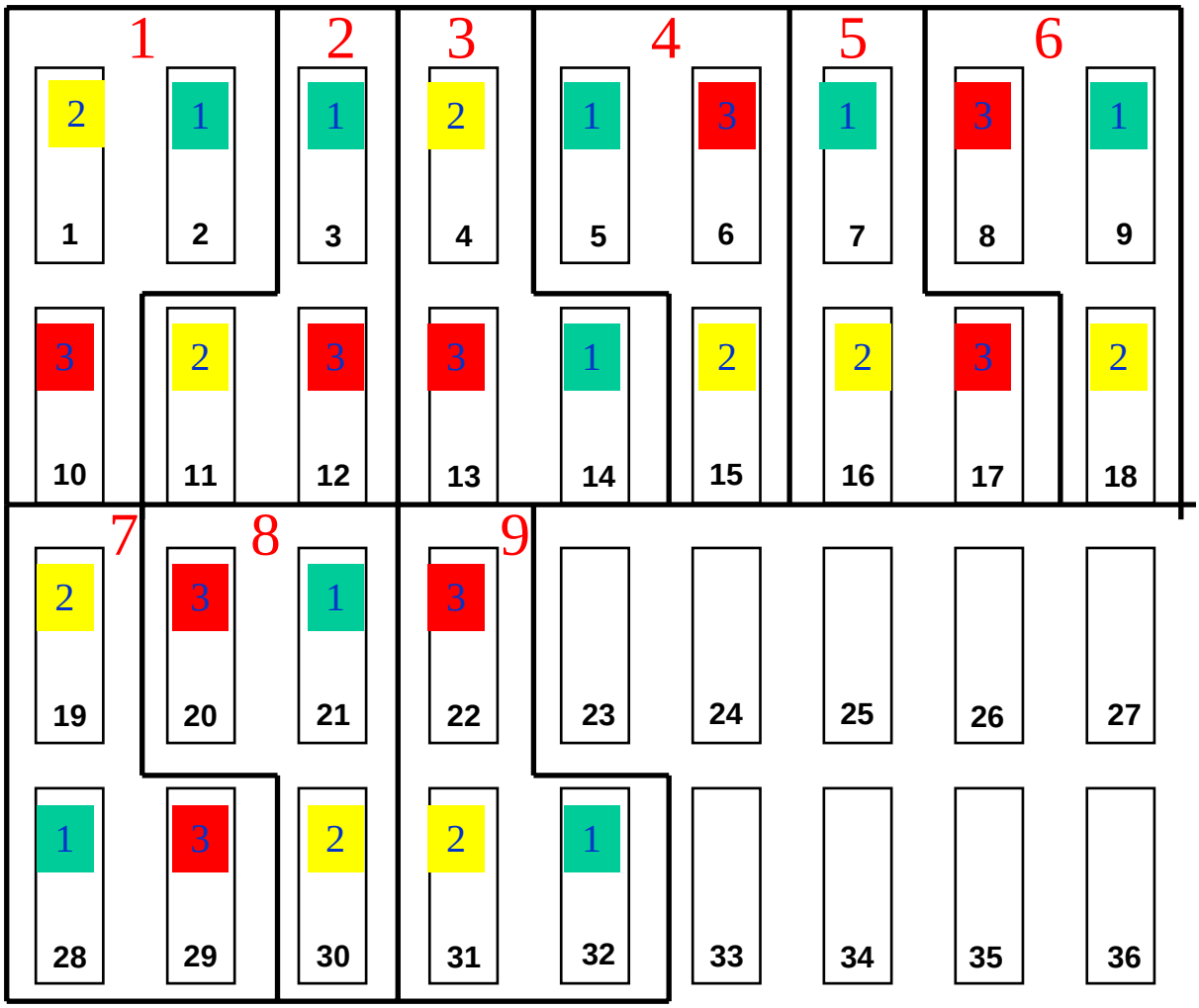


Figure 93

Figure 94. Proposed design for full experiment to test for intra- and interspecific nesting interactions.



Crypt Number - **1**

Block Number - 1

Treatment Number - 2

S

GATE

Figure 95.

Design of the Third Experiment Showing Treatments Assigned to Tanks.
Treatment 1 = Intra-specific – *H. letourneuxi*;
Treatment 2 = Intra-specific - dollar sunfish; Treatment 3 = Inter-specific.

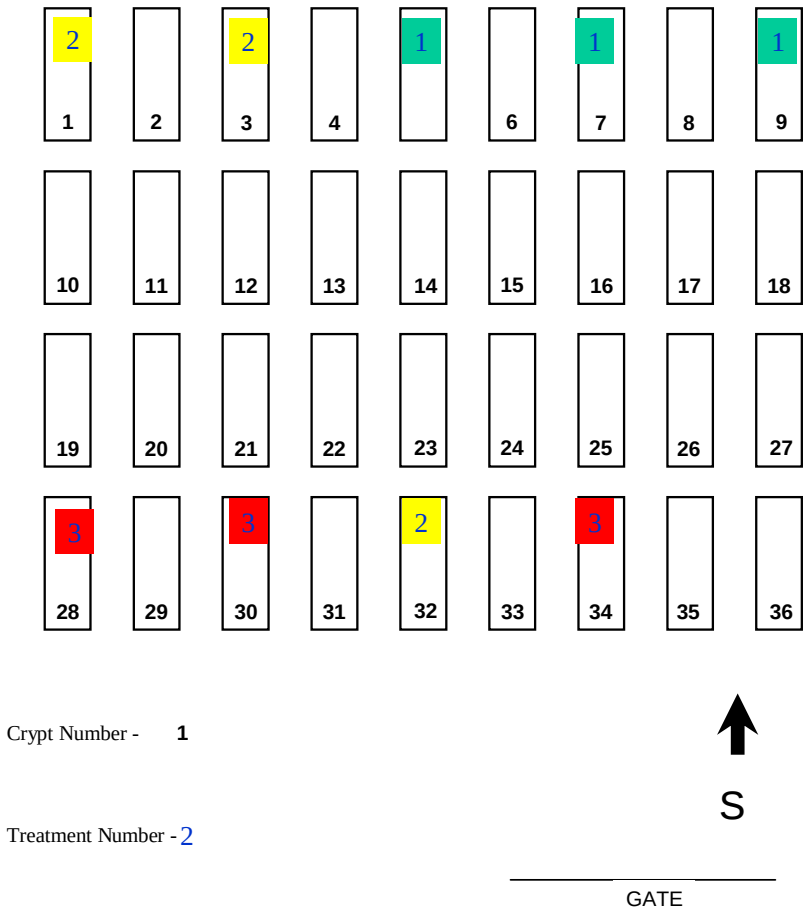


Figure 96. Compilation of display and chase behaviors by male dollar sunfish and African jewelfish and their targets in the interspecific-nesting treatment in the pilot study.

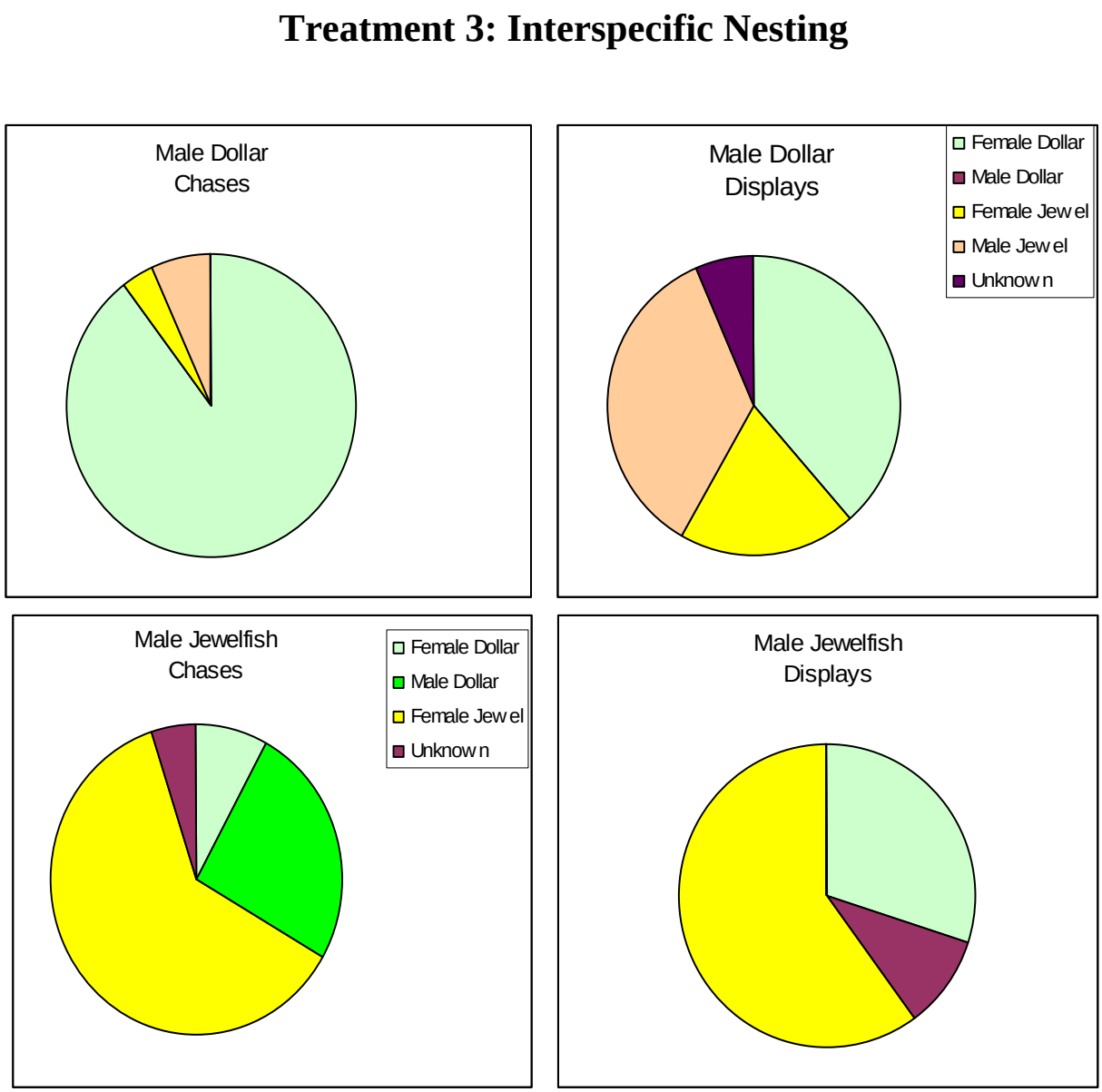
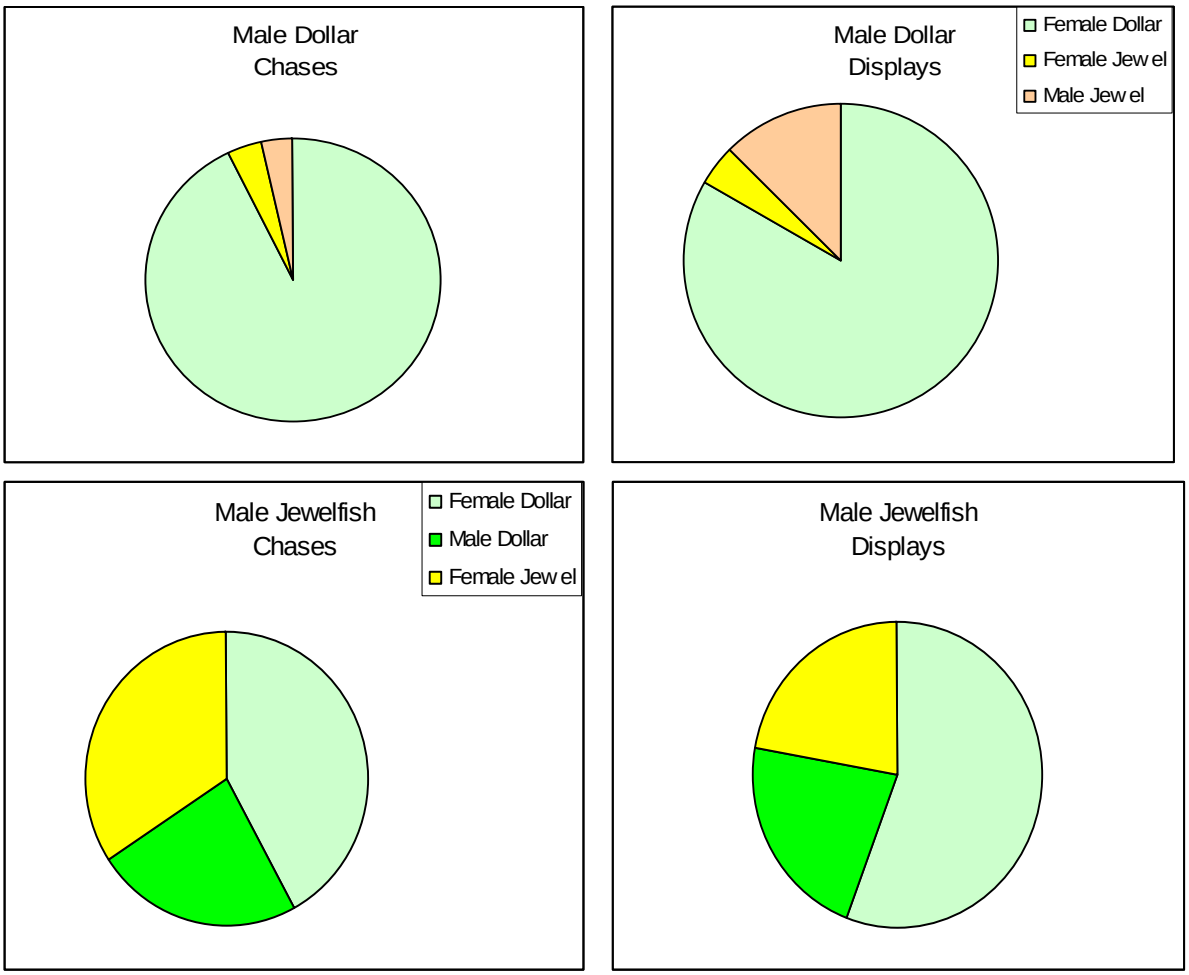


Figure 97. Compilation of display and chase behaviors by male dollar sunfish and African jewelfish and their targets in the interspecific-nesting treatment in the full study.

