EXPLORATION OF DEEP HOLE, MYAKKA RIVER STATE PARK, FLORIDA

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Deep Hole is a karst sink located in Myakka River State Park, Sarasota County, Florida. The park is popular for hiking, fishing, camping, and wildlife observation. Deep Hole is located on the northwest bank of the Myakka River just outside the southern terminus of the Lower Myakka Lake in the Wilderness Preserve section of the park. Lake levels exhibit pronounced depth variation from wet to dry season and Deep Hole is a refuge for wildlife during the dry season. Prior studies of river rocks estimated the age of the Myakka River basin at several million years although the formation period for Deep Hole is unknown. Notably, evidence for one of the earliest documented human settlements in the area now defined as the United States occurs within the Myakka River basin from two sinkhole features, Warm Mineral Springs (WMS) and Little Salt Spring (LSS) which yielded artifacts that have established human habitation in the area to 10,000 - 12,000 years before present. The authors collaborated to compile existing information and conduct preliminary investigations of water quality and underwater topography. Water quality data were collected in August 2011 and in April 2012 a technical dive team explored the sink to determine the overall depth and document similarities to WMS and LSS, and offshore submarine springs. Unique characteristics of the site necessitated planning for unknown depth, potential caves, poor visibility and a large number of adult alligators. Findings showed the maximum depth to be 41 m for ambient dry season lake levels, no significant ledges or caves were found. There was a strong thermocline at ~9 m in August 2011and 6 m in April 2012 below which the water was anoxic. For the August visit water temperature was uniformly 14.2°C below 12 m, colder than the typical ~22.5°C for Florida spring water indicating the sink does not have underlying spring flow. Long-term temperature records indicated there is some seasonal warming near the thermocline. Water quality parameters varied with the temperature stratification and were dissimilar to Warm Mineral Springs and Little Salt Spring where warm, mineralized water rises from a deep aquifer.

Introduction and Background

Study Site

Deep Hole is a sinkhole located in Myakka River State Park, one of Florida's oldest and largest state parks. The "Florida Wild and Scenic Myakka River" flows through 57 square miles of wetlands, prairies and woodlands. The Park is popular for hiking, fishing, camping, and wildlife observation. The main entrance of the park is located off State Road 72 in eastern Sarasota County. Deep Hole is a sinkhole located on the southwest shoreline of the Lower Myakka Lake in the Wilderness Preserve section of the park, which requires a permit for access. Prior to creation of the State Park the area surrounding Deep Hole was used for grazing ranchlands.

Deep Hole is located just southwest of the shoreline of the Lower Myakka Lake where the lake empties into the lower Myakka River. The sink is approximately 90 m in diameter (Fig. 1). The sink perimeter is well defined in the dry season as shown in Figure 1, but is mostly obscured during a strong wet season when lake levels may rise by +2 m (Fig. 2).

Figure 1. Image of Deep Hole and Lower Myakka Lake taken during the dry season low lake level.

Figure 2. Image of Deep Hole and Lower Myakka Lake taken during wet season with high lake water.

During severe dry seasons the depth and area of the Lower Myakka Lake decline greatly. Deep Hole subsequently becomes a refuge for fishes and other fauna as the water levels drop and the tremendous diversity of the park becomes evident as many species aggregate near water sources. At least 40 species of fishes are known to occur in the Myakka River State Park. In addition, according to Park records, there are 48 species of reptiles, 22 species of amphibians, 32 species of mammals, and the Park checklist includes 255 species of resident and migratory birds. The dry season lake water drop and the resultant high numbers of fish contained within Deep Hole results in the aggregation of the American alligator (*Alligator mississippiensis*). During the period of the April 2012 survey in excess of 150 alligators were counted within Deep Hole from still images of the site.

The report "A History of the Myakka River Sarasota County, Florida" (McCarthy and Dame, 1983) relates that the estimated age of the river basin is several million years old based on rock samples from the river. It is notable that evidence for the earliest documented human settlements in the United States occurs within the Myakka basin from two sinkhole features, Warm Mineral Springs and Little Salt Spring. The proximity of these sites to Deep Hole was one aspect of the motivation to conduct this study.

