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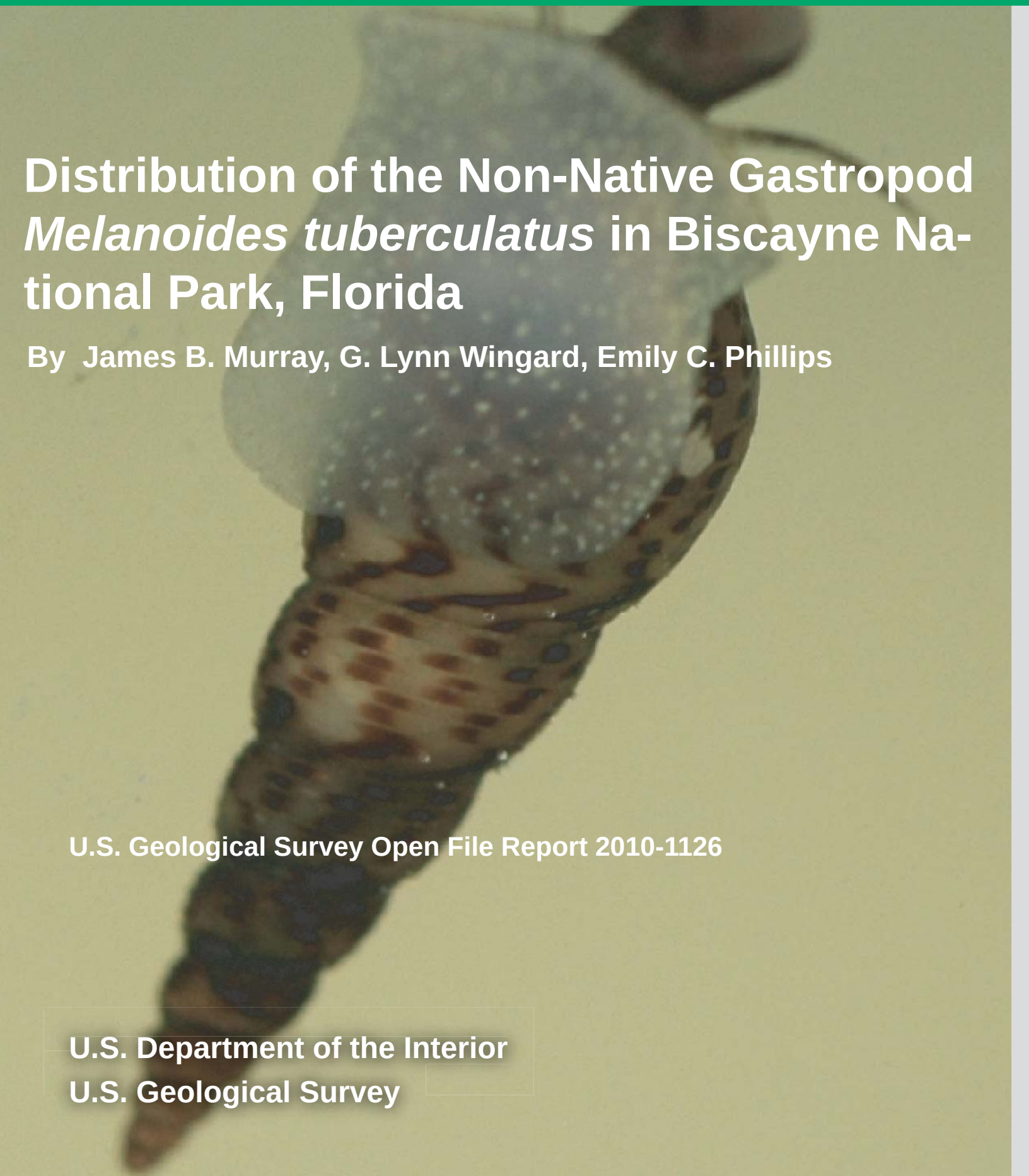

Distribution of the Non-Native Gastropod *Melanoides tuberculatus* in Biscayne National Park, Florida

By James B. Murray, G. Lynn Wingard, Emily C. Phillips

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U.S. Geological Survey

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Introduction

Melanoides tuberculatus (fig. 1), a gastropod that is not native to South Florida, was identified in Biscayne National Park (BNP) while researchers from the U.S. Geological Survey were conducting other studies around the Black Point canals in the summer of 2003. A study to determine the distribution, genetics, and salinity tolerance of this freshwater species began in 2004. For park managers and the recreational users of BNP, the presence of *Melanoides tuberculatus* is cause for concern because it is the intermediate host for several trematode parasites that affect humans and animals in multiple ways:

1) ***Human health concerns*** include parasites (trematode worms) that affect the lung (*Paragonimus westermani)* and the liver (*Clonorchis sinensis*, and *Opisthorchis* sp.). Skin irritations and lesions can also be caused by trematodes that normally infect other species.
2) ***Animal health concerns*** include parasites that affect the eyes of waterfowl (*Philophthalmus megalurus)*, a trematode that burrows into the cartilage of fish and can lead to death (*Centrocestus formosanus)*, and a trematode that infects the muscle tissue of fish and causes multiple abnormalities (*Haplorchis* sp.). When parasite-infected fish or