Treatment 3: Interspecific Nesting



APPENDIX 1. Fish species collected in the Rocky Glades

LEPISOSTEIDAE	GARS
Lepisosteus platyrhincus	Florida gar
CATOSTOMIDAE	SUCKERS
Erimyzon sucetta	Lake chubsucker
ICTALURIDAE	BULLHEAD CATFISHES
Ameiurus natalis	Yellow bullhead
Noturus gyrinus	Tadpole madtom
CLARIIDAE	LABYRINTH CATFISHES
▲*Clarias batrachus*	Walking Catfish
CALLICTHYIDAE	MAILED CATFISHES
▲*Hoplosternum littorale*	Brown hoplo
CYPRINODONTIDAE	KILLIFISHES
Cyprinodon variegatus	Sheepshead minnow
Jordanella floridae	Flagfish
APHREDODERIDAE	PIRATE PERCHES
Aphredoderus sayanus	Pirate Perch
EXOCIDAE	PIKES
Esox americanus	Redfin Pickerel
FUNDULIDAE	TOPMINNOWS
Fundulus chrysotus	Golden topminnow
Fundulus confluentus	Marsh killifish
Lucania parva	Rainwater killifish
Lucania goodei	Bluefin killifish
POECILIIDAE	LIVEBEARERS
▲*Belonesox belizanus*	Pike killifish
Gambusia holbrooki	Mosquitofish
Heterandria formosa	Least killifish
Poecilia latipinna	Sailfin molly
ATHERINIDAE	SILVERSIDES
Labidesthes sicculus	Brook silverside
ELASSOMATIDAE	PYGMY SUNFISHES
Elassoma evergladei	Everglades pygmy sunfish
CENTRARCHIDAE	SUNFISHES
Enneacanthus gloriosus	Bluespotted sunfish
Lepomis gulosus	Warmouth
Lepomis macrochirus	Bluegill
Lepomis marginatus	Dollar sunfish
Lepomis microlophus	Redear sunfish
Lepomis punctatus	Spotted sunfish
Micropterus salmoides	Largemouth bass
CICHLIDAE	CICHLIDS
▲*Astronotus ocellatus*	Oscar
▲*Cichlasoma bimaculatum*	Black acara
▲*Cichlasoma urophthalmus*	Mayan cichlid
▲*Oreochromis aureus*	Blue tilapia
▲*Cichlasoma managuense*	Jaguar guapote
▲*Hemichormis letourneuxi*	African jewelfish
▲*Tilapia mariae*	Spotted tilapia
MASTACEMBELIDAE	SPINY EELS
▲*Macrognathus siamensis*	Spotfin spiny eel

▲**Non-indigenous fish species**

APPENDIX 2a. CESI Project Organization: Introduced Fishes in Short-hydroperiod Wetlands: Evaluation of Sampling, Status, and Potential Effects

Project: BAA/RFP Q5284404 CESI
Permit: EVER-2004-SCI-0090

Duration: July 2004 – June 2005 (Extended through October 2005)

Research Questions	Study Components	Time Frame
How do hydrological and physico-chemical parameters differ between study habitats?	• Collection of depth, flow, rainfall, and temperature data the arrays • Deployment of YSI 600s on the marsh surface	Wet Seasons of 2004 and 2005 Winter 2004 and Summer 2005
How do the composition, recruitment, and size structure of aquatic animals change during the flooding period?	• Monthly sampling of arrays • Daily sampling arrays at the onset of flooding	July 2004 – January 2005 June 7th – July 4th 2005
Are there diel patters to fish catches?	• 24-hour sampling of arrays # 1-3	July 6th – 7th 2005
How do fish communities vary in solution holes throughout the dry season?	• Monthly sampling of solution holes during the dry season	September 2004 – June 2005
What factors contribute to changes in species compositions in solution holes?	• Monthly collections of abiotic data (depth category, water depth, temperature, dissolved oxygen, specific conductance and pH) with a YSI 556 unit during the dry season • Deployment of YSI 600s in solution holes	September 2004 – June 2005 Winter and Summer of 2005
What are the potential effects of jewel cichlids on native fishes?	• Mosquitofish survival in solution holes during the dry season • Predation experiment • Nesting experiment	Spring 2005 October 2005 August 2005
What sampling biases may be associated with the drift-fence/ minnow trap method?	• Throw – trapping near the arrays • Electroshocking near the arrays	January 2006; (To be continued) (To be continued)
What sampling biases may be associated with using minnow traps in solution holes?	• Density/Depletion in solution holes and Priority effects in minnow traps • Minnow trap efficiency in mesocosms	January and February 2006 Summer and Winter 2005

List of Deliverables:

Progress Report	January 31, 2005
Semi-Annual Report	June 30, 2005
Annual Report	March 31, 2005

APPENDIX 2b. CESI Project Organization: Introduced Fishes in Short-hydroperiod Wetlands: Evaluation of Sampling, Status, and Potential Effects

Project: CESI: IA F5284-04-0039
Permit: EVER-2005-SCI-0106

Duration: November 2005 – November 2006

Research Questions	Study Components	Time Frame
How do hydrological and physico-chemical parameters differ between study habitats?	• Collection of depth, flow, rainfall, and temperature data the arrays	Wet season of 2006
How do the composition, recruitment, and size structure of aquatic animals change during the flooding period?	• Monthly sampling of arrays • Daily sampling of drift-fence arrays at the onset of flooding	Monthly through September 2006 Summer 2006
What are the potential effects of jewel cichlids on native fishes? (Are there behavioral differences among native prey species that may account for differences in survivorship?)	• Prey behavior experiment	June 2006
What are the diet and reproductive trends of jewel cichlids in the Rocky Glades?	• Quarterly collections of jewels for gut and gonad analysis	Fall 2005; January, April, July, October 2006

List of Deliverables:

Semi-Annual Report	May 30, 2006
Final Report	November 30, 2006

APPENDIX 3. Depth, temperature, and flow data (cm/sec) from surface-water samples at the drift fence arrays.

M	D	Samples	Date	Array	Depth	Temperature	Flow Direction	Flow Velocity
X	.	X	8/31/04	1	15.0	31.0	West to East	0.51
X	.	X	8/31/04	2	33.0	31.0	East to West	0.70
X	.	X	8/31/04	3	22.0	31.0	East to West	1.65
X	.	X	8/31/04	4	45.0	31.0	East to West	0.63
X	.	X	8/31/04	5	40.5	31.0	East to West	0.88
X	.	X	8/31/04	6	26.0	31.0	East to West	0.91
X	.	X	9/30/04	3	21.0	32.0	No Flow	0.00
X	.	X	9/30/04	4	47.7	32.0	East to West	0.28
X	.	X	9/30/04	5	33.0	32.0	East to West	0.36
X	.	X	9/30/04	6	31.0	32.0	No Flow	0.00
X	.	X	10/29/04	1	11.5	25.0	No Flow	0.00
X	.	X	10/29/04	2	14.1	25.0	No Flow	0.00
X	.	X	10/29/04	3	19.5	25.0	East to West	0.75
X	.	X	10/29/04	4	54.5	24.0	East to West	1.25
X	.	X	10/29/04	5	34.5	25.0	East to West	0.88
X	.	X	10/29/04	6	24.7	25.0	No Flow	0.00
X	.	X	11/29/04	4	41.0	24.0	No Flow	0.00
X	.	X	11/29/04	5	15.0	23.0	No Flow	0.00
X	.	X	12/30/04	4	30.0	20.0	East to West	0.32
X	.	X	1/27/05	4	18.0	23.0	No Flow	0.00
X	.	X	1/27/05	4	33.0	18.0	No Flow	.
X	.	X	2/28/05	4	35.0	19.5	No Flow	.
.	X	X	6/8/05	4	22.5	28.5	No Flow	0.00
.	X	X	6/9/05	4	23.0	27.0	No Flow	0.00
.	X	X	6/10/05	4	27.5	25.0	No Flow	0.00
.	X	X	6/11/05	3	12.0	29.0	No Flow	0.00
.	X	X	6/11/05	4	32.5	29.0	East to West	0.64
.	X	X	6/11/05	5	18.0	31.0	No Flow	0.00
.	X	X	6/12/05	3	12.5	27.0	No Flow	0.00
.	X	X	6/12/05	4	32.0	27.0	Northeast to Southwest	0.87
.	X	X	6/12/05	5	20.5	29.0	No Flow	0.00
.	X	X	6/13/05	3	13.0	27.0	No Flow	0.00
.	X	X	6/13/05	4	31.0	28.0	No Flow	0.00
.	X	X	6/13/05	5	19.5	27.0	No Flow	0.00
.	X	X	6/14/05	3	12.5	29.0	No Flow	0.00
.	X	X	6/14/05	4	29.8	29.0	Northeast to Southwest	0.61
.	X	X	6/14/05	5	18.5	29.0	No Flow	0.00
.	X	X	6/15/05	4	28.0	29.0	East to West	0.52
.	X	X	6/15/05	5	16.0	30.0	No Flow	0.00
.	X	X	6/16/05	4	26.5	27.0	East to West	0.27
.	X	X	6/16/05	5	14.5	29.0	No Flow	0.00
.	X	X	6/17/05	4	25.5	27.0	East to West	0.42
.	X	X	6/17/05	5	15.0	28.0	No Flow	0.00
.	X	X	6/18/05	4	24.0	33.0	East to West	Slight
.	X	X	6/18/05	5	19.0	32.0	No Flow	0.00
.	X	X	6/19/05	4	23.5	28.0	East to West	0.63
.	X	X	6/19/05	5	18.0	29.0	No Flow	0.00
.	X	X	6/20/05	3	18.0	26.0	East to West	0.71

M	D	Samples	Date	Array	Depth	Temperature	Flow Direction	Flow Velocity
.	X	X	6/20/05	4	26.0	26.0	No Flow	0.00
.	X	X	6/20/05	5	32.5	26.0	East to West	0.51
.	X	X	6/20/05	6	20.0	26.0	No Flow	0.00
.	X	X	6/21/05	1	16.5	29.0	West to East	0.52
.	X	X	6/21/05	2	32.0	27.0	No Flow	0.00
.	X	X	6/21/05	3	27.0	24.0	East to West	0.92
.	X	X	6/21/05	4	38.5	24.0	East to West	0.56
.	X	X	6/21/05	5	40.5	26.0	East to West	0.92
.	X	X	6/21/05	6	29.0	25.0	East to West	1.02
.	X	X	6/22/05	1	21.0	31.0	West to East	0.51
.	X	X	6/22/05	2	32.5	30.0	West to East	0.25
.	X	X	6/22/05	3	26.0	27.0	East to West	0.80
.	X	X	6/22/05	5	40.0	28.0	East to West	1.13
.	X	X	6/22/05	6	28.5	27.0	East to West	1.55
.	X	X	6/23/05	1	24.5	29.0	West to East	0.67
.	X	X	6/23/05	2	38.0	27.0	West to East	0.48
.	X	X	6/23/05	3	28.5	25.0	East to West	1.13
.	X	X	6/23/05	5	44.0	26.0	East to West	0.76
.	X	X	6/23/05	6	32.0	26.0	East to West	1.29
X	X	X	6/24/05	1	27.0	31.0	West to East	0.92
X	X	X	6/24/05	2	40.0	29.0	No Flow	0.00
X	X	X	6/24/05	3	28.0	25.0	East to West	1.45
X	X	X	6/24/05	4	50.0	25.0	No Flow	0.00
X	X	X	6/24/05	5	44.0	28.0	East to West	0.85
X	X	X	6/24/05	6	30.0	26.0	East to West	1.02
.	X	X	6/25/05	1	30.0	32.5	West to East	0.82
.	X	X	6/25/05	2	42.0	33.5	East to West	0.83
.	X	X	6/25/05	3	26.0	33.5	East to West	1.02
.	X	X	6/25/05	6	28.5	35.0	East to West	1.50
.	X	X	6/26/05	1	27.0	32.0	West to East	0.83
.	X	X	6/26/05	2	37.0	31.0	East to West	0.73
.	X	X	6/26/05	3	24.0	28.0	East to West	1.18
.	X	X	6/26/05	6	25.0	29.0	East to West	1.32
.	X	X	6/27/05	1	29.0	32.0	West to East	1.00
.	X	X	6/27/05	2	41.0	30.0	East to West	0.65
.	X	X	6/27/05	3	27.0	28.0	East to West	0.63
.	X	X	6/27/05	6	29.0	29.0	East to West	1.15
.	X	X	6/28/05	1	31.0	30.0	West to East	0.76
.	X	X	6/28/05	2	43.0	29.0	No Flow	0.00
.	X	X	6/28/05	3	29.0	27.0	East to West	0.98
.	X	X	6/28/05	6	32.0	28.0	East to West	1.32
.	X	X	6/29/05	1	29.0	31.0	West to East	1.00
.	X	X	6/29/05	2	41.5	30.0	East to West	0.64
.	X	X	6/29/05	3	28.0	28.0	East to West	0.78
.	X	X	6/29/05	6	30.5	28.0	East to West	1.02
.	X	X	6/30/05	1	32.0	31.0	West to East	0.42
.	X	X	6/30/05	2	42.0	30.0	East to West	0.36
.	X	X	6/30/05	3	31.0	28.0	East to West	1.18
.	X	X	6/30/05	6	33.0	29.0	East to West	1.50
.	X	X	7/1/05	1	28.0	31.0	West to East	0.41
.	X	X	7/1/05	2	39.7	30.0	No Flow	0.00

M	D	Samples	Date	Array	Depth	Temperature	Flow Direction	Flow Velocity
.	X	X	7/1/05	3	29.3	29.0	East to West	1.15
.	X	X	7/1/05	6	19.6	29.0	East to West	1.22
.	X	X	7/2/05	1	26.5	36.0	West to East	0.76
.	X	X	7/2/05	2	38.0	34.0	No Flow	0.00
.	X	X	7/2/05	3	27.0	32.0	East to West	1.00
.	X	X	7/2/05	6	29.5	32.0	East to West	0.74
.	X	X	7/3/05	1	24.9	33.0	East to West	0.76
.	X	X	7/3/05	2	36.0	34.0	East to West	0.45
.	X	X	7/3/05	3	25.4	29.0	East to West	0.76
.	X	X	7/3/05	6	28.7	30.0	East to West	1.18
.	X	X	7/4/05	1	23.0	34.5	West to East	0.47
.	X	X	7/4/05	2	33.0	33.5	East to West	0.29
X	.	X	7/28/05	3	15.0	30.0	No Flow	0.00
X	.	X	7/28/05	4	49.0	32.5	East to West	0.35
X	.	X	7/28/05	5	28.0	30.0	No Flow	0.00
X	.	X	7/28/05	6	19.0	33.0	No Flow	0.00
X	.	X	8/31/05	1	44.5	33.0	West to East	0.67
X	.	X	8/31/05	2	53.0	33.0	East to West	0.87
X	.	X	8/31/05	3	41.0	35.0	East to West	1.20
X	.	X	8/31/05	4	84.0	35.0	East to West	1.76
X	.	X	8/31/05	5	56.0	35.0	East to West	1.19
X	.	X	8/31/05	6	44.0	35.0	East to West	0.66
X	.	X	9/29/05	1	38.0	29.0	West to East	0.55
X	.	X	9/29/05	2	47.5	29.0	East to West	0.82
X	.	X	9/29/05	3	37.0	30.0	East to West	1.01
X	.	X	9/29/05	4	78.7	31.0	East to West	1.29
X	.	X	9/29/05	5	53.5	31.0	East to West	1.69
X	.	X	9/29/05	6	41.5	31.0	East to West	1.92
X	.	X	11/30/05	4	49.5	26.0	No Flow	.
X	.	X	12/28/05	4	42.0	18.5	East to West	.
.	X	X	5/26/06	4	13.0	31.0	No Flow	.
.	X	X	5/27/06	3	17.0	32.0	No Flow	.
.	X	X	5/27/06	4	20.0	32.0	No Flow	.
.	X	X	5/27/06	5	34.0	32.0	No Flow	.
.	X	X	5/27/06	6	32.0	32.0	No Flow	.
.	X	X	5/28/06	3	16.5	36.0	No Flow	.
.	X	X	5/28/06	4	21.5	36.0	No Flow	.
.	X	X	5/28/06	5	24.0	36.0	No Flow	.
.	X	X	5/28/06	6	31.5	36.0	No Flow	.
.	X	X	5/29/06	3	16.0	31.0	No Flow	.
.	X	X	5/29/06	4	21.0	30.0	No Flow	.
.	X	X	5/29/06	5	23.0	33.0	No Flow	.
.	X	X	5/29/06	6	31.0	31.0	No Flow	.
.	X	X	5/30/06	3	15.0	32	No Flow	.
.	X	X	5/30/06	4	20.0	31	No Flow	.
.	X	X	5/30/06	5	22.0	33	No Flow	.
.	X	X	5/30/06	6	30.0	33	No Flow	.
.	X	X	5/31/06	3	14.0	30	No Flow	.
.	X	X	5/31/06	4	22.0	29	No Flow	.
.	X	X	5/31/06	5	22.0	32	No Flow	.
.	X	X	5/31/06	6	29.0	31	No Flow	.

M	D	Samples	Date	Array	Depth	Temperature	Flow Direction	Flow Velocity
.	X	X	6/1/06	3	13.0	30	No Flow	.
.	X	X	6/1/06	4	19.5	29	No Flow	.
.	X	X	6/1/06	5	21.0	31	No Flow	.
.	X	X	6/1/06	6	18.0	28	No Flow	.
.	X	X	6/2/06	3	11.5	31	No Flow	.
.	X	X	6/2/06	4	20.0	29	No Flow	.
.	X	X	6/2/06	5	19.0	31	No Flow	.
.	X	X	6/2/06	6	24.0	31	No Flow	.
.	X	X	6/3/06	3	12.5	35.0	No Flow	.
.	X	X	6/3/06	4	27.0	37.0	No Flow	.
.	X	X	6/3/06	5	21.0	33.0	No Flow	.
.	X	X	6/3/06	6	25.0	32.0	No Flow	.
.	X	X	6/4/06	3	23.0	38	No Flow	.
.	X	X	6/4/06	4	26.0	36	No Flow	.
.	X	X	6/4/06	5	20.5	37	No Flow	.
.	X	X	6/4/06	6	11.0	36	No Flow	.
.	X	X	6/5/06	3	10.0	28	No Flow	.
.	X	X	6/5/06	4	25.0	29	No Flow	.
.	X	X	6/5/06	5	19.0	29	No Flow	.
.	X	X	6/5/06	6	22.0	28	No Flow	.
.	X	X	6/6/06	3	7.0	25	No Flow	.
.	X	X	6/6/06	4	24.0	26	No Flow	.
.	X	X	6/6/06	5	17.0	26	No Flow	.
.	X	X	6/6/06	6	22.0	23	No Flow	.
.	X	X	6/7/06	3	5.5	27	No Flow	.
.	X	X	6/7/06	4	10.0	27	No Flow	.
.	X	X	6/7/06	5	15.5	28	No Flow	.
.	X	X	6/7/06	6	6.0	26	No Flow	.
.	X	X	6/8/06	3	3.0	30	No Flow	.
.	X	X	6/8/06	4	9.5	27	No Flow	.
.	X	X	6/8/06	5	13.0	29	No Flow	.
.	X	X	6/8/06	6	2.0	26	No Flow	.
.	X	X	6/9/06	3	17.5	28	No Flow	.
.	X	X	6/9/06	4	20.0	28	No Flow	.
.	X	X	6/9/06	5	27.0	28	No Flow	.
.	X	X	6/9/06	6	19.0	27	No Flow	.
.	X	X	6/10/06	3	23.0	30	East to West	1.73
.	X	X	6/10/06	4	20.0	30.5	No Flow	.
.	X	X	6/10/06	5	27.0	28	No Flow	.
.	X	X	6/10/06	6	22.0	30	East to West	1.18
.	X	X	6/11/06	3	25.5	22	No Flow	.
.	X	X	6/11/06	4	24.0	26	No Flow	.
.	X	X	6/11/06	5	34.0	27	No Flow	.
.	X	X	6/11/06	6	24.0	26	No Flow	.
.	X	X	6/12/06	3	25.0	28	No Flow	.
.	X	X	6/12/06	6	23.0	28	No Flow	.
.	X	X	6/13/06	3	24.5	31	East to West	0.79
.	X	X	6/13/06	6	22.0	33	No Flow	.
.	X	X	6/15/06	1	24.5	.	.	.
.	X	X	6/15/06	2	50.5	.	.	.
.	X	X	6/16/06	1	23.0	.	.	.

