Alligator Creek Addition
Restoration Structural Monitoring Report

Rosette Spoonbills using the site during construction. Credit: Bob Repenning, formerly FDEP

Charlotte Harbor National Estuary Program
Technical Report 14-2
Approved: 8/26/2014

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The Charlotte Harbor National Estuary Program is a partnership of citizens, elected officials, resource managers and commercial and recreational resource users working to improve the water quality and ecological integrity of the greater Charlotte Harbor watershed. A cooperative decision-making process is used within the program to address diverse resource management concerns in the 4,400 square mile study area. Many of these partners also financially support the Program, which, in turn, affords the Program opportunities to fund projects such as this. The entities that have financially supported the program include the following:

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Executive Summary

The Alligator Creek project is located on a 1,600 acre site that is owned by the Florida Department of Environmental Protection (FDEP) and is located south of Punta Gorda abutting Charlotte Harbor. The Southwest Florida Water Management District (SWFWMD) funded planning and permitting for several phases of Alligator Creek restoration, including Alligator Creek Restoration Project 16.

In 2003, the Charlotte Harbor National Estuary program (CHNEP) sought implementation resources under Estuary Restoration Act of 2000 Act. The act authorizes the Secretary of the Army to carry out projects and provide technical assistance to meet restoration goals.

The Act required restoration monitoring as a component of the implementation. The approach also included structural and functional components. However, challenges and new resources altered the original restoration monitoring approach over time.

Aerial photography from 1951 and then about every other year from 2002 through 2014 reveal a changing landscape. Mosquito ditches constructed in the 1960s and 1970s altered the hydrology of the site. Salt marshes were fragmented, ditches allowed landward expansion of mangroves and spoil piles and dikes became sites for invasive exotic vegetation. By 2009, the associated ditches and piles were graded by the Army Corps of Engineers so that topography was level with adjacent native areas. By 2014, the scars of the restoration are still apparent. However, salt marshes are expanding on the eastern restoration sites. In these areas, the scars are now less evident.

The restoration resulted in the direct removal of 18 acres of Brazilian pepper. Because the higher elevation spoil is no longer present, the Brazilian pepper will not be able to return to grow successfully.

Several land cover maps have been prepared over the years. In 2010, CHNEP completed a pre-development vegetation map, based on General Land Office survey notes. Periodically SWFWMD prepares a regional scale land cover map. Finally, in 2011, SWFRPC completed a ground-truthed salt marsh map, by type funded by US EPA. Reviewing these resources reveals landward retreat of salt marshes as a result of sea level rise, between 1840 and 1951. By 1995, the effects of the mosquito control ditching on the salt marshes was evident. Based on SWFWMD 1995 Land Use mapping, salt marsh cover had been reduced from 1951 acreage (303 acres) by 60% to 127 acres. Based on SWFWMD 2004 Land Use mapping, salt marsh cover had been reduced from 1995 acreage by another 16% to 107 acres. The most recent SWFWMD mapping captures no changes.

The 2011 SWFRPC mapping is a more specific source of information regarding salt marsh location. Using this resource in concert with the aerial photographs suggests that pre-restoration 2008 salt marsh area totaled 58 acres. Three years after restoration in 2011, salt marsh area totaled 64 acres. A 2014 update suggests a total of 68 acres, a 17% increase of salt marsh habitat as a result of hydrologic restoration and natural recruitment.

The 2011 SWFRPC salt marsh study provides several solutions for salt marsh and general coastal resiliency. Filling in mosquito ditches is an important way not to invite sea level rise inland. The Alligator Creek Restoration Project 16 was cited as an important coastal resilience project.

Introduction

Project History

The Alligator Creek project is located on a 1,600 acre site that is owned by the Florida Department of Environmental Protection (FDEP) and is located south of Punta Gorda abutting Charlotte Harbor. This property includes the original 1,300 acre parcel and a 300 acre parcel that was recently purchased, also by FDEP (See Figure 2.) Funds budgeted by the Southwest Florida Water Management District (SWFWMD) involved developing a restoration master plan for the original 1,300 acre parcel, and to design and permit two restoration projects on the original property with the acceptance (in March 2000) of a restoration master plan for the site.

