Relating Fish Abundance and Condition to Environmental Factors in Desert Sinkholes

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Introduction

When relating fish assemblages to abiotic (i.e. physical and chemical) variables, numerous studies have utilized a multiple-lake approach. That is, several lakes are used as experimental units and various abiotic variables are correlated to fish species composition, productivity, yield, or abundance. For example, Moyle (1956) found a correlation between fish biomass and total phosphorus, total nitrogen, alkalinity, and salinity. Correlations have also been established with lake area (Rounsefell 1946, Tonn and Magnuson 1982, Robinson and Tonn 1989), mean lake depth (Rawson 1952; Prepas 1983), maximum lake depth (Robinson and Tonn 1989, Tejerina-Garro et al. 1998), dissolved oxygen (Jackson et al. 2001), pH (Rahel and Magnuson 1983, Rago and Weiner 1986, Jackson et al. 2001), lake transparency (Tejerina-Garro et al. 1998), and winter oxygen concentration and lake connectedness (Tonn and Magnuson 1982). Finally, Ryder (1965) developed the morphoedaphic index (MEI), which related total dissolved solids-mean lake depth ratios to fish yield.

Multi-lake studies have largely been performed in north-temperate locations such as Wisconsin (Tonn and Magnuson 1982), Ontario (Ryder 1965, Marshall and Ryan 1987, Hinch et al. 1991, Hinch and Collins 1993), and Alberta (Robinson and Tonn 1989). Consequently, studies have focused on cold- and coolwater fish communities, and information on warmwater fish communities is lacking (Hinch 1991). Some studies have been conducted on species in tropical lakes (Rodriguez and Lewis 1997, Tejerina-Garro et al. 1998), but information on desert species is limited by scarce water resources and the rarity of multiple lakes within a relatively confined geographic region. Yet, some groupings of water bodies in deserts exist, such as springs and sinkholes, and they support fish communities. A lack of knowledge exists regarding fish abundance as related to abiotic factors in desert systems.

Bitter Lake National Wildlife Refuge near Roswell, New Mexico, contains >60 gypsum sinkholes within a few square kilometers that provide habitat for 6 native fish species. Pecos pupfish (*Cyprinodon pecosensis*) is often the only species present in the 23 sinkholes that contain fish. Pupfish abundances vary greatly among sinkholes, as do abiotic variables such as depth, surface area, temperature, salinity, dissolved oxygen, turbidity, phosphorus, and nitrogen (Hoagstrom and Brooks 1999, Swaim and Boeing, unpublished data). In a desert environment, abiotic factors can have extreme values (Swaim and Boeing, unpublished data). We hypothesized that fish abundance in desert sinkholes is primarily determined by abiotic factors and not biological factors, such as food availability and competition.

Materials and Methods

Fish Sampling

Data collection began at the end of July and lasted approximately 2.5 weeks in both 2006 and 2007. Mark-recapture methods were used to estimate abundance of adult pupfish. Baited minnow traps (approximately 0.25 inch mesh) were set in late afternoon / early evening, and retrieved the following morning. Traps were set from 13 to 20 hours. Captured fish were marked by clipping the upper portion of the caudal fin with scissors.

Due to the smaller caudal fin of Pecos gambusia, mark-recapture methods were not used. Instead, catch-per-unit-effort (CPUE) was calculated to determine relative abundances of Pecos gambusia. In 2006, the mesh size of the minnow traps was too large to reliably capture Pecos gambusia and therefore CPUE was not calculated. In 2007, the traps were lined with window screening that enabled juvenile and adult Pecos gambusia to be captured, as well as juvenile Pecos pupfish.

Standard lengths (mm) and weights (g) of up to fifty adult individuals per species were measured as an index of body condition. The diet of Pecos pupfish was also examined. Several unbaited traps were set for approximately 30 minutes and five captured adults were sacrificed per sinkhole for the majority of sinkholes in which they occurred. Fish were preserved in 10% formalin until they could be processed in the lab. Once in the lab, fish were dissected under a microscope. Length was measured, sex was determined, and quantity of fat deposits was recorded. Gut length was measured, as was relative fullness of the gut. Items in the gut were ranked according to abundance. Pecos gambusia diet was not analyzed.

Environmental Factors – Abiotic

Two morphometric variables, total depth and diameter, were measured with metered rope. Total depth was measured to the nearest tenth of a meter and was measured in the center of each sinkhole. Diameter was measured to the nearest half-meter.

A Hydrolab (Hach Environmental) measured temperature, salinity, dissolved oxygen, pH, and turbidity at 1-m depth intervals and average values for each sinkhole were also calculated. A horizontal water sampler collected water samples also at 1-m depth intervals. The samples from each meter were mixed in a bucket. Two 125-mL water samples were obtained in 2006: one for the analysis of total phosphorus and the second for calcium carbonate. Both samples were kept at 4°C until they were handed over to NMSU's Soil, Water, and Agricultural Testing (SWAT) Lab for analysis. Total phosphorus and calcium carbonate were not measured in 2007. Secchi depth, a measure of lake transparency, was measured with a Secchi disk. Abiotic variables were collected from forty-one sinkholes.

Environmental Factors – Biotic

From the water sample collected in the manner described above, chlorophyll a was measured, giving an estimate of phytoplankton biomass. 100-500 mL of the water sample was filtered with a hand pump onto a GF/C filter. The filters were wrapped in aluminum foil and kept frozen until they could be processed. Filters were ground in a foil-covered test tube with an aqueous acetone-magnesium carbonate solution and allowed to sit overnight. The following day the samples were centrifuged and chlorophyll a was measured with a spectrophotometer (Thermo Spectronic).

Zooplankton samples were collected via vertical tows with a zooplankton net (Ø 20 cm, 110-μm mesh). Two samples were collected per sinkhole and preserved in 95% ethanol. Samples were processed in the lab and species abundance was determined using a dissecting microscope.

Statistical Analyses

Fish abundance – The modified Lincoln-Petersen method was used to estimate adult pupfish abundance. For a few sinkholes, when capture rate was very low, traps were set for an extra night and the Schnabel method was then used to estimate abundance. CPUE was computed as fish per trap per day.

Body condition – Relative weight (Wege and Anderson 1978) was used as an index of body condition. Relative weight is useful because it describes fish in good condition (Anderson and Neumann 1996) and variations in relative weight may be related to ecological conditions (Wege and Anderson 1978). In order to calculate relative weight, a standard weight equation must be developed. I used the regression-line-percentile (RLP) technique (Murphy et al. 1990), which is currently the accepted method for development of standard weight equations (Blackwell et al. 2000). This technique uses 75th percentile weights to calculate a standard weight equation so that fish are represented in better-than-average condition (Wege and Anderson 1978, Murphy et al. 1990). Equations were developed for both pupfish and gambusia; in 2007 a second equation was developed for pupfish to compare it to the equation from 2006. An average relative weight was calculated for each sinkhole.