M	D	Samples	Date	Array	Depth	Temperature	Flow Direction	Flow Velocity
.	X	X	6/16/06	2	47.0	.	.	.
.	X	X	6/17/06	1	21.5	.	.	.
.	X	X	6/17/06	2	45.5	.	.	.
.	X	X	6/18/06	1	29.0	29	.	.
.	X	X	6/18/06	2	43.0	30	.	.
.	X	X	6/19/06	1	21.0	28	.	.
.	X	X	6/19/06	2	43.0	29	.	.
.	X	X	6/20/06	1	20.0	.	.	.
.	X	X	6/20/06	2	45.0	28	.	.
.	X	X	6/21/06	1	19.0	.	.	.
.	X	X	6/21/06	2	44.0	28	.	.
.	X	X	6/22/06	1	19.5	28	.	.
.	X	X	6/22/06	2	44.5	29	.	.
.	X	X	6/23/06	1	27.0	35	West to East	0.48
.	X	X	6/23/06	2	52.5	32	West to East	0.36
.	X	X	6/24/06	1	26.5	33	West to East	0.50
.	X	X	6/24/06	2	51.5	32	East to West	0.36
.	X	X	6/25/06	1	26.0	32	West to East	0.52
.	X	X	6/25/06	2	50.0	31	East to West	0.37
.	X	X	6/26/06	1	26.0	30	.	0.54
.	X	X	6/26/06	2	49.0	30	.	0.38
.	X	X	6/27/06	1	24.5	30	.	0.55
.	X	X	6/27/06	2	46.0	31	.	0.39
X	.	X	6/30/06	3	20.1	31.5	No Flow	.
X	.	X	6/30/06	4	32.5	29.5	No Flow	.
X	.	X	6/30/06	5	26.5	32	No Flow	.
X	.	X	6/30/06	6	20.0	32	No Flow	.
X	X	X	7/28/06	1	23.5	30	.	0.56
X	X	X	7/28/06	2	43.5	29	.	0.41
X	.	X	7/28/06	3	24.5	29.5	East to West	0.56
X	.	X	7/28/06	4	53.0	30.5	East to West	0.36
X	.	X	7/28/06	5	38.5	30	.	0.44
X	.	X	7/28/06	6	25.0	29	East to West	0.56
.	X	X	7/29/06	1	24.0	.	.	.
.	X	X	7/30/06	1	21.0	35	.	.
.	X	X	7/31/06	1	19.0	30	.	.
X	.	X	8/31/06	1	25.5	28	.	.
X	.	X	8/31/06	2	29.5	28	.	.
X	.	X	8/31/06	3	26.5	29	East to West	0.54
X	.	X	8/31/06	4	51.0	30.5	East to West	0.37
X	.	X	8/31/06	5	43.5	29	East to West	0.41
X	.	X	8/31/06	6	31.0	.	.	.
X	.	X	9/29/06	1	24.5	29	.	.
X	.	X	9/29/06	2	39.0	27	.	.
X	.	X	9/29/06	3	21.0	27	East to West	0.63
X	.	X	9/29/06	4	47.0	30	East to West	0.39
X	.	X	9/29/06	5	38.0	27	Northeast to Southwest	0.46
X	.	X	9/29/06	6	26.0	30	East to West	0.54

Appendix 4. Rain gauge data from arrays #2-5. Note that readings are for an entire month once we stopped performing daily visits to the sites (See Methods for array sampling).

Date	Array	Rain Gauge (Inches)
8/31/04	2	7.59
8/31/04	3	8.70
8/31/04	4	8.95
8/31/04	5	10.20
9/30/04	2	4.00
9/30/04	3	7.17
9/30/04	4	7.27
9/30/04	5	7.81
10/29/04	2	9.45
10/29/04	3	9.30
10/29/04	4	8.89
10/29/04	5	9.20
11/30/04	2	2.05
11/30/04	3	1.70
11/30/04	4	1.66
11/30/04	5	1.99
12/30/04	2	0.02
12/30/04	3	0.04
12/30/04	4	2.00
12/30/04	5	0.05
2/25/05	2	0.03
2/25/05	3	0.14
2/25/05	4	0.15
2/25/05	5	0.16
3/30/05	2	2.62
3/30/05	3	4.04
3/30/05	4	2.95
3/30/05	5	2.84
4/28/05	2	1.41
4/28/05	3	1.47
4/28/05	4	1.42
4/28/05	5	1.30
5/26/05	2	1.02
5/26/05	3	2.60
5/26/05	4	2.05
5/26/05	5	1.38
6/7/05	2	3.45
6/7/05	3	3.77
6/7/05	4	4.70
6/7/05	5	3.59
6/8/05	2	0.22
6/8/05	3	0.30
6/8/05	4	0.72
6/8/05	5	0.03
6/9/05	2	0.01
6/9/05	3	0.01
6/9/05	4	0.10
6/9/05	5	0.01

Date	Array	Rain Gauge (Inches)
6/10/05	2	1.38
6/10/05	3	1.55
6/10/05	4	0.99
6/10/05	5	1.59
6/11/05	2	0.92
6/11/05	3	0.87
6/11/05	4	0.62
6/11/05	5	0.77
6/12/05	2	0.02
6/12/05	3	0.03
6/12/05	4	0.02
6/12/05	5	0.02
6/13/05	2	0.00
6/13/05	3	0.06
6/13/05	4	0.11
6/13/05	5	0.01
6/14/05	2	0.06
6/14/05	3	0.05
6/14/05	4	0.01
6/14/05	5	0.01
6/15/05	2	0.01
6/15/05	3	0.01
6/15/05	4	0.01
6/15/05	5	0.00
6/16/05	2	0.00
6/16/05	3	0.00
6/16/05	4	0.00
6/16/05	5	0.00
6/17/05	2	0.77
6/17/05	3	0.02
6/17/05	4	0.29
6/17/05	5	0.30
6/18/05	2	0.26
6/18/05	3	0.68
6/18/05	4	0.02
6/18/05	5	0.95
6/19/05	2	0.18
6/19/05	3	0.07
6/19/05	4	0.09
6/19/05	5	0.03
6/20/05	2	3.64
6/20/05	3	2.05
6/20/05	4	0.93
6/20/05	5	2.82
6/21/05	2	1.38
6/21/05	3	2.53
6/21/05	4	3.07
6/21/05	5	2.02
6/22/05	2	0.02
6/22/05	3	0.01
6/22/05	5	0.01

Date	Array	Rain Gauge (Inches)
6/23/05	2	2.91
6/23/05	3	2.20
6/23/05	4	2.26
6/23/05	5	2.43
6/24/05	2	1.07
6/24/05	3	0.28
6/24/05	4	1.34
6/24/05	5	0.06
6/25/05	2	0.94
6/25/05	3	0.02
6/26/05	2	0.01
6/26/05	3	0.00
6/27/05	2	1.39
6/27/05	3	1.10
6/28/05	2	0.98
6/28/05	3	0.78
6/29/05	2	0.00
6/29/05	3	0.00
6/30/05	2	0.97
6/30/05	3	1.87
7/1/05	2	0.16
7/1/05	3	0.08
7/2/05	2	0.00
7/2/05	3	0.02
7/3/05	2	0.00
7/3/05	3	0.00
7/4/05	2	0.00
7/28/05	2	3.25
7/28/05	3	3.32
7/28/05	4	3.40
7/28/05	5	3.00
8/31/05	2	9.03
8/31/05	3	9.60
8/31/05	4	10.00
8/31/05	5	6.35
12/28/05	2	4.45
12/28/05	3	1.35
12/28/05	5	4.15
5/23/06	4	0.00
5/25/06	3	3.80
5/25/06	4	1.66
5/26/06	2	2.75
5/26/06	3	0.02
5/26/06	4	0.00
5/26/06	5	3.60
5/27/06	2	0.03
5/27/06	3	0.40
5/27/06	5	0.10
5/27/06	6	0.00
5/28/06	3	0.05
5/28/06	4	0.29

Date	Array	Rain Gauge (Inches)
5/28/06	5	0.01
5/29/06	3	0.02
5/29/06	4	0.00
5/29/06	5	0.01
5/30/06	3	0.11
5/30/06	4	0.20
5/30/06	5	0.10
5/31/06	3	0.05
5/31/06	4	0.00
5/31/06	5	0.51
6/1/06	3	0.02
6/1/06	4	0.00
6/1/06	5	0.02
6/2/06	3	0.03
6/2/06	4	0.13
6/2/06	5	0.03
6/3/06	3	0.57
6/3/06	4	1.16
6/3/06	5	0.31
6/4/06	3	0.01
6/4/06	4	0.05
6/4/06	5	0.01
6/5/06	3	0.00
6/5/06	4	0.00
6/5/06	5	0.00
6/5/06	6	0.00
6/6/06	3	0.00
6/6/06	4	0.00
6/6/06	5	0.00
6/7/06	3	0.00
6/7/06	4	0.00
6/7/06	5	0.00
6/8/06	3	0.00
6/8/06	4	0.00
6/8/06	5	0.00
6/9/06	3	2.10
6/9/06	4	1.58
6/9/06	5	2.10
6/10/06	3	1.03
6/10/06	4	0.26
6/10/06	5	1.29
6/11/06	3	0.95
6/11/06	4	1.35
6/11/06	5	0.95
6/12/06	3	0.03
6/13/06	3	0.01
6/30/06	3	10.10
6/30/06	4	8.59
6/30/06	5	3.55
7/15/06	2	0.02
7/16/06	2	0.00

Date	Array	Rain Gauge (Inches)
7/17/06	2	0.04
7/18/06	2	0.01
7/19/06	2	0.31
7/20/06	2	0.31
7/21/06	2	0.01
7/22/06	2	0.34
7/23/06	2	1.65
7/24/06	2	0.01
7/25/06	2	0.01
7/26/06	2	0.00
7/27/06	2	0.02
7/28/06	2	0.04
7/28/06	3	9.64
7/28/06	4	11.99
7/28/06	5	9.62
8/31/06	2	7.73
8/31/06	3	9.63
8/31/06	4	9.44
8/31/06	5	10.30
9/29/06	2	5.43
9/29/06	3	6.03
9/29/06	4	6.68
9/29/06	5	5.13

APPENDIX 5. UTMs of the six drift fence arrays along the Main Park Road.

Array	UTM (m)	
	E	N
1	535974	2811232
2	533778	2811198
3	526679	2812938
4	522098	2813043
5	530596	2813338
6	526650	2813115

APPENDIX 6. UTMs of the solution holes sites in Everglades National Park

Solution Hole Complex	Depth Category	UTM (m)	
		E	N
1HL	M1	538575	2807348
1HL	M2	538575	2807348
2HL	S	538564	2807342
3HL	S	538552	2807367
3HL	D2	538544	2807366
3HL	M	538545	2807360
3HL	D1	538547	2807353
2MB	D	538662	2810087
2MB	M	538664	2810088
BLUE BAG	M	538637	2810053
BLUE BAG	D	538635	2810054
MR8	D1	538552	2810100
MR8	D2	538554	2810100
MR7	D	538551	2810096
MR7	M	538553	2810097
3SB	M	538550	2810084
3MB	M1	538556	2810081
3MB	M2	538556	2810078
MR9	D1	537192	2810932
MR9	D2	537186	2810931
4MB	D1	537180	2810937
4MA	D2	537192	2810947
4MA	M1	537193	2810946
4MB	M2	537232	2811000
1WR	D	534004	2811482
1WR	S	534006	2811474
3WR	D1	534771	2811962
3WR	D2	534773	2811965
4WR	M	535043	2811902
4WR	D	535084	2811884
2WR	D	534666	2812055
2WR	M	534673	2812084
MR10	M	530581	2813222
MR10	D	530581	2813213
5SB	D	530619	2813294
5SB	M	530618	2813295
5SA	S1	530621	2813243
5SA	S2	530622	2813240
MR11	D	526657	2812983
MR11	M	526655	2812980

Appendix 7. Physical data collected in solution holes during the dry season of 2004-05. Physico-chemical data were collected with a YSI 556 unit.

Date	Solution Hole Complex	Depth Category	Water Depth (cm)	Surface Depth (cm)	Temperature (ºC)	Specific Conductance (ms/cm)	DO %	DO (mg/L)	pH
9/30/04	1WR	D	112	33	27.1	0.355	1.7	0.14	6.5
9/30/04	2MB	D	81.5	-3.5	26.1	0.354	23.6	1.87	6.5
9/30/04	2MB	M	41	9	26.3	0.353	43.9	3.49	6.5
9/30/04	2WR	D	105	37	26.9	0.313	9.6	0.79	6.5
9/30/04	2WR	M	51	28	27.6	0.344	13.4	1.06	6.5
9/30/04	3MB	M1	38	5	30.3	0.107	51.8	4.04	7
9/30/04	3MB	M2	44	4	30.5	0.31	6.7	0.5	7
9/30/04	3SB	M	33	9	26.7	0.555	9.2	0.73	6.5
9/30/04	3WR	D2	115	30	26.3	0.37	0.9	0.08	7
9/30/04	3WR	D1	98	112	26.6	0.361	1	0.08	7
9/30/04	4MA	M2	49	15	25.2	0.385	7.1	0.57	6.5
9/30/04	4MA	M1	60	11	25.4	0.253	10	0.83	6.5
9/30/04	4MB	D1	82	0	25.7	0.402	3.1	0.25	7
9/30/04	4MB	D2	72	8	25.9	0.367	2.5	0.2	7
9/30/04	4WR	D	140	23	26.1	0.391	3.1	0.25	6
9/30/04	4WR	M	36	12	26.5	0.442	13.9	1.1	6.5
9/30/04	BLUE BAG	D	79	26	26.9	0.352	13.6	1.09	6.5
9/30/04	BLUE BAG	M	43	21	27.1	0.34	18.1	1.41	7
9/30/04	MR7	M	39	10	27.4	0.283	4.5	0.35	7
9/30/04	MR7	D	95	5	27.7	0.334	4.5	0.35	7
9/30/04	MR8	D1	101	9	27.9	0.333	4.4	0.33	6.5
9/30/04	MR8	D2	72	33	28.1	0.333	9.7	0.75	7
9/30/04	MR9	D1	52	40	26.3	0.304	13.3	1.07	7
9/30/04	MR9	M	69.5	22.5	27.3	0.396	12.8	1	6.5
11/30/04	1WR	D	107	38	23.25	0.257	7.8	0.66	.
11/30/04	2WR	D	114	28	21.78	0.279	21.6	1.89	.
11/30/04	2WR	M	39	40	21.98	0.277	38.7	3.38	.
11/30/04	2WR	S	16		22.83	0.297	35.4	3.03	.
11/30/04	3SB	M	35	7	22.19	0.269	46	4.01	.
11/30/04	3WR	D1	116	-6	21.96	0.305	35.1	3.08	.
11/30/04	3WR	D2	114	-4	22.15	0.306	19.7	1.71	.
11/30/04	4MA	M1	63	8	21.97	0.286	16.2	1.41	.
11/30/04	4MA	M2	54	10	21.97	0.286	16.2	1.41	.
11/30/04	4MB	D1	46	36	21.66	0.29	16.7	1.47	.
11/30/04	4MB	D2	69	17	22.08	0.288	18.3	1.6	.
11/30/04	4WR	D	110	53	22.15	0.319	8.8	0.76	.
11/30/04	4WR	M	42	6	23.69	0.329	27.1	2.29	.
11/30/04	5SA	S1	13.5	13.5	20.82	0.256	31.9	2.85	.
11/30/04	5SA	S2	25	2	21.22	0.271	33.4	2.96	.
11/30/04	5SB	M	42	19	22.49	0.209	72.8	6.32	.
11/30/04	5SB	D	65	16	22.51	0.204	82.6	7.16	.
11/30/04	BLUE BAG	M	54	10	23.15	0.347	17.6	1.63	.
11/30/04	BLUE BAG	D	89	16	23.38	0.269	12.3	1.04	.
11/30/04	MR10	D	64	18	21.69	0.258	55	4.84	.
11/30/04	MR10	M	54	14	24.88	0.287	17.4	1.44	.
11/30/04	MR11	D	93	11	20.78	0.292	43.7	3.91	.