The Estuary Restoration Act of 2000 Act authorizes a program under which the Secretary of the Army may carry out projects and provide technical assistance to meet restoration goals. The “Estuary Habitat Restoration Council” consisting of representatives of the National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA), Department of the Interior (U.S. Fish and Wildlife Service- FWS), Department of Agriculture, and the Department of Army is established. There may also be one ex officio member appointed by the President. Responsibilities of the Council include soliciting, evaluating, reviewing, and recommending project proposals for funding, developing a national strategy, reviewing the effectiveness of the strategy and providing advice on development of databases, monitoring standards, and reports required under the Act. In accordance with the Act the Council developed a national strategy to ensure a comprehensive and integrated restoration approach and foster coordination of Federal and non-Federal restoration activities. Elements of the strategy, its coordination and updating are also discussed in the Act. The original strategy was published in the Federal Register in December 2002.

Working with the EPA's Office of Wetlands, Oceans and Watershed, the Charlotte Harbor National Estuary Program (CHNEP) sought restoration support of the Alligator Creek Restoration Project 16, one of the phased projects under the SWFWMD restoration master plan. CHNEP served as the non-Federal sponsor. Project Partners included Southwest Florida Water Management District (SWFWMD), Florida Department of Environmental Protection (FDEP), NOAA and FWS.

Project Description

> "The primary goal of this project is to restore the historic saltern that once comprised the majority of the west central portions of the Alligator Creek Addition parcel. The area has been severely impacted by the construction of mosquito ditches, which functioned to divert water flow and subsequently altered the hydroperiod of the saltern. Restoration will involve backfilling approximately 35,000 linear feet of mosquito ditches. Backfilling will allow a more diffuse sheet flow of fresh water from upland areas and will allow extreme high tide events to flood the salterns and slowly flow out through the mangrove forest fringe to the west. This project is anticipated to restore the natural hydroperiod, raise the interstitial salinities, and restore the natural sill in the saltern resulting in approximately 350 acres of saltern restoration and enhancement."

Through the assistance of an EPA Region 4 Wetland Program Development Grant, CHNEP had the Southwest Florida Regional Planning Council (SWFRPC) investigated and mapped eleven distinct salt marsh types, including saltern. Less than one acre of 94 salt marsh acres consisted of saltern. All salt marsh types were considered.

