Fish Communities and Habitat of Upper Phillippi Creek and Associated Storm Water Canals of Sarasota, Florida

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Introduction

Urban waterways are naturally occurring water bodies which are modified to accommodate the needs of urbanization. The reengineering of waterways has been in practice for as long as humans have lived in urban settings. The principal modifications to these systems include straightening and often hardening of shorelines to rapidly move large volumes of water for the prevention of localized flooding. These same modifications may also serve to provide water for human consumption or industrial purposes. Because these alterations represent a departure from the natural state of the waterway habitat loss and ecosystem function are often a consequence (Walsh et al., 2005). Additionally, the cost to maintain modifications to a waterway can be high. Establishing a balance between the primary role of storm water management and ecosystem function can therefore provide benefits to the environment by preserving or enhancing habitat value and to management by lowering maintenance costs associated with urban waterways.

Phillippi Creek is a tidal creek system that lies within the Sarasota Bay Watershed and drains an area of approximately 145 km^2. The lower estuarine portion of the creek south of Bahia Vista Street and west of Beneva Road is relatively unaltered and includes Red Bug Slough Preserve, a side branch of the main creek. Upstream from this intersection modifications have been made to the creek system for storm water management purposes which include straightened and channelized canals to allow for more efficient drainage of storm water, two sediment traps to reduce downstream sedimentation, and retention ponds known as the celery fields located east of Interstate 75. These modifications reflect the primary management goals of flood control for the upstream portion of the watershed drainage basin. Some areas of the upper creek canal system are less modified (e.g. non-straightened) and there are restored wetland areas south of the Celery Fields, adjacent to the S16 weir known as South Cell and the Walker Tract.

While flood control will continue to be the main priority for the management of the upper creek, interest in documenting fish communities and associated habitat in the upstream portions is needed to guide habitat restoration and enhancement projects. The purpose of this study was to describe the fish communities and the distribution abundance and habitat use patterns of select species in upper Phillippi creek and make recommendations to guide habitat restoration and enhancement efforts.

Methods:

Field Data Collection

Preliminary meetings with members of Mote Marine Lab, Sarasota County, and Sarasota Bay Estuary Program were held to discuss the project objectives and logistics. Strata for sampling fish communities within the majority of canals in upper Phillippi Creek were chosen. In addition to the main and side canals several sites that represented natural or restored areas were selected which included Red Bug Slough Preserve, a side branch of the lower portion of Phillippi Creek, and the restored habitats of South Cell & Walker Tract located near the S16 weir south of the celery fields.

In total, 14 separate strata representing 3 different general habitat types within the creek system were chosen as follows: 8 canals strata, 4 secondary stage canal strata, and 2 retention pond strata. All strata were in upper Phillippi Creek with the exception of Red Bug Slough. Five replicate sites were sampled in each stratum. Site locations were selected randomly at 50 meter minimum separation distance with ArcGIS V. 10.4. Dry season samples were collected between March and May, 2016 (Fig. 1A). Wet season samples were collected between September and November, 2016 (Fig. 1B).

Fishes and select invertebrates (grass shrimp, *Palaemonetes* sp. and crayfish, *Procambarus* sp.) were sampled with a 9.1 x 1.5m center bag seine net with 6mm mesh. At each sample site net length and distance from shore were measured to standardize the abundance of taxa collected as density (number square meter). After pursing the seine net, taxa were removed from the center bag and placed in a 20 liter plastic tub with water to keep them in good condition prior to counting and identifying all individuals. The first 25 individuals of each taxon were measured for total and standard lengths. All animals were returned to the water with the exception of voucher samples brought to the lab for positive species identification. A YSI multi-parameter sonde was used to measure temperature, salinity, dissolved oxygen, and turbidity at the surface and bottom of each site or at surface only if depth was <1m. Shore line vegetation and submerged vegetation were noted when conditions allowed.

Data Analysis

All field data were entered into a Microsoft Access database. Data were grouped by season (wet or dry) and by habitat type (canal, secondary stage canal, retention pond). Statistical analyses were performed in MATLAB version R2009b using functions in the FATHOM toolbox (Jones, 2011). Standardized abundance of taxa were fourth root transformed to down weigh the influence of the most abundant taxa (Clarke and Warwick 2001). A Bray-Curtis dissimilarity matrix (BCDM) was created from these data and used as input for multiple analysis of variance tests (MANOVA). Permutational MANOVA with Holms post-hoc test for pairwise comparisons were used to test whether the composition of fish communities was significantly different between seasons and habitat types. All MANOVA analyses were performed with1000 permutations. Comparisons of fish communities were made for dry vs. wet season (all sites combined) and between seasons and habitat type (i.e. dry canal vs. wet canal vs. retention ponds, etc.). Canonical discriminant analyses (CDA) were used to construct an ordination plot for visualizing the differences in community structure tested for with MANOVA. Kruskal-Wallis tests were used to compare interspecific densities of common snook (*C. undecimalis*), largemouth bass (*M. salmoides*) and Tilapia spp. (*Oreochromis*) between seasons and habitat types. Length-frequency plots were made for snook, largemouth bass, and tilapia to understand patterns in reproduction and recruitment within different habitats. The Shannon diversity index, species richness, species evenness, and the theoretical maximum of diversity were calculated for each habitat and season.

Results:

A total of 36,136 fishes and select invertebrates representing 37 taxa were collected during this study. Invertebrates accounted for included a Palaemonetes shrimp and a Procambarus crayfish. The most abundant species collected overall were the eastern mosquitofish (*G. holbrooki*), tilapia (*Oreochromis* spp.), grass shrimp (*Palaemonetes spp.)*, and sailfin molly (*Poecilia latipinna)* which accounted for 46.5%, 13.3%, 11.5%, and 9.2% of the total abundance, respectively. The eastern mosquitofish was the most abundant species during both seasons and among all habitats and with only one exception in strata was an order of magnitude greater in abundance than tilapia which was the next most abundant taxa. Other semi-abundant species included the blue killifish (*Lucania goodie*), least killifish (*Heterandria formosa*), and Seminole killifish (*Fundulus seminolis*). Approximately 35% more fishes were collected during the dry season; this difference was almost entirely due to the increased abundance of eastern mosquitofish and to a lesser extent tilapia. Abundance of taxa collected during each season and in each habitat type are listed in Tables 1A – 1I. Water at all sample sites was fresh (<0 ppt salinity) and dissolved oxygen ranged from approximately 1.5 mg/L to 12.5 mg/L. Taxa in these environments are well adapted to the conditions found.

Community Analyses

The MANOVA results demonstrated fish communities differed significantly between seasons and among all habitat types except for the dry vs. wet season comparison of the retention pond strata ($t = 1.21$, $p = 0.19$). MANOVA test results are summarized in Table 2. The CDA depicted 100% of among group variation of community taxa between seasons using 2 of 6 axes (Fig. 2A). Taxa with the greatest influence on differences in community composition between seasons included the least killifish, tilapia spp., Mayan cichlid (*Cichlasoma urophthalmus*), common snook (C*entropomus undecimalis*), African jewelfish (*Hemichromis bimaculatus*), and hogchoker (*Trinectes maculatus*) (Fig. 2B). Taxa with the greatest influence affecting differences between habitat types and seasons included the African jewelfish, least killifish, Menidia spp., bluegill (*Leopomis macrochirus*) and common snook. These are illustrated by the vector plots associated with canonical discriminant analyses (Figs. 3A and 3B).

Diversity Indices

Biodiversity indices were calculated for each season with sites combined and for each habitat type during each season. The diversity index including the theoretical maximum of diversity and species evenness (latter two shown in parentheses) for combined sites by season were 1.72 (3.61, 0.48) for the dry season and 2.09 (3.56, 0.59) for the wet season. Diversity indices calculated for each habitat type from dry season data were 1.28 (3.47, 0.37) for canal strata, 1.35 (2.83, 0.48) for retention pond strata, and 1.79 (3.37, 0.53) for secondary stage canal habitat. Diversity indices calculated for each habitat type from wet season data were 1.83 (3.47, 0.53) for canal strata, 2.01 (2.83, 0.71) for retention pond strata, and 2.32 (3.26, 0.71) for secondary stage habitat. Summary of biodiversity indices are listed in Table 3.

Common Snook

A total of 146 snook were collected during both seasons at 15 sites in 7 strata: 56 (38.4%) were collected in 3 different canal habitat strata and 90 (61.6%) were collected in secondary stage habitat, of which 72 (80% or half the overall total) were collected in sediments traps A and B. During the wet season, a total of 126 snook were collected: 72 (57.1%) in 4 different secondary stage habitat strata and 54 (42.9%) in 3 different canal habitat strata. During the dry season a total of 20 snook were caught in 2 different strata; 18 (90%) in a secondary stage habitat and 2 (10%) in canal habitat. While total abundance between seasons was very different, densities of common snook were not significantly different between seasons or between season by habitat comparisons (Figs. 4A and 4B). Length-frequency data reflect the summer reproductive and recruitment period of this species (Figure 5). Detailed summary of the abundance and distribution of snook by sizes are presented in Table 4.

Young of the year snook (n = 102 , mean = 70mm TL , SD = 16mm) were collected in four strata including Sediment Trap A, Red Bug Slough, Main Channel A – McIntosh, and Main Channel C. Sediment Trap A and Red Bug Slough were classified as secondary stage habitat and hosted 50% and 7% of age 0 snook, respectively. Main Channel A- McIntosh and Main Channel C were both classified as canal habitat and hosted 21% and 22% of age 0 snook, respectively. Age 1 snook (n = 42, mean = 253mm TL, SD = 48) were collected in 5 different strata, 4 secondary stage canal, two of which were in common with age 0 snook, Sediment Trap A (2%) and Red Bug Slough (12%) and also in Sediment Trap B (45%) and the Walker Tract (13%) and in Main C – Celery Fields (28%), a canal habitat strata.

Largemouth Bass

A total of 211 largemouth bass were collected at 30 sites in 8 strata: 43 (20.4%) in 4 different canal habitat strata, 146 (69.2%) in 3 different secondary stage habitat strata and 22 (10.4%) in 1 retention pond. During the dry season, 199 largemouth bass were collected at 24 sites in 7 different strata: 36 (18.1 %) were collected in 3 canal habitat, 141 (70.9 %) were collected in 3 secondary stage canal habitat, and 22 (11.1 %) were collected in one retention pond site. During the wet season 12 largemouth bass were collected at 6 sites in 4 strata: 7 (58.3%) in 2 different canal habitat strata and 5 (41.7%) in 2 different secondary stage canal strata. Densities of largemouth bass were significantly different between seasons (H = 5.98, P = 0.02) but were not different in comparison of season by habitat type (Figs. 6A and 6B). The Length-frequency plot illustrates the reproductive timing of this species during the spring dry season in Phillippi Creek (Figure 7). Detailed summary data of the abundance and distribution of snook are listed in Table 5.

Collections of young of the year largemouth bass (n = 177, mean = 44mm TL, SD = 14mm) during the dry season revealed 6 spawning/recruitment strata. Three of these were secondary stage canal habitat strata and included Red Bug Slough (38%), Walker Tract (22%) and Sediment Trap B (6%) ; two were canal strata, Main A – McIntosh (16%) and Main B (6%); and one was a retention pond stratum, Celery Fields – South (12%). Largemouth bass greater than 100mm (n = 34, mean = 257mm TL, SD = 43mm) were collected in 6 different strata including 2 secondary stage, sediment trap B (47%) and Walker Tract (3%); and 4 canal strata including, Branch BB (3%), Main A – McIntosh (9%), Main B (15%), and Main C (24%).

Tilapia spp.