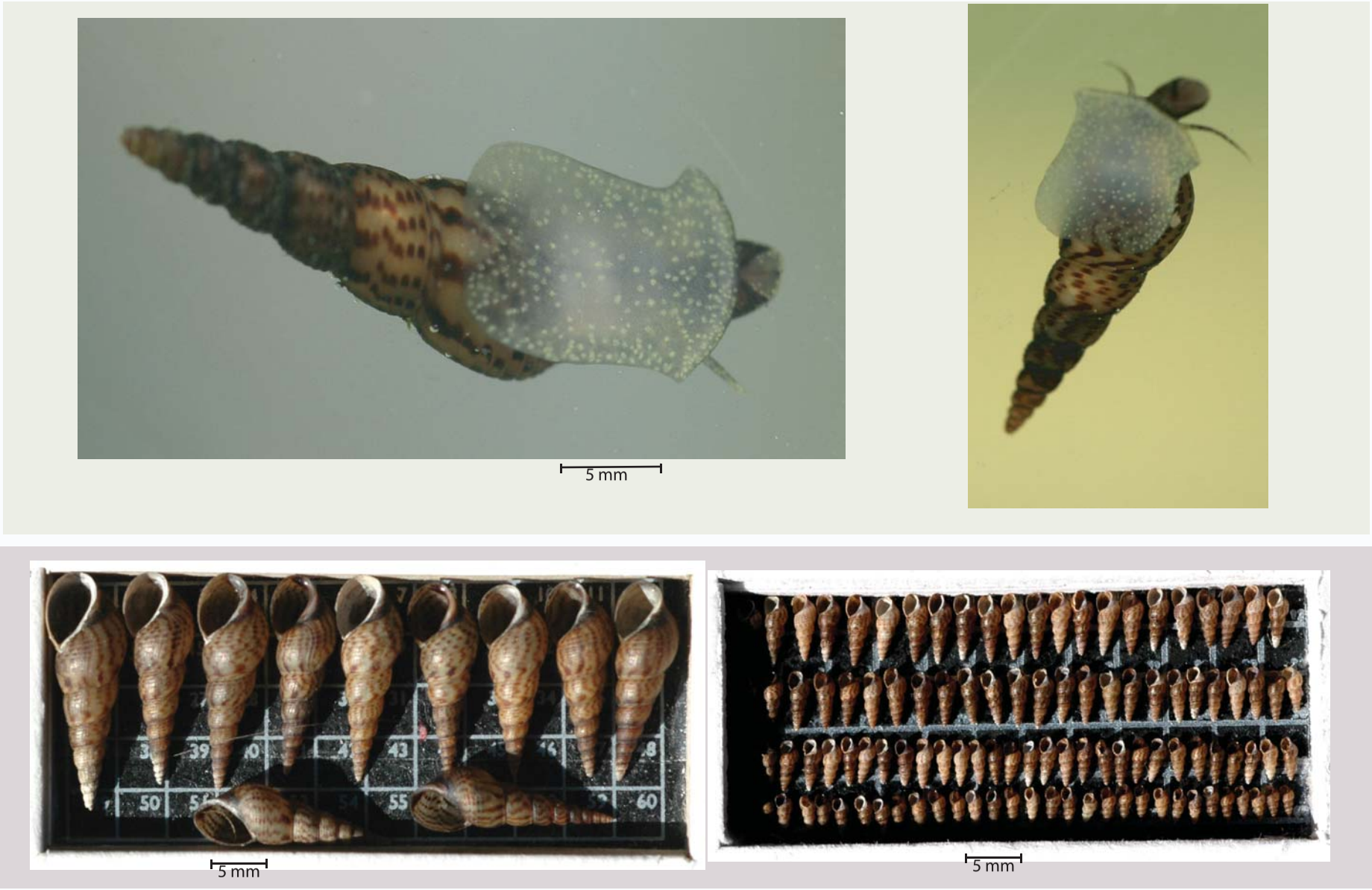

Figure 1.
Melanoides tuberculatus samples collected from Biscayne National Park, FL. The two top images are live specimens used in the salinity resilience experiments. The two bottom images are pristine debris, adults (left) and juveniles (right) collected from BNP.

crustaceans are eaten by birds or mammals, the next stage of the life cycle is in place (fig. 2).

3) ***Native snail species concerns*** include the potential displacement of invertebrate species that make up the natural nearshore benthic communities in BNP. *M. tuberculatus* has very high reproductive rates, reproduces via parthenogenesis, and is live bearing, factors which increase the survivability of the offspring and increase competition for limited resources.

These snails are considered to be freshwater animals in their native habitat of Southeast Asia. However, they have been collected in BNP in both estuarine and marine waters along the western margins of BNP and, as far as 1.7 kilometers (km) from shore at the Black Point canal inflow into Biscayne Bay (383 live per square meter (/m^2). In BNP, *M. tuberculatus* is a benthic inhabitant grazing on micro algal components at the sediment surface. A documented population with as many as 23,000/m^2 was observed at Snapper Creek, near Coral Gables, FL (Roessler and others, 1977), north of BNP.

Methods

Site surveys, collection, and mapping began in 2004 and continued until 2007 in BNP and the surrounding areas, and in the canals that flow into Biscayne Bay. The samples were taken using a Petite Ponar bottom sampler. Three random grab samples were taken at each location, and all samples were examined to determine whether *M. tuberculatus* was present or not. The Black Point canal outflow into the bay was examined in detail due to the large population of *M. tuberculatus* along the canal. A transect consisting of six points was set up along the outflow