There are relatively few sinkholes in Sarasota County compared with other areas of west Florida. However, Little Salt Spring and Warm Mineral Springs have proved to be of great archaeological significance for documentation of early human settlement in North America. Deep Hole (27.214928°N, 82.335214°W) is located approximately 11.5 miles from Little Salt Spring (27.074678°N, 82.233111°W) and 11.6 miles from Warm Mineral Spring (27.059900°N, 82.260327°W). Warm Mineral Springs is located 1.97 miles from Little Salt Spring at a bearing of 238 degrees from north. The scientific relevance of these nearby sites was the impetus for the investigation of Deep Hole for which there are no known records of scientific investigation and only undocumented reports of scuba divers having investigated the sink. The overall dimensions and the depth of the site were unknown prior to this survey.

Little Salt Spring (LSS), located within the City of North Port, owned by the University of Miami since 1982, has been a scientific study site since the 1970s and has provided human remains and artifacts dating to ~12,000-13,450 years before present (Clausen et al., 1979; Purdy, 2008; Gifford and Koski, 2011). Only recently have the sources of the water from the spring vents been investigated (Van Ee and Riera-Gomez, 2009) with results suggesting multiple sources.

Warm Mineral Springs (WMS) is also within the City of North Port in Sarasota County. WMS has a primary deep source spring of highly mineralized warm water (~30°C) with the vent located ~63 meters below the spring surface within a cave and also has additional lesser flow freshwater seeps closer to the surface. WMS was a privately owned tourist attraction until 2010 when it was jointly purchased by Sarasota County and the City of North Port. In July 2013, WMS was closed to the public and the future fate is dependent upon development of a plan for the future use and development.

In the 1950s, a retired Air Force Colonel William Royal began scuba diving in WMS and discovered stalactites, human remains and artifacts. In 1959, Colonel Royal invited Dr. Eugenie Clark, then the Director of Mote Marine Laboratory in Placida, to examine the site. During these dives additional artifacts were collected including an intact human skull with remains of brain tissue. A charred log beneath the human remains subsequently was carbon dated to 8,000 B.C. ± 200 years, the earliest known habitation for man in Florida at that time (Royal and Clark, 1960). Like LSS, this site proved to be a valuable archaeological site but was largely ignored by the archaeological community until 1972 when an archaeologist from Florida State University began working in WMS (Cockrell, 1987).

The results of the studies in LSS and WMS provided conclusive evidence of human habitation of the area for approximately 10,000 years. The creek formed by WMS flows into the Myakka River and through the use of the river for transportation Lower Myakka Lake and Deep Hole would have been readily available to these settlers. These potential links and the possibility of discoveries of archaeological significance were the impetus for the exploration of Deep Hole.

Methods and Materials

Physical water parameters and water quality samples were collected in August 2011 by Sarasota County Water Resources with personnel accessing the site in a small Jon boat. Water levels were higher than for the following spring when the bathymetry and diving surveys were conducted. In situ measurements of temperature, salinity, conductivity, dissolved oxygen and pH were measured in the field with a multiparameter meter. Water quality samples were obtained at depths of 3, 15, 30, 45, 60, 90, and 105 ft for analysis of nutrients, minerals and trace metals according to National Environmental Laboratory Accreditation Conference (NELAC) standards by an independent contract laboratory certified by the Florida Department of Health Environmental Laboratory Certification Program.

The collaborative research team consulted with the Myakka State Park personnel to arrange for a research permit and vehicle access permission to conduct an investigative survey and scuba dive in Deep Hole within the wilderness preserve. Abnormally dry conditions allowed the team to transport equipment to the edge of the hole by vehicle. In early 2012, the site was visited several times to map the subsurface contours using an aluminum Jon boat equipped with a WAAS enabled Global Positioning System coupled with a digital fathometer. A surface deployed drop camera was also deployed to provide the team with estimates of the expected visibility and the composition of the bottom. On February 12, 2012 two Onset Computer HOBO® thermographs were placed in the hole, one near the surface and the second below the thermocline at ~9 m (30 ft) to obtain a long-term record of temperature variation. The thermographs were recovered on March 11, 2013. The surface thermograph had been damaged from what appeared to be an alligator bite. The thermocline thermograph was recovered and data are considered reliable through November 28, 2012 at which time there was a sudden spike in temperature. This anomaly was believed to be a result of the thermograph being pulled closer to the surface possibly by entanglement of the line with an alligator.