Fish abundance and body condition vs. environmental factors – Multiple linear regression analyses were used to discern associations between abundance and body condition and environmental factors. Separate regressions were done for both years and both dependent variables. Analyses were further divided into sinkholes containing just pupfish and sinkholes containing multiple species; justification for this will be explained in the Results section. To account for the presence of multiple species, a dummy variable was created where sinkholes containing only pupfish were given a value of 0 and those containing multiple species given a value of 1. Data for gambusia was included in 2007. Fourteen total regression analyses were performed using SAS (SAS Institute 2003).

Diet – Once food items were ranked for each of the five fish sacrificed per sinkhole an average rank of food items per sinkhole was calculated. For example, diatoms were ranked 4, 4, 3, 5, and 6 in the five fish collected from sinkhole 22, giving an average of 4.2. After each food item had been averaged as such, the averages were rescored to provide rankings on a per-sinkhole scale so comparisons could be made among sinkholes. I used cluster analysis (SAS Institute 2003) to evaluate whether sinkholes could be meaningfully grouped based on pupfish diet.

Results

A key result that not only was produced from statistical analyses but was readily observable in the field was that when pupfish occurred with other species their abundance dropped drastically, often by an order or two of magnitude. Because of this finding, analyses were further split into sinkholes that only contained pupfish (n = 14), and those that contained multiple species (n = 6) and results will be presented with this distinction. Additionally, it was not possible to calculate pupfish population estimates in some sinkholes. Instead, CPUE was used because it gave a more accurate picture of pupfish abundance among sinkholes and allowed for all sinkholes to be used in the regression analyses.

Fish Abundance

In 2006, a significant difference in pupfish CPUE was present between the two groups of sinkholes (Figure 1, $p = 0.0123$). Significant differences also existed in 2007 and overall more fish were captured this year (Figure 2, $p = 0.0002$). Gambusia CPUE was significantly different from pupfish CPUE where they co-occurred ($p = 0.0307$). While gambusia CPUE included both adult and juvenile stages, no juvenile pupfish were ever caught in any of the sinkholes where they occurred with gambusia, so direct comparisons could be made. While there were not significant differences in CPUE between years for both groups of sinkholes, catch rate did vary among sinkholes. In particular, among sinkholes that just contained pupfish, sinkholes that had few pupfish in 2006 had higher catch rates in 2007 and vice versa (Figure 3).

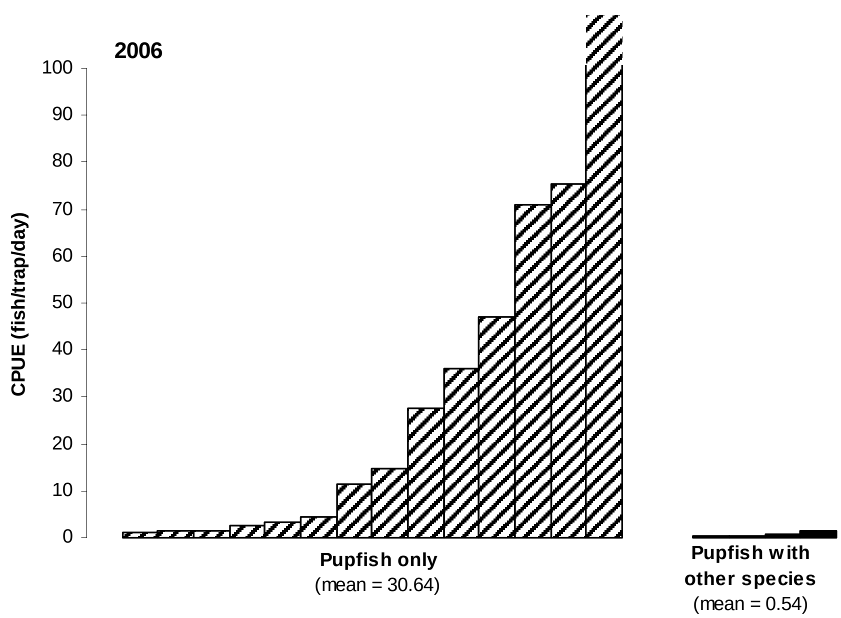


Figure 1. Pecos pupfish CPUE, 2006. Each bar represents a sinkhole.

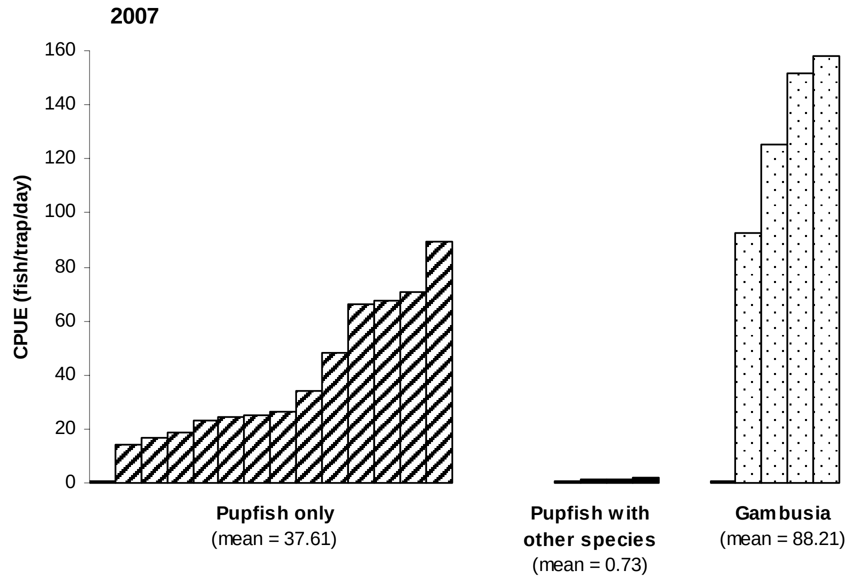


Figure 2. Pecos pupfish and Pecos gambusia CPUE, 2007. Each bar represents a sinkhole.