A total of 4,870 Tilapia were collected during this study in 12 different strata: 674 (13.8%) were collected in 6 different canal strata, 483 (9.9%) were collected in 4 different secondary stage strata and 3,713 (76.2%) were collected in 2 retention ponds. During the wet season 1,146 tilapia were collected at 25 sites in 10 strata: 541 (47.2%) were collected in 5 canal habitat strata, 36 (3.1%) were collected in 3 different secondary stage strata and 569 (49.7%) were collected in the 2 retention pond habitats. During the dry season, 3,723 tilapia were collected at 25 sites in 9 strata: 133 (3.6%) were collected in 4 different canal strata, 447 (12.8%) were collected in 3 different secondary stage strata and 3,144 (84.4%) were collected in the retention pond strata. Densities of tilapia were not significantly different between seasons or season by habitat comparisons (Figs. 8A and 8B). Length-frequency reflects the reproductive patterns of this species in the Phillippi Creek system occurs during both wet and dry seasons (Figs. 9A and 9B). Detailed summary of the abundance and distribution of tilapia are presented in Table 6.

Young of the year tilapia (<50mm TL) were collected in both the wet and dry seasons. During the wet season 1,096 tilapia were collected in 8 strata; 4 canal, Branch AA and BB (<1%), Main C – Celery Fields (36%) and Main C (11%); 2 secondary stage, Sediment Traps A & B (1%); and 2 retention ponds, Celery Fields North (51%) and Celery Fields South (<1%). During the dry season 3,625 tilapia were collected in 8 strata; 4 canal, Main B (<1%), Main C – Celery Fields (2%), Main A (<1%), Main B (1%); 2 secondary stage canals, Red Bug Slough (4%), and Walker Tract (1%); 2 retention ponds, Celery Fields North (20%), Celery Fields South (71%). In a single net haul 2,650 tilapia were collected during the dry season in the Celery Fields South, retention pond strata. The median total length of fish in this particular sample was 19mm (mean = 26mm).

Discussion

This study documented fish communities in three general habitat types in the Phillippi Creek system. These habitat types were based on general morphology as 1.) canals which were more or less straightened shorelines maintained for efficient conveyance of storm water; 2.) secondary stage canals with more complex shoreline (e.g. ‘bent’) and which included restored wetland areas, a natural preserve, and the sediment traps; and 3.) retention ponds, known as the Celery Fields. With the exception of the Red Bug Slough preserve all sample sites were located in the upper portion of Phillippi Creek, north of Bahia Vista Street and east of Beneva Road. This portion of Phillippi Creek is managed primarily for storm water control.

The data collected in this study represent the first documentation of fish communities in upper Phillippi Creek. This information will therefore be useful as baseline for future comparison of fish abundance and community structure particularly in the context of planning and evaluating habitat restoration and enhancement projects. A prior survey of fish communities was conducted in Phillippi Creek during 2013-2014 as part of an EPA funded nutrient criteria study in southwest Florida tidal creeks but only the lower estuarine portion of the creek was sampled (Wessel et al., 2016).

The most numerically abundant species collected overall in this study was the eastern mosquito fish (*G. holbroo*ki) which accounted for 46.5% of total number of organisms collected. The second most abundant taxa was the tilapia (*Oreochromis* spp.), though it could not be determined if these exotics were blue or Nile tilapia which have hybridized throughout Florida (Eddie Mathieson FWC, per comm). The third most abundant taxa was a *Palaemonetes* species of grass shrimp, which as a detritivore serves as a trophic link between producer and consumer and is an important ecosystem component. The sailfin molly (*P. latipinna*) also a native species with a similar ecological role as the eastern mosquitofish, was the third most highly abundant fish species. All of these taxa represent an important forage base for higher trophic level predators common in the study area including a variety of wading birds and fishes such as largemouth bass common snook and other piscivores. (Stevens et al., 2006; Adams et al., 2009; Rock, 2009) The order of most abundant species varied somewhat by season and habitat but was always represented by similar forage base taxa common to stenohaline / freshwater salt marsh and tidal creek habitats of southwestern Florida.

Estimates of biodiversity and species evenness were higher in all habitat types during the wet season. This pattern is generally expected due to higher levels of seasonal productivity associated with warmer temperatures, longer periods of sunlight, increased nutrient input associated with rainfall and runoff and reproductive timing and recruitment. Secondary stage canal habitat had the highest levels of biodiversity and species evenness during the wet and dry seasons followed by the retention ponds and then canals, the latter two being closer in score. This result is also expected because secondary stage canals have more complex morphology and higher habitat value which typically support higher biodiversity and more stable ecosystems (Kiefer et al., 2015).

Wessel et al. (2016) also estimated biodiversity with the Shannon-Weiner index for 16 tidal creeks in southwest Florida. The biodiversity estimate reported for the lower estuarine portion of Phillippi Creek was expressed as a median index value of approximately 1.9 for wet and dry seasons combined and excluded exotic species. Though we did not sample in this same part of the creek, the habitat is most similar to the secondary stage canal habitat we sampled which had a mean diversity index of 2.1. Our biodiversity index included exotics which could explain the similar but slightly higher value in our study. Among 16 creeks surveyed in the Wessel et al. study, Phillippi Creek had the highest median biodiversity value.

Community level differences between sites and seasons reflect differences in the reproductive timing and recruitment of taxa and heterogeneity of habitat among strata. For example, 86% of snook were collected during the wet season and 57% of these in secondary canal habitat which influenced the differences between community composition in seasons and habitat. The increased abundance of snook seasonally and in secondary stage canals reflects the summer time spawning and recruitment to settlement habitats within Phillippi Creek. Other species whose reproductive timing and recruitment influenced community level differences between season and habitat included tilapia, Mayan cichlids, African jewelfish, hog chockers, least killifish, and bluegill. Community level differences between seasons were not significant in the retention pond habitat. This may be due to the homogeneous physical habitat which is more resilient to seasonal influence and by the abundant tilapia which reproduce during both wet and dry seasons.

Four snook recruitment strata/sites were identified based on collection of young of the year fish. These included Sediment Trap A, Red Bug Slough, Main Channel A – McIntosh, and Main Channel C. Sediment Trap A and Red Bug Slough were classified as secondary stage habitat and hosted 50% and 7% of age 0 snook, respectively. Main Channel A- McIntosh and Main Channel C were both classified as canal habitat and hosted 21% and 22% of age 0 snook, respectively. The greatest number of young of the year snook was collected in the sediment traps and sediment trap A had densities of newly recruited snook up to 8.9 m^2. This result was predicted at the onset of the study because the engineered sediment traps closely mimic the terminal pond settlement habitat found in natural tidal creek systems (Adams et al., 2009 ; Locascio et al., 2014) These shallow, low energy backwater environments can provide refuge from larger predators and a quality forage base for early juvenile fishes. Red Bug Slough Preserve is a side branch of the lower estuarine portion of Phillippi Creek and also has suitable habitat qualities to support snook recruitment and juvenile development. Main Channel A – McIntosh and Main Channel C strata were both classified as canal habitat which in the context of our classification scheme would not generally be expected to support snook recruitment. However when using Google Earth to examine details of the sites where post-settlement snook were collected in these strata some degree of meander characteristic of secondary stage canals was evident. In meandering streams shoreline morphology (e.g. 'bends') contribute to varying hydrodynamics and sedimentation processes (erosion/deposition) which result in more complex habitat which in turn increase diversity (Allan and Castillo, 2007). Kiefer et al., 2015, applied this concept to a variety of Florida streams and were able to quantify a specific range of bend dimensions associated with watershed size including bend pool depths, spacing and curvature. This model could be useful for helping to explain a finer scale resolution of the distribution of snook recruitment and other fishes in the Phillippi Creek system across a gradient of habitat as opposed to the more coarse classification scheme we used.

Ages 1 snook were collected in five different strata, two of which were in common with age 0 snook (i.e. sediment trap A and Red Bug Slough). Other strata included Sediment Trap B and the South Cell/Walker Tract both of which are classified as secondary stage canals. The fifth, Main C – Celery Fields is a canal without typical recruitment habitat at the sites where age 1 snook was collected. At approximately this age, snook begin to leave recruitment habitat and extend their range; collection of snook at this site was probably associated with this ontogenetic behavioral shift.

Collections of young of the year largemouth bass revealed 6 spawning/recruitment strata. Three of which were in secondary stage habitat and included Red Bug Slough (38%), South Cell/ Walker Tract (22%) and Sediment Trap B (6%) ; two were in canal strata, Main A – McIntosh

(16%) and Main B (6%); and one was in a retention pond stratum, Celery Fields – South (12%). Largemouth bass greater than 100mm were collected within 6 different strata including 2 secondary stage, sediment trap B (47%) and South Cell/Walker Tract (3%); and 4 canal strata including, Branch BB (3%), Main A – McIntosh (9%), Main B (15%), and Main C (24%). Four of the 6 strata were used in common by juvenile and adult largemouth bass.

Despite the relatively course habitat typing used in this study, it was clear that secondary stage canal habitat which included preserves, sediment traps and restored wetlands were most important for snook and largemouth bass and maintained the highest levels of diversity. Of the 7 strata used by snook and 8 by largemouth bass, 6 were used in common demonstrating a high degree of niche overlap. However, because most snook were juveniles collected during the wet season and most bass were juveniles collected during the dry season the timing of recruitment at these locations was out of phase. While interspecific competition between similarly aged juveniles was minimized by the temporal offset in recruitment the risk of predation on bass by snook and snook on bass would consequently be increased. The primary location for young of the year tilapia did not overlap greatly with snook and bass habitat. Young of the year tilapia were collected in many more strata than snook and largemouth bass however the vast majority (70%) were collected in the Celery Field retention ponds. No snook were collected in the retention ponds and only 22 (10%) juvenile largemouth bass were collected there during the dry season.

Upper Phillippi Creek is a highly modified yet productive tidal creek system that supports an abundance of prey fishes, functions as nursery habitat for snook and fulfills the complete life history requirements of many higher tropic level freshwater species. Differences in diversity, abundance and habitat use patterns of fishes collected in this study were somewhat predictable based on our knowledge of important habitat features and of stream geomorphology associated with creating and maintaining quality fish habitat. Successful prediction of habitat use patterns of important fishes in Phillippi Creek should translate into successful habitat restoration and enhancement at the species and ecosystem levels.

Because the Phillippi Creek system has been modified for flood control much of the natural meandering shoreline has been replaced by straight canals to allow for more efficient water flow. Maintenance requirements associated with managing the system for flood control and aesthetics (e.g. mowed shorelines) are costly. Some of these costs however may be mitigated by restoring areas of the creek to more natural conditions. Ideal locations for this would have relatively high maintenance costs, would not critically compromise flood control performance, and would be conducive to quality habitat restoration/enhancement. Finally, the concept of habitat connectivity should be considered in the design, implementation and monitoring of restoration and enhancement projects in Phillippi Creek. Habitat connectivity is important to maintaining biodiversity and in fulfilling life history requirements of resident species and species, like snook, which rely on different habitats during different life history stages.

Recommendations:

1. The sediment traps in Phillippi Creek are engineered to limit downstream sedimentation but also function well as snook recruitment habitat because they mimic the low energy recruitment environments found in natural systems. To increase recruitment/spawning habitat for snook and largemouth bass in Phillippi Creek similar features could be constructed. These features could be designed with different characteristics to test hypotheses about nursery habitat quality and density dependence as related to growth,

condition, mortality and ultimately recruitment into the adult population. The latter point is an important distinction because while high densities of snook were found in sediment trap A and Main A-McIntosh (up to 8.9 and 6.3 snook /m ^{2}, respectively) perhaps the most important measure of a nursery habitat is the quantity of fish it sources to the adult population (e.g. habitat connectivity). Tagging studies have been designed for this purpose and could be applied to restoration in monitoring in Philippi Creek (Barbour and Adams, 2012).