In April 2012, a technical dive team explored the sink to determine the overall depth and document similarities to WMS, LSS, and offshore submarine springs and sinks. Diving safety was focused on accounting for unknown depth and water conditions and the presence of unusually large number of adult alligators. The overall depth and subsurface configuration of the hole was unknown to the dive team. The team planned for the possibility of depths as great as 76 m (~250 ft), the presence of caves or caverns and low visibility. There were two deep divers, one diving a side-mount configuration and the second a traditional double tank back mount cave diving configuration. Bottom gas consisted of trimix and separate stage tanks for travel gas (Nitrox) and oxygen decompression were also carried by each diver. Both divers wore drysuits since the water quality survey in 2011 indicated a large temperature decrease at 6-9 m. A weighted downline buoyed to the surface was placed as a descent and ascent guide for the divers. Surface support consisted of fully outfitted stand-by divers and alligator proximity observers. Surface team members were also briefed in first aid and evacuation protocols in the event of a medical emergency.

After consultation with several alligator behavior research scientists it was deemed prudent to arrange for a shark cage enclosure to use at the 6-9 meter (20-30 ft.) decompression stops. The shark cage was made available for the project and transported to the site by Think Out Loud Productions®. The cage was suspended with surface buoys so the bottom of the cage was located at ~9 m. The bottom panel of the cave was removed to allow easy entry by the deep dive team. Divers conducted their final decompression stop at approximately 7 m.

The divers descended the down line and upon reaching the bottom attached a cave reel line to the dropline weight. The divers then swam out perpendicular to the down line until encountering the rock wall and proceeded to circumnavigate the cavern.

Results

Water Parameters, Minerals, Nutrients and Trace Metals

It should be noted that a one-time sampling event is insufficient for definitive conclusions regarding water quality in natural systems. For that reason the results of the water quality analysis are presented with the caveat that they should be used only to provide insight on the general conditions of the hole at the time of the survey. It is possible that Deep Hole may exhibit significant seasonal variation.

Data for the August 2011 field water measurements and water quality analyses are found in Tables 1 - 4. The physical water parameters were generally stable but stratified by two depth zones; a shallow warm zone, 0 to ~10 m (0-30 ft.) and a cold deep zone greater than ~10 m (Table 1). Water temperature dropped from 28.5ºC at the surface to 14.2ºC at 12 m (Δt = 14.3ºC). The low water temperature at depth indicates a lack of spring flow into the system. During the April 2012 diver survey it was noted that the thermocline was close to the 6-m (20 ft.) depth corresponding with the sharp drop past the lip of the collapse rim. The data from the thermograph located near the thermocline (~10 m) are shown in Figure 3. The water temperature at this depth illustrated a gradual warming as a result of the combination of summer warming and continued lake level drop during the dry winter months. The anomaly caused by the presumed alligator bite is observed on 11/28/2012.

Total dissolved solids, turbidity and biochemical oxygen demand were all higher below 10 m (30 ft.) but total suspended solids (TSS) and total organic carbon were greater near the surface. The temperature gradient of the system most likely keeps TSS in suspension over the more dense cold water. The pH of the system was only slightly lower than a typical Florida stream.

Table 1. Physical water measurements for Deep Hole, August 31, 2013.

Depth (ft.) Depth (~m)	3 1	15 4.6	30 9.1	45 13.7	60 18.2	75 22.9	90 27.4	105 32.0	Shallow Avg. (3-15 ft.)	Deep Avg. (30+ ft.)	All Avg	Typical Florida Stream
Temp C	28.5	28.2	21.6	14.2	14.2	14.2	14.2	14.2	26.1	14.2	18.7	--
Temp F	83.3	82.8	70.8	57.6	57.6	57.6	57.6	57.6	83.1	57.6	65.6	--
Salinity (PSU)	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	.2	0.4	0.3	0.5
Conductivity (umhos/cm)	375	375	638	795	801	803	798	795	375	772	673	475
Total Dissolved Solids (mg/l)	268	292	440	532	528	520	548	536	333	533	458	214
Color (PCU)	250	250	250	100	100	100	100	100	250	100	156	350
Dissolved Oxygen[1] (mg/l)		0.2	0.9								0.5	5.5
Dissolved Oxygen %		1.9	0.8								1.4	62
Biochemical Oxygen Demand (mg/l)	2	2	7	14	14	14	15	15	4	14	10	1.3
Turbidity (NTUI)	2	2	60	50	52	40	50	50	2	50	38	2.5
Total Suspended Solids (mg/l)	2.8	2.0	1.8	1.0	0.8	0.8	1.0	0.8	2.2	0.9	1.4	4.0
Total Organic Carbon (mg/l)	26	26	21	18	19	18	18	18	24	18	20	17
Fecal Coliform (cfu/100ml)	400								400		400	60
pH	6.7	6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.7	6.9	6.9	7.2