Body Condition

In 2006, the standard weight equation for pupfish was:

$$log_{10}(W_s) = 3.3599 * log_{10}(Length) – 4.9423$$

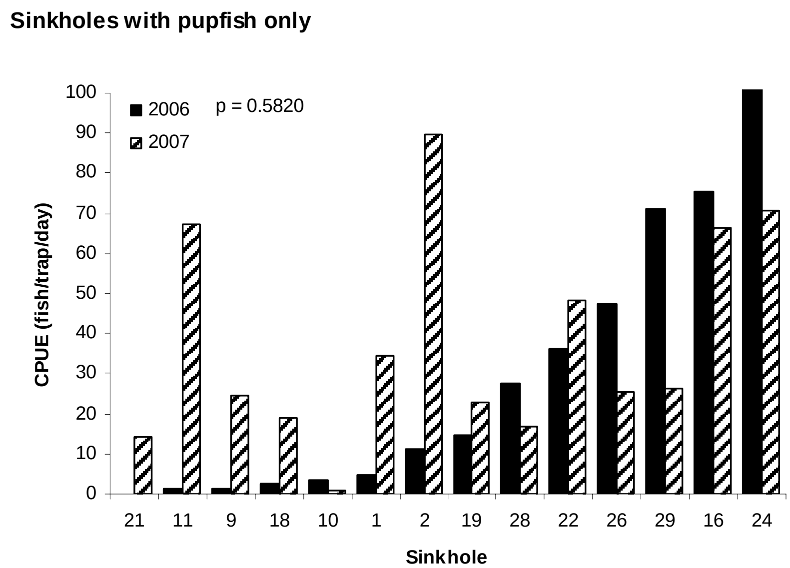
where W_s = the length-specific standard weight and *Length* = standard length in mm. In 2007, this equation was:

$$log_{10}(W_s) = 3.0749 * log_{10}(Length) – 4.5104$$

The standard weight equation developed for gambusia was:

$$log_{10}(W_s) = 3.0259 * log_{10}(Length) – 4.6561$$

In 2006, a t-test for differences in pupfish relative weight between sinkholes with only pupfish and those with pupfish and other species was p = 0.0486 (Figure 4). In 2007, the same analysis resulted in p = 0.7737 (Figure 5). In sinkholes where pupfish and gambusia co-occurred, a t-test for differences in relative weight of pupfish and gambusia was p = 0.6919 (Figure 5). T-tests between years did not show significant differences in relative weight. For sinkholes with pupfish only, p = 0.2332. For sinkholes with pupfish and other species, p = 0.1936 (Figure 6).



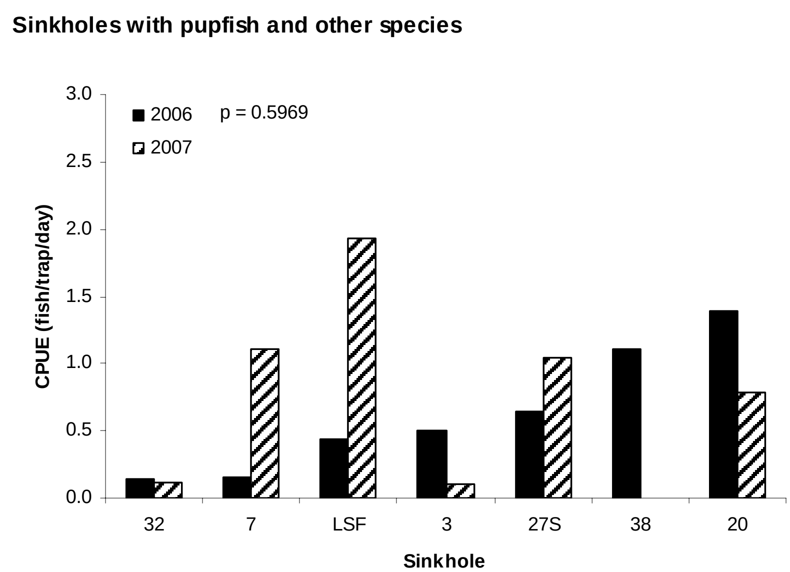


Figure 3. Yearly comparison of Pecos pupfish CPUE. Note the different scales on the y-axis.

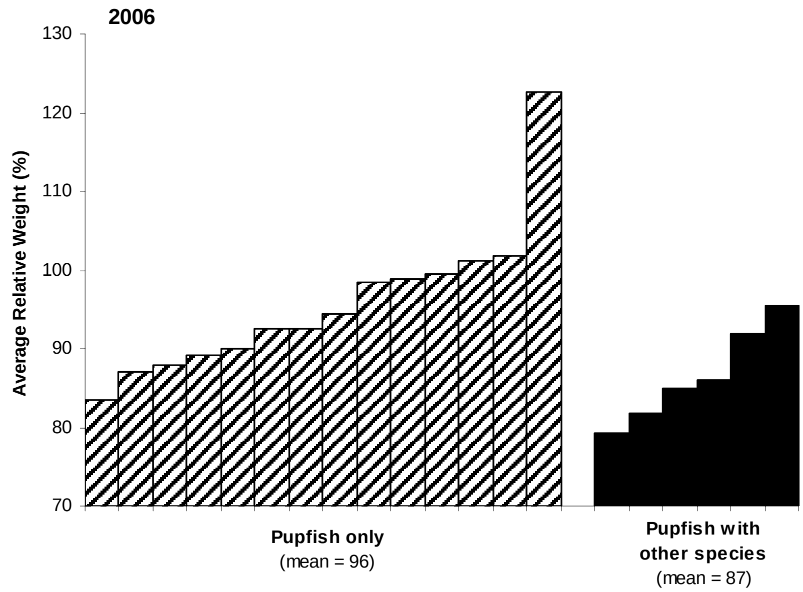


Figure 4. Average relative weight of Pecos pupfish, 2006. Each bar represents a sinkhole.

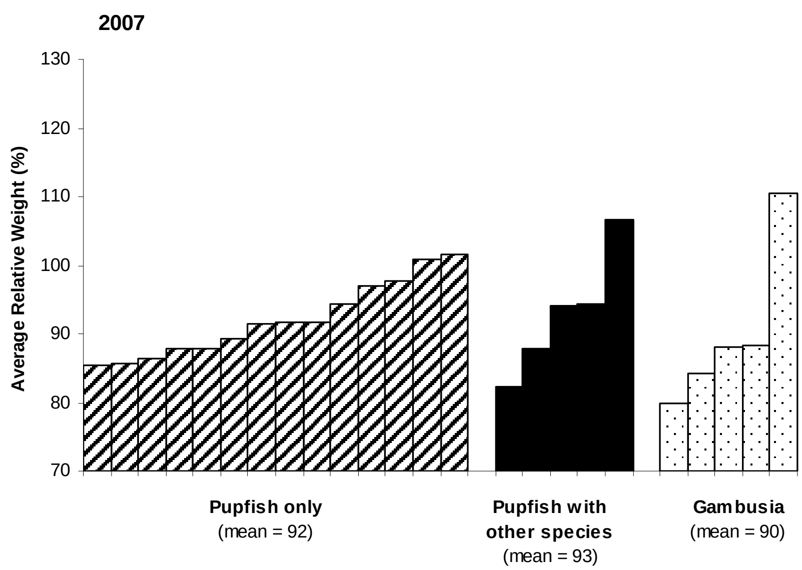
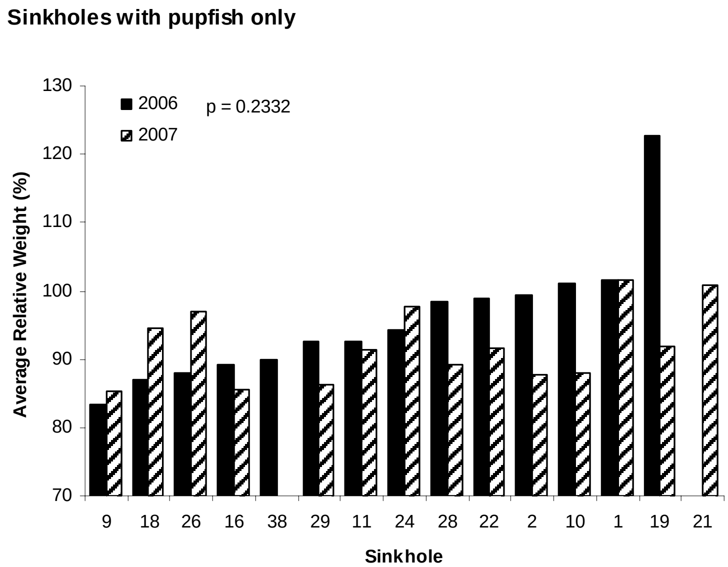