Habitat design and locations should be discussed with county administration and engineers to identify suitable locations and a monitoring program to evaluate the effectiveness of habitat restoration. The Bobby Jones Golf Course administration has expressed interested in habitat enhancement projects and may be one, of many, areas that should be considered for creating recruitment habitat. High nutrients and low dissolved oxygen levels are often characteristic of ponds located on or near golf courses and this should be considered.

2. In this study, some sample sites located in "canal" strata functioned more like secondary stage canal habitat due to shoreline bend (i.e. Main – A McIntosh and Main C). This grouping was due to the generalized resolution of our habitat classification scheme. The results however demonstrate the scale and gradient of habitat quality/heterogeneity associated with stream geomorphology that exists in parts of Phillippi Creek. Kiefer et al., 2015 provided quantitative details about the associations of stream geomorphology and fish habitat for Florida streams. A future study could apply the fish data collected in this study to the model developed by Kiefer et al. to evaluate the efficacy of the model to multi-scale habitat restoration/enhancement projects in Phillippi Creek. This would allow

us to perform scaled restoration projects at strategic sites within Phillippi Creek and further develop and test hypotheses about the creation, sustainability and connectivity of fish habitat associated with meandering shoreline and hydraulic input. This is a good fit given the expertise and local knowledge in engineering, fluvial dynamics, and ecology we have available.

3. The Celery Fields retention ponds, located far upstream in Phillippi Creek, produce an abundance of tilapia. Blewett et al., 2017 documented the importance of tilapia as prey during high flow periods in the Peace River when sportfish exploit the concentrated abundance of tilapia and other prey items washing off floodplains. Increased prey availability during a short period ("pulsed prey") resulted in increased condition of fish and had the effect of exporting resources to downstream estuarine/marine environments. Could the Celery Fields function in this way as a resource for sport fish? The first consideration is that fishes in the Celery Fields are somewhat isolated by weirs which allow limited flow into an adjacent restored wetland area (habitat connectivity). It does not appear that many tilapia are making their way downstream from the Celery Fields based on differences in their abundance between strata. If weir operation could be managed to allow pulsed prey events to occur, the floodplain scenario may be simulated assuming predators have access and ability to respond to the opportunity and assuming tilapia leave the celery fields under these conditions. Mark and recapture and dietary projects could be designed to test the efficacy of this. Opening weirs to pulse prey downstream may also affect the hydrology and habitat dynamics downstream the effects of which must also be considered.

Acknowledgements

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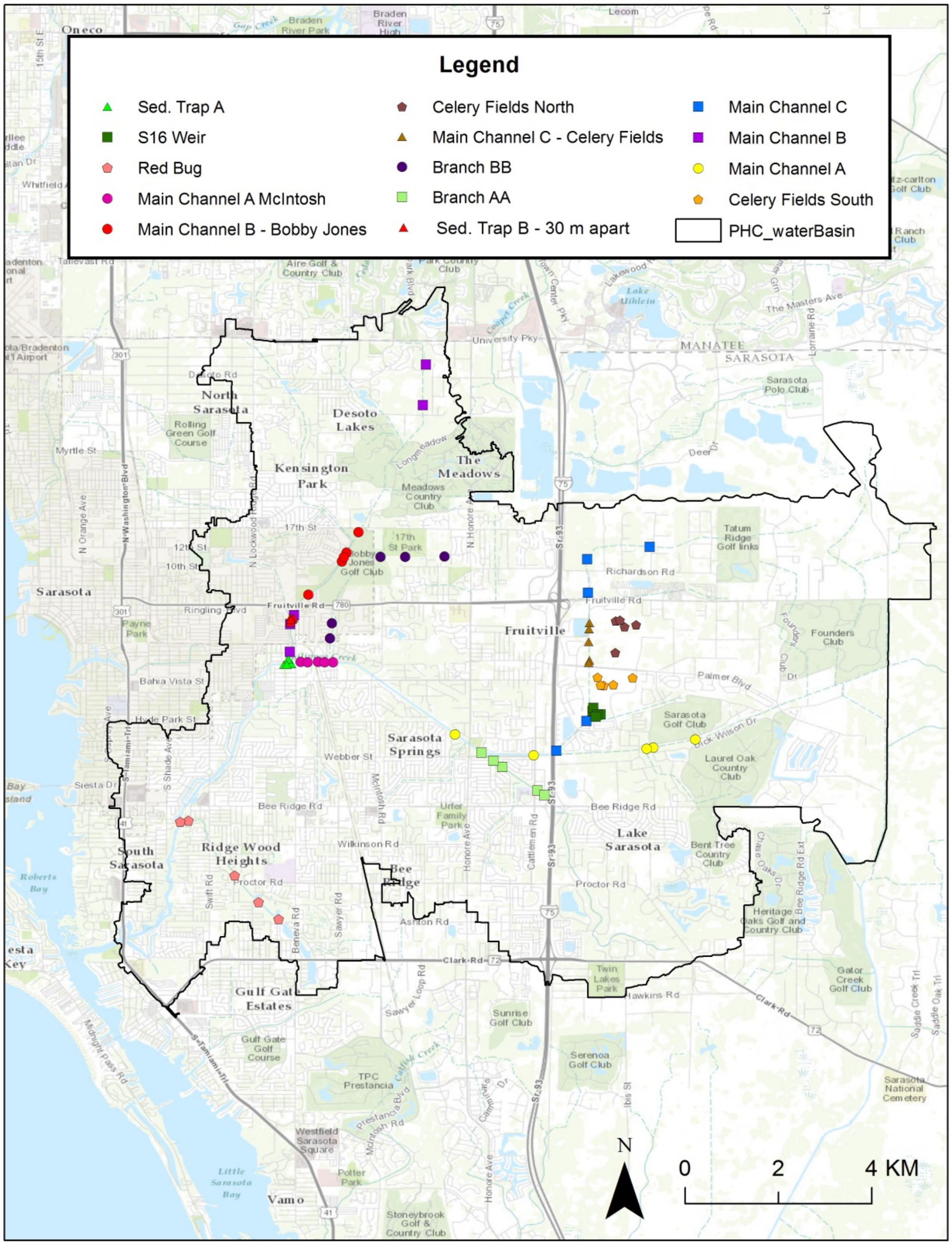

Figure 1A. Locations of randomly selected sample sites for dry season field work conducted March – May, 2016.

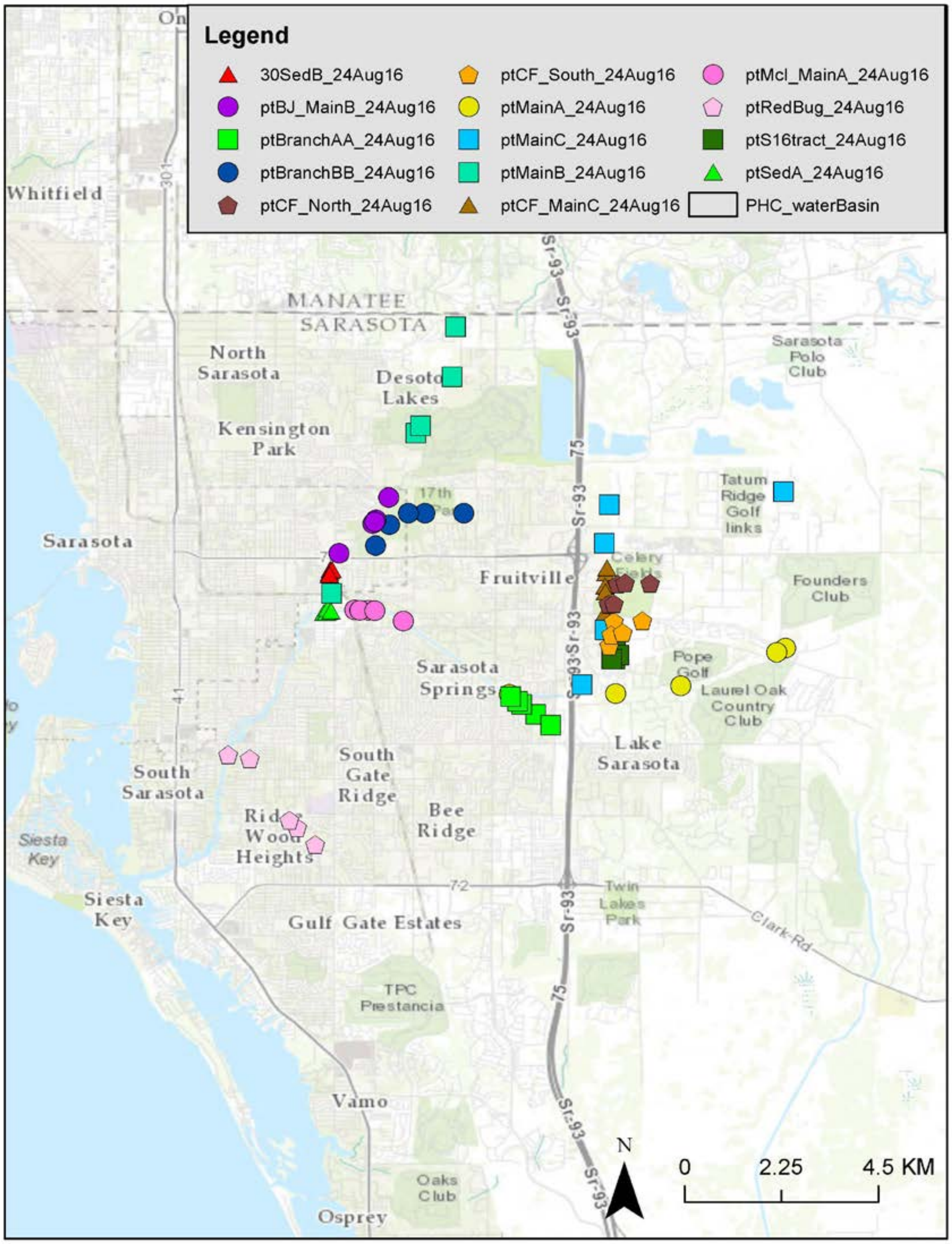

Figure 1B. Locations of randomly selected sample sites for wet season field work conducted during September – November, 2016.

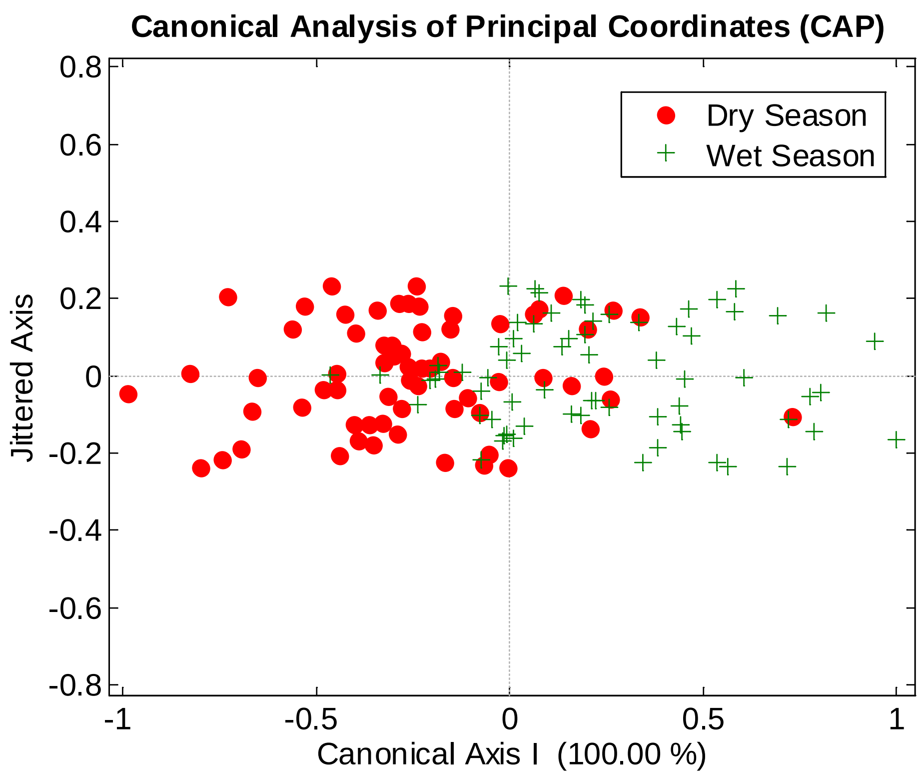

Figure 2A. Canonical analysis of principal components illustrating community level differences between the wet and dry seasons, sites combined. Communities were significantly different between seasons ($t = 5.52$, $p = 0.001$).