Footnotes: 1, Dissolved oxygen probe malfunction in the field make data for this parameter unreliable.

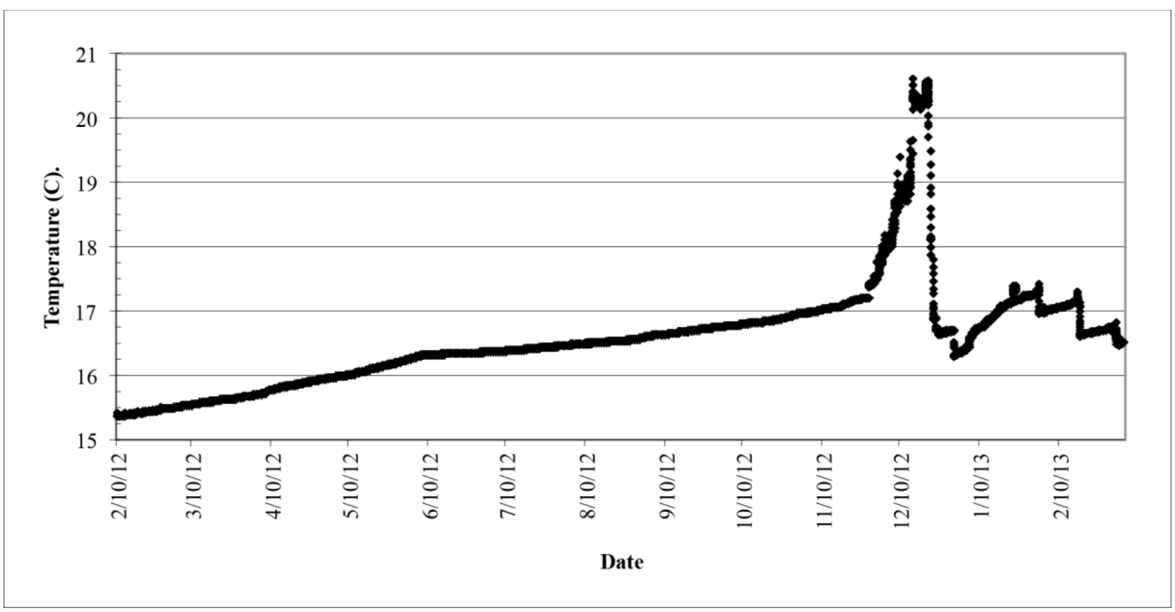

Figure 3. Deep Hole temperature record at a depth of ~10 m for the period of Feb. 2012 to March 2013.

Dissolved oxygen levels were not reliably recorded during the August site visit. The dissolved oxygen membrane probe failed during the visit to the site. Hydrogen sulfide levels were high below the temperature thermocline (see Table 2) and this may have poisoned the oxygen electrode.

Table 2. Mineral concentrations for water samples obtained from Deep Hole, August 31, 2011. Values in mg/l except where noted.