Date	Solution Hole Complex	Depth Category	Water Depth (cm)	Surface Depth (cm)	Temperature (ºC)	Specific Conductance (ms/cm)	DO %	DO (mg/L)	pH
11/30/04	MR11	M	33	22	21.54	0.288	53.3	4.69	.
11/30/04	MR7	M	46	9	21.79	0.236	17.9	1.57	.
11/30/04	MR7	D	98	2	21.88	0.237	19.1	1.67	.
11/30/04	MR8	D2	76	29	23.02	0.255	24.2	2.07	.
11/30/04	MR8	D1	105	5	23.18	0.256	10.9	0.91	.
11/30/04	MR9	D2	91	16	21.54	0.287	7.3	0.64	.
11/30/04	MR9	D1	76	16	22.3	0.284	20	1.74	.
12/30/04	1HL	M2	61	16	16.14	0.318	37.1	3.65	.
12/30/04	1HL	M1	49	14	16.38	0.325	50.1	4.88	.
12/30/04	1WR	D	86	59	21.67	0.268	10.7	0.95	.
12/30/04	2HL	S	18	14	16.5	0.345	42	4.1	.
12/30/04	2MB	M	25	25	20.29	0.29	19.2	1.73	.
12/30/04	2MB	D	63	22	20.44	0.29	19.5	1.77	.
12/30/04	2WR	M	19	60	19.4	0.316	14.6	1.33	.
12/30/04	2WR	D	86	56	19.57	0.318	24.8	2.27	.
12/30/04	3HL	S	23	15	16.28	0.36	49.9	4.88	.
12/30/04	3HL	D1	68	14	16.83	0.324	23	2.24	.
12/30/04	3HL	M	42	16	17.07	0.323	16.5	1.6	.
12/30/04	3HL	D2	64	16	17.29	0.325	17	1.64	.
12/30/04	3MB	M2	24	24	19.1	0.284	37	3.42	.
12/30/04	3MB	M1	23	20	20.92	0.27	83	7.41	.
12/30/04	3SB	M	13	29	20.09	0.277	37	3.35	.
12/30/04	3WR	D2	82	63	20.34	0.326	8.3	0.74	.
12/30/04	3WR	D1	61	49	20.67	0.315	16.7	1.05	.
12/30/04	4MA	M2	25	39	20.66	0.287	29	2.6	.
12/30/04	4MA	M1	33	38	20.86	0.285	38.8	3.45	.
12/30/04	4MB	D2	40	46	19.67	0.299	22.7	2.07	.
12/30/04	4MB	D1	33	49	19.74	0.291	11.8	1.09	.
12/30/04	4WR	D	105	58	20.02	0.33	15.6	1.42	.
12/30/04	5SB	D	50	31	18.3	0.232	86.5	8.06	.
12/30/04	5SB	M	10	51	19.76	0.42	106.9	9.78	.
12/30/04	BLUE BAG	M	26	38	21.38	0.283	26.9	2.38	.
12/30/04	BLUE BAG	D	62	43	21.55	0.286	19.1	1.68	.
12/30/04	MR10	D	41	41	17.91	0.308	61.2	5.84	.
12/30/04	MR10	M	24	44	22.72	0.325	47.3	4.08	.
12/30/04	MR11	D	63	41	17.33	0.285	65.74	5.05	.
12/30/04	MR11	M	5	50	21.32	0.292	39.4	3.49	.
12/30/04	MR7	D	83	17	18.69	0.268	39.3	3.62	.
12/30/04	MR7	M	20	29	19.08	0.268	26.1	2.41	.
12/30/04	MR8	D1	82	28	21	0.267	39.3	3.5	.
12/30/04	MR8	D2	54	51	21.97	0.268	12.7	1.11	.
12/30/04	MR9	D2	62	45	20.05	0.289	7.2	0.35	.
12/30/04	MR9	D1	43	49	20.56	0.286	15.2	1.36	.
1/27/05	1HL	M1	35.5	27.5	14.48	0.352	41.6	4.24	.
1/27/05	1HL	M2	42.5	34.5	15.28	0.407	43.6	4.37	.
1/27/05	1WR	D	67	78	20.79	0.304	6.5	0.58	.
1/27/05	2HL	S	7	25	18.73	0.396	59.8	5.57	.
1/27/05	2MB	D	43	42	20.79	0.315	10.8	0.96	.
1/27/05	2MB	M	10	40	21.04	0.311	62.8	5.58	.
1/27/05	2WR	D	36	106	18.38	0.356	3.7	0.35	.

Date	Solution Hole Complex	Depth Category	Water Depth (cm)	Surface Depth (cm)	Temperature (ºC)	Specific Conductance (ms/cm)	DO %	DO (mg/L)	pH
1/27/05	3HL	D1	48	34	14.9	0.36	29.2	2.94	.
1/27/05	3HL	D2	57	33	15.07	0.365	25.5	2.56	.
1/27/05	3HL	S	9.5	28.5	15.6	0.4	32.1	3.19	.
1/27/05	3HL	M	32	26	15.6	0.363	16	1.58	.
1/27/05	3MB	M2	5	43	21.93	0.311	38.7	3.29	.
1/27/05	3WR	D1	43	67	18.8	0.356	17.6	0.63	.
1/27/05	3WR	D2	69	69	18.85	0.358	2.9	0.26	.
1/27/05	4MA	M1	17	54	20.38	0.311	38.7	3.29	.
1/27/05	4MA	M2	7	57	22.41	0.301	26.6	2.31	.
1/27/05	4MB	D2	19	67	19.86	0.329	9.9	0.9	.
1/27/05	4MB	D1	15	67	20.2	0.317	28.7	2.6	.
1/27/05	4WR	D	98	65	19.11	0.374	9.6	0.88	.
1/27/05	5SB	D	17.5	63.5	18.77	0.269	66.7	6.21	.
1/27/05	BLUE BAG	M	9	55	21.3	0.314	34.7	3.07	.
1/27/05	BLUE BAG	D	45	60	21.53	0.319	9.8	0.86	.
1/27/05	MR10	D	27	55	15.61	0.36	31.9	3.16	.
1/27/05	MR10	M	7	61	22.96	0.355	45.1	3.87	.
1/27/05	MR11	D	49	55	15.69	0.321	33.7	3.33	.
1/27/05	MR7	D	52	48	18.83	0.295	31	2.93	.
1/27/05	MR8	D1	65.5	44.5	21.21	0.304	4.4	0.39	.
1/27/05	MR8	D2	39	66	22.03	0.3	19	1.66	.
1/27/05	MR9	D2	42	65	18.41	0.316	6.1	0.58	.
1/27/05	MR9	D1	42	50	20.17	0.314	7.1	0.64	.
2/25/05	1HL	M2	24	53	19.49	0.373	32.8	3.01	.
2/25/05	1HL	M1	19	44	19.99	0.38	31.9	2.9	.
2/25/05	1WR	D	46	99	20.78	0.346	12.9	1.16	.
2/25/05	2MB	D	25	60	21.27	0.35	10.2	0.9	.
2/25/05	2WR	D	41	101	19.33	0.391	4.5	0.42	.
2/25/05	3HL	D1	26	56	19.24	0.397	12.8	1.18	.
2/25/05	3HL	D2	46	34	19.51	0.402	20.1	1.84	.
2/25/05	3HL	M	18	40	20	0.399	25.8	2.34	.
2/25/05	3WR	D2	39	106	20.8	0.394	3.4	0.3	.
2/25/05	3WR	D1	10	100	20.99	0.392	18.1	1.61	.
2/25/05	4WR	D	68	95	20.99	0.397	1.9	0.17	.
2/25/05	BLUE BAG	D	23	82	21.97	0.351	10.9	0.95	.
2/25/05	MR11	D	25	79	21.82	0.383	35.1	3.08	.
2/25/05	MR7	D	38	62	21.24	0.346	22.6	2	.
2/25/05	MR8	D1	43	67	21.94	0.352	3.3	0.29	.
2/25/05	MR8	D2	15	90	22	0.352	11.9	1.04	.
2/25/05	MR9	D2	19	88	19.97	0.346	13.2	1.2	.
3/31/05	1HL	M2	31	46	24.03	0.378	158.6	13.22	.
3/31/05	1HL	M1	26	37	24.21	0.381	79.7	6.67	.
3/31/05	1WR	D	60	85	22.17	0.355	7.8	0.68	.
3/31/05	2MB	D	32	53	23.64	0.349	53	4.5	.
3/31/05	2WR	D	55	87	21.76	0.386	7.1	0.62	.
3/31/05	3HL	D2	36	44	23.06	0.404	46.1	3.91	.
3/31/05	3HL	M	19	39	24.38	0.391	149.2	12.57	.
3/31/05	3HL	D1	28	54	24.74	0.387	91.2	7.59	.
3/31/05	3WR	D2	56	89	22.21	0.385	1.6	0.15	.
3/31/05	3WR	D1	27	83	22.59	0.382	15.1	1.31	.

Date	Solution Hole Complex	Depth Category	Water Depth (cm)	Surface Depth (cm)	Temperature (ºC)	Specific Conductance (ms/cm)	DO %	DO (mg/L)	pH
3/31/05	4WR	D	71	92	22.34	0.386	2.5	0.21	.
3/31/05	BLUE BAG	D	29	76	23.75	0.35	29.4	2.49	.
3/31/05	MR11	D	36	68	23.22	0.341	24.2	2.07	.
3/31/05	MR7	D	36	64	24.95	0.31	66.3	5.48	.
3/31/05	MR8	D1	50	60	24.52	0.349	18.2	1.52	.
3/31/05	MR8	D2	25	80	25.2	0.347	46.7	3.81	.
3/31/05	MR9	D2	29	78	21.09	0.354	7.5	0.66	.
4/28/05	1HL	M1	12	51	24.44	0.437	62.8	5.26	7.13
4/28/05	1HL	M2	32	45	25.45	0.44	72.5	5.9	6.92
4/28/05	1WR	D	42	103	22.5	0.383	27.6	2.38	7.19
4/28/05	2MB	D	26	59	22.44	0.375	24.6	2.13	7.24
4/28/05	2WR	D	37	105	21.47	0.408	22.1	1.95	7.22
4/28/05	3HL	D2	36	44	22.03	0.413	38.7	3.39	7.21
4/28/05	3HL	D1	21	61	22.81	0.413	51.6	4.45	7.24
4/28/05	3HL	M	10	48	26.09	0.405	104.5	8.51	7.36
4/28/05	3WR	D2	32	113	21.46	0.4	23.6	2.07	7.22
4/28/05	3WR	D1	7	103	21.98	0.396	36	3.15	7.23
4/28/05	4WR	D	60	103	21.84	0.416	16.6	1.45	7.14
4/28/05	BLUE BAG	D	16	89	22.93	0.375	23.5	2.01	7.22
4/28/05	MR11	D	18	86	23.03	0.371	48.8	4.19	6.86
4/28/05	MR7	D	24	76	22.35	0.366	34.9	3.02	7.22
4/28/05	MR8	D1	37	73	23.26	0.382	23.6	2.01	7.05
4/28/05	MR9	D2	12	95	27.65	0.36	22.8	7	7.1
5/25/05	1HL	M1	16	47	25.71	0.502	41.9	2.72	7.38
5/25/05	1HL	M2	28	49	26.66	0.481	29.6	2.37	7.07
5/25/05	1WR	D	28	117	24.54	0.399	40.8	3.23	7.46
5/25/05	2MB	D	15	70	23.98	0.392	34.3	2.89	7.78
5/25/05	2WR	D	27	115	23.6	0.412	21.2	1.8	7.51
5/25/05	3HL	D1	20	62	24.06	0.427	23.8	2.16	7.78
5/25/05	3HL	D2	25.5	54.5	25.14	0.431	29.4	2.59	7.27
5/25/05	3WR	D2	31	114	23.58	0.417	16.8	1.42	7.44
5/25/05	4WR	D	52	111	23.54	0.416	11.4	0.96	7.56
5/25/05	BLUE BAG	D	15	90	24.87	0.394	33.2	2.75	7.54
5/25/05	MR11	D	12	92	28.18	0.387	30.7	2.38	7.04
5/25/05	MR7	D	23	77	25.69	0.369	39.6	3.23	7.61
5/25/05	MR8	D1	29	81	24.85	0.385	22.2	2	7.18
5/25/05	MR9	D1	9	83	23.68	0.385	20.2	1.69	7.74

APPENDIX 8. Physical characteristics of the solution holes sampled.

Complex	Solution Hole	Vegetation Cover (%)	Dominant Macrophyte Species	Complexity Score (1-3)	Length (cm)	Width (cm)	Maximum Depth (cm)
1HL	M1	90	*Bacopa caroliniana*	1	130	70	63
1HL	M2	25	*Bacopa caroliniana*	2	500	400	77
2HL	S	15	*Cladium jamaicense, Bacopa caroliniana,*	1	230	170	32
3HL	S	> 90	*Crinum americanum, Bacopa caroliniana*	1	300	270	38
3HL	D2	< 10	*Bacopa caroliniana*	2	320	300	80
3HL	M	10	*Ludwigia repens, Utricularia foliosa*	2	300	140	58
3HL	D1	< 10	*Ludwigia repens*	1	330	230	82
2MB	D	85	*Salix caroliniana, Pontedaria cordata, Bacopa caroliniana, Cladium jamaicense*	3	270	400	85
2MB	M	> 90	*Bacopa caroliniana, Panicum sp., Cladium jamaicense*	2	265	295	50
Blue Bag	M	60	*Ludwigia repens, Sagittaria lancifolia, Proserpinaca palustris*	2	170	165	64
Blue Bag	D	30	*Chara sp.*	2	410	200	105
MR8	D1	0		2	120	110	110
MR8	D2	80	*Chara sp.*	3	190	110	105
MR7	D	< 10	*Chara sp.*	1	160	160	100
MR7	M	15	*Sagittaria lancifolia*	2	100	100	49
3SB	M	> 90	*Sagittaria lancifolia, Proserpinaca palustris*	2	320	270	42
3MB	M1	15	*Cladium jamaicense*	1	240	145	43
3MB	M2	> 90	*Sagittaria lancifolia, Polygonum densiflorum, Salix caroliniana*	2	820	680	48
MR9	D1	0		2	140	70	92
MR9	D2	0		2	150	140	107
4MA	M1	40	*Sagittaria lancifolia, Cladium jamaicense, Mikania scandens*	3	340	100	71
4MA	M2	> 90	*Cladium jamaicense, Sagittaria lancifolia*	3	300	380	64
1WR	D	0		1	290	270	145
1WR	S	< 10	*Cladium jamaicense*	1	190	240	38
3WR	D1	20	*Panicum sp., Cladium jamaicense*	2	240	190	110
3WR	D2	0		3	250	200	145
4WR	M	> 90	*Sagittaria lancifolia, Cladium jamaicense, Prosperpinaca palustris*	3	450	350	48
4WR	D	0		2	260	220	163
2WR	D	< 10	*Sagittaria lancifolia*	3	760	680	142
2WR	M	< 10	*Polygonum densiflorum, Panicum sp.*	2	330	159	79
MR10	M	15	*Prosperpinaca palustris*	2	290	240	68
MR10	D	20	*Salix caroliniana, Cladium jamaicense, Sagittaria lancifolia Ludwigia repens*	2	350	200	82
5SB	D	< 10	*Pluchea sp., Eupatorium leptophyllum*	1	260	260	81
5SB	M	35	*Cladium jamaicense, Rhynchospora sp.*	2	440	190	61
5SA	S1	> 90	*Cladium jamaicense, Mikania scandens, Pluchea sp., Eupatorium leptophyllum*	2	450	200	27
5SA	S2	80	*Cladium jamaicense, Prosperpinaca palustris*	2	430	360	27
MR11	D	< 10	*Cladium jamaicense, Alternanthera philoxeroides*	1	370	300	104
MR11	M	40	*Prosperpinaca palustris*	2	87	61	55

APPENDIX 9. Data collected during the 14-days samples of the drift-fence arrays for the wet seasons of 2005 and 2006.