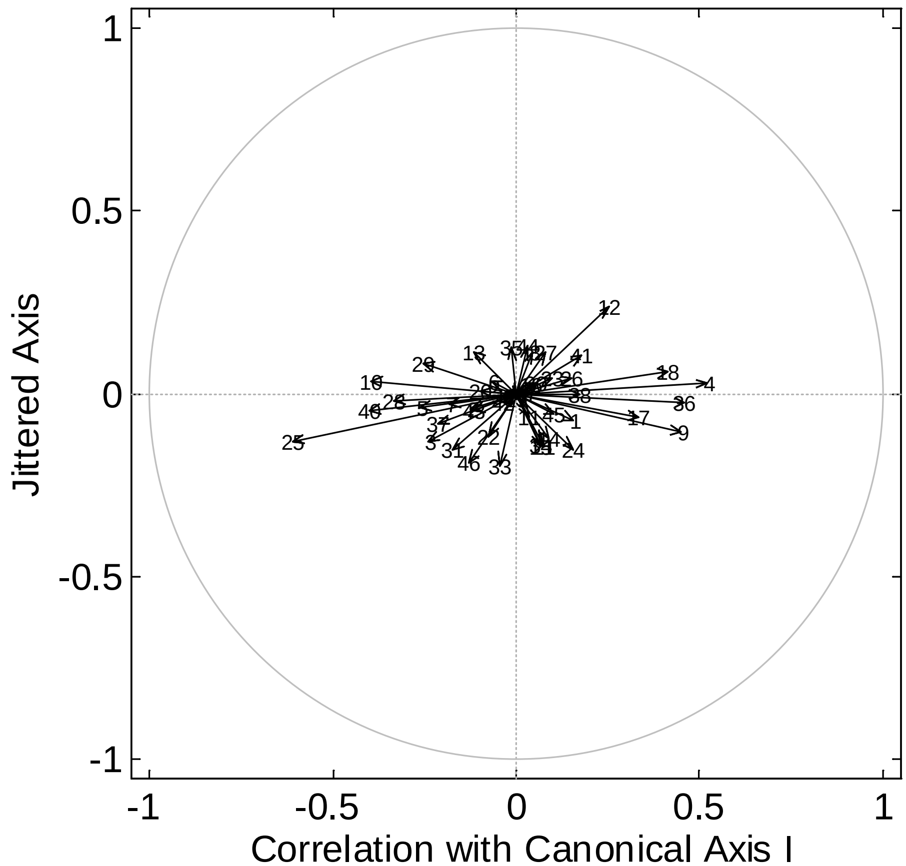

Figure 2B. Vector plot showing the influence of individual taxa on the community level differences illustrated in the CAP plot (Fig. 2A). Taxa are numerically coded. Taxa with the most influence on differences in community structure have longer arrows.

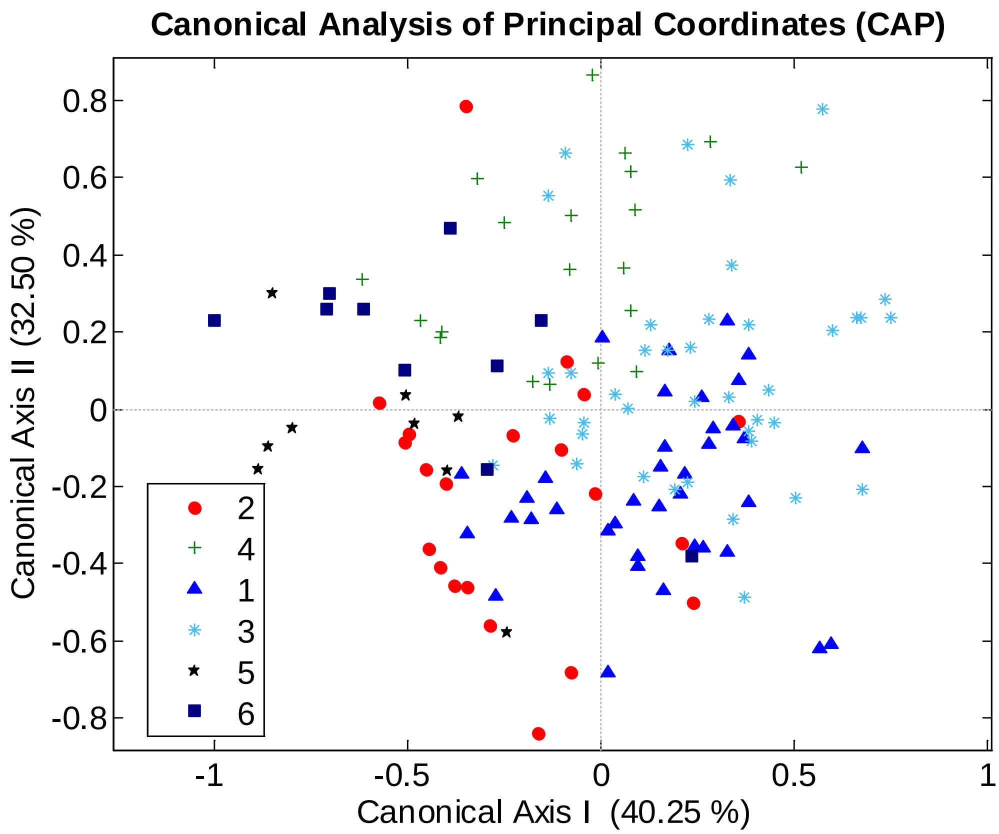

Figure 3A. Canonical analysis of principal components illustrating community level differences between habitats and seasons. Factors are coded as: 1. dry season, canal; 2. dry season, secondary stage canal; 3. wet season, canal; 4. wet season, secondary stage canal; 5. dry season, retention pond; 6. wet season, retention pond. Differences between sites and season were significant with the exception of the seasonal comparison for the Celery Fields retention pond strata.

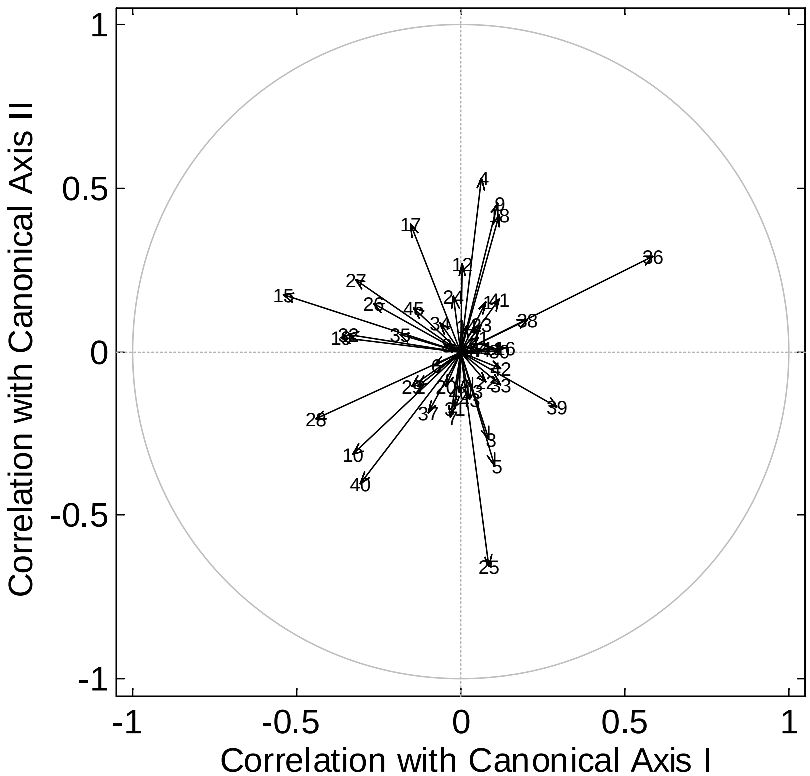

Figure 3B. Vector plot showing the influence of individual taxa on the community level differences illustrated in the CAP plot (Fig. 3A). Taxa are numerically coded. Taxa with the most influence on differences between community structure have the longest arrows.

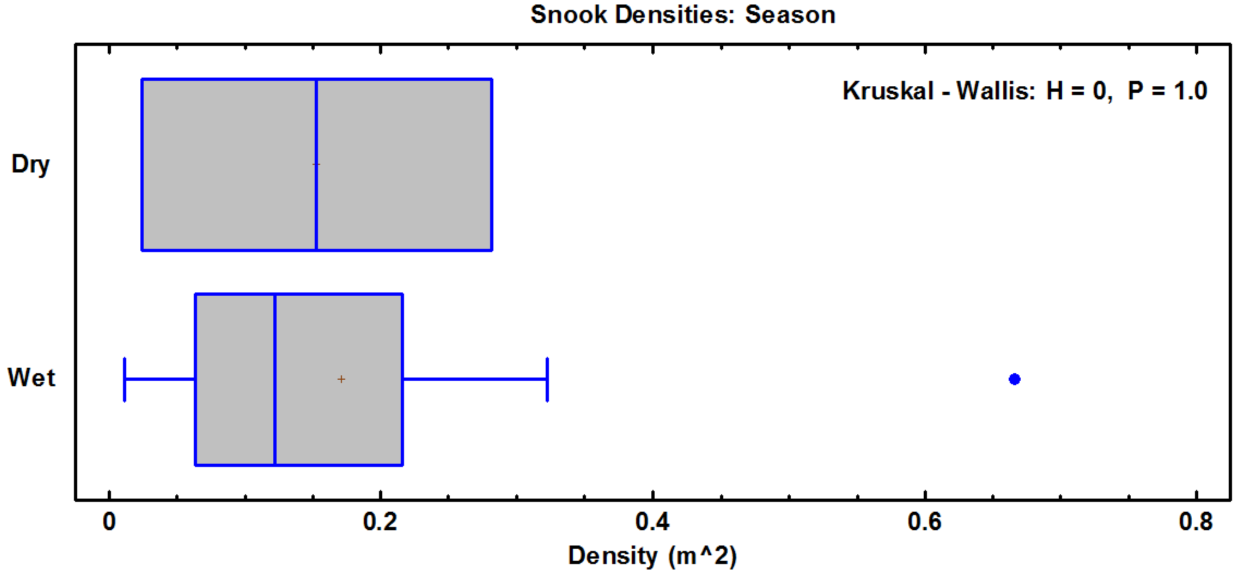

Figure 4A. Kruskal – Wallis comparison of snook densities between seasons, sites combined. Absolute numbers of snook varied considerably between seasons but densities did not.

