Pre-Restoration Monitoring of Juvenile Tarpon and Snook at Coral Creek Preserve

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INTRODUCTION

Tarpon are a prized saltwater fish that can live in excess of 80 years, grow to over 250 pounds, and are the focus of an economically important recreational fishery throughout their geographic range. The annual economic impact of the recreational tarpon fishery exceeds $110 million in Charlotte Harbor and $70 million in St. Lucie estuary, tarpon are a part of the $465 million/year flats fishery in the Florida Keys, and the $1 billion fishery in the Everglades. Despite their popularity as a recreational species, there are numerous threats to the future of the fishery – primarily habitat loss and harvest.

Because of these threats, a recent International Union for the Conservation of Nature scientific assessment classified the tarpon population as “Vulnerable”. This classification means that the tarpon population declined at least 30% in the recent past. This decline occurred for two reasons: harvest primarily in the Caribbean and Gulf of Mexico in the 1960s and 1970s, though recreational harvest within the United States through the 1980s was also a contributor; habitat loss and degradation. The IUCN assessment also determined that declines may continue due to habitat loss and degradation.

The habitat most at risk is mangrove wetlands, the nursery habitat for juvenile tarpon, which depend upon healthy, shallow mangrove and marsh habitats. Since the health of the fishery depends upon sufficient juveniles growing up in healthy juvenile habitats, there is an urgent need to protect and restore juvenile tarpon mangrove nursery habitats.

Unfortunately, mangroves are under threat worldwide: globally, approximately 35% of mangroves have been lost, and continue to be lost at a rate of 2% per year; in Florida, approximately 50% of mangroves have already been lost, and degradation of these habitats continues. Since the amount of available habitat is one of the most important factors in determining the overall population size for most fish species, the loss of these critical habitats has direct and immediate effects on tarpon and the fisheries they support.

Because tarpon’s juvenile life stage depends upon coastal wetland habitats that continue to be lost, and tarpon are so long-lived, the loss of these habitats can have significant long-term effects on the tarpon populations. For example, impacts on long-lived and late maturing species like tarpon (tarpon are sexually mature at 8 – 12 years of age and can live to 80 years) might not be visible in an adult population until a decade after the habitat is lost. The species have similarly long population recovery times. This is because it takes so long for tarpon to become mature that even when lost juvenile habitats are restored and more juveniles survive to adulthood, there is a delay of ten or more years before these new fish are able to reproduce and add to the population. Therefore, juvenile tarpon habitat restoration is truly an investment in the future of the fishery with long-term implications.

Although Charlotte Harbor has retained much of its mangrove shoreline, there have been significant losses of mangrove wetlands. Perhaps more problematic has been the alteration of freshwater flows into these mangrove wetlands. Alteration of freshwater flow into estuarine habitats has significant negative impacts of fish and invertebrates. For example, research on the diet of juvenile snook in mangrove creeks of Charlotte Harbor revealed that juveniles in creeks with natural freshwater flow had a diet twice as diverse, and ate more prey, than juveniles in creeks with altered freshwater flows. Since diet affects juvenile snook growth and survival, it also has impacts on the regional population. The same will be true for juvenile tarpon.

Fortunately for the Charlotte Harbor region, much of the habitat degradation that has occurred can be corrected, and planning can still occur to prevent further habitat loss. In other words, Charlotte Harbor is still in a state where habitat restoration and protection can keep the estuary and its fisheries from following the course of decline that so many other estuaries have followed.

Previous work on juvenile snook use of mangrove creeks in Charlotte Harbor (conducted by A. Adams from 2002 – 2012), and ongoing work on juvenile tarpon at Wildflower Preserve (by J. Wilson from 2012 – present) has provided information directly applicable to habitat restoration. In fact, resources management agencies working in Charlotte Harbor (including Charlotte Harbor National Estuary Program (CHNEP), Southwest Florida Water Management District (SWFWMD), Florida Fish and Wildlife Conservation Commission (FWC)), have altered their approaches in response to information from our work. For example, FWC biologists recently initiated sampling of backcountry habitats in Charlotte Harbor to identify important nursery habitats for juvenile tarpon and snook. More importantly, SWFWMD and CHNEP have adjusted their habitat restoration strategies to address these important nursery habitats, and have asked for our input on their strategy adjustments. However, even as new habitat restoration strategies are implemented, there remains a strong need for evaluation of whether these restoration strategies work: if they work, it will be appropriate to move forward with the same strategy in future restoration; to the extent that they don't work, lessons learned can be applied to future restoration projects.