Figure 5. Average relative weight of Pecos pupfish and Pecos gambusia, 2007. Each bar represents a sinkhole.



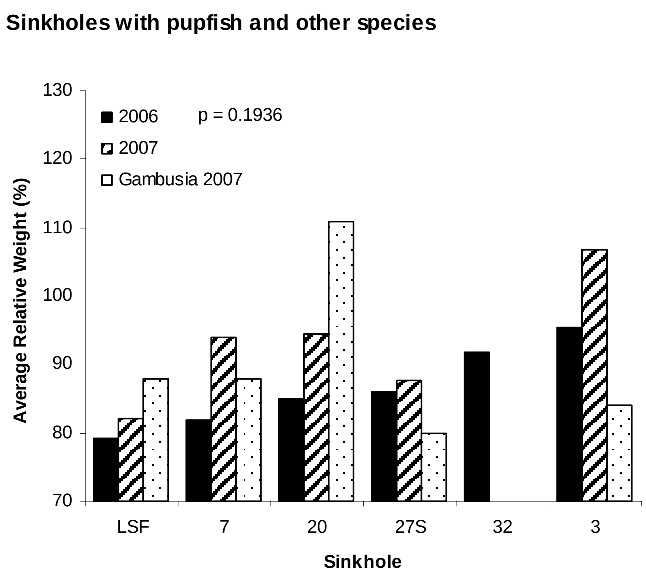


Figure 6. Yearly comparison of Pecos pupfish average relative weight. Pecos gambusia average relative weights from 2007 are also included.

Environmental Factors – Abiotic and Biotic

Appendix 1 lists average values of the environmental variables for each sinkhole. I did not expect total depth to change from 2006 to 2007 as the sinkholes are fed by groundwater. However, from August 2005 through July 2006 rainfall was lower than average and at the time of sampling in 2006, the refuge biologist stated that water levels were the lowest he had seen in his eight years working for the refuge (Gordon Warrick, personal communication). In the following year, rainfall was higher and this was reflected in the greater total depths for 2007. Significant differences did not exist for environmental variables between years with the exception of salinity (p = 0.0055), which decreased from 2006 to 2007, and chlorophyll a (p = 0.0173), which increased from 2006 to 2007. A more-typical amount of precipitation may have contributed to the decreased salinity in 2007. Of note was sinkhole 21: in 2006 this sinkhole had almost no dissolved oxygen and a salinity of 122 ppt, nearly four times saltier than the ocean. Yet this sinkhole contained pupfish. Although no pupfish were captured in the traps, I observed a few swimming at the surface, likely obtaining oxygen from the air. I was able to catch one fish with a small dip net and found it to be emaciated. In 2007, salinity had decreased to 87 ppt and we estimated the pupfish population to be at least 2500, indicating how well pupfish can survive extremely harsh conditions and then thrive once conditions improve.

Abundance and Body Condition vs. Environmental Factors

Figures 7-10 show the results of the fourteen regression analyses. Figure 7 illustrates the results for CPUE in 2006. When all sinkholes were included, the effect of other species on pupfish abundance was confirmed. In sinkholes that contained only pupfish, CPUE was associated positively with oxygen and chlorophyll a and negatively with total depth. Where pupfish occurred with other species, abundance was positively associated with temperature but negatively associated with chlorophyll a. Results were different for pupfish abundance in 2007 (Figure 8). The effect of other species on pupfish abundance was still apparent. However, in both groups of sinkholes, CPUE was associated with temperature: positively in sinkholes with only pupfish, but negatively where pupfish occurred with other species. Temperature was highly correlated with total depth (r = -0.86) in sinkholes where pupfish occurred with other species. Gambusia abundance was related positively to salinity and negatively to oxygen and chlorophyll a.

In 2006, pupfish relative weight was negatively associated with total depth when all sinkholes were included (Figure 9). There was a positive relationship between relative weight and temperature in sinkholes that contained only pupfish, but the relationship is not strong and may be driven by a single observation. If this observation is removed then no factors correlate with relative weight and this may be a more appropriate conclusion. Where pupfish occurred with other species, relative weight was positively associated with salinity and chlorophyll a. In 2007, the presence of other species did affect pupfish relative weight when all sinkholes were analyzed together, as did temperature (Figure 10). In this case, species presence is positively related to relative weight, yet there was no difference in relative weight among the two groups of sinkholes (Figure 5). When sinkholes are split into their respective groups both are positively associated with temperature. In sinkholes with only pupfish, temperature was highly correlated with salinity (r = 0.87). The strength of this model appears to be influenced by one observation. When this observation is removed the p-value becomes much larger (p = 0.3985). Again, it may be more appropriate to conclude that no variables explain relative weight for this group of sinkholes. In sinkholes with multiple species temperature was highly correlated with total depth (r = -0.85). Gambusia relative weight was negatively associated with total depth and salinity.

The results of some of these analyses may be limited by small sample sizes. I suggest that these results should be interpreted for general patterns but placing significance on them should be done judiciously.