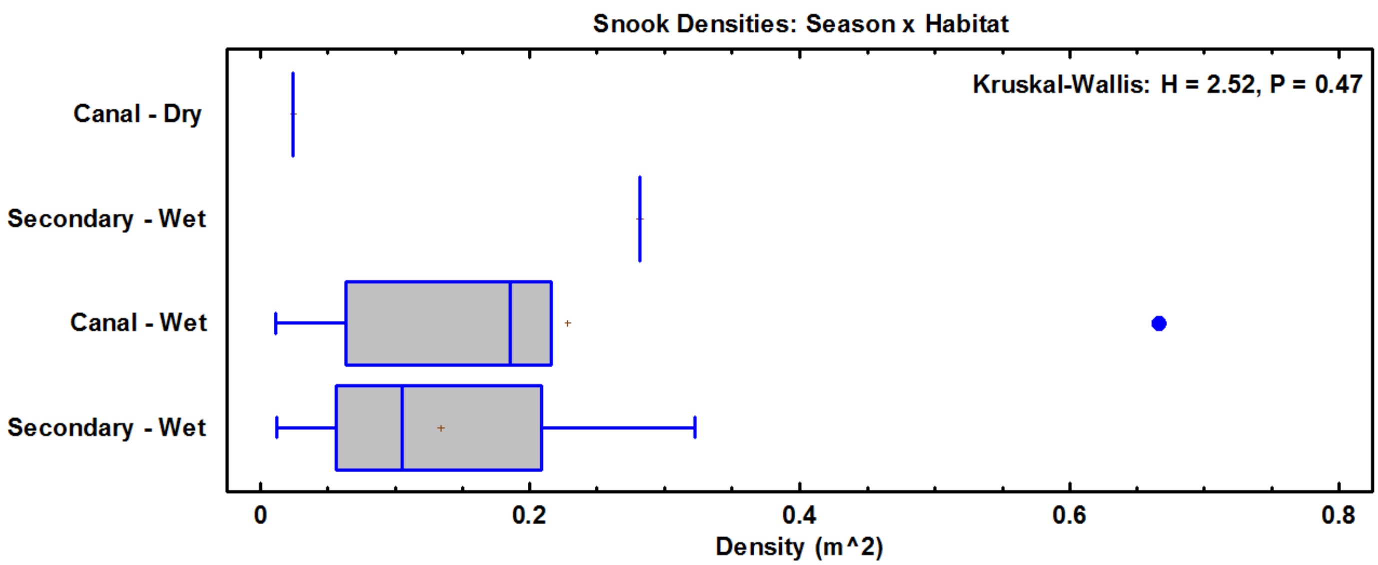

Figure 4B. Kruskal – Wallis comparison of snook densities by season and habitat. Absolute numbers of snook were more variable but densities were not significantly different.

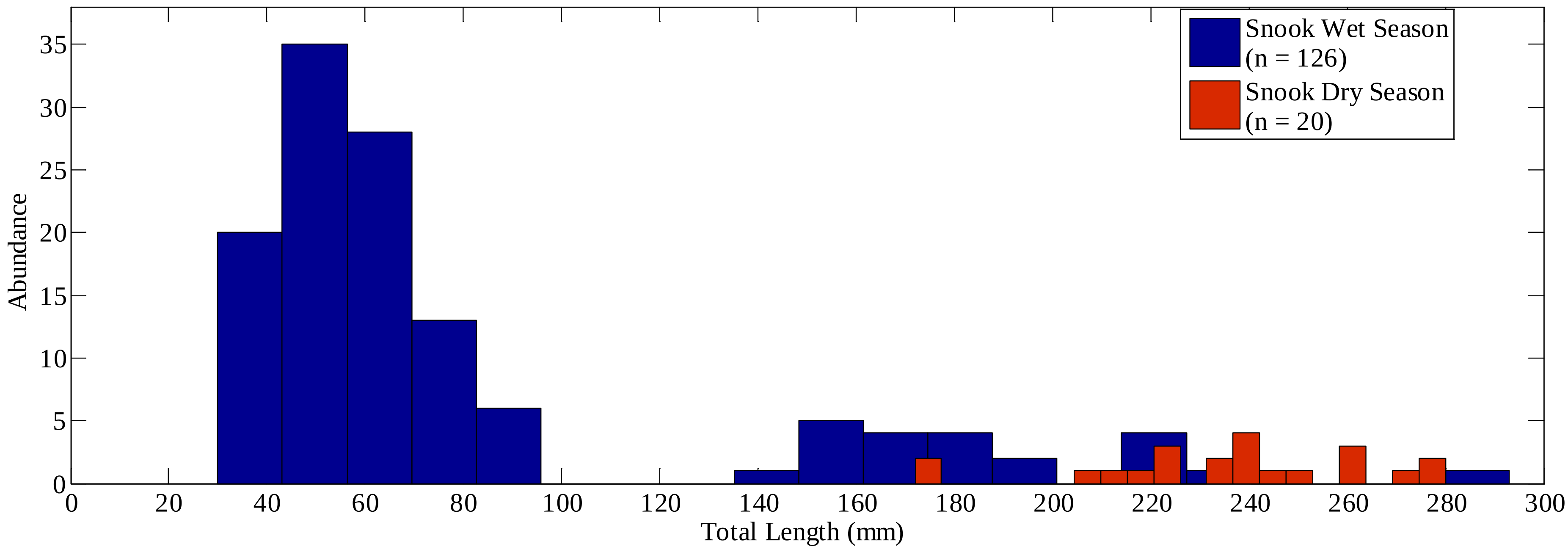

Figure 5. Length frequency of snook collected at all sites, seasons combined. Abundance of smaller snook collected during the wet season reflects recruitment to juvenile habitat in Phillippi following summertime spawning.

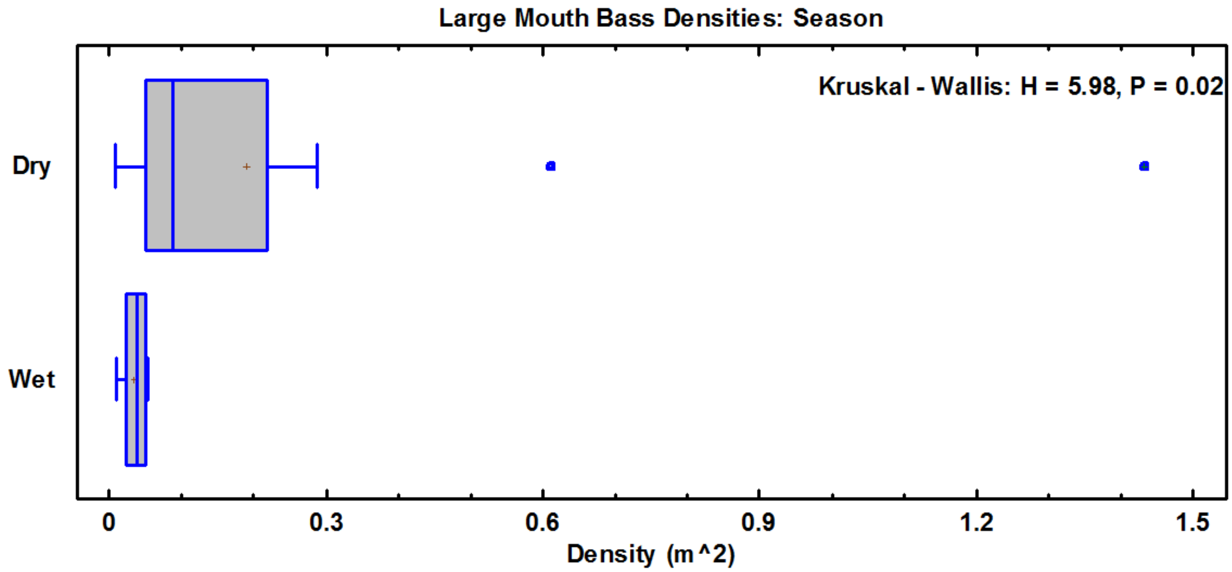

Figure 6A. Kruskal – Wallis comparison of largemouth bass densities between seasons. Densities of largemouth bass were significantly higher during the spring time spawning season.

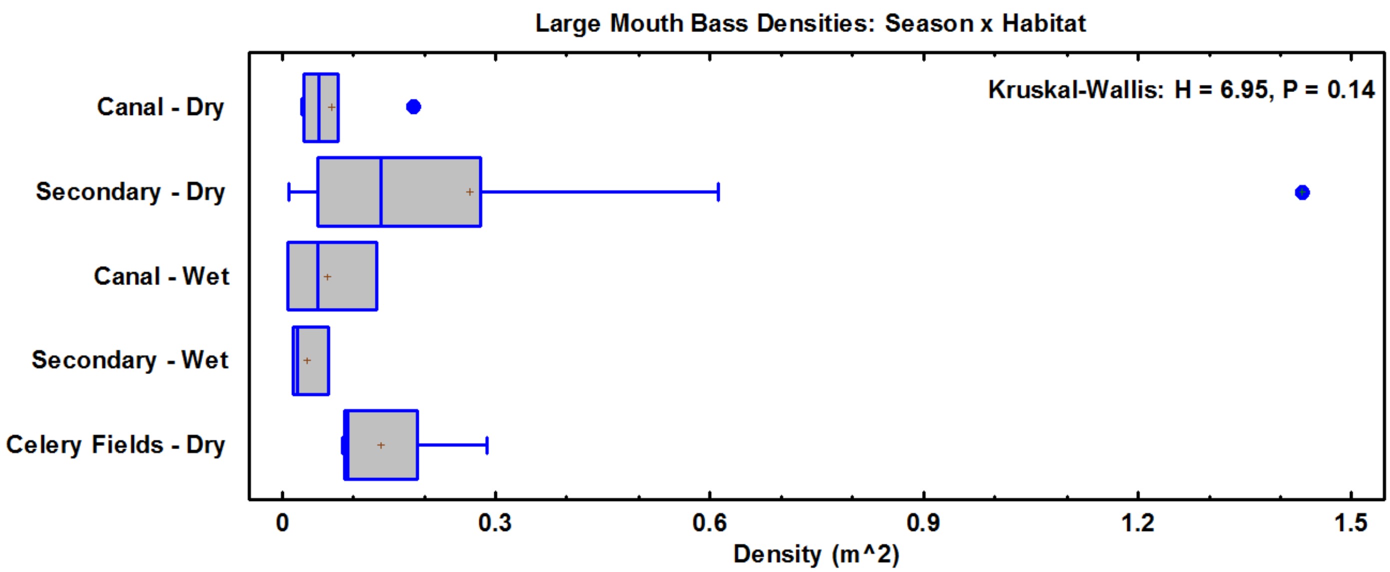

Figure 6B. Kruskal – Wallis comparison of largemouth bass densities by season and habitat. Densities were greatest in secondary stage habitats during the dry season but were not significantly different from other sites between seasons.

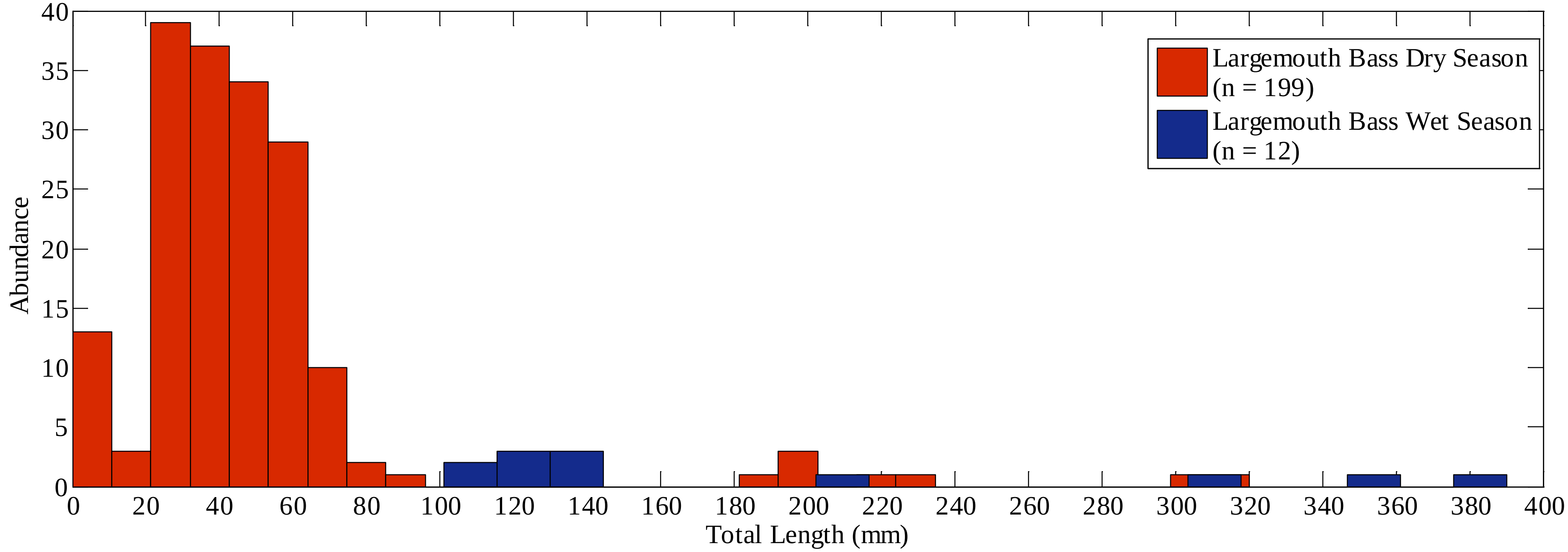

Figure 7. Length frequency of largemouth bass collected at all sites, seasons combined. Abundance of smaller largemouth bass collected during the dry season reflects the spring time spawning period. Largemouth bass and snook used the same juvenile habitat in Phillippi Creek but recruitment was offset by season.