This project will use an experimental approach to evaluate the relative effectiveness of three habitat restoration strategies for juvenile tarpon. The results will provide information that will be immediately applicable to restoration efforts in Charlotte Harbor and on a regional (and perhaps larger) scale. This is especially true given that this will be only the second project to examine the effectiveness of habitat restoration for juvenile tarpon, the first one being the ongoing Wildflower project.

PROJECT LOCATION

The project site is on land owned by the State of Florida and managed by Florida Department of Environmental Protection in an area that is undergoing multiple stages of habitat restoration (Figure 1). Stage 1 is nearing completion, and although it did a good job restoring upland habitats, the changes to freshwater flows into the estuary likely decreased the quality of habitat for estuarine creek fishes. For Stage 2 restoration, which includes this project, BTT is actively working with SWFMD and CHNEP in restoration planning.

The site is immediately south of the Rotonda community on the Cape Haze Peninsula, immediately east of the West Branch of Coral Creek. There are remnants of six, shallow, manmade canals that are tidally connected to Coral Creek via a small creek and mangrove wetland. Although these canals are tidally connected to Coral Creek, at present they are shallow, soft-bottom, with little or no shoreline vegetation – not quality habitats – and harbor few fishes. The original plan by SWFWMD was to fill in these canals to create terrestrial habitat, but the revised strategy is to restore these areas to suitable tidal creek habitat.