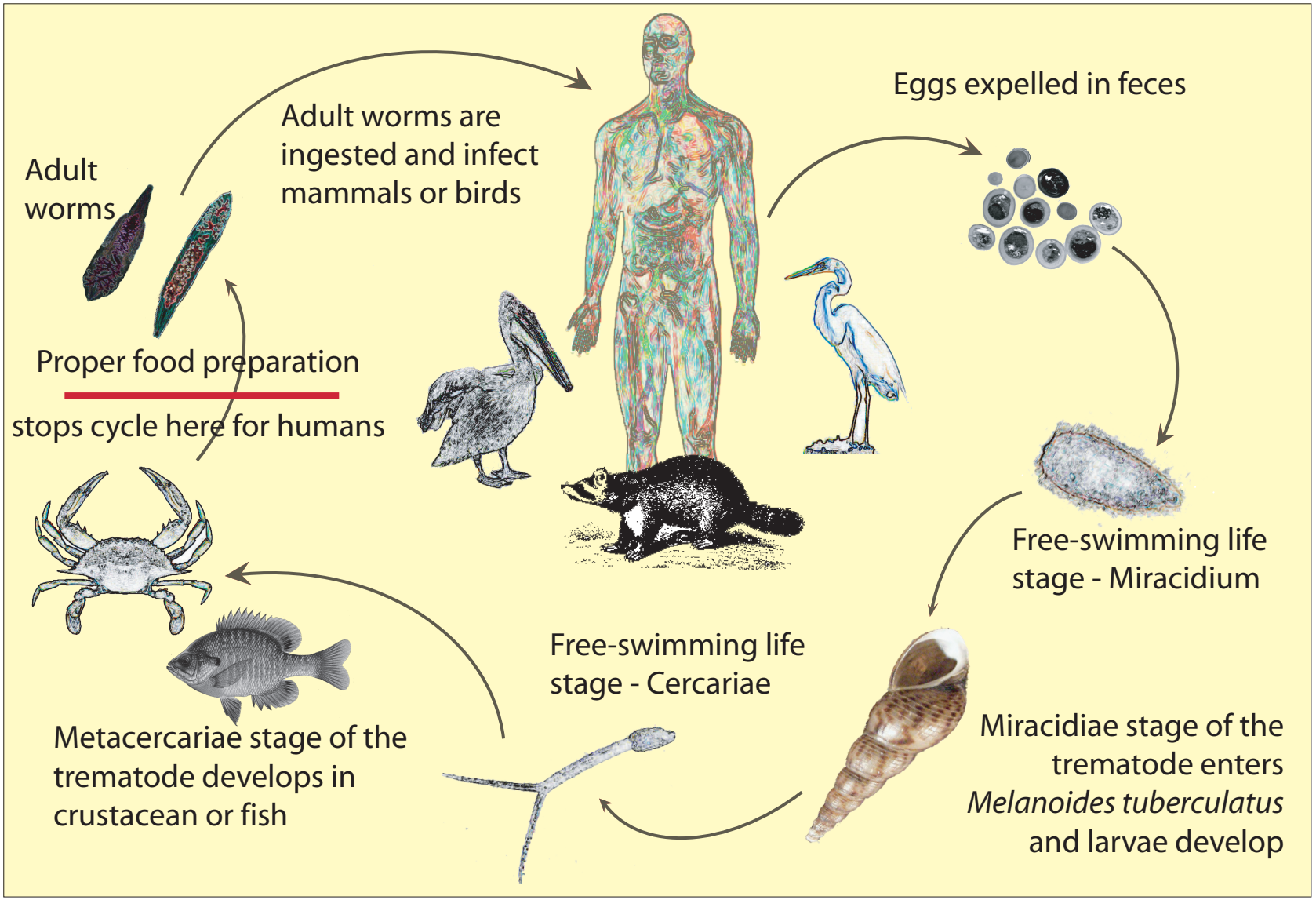

Figure 2.
Life cycle of parasites that utilize *Melanoides tuberculatus* as an intermediate host. Note the multiple vectors in the metacercaria and adult stages (From Wingard and others, 2008).

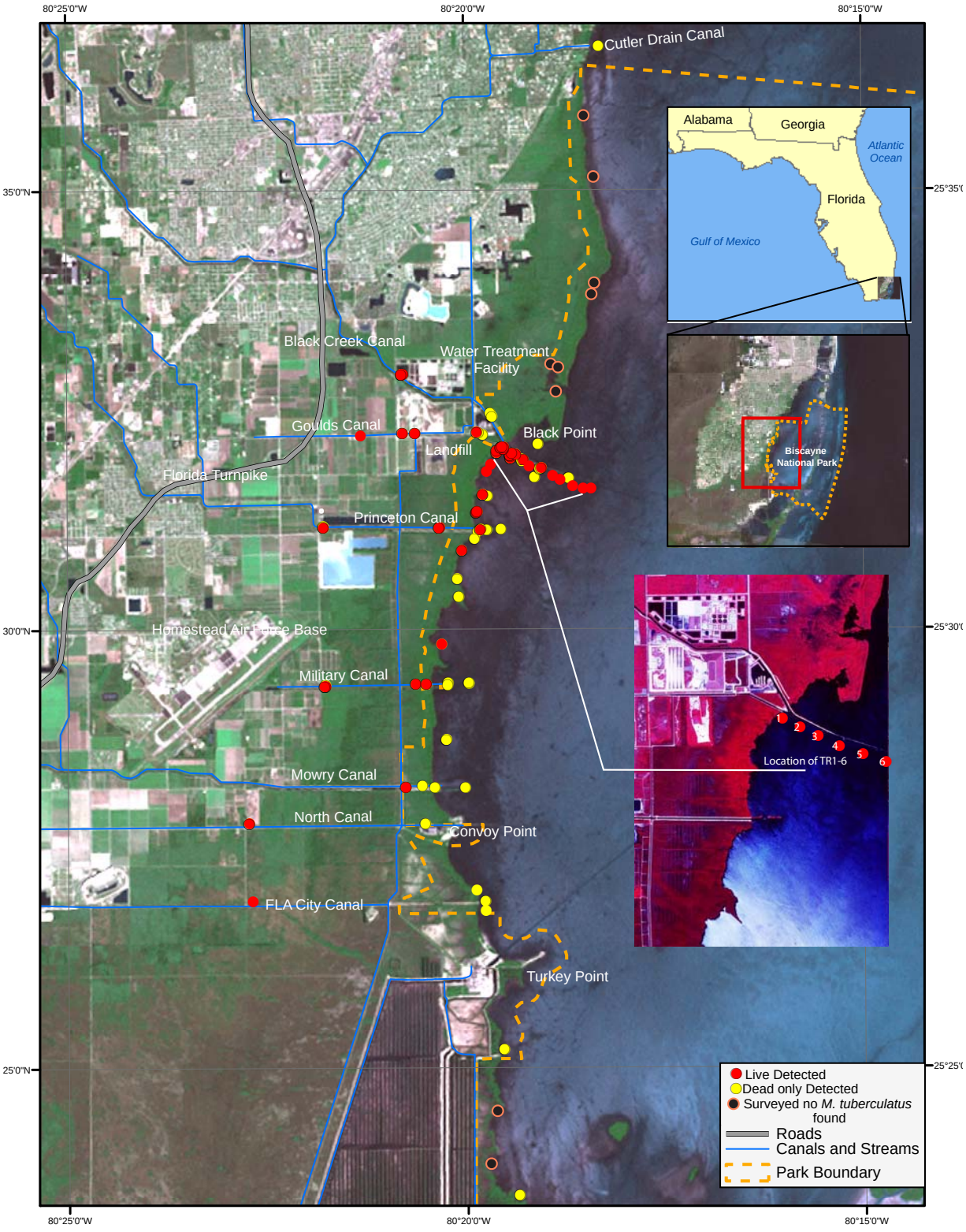

Figure 3
Distribution map, showing live collected and dead collected of the snail *Melanoides tuberculatus* in Biscayne National Park and the adjacent areas. The collections taken from 2004-2005 are shown on this map.

route (TR1-TR6, in fig. 3) The sites were visited three to five times each to record changes in population dynamics and distribution over 3 years. The snails collected live were retained for salinity experiments.