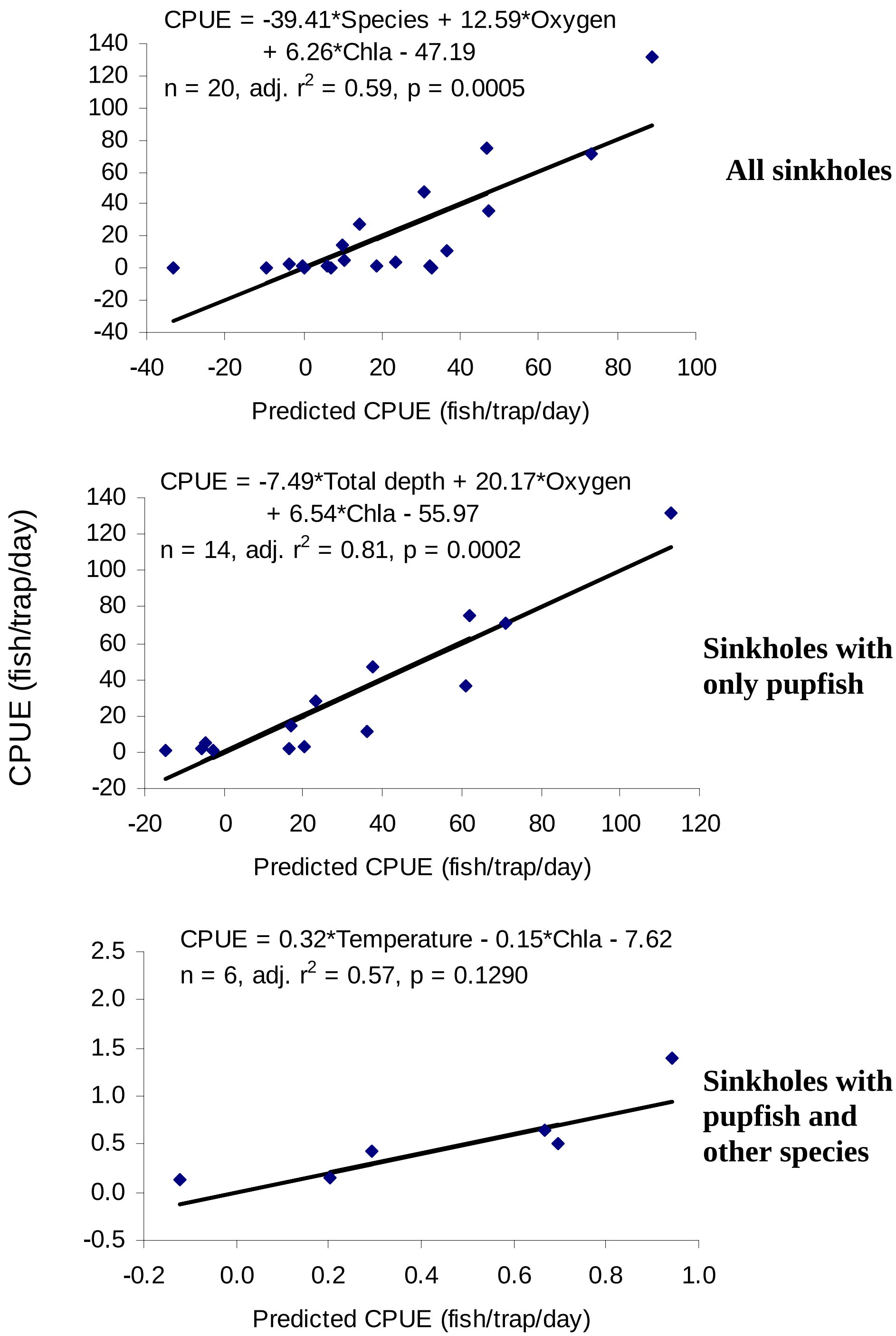


Figure 7. Predicted regression models for pupfish CPUE, 2006. Where there are two or more predictors, the x-axis becomes a combination of the predictors so that results can be displayed graphically.

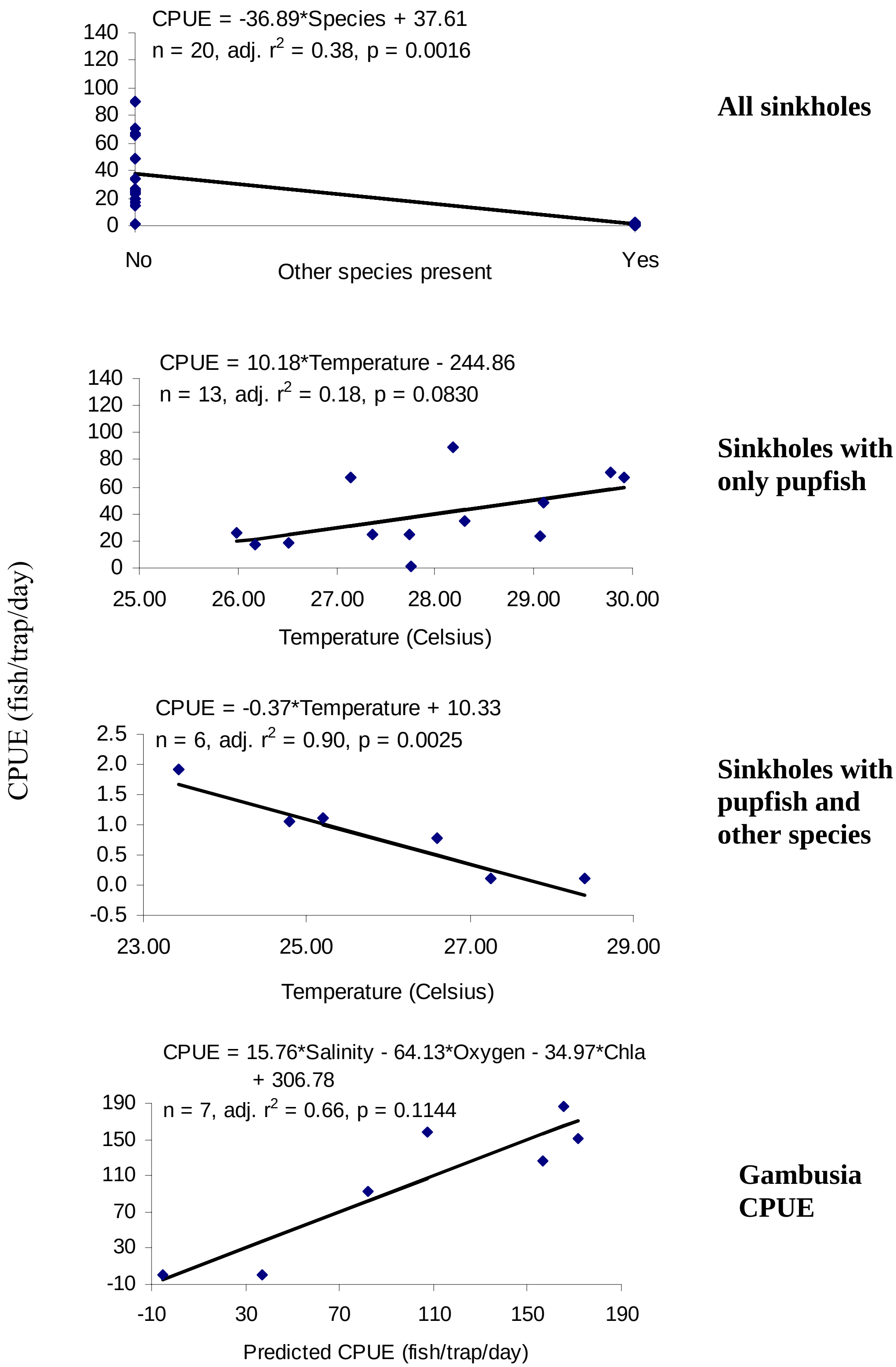


Figure 8. Predicted regression models for pupfish CPUE, 2007. Where there are two or more predictors, the x-axis becomes a combination of the predictors so that results can be displayed graphically. Gambusia CPUE is also included.