Depth (ft.) Depth (~m)	3 1	15 4.6	30 9.1	45 13.7	60 18.2	75 22.9	90 27.4	105 32.0	Shallow Avg. (3-15 ft.)	Deep Avg. (30+ ft.)	All Avg.
Hardness total	152	146	336	359	363	342	384	360	149	357	305
Sulfate	104	105	217	225	226	226	226	227	105	225	195
Iron	377	353	338	119	84	83	110	82	365	136	193
Alkalinity, bicarbonate	39.0	39.0	70.0	110.0	114.0	112.0	112.0	112.0	39.0	105.0	88.5
Alkalinity, total	39.0	39.0	70.0	110.0	114.0	112.0	112.0	112.0	39.0	105.0	88.5
Calcium	34.6	32.8	77.1	82.9	85.5	82.2	91.6	84.4	33.7	84.0	71.4
Manganese (ug/l)	23.5	22.9	108.0	63.6	48.4	47.2	49.8	48.7	23.2	61.0	51.5
Magnesium	15.9	15.5	34.9	36.8	36.2	33.1	37.8	36.3	15.7	35.9	30.8
Chloride	17.4	17.4	25.3	28.9	29.0	28.9	29.0	29.1	17.4	28.4	25.6
Sodium	11.4	11.1	15.9	17.3	18.3	17.6	17.7	18.0	11.3	17.5	15.9
Sulfide	0.054	0.264	11.000	22.900	23.500	19.800	21.400	21.500	0.159	20.017	15.052
Silica, dissolved	15.9	15.8	11.2	8.2	8.2	8.3	8.4	8.5	15.9	8.8	10.6
Hydrogen Sulfide, unionized	0.032	0.156	5.750	13.900	13.800	12.200	12.800	13.000	0.094	11.908	8.955
Potassium	8.0	7.7	11.3	8.8	8.5	8.0	8.9	8.5	7.9	9.0	8.7
Strontium	1.9	1.9	2.9	3.4	3.6	3.4	3.4	3.5	1.9	3.3	3.0
Alkalinity, carbonate	0.594	0.594	0.594	0.594	0.594	0.594	0.594	0.594	0.594	0.594	0.594
Fluoride	0.224	0.223	0.259	0.308	0.295	0.293	0.301	0.297	0.224	0.292	0.275

Fecal coliform levels were somewhat elevated, 400 cfu/100ml, and likely caused by the presence of high densities of waterfowl, feral pigs and deer in the area and the low flow conditions at the site. Statewide numeric criteria whereby counts of colonies do not exceed a monthly average of <200 colonies/100 ml, a maximum of 400 colonies/100 ml in 10% of the samples, or a maximum of 800 colonies/100 ml on any one day.

Dissolved mineral data for Deep Hole water are presented in Table 2, which illustrates the site is fresh water without substantial input of deep mineralized spring water. There was some stratification by depth with mineral concentrations at depth usually different than the shallow water values. Iron and silica were the only minerals with higher concentrations near the surface. All others were higher at depth, except strontium, which did not vary by depth. There was no carbonate alkalinity.

Water nutrient data are presented in Table 3. Ammonia levels were high a deeper depths as a result of the anoxic conditions and consequently nitrate and nitrite levels were very low, and are typical of low oxygen environments. TKN also illustrated high values at depth. Total nitrogen was high at depth and was dominated by the ammonia and organic constituents. Total and ortho-phosphorus were high reflecting the phosphorous rich soils of the Myakka River basin. Chlorophyll levels near the surface were typical for a Florida lake as was phaeophytin.

Table 3. Nutrient parameters for Deep Hole water, August 31, 2013. Values in mg/l except as noted.

Depth (ft.) Depth (~m)	3 1	15 4.6	30 9.1	45 13.7	60 18.2	75 22.9	90 27.4	105 32.0	Shallow Avg.	Deep Avg.	Average	Typical Florida Stream	MDL
Ammonia	0.121	0.111	2.660	3.100	3.420	3.210	3.550	3.160	0.12	3.18	2.417	0.04	0.008
Nitrate + Nitrate	0.008	0.012	0.005	0.006	0.008	0.006	0.004	0.004	0.01	0.01	0.007	0.07	0.004
Total Kjeldahl Nitrogen	1.62	1.55	3.25	4.81	4.93	4.94	4.88	4.96	2.14	4.90	3.868	1.06	0.05
Total Nitrogen	1.63	1.56	3.25	4.82	4.94	4.95	4.88	4.96	2.15	4.91	3.874	1.05	0.05
Ortho Phosphorus	0.555	0.559	0.861	0.512	0.483	0.448	0.436	0.498	0.56	0.54	0.544	0.06	0.002
Total Phosphorus	0.712	0.725	1.03	0.918	0.906	0.894	0.898	0.891	0.72	0.92	0.872	0.08	0.008
Chlorophyll a (mg/m^3)	17.2	13.5	7.47	3.33	1.78	2.51	2.09	2.13	12.72	2.37	6.251	4.22	0.25
Pheophytin (mg/m^3)	2.17	0.25	4.33	3.20	1.82	2.31	2.07	2.20	1.21	2.66	2.294	1.66	0.25

Results for trace metal analysis are presented in Table 4. All concentrations were very low. Cadmium, mercury, molybdenum, nickel, selenium and zinc were not detected at all and are shown as minimum detection levels (MDL). The practical quantification limit (PQL) is shown on the far right of Table 4. Arsenic, chromium, copper and lead were at very low levels.