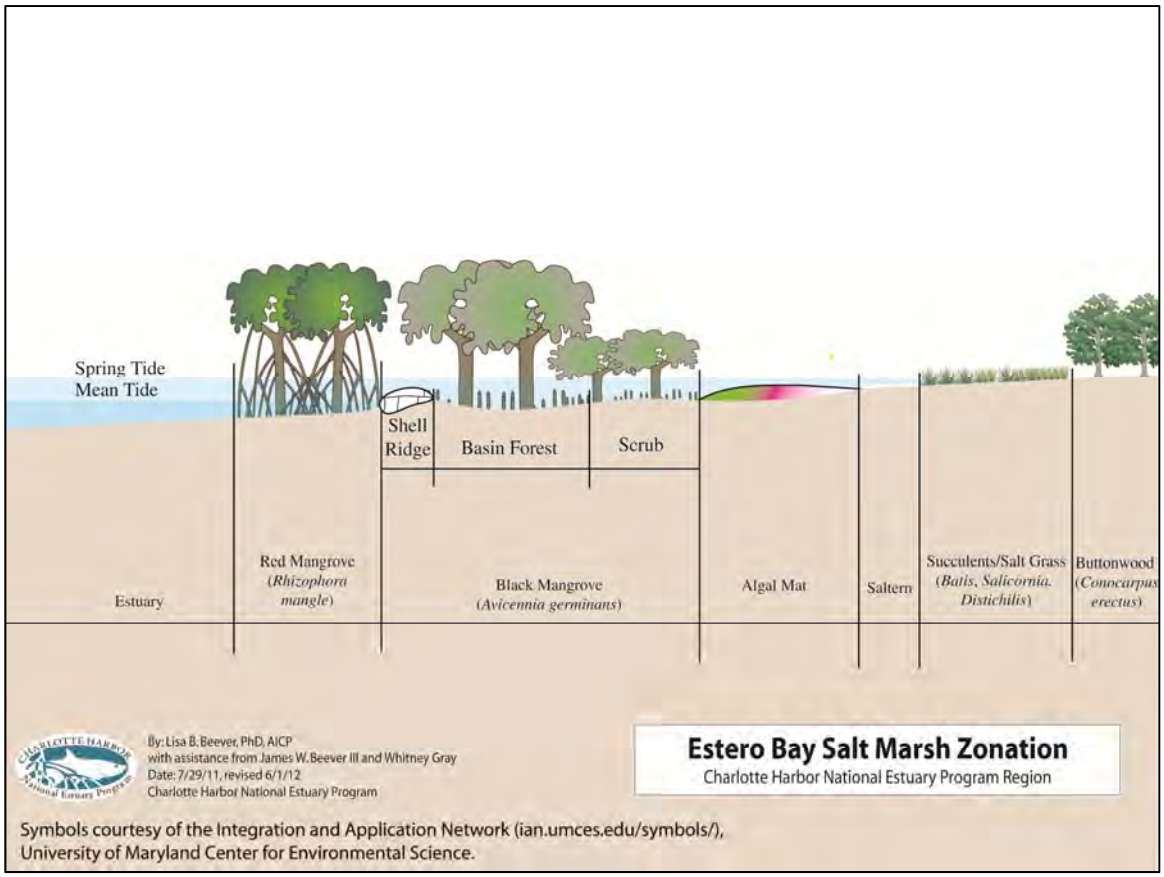


Figure 1: Salt Marsh Zonation.

Of the conceptual diagrams of salt marsh zonation prepared for the 2012 Salt Marsh Study, the Estero Bay location best matches the Alligator Creek Addition. The diagram is shown as Figure 1: Salt Marsh Zonation. Salt marsh types in the project area include mixed meadow (60 acres), succulent meadow (13 acres), algal mat (10 acres), grassy meadow (9 acres) and saltern (1 acre) (SWFRPC 2011).

Project Location

The project area is 489 acres and is located within the Charlotte Harbor Preserve State Park, owned and management by FDEP. The location is landward (east) of the East Wall of Charlotte Harbor. The general location is shown with a yellow staff on Figure 2: Project Location.