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/8/05	4	E	18	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	28	0
6/8/05	4	N	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/8/05	4	W	2	1	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28	28	0
6/9/05	4	E	7	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
6/9/05	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/9/05	4	W	21	4	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31	31	0
6/10/05	4	E	9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
6/10/05	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/10/05	4	W	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0
6/11/05	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11/05	3	N	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/11/05	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11/05	4	E	2	1	1	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	0	0	0	0	64	12	52
6/11/05	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11/05	4	W	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/11/05	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11/05	5	N	6	0	0	9	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	21	0
6/11/05	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/11/05	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/05	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/05	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/05	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/05	4	E	1	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0
6/12/05	4	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/12/05	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/12/05	5	E	2	1	2	6	9	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	23	23	0
6/12/05	5	N	0	1	5	38	29	0	0	1	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	1	1	0	88	86	2
6/12/05	5	S	9	3	9	15	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	45	45	0
6/12/05	5	W	0	0	1	10	13	0	0	3	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	40	40	0
6/13/05	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/13/05	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/13/05	3	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/13/05	4	E	3	0	2	0	2	1	1	4	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	1	17	15	2
6/13/05	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/13/05	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	16	0	0	0	0	0	0	0	0	0	17	17	0
6/13/05	5	E	4	0	9	5	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	36	36	0
6/13/05	5	N	25	0	22	11	14	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	74	74	0
6/13/05	5	S	0	0	0	1	9	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	13	13	0
6/13/05	5	W	0	0	8	3	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	29	29	0
6/14/05	3	E	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
6/14/05	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/14/05	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/14/05	4	E	2	0	7	6	7	0	0	10	0	0	0	0	0	0	0	1	0	0	0	15	0	0	0	0	0	0	0	0	0	48	48	0
6/14/05	4	N	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/14/05	4	W	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	10	0	0	0	0	0	0	0	0	0	12	12	0
6/14/05	5	E	9	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	16	16	0
6/14/05	5	N	6	1	2	3	3	0	0	0	0	0	0	0	0	0	0	1	0	2	0	21	0	0	0	0	0	0	0	0	0	39	39	0
6/14/05	5	S	7	0	2	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	21	21	0
6/14/05	5	W	7	0	1	5	7	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	23	23	0
6/15/05	4	E	2	1	0	0	2	0	1	5	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	1	0	0	19	18	1
6/15/05	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	3	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/15/05	4	W	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	20	0	0	2	0	0	0	0	0	0	25	23	2
6/15/05	5	E	11	0	1	2	9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	1	0	0	36	35	1
6/15/05	5	N	27	3	1	25	10	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	71	69	2
6/15/05	5	S	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
6/15/05	5	W	5	0	0	7	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	6	0	0	0	0	0	0	0	0	0	21	21	0
6/16/05	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	7	0	0	20	13	7
6/16/05	4	N	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	4	4	0
6/16/05	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	8	8	0
6/16/05	5	E	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	0
6/16/05	5	N	13	0	6	26	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	48	0
6/16/05	5	S	1	0	0	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	12	0
6/16/05	5	W	1	0	1	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	1	0	0	16	15	1
6/17/05	4	E	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	1	0	0	0	2	0	0	17	14	3
6/17/05	4	N	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	15	15	0
6/17/05	4	W	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	41	41	0
6/17/05	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/17/05	5	N	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	0
6/17/05	5	S	6	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
6/17/05	5	W	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	6	1
6/18/05	4	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	0	0	24	24	0
6/18/05	4	N	0	0	0	0	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	31	31	0
6/18/05	4	W	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	10	10	0
6/18/05	5	E	11	0	0	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	22	0
6/18/05	5	N	4	0	1	8	12	0	0	1	0	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	31	31	0
6/18/05	5	S	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	7	7	0
6/18/05	5	W	0	0	0	4	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
6/19/05	4	E	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/19/05	4	N	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/19/05	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
6/19/05	5	E	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	9	9	0
6/19/05	5	N	0	0	0	5	5	0	0	1	0	0	0	0	0	0	0	1	0	0	0	8	0	0	0	0	0	0	0	0	0	20	20	0
6/19/05	5	S	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
6/19/05	5	W	7	0	0	2	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	12	0
6/20/05	3	E	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	3	0
6/20/05	3	N	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0
6/20/05	3	W	8	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	0
6/20/05	4	E	1	0	0	0	4	0	0	0	0	0	0	0	0	0	0	3	0	0	0	17	0	0	0	0	0	0	1	0	0	26	25	1
6/20/05	4	N	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/20/05	4	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	12	12	0
6/20/05	5	E	2	0	0	7	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1	0	0	17	16	1
6/20/05	5	N	3	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	15	15	0
6/20/05	5	S	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/20/05	5	W	1	0	0	10	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	1	0	0	22	21	1
6/20/05	6	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/20/05	6	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/20/05	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/20/05	6	W	4	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	13	0
6/21/05	1	E	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	2	1
6/21/05	1	N	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/21/05	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/21/05	2	E	2	0	0	0	52	0	0	1	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	70	70	0
6/21/05	2	N	19	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	21	0
6/21/05	2	W	38	0	0	0	8	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	49	49	0
6/21/05	3	E	2	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/21/05	3	N	8	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
6/21/05	3	W	10	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	12	0
6/21/05	4	E	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	27	27	0
6/21/05	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/21/05	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	7	7	0
6/21/05	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/21/05	5	N	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2	0
6/21/05	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/21/05	5	W	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	6	5	1
6/21/05	6	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/21/05	6	N	18	0	0	1	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	22	22	0
6/21/05	6	S	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	2	1
6/21/05	6	W	15	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	1	0	0	44	43	1
6/22/05	1	E	11	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	17	17	0
6/22/05	1	N	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
6/22/05	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/22/05	2	E	4	1	0	0	9	1	1	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	1	0	0	44	43	1
6/22/05	2	N	4	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	9	8	1
6/22/05	2	W	7	0	0	3	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	1	0	0	27	26	1
6/22/05	3	E	2	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
6/22/05	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/22/05	3	W	47	1	1	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	57	56	1
6/22/05	5	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2	2
6/22/05	5	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2	0
6/22/05	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/22/05	5	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	36	36	0
6/22/05	6	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/22/05	6	N	3	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	14	14	0
6/22/05	6	S	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
6/22/05	6	W	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	3	0	0	42	39	3
6/23/05	1	E	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3	8	5	3
6/23/05	1	N	13	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	0
6/23/05	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/23/05	2	E	22	0	0	0	0	34	3	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0	0	0	0	1	0	0	122	121	1
6/23/05	2	N	2	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
6/23/05	2	W	10	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	0
6/23/05	3	E	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/23/05	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	2	0
6/23/05	3	W	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	15	15	0
6/23/05	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
6/23/05	5	N	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/23/05	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/23/05	5	W	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0	0	0	0	0	0	67	67	0
6/23/05	6	E	5	0	0	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
6/23/05	6	N	5	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	12	12	0
6/23/05	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/23/05	6	W	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	34	0	0	0	0	0	0	0	0	0	37	37	0
6/24/05	1	E	11	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	1	31	30	1
6/24/05	1	N	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	9	8	1
6/24/05	1	W	51	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	55	55	0
6/24/05	2	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/24/05	2	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/24/05	2	W	1	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	8	0	50	42	8
6/24/05	3	E	4	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	8	7	1

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/24/05	3	N	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	0
6/24/05	3	W	25	3	0	0	12	19	3	0	0	0	0	0	0	0	0	0	0	0	0	13	2	0	0	0	0	0	2	0	0	79	77	2
6/24/05	5	E	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2	0
6/24/05	5	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24/05	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24/05	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82	0	0	0	0	0	0	0	0	0	82	82	0
6/24/05	6	E	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
6/24/05	6	N	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/24/05	6	S	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/24/05	6	W	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	85	0	0	0	0	0	0	0	0	0	88	88	0
6/25/05	1	E	270	8	1	0	3	22	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	309	309	0
6/25/05	1	N	2	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	11	11	0
6/25/05	1	W	910	0	2	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0	0	0	1	0	0	924	923	1
6/25/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	42	0	1	0	0	0	0	0	0	0	46	46	0
6/25/05	2	N	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	9	9	0
6/25/05	2	W	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	96	0	2	0	0	0	0	2	0	0	103	101	2
6/25/05	3	E	1	0	0	1	5	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	11	11	0
6/25/05	3	N	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	7	7	0
6/25/05	3	W	53	7	2	0	18	12	72	0	0	0	0	0	0	0	0	0	0	0	0	2	0	8	0	0	0	0	0	0	0	174	174	0
6/25/05	6	E	7	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	14	0
6/25/05	6	N	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	13	13	0
6/25/05	6	S	5	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	13	0
6/25/05	6	W	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	1	0	52	0	1	0	0	0	0	2	0	0	63	61	2
6/26/05	1	E	1	0	0	1	12	0	0	5	0	0	0	0	0	0	0	0	0	0	0	20	0	1	0	0	0	0	2	0	0	42	40	2
6/26/05	1	N	0	2	0	0	1	0	0	14	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	20	20	0
6/26/05	1	W	356	4	0	2	3	4	6	2	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	1	0	0	397	396	1
6/26/05	2	E	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	70	0	0	2	0	0	1	0	0	0	76	73	3

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/26/05	2	N	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	3	1	0	0	0	0	0	0	0	0	9	9	0
6/26/05	2	W	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	4	1	0	0	62	0	0	0	0	0	0	0	1	0	71	70	1
6/26/05	3	E	0	3	0	0	2	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
6/26/05	3	N	44	4	0	0	0	151	32	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	1	0	0	243	242	1
6/26/05	3	W	8	0	0	1	4	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	16	16	0
6/26/05	6	E	17	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	24	24	0
6/26/05	6	N	8	2	0	1	4	2	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	20	20	0
6/26/05	6	S	12	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	22	22	0
6/26/05	6	W	2	0	0	0	15	2	24	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	59	59	0
6/27/05	1	E	124	0	1	0	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	1	0	0	0	0	0	0	1	158	157	1
6/27/05	1	N	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	17	17	0
6/27/05	1	W	71	0	0	1	9	4	1	1	0	0	0	0	0	0	0	1	0	0	0	53	0	0	0	0	0	0	0	1	0	142	141	1
6/27/05	2	E	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97	0	0	0	0	0	0	0	0	0	109	109	0
6/27/05	2	N	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	7	7	0
6/27/05	2	W	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	62	62	0
6/27/05	3	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/27/05	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	2	0
6/27/05	3	W	22	68	0	0	1	106	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	202	201	1
6/27/05	6	E	3	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	11	11	0
6/27/05	6	N	2	1	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	14	14	0
6/27/05	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/27/05	6	W	6	1	0	0	4	0	8	0	0	0	0	0	0	0	0	0	0	0	1	4	1	0	0	0	0	0	0	0	0	25	25	0
6/28/05	1	E	84	0	0	1	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	120	119	1
6/28/05	1	N	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	19	0	0	0	0	0	0	0	0	0	21	21	0
6/28/05	1	W	99	1	0	2	0	40	2	0	0	0	0	0	0	0	1	6	0	0	0	31	0	5	0	0	0	0	0	0	0	187	187	0
6/28/05	2	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	97	0	0	0	0	0	0	0	0	0	98	98	0
6/28/05	2	N	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0	0	0	11	11	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/28/05	2	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	59	0	1	0	0	0	0	0	0	0	65	65	0
6/28/05	3	E	1	0	0	0	4	0	1	0	0	0	0	0	0	0	0	4	0	0	0	2	0	4	0	0	0	0	0	0	0	16	16	0
6/28/05	3	N	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	7	0
6/28/05	3	W	51	67	0	0	0	131	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	254	253	1
6/28/05	6	E	1	1	0	0	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	12	12	0
6/28/05	6	N	4	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
6/28/05	6	S	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/28/05	6	W	0	1	0	0	9	2	6	0	0	0	0	0	0	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	22	22	0
6/29/05	1	E	4	0	0	0	1	11	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	20	20	0
6/29/05	1	N	4	0	0	1	2	4	0	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	17	17	0
6/29/05	1	W	294	0	1	1	6	72	0	6	0	0	0	0	0	0	1	0	0	0	0	48	4	0	0	0	0	0	0	0	0	433	433	0
6/29/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0	0	0	0	0	0	53	53	0
6/29/05	2	N	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	0	0	0	0	0	0	11	11	0
6/29/05	2	W	0	1	1	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	1	0	0	0	1	0	0	0	59	58	1
6/29/05	3	E	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	12	0	3	0	0	0	0	0	0	0	20	20	0
6/29/05	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/29/05	3	W	4	8	0	0	0	16	102	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5	0	0	0	0	0	0	0	137	137	0
6/29/05	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
6/29/05	6	N	4	0	0	3	0	14	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	24	24	0
6/29/05	6	S	3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
6/29/05	6	W	3	8	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	19	19	0
6/30/05	1	E	1	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	6	5	1
6/30/05	1	N	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	5	5	0
6/30/05	1	W	102	3	0	2	2	19	0	0	0	0	0	0	0	0	0	1	0	0	0	51	0	1	0	0	0	0	0	0	0	181	181	0
6/30/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	64	0	0	0	0	0	0	0	1	0	65	64	1
6/30/05	2	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	4	4	0
6/30/05	2	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	63	0	1	0	0	0	1	1	0	0	67	65	2