One of the goals of this study was to determine the likelihood of the marine waters of Biscayne Bay limiting the expansion of this freshwater snail into the estuarine and marine environments. Research into the salinity resilience of *M. tuberculatus* was conducted in two different experiments: (1) gradual salinity changes over the course of weeks that would mimic seasonal changes from wet to dry season and (2) rapid salinity changes that mimic tidal and storm cycles. The experimental populations consisted of 10 adult individuals collected from BNP and the surrounding canals for the initial populations. Salinities were changed on a weekly basis starting at 5 parts per thousand (ppt) dissolved salts (limnetic to oligohaline) and increasing incrementally (at approximately 5 ppt per week) up to mesohaline (5-18 ppt), polyhaline (18-30 ppt), and ending with hypersaline (45 ppt) salinities. A third system was maintained at 5 ppt as the experimental control. Thirty adult individuals were used in each system, and daily observations were made to monitor population changes, temperature, and salinity.

Results

M. tuberculatus is present in significant numbers along the shoreline of the western margin of BNP, including both Black Point canals (Black Creek and Goulds Canal) and other canals that flow into the bay. The data from all of the site collections were used to create a map showing the distribution of *M. tuberculatus* within the park and surrounding areas (fig. 3, and app.1). The

data show that *M. tuberculatus* is (or has recently been) living in areas throughout the park along the entire western margin and into the canals that flow into the bay. These marginal populations appear to be expanding in geographic range and numbers throughout the park. The population size and expansion at the Black Point canal transect show a dramatic increase in the number of individuals between 2004 and 2007 (fig. 4).

The expansion and growth of the *M. tuberculatus* populations are in part due to an apparent adaptation to higher salinities, as is demonstrated by the results of the salinity tolerance experiments (fig. 5). The tested experimental populations increased in number and went on to reproduce a second generation in the polyhaline and euhaline systems. The snails in both of the experimental estuarine and the marine systems increased their population size by 300 to 400 percent, while the 5-ppt control system had no reproduction. The snails in the higher saline waters were maintained at the high salinities for 3 more months with no die-off. Juveniles grew at a steady rate with no apparent abnormalities. The rapid change (35-40 ppt to 5-10 ppt) salinity experiments had similar results with no fatalities. The snails would retract in their shells and go into stasis for more than 24 hours when initially stressed, so normal tide cycles have little effect. When the water was left at the high salinity (40 ppt) for several days and the snail emerged, there was a 3 percent death rate.

Summary

The areas of Biscayne Bay where *M. tuberculatus* have been found also are the areas used for many recreational activities including fishing, crabbing, and swimming. Fishing and crabbing in and around the canals are of particular concern due to the possibility of crustaceans and fish being infected by parasites from *M. tuberculatus*. Improper handling and preparation of any

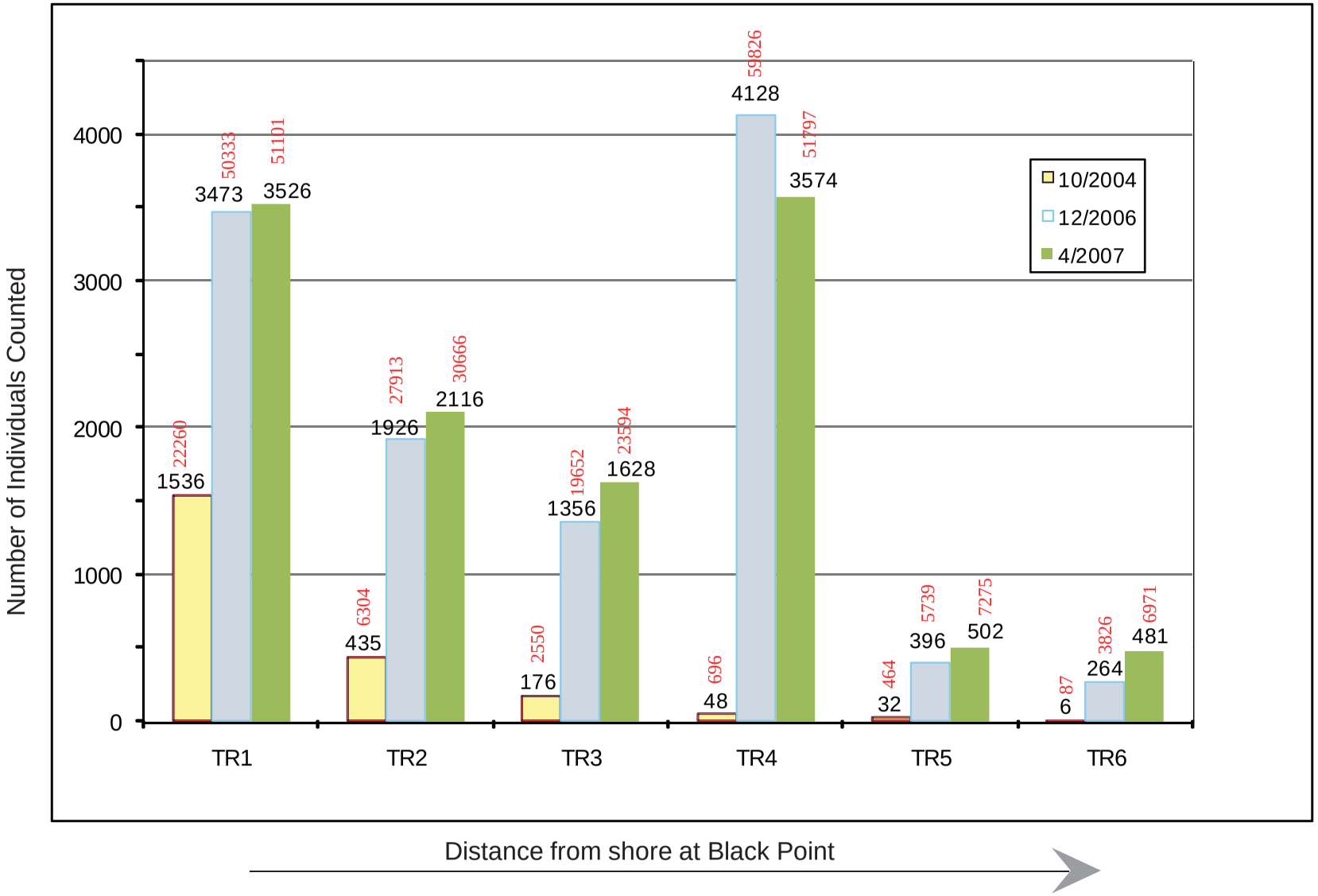

Figure 4.
Raw count of all *Melanoides tuberculatus*, live and dead, collected in 2004 through 2007 along a transect from Black Point. Black numbers are actual counts from three bottom grab samples (using a Petite Ponar device) at each site. Red numbers represent estimates of the numbers of individuals per square meter based on the raw count from the ponar samples, which collect 0.069 m^2.