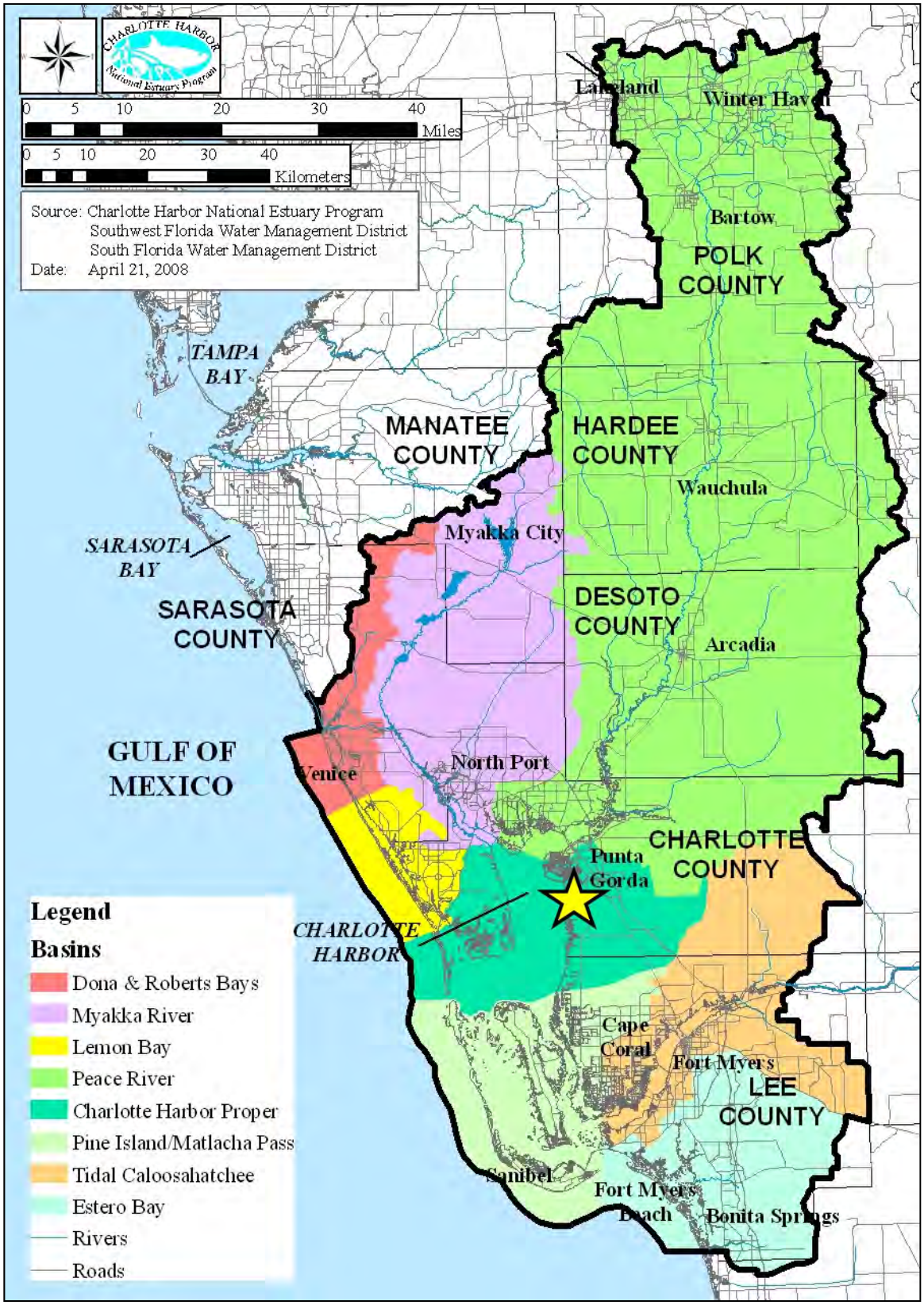


Figure 2: Project Location identified with Yellow Star.