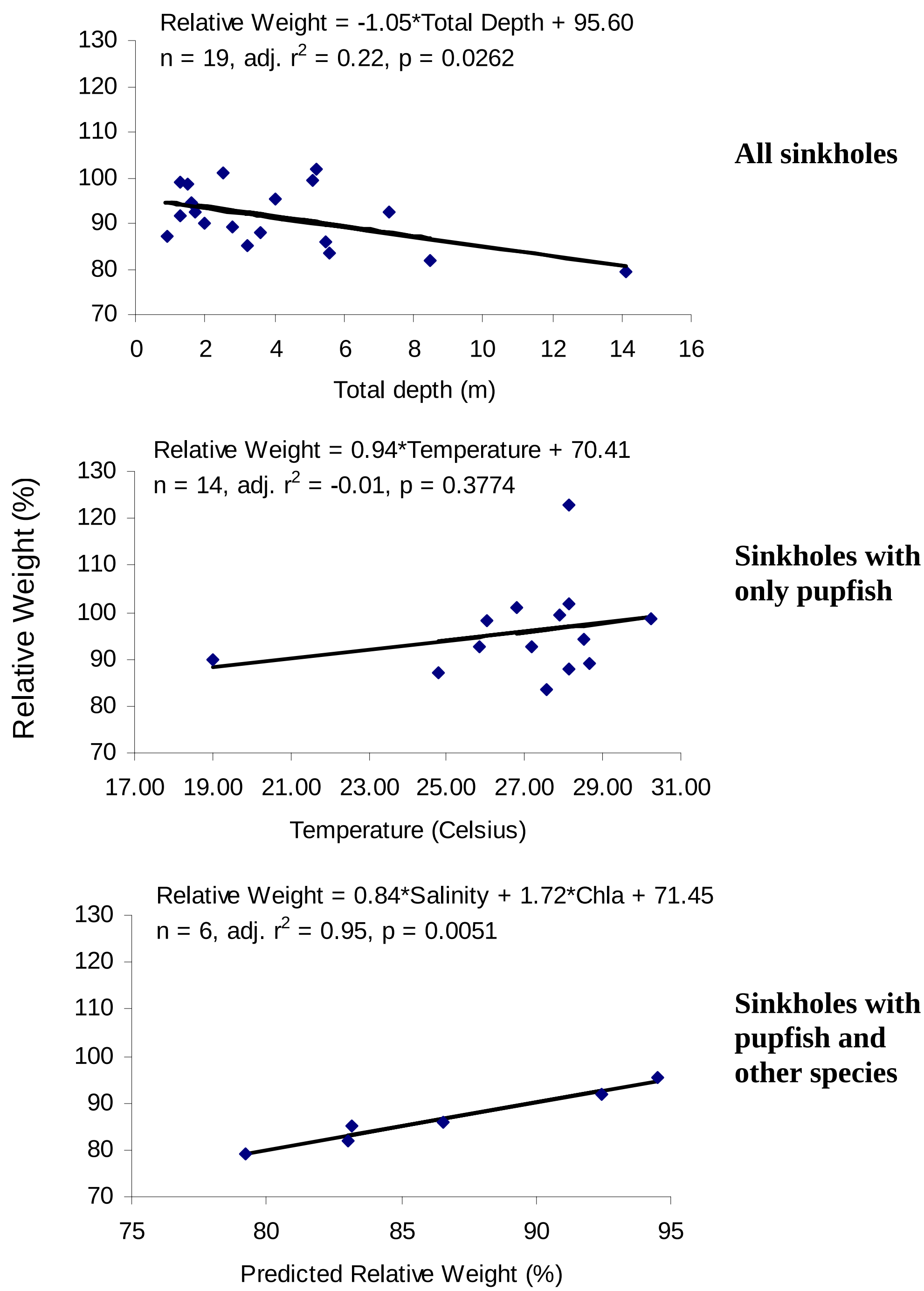


Figure 9. Predicted regression models for pupfish relative weight, 2006. Where there are two or more predictors, the x-axis becomes a combination of the predictors so that results can be displayed graphically.