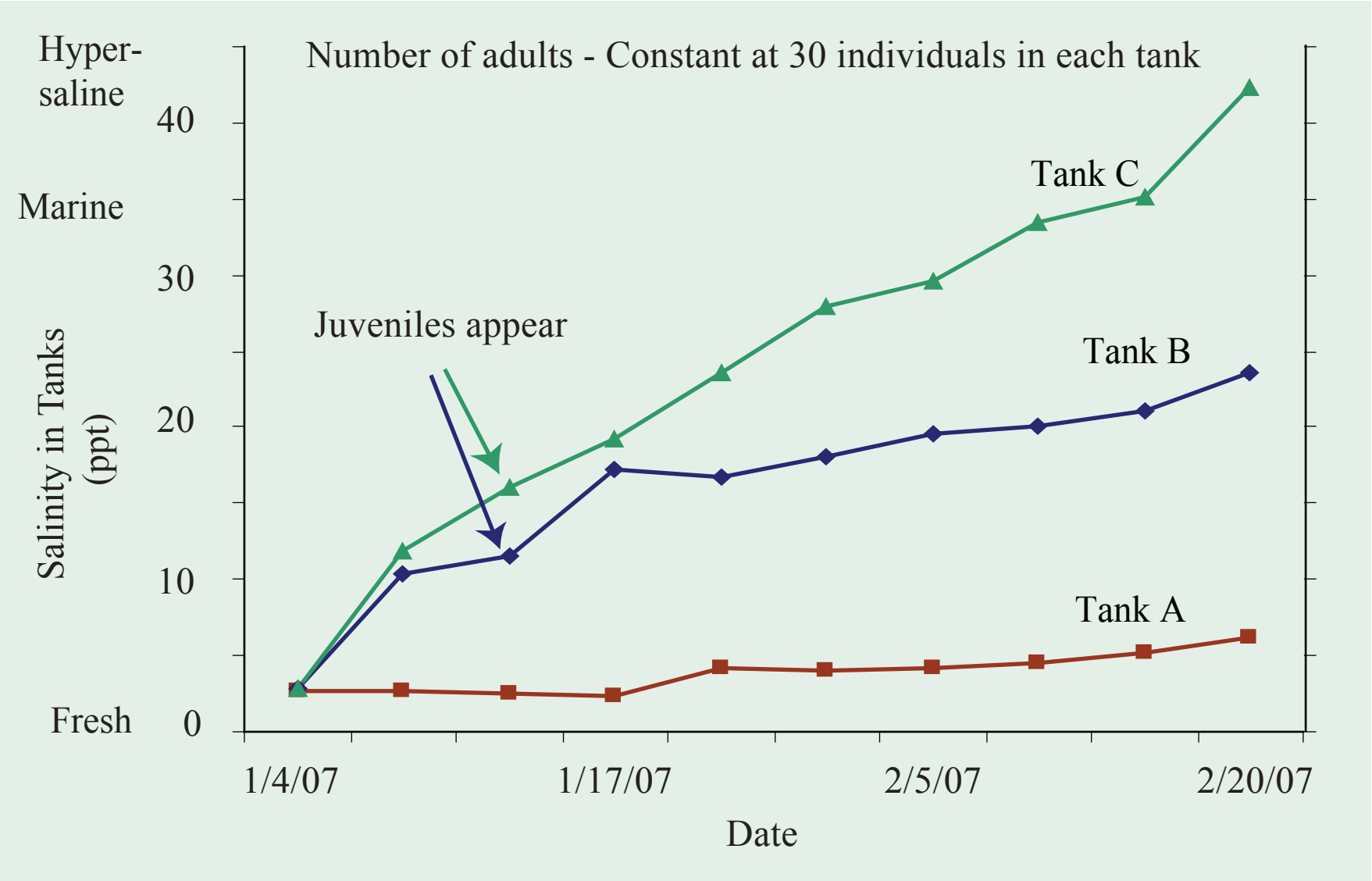

Figure 5. Graph showing salinity during a 6-week experiment to test the tolerance of *Melanoides tuberculatus* for increasing salinity. Starting point salinity was < 5 parts per thousand (ppt) dissolved salts. Salinities in tanks B and C were gradually increased to determine the effects on Melanoides, while tank A was maintained at approximately 5 ppt as a control. All 30 adults placed in each tank survived and juveniles appeared in tanks B and C, confirming that the freshwater snail *M. tuberculatus* is adapting to estuarine salinities.

infected catch can lead to infection. While treatments are available for parasite infection, the condition can go undetected for some time, allowing the life cycle to begin again. With the rapid population growth, nearby landfill, and sewage treatment areas, *M. tuberculatus* fills a niche that will allow for the rapid spread of any or all of these parasites throughout the margins of BNP. Monitoring the presence and population expansion of *M. tuberculatus* in BNP and surrounding areas would be benificial. Its apparent ability to withstand broad ranges of salinity suggests multiple concerns for BNP managers and the visitors that use the park:

1. With increased tolerance to salinity, the expansion will likely continue, and native species of benthic animals will be affected or displaced in BNP.
2. If the population and distribution of *M. tuberculatus* increase due to sustainable high reproduction rates, higher tolerances to varying salinities, and projected global climate changes, the risk of parasite infection to native animals and humans will likely increase.