Table 4. Results of trace metal analysis for Deep Hole water, August 31, 2013. Values µg/l.

Depth (ft.)	3	15	30	45	60	75	90	105	Average	MDL	PQL
Arsenic	0.951	0.853	1.270	0.855	1.350	1.120	1.550	1.400	1.169	0.689	2.756
Cadmium	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.9	3.6
Chromium	3.10	3.40	3.00	3.30	3.00	3.00	3.20	2.70	3.09	2	8
Copper	4.30	4.30	4.00	5.80	4.30	4.40	3.20	4.60	4.36	4	16
Lead	0.670	0.670	0.670	0.670	0.758	0.670	0.670	0.670	0.681	0.670	2.680
Mercury	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.198	0.792
Molybdenum	2.0	2.0	2.0	2.0	2.1	2.0	2.0	2.0	2.0	2	8
Nickel	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	1.18	4.72
Selenium	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	6.28
Zinc	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.4	5.6

Sink Topography and Diver Observations

The circular basin of Deep Hole has a substratum that consists primarily of medium to coarse quartz sands typical of the Myakka River soils. In the shallows the surface of the sand exhibited a greenish layer of periphyton. Shells and live individuals of the Florida Shiny Spike, *Elliptio buckleyi* (Lea, 1843), a Unionidae bivalve, were very abundant in the shallows of the bowl. During several site visits it appeared that both alligators and hogs feed on this mussel. The location of the collapse feature within the bowl of Deep Hole is shown in Figure 4. The collapse portion of the sink is located toward the northern side of the bowl and is irregular in shape. Figure 5 presents an oblique view of the hole. Figure 6 illustrates a cross section of the collapse section that is irregular in shape but approximately 33 m (110 ft.) across and drops to a depth of ~34 m (~112 ft.) from the water surface for conditions at the time of the survey in February 2013. For the time of the depth survey the Myakka River level gauge was 1.5 ft. as recorded at a flow control structure near Laurel (USGS gage 02298880). The top of the debris cone was approximately 25 m (82 ft.) below the edge of the collapse opening. The vertical section of wall along the collapse area was small generally <3 m (10 ft.). Divers noted a shallow sand covered ledge around a portion of the vertical wall section but the ledge was not examined in detail for the entire circumference because of the extremely poor visibility.