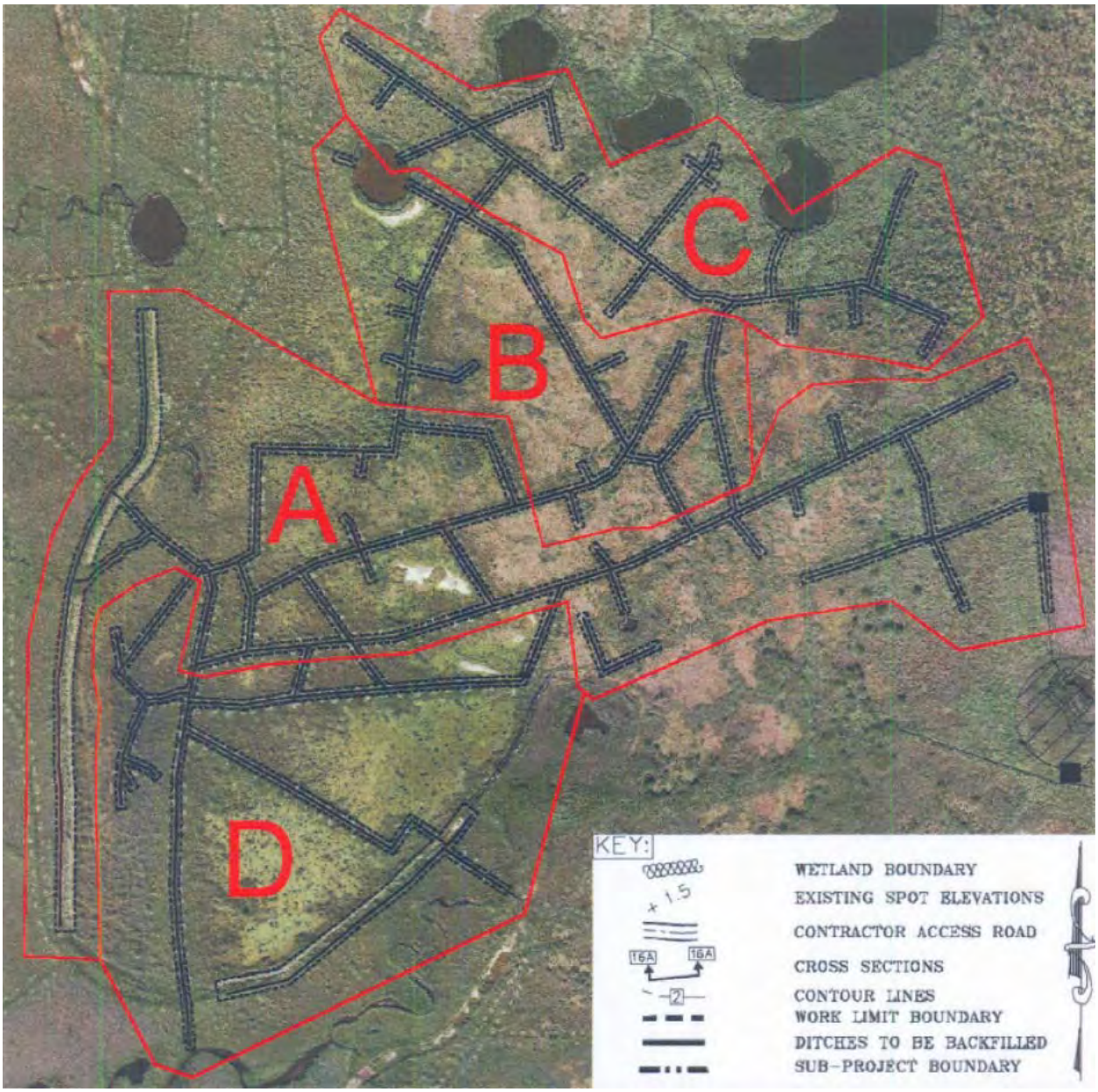


Figure 3: Project Phasing

Project was divided into 4 phases, A to D as shown above in Figure 3.

Expected Benefits

This project will restore and increase the diversity of coastal habitats by returning the historic hydroperiod and historic function to the area. The project will also complement and enhance the environmental value of adjacent restoration activities.

Restoration Monitoring Strategy

Restoration Monitoring Approaches

Science-Based Restoration Monitoring of Coastal Habitats, Volume One: A Framework for Monitoring Plans Under the Estuaries and Clean Waters Act of 2000 (Public Law 160-457) provides guidance regarding restoration monitoring approaches. The framework calls to identify specific structural and functional characteristics to monitor during restoration projects for each and every local or regional habitat type.

The focus on structural and functional monitoring was part of the original 2003 monitoring plan and continued through its iterations.

Restoration monitoring continues to be an evolving science. After project approval in 2005, *Science-Based Restoration Monitoring of Coastal Habitats, Volume Two: Tools for Monitoring Coastal Habitats* was published. Salt marsh impacts cited in the document included diking, sea level rise and invasive species. These are key components that are included in the restoration monitoring, as it evolved.

Original 2003 Monitoring Plan

A monitoring plan was submitted with the project application in 2003. The plan included two components: structural and functional. The following paragraphs were the original monitoring plan:

> FDEP will monitor the project site using a multiple transect system. Within each treatment area 500 meter transects will be established to measure the structural and species composition of the vegetation. Tree and shrub density and height will be measured and percent ground cover will be measured along each transect. At random points along each transect three lateral 10 trap mammal transects