Acknowledgments

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Appendix A **Site information for the *Melanoides tuberculatus* distribution and resilience study.**

ID Number	Site	N Latitude	W Longitude	Salinity (ppt) Top	Temp (°C) Top	pH (top)	Dissolved O_2 (top)	Date Collected	Melanoides found live	Debris-Melanoides
GLW0203 BB07	Black Point 1	not recorded	not recorded	21.37	22.37	8.43	10.3	2/3/03	N	Y
GLW0603 BB07	Black Point 1	N25 31.733'	W80 19.171'	5.7	28.74	8.12	2.64	6/19/03	N	Y
TMC1103 BB07	Black Point 1	not recorded	not recorded	5.4	26.5			11/5/03	N	Y
GLW1004 BB07	Black Point 1	N25 31.968'	W80 19.473'	9.84	26	7.45	3.5	10/25/04	N	N
GLW1004 BB13	Black Point north	not recorded	not recorded	15.96	25.65	7.38	3.42	10/25/04	Y	Y
GLW1004 BB CAN BCC	Black Creek Canal	N25 32.899'	W80 20.841'	0.24	26.4	7.14	2.43	10/25/04	N	Y
GLW1004 BB07 TR1	Black Point 1 Transect 1	N25 32.032'	W80 19.647'	15.96	27.54	7.6	3.44	10/26/04	N	Y
GLW1004 BB CAN PRN	Princeton Canal	N25 31.129'	W80 19.858'	18.54	27.78	7.61		10/26/04	Y	Y
GLW1004 BB CAN MOW	Mowry Canal	N25 28.201'	W80 20.358'	8.02	26.73	7.25	4.89	10/26/04	N	N
GLW1004 BB CAN MIL	Military Canal	N28 29.378'	W80 20.305'	8.07	27.75	7.43		10/26/04	N	N
GLW1004 BB07 TR3	Black Point 1 Transect 3	N25 31.978'	W80 19.476'	9.95	26.19	7.49	3.58	10/26/04	Y	Y
GLW1004 BB14	Black Point south	N25 31.330'	W80 19.909'	12.27	25.65	7.22		10/26/04	Y	Y
GLW1004 BB07 TR4	Black Point 1 Transect 4	N25 31.930'	W80 19.315'	15.37	26.35	7.62	4.13	10/26/04	N	Y
GLW1004 BB07 TR5	Black Point 1 Transect 5	N25 31.833'	W80 19.086'	19.68	26.35	7.79	4.86	10/26/04	Y	Y
GLW1004 BB07 TR2	Black Point 1 Transect 2	N25 32.075'	W80 19.574'	16.19	27.19	7.66	3.95	10/26/04	Y	Y
GLW1004 BB07 TR6	Black Point 1 Transect 6	N25 31.734'	W80 18.793'	20.54	26.47	7.81	5.25	10/26/04	N	Y
GLW0305 BB07 TR6	Black Point 1 Transect 6	N25 31.746'	W80 18.758'	22.78	28.99	8.32	7.51	3/25/05	Y	Y
GLW0305 BB07 TR4/5	Black Point 1 Transect between TR4 and TR5	N25 31.900'	W80 19.209'	22.07	29.47	8.36	7.33	3/25/05	Y	Y
GLW0305 BB07 TR3	Black Point 1 Transect 3	N25 31.986'	W80 19.406'	22.27	29.66	8.45	8.51	3/25/05	N	Y
GLW0705 BB CAN NOR	North Canal	N25 27'47.22"	W80 20'48.55"	0.32	26.58	7.85	0	7/9/05	N	Y
GLW0705 BB CAN MOW	Mowry Canal	N25 28.283'	W80 22.766'	0.34	26.22	7.58	3.07	7/9/05	Y	Y
GLW0705 BB CAN MIL	Military Canal	N25 29.350'	W80 21.804'	0.27	27.29	7.58	2.9	7/9/05	N	Y
GLW0705 BB CAN FCC	Florida City Canal	N25 26.914'	W80 20.997'	0.32	26.61	7.77		7/9/05	N	N
GLW0705 BB CAN CRPP	Cutler Ridge Power Plant	N25 37.810'	W80 17.744'	19.1	32.87	8.06		7/9/05	N	Y
GLW0705 BB CAN BCC	Black Creek Canal	N25 32.55'	W80 19.90'	0.24	27.14	7.71	3.09	7/9/05	N	N
GLW0705 BB CAN PRN	Princeton Canal	N25 31.161'	W80 21.828'	0.34	25.93	7.49	2.89	7/9/05	N	N

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ID Number	Site	N Latitude	W Longitude	Salinity (ppt) Top	Temp (°C) Top	pH (top)	Dissolved O_2 (top)	Date Collected	Melanoides found live	Debris-Melanoides
GLW0705 BB07 TR6	Black Point 1 Transect 6	N25 31.722'	W80 18.801'	1.68	30.46	7.99	5.13	7/11/05	N	Y
GLW0705 BB07 TR3	Black Point 1 Transect 3	N25 31.976'	W80 19.478'	1.56	29.87	7.79	4.63	7/11/05	N	N
GLW0705 BB07 TR4	Black Point 1 Transect 4	N25 31.918'	W80 19.314'	1.29	30.06	7.98	5.67	7/11/05	N	Y
GLW0705 BB07 TR1	Black Point 1 Transect 1	N25 32.009'	W80 19.650'	0.94	32.01	8.13	5.94	7/11/05	N	Y
GLW0705 BB CAN C111	C111 Canal	N25 15.878'	W80 25.929'	14.31	27.53	7.7	0	7/11/05	N	Y
GLW0705 BB07 TR5	Black Point 1 Transect 5	N25 31.834'	W80 19.099'	1.53	30.12	7.97	0	7/11/05	N	N
GLW0705 BB07 TR2	Black Point 1 Transect 2	N25 32.067'	W80 19.560'	2.23	30.17	8.17	6.65	7/11/05	N	Y
GLW1206 BB MEL01	Convoy to Black - Mowry	N25 28.197'	W80 20.440'	5.83	23.72	8.48	2.66	12/6/06	N	Y
GLW1206 BB MEL05	Convoy to Black - Princeton Canal Mouth	N25 31.136'	W80 19.860'	15.72	22.54			12/7/06	N	N
GLW1206 BB MEL04	Convoy to Black - Drainage N Princeton mouth	N25 31.336'	W80 19.901'					12/7/06	N	N
GLW1206 BB MEL03	Convoy to Black - Drainage N of Princeton	N25 31.542'	W80 19.829'					12/7/06	Y	Y
GLW1206 BB07 TR1	Black Point 1 Transect 1	N25 32.066'	W80 19.596'	15.68	26.3			12/7/06	Y	Y
GLW1206 BB MEL06	Convoy to Black - Princeton Canal/E End of Channel	N25 31.144'	W80 19.598'	10.22	25.6			12/7/06	Y	Y
GLW1206 BB07 TR2	Black Point 1 Transect 2	N25 32.046'	W80 19.560'	15.19	25.6			12/7/06	N	Y
GLW1206 BB07 TR6	Black Point 1 Transect 6	N25 31.720'	W80 18.748'	23.93	23.12	8.66	1.18	12/7/06	N	N
GLW1206 BB07 TR5	Black Point 1 Transect 5	N25 31.831'	W80 19.101'	27.17	23.46	8.72	1.27	12/7/06	N	Y
GLW1206 BB07 TR3	Black Point 1 Transect 3	N25 31.946'	W80 19.475'	10.79	25.1			12/7/06	N	Y
GLW1206 BB07 TR4	Black Point 1 Transect 4	N25 31.918'	W80 19.326'	19.25	25.2			12/7/06	N	Y
GLW1206 BB MEL02	Convoy to Black - Drainage N of Princeton	N25 31.517'	W80 19.764'	12.78	26.8			12/7/06	N	N
GLW1206 BB MEL19	Convoy to Black - Mowry	N25 28.229'	W80 20.590'	12.64	22.21			12/8/06	N	N
GLW1206 BB MEL29	Black Point - Black Creek	N25 32.432'	W80 19.718'	21.56	22.42			12/8/06	N	N
GLW1206 BB MEL09	Convoy to Black - Drainage south of Princeton	N25 30.895'	W80 20.088'	17.16	22.5			12/8/06	N	N