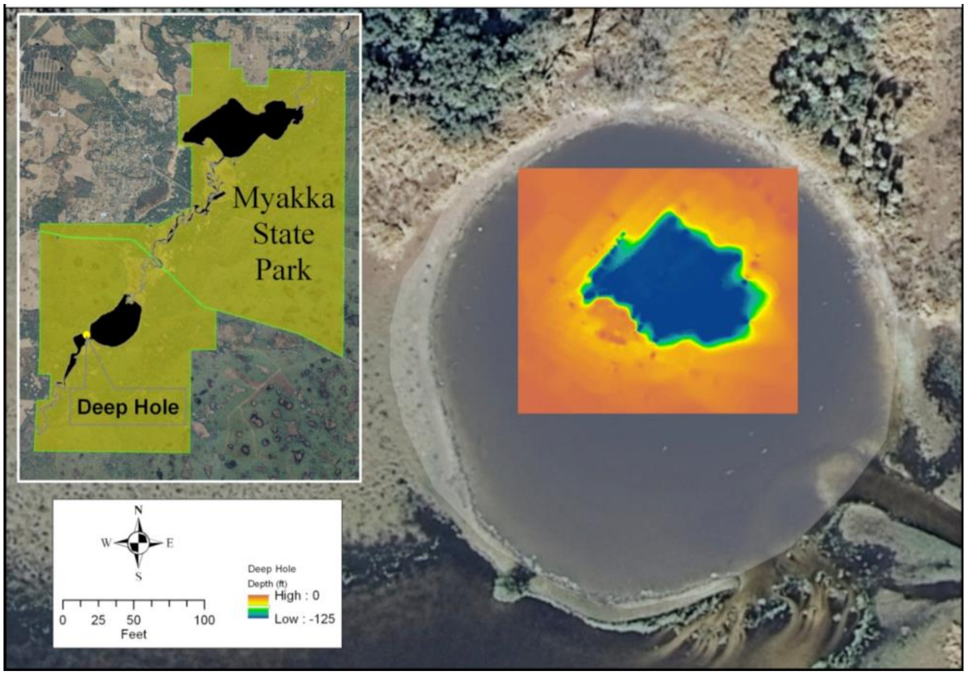

Figure 4. Image of Deep Hole illustrating the location of the collapse feature.

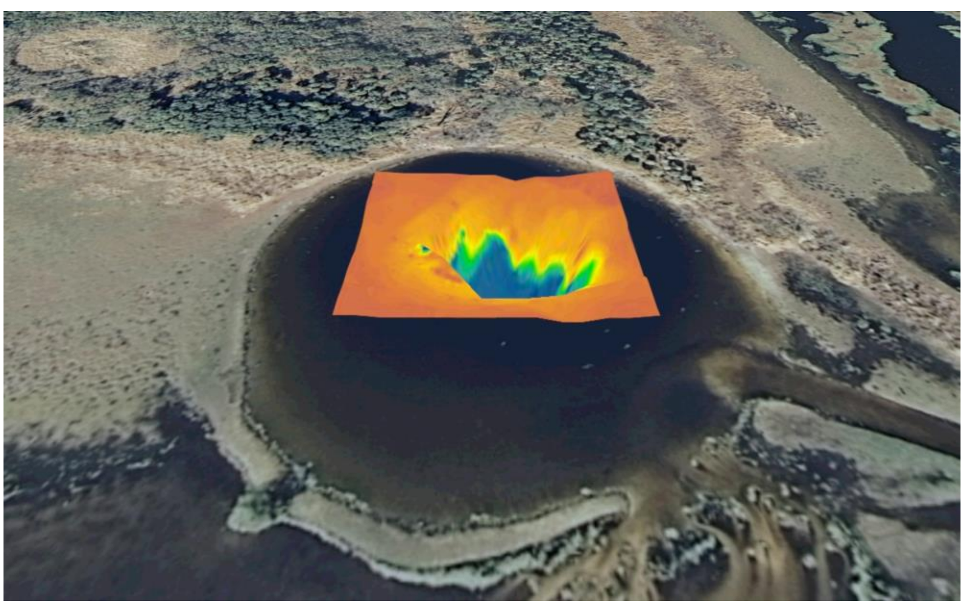

Figure 5. Oblique image of Deep Hole illustrating the location of the collapse feature.