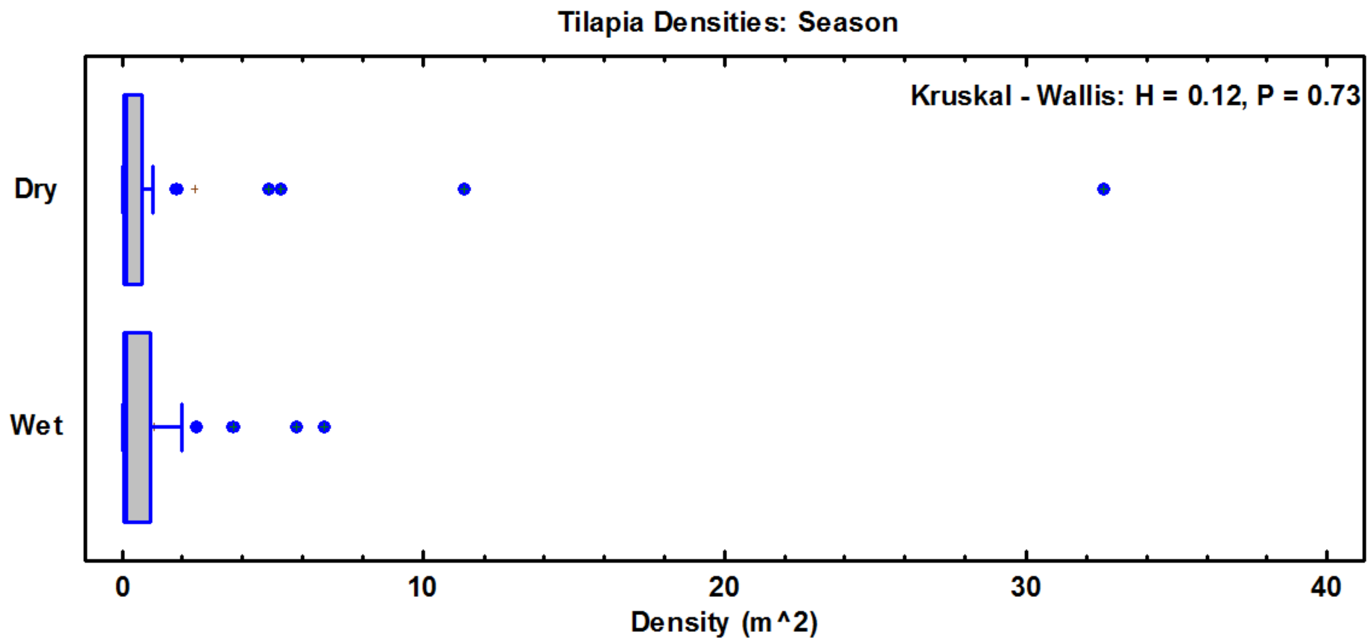

Figure 8A. Kruskal – Wallis comparison of tilapia densities between wet and dry seasons. Similar densities reflects that spawning occurs during each season.

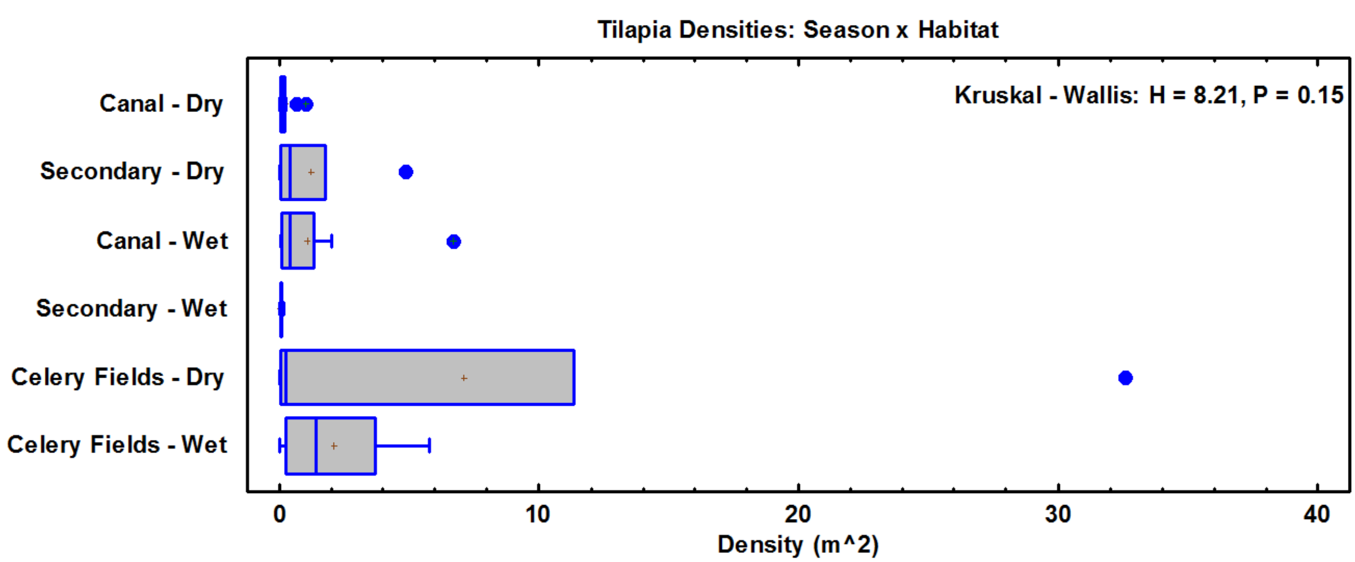

Figure 8B. Kruskal – Wallis comparison of tilapia densities between season and habitat type. Densities were greatest in the celery field retention ponds but not significantly from other sites by season.

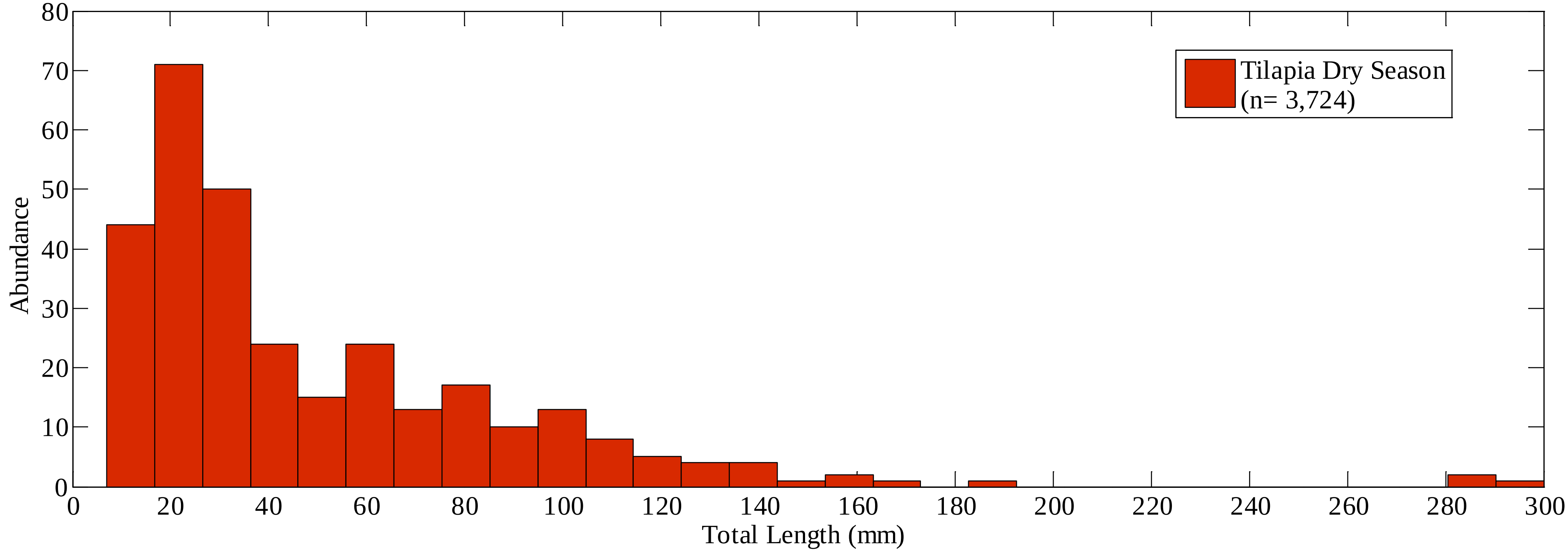

Figure 9A. Length frequency of tilapia collected at all sites, seasons combined. Abundance of smaller tilapia reflects spawning occurs during the dry season.

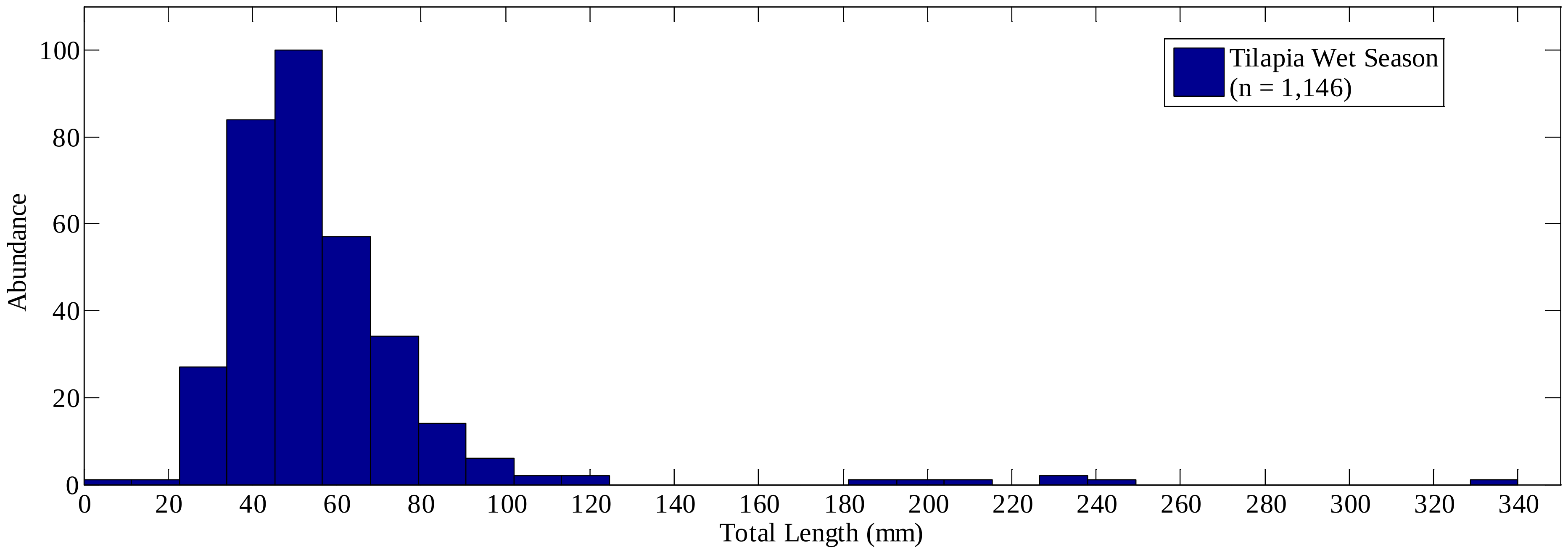

Figure 9B. Length frequency of tilapia collected at all sites, seasons combined. Abundance of smaller tilapia reflects spawning also occurs during the wet season. Steepness of apparent mortality is greater in the wet season indicating the possibility of increased predation on smaller tilapia during this period.