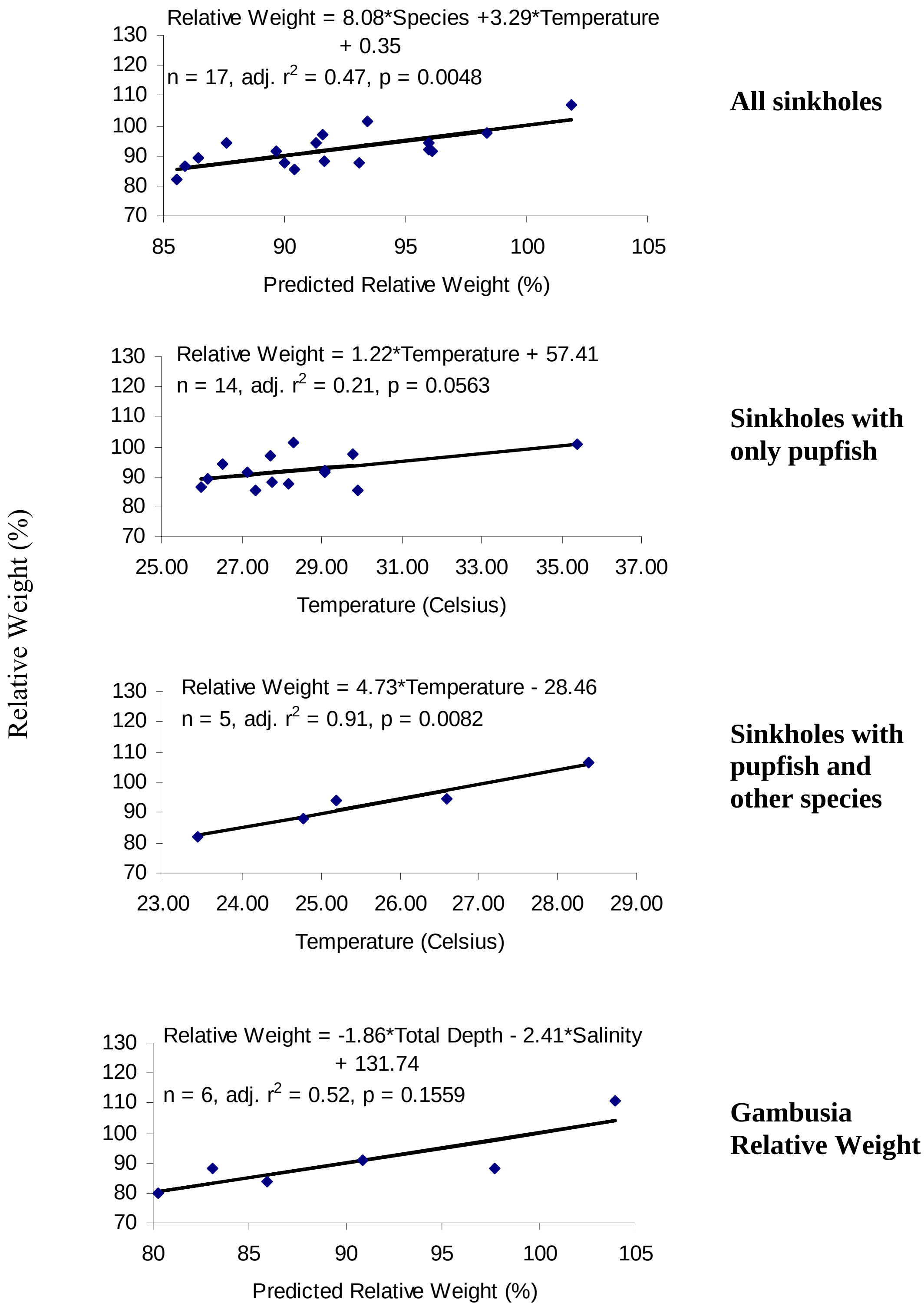


Figure 10. Predicted regression models for pupfish relative weight, 2007. Where there are two or more predictors, the x-axis becomes a combination of the predictors so that results can be displayed graphically. Gambusia relative weight is also included.

Diet

Pupfish from all sinkholes had large amounts of detritus and diatoms in their gut. Cluster 1, which contained sinkholes 16, 19, 22, 24, and 26, was comprised of pupfish that had larger amounts of detritus and algae in their gut. Cluster 2, which contained sinkholes 1, 2, 9, 10, 11, 20, 28, and 29, included pupfish that had larger amounts of diatoms and dinoflagellates in their gut. Lake St. Francis was kept as a separate cluster because pupfish had larger amounts of gypsum and pollen in their gut. Significant differences were present between clusters 1 and 2 for detritus, diatoms, algae, and dinoflagellates.

Conclusions

That Pecos pupfish abundance decreases in the presence of other species was an unexpected result. It is apparent that biotic factors are driving pupfish abundance more than abiotic factors and the mechanisms behind this (i.e., competition, predation, etc.) have yet to be determined. Pecos pupfish occurs most often with Pecos gambusia. It does not appear that the two species are competing for food. While pupfish feed on detritus and diatoms, Pecos gambusia feed primarily on invertebrates at the surface (Bednarz 1979). Another species of gambusia, the mosquitofish (*Gambusia affinis*), is known to eat larval fish (Meffe 1985). It is possible that Pecos gambusia are eating larval pupfish.

Additionally, our results provide information regarding the potential management of these two critical species. Both state-threatened Pecos pupfish and federally-endangered Pecos gambusia have been affected by habitat alteration and non-native species introductions and their historic ranges have been greatly reduced. If refuge managers were to show interest in establishing additional populations of both pupfish and gambusia in sinkholes of Bitter Lake National Wildlife Refuge, then populations would need to be maintained separately.

Presentations

Swaim, K.M. and W.J. Boeing. Relating fish abundance and condition to environmental factors in desert sinkholes. North American Benthological Society, Columbia, SC. June 2007.

Swaim, K.M. and W.J. Boeing. Favorable environmental conditions for management of native fishes in desert sinkholes. International Center for Arid and Semiarid Land Studies, Lubbock, TX. November 2006.

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Appendix 1. Environmental variables measured on sinkholes of Bitter Lake NWR, 2006 and 2007. Values are averaged from 1-meter depth interval measurements. An 'x' indicates the variable was not measured. An asterisk indicates a sinkhole that contains fish. Diameter was not measured in 2007.