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/30/05	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	6	0	0	0	0	0	0	0	0	0	8	8	0
6/30/05	3	N	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	4	4	0
6/30/05	3	W	17	85	0	0	0	63	5	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	174	174	0
6/30/05	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/30/05	6	N	2	3	0	1	6	9	1	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	27	27	0
6/30/05	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/30/05	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
7/1/05	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1
7/1/05	1	N	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3	2	1
7/1/05	1	W	16	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0	1	0	0	0	0	0	0	0	92	92	0
7/1/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0	0	0	0	0	0	38	38	0
7/1/05	2	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	7	0	2	0	0	0	0	0	0	0	10	10	0
7/1/05	2	W	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	48	0	0	0	0	0	0	0	0	0	52	52	0
7/1/05	3	E	9	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	18	18	0
7/1/05	3	N	6	4	0	0	4	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	18	0
7/1/05	3	W	61	129	0	0	0	142	12	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	347	346	1
7/1/05	6	E	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3	3	0
7/1/05	6	N	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	6	6	0
7/1/05	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
7/1/05	6	W	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	7	7	0
7/2/05	1	E	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	8	8	0
7/2/05	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	2	0
7/2/05	1	W	71	17	0	0	1	32	2	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	1	0	0	133	132	1
7/2/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	66	0	0	0	0	0	0	0	0	0	68	68	0
7/2/05	2	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/2/05	2	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	60	0	0	1	0	0	0	0	0	0	63	62	1
7/2/05	3	E	9	3	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	19	19	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
7/2/05	3	N	19	9	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	30	0
7/2/05	3	W	108	20	0	0	2	80	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	213	213	0
7/2/05	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
7/2/05	6	N	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
7/2/05	6	S	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/2/05	6	W	7	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	9	8	1
7/3/05	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	1	1	0	0	9	7	2
7/3/05	1	N	0	7	0	2	0	2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	16	15	1
7/3/05	1	W	10	13	0	4	0	7	2	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	45	45	0
7/3/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/3/05	2	N	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	5	5	0
7/3/05	2	W	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	27	0	0	0	0	0	0	0	0	0	28	28	0
7/3/05	3	E	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	8	8	0
7/3/05	3	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/3/05	3	W	34	20	0	0	1	41	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	99	99	0
7/3/05	6	E	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	15	15	0
7/3/05	6	N	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
7/3/05	6	S	6	0	0	0	0	0	6	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	15	15	0
7/3/05	6	W	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
7/4/05	1	E	6	1	0	1	0	2	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	15	14	1
7/4/05	1	N	3	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
7/4/05	1	W	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	11	11	0
7/4/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	40	0	0	2	0	0	0	0	0	0	44	42	2
7/4/05	2	N	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	8	8	0
7/4/05	2	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	39	0	0	0	0	0	1	1	0	0	45	43	2
5/26/06	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26/06	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
5/26/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26/06	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26/06	4	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
5/26/06	4	W	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
5/26/06	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/26/06	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	3	E	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
5/27/06	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	4	W	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
5/27/06	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	5	N	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0
5/27/06	5	S	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
5/27/06	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	6	N	14	0	0	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	19	0
5/27/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/27/06	6	W	44	0	0	9	32	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86	86	0
5/28/06	3	E	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0
5/28/06	3	N	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
5/28/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/28/06	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/28/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
5/28/06	4	W	3	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
5/28/06	5	E	29	0	0	4	23	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	60	60	0
5/28/06	5	N	27	0	0	11	50	0	3	2	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	2	0	0	0	102	100	2
5/28/06	5	S	2	0	1	11	32	0	1	5	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	54	54	0
5/28/06	5	W	0	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	8	8	0
5/28/06	6	E	1	0	0	2	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
5/28/06	6	N	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
5/28/06	6	S	7	0	0	0	23	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	32	0
5/28/06	6	W	36	0	0	5	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	47	0
5/29/06	3	E	1	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	6	0
5/29/06	3	N	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	5	5	0
5/29/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/29/06	4	E	1	0	0	1	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	18	18	0
5/29/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/29/06	4	W	3	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
5/29/06	5	E	3	0	2	4	7	0	0	3	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	29	29	0
5/29/06	5	N	72	0	0	14	13	0	10	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	115	115	0
5/29/06	5	S	2	0	1	19	8	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	35	0
5/29/06	5	W	13	0	0	5	4	0	1	6	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	37	37	0
5/29/06	6	E	2	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
5/29/06	6	N	5	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
5/29/06	6	S	2	0	0	0	1	0	1	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	10	10	0
5/29/06	6	W	10	0	0	10	49	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	75	75	0
5/30/06	3	E	4	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
5/30/06	3	N	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	4	0
5/30/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/30/06	4	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3	3	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
5/30/06	4	N	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
5/30/06	4	W	12	0	0	4	15	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	35	35	0
5/30/06	5	E	9	0	0	3	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	49	49	0
5/30/06	5	N	198	0	0	6	16	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	224	224	0
5/30/06	5	S	4	0	0	13	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	1	0	0	56	55	1
5/30/06	5	W	5	0	0	14	9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	32	32	0
5/30/06	6	E	0	0	0	1	9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	0
5/30/06	6	N	11	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	13	0
5/30/06	6	S	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	18	18	0
5/30/06	6	W	7	0	0	1	11	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	22	0
5/31/06	3	E	4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	8	8	0
5/31/06	3	N	0	0	0	1	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	14	14	0
5/31/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/31/06	4	E	4	0	0	3	7	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	18	18	0
5/31/06	4	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
5/31/06	4	W	1	0	0	1	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
5/31/06	5	E	4	0	0	7	9	0	0	2	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	33	33	0
5/31/06	5	N	17	0	0	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	38	38	0
5/31/06	5	S	1	0	0	7	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	1	0	0	0	57	56	1
5/31/06	5	W	0	0	0	5	12	0	0	1	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	32	32	0
5/31/06	6	E	3	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
5/31/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/31/06	6	S	1	0	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
5/31/06	6	W	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
6/1/06	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/1/06	3	N	1	0	0	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	12	12	0
6/1/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/1/06	4	E	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5	5	0
6/1/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/1/06	4	W	3	0	0	3	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	21	0
6/1/06	5	E	31	0	1	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	59	59	0
6/1/06	5	N	5	0	0	9	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	35	35	0
6/1/06	5	S	1	0	0	10	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	44	44	0
6/1/06	5	W	50	0	0	15	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	83	83	0
6/1/06	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/1/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/1/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/1/06	6	W	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/2/06	3	E	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/2/06	3	N	13	0	0	10	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	27	0
6/2/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/06	4	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/2/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/06	4	W	3	0	0	1	11	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	21	21	0
6/2/06	5	E	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	12	0
6/2/06	5	N	118	0	0	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	128	128	0
6/2/06	5	S	7	0	0	2	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	27	27	0
6/2/06	5	W	2	0	0	1	11	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	18	18	0
6/2/06	6	E	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/2/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/2/06	6	W	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/3/06	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
6/3/06	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/3/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/3/06	4	E	14	0	0	0	10	0	0	2	0	0	0	0	0	0	0	1	0	0	0	7	0	0	0	0	0	0	0	0	0	34	34	0
6/3/06	4	N	6	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	12	12	0
6/3/06	4	W	6	0	0	6	51	0	0	3	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	78	78	0
6/3/06	5	E	26	0	0	1	25	0	0	2	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	67	67	0
6/3/06	5	N	41	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	59	59	0
6/3/06	5	S	53	0	0	2	17	0	0	1	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	86	86	0
6/3/06	5	W	6	0	0	0	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	13	0
6/3/06	6	E	0	0	0	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	0
6/3/06	6	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/3/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/3/06	6	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/4/06	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/4/06	3	N	28	0	0	1	5	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	39	0
6/4/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/4/06	4	E	11	0	0	0	15	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	31	31	0
6/4/06	4	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/4/06	4	W	6	0	0	3	12	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	26	26	0
6/4/06	5	E	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	4	0
6/4/06	5	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	10	10	0
6/4/06	5	S	69	0	0	21	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	119	119	0
6/4/06	5	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0	0	0	0	0	0	7	7	0
6/4/06	6	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/4/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/4/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/4/06	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/5/06	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/5/06	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/5/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/5/06	4	E	5	0	0	2	8	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	16	0
6/5/06	4	N	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	3	0
6/5/06	4	W	4	0	0	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	19	19	0
6/5/06	5	E	6	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	10	10	0
6/5/06	5	N	24	0	0	4	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	8	0	0	0	0	0	0	0	0	0	41	41	0
6/5/06	5	S	12	0	0	2	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	32	32	0
6/5/06	5	W	6	0	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	17	17	0
6/5/06	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/5/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/5/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/5/06	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/6/06	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/6/06	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/6/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/6/06	4	E	2	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0
6/6/06	4	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/6/06	4	W	0	0	0	0	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	9	9	0
6/6/06	5	E	3	0	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	14	14	0
6/6/06	5	N	56	0	0	10	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	75	75	0
6/6/06	5	S	1	0	0	7	5	0	3	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	19	19	0
6/6/06	5	W	4	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	10	10	0
6/6/06	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/6/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/6/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/6/06	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/7/06	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/7/06	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/7/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/7/06	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/7/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/7/06	4	W	1	0	0	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	12	0
6/7/06	5	E	3	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	9	9	0
6/7/06	5	N	14	0	0	0	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	19	0
6/7/06	5	S	8	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	12	0
6/7/06	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
6/7/06	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/7/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/7/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/7/06	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	3	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	4	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/8/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	5	N	5	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	0
6/8/06	5	S	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
6/8/06	5	W	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/8/06	6	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/8/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/8/06	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/9/06	3	E	11	0	0	1	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0
6/9/06	3	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	4	4	0
6/9/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/9/06	4	E	1	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	41	41	0
6/9/06	4	N	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
6/9/06	4	W	4	0	0	4	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	49	49	0
6/9/06	5	E	54	0	0	13	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	77	77	0
6/9/06	5	N	0	0	0	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	29	29	0
6/9/06	5	S	0	0	0	9	13	0	0	1	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	29	29	0
6/9/06	5	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	5	5	0
6/9/06	6	E	12	0	0	16	3	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	35	0
6/9/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/9/06	6	S	4	0	0	0	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	0
6/9/06	6	W	4	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
6/10/06	3	E	0	0	0	10	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	22	0
6/10/06	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	2	0
6/10/06	3	W	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/10/06	4	E	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	26	26	0
6/10/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
6/10/06	4	W	0	0	0	8	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	2	0	0	0	0	0	0	65	63	2
6/10/06	5	E	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	10	10	0
6/10/06	5	N	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	18	18	0
6/10/06	5	S	0	0	0	4	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	16	0
6/10/06	5	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/10/06	6	E	0	0	0	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	34	0
6/10/06	6	N	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	4	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/10/06	6	S	0	0	0	8	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	11	0
6/10/06	6	W	0	0	0	4	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	53	53	0
6/11/06	3	E	9	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	16	15	1
6/11/06	3	N	13	1	0	2	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	32	32	0
6/11/06	3	W	3	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0
6/11/06	4	E	20	0	0	1	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	32	0
6/11/06	4	N	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	32	32	0
6/11/06	4	W	3	0	0	1	9	0	0	1	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	4	0	37	33	4
6/11/06	5	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/11/06	5	N	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/11/06	5	S	1	0	0	3	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	9	9	0
6/11/06	5	W	32	0	0	1	11	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	46	46	0
6/11/06	6	E	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/11/06	6	N	8	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	20	20	0
6/11/06	6	S	15	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	22	22	0
6/11/06	6	W	7	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	52	52	0
6/12/06	3	E	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/12/06	3	N	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	8	8	0
6/12/06	3	W	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	4	0
6/12/06	6	E	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	4	0
6/12/06	6	N	7	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	13	13	0
6/12/06	6	S	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/12/06	6	W	9	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	13	13	0
6/13/06	3	E	17	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	23	23	0
6/13/06	3	N	14	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	31	31	0
6/13/06	3	W	14	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	22	22	0
6/13/06	6	E	4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	8	8	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
6/13/06	6	N	0	0	0	4	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	25	25	0
6/13/06	6	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/13/06	6	W	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	32	0	0	0	0	0	0	0	0	0	37	37	0
7/15/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/15/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0
7/15/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/15/06	2	E	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0	0	0	0	0	111	111	0
7/15/06	2	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	40	0	0	0	0	0	0	0	0	0	42	42	0
7/15/06	2	W	52	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	46	0	0	0	0	0	0	0	0	0	101	101	0
7/16/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/16/06	1	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/16/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/16/06	2	E	2	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	0	0	0	0	0	0	0	0	0	61	61	0
7/16/06	2	N	9	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	0	0	53	53	0
7/16/06	2	W	37	4	0	10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	3	1	0	0	58	54	4
7/17/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/17/06	1	N	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
7/17/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/17/06	2	E	71	5	0	1	3	1	0	0	4	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	92	92	0
7/17/06	2	N	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	5	4	1
7/17/06	2	W	32	0	1	24	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	74	74	0
7/18/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	7	7	0
7/18/06	1	N	14	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	16	0
7/18/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/18/06	2	E	1	0	0	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	15	15	0
7/18/06	2	N	17	0	0	11	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	35	35	0
7/18/06	2	W	10	0	5	6	0	0	0	10	0	1	0	0	0	0	0	0	0	0	0	8	0	0	1	0	0	0	2	0	0	43	40	3

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
7/19/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/19/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/19/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/19/06	2	E	4	0	0	6	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	17	17	0
7/19/06	2	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	3	3	0
7/19/06	2	W	0	0	0	2	5	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	12	12	0
7/20/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/20/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/20/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/20/06	2	E	50	2	0	11	1	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	70	70	0
7/20/06	2	N	5	2	0	11	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	22	0
7/20/06	2	W	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	4	4	0
7/21/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/21/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/21/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/21/06	2	E	7	0	0	3	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	18	18	0
7/21/06	2	N	1	0	0	1	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	8	8	0
7/21/06	2	W	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	11	11	0
7/22/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/22/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/22/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/22/06	2	E	2	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	14	14	0
7/22/06	2	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/22/06	2	W	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	3	0
7/23/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	3	0
7/23/06	1	N	31	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	34	34	0
7/23/06	1	W	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
7/23/06	2	E	63	0	0	7	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	0	0	0	0	0	0	0	0	115	115	0
7/23/06	2	N	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	1	0	15	14	1
7/23/06	2	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	33	0	0	0	0	0	0	0	2	0	39	37	2
7/24/06	1	E	1	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	10	10	0
7/24/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	2
7/24/06	1	W	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	2	0	0	8	6	2
7/24/06	2	E	0	0	0	2	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	0	0	0	0	0	1	0	38	37	1
7/24/06	2	N	16	2	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	57	57	0
7/24/06	2	W	0	0	0	5	12	0	0	0	0	0	0	0	0	0	0	1	0	0	0	42	0	0	0	0	0	0	0	0	0	60	60	0
7/25/06	1	E	14	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	19	19	0
7/25/06	1	N	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	3	2	1
7/25/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1
7/25/06	2	E	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	0	0	1	0	0	0	1	3	0	36	31	5
7/25/06	2	N	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	8	8	0
7/25/06	2	W	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	18	18	0
7/26/06	1	E	4	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	14	12	2
7/26/06	1	N	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4	4	0
7/26/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1
7/26/06	2	E	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	1	0	0	0	0	0	0	29	28	1
7/26/06	2	N	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	1	0	11	10	1
7/26/06	2	W	31	3	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	1	0	59	58	1
7/27/06	1	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/27/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/27/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/27/06	2	E	19	5	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	12	0	0	0	0	0	0	0	0	0	41	41	0
7/27/06	2	N	11	0	0	3	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	17	17	0
7/27/06	2	W	51	1	0	4	3	0	0	0	0	0	0	0	0	0	0	1	0	0	1	7	0	1	0	0	0	0	0	0	0	69	69	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Labidesthes sicculus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Microlophus salmoides*	*Notropis maculatus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis macrochirus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**Exotic Fish Species Abundance**
7/28/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/28/06	1	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/28/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/28/06	2	E	8	0	0	5	9	0	1	8	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	36	36	0
7/28/06	2	N	2	1	0	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	8	8	0
7/28/06	2	W	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	1	0	0	8	7	1
7/29/06	1	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/29/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/29/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/30/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/30/06	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/30/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/31/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/31/06	1	N	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
7/31/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL			**5822**	**577**	**118**	**1021**	**1882**	**1125**	**405**	**255**	**4**	**5**	**1**	**1**	**4**	**4**	**4**	**94**	**1**	**3**	**7**	**4012**	**24**	**78**	**68**	**2**	**1**	**12**	**64**	**30**	**8**	**15632**	**15447**	**185**

APPENDIX 10. Data collected during the monthly drift-fence samples from August 2004 – September 2006.

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
7/30/04	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/30/04	1	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/30/04	1	W	4	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
7/30/04	2	E	23	2	1	4	17	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	48	0
7/30/04	2	N	10	0	0	6	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	23	23	0
7/30/04	2	W	18	12	0	9	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	80	0
7/30/04	3	E	0	1	0	27	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33	33	0
7/30/04	3	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/30/04	3	W	0	0	0	11	5	1	0	2	0	0	0	0	0	0	0	0	5	0	1	1	0	0	0	0	0	0	0	0	26	26	0
7/30/04	4	E	1	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	1	0	24	23	1
7/30/04	4	N	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
7/30/04	4	W	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	1	0	0	0	0	20	19	1
7/30/04	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/30/04	5	N	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
7/30/04	5	S	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/30/04	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4	4	0
7/30/04	6	E	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
7/30/04	6	N	1	0	0	43	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	46	0
7/30/04	6	S	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/30/04	6	W	8	1	0	30	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	0
8/31/04	1	E	6	0	0	1	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	24	0
8/31/04	1	N	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	4	0
8/31/04	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/31/04	2	E	2	0	0	1	2	0	0	2	0	0	0	0	0	0	0	0	15	0	0	0	0	0	1	0	0	0	1	0	24	22	2

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
8/31/04	2	N	3	0	0	0	2	0	2	1	0	0	0	0	0	0	0	0	7	0	1	0	0	0	0	0	0	0	1	0	17	16	1
8/31/04	2	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	3	1	2
8/31/04	3	E	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	6	0	0	0	0	0	0	0	0	0	0	0	9	9	0
8/31/04	3	N	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
8/31/04	3	W	3	2	0	0	5	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	14	13	1
8/31/04	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/31/04	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	5	5	0
8/31/04	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	6	0	0	0	0	0	0	0	1	0	18	17	1
8/31/04	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	55	0	1	0	0	0	0	0	0	0	5	0	72	67	5
8/31/04	5	N	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	2	0	0	0	0	0	16	14	2
8/31/04	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2	0
8/31/04	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	5	5	0
8/31/04	6	E	2	5	0	0	2	0	0	0	0	0	0	0	0	4	0	0	15	0	0	0	0	0	0	1	0	0	0	0	29	28	1
8/31/04	6	N	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	5	0
8/31/04	6	S	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	2	1
8/31/04	6	W	5	1	0	0	3	1	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	13	13	0
9/30/04	3	E	68	5	0	6	33	0	0	1	0	0	0	0	0	10	0	0	113	0	0	0	0	0	0	0	6	0	0	0	242	236	6
9/30/04	3	N	1	0	0	4	2	0	0	5	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	22	22	0
9/30/04	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0
9/30/04	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	4	0	7	1	6
9/30/04	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	3	0	0	2	0	10	5	5
9/30/04	5	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	34	34	0
9/30/04	5	N	1	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	6	0
9/30/04	5	S	0	0	0	0	2	0	0	0	0	0	0	0	0	7	0	0	37	0	0	0	0	0	0	1	0	0	0	0	47	46	1
9/30/04	5	W	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	1	1	0	0	0	13	11	2