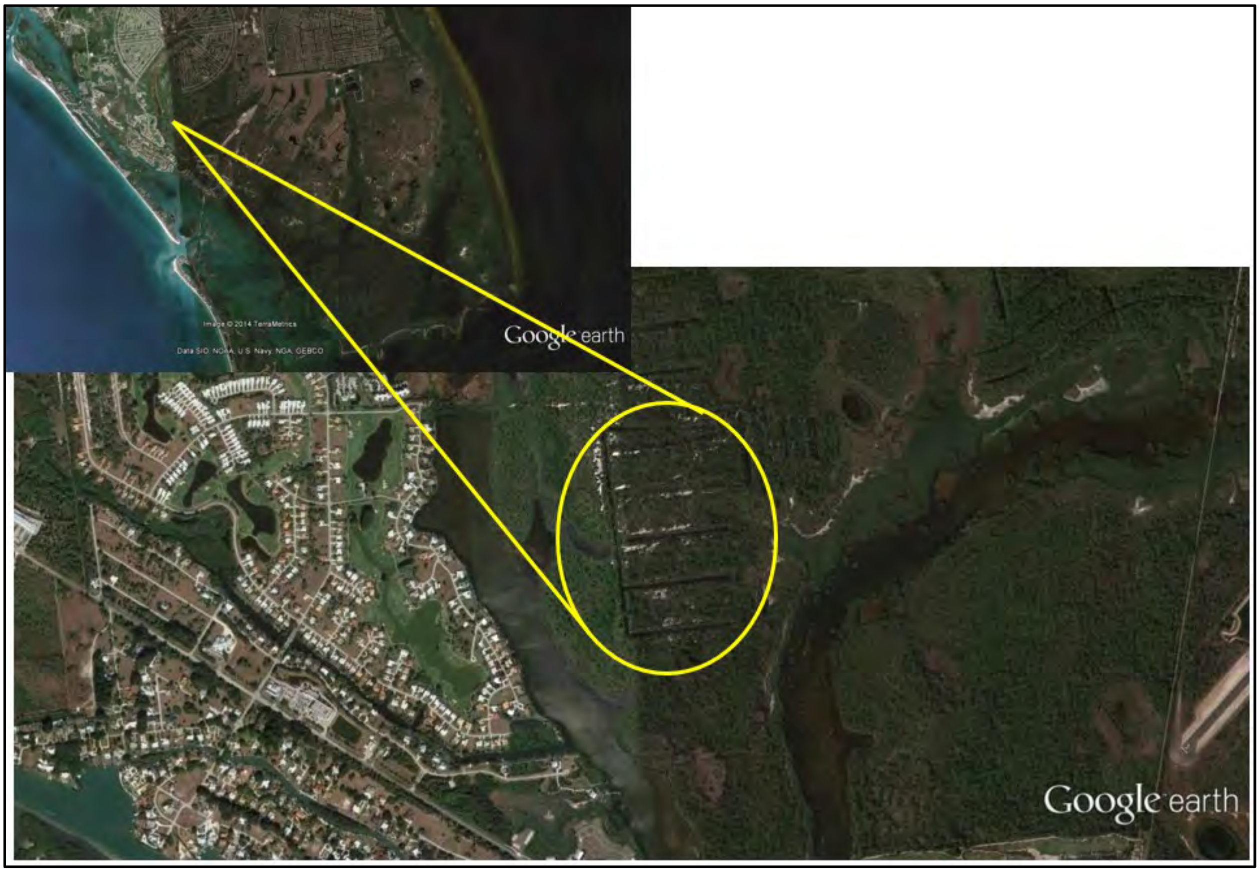

Figure 1. Map showing the location of the restoration site on the Cape Haze peninsula.

This location is especially appealing as a restoration site for juvenile tarpon habitat for two reasons. First, because of its proximity to Boca Grande Pass. Ongoing research indicates that tarpon spawn in offshore waters in the Gulf of Mexico. Their larvae drift in open water as plankton for approximately one month before moving into inshore waters and searching for mangrove backwater habitats. The proximity of the restoration site increases the likelihood that tarpon larvae will find the site. That juvenile tarpon have been found in nearby Coral Creek supports the notion that this is a good location to enhance available juvenile tarpon habitat.

Second, Coral Creek and other nearby creeks provide good habitat for older juvenile tarpon. The type of habitat being restored at the restoration site is suitable for tarpon up to one year old. Once reaching one year, tarpon generally migrate from the shallow backwater nursery habitats to more open (but still protected) habitats. In areas where the nursery habitats are isolated from the older juvenile habitats, it is likely that juvenile tarpon survival is very low. Because this restoration site is adjacent to a network of older juvenile habitats should increase the survival of juveniles, and thus help increase the overall size of the tarpon population.

This project will focus on the extent to which habitat restoration improves the quality of habitat for juvenile tarpon (as measured by juvenile tarpon abundance, survival, and growth), and the ability of juvenile tarpon to exit these habitats and enter estuarine habitats. Since the true measure of the quality of a juvenile habitat is the portion of juveniles that successfully grow and are able to leave the juvenile habitat to contribute to the estuarine population, the successful movement of juvenile tarpon from the restored habitats to the estuary will be viewed as a successful habitat restoration.

The monthly tag-recapture sampling will allow us to estimate survival, growth, and movements of juvenile tarpon within the restoration canal system. The antenna data will be used to estimate movements between canals, level of fidelity to specific canals, and the rate of emigration from the restoration site to Coral Creek (and possible return).

Sampling will occur for one year prior to the restoration, and for one or two years after the restoration. This will allow a comparison of pre- vs post-restoration use of these canals by juvenile tarpon. In addition, the post-restoration sampling will allow comparison of the two experimental restoration strategies, as well as used to monitor movements by individuals between habitat types.

METHODS

Of the six remnant canals, currently 4 have direct access to the perpendicular feeder canal. One is completely sealed off via a large dirt berm (canal 4) and one is sealed off via berm to the feeder canal, but connects on the opposite end to an adjacent canal (canal 2). Canal 1's opening is shallow as is the rest of the canal, which also has many trees standing within the canal. Canal 3 has a small opening, is the smallest canal, and closely resembles a small pond due to the excessive growth of melaleuca that blocks water flow. Canals 5 and 6 are open, with no debris, and have deep access to the feeder canal.