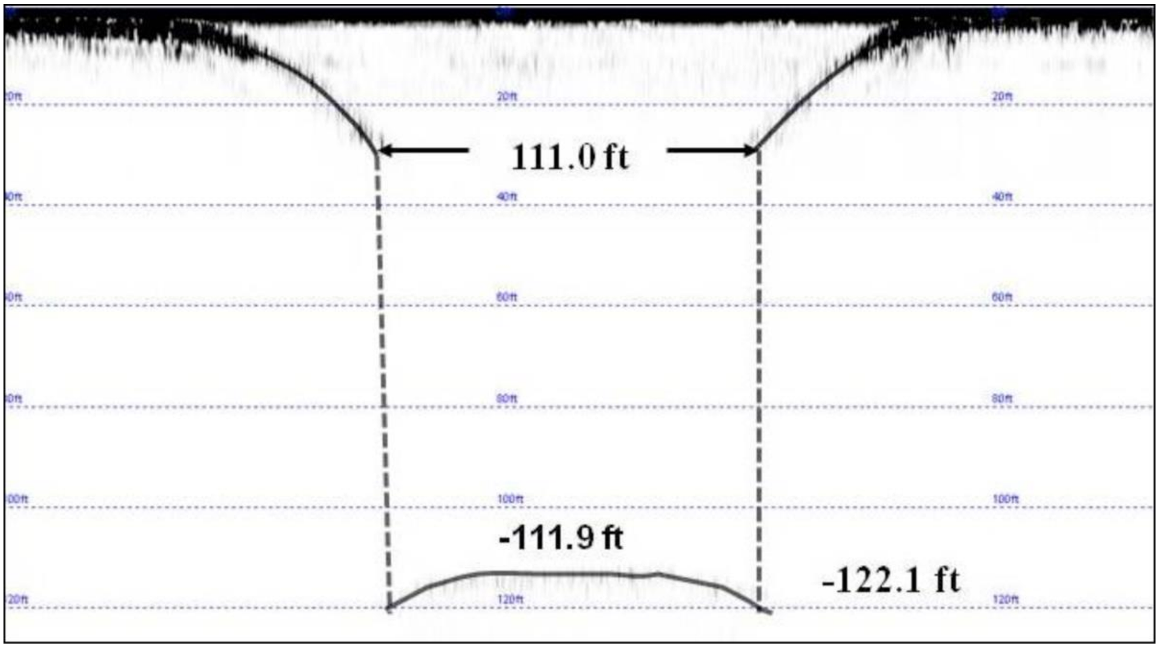

Figure 6. Cross section of the collapse feature of Deep Hole illustrating the overall dimensions.

The divers reported that underwater visibility was very poor ranging between 30 - 60 cm (1-2 ft.). Hydrogen sulfide was present below the thermocline. The bottom of the sink consisted of very soft brownish-gray sediment pocked with numerous circular holes ~4-5 cm in diameter. The sediment was not probed to determine the thickness. Dead fish were common across the bottom. There was relatively little identifiable plant material or other debris. From the down line near the apex of the debris pile the bottom sloped gently down toward the periphery and a maximum recorded depth of 40 m (131 ft.). The diameter of the sink at the bottom was estimated to be in excess of 46 m (150 ft.) although exact measurements were not obtained. Divers made their ascent along the sloping wall and with the exception of the small ledge at approximately 9 m (30 ft.) no caves or significant structures were noted although such structures could be present.

Discussion

The primary objectives of this project were accomplished. The relative size, depth and shape of the feature have been described and basic water chemistry determined. The results of this project show that for the present day Deep Hole is a very different sinkhole habitat than Warm Mineral Springs and Little Salt Spring. Although the chemistry and most of the physical data collected by this project represent only one summer period the information illustrates that Deep Hole is a static sink and does not have obvious spring activity. The sharp thermocline with a much lower temperature than Florida spring water indicates that groundwater influence is minimal since temperature would be moderated if there were significant spring flow into the sink. During winter cold periods the surface waters sink into the basin and remain trapped. The hole is likely a net nutrient sink with plant debris and animal carcasses, such as the observed fish, being trapped under the thermocline.

We speculate that the concentration of fishes during the dry months may exceed the carrying capacity of the basin. Fish may succumb as a result of starvation, cold shock or the depletion of oxygen caused by the hydrogen sulfide layer being relatively close to the surface. A moderate winter turnover associated with the sinking of cold water could result in some release of nutrients to the Myakka River but the volume of water displaced would likely be relatively small and in years of extreme low lake level the sink does not have much direct interaction with the river.

Much remains to be learned about the site although the utility of scientific diving will be limited because of the uniformly poor visibility. A geologic determination of the age of the sinkhole would be valuable to determine if the feature was present during the same time period as WMS and LSS. If Deep Hole formed from a collapse of the same rock strata as WMS and LSS then the overall depth of the original collapse hole could be much deeper. If Deep Hole was present during the period of human occupation of WMS and LSS it may have been utilized as a seasonal hunting area because of the accumulation of fish and wildlife during dry periods. Additional relevant archaeological information could possibly be obtained by a close examination of the shallow ledge observed along a portion of the break. However, the small size of the ledge would likely preclude significant use as human habitat.

Perhaps the most intriguing possibility for Deep Hole is that it may serve as a biological record of the flora and fauna of the recent geologic past. The bottom sediment is likely mostly undisturbed and may be quite thick. Observations during this study indicate that potentially large numbers of fish and possibly other organisms may be entombed in the bottom sediments such as those found in a sinkhole known as "Sawmill Sink" on Abaco, the Bahamas where numerous well preserved skeletal remains were recovered including extinct tortoises (Steadman et al., 2007). The direct accessibility of the hole to a variety of wildlife during low water periods provides for a high probability that remains of organisms other than fish and alligators may be present in the bottom sediment.

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