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
9/30/04	6	E	27	2	0	19	39	0	0	3	0	0	0	0	0	19	0	0	72	0	0	0	0	0	0	0	1	0	0	0	182	181	1
9/30/04	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	6	S	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
9/30/04	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/04	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/04	1	N	20	1	0	6	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	30	0
10/29/04	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/04	2	E	2	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
10/29/04	2	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/04	2	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/04	3	E	25	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	31	0	0	0	0	0	0	0	2	0	0	0	65	63	2
10/29/04	3	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1
10/29/04	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1
10/29/04	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	3	3	0
10/29/04	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/04	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0
10/29/04	5	E	173	1	0	0	12	1	0	0	0	0	1	0	0	3	0	0	67	0	0	0	0	0	0	0	0	0	0	0	258	258	0
10/29/04	5	N	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	3	0
10/29/04	5	S	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	8	0	0	0	0	0	0	0	0	0	0	0	10	10	0
10/29/04	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	1	0	0	0	6	5	1
10/29/04	6	E	97	1	0	1	7	0	0	0	0	0	0	0	0	3	0	0	13	0	0	0	0	0	0	0	10	0	1	0	133	122	11
10/29/04	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/29/04	6	S	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
10/29/04	6	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
11/29/04	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	3	0	0	18	0	51	30	21
11/29/04	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	3	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
11/29/04	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	3	0	0	0	0	2	0	0	0	0	11	9	2
11/29/04	5	E	34	0	0	0	6	0	0	2	0	0	0	0	0	2	0	0	15	0	0	0	0	0	0	0	1	0	0	0	60	59	1
11/29/04	5	N	17	0	0	1	2	0	0	3	0	0	0	0	0	1	0	0	18	0	0	0	0	0	0	1	0	0	0	0	43	42	1
11/29/04	5	S	29	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	47	47	0
11/29/04	5	W	29	0	0	0	4	0	0	3	0	0	0	0	0	1	0	0	9	0	0	0	0	0	0	1	0	0	0	0	47	46	1
12/30/04	4	E	31	1	0	17	40	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	0	0	0	0	1	0	0	131	130	1
12/30/04	4	N	31	1	0	18	30	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	1	0	0	0	0	93	92	1
12/30/04	4	W	20	0	0	31	18	0	0	0	0	0	0	0	0	2	0	1	19	0	1	0	0	0	0	0	0	0	0	0	92	92	0
1/27/05	4	E	20	0	0	59	23	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	120	119	1
1/27/05	4	N	27	0	0	26	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	55	0
1/27/05	4	W	0	0	0	10	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	15	14	1
6/24/05	1	E	11	0	2	1	0	1	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	1	31	30	1
6/24/05	1	N	2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	9	8	1
6/24/05	1	W	51	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	55	55	0
6/24/05	2	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/24/05	2	N	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/24/05	2	W	1	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	8	0	50	42	8
6/24/05	3	E	4	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	8	7	1
6/24/05	3	N	4	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	0
6/24/05	3	W	25	3	0	0	12	19	3	0	0	0	0	0	0	0	0	0	13	2	0	0	0	0	0	0	2	0	0	0	79	77	2
6/24/05	4	E	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	33	0	5	0	0	0	0	0	0	0	0	0	39	39	0
6/24/05	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/24/05	4	W	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	11	11	0
6/24/05	5	E	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	2	0
6/24/05	5	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6/24/05	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
6/24/05	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82	0	0	0	0	0	0	0	0	0	0	0	82	82	0
6/24/05	6	E	0	0	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
6/24/05	6	N	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
6/24/05	6	S	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
6/24/05	6	W	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	85	0	0	0	0	0	0	0	0	0	0	0	88	88	0
7/28/05	3	E	1	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6	6	0
7/28/05	3	N	4	0	0	0	5	2	0	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	16	16	0
7/28/05	3	W	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
7/28/05	4	E	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	7	0	0	0	1	0	0	0	0	0	14	13	1
7/28/05	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/28/05	4	W	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	1	0	0	0	0	10	9	1
7/28/05	5	E	7	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	1	0	0	0	12	11	1
7/28/05	5	N	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	0
7/28/05	5	S	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	2	0
7/28/05	5	W	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
7/28/05	6	E	12	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	16	0
7/28/05	6	N	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
7/28/05	6	S	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	8	0
7/28/05	6	W	15	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	18	0
8/31/05	1	E	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	0	97	1	96
8/31/05	1	N	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	13	6	7
8/31/05	1	W	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	185	0	186	1	185
8/31/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	1	0	0	37	0	42	3	39
8/31/05	2	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/31/05	2	W	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0	0	1	0	0	66	0	71	4	67
8/31/05	3	E	14	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	38	0	55	17	38

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
8/31/05	3	N	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	33	13	20
8/31/05	3	W	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	12	11	1
8/31/05	4	E	72	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	74	73	1
8/31/05	4	N	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	28	8	20
8/31/05	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0	64	0	69	2	67
8/31/05	5	E	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	8	2	6
8/31/05	5	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	13	0	13
8/31/05	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	1	2	0	0	0	0	10	7	3
8/31/05	5	W	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	22	22	0
8/31/05	6	E	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0	11	5	6
8/31/05	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	0	7	1	6
8/31/05	6	S	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	12	0	14	2	12
8/31/05	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	15	0	15
9/29/05	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/29/05	1	N	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	2	0	12	10	2
9/29/05	1	W	17	0	0	1	22	0	1	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	1	15	0	65	49	16
9/29/05	2	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	2	0	6	4	2
9/29/05	2	N	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	6	0	1	0	0	0	0	0	0	1	14	0	27	12	15
9/29/05	2	W	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	12	0	48	35	13
9/29/05	3	E	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	51	0	0	0	0	0	0	1	0	0	1	0	67	65	2
9/29/05	3	N	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
9/29/05	3	W	49	0	0	0	1	0	4	0	0	0	0	0	0	0	0	0	6	0	1	0	0	0	0	0	0	0	1	0	62	61	1
9/29/05	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/29/05	4	N	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	3	0
9/29/05	4	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	4	2	2
9/29/05	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
9/29/05	5	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	2	1	1
9/29/05	5	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/29/05	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/29/05	6	E	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	23	23	0
9/29/05	6	N	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	3	0	26	21	5
9/29/05	6	S	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	3	1
9/29/05	6	W	41	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	43	42	1
11/30/05	4	E	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	28	0	0	0	0	0	0	4	0	0	1	0	35	30	5
11/30/05	4	N	2	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	8	6	2
11/30/05	4	W	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	2	0	0	1	0	7	4	3
12/30/05	4	E	0	0	0	0	1	0	0	4	0	0	0	0	0	0	0	0	72	0	0	0	0	0	0	3	3	0	6	0	89	77	12
12/30/05	4	N	2	3	0	0	0	0	1	6	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	2	0	30	28	2
12/30/05	4	W	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	0	1	0	0	0	0	16	15	1
1/27/06	4	E	70	0	0	4	4	0	0	5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	1	0	87	84	3
1/27/06	4	N	112	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	11	0	131	119	12
1/27/06	4	W	26	1	0	65	3	0	0	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0	0	0	1	0	3	0	105	101	4
2/28/06	4	E	77	4	0	7	2	0	1	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0	1	0	5	0	115	109	6
2/28/06	4	N	52	4	0	7	6	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	70	70	0
2/28/06	4	W	23	1	0	7	1	0	0	0	0	0	0	0	0	0	0	2	9	0	0	0	0	0	0	0	0	0	5	0	48	43	5
5/31/06	3	E	4	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	8	8	0
5/31/06	3	N	0	0	0	1	5	0	0	2	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	14	14	0
5/31/06	3	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/31/06	4	E	4	0	0	3	7	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	18	18	0
5/31/06	4	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
5/31/06	4	W	1	0	0	1	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
5/31/06	5	E	4	0	0	7	9	0	0	2	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	33	33	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
5/31/06	5	N	17	0	0	4	5	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	38	38	0
5/31/06	5	S	1	0	0	7	22	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	0	1	0	0	0	0	57	56	1
5/31/06	5	W	0	0	0	5	12	0	0	1	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	32	32	0
5/31/06	6	E	3	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
5/31/06	6	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/31/06	6	S	1	0	0	2	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	0
5/31/06	6	W	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
6/30/06	3	E	88	0	0	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	98	98	0
6/30/06	3	N	9	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	17	17	0
6/30/06	3	W	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	34	33	1
6/30/06	4	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	0	0	0	0	0	0	0	0	0	52	52	0
6/30/06	4	N	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	0	0	0	0	0	0	34	34	0
6/30/06	4	W	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	19	0	0	0	1	0	0	0	0	0	0	0	23	22	1
6/30/06	5	E	10	1	0	8	3	0	0	1	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	30	30	0
6/30/06	5	N	7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	17	17	0
6/30/06	5	S	0	0	0	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0
6/30/06	5	W	35	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	43	43	0
6/30/06	6	E	9	0	0	4	0	1	0	0	0	0	0	0	0	1	0	0	35	0	0	0	0	0	0	0	0	0	0	0	50	50	0
6/30/06	6	N	9	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	13	13	0
6/30/06	6	S	10	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	20	20	0
6/30/06	6	W	10	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	19	19	0
7/28/06	1	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/28/06	1	N	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/28/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/28/06	2	E	8	0	0	5	9	0	1	8	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	0	0	36	36	0
7/28/06	2	N	2	1	0	1	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	8	8	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
7/28/06	2	W	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	1	0	0	0	8	7	1
7/28/06	3	E	2	1	0	2	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	8	8	0
7/28/06	3	N	16	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	26	25	1
7/28/06	3	W	10	7	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	22	22	0
7/28/06	4	E	10	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	26	0	7	0	0	0	0	0	0	0	0	0	45	45	0
7/28/06	4	N	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5	0	0	0	0	0	0	0	0	0	17	17	0
7/28/06	4	W	10	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	10	0	10	0	0	0	0	0	0	0	0	0	32	32	0
7/28/06	5	E	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	16	0	1	0	0	0	0	0	0	0	0	0	21	21	0
7/28/06	5	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/28/06	5	S	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
7/28/06	5	W	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	5	5	0
7/28/06	6	E	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0
7/28/06	6	N	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
7/28/06	6	S	8	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	15	0
7/28/06	6	W	10	5	0	3	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	0
8/31/06	1	E	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
8/31/06	1	N	4	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	9	0	16	7	9
8/31/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/31/06	2	E	6	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	14	0	0	0	0	0	0	0	0	0	1	0	23	22	1
8/31/06	2	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	8	0	10	2	8
8/31/06	2	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	1	2	0	0	32	0	62	27	35
8/31/06	3	E	107	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	52	0	0	0	0	0	0	0	0	0	9	0	168	159	9
8/31/06	3	N	2	0	0	0	11	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	18	18	0
8/31/06	3	W	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	4	0
8/31/06	4	E	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	2	0	0	0	0	16	14	2
8/31/06	4	N	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0	1	0	0	2	0	40	37	3

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
8/31/06	4	W	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	2	0	0	0	0	0	0	0	0	0	22	22	0
8/31/06	5	E	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	35	0	0	0	0	0	0	0	0	0	0	0	36	36	0
8/31/06	5	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
8/31/06	5	S	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
8/31/06	5	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	14	14	0
8/31/06	6	E	42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42	42	0
8/31/06	6	N	11	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	2	0	20	18	2
8/31/06	6	S	5	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	1	0	0	0	9	8	1
8/31/06	6	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	3	0
9/29/06	1	E	2	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	9	0
9/29/06	1	N	34	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	36	35	1
9/29/06	1	W	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/29/06	2	E	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	4	2	2
9/29/06	2	N	4	0	0	4	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	12	11	1
9/29/06	2	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	10	1	9
9/29/06	3	E	167	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	170	170	0
9/29/06	3	N	6	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	10	10	0
9/29/06	3	W	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
9/29/06	4	E	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	2	0	0	0	0	24	22	2
9/29/06	4	N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/29/06	4	W	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	7	0	1	0	0	0	0	2	0	0	0	0	12	10	2
9/29/06	5	E	71	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	75	75	0
9/29/06	5	N	3	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	7	7	0
9/29/06	5	S	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
9/29/06	5	W	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
9/29/06	6	E	176	3	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	183	183	0

Date	Array	Trap	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Aphredoderus sayanus*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Elassoma evergladei*	*Enneacanthus gloriosus*	*Lucania parva*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*	**Total Abundance Fish Only**	**Native Fish Species Abundance**	**NI Fish Species Abundance**
9/29/06	6	N	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0
9/29/06	6	S	13	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	16	15	1
9/29/06	6	W	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	5	4	1
TOTAL			**2681**	**91**	**4**	**581**	**587**	**38**	**24**	**91**	**1**	**1**	**4**	**4**	**2**	**84**	**2**	**10**	**1872**	**3**	**77**	**1**	**1**	**1**	**14**	**55**	**52**	**4**	**786**	**1**	**7072**	**6158**	**914**

APPENDIX 11. Data collected during the throw-trap comparison with Array 4 in January 2006.

Date	Method	Sample #	Direction	Depth	Periphyton (ml)	Cladium stems	Eleocharis stems	Bacopa stems	Taxodium stems	Gambusia holbrooki	*Poecilia latipinna*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Procambarus alleni*	*Lepomis gulosus*	*Lepomis punctatus*	*Lepomis marginatus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Hemichromis letourneuxi*
1/13/2006	Throw Trap	1	West	24	5860	36	11	6	.	1	0	0	0	0	0	0	5	0	0	1	0	0	1
1/13/2006	Throw Trap	2	West	34	6450	5	16	7	.	1	0	0	0	0	1	1	4	0	0	0	0	0	0
1/13/2006	Throw Trap	3	West	27	5200	9	6	10	.	2	0	0	0	0	0	0	4	0	1	0	0	0	0
1/13/2006	Throw Trap	4	West	19	2900	7	72	7	1	0	1	1	0	0	0	3	3	1	0	0	0	0	0
1/13/2006	Throw Trap	5	West	24	3300	27	24	24	.	4	0	0	0	2	1	0	5	0	0	0	0	0	0
1/13/2006	Throw Trap	6	North	26	3950	62	7	16	.	0	0	0	0	0	0	1	2	0	0	0	0	0	0
1/13/2006	Throw Trap	7	North	24	3800	6	41	66	.	3	0	0	0	0	0	1	7	0	0	0	0	0	0
1/13/2006	Throw Trap	8	North	28	3350	22	19	1	.	1	0	0	0	0	0	0	7	0	0	2	0	0	1
1/13/2006	Throw Trap	9	North	20	3600	17	22	.	.	2	0	0	0	0	0	0	2	0	0	0	0	0	0
1/13/2006	Throw Trap	10	North	19	4650	.	4	29	.	0	0	2	0	0	0	1	7	0	0	0	0	0	0
1/13/2006	Throw Trap	11	East	22	2300	6	49	.	.	0	0	0	0	0	1	2	0	0	0	0	0	0	0
1/13/2006	Throw Trap	12	East	22	3820	9	22	17	.	1	0	1	1	0	1	2	8	0	0	1	0	0	0
1/13/2006	Throw Trap	13	East	24	2850	89	36	.	.	0	0	0	0	0	0	0	4	0	0	0	0	0	0
1/13/2006	Throw Trap	14	East	26	4050	27	29	.	.	0	0	0	0	0	0	0	2	0	0	0	0	1	0
1/13/2006	Throw Trap	15	East	26	5200	22	122		.	0	0	0	0	0	0	1	0	0	0	1	0	0	0
1/12/2006	Array	.	West	24	.	.	.	.	.	3	0	22	3	0	0	1	5	0	0	12	2	0	5
1/12/2006	Array	.	East	24	.	.	.	.	.	3	0	6	1	0	0	0	0	0	0	41	3	0	2
1/12/2006	Array	.	North	24	.	.	.	.	.	18	8	14	6	0	0	2	1	0	0	15	0	2	3

APPENDIX 12. Data collected during the diel drift-fence array samples in October 2005.