Monthly samplings from August 2014 – November 2015 were conducted using seine nets and cast nets to capture and tag juvenile tarpon and snook. The canals are labeled from 1-6 working from north to south. Canals 1-4 are sampled using cast nets at strategic locations along the bank. Canals 5 and 6 are sampled using a 130' seine net deployed from a 10' jon boat. The seine net is set in 2 locations per canal in a circular, counter-clockwise form. Cast netting from shore occurs in canals 1-4 at two locations per canal. The cast net is thrown up to 4 times from each location in order to maximize the sample area. Tarpon and snook ≥ 190 mm Standard Length (tip of the nose to base of the tail) were implanted with 23mm PIT (Passive Integrated Transponder) tags (Figure 2). Juvenile tarpon and snook < 190 mm SL were implanted with 12mm PIT tags. PIT tags are glass-encapsulated computer chips that contain a unique identification number.

The tags are inserted into the fish's abdominal cavity through a small incision (< 3 mm). The incision heals on its own, with no stitches needed. All juvenile tarpon and snook will be measured for SL and Fork Length (tip of the nose to fork in the tail) and released. Captured tarpon and snook will be scanned for PIT tags using a handheld reader.

Figure 2. PIT tag used for tagging juvenile tarpon.

Underwater antenna arrays were constructed that are able to detect tagged organisms as they swim past at the entrance to each canal and at the connection to the natural creek that connects the restoration site to Coral Creek. Five antenna arrays were installed: 1 at the creek entrance; 4 at the mouths of each canal that was connected to the main feeder canal – 2 canals did not connect due to sand berms. Each antenna recorded date, time and the unique PIT tag identification number of each tag that was within read range of the antenna. We have used these antennae to monitor juvenile snook movements and survival in four mangrove creeks on the eastern shoreline of Charlotte Harbor for six years, and are using antennae in the Wildflower project. The computers that operate the antennae are powered by solar panels. A schematic of the antenna, as used for studies of juvenile snook, is shown below (Figure 3).

Water parameters including salinity, temperature, dissolved oxygen and pH were taken in each canal using a YSI (Appendix A).

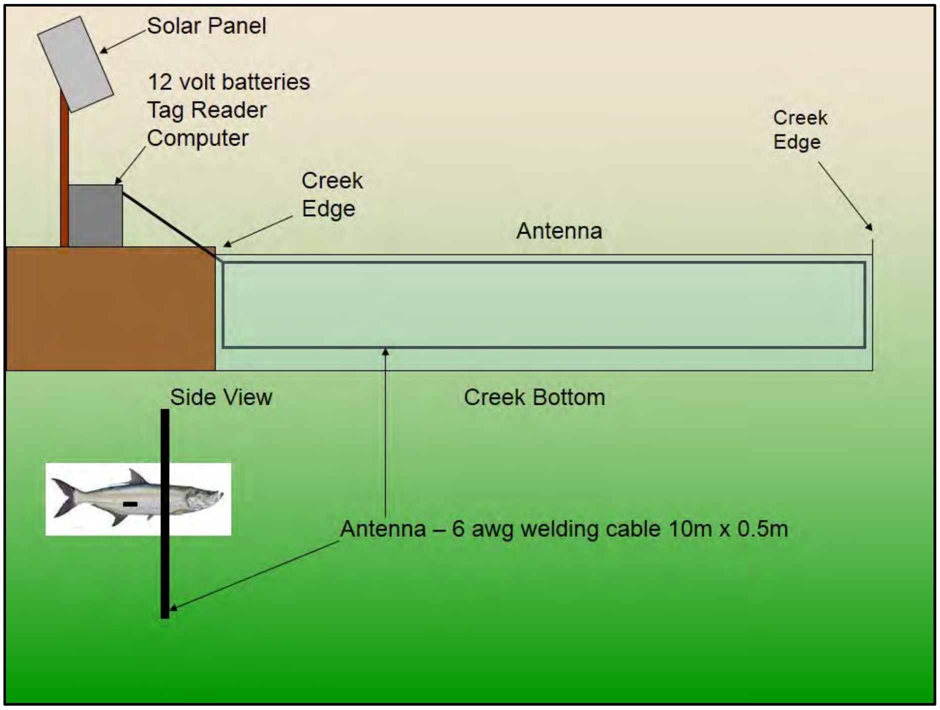

Figure 3: Antenna, as used in juvenile snook studies.