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ID Number	Site	N Latitude	W Longitude	Salinity (ppt) Top	Temp (°C) Top	pH (top)	Dissolved O_2 (top)	Date Collected	Melanoides found live	Debris-Melanoides
GLW1206 BB MEL20	Convoy to Black - Mowry Canal Out past mouth	N25 28.188'	W80 20.062'	17.65	22.24			12/8/06	Y	N
GLW1206 BB MEL15	Convoy to Black - Military	N25 29.380'	W80 20.565'	16.34	23.56			12/8/06	N	N
GLW1206 BB MEL08	Convoy to Black - Cove S of Princeton	N25 31.030'	W80 19.925'	17.6	22.86			12/8/06	N	N
GLW1206 BB MEL07	Convoy to Black - Drainage just south of Princeton	N25 31.112'	W80 19.883'	18.13	22.41			12/8/06	Y	N
GLW1206 BB MEL10	Convoy to Black - Cove N Fender Pt.	N25 30.570'	W80 20.148'	18.33	21.98			12/8/06	Y	Y
GLW1206 BB MEL11	Convoy to Black - N side Fender Pt.	N25 30.301'	W80 19.996'	18.13	22.14			12/8/06	Y	N
GLW1206 BB MEL12	Convoy to Black - South of Fender Point Inlet	N25 30.374'	W80 20.130'	17.08	22.3			12/8/06	Y	Y
GLW1206 BB MEL13	Convoy to Black - Between Fender Point and Military	N25 29.828'	W80 20.347'	16.59	22.02			12/8/06	N	N
GLW1206 BB MEL14	Convoy to Black - Cove N. of Military	N25 29.578'	W80 20.370'	16.35	22.23			12/8/06	N	N
GLW1206 BB MEL18	Convoy to Black - S Military and N Mowry	N25 28.567'	W80 20.410'	16.41	22.13			12/8/06	N	N
GLW1206 BB MEL16	Convoy to Black - Mouth of Military	N25 29.358'	W80 20.264'	17.36	22.6			12/8/06	Y	N
GLW1206 BB MEL17	Convoy to Black - S Military and N Mowry	N25 28.984'	W80 20.349'	17.28	22.09			12/8/06	N	N
GLW1206 BB MEL27	Black to Chicken - Natural Creek just N of Black Point	N25 33.009'	W80 18.865'	27.11	20.8			12/9/06	N	N
GLW1206 BB MEL26	Black to Chicken - Natural Drainage N of Black Creek	N25 33.932'	W80 18.411'	27.39	20.54			12/9/06	Y	Y
GLW1206 BB MEL21	Black to Chicken - Chicken Key	N25 37.241	W80 17.216	29.97	20.58			12/9/06	Y	Y

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ID Number	Site	N Latitude	W Longitude	Salinity (ppt) Top	Temp (°C) Top	pH (top)	Dissolved O_2 (top)	Date Collected	Melanoides found live	Debris-Melanoides
GLW1206 BB MEL25	Black to Chicken - Canal S of Cutler Canal	N25 35.022'	W80 18.407'	26.47	20.63			12/9/06	Y	N
GLW1206 BB MEL24	Black to Chicken - South of Cutler Canal	N25 36.098'	W80 18.468'	27.83	20.79			12/9/06	Y	N
GLW1206 BB MEL23	Black to Chicken - Cutler Canal Mouth	N25 36.638	W80 18.377'	27.54	20.96			12/9/06	Y	N
GLW1206 BB MEL22	Black to Chicken - Mouth of Canal outflow from Cutler	N25 37.661'	W80 17.174'	27	20.82			12/9/06	Y	N
GLW1206 BB13	Black Point North	N25 32.797'	W80 18.783'	27.14	20.87			12/9/06	Y	N
GLW1206 BB MEL28	Black Point - Gould's Canal	N25 32.217'	W80 19.824'	21.67	21.95			12/9/06	N	N
GLW1206 BB CAN MIL	Military Canal	N 25.489168	W 80.363630					12/10/06	N	N
GLW1206 BB MEL31	Convoy to Arsenicker - West of Mangrove Point	N25 23.548'	W80 19.398'	26.35	20.99			12/10/06	Y	N
GLW1206 BB CAN MOW	Mowry Canal	N 25.471157	W 80.379545					12/10/06	Y	Y
GLW1206 BB CAN PRN	Princeton Canal	N 25.519573	W 80.363852	0.3	22.06			12/10/06	Y	Y
GLW1206 BB CAN GOUL	Gould's Canal	N 25.537232	W 80.347151	0.72	22.46			12/10/06	Y	Y
GLW1206 BB CAN BCC	Black Creek Canal	N 25.548442	W 80.347026	0.3	23.7			12/10/06	N	N
GLW1206 BB MEL30	Convoy Point	N 25.463409	W 80.333387					12/10/06	N	N
GLW1206 BB MEL32	Convoy to Arsenicker - Turtle Point	N25 25.211'	W80 19.583'	20.73	20.74			12/10/06	N	Y
GLW1206 BB MEL33	Convoy to Arsenicker - FLA City Canal Mouth	N25 26.881'	W80 19.026'	18.83	21.2			12/10/06	N	N
GLW1206 BB CAN NOR	North Canal	N25.463071	W80.379135					12/10/06	N	N
GLW0307 BB CAN BCC	Black Creek Canal	N25 32.902	W80 20.843	0.19	26.09	8.77	6.22	3/30/07	N	N
GLW0307 BB CAN GOUL	Gould's Canal	N25 32.232	W80 20.671	0.36	25.56	8.81	6.22	3/30/07	N	N
GLW0307 BB CAN MIL	Military Canal	N25 29.368	W80 21.809	0.22	25.21	8.72	5.84	3/30/07	N	N
GLW0307 BB CAN MOW	Mowry Canal	N25 28.199	W80 20.806	0.84	24.27	8.84	5.38	3/30/07	N	N
GLW0307 BB CAN NOR	North Canal	N25 27.790	W80 22.772	0.79	24.62	8.62	0	3/30/07	N	N