Date	Array	Trap	Time	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Procambarus alleni*	*Aphredoderus sayanus*	*Lepomis gulosus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*
7/6/2005	1	E	12:00	6	5	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
7/6/2005	1	N	12:00	3	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/6/2005	1	W	12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	2	1	0	0	0	0	0	0
7/6/2005	1	W	18:00	17	6	0	12	5	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/6/2005	2	E	0:00	2	3	0	3	0	0	2	1	0	0	0	0	0	4	0	0	0	4	0	0	0	0	0	1
7/6/2005	2	E	12:00	10	3	0	0	4	0	0	0	0	0	0	0	0	0	0	21	4	20	0	2	0	0	0	6
7/6/2005	2	N	12:00	17	6	0	0	3	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/6/2005	2	N	18:00	40	32	4	7	15	3	4	8	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
7/6/2005	2	W	12:00	9	4	1	0	6	2	3	0	0	0	0	0	0	0	0	9	0	6	0	0	0	0	1	0
7/6/2005	2	W	18:00	23	13	2	2	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/6/2005	3	N	18:00	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/6/2005	3	W	12:00	1	0	0	1	0	2	21	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
7/7/2005	1	N	6:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
7/7/2005	1	W	6:00	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/7/2005	3	W	6:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
10/3/2005	1	E	12:00	43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
10/3/2005	1	E	18:00	20	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3
10/3/2005	1	N	12:00	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/3/2005	1	N	18:00	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/3/2005	1	W	12:00	397	1	0	0	4	0	1	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	1
10/3/2005	1	W	18:00	504	7	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
10/3/2005	2	E	12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	2
10/3/2005	2	E	18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	0	0	0	0	5

Date	Array	Trap	Time	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Procambarus alleni*	*Aphredoderus sayanus*	*Lepomis gulosus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*
10/3/2005	2	N	18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
10/3/2005	2	W	12:00	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	8	0	0	0	0	1	0	0	8
10/3/2005	2	W	18:00	106	3	0	0	0	0	0	0	0	0	1	0	0	0	0	6	0	0	0	0	0	0	0	8
10/3/2005	3	E	12:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0	0	0	0
10/3/2005	3	E	18:00	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/3/2005	3	N	12:00	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
10/3/2005	3	N	18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1
10/3/2005	3	W	12:00	5	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/3/2005	3	W	18:00	2	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/4/2005	1	E	0:00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/4/2005	1	E	6:00	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
10/4/2005	1	N	0:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
10/4/2005	1	N	6:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10/4/2005	1	W	0:00	40	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	4
10/4/2005	1	W	6:00	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
10/4/2005	2	E	6:00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
10/4/2005	2	N	0:00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/4/2005	2	N	6:00	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
10/4/2005	2	W	6:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
10/17/2005	1	E	12:00	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/17/2005	1	E	18:00	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
10/17/2005	1	N	12:00	28	0	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/17/2005	1	N	18:00	3	1	0	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10/17/2005	1	W	12:00	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1
10/17/2005	1	W	18:00	156	0	0	0	1	0	0	3	0	0	0	0	0	0	0	6	0	0	0	0	0	0	2	3
10/17/2005	2	E	12:00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0

Date	Array	Trap	Time	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Heterandria formosa*	*Lucania goodei*	*Fundulus chrysotus*	*Ameiurus natalis*	*Lepisosteus platyrhincus*	*Esox americanus*	*Procambarus alleni*	*Aphredoderus sayanus*	*Lepomis gulosus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*
10/17/2005	2	E	18:00	90	2	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
10/17/2005	2	N	12:00	31	0	0	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/17/2005	2	N	18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	14
10/17/2005	2	W	12:00	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	2
10/17/2005	2	W	18:00	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
10/17/2005	3	E	12:00	301	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
10/17/2005	3	E	18:00	207	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10/17/2005	3	N	12:00	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	1	0	0	4
10/17/2005	3	W	12:00	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/17/2005	3	W	18:00	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2005	1	E	0:00	3	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
10/18/2005	1	E	6:00	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2005	1	N	6:00	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10/18/2005	1	W	0:00	23	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	2
10/18/2005	1	W	6:00	67	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2005	2	N	0:00	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2005	2	W	0:00	0	0	0	0	0	0	0	0	4	0	0	1	0	0	0	0	0	0	2	0	1	10	0	4
10/18/2005	3	E	0:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
10/18/2005	3	E	6:00	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10/18/2005	3	N	0:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
10/18/2005	3	N	6:00	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 13. Solution-hole data collected during the dry season of 2004-05.

Date	SH Complex	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
9/30/04	3HL	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	3HL	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	3HL	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	2MB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	2MB	M	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0
9/30/04	BLUE BAG	M	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	BLUE BAG	D	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	MR8	D1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	MR8	D2	1	5	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	MR7	D	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	MR7	M	3	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
9/30/04	3SB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	3MB	M1	0	1	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	3MB	M2	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
9/30/04	MR9	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	MR9	M	7	2	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0
9/30/04	4MA	M1	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0
9/30/04	4MA	M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0
9/30/04	4MB	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	4MB	D2	6	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	8	0
9/30/04	1WR	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	1WR	D	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
9/30/04	3WR	D1	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0
9/30/04	3WR	D2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
9/30/04	4WR	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Date	SH Complex	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
9/30/04	4WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	2WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	1HL	M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	1HL	M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	2HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	3HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	2WR	M	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
9/30/04	MR10	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	MR10	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	5SB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	5SB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	5SA	S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	5SA	S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	MR11	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9/30/04	MR11	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	1HL	M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	1HL	M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	2HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	3HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	3HL	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	3HL	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	2MB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	2MB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	BLUE BAG	M	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0
11/30/04	BLUE BAG	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	MR8	D1	1	5	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	1	1
11/30/04	MR8	D2	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date		SH Complex	*Depth Category*	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
11/30/04	MR7		D	0	8	0	0	6	0	0	0	0	3	0	3	0	0	0	0	0	0	0	0	1	0
11/30/04	MR7		M	1	15	0	0	8	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
11/30/04	3SB		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	3MB		M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	3MB		M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	MR9		D1	15	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	MR9		D2	1	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	4MA		M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	4MA		M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	4MB		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	4MB		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
11/30/04	1WR		D	0	1	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0
11/30/04	1WR		S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	3WR		D1	0	0	0	0	0	0	2	0	1	0	0	2	0	0	0	0	0	0	0	0	1	0
11/30/04	3WR		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	4WR		M	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
11/30/04	4WR		D	0	0	0	0	0	0	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
11/30/04	2WR		D	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	2WR		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	2WR		S	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	MR10		M	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	MR10		D	4	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
11/30/04	5SB		D	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
11/30/04	5SB		M	9	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0
11/30/04	5SA		S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11/30/04	5SA		S2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
11/30/04	MR11		D	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Date	SH Complex	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
11/30/04	MR11	M	2	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12/30/04	1HL	M1	2	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0
12/30/04	1HL	M2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
12/30/04	2HL	S	2	0	0	1	0	0	0	0	2	0	1	0	0	0	0	0	0	2	1	0	0	0
12/30/04	3HL	S	12	6	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0
12/30/04	3HL	D2	0	0	0	0	0	0	0	0	1	0	1	4	0	0	0	0	0	4	0	0	2	0
12/30/04	3HL	M	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	3	0	0	0	0
12/30/04	3HL	D1	5	0	0	0	0	0	1	0	0	0	0	0	0	5	0	0	0	1	0	0	0	1
12/30/04	2MB	D	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	8	0
12/30/04	2MB	M	3	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	4	0
12/30/04	BLUE BAG	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	BLUE BAG	D	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12/30/04	MR8	D1	0	16	0	0	0	0	0	0	4	0	0	0	0	5	4	0	0	0	3	0	1	0
12/30/04	MR8	D2	0	8	0	0	0	0	1	0	0	0	0	0	0	2	0	0	3	0	0	0	0	1
12/30/04	MR7	D	1	18	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0
12/30/04	MR7	M	0	14	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	3	0	0	0
12/30/04	3SB	M	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	3MB	M1	4	20	0	2	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
12/30/04	3MB	M2	13	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	MR9	D1	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	MR9	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	4MA	M1	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0
12/30/04	4MA	M2	4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
12/30/04	4MB	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	4MB	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0
12/30/04	1WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	1WR	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	SH Complex	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
12/30/04	3WR	D1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12/30/04	3WR	D2	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12/30/04	4WR	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	4WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
12/30/04	2WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
12/30/04	2WR	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	2WR	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	MR10	M	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12/30/04	MR10	D	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	5SB	D	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	5SB	M	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12/30/04	5SA	S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	5SA	S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12/30/04	MR11	D	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12/30/04	MR11	M	0	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	0	0	1	0	0	0
1/27/05	1HL	M1	8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	1HL	M2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
1/27/05	2HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	3HL	S	6	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	3HL	D2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	3HL	M	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0
1/27/05	3HL	D1	0	0	0	0	0	0	0	0	1	0	1	2	0	0	0	1	0	0	0	0	0	0
1/27/05	2MB	D	4	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	21	0
1/27/05	2MB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	BLUE BAG	M	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
1/27/05	BLUE BAG	D	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	MR8	D1	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0

Date		SH Complex	*Depth Category*	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
1/27/05	MR8		D2	0	17	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0
1/27/05	MR7		D	0	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	MR7		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	3SB		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	3MB		M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	3MB		M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	MR9		D1	5	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	MR9		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	4MA		M1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
1/27/05	4MA		M2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	4MB		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	4MB		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
1/27/05	1WR		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	1WR		S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	3WR		D1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
1/27/05	3WR		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1/27/05	4WR		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	4WR		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	2WR		D	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1	0
1/27/05	2WR		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	2WR		S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	MR10		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	MR10		D	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	5SB		D	8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	5SB		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	5SA		S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1/27/05	5SA		S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	SH Complex	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
1/27/05	MR11	D	0	0	0	0	0	0	2	0	2	0	0	1	0	1	0	0	0	0	0	0	0	0
1/27/05	MR11	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	1HL	M1	1	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0
2/25/05	1HL	M2	6	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	5	0	2	5	0
2/25/05	2HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	3HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	3HL	D2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0
2/25/05	3HL	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0
2/25/05	3HL	D1	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	2MB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
2/25/05	2MB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	BLUE BAG	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	BLUE BAG	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
2/25/05	MR8	D1	0	13	0	0	0	0	0	0	0	0	0	0	0	1	0	0	4	0	0	0	0	0
2/25/05	MR8	D2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	MR7	D	0	25	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0
2/25/05	MR7	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	3SB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	3MB	M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	3MB	M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	MR9	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	MR9	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	4MA	M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	4MA	M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	4MB	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	4MB	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	1WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	SH Complex	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
2/25/05	1WR	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	3WR	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	3WR	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	4WR	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	4WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	2WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	2WR	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	2WR	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	MR10	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	MR10	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	5SB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	5SB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	5SA	S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	5SA	S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/25/05	MR11	D	0	4	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	4	0	1	0
2/25/05	MR11	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	1HL	M1	0	0	0	0	0	0	0	0	3	0	0	1	0	2	0	0	0	0	0	0	0	0
3/31/05	1HL	M2	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	0	3	0	0	2	0
3/31/05	2HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	3HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	3HL	D2	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
3/31/05	3HL	M	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
3/31/05	3HL	D1	0	0	0	0	0	0	2	0	1	0	0	1	0	0	0	0	0	0	0	0	2	0
3/31/05	2MB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	2MB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	BLUE BAG	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	BLUE BAG	D	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Date		SH Complex	*Depth Category*	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
3/31/05	MR8		D1	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0
3/31/05	MR8		D2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	MR7		D	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
3/31/05	MR7		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	3SB		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	3MB		M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	3MB		M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	MR9		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	MR9		D2	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	4MA		M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	4MA		M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	4MB		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	4MB		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	1WR		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	1WR		S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	3WR		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
3/31/05	3WR		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	4WR		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	4WR		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	2WR		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	2WR		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	2WR		S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	MR10		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	MR10		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	5SB		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	5SB		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	5SA		S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	SH Complex	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
3/31/05	5SA	S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3/31/05	MR11	D	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
3/31/05	MR11	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	1HL	M1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	1HL	M2	0	3	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	1	0	0	3	0
4/28/05	2HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	3HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	3HL	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	3	0
4/28/05	3HL	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	3HL	D1	0	0	0	0	0	0	0	0	2	0	0	1	0	0	1	3	0	2	0	0	0	0
4/28/05	2MB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
4/28/05	2MB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	BLUE BAG	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	BLUE BAG	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
4/28/05	MR8	D1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
4/28/05	MR8	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	MR7	D	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
4/28/05	MR7	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	3SB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	3MB	M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	MR9	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	MR9	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	4MA	M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	4MA	M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	4MB	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	4MB	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	1WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date	SH Complex	Depth Category	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
4/28/05	1WR	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	3WR	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	3WR	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	4WR	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	4WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	2WR	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	2WR	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	2WR	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	MR10	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	MR10	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	5SB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	5SB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	5SA	S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	5SA	S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	MR11	D	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4/28/05	MR11	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	1HL	M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	1HL	M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	2HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3HL	S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3HL	D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3HL	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3HL	D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	2MB	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	2MB	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	BLUE BAG	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	BLUE BAG	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date		SH Complex	*Depth Category*	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
5/25/05	MR8		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR8		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR7		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR7		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3SB		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3MB		M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3MB		M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR9		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR9		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	4MA		M1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	4MA		M2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	4MB		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	4MB		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	1WR		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	1WR		S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3WR		D1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	3WR		D2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	4WR		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	4WR		D	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	2WR		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	2WR		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	2WR		S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR10		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR10		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	5SB		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	5SB		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	5SA		S1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Date		SH Complex	*Depth Category*	*Gambusia holbrooki*	*Poecilia latipinna*	*Cyprinodon variegatus*	*Fundulus confluentus*	*Jordanella floridae*	*Fundulus chrysotus*	*Ameiurus natalis*	*Noturus gyrinus*	*Lepomis gulosus*	*Lepomis microlophus*	*Lepomis punctatus*	*Lepomis marginatus*	*Enneacanthus gloriosus*	*Cichlasoma bimaculatum*	*Clarias batrachus*	*Tilapia mariae*	*Oreochromis aureus*	*Cichlasoma urophthalmus*	*Belonesox belizanus*	*Cichlasoma managuense*	*Hemichromis letourneuxi*	*Hoplosterum littorale*
5/25/05	5SA		S2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR11		D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5/25/05	MR11		M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX 14. Fish species collected in minnow traps (08-09 February 2005; 24-h soak time) in solution holes prior to predator inclusion/exclusion experiment.

Region	Hole	*Ameiurus natalis*	*Belonesox belizanus*	*Cichlasoma bimaculatum*	*Gambusia holbrooki*	*Hemichromis letourneuxi*	*Jordanella floridae*	*Lepomis gulosus*	*Lepomis marginatus*	*Lepomis punctatus*	*Poecilia latipinna*	Total fish in trap
BR	01	0	0	2	0	5	0	0	0	0	0	7
	02	0	0	0	0	0	0	0	3	0	0	3
	03	0	0	0	0	5	0	1	0	0	1	7
	04	0	0	1	0	23	0	2	1	0	0	27
	05	0	0	0	0	4	0	0	0	0	0	4
MR	06	0	0	0	0	0	0	0	0	0	0	0
	07	0	0	0	4	0	1	0	1	0	0	6
	08	0	0	0	0	0	0	0	0	0	0	0
	09	0	0	0	3	2	0	0	1	0	0	6
	10	0	1	0	0	0	0	0	0	0	25	26
WR	11	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0
	13	1	1	1	0	0	0	2	1	2	1	9
	14	0	0	0	0	0	0	0	0	0	0	0
	15	0	0	0	2	0	0	0	0	0	0	2
Species total:		1	2	4	9	39	1	5	7	2	27	97

APPENDIX 15. Fish species observed in solution holes prior to predator inclusion/exclusion experiment. Presence/absence data include species collected in minnow traps (08-09 February 2005; 24-h soak time) and those observed during site visits on 8 and 9 February 2005. "X" indicates species presence.

Region	Hole	*Ameiurus natalis*	*Belonesox belizanus*	*Cichlasoma bimaculatum*	*Cichlasoma urophthalmus*	*Clarias batrachus*	*Gambusia holbrooki*	*Hemichromis letourneuxi*	*Jordanella floridae*	*Lepomis gulosus*	*Lepomis marginatus*	*Lepomis punctatus*	*Oreochromis aureus*	*Poecilia latipinna*	*Tilapia mariae*
	01			X				X							
	02										X				
BR	03	X	X	X	X	X		X		X			X	X	X
	04			X				X		X	X				
	05							X							
	06														
	07						X		X		X				
MR	08														
	09						X	X			X				
	10		X											X	
	11														
	12	X													
WR	13	X	X	X						X	X	X		X	
	14														
	15	X					X								

APPENDIX 16. Data sheet used in recording behavioral information for the pilot and second experiments.

Pilot Nesting Study				**Date:**							**Weather:**							**Observers:**
				Male behavior observed on nest												Behavior off nest		
				Is Male	Time on	**Total**	Chase target:				**Total**	Display target:						
Tank	TRT	Time	Fish	Nesting?	nest	**Chases**	FeD	MaD	FeJ	MaJ	**Displays**	FeD	MaD	FeJ	MaJ	Refuge	Active	*Other comments*
34	3		D															
			J															
30	3		D															
			J															
28	3		D															
			J															
32	2		D1															
			D2															
1	2		D1															
			D2															
3	2		D1															
			D2															
5	1		D															
7	1		D															
9	1		D															