RESULTS

Over the 16-month study, 140 common snook (87 mm – 509 mm SL), 1 Atlantic tarpon (451 mm SL) and a variety of other species that included striped mojarra, bluegill, red drum, African jewelfish, remora, tidewater mojarra, redfin needlefish, mullet, sheepshead, ladyfish, pinfish, Irish pompano, sailfin molly, crested goby, blue crab, gulf killifish, sheepshead minnow, rainwater killifish, black drum, Atlantic stingray, pink shrimp, zebra shelldweller, and mayan cichlid were captured. The snook and tarpon were measured, implanted with a PIT tag and released, and the other species were recorded as present and released. Eight snook were recaptured at a later sampling and only 1 was recaptured in a different canal from its initial tag location. The average growth of recaptured snook was 0.12 mm/day. There were no noted fish casualties during this study.

DISCUSSION

The most notable finding in the pre-restoration monitoring is the absence of juvenile tarpon at the study site. This could be attributed to numerous factors including a poor recruitment year, changes in water quality and/or the increased species richness of other fishes that was not found at Wildflower Preserve. In May 2013, Dr. Phil Stevens and Dave Blewett of the Charlotte Harbor FWC Laboratory were the first to identify juvenile tarpon at Coral Creek preserve by cast netting off the bank of Canal 1. Due to the behavior of tarpon in low oxygen conditions, Dave and Phil reported seeing hundreds of tarpon rolling in the first canal. They did not explore the other 5 canals. BTT did not begin sampling until August 2014 and only saw evidence of tarpon rolling in the main feeder canal during 1 sampling. However, we were surprised to find how many other species of fishes were present at the site – the majority too large to be prey items for tarpon which then creates competition between species.

One advantage of tarpon physiology is their ability to take in oxygen from the surface instead of solely relying on dissolved oxygen in the water. The ability to thrive in low or anoxic conditions is believed to be an integral part of tarpon survival in the nursery habitat. Due to the numerous species present at the site and the relatively high dissolved oxygen readings from the YSI, it may not be a benefit for tarpon to inhabit the Coral Creek canal system versus a nearby lower dissolved oxygen system (like Wildflower Preserve). Coincidentally, FWC personnel from the Charlotte Harbor lab continued BTT's monthly sampling at Wildflower Preserve concurrent with BTT's Coral Creek sampling. They recorded substantially lower catch rates from August 2014 – November 2015 following BTT's August 2012 – July 2014 monthly samplings, underscoring the possibility of a poor recruitment year for juvenile tarpon in Charlotte Harbor.

Although the pre-restoration monitoring was meant to give us insight on juvenile tarpon habitat use, ultimately the post-restoration monitoring will be quite valuable once the various restoration designs are implemented. Scientists from FWC, BTT and CHNEP designed 3 treatment plans that will be randomly assigned to the six canals (2 canals per treatment). The designs are as follows:

- **Treatment 1:** A deep entrance allowing constant tidal connection, mixture of depths (1/3 of canal = 2m depth, remainder subtidal and intertidal marsh)
- **Treatment 2:** A berm at the entrance that only allows tidal connection at higher tides and during wet season (the perceived preference by juvenile tarpon, but more difficult to construct), mixture of depths (1/3 of canal = 2m depth, remainder subtidal and intertidal marsh)
- **Treatment 3:** A berm at the entrance that only allows tidal connection at higher tides and during wet season, shallow intertidal marsh throughout canal
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The goals of this study are to: 1) determine movement patterns of juvenile snook and tarpon following habitat restoration; and 2) determine habitat preference of juvenile snook and tarpon by presenting 3 habitat designs, with implications for future habitat restoration design.