Table 1A. Total abundance of taxa collected seasons and sites combined.

Phillippi Creek, 2016 Common Name	Scientific Name	Seasons Combined
Eastern Mosquito Fish	*Gambusia holbrooki*	16,803
Tilapia spp.	*Oreochromis spp.*	4,870
Grass Shrimp	*Palaemonetes spp.*	4,087
Sailfin Molly	*Poecilia latipinna*	3,311
Seminole Killifish	*Fundulus seminolis*	1,243
Bluefin Killifish	*Lucania goodei*	884
Silverside	*Menidia spp.*	688
Gizzard Shad	*Dorosoma cepedianum*	606
Least Killifish	*Heterandria formosa*	559
Sunfish spp.	*Lepomis spp.*	449
Brook Silverside	*Labidesthes sicculus*	365
African Jewelfish	*Hemichromis lifalili*	336
Threadfin Shad	*Dorosoma petenense*	318
Bluegill	*Lepomis macrochirus*	246
Largemouth Bass	*Micropterus salmoides*	211
Tidewater Mojarra	*Eucinostomus harengulus*	197
Common Snook	*Centropomus undecimalis*	146
Sailfin Catfish	*Pterygoplichthys disjunctivus*	142
Golden Shiner	*Notemigonus crysoleucas*	133
Redear Sunfish	*Lepomis microlophus*	107
Flagfish	*Jordanella floridae*	85
Hogchoker	*Trinectes maculatus*	69
Warmouth	*Lepomis gulosus*	63
Crayfish	*Procambarus alleni*	61
Spotted Sunfish	*Lepomis punctatus*	39
Mayan Cichlid	*Mayaheros urophthalmus*	34
Coastal Shiner	*Notropis petersoni*	16
Florida Gar	*Lepisosteus platyrhincus*	16
Swamp Darter	*Etheostoma fusiforme*	10
Stripped Mullet	*Mugil cephalus*	9
Marsh Killifish	*Fundulus heteroclitus*	5
Golden Topminnow	*Fundulus chrysotus*	4
UI Fish	Osteichthyes	4
Brown Hoplo	*Hoplosternum littorale*	4
Bay Anchovy	*Anchoa mitchilli*	3
Tadpole Madtom	*Noturus gyrinus*	3

Rainwater Killifish	*Lucania parva*	3
Black Crappie	*Pomoxis nigromaculatus*	2
Brown Bullhead	*Ameiurus nebulosus*	2
Taillight Shiner	*Notropis maculatus*	2
Brevortia spp.	*Brevortia spp.*	1
Yellow Bullhead	*Ameiurus natalis*	1
Total Fish		36,137

Table 1B. Total abundance of taxa collected during the dry season, sites combined.

Phillippi Creek, 2016 Common Name	Scientific Name	Dry Season
Eastern Mosquito Fish	*Gambusia holbrooki*	11,365
Tilapia spp.	*Oreochromis spp.*	3,724
Grass shrimp	*Palaemonetes spp.*	2,492
Sailfin Molly	*Poecilia latipinna*	723
Gizzard Shad	*Dorosoma cepedianum*	585
Bluefin Killifish	*Lucania goodei*	536
Least Killifish	*Heterandria formosa*	500
Silverside	*Menidia spp.*	353
Seminole Killifish	*Fundulus seminolis*	259
Largemouth Bass	*Micropterus salmoides*	199
Bluegill	*Lepomis macrochirus*	184
Threadfin Shad	*Dorosoma petenense*	175
Brook Silverside	*Labidesthes sicculus*	164
Golden Shiner	*Notemigonus crysoleucas*	130
Sunfish spp.	*Lepomis spp.*	93
Flagfish	*Jordanella floridae*	71
African Jewelfish	*Hemichromis lifalili*	53
Crayfish	*Procambarus alleni*	49
Redear Sunfish	*Lepomis microlophus*	40
Warmouth	*Lepomis gulosus*	32
Sailfin Catfish	*Pterygoplichthys disjunctivus*	22
Common Snook	*Centropomus undecimalis*	20
Coastal Shiner	*Notropis petersoni*	13
Tidewater Mojarra	*Eucinostomus harengulus*	9
Spotted Sunfish	*Lepomis punctatus*	9
Stripped Mullet	*Mugil cephalus*	9
Florida Gar	*Lepisosteus platyrhincus*	7

Hogchoker	*Trinectes maculatus*	5
UI Fish	Osteichthyes	4
Golden Topminnow	*Fundulus chrysotus*	3
Tadpole Madtom	*Noturus gyrinus*	3
Rainwater Killifish	*Lucania parva*	3
Brown Bullhead	*Ameiurus nebulosus*	2
Mayan Cichlid	*Mayaheros urophthalmus*	2
Swamp Darter	*Etheostoma fusiforme*	2
Taillight Shiner	*Notropis maculatus*	2
Brevortia	*Brevortia spp.*	1
Total Fish		21,843

Table 1B. Total abundance of taxa collected during the wet season, sites combined.

Phillippi Creek, 2016 Common Name	Scientific Name	Wet Season
Eastern Mosquito Fish	*Gambusia holbrooki*	5,438
Sailfin Molly	*Poecilia latipinna*	2,588
Grass shrimp	*Palaemonetes spp.*	1,595
Tilapia spp.	*Oreochromis spp.*	1,146
Seminole Killifish	*Fundulus seminolis*	984
Sunfish spp.	*Lepomis spp.*	356
Bluefin Killifish	*Lucania goodei*	348
Silverside	*Menidia spp.*	335
African Jewelfish	*Hemichromis lifalili*	283
Brook Silverside	*Labidesthes sicculus*	201
Tidewater Mojarra	*Eucinostomus harengulus*	188
Threadfin Shad	*Dorosoma petenense*	143
Common Snook	*Centropomus undecimalis*	126
Sailfin Catfish	*Pterygoplichthys disjunctivus*	120
Redear Sunfish	*Lepomis microlophus*	67
Hogchoker	*Trinectes maculatus*	64
Bluegill	*Lepomis macrochirus*	62
Least Killifish	*Heterandria formosa*	59
Mayan Cichlid	*Mayaheros urophthalmus*	32
Warmouth	*Lepomis gulosus*	31
Spotted Sunfish	*Lepomis punctatus*	30
Gizzard Shad	*Dorosoma cepedianum*	21
Flagfish	*Jordanella floridae*	14

Crayfish	*Procambarus alleni*	12
Largemouth Bass	*Micropterus salmoides*	12
Florida Gar	*Lepisosteus platyrhincus*	9
Swamp Darter	*Etheostoma fusiforme*	8
Marsh Killifish	*Fundulus heteroclitus*	5
Brown Hoplo	*Hoplosternum littorale*	4
Coastal Shiner	*Notropis petersoni*	3
Golden Shiner	*Notemigonus crysoleucas*	3
Bay Anchovy	*Anchoa mitchilli*	3
Black Crappie	*Pomoxis nigromaculatus*	1
Yellow Bullhead	*Ameiurus natalis*	1
Golden Topminnow	*Fundulus chrysotus*	1
Total Fish		14,277

Table 1D. Total abundance of taxa collected in canal strata during the wet season.

Phillippi Creek, 2016 Common Name	Scientific Name	Canal Wet Season
Eastern Mosquito Fish	*Gambusia holbrooki*	4,449
Sailfin Molly	*Poecillia latipinna*	120
Seminole killifish	*Fundulus seminolis*	120
Silverside	*Menidia spp.*	104
Tilapia spp.	*Oreochromis spp.*	24
Common Snook	*Centropomus undecimalis*	23
Grass Shrimp	*Palaemonetes spp.*	22
Bluefin Killifish	*Lucania goodei*	14
African jewelfish	*Hemichromis letourneuxi*	8
Tidewater Mojarra	*Eucinostomus harengulus*	5
Hogchoker	*Trinectes maculatus*	5
Largemouth Bass	*Micropterus salmoides*	5
Marsh Killifish	*Fundulus confluentus*	5
Sunfish	*Lepomis spp.*	4
Flagfish	*Jordanella floridae*	4
Swamp Darter	*Etheostoma fusiforme*	4
Brown Hoplo	*Hoplosternum littorale*	4
Gizzard Shad	*Dorosoma cepedianum*	4
Bay Anchovy	*Anchoa mitchilli*	3
Brook Silverside	*Labidesthes sicculus*	2

Coastal Shiner	*Notropis petersoni*	2
Walking Catfish	*Clarias batrachus*	2
Sailfin Catfish spp.	*Pterygoplichthys spp.*	1
Least Killifish	*Heterandria formosa*	1
Warmouth	*Lepomis gulosus*	1
Spotted Sunfish	*Lepomis punctatus*	1
Bluegill	*Lepomis macrochirus*	1
Redear Sunfish	*Lepomis microlophus*	1
Crayfish	*Procambarus spp.*	1
Florida Gar	*Lepisosteus platyrhincus*	1
Golden Topminnow	*Fundulus chrysotus*	1
Golden Shiner	*Notemigonus crysoleucas*	1
Total Fish		4,943

Table 1E. Total abundance of taxa collected in canal strata during the dry season.

Phillippi Creek, 2016 Common Name	Scientific Name	Canal Dry Season
Eastern Mosquito Fish	*Gambusia holbrooki*	5,238
Grass Shrimp	Palaemonetes spp.	686
Sailfin Molly	*Poecillia latipinna*	606
Least Killifish	*Heterandria formosa*	327
Bluefin Killifish	*Lucania goodei*	157
Tilapia spp.	*Oreochromis spp.*	133
Seminole killifish	*Fundulus seminolis*	85
Brook Silverside	*Labidesthes sicculus*	54
African jewelfish	*Hemichromis letourneuxi*	51
Flagfish	*Jordanella floridae*	37
Bluegill	*Lepomis macrochirus*	36
Largemouth Bass	*Micropterus salmoides*	36
Crayfish	*Procambarus spp.*	34
sunfish	*Lepomis spp.*	20
redear sunfish	*Lepomis microlophus*	13
warmouth	*Lepomis gulosus*	13
stripped mullet	*Mugil cephalus*	9
tidewater mojarra	*Eucinostomus harengulus*	9
spotted sunfish	*Lepomis punctatus*	8
sailfin catfish	*Pterygoplichthys disjunctivus*	7

coastal shiner	*Notropis petersoni*	5
Florida gar	*Lepisosteus platyrhincus*	5
hogchoker	*Trinectes maculatus*	4
golden topminnow	*Fundulus chrysotus*	3
brown bullhead	*Ameiurus nebulosus*	2
common snook	*Centropomus undecimalis*	2
swamp darter	*Etheostoma fusiforme*	2
tadpole madtom catfish	*Noturus gyrinus*	2
taillight shiner	*Notropis maculatus*	2
unknown fish	*unknown fish*	2
herring sp.	*Brevoortia spp.*	1
silverside spp.	*Menidia spp.*	1
Total Fish		7,590

Table 1F. Total abundance of taxa collected in secondary stage canal strata during the wet season.