Appendix A **Site information for the *Melanoides tuberculatus* distribution and resilience study.**

ID Number	Site	N Latitude	W Longitude	Salinity (ppt) Top	Temp (°C) Top	pH (top)	Dissolved O_2 (top)	Date Collected	Melanoides found live	Debris-Melanoides
GLW0407 BB07 TR4	Black Point 1 Transect 4	N25 31.913	W80 19.330	32.4	23.64	8.86	8.84	3/31/07	N	N
GLW0407 BB MEL06	Convoy to Black - Princeton Canal/E End of channel	N25 31.133'	W80 19.599	33.2	24.89	9.07	9.19	3/31/07	N	N
GLW0407 BB CAN MIL	Military Canal	N25 29.377	W80 20.676	14.45	25.1	8.66	12.51	3/31/07	N	N
GLW0407 BB CAN PRN	Princeton Canal	N25 31.160	W80 20.368	11.32	23.46	8.73	9.11	3/31/07	N	N
GLW0407 BB MEL34	Convoy to Black - Black Pt. SEI Core Site	N25 32.110	W80 19.127	33.09	23.13	8.74	6.51	3/31/07	N	N
GLW0407 BB07 TR6	Black Point 1 Transect 6	N25 31.723	W80 18.747	34.02	23.79	9	9.71	3/31/07	N	N
GLW0407 BB07 TR5	Black Point 1 Transect 5	N25 31.829	W80 19.108	33.86	23.68	8.93		3/31/07	N	N
GLW0407 BB07 TR3	Black Point 1 Transect 3	N25 32.005	W80 19.456	32.52	23.45	8.89	9.02	3/31/07	N	N
GLW0407 BB07 TR1	Black Point 1 Transect 1	N25 32.064	W80 19.597	32.9	22.7	8.8	6.05	3/31/07	N	N
GLW0407 BB07 TR2	Black Point 1 Transect 2	N25 32.053	W80 19.561	32.98	22.72	8.91	7.31	3/31/07	N	N
GLW0407 BB MEL35	Convoy to Black - Transect out from Princeton	N25 31.128	W80 19.774	33.35	24.91	9.09	10.46	3/31/07	N	N
GLW0407 BB MEL37	Convoy to Black - Out from Military Canal even with	N25 29.381	W80 20.008	34.44	23.11	9.12	13.83	4/1/07	N	N
GLW0407 BB MEL05	Convoy to Black - Princeton Canal Mouth	N25 31.134'	W80 19.851	26.3	23	8.74	7.29	4/1/07	N	N
GLW0407 BB MEL19	Convoy to Black - Mowry	N25.47019	W80.34378	16.29	23.55	8.84	10.5	4/1/07	N	Y
GLW0407 BB07 TR4-TR7	Black Point 1 Transect between TR4 and TR7			32.09	22.63	8.97		4/1/07	N	Y
GLW0407 BB CAN NOR	North Canal	N25 27.787	W80 20.558	28.01	28.03	8.77	8.91	4/1/07	N	N
GLW0407 BB CAN MOW	Mowry Canal			31.24	24.24	8.95	32.8	4/1/07	N	N
GLW0407 BB MEL36	Convoy to Black - Midway between PRN and Fender	N25 30.728	W80 19.745	33.23	22.62	9.05	9.18	4/1/07	N	Y
GLW0407 BB MEL38	Convoy to Black - Midway between Military and Mowry	N25 28.740	W80 20.294	31.53	23.99	9.04	10.71	4/1/07	N	N
GLW0407 BB CAN BCC	Black Creek Canal	N25 32.462	W80 19.728	30.95	24.08	8.87		4/1/07	Y	Y

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ID Number	Site	N Latitude	W Longitude	Salinity (ppt) Top	Temp (°C) Top	pH (top)	Dissolved O_2 (top)	Date Collected	Melanoides found live	Debris-Melanoides
GLW0407 BB MEL20	Convoy to Black - Mowry Canal out past mouth	N25 28.195	W80 20.061	31.16	24.34	9.13	12.61	4/1/07	Y	Y
GLW0407 BB CAN GOUL	Gould's Canal	N25 32.243	W80 19.895	29.65	23.24	8.65		4/1/07	Y	Y
GLW0407 BB MEL16	Convoy to Black - Mouth of Military	N25 29.388'	W80 20.266	31.08	23.78	8.79	9.47	4/1/07	N	Y
GLW0407 BB MEL40	Convoy to Arsenicker - Cove South of Turkey Point	N25 24.361	W80 19.683	32.7	23.92	8.93	9.8	4/2/07	N	Y
GLW0407 BB MEL33	Convoy to Arsenicker - FLA City Canal Mouth	N25 26.904	W80 19.809	30.19	26.76	9.07	12.68	4/2/07	N	Y
GLW0407 BB MEL32	Convoy to Arsenicker - Turtle Point	N25 25.214	W80 19.599	31.4	23.88	8.87	8.72	4/2/07	N	N
GLW0407 BB MEL31	Convoy to Arsenicker - West of Mangrove Point	N25 23.548	W80 19.398	32.96	24.2	8.91	9.65	4/2/07	N	Y
GLW0407 BB MEL39	Convoy to Arsenicker - Inlet South of Turkey Point	N25 24.840	W80 19.668	32.88	23.89	8.88	8.27	4/2/07		