Sinkhole	Total Depth (m)		Diameter (m)		Secchi Depth (m)		Temperature (°C)		Salinity (ppt)		Turbidity (NTU)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1*	5.2	5.5	32.0	32.0	2.3	1.7	28.14	28.30	22.97	20.47	0.0	0.6
2*	5.1	5.6	28.5	28.5	3.0	2.3	27.91	28.18	16.80	15.05	0.0	0.2
3*	4.0	4.0	30.0	30.0	2.8	2.95	27.99	28.40	18.71	15.98	0.0	0.6
4	1.7	2	14.5	14.5	1.7	1.25	28.17	28.95	27.61	19.35	0.0	126.8
5	2.3	3	23.0	23.0	0.7	0.75	29.63	32.44	51.16	35.57	1.8	172.9
6	2.1	2.8	21.5	21.5	1.4	1.05	30.47	28.93	48.38	34.48	0.4	119.4
7*	8.5	9.3	41.0	41.0	3.8	2.25	25.95	25.19	7.26	6.95	0.2	0.8
8	0.8	1	10.0	10.0	0.4	0.8	28.20	28.35	67.23	27.78	12.6	10.4
9*	5.6	6.2	39.0	39.0	3.2	2.25	27.58	27.37	25.29	22.83	0.0	0.0
10*	2.5	2.9	17.0	17.0	1.3	1.1	26.81	27.75	17.41	14.60	0.0	0.6
11*	7.3	6.6	36.0	36.0	3.1	1.5	27.16	27.15	31.55	28.64	0.0	0.4
14	0.7	1.4	14.5	14.5	0.1	0.5	30.93	29.85	94.18	27.60	130.9	6.0
15	2.9	3.3	15.5	15.5	0.9	0.85	28.30	28.03	30.84	25.69	0.3	9.4
16	2.8	3.4	17.0	17.0	1.1	1.3	28.68	29.92	49.44	36.49	0.6	45.0
17	2.0	3.2	15.0	15.0	0.7	0.3	27.91	28.26	90.28	53.38	8.7	19.6
18*	0.9	1.8	9.0	9.0	0.6	0.7	24.79	26.52	33.52	13.23	0.0	25.8
19*	2.5	3.3	32.5	32.5	1.8	1.85	28.12	29.07	36.00	25.41	0.0	6.4
20*	3.2	4.2	23.5	23.5	1.3	2.5	27.76	26.60	9.54	8.28	0.0	1.5
21*	3.6	4.2	41.0	41.0	0.3	0.6	26.93	35.37	121.60	86.62	29.2	44.9
22*	1.3	2	7.0	7.0	0.4	0.4	30.26	29.10	90.74	33.74	16.6	19.3
23	2.1	2.9	x	x	0.8	0.8	32.08	34.28	64.64	40.52	3.4	11.9
24*	1.6	2.6	11.0	11.0	0.5	0.75	28.50	29.78	42.88	25.91	15.1	4.9
25	1.4	2.3	20.0	20.0	1.4	1.7	29.31	26.42	24.61	16.75	0.0	2.7
26*	3.6	4	31.0	31.0	0.9	2.35	28.11	27.73	41.38	32.16	0.0	10.8
27N*	0.6	1.2	11.0	11.0	0.6	0.8	26.41	24.97	31.18	16.03	3.8	14.3
27S*	5.5	6.4	26.0	26.0	2.4	2.3	25.90	24.79	17.95	16.42	0.0	1.4
28*	1.5	2.2	10.5	10.5	1.1	0.9	26.03	26.17	33.13	25.07	0.0	5.9
29*	1.7	2.4	15.5	15.5	0.8	0.9	25.86	25.99	30.26	22.70	0.2	4.0
31*	0.9	1	19.0	19.0	0.9	0.95	24.31	20.45	5.92	6.34	0.0	12.2
32*	1.3	1.8	19.0	19.0	1.3	1.4	25.93	27.25	14.09	10.10	0.0	2.6
LSF*	14.1	14.5	59.0	59.0	4.7	4.25	24.73	23.44	9.25	9.00	0.0	0.0
38*	2.0	2.1	7.5	7.5	2.0	1.5	19.00	20.03	4.92	6.26	0.0	10.5
40	1.4	2.6	7.0	7.0	1.0	1.2	24.98	30.94	28.90	14.89	0.0	46.9
42N	0.4	0.5	x	x	0.4	0.5	27.15	30.52	12.47	7.27	3.4	4.5
42S	0.3	0.7	x	x	0.3	0.7	27.65	31.25	17.31	7.31	2.1	115.3
44	1.1	2.2	15.0	15.0	0.1	0.85	24.70	32.37	85.32	85.32	103.4	55.0
48	0.6	1.2	16.0	16.0	0.2	0.2	31.32	27.97	102.22	41.77	50.3	90.6
50	1.7	2.8	x	x	0.1	0.5	25.11	30.80	74.10	38.87	302.6	49.3
51	1.0	1.7	9.0	9.0	0.1	0.8	26.37	32.33	96.98	26.03	106.9	75.4
52	0.6	1.1	14.0	14.0	0.2	0.55	30.63	25.90	91.14	38.40	75.8	7.1
59	2.8	4.3	12.0	12.0	2.8	4.3	25.42	26.20	3.85	4.08	0.0	0.0

Appendix 1. continued.

Sinkhole	Dissolved Oxygen (mg/L)		pH		$CaCO_3$ (mg/L)		Total Phosphorus (mg/L)		Chlorophyll a (mg/m^3)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
1	4.30	5.63	7.81	8.165	3545	x	<0.05	x	0.534	2.670
2	6.11	6.86	8.07	8.40	6570	x	<0.05	x	1.068	2.670
3	5.32	6.85	7.80	8.39	6430	x	<0.05	x	4.272	1.068
4	0.32	1.50	7.29	7.38	7285	x	0.07	x	9.612	118.370
5	0.84	4.65	7.64	7.79	11835	x	<0.05	x	16.020	142.400
6	2.23	1.43	7.94	7.44	8290	x	<0.05	x	6.230	205.590
7	5.30	4.33	7.69	7.99	3485	x	<0.05	x	3.204	0.890
8	0.54	3.25	7.49	8.12	16230	x	<0.05	x	37.380	4.272
9	4.45	3.89	7.99	7.93	8570	x	<0.05	x	3.738	1.602
10	2.97	7.13	7.63	8.13	5940	x	<0.05	x	5.340	3.738
11	3.89	6.45	7.81	8.25	5250	x	<0.05	x	2.670	1.068
14	2.64	2.66	7.60	7.88	16340	x	0.16	x	x	4.272
15	3.15	4.42	7.98	7.99	7710	x	<0.05	x	4.005	81.880
16	5.86	6.57	8.03	8.26	13800	x	0.09	x	3.204	46.725
17	5.99	2.38	8.00	7.87	16275	x	<0.05	x	1.526	18.690
18	1.61	2.29	7.83	7.61	10030	x	<0.05	x	3.738	5.340
19	4.55	3.89	8.08	8.04	9440	x	<0.05	x	0.000	12.816
20	6.31	3.91	8.02	7.90	3800	x	<0.05	x	2.136	4.272
21	0.09	3.28	7.69	7.90	17100	x	0.1	x	6.408	2.670
22	3.97	2.12	7.85	7.90	17920	x	0.09	x	7.120	23.140
23	0.91	2.10	7.93	7.79	11790	x	<0.05	x	10.680	10.680
24	5.50	1.06	8.10	7.75	9715	x	<0.05	x	10.680	1.335
25	9.90	4.65	9.07	8.77	6250	x	<0.05	x	1.602	3.738
26	5.54	3.88	8.02	8.03	9270	x	<0.05	x	1.335	16.554
27N	4.01	2.07	8.06	8.23	8525	x	<0.05	x	0.534	7.476
27S	6.12	4.98	7.92	8.01	5050	x	<0.05	x	-0.534	2.136
28	3.67	3.80	8.23	8.37	8000	x	<0.05	x	2.465	6.230
29	2.04	1.20	8.02	7.80	10005	x	<0.05	x	15.130	5.874
31	6.16	4.58	6.89	7.24	3120	x	<0.05	x	1.335	20.292
32	6.83	6.77	8.66	8.75	5265	x	<0.05	x	5.340	1.068
LSF	4.22	4.26	7.69	7.90	3295	x	<0.05	x	0.000	0.534
38	2.68	1.61	6.87	7.15	2920	x	<0.05	x	2.136	2.136
40	0.17	4.27	7.18	7.75	6605	x	<0.05	x	16.554	x
42N	21.21	14.89	8.71	8.12	4440	x	<0.05	x	5.340	3.204
42S	15.93	15.47	8.83	9.46	5580	x	<0.05	x	1.526	3.204
44	1.15	1.97	7.59	7.61	15730	x	0.23	x	x	32.040
48	6.38	5.53	7.86	8.62	x	x	x	x	x	19.580
50	1.49	2.04	7.45	7.38	14840	x	0.59	x	x	82.770
51	2.14	2.15	7.59	7.67	17530	x	<0.05	x	x	13.350
52	3.76	3.45	7.65	8.51	17535	x	<0.05	x	x	1.602
59	11.70	7.10	8.18	8.02	2410	x	1.57	x	0.534	0.534