Phillippi Creek, 2016 Common Name	Scientific Name	2nd Stage Wet Season
Eastern Mosquito Fish	*Gambusia holbrooki*	663
Brook Silverside	*Labidesthes sicculus*	194
African jewelfish	*Hemichromis letourneuxi*	147
tidewater mojarra	*Eucinostomus harengulus*	123
sunfish	*Lepomis spp.*	114
Sailfin Molly	*Poecillia latipinna*	82
Seminole killifish	*Fundulus seminolis*	81
snook	*Centropomus undecimalis*	72
redear sunfish	*Lepomis microlophus*	49
silverside spp.	*Menidia spp.*	39
tilapia spp.	Oreochromis spp.	36
bluefin killifish	Lucania goodei	34
Mayan cichlid	Cichlasoma urophthalmus	32
bluegill	Lepomis macrochirus	29
hogchoker	Trinectes maculatus	25
grass shrimp	Palaemonetes spp.	17
spotted sunfish	Lepomis punctatus	10
threadfin shad	Dorosoma petenense	8
sailfin catfish	Pterygoplichthys disjunctivus	7

largemouth bass	Micropterus salmoides	5
Florida gar	Lepisosteus platyrhincus	5
swamp darter	Etheostoma fusiforme	4
crayfish	Procambarus spp.	2
golden shiner	Notemigonus crysoleucas	2
warmouth	Lepomis gulosus	2
black crappie	Promoxis nigromaculatus	1
Total Fish		1,783

Table 1G. Total abundance of taxa collected in secondary stage canal strata during the dry season.

Phillippi Creek, 2016 Common Name	Scientific Name	2nd Stage Dry Season
Eastern Mosquito Fish	*Gambusia holbrooki*	4,012
grass shrimp	*Palaemonetes spp.*	840
gizzard shad	*Dorosoma cepedianum*	585
tilapia spp.	*Oreochromis spp.*	447
bluefin killifish	*Lucania goodei*	361
silverside spp.	*Menidia spp.*	177
least killifish	*Heterandria formosa*	172
largemouth bass	*Micropterus salmoides*	141
bluegill	*Lepomis macrochirus*	138
golden shiner	*Notemigonus crysoleucas*	130
brook silverside	*Labidesthes sicculus*	104
Sailfin Molly	*Poecillia latipinna*	81
sunfish	*Lepomis spp.*	71
seminole killifish	*Fundulus seminolis*	62
flagfish	*Jordanella floridae*	34
redear sunfish	*Lepomis microlophus*	26
warmouth	*Lepomis gulosus*	19
snook	*Centropomus undecimalis*	18
crayfish	*Procambarus spp.*	14
coastal shiner	*Notropis petersoni*	8
rainwater killifish	*Lucania parva*	3
sailfin catfish	*Pterygoplichthys disjunctivus*	3
African jewelfish	*Hemichromis letourneuxi*	2
Mayan cichlid	*Mayaheros urophthalmus*	2

unknown fish	*unknown fish*	2
threadfin shad	*Dorosoma petenense*	1
spotted sunfish	*Lepomis punctatus*	1
tadpole madtom catfish	*Noturus gyrinus*	1
hogchoker	*Trinectes maculatus*	1
Total Fish		7,456

Table 1H. Total abundance of taxa collected in retention pond strata during the dry season.

Phillippi Creek, 2016 Common Name	Scientific Name	Dry Season Celery Fields
tilapia spp.	*Oreochromis spp.*	3144
Eastern Mosquito Fish	*Gambusia holbrooki*	2115
grass shrimp	*Palaemonetes spp.*	966
silverside spp.	*Menidia spp.*	175
threadfin shad	*Dorosoma petenense*	174
seminole killifish	*Fundulus seminolis*	112
sailfin molly	*Poecillia latipinna*	36
largemouth bass	*Micropterus salmoides*	22
bluefin killifish	*Lucania goodei*	18
bluegill	*Lepomis macrochirus*	10
brook silverside	*Labidesthes sicculus*	6
sunfish	*Lepomis spp.*	2
Florida gar	*Lepisosteus platyrhincus*	2
least killifish	*Heterandria formosa*	1
crayfish	*Procambarus spp.*	1
Total Fish		6784

Table 1I. Total abundance of taxa collected in retention pond strata during the wet season.

Phillippi Creek, 2016 Common Name	Scientific Name	Wet Season Celery Fields
Eastern Mosquito Fish	*Gambusia holbrooki*	1105
tilapia spp.	*Oreochromis spp.*	569
grass shrimp	*Palaemonetes spp.*	282
seminole killifish	*Fundulus seminolis*	187
silverside spp.	*Menidia spp.*	111

sailfin molly	*Poecillia latipinna*	99
sunfish	*Lepomis spp.*	34
bluegill	*Lepomis macrochirus*	18
gizzard shad	*Dorosoma cepedianum*	17
bluefin killifish	*Lucania goodei*	11
least killifish	*Heterandria formosa*	9
redear sunfish	*Lepomis microlophus*	6
flagfish	*Jordanella floridae*	5
crayfish	*Procambarus spp.*	3
sailfin catfish	*Pterygoplichthys disjunctivus*	2
African jewelfish	*Hemichromis letourneuxi*	1
Total Fish		2459

Table 2. Results of permutational MANOVA comparisons of communities between seasons and habitat type

Factors	T statistic	p value	p value Holm	n Dry	n Wet
Dry Season vs. Wet Season All Sites	5.52 (F)	0.001		70	70
Dry Season Canal vs. Dry Season 2nd Stage	2	0.001	0.015	40	20
Dry Season Canal vs. Wet Season Canal	1.84	0.002	0.015	40	40
Dry Season Canal vs. Wet Season 2nd Stage	2.81	0.001	0.015	40	20
Dry Season Canal vs. Dry Season Celery Fields	2.53	0.001	0.015	40	10
Dry Season Canal vs. Wet Season Celery Fields	2.45	0.001	0.015	40	10
Dry Season 2nd Stage vs. Wet Season Canal	2.31	0.001	0.015	20	40
Dry Season 2nd Stage vs. Wet Season 2nd Stage	1.93	0.001	0.015	20	20
Dry Sesaon 2nd Stage vs. Dry Season Celery Fields	1.83	0.003	0.015	20	10
Wet Season Canal vs. Wet Season 2nd Stage	1.98	0.001	0.015	40	20
Wet Season Canal vs. Wet Season 2nd Stage	2.1	0.001	0.015	40	20
Wet Season Canal vs. Dry Season Celery Fields	2.46	0.001	0.015	40	10
Wet Season Canal vs. Wet Season Celery Fields	2.31	0.001	0.015	40	10
Wet Season 2nd Stage vs. Dry Season Celery Fields	2.26	0.001	0.015	20	10
Wet Season 2nd Stage vs. Wet Season Celery Fields	1.97	0.001	0.015	20	10
Dry Season Celery Fields vs. Wet Season Celery Fields	1.21	0.186	0.186	10	10

Table 3. Results of Shannon biodiversity estimates and associated parameters for each season and habitat type.

Factors	n Strata	n Samples	Species Richness	Diversity Index (H')	H max	Species Evenness
Wet Season 2nd Stage	4	20	26	2.32	3.26	0.71
Wet Season All Sites	14	70	35	2.09	3.56	0.59
Wet Season Celery Fields	2	10	16	2.01	2.83	0.71
Wet Season Canal	8	40	32	1.83	3.47	0.53
Dry Season 2nd Stage	4	20	29	1.79	3.37	0.53
Dry Season All Sites	14	70	37	1.72	3.61	0.48
Dry Season Celery Fields	2	10	15	1.35	2.83	0.48
Dry Season Canal	8	40	32	1.28	3.47	0.37

Table 4. Summary of snook size and abundance by strata/habitat type and season. Based on fish length (>40mm) at least four snook recruitment strata/sites were documented in Phillippi Creek.

Strata	Habitat Type	Season	# of Snook	Size Range SL (mm)	Mean	St. Dev.
Sediment Trap A	Secondary Stage	Wet	53	31 - 90	60	15
Main Channel C	Canal	Wet	23	38 - 75	56	10
Main Channel A McIntosh	Canal	Wet	21	33 - 65	48	8
Sediment Trap B	Secondary Stage	Dry	18	205 - 280	244	21
Red Bug Slough	Secondary Stage	Wet	12	30 - 225	115	75
Main Channel C-Celery Fields	Canal	Wet	10	148 -175	162	9
S16 Weir	Secondary Stage	Wet	6	180 - 293	223	40
Main Channel C-Celery Fields	Canal	Dry	2	172 - 221	197	35
Sediment Trap B	Secondary Stage	Wet	1	194	NA	NA

Table 5. Summary of bass size and abundance by strata/habitat type and season. Based on fish length (>35mm) at least six bass spawning strata/sites were documented in Phillippi Creek. Several of these bass spawning sites are also used as recruitment sites by snook.

Strata	Habitat Type	Season	Bass #	Size Range SL (mm)	Mean	St. Dev.
Red Bug Slough	Second Stage	Dry	78	30 - 89	45	11
S16 Weir	Second Stage	Dry	50	32 - 72	54	9
Main Channel A-McIntosh	Canal	Dry	24	25 - 320	41	44
Celery Fields South	Celery Fields	Dry	22	33 - 85	55	95
Sediment Trap B	Second Stage	Dry	13	14 - 300	91	95
Main Channel B	Canal	Dry	10	15 - 202	46	55
Main Channel C	Canal	Wet	6	101 - 212	139	39
Sediment Trap B	Second Stage	Wet	4	129 - 390	293	115
Main Channel C	Canal	Dry	2	220 - 227	224	5
Branch BB	Canal	Wet	1	108	NA	NA
S16 Weir	Second Stage	Wet	1	140	NA	NA

Table 6. Summary of tilapia size and abundance by strata/habitat type and season. Based on fish length it appears tilapia spawn in all habitat types in Phillippi Creek with the greatest abundance in the retention pond habitat.

Strata	Habitat Type	Season	Tilapia #	Size Range SL (mm)	Mean	St. Dev.
Celery Fields South	Retention Pond	Dry	2,650	9 - 290	26	49
Celery Fields North	Retention Pond	Wet	568	26 - 184	54	18
Celery Fields North	Retention Pond	Dry	494	11 - 125	33	10
Red Bug Slough	Second Stage	Dry	415	10 - 300	50	36
Main Channel C-Celery Fields	Canal	Wet	408	25 - 340	58	36
Main Channel C	Canal	Wet	118	15 - 116	53	15
Main Channel C-Celery Fields	Canal	Dry	74	15 - 160	66	28
Main Channel B	Canal	Dry	47	7 - 35	16	6
S16 Weir	Second Stage	Dry	31	20 - 88	6	16
Sediment Trap A	Second Stage	Wet	21	40 - 202	76	40
Sediment Trap B	Second Stage	Wet	12	29 - 240	93	89
Main Channel A	Canal	Dry	8	18 - 40	30	7
Main Channel A	Canal	Wet	8	55 - 66	62	4
Branch AA	Canal	Wet	6	25 - 65	48	14
Branch AA	Canal	Dry	4	55 - 170	87	55
S16 Weir	Second Stage	Wet	3	69 - 77	72	5
Branch BB	Canal	Wet	1	38	NA	NA
Celery Fields South	Retention Pond	Wet	1	24	NA	NA
Sediment Trap B	Second Stage	Dry	1	97	NA	NA