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APPENDIX A: YSI MEASUREMENTS

September 13, 2014	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	32.47		30.3		29.7	29.33
Salinity (‰)	28.22		3.46		30.5	30.35
Dissolved Oxygen (mg/L)	11.58		0.11		4	2.71
pH	8.17		7.77		7.77	7.73

October 25, 2014	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	25.48	25.63	23.58	23.7	23.57	23.71
Salinity (‰)	14.56	11.86	15.66	1.77	16.77	16.96
Dissolved Oxygen (mg/L)	4.6	4.9	6.03	5.14	5.25	5.27
pH	6.11	5.01	5.74	4.82	7.7	7.69

November 18, 2014	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)					21.8	23.68
Salinity (‰)					25.92	25.38
Dissolved Oxygen (mg/L)					6.4	7.19
pH					7.41	7.41

December 13, 2014	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	17.9	13.7	17.4	14.4	14.8	14.8
Salinity (‰)	21	15.17	22.16	1.65	22.91	23.12
Dissolved Oxygen (mg/L)	5.35	8.76	5.59	7.55	5.21	7.05
pH	6.52	6.91	6.79	5.61	7.45	7.67

January 10, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	16.5	14.66	14.74	15.25	16	16
Salinity (‰)	22.91	17.97	26.73	1.77	27.3	28
Dissolved Oxygen (mg/L)	5.6	8.38	5.02	8.44	7.4	7.1
pH	6.96	6.82	7.1	4.71	7.6	7.77

February 21, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	17.46	19.16	16.62	15.85	15.27	15.1
Salinity (‰)	27.7	17.17	29.53	1.75	30.95	31.42
Dissolved Oxygen (mg/L)	7.13	11.3	4.08	9.17	7.88	5.62
pH	7.22	7.35	6.81	5.56	7.7	7.52

March 21, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	26.51	Dry	23.43	25	25.87	25.45
Salinity (‰)	28.88	Dry	35.9	1.99	34.54	35.15
Dissolved Oxygen (mg/L)	5.09	Dry	5.56	5.58	4.26	4.19
pH	7.28	Dry	7	7.43	7.39	7.48

April 18, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	30.1	Dry	29.7	28.6	29.2	28.5
Salinity (‰)	38.7	Dry	39.46	2.3	38.2	38.6
Dissolved Oxygen (mg/L)	3.4	Dry	4.6	6.3	4.8	4.7
pH	7.4	Dry	7.07	7.7	7.7	7.6

May 30, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	28.86	25.54	26.63	27.78	29.65	30.02
Salinity (‰)	33.33	9.39	34.17	2.13	37.54	38.08
Dissolved Oxygen (mg/L)	3.52	5.38	4.55	5.12	3.66	2.91
pH	7.09	6.81	5.82	5.75	7.95	7.86

June 20, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	34.66	33.4	33.88	32.23	33.08	31.9
Salinity (‰)	21.63	8.75	19.95	1.83	29.35	29.63
Dissolved Oxygen (mg/L)	2.73	4.99	2.7	4.72	4.17	3.22
pH	6.79	6.1	6.4	4.88	7.58	7.62

July 22, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	36.8	37.1	38.7	35	35.8	35.4
Salinity (‰)	26.45	10.7	28.03	1.98	30.53	30.51
Dissolved Oxygen (mg/L)	7.41	4.96	6.85	7.49	7.8	7.2
pH	7.27	6.61	7.32	6.96	7.94	7.94

August 26, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	34.1	35.3	34.5	33.4	33.7	33.3
Salinity (‰)	15.9	13.7	17.3	1.8	15.7	16
Dissolved Oxygen (mg/L)	6	6.9	5.5	7.2	5.1	4.2
pH	7	4.9	7.1	5	7.7	7.6

September 30, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	29.3	28.7	29.1	28	29.2	29
Salinity (‰)	2.6	2.5	2.7	1.5	14	14.1
Dissolved Oxygen (mg/L)	12.8	8.9	11.7	4.49	3.7	3
pH	6.6	6.4	6	5	7.4	7.4

October 17, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	27.03	25.37	26.41	25.85	26.16	26.39
Salinity (‰)	17.24	11.28	19.44	1.51	18.66	18.84
Dissolved Oxygen (mg/L)	2.73	3.59	2.97	3.84	3.9	4.07
pH	7	6.48	7.2	4.45	7.46	7.49

November 11, 2015	Canal 1	Canal 2	Canal 3	Canal 4	Canal 5	Canal 6
Temperature (◦C)	28.4	28.2	27.8	27.9	28	27.7
Salinity (‰)	22.4	19.7	22.9	1.6	24.3	24.1
Dissolved Oxygen (mg/L)	5.5	6.2	4.6	5.6	5.7	4.4
pH	7.1	7	7	5.1	7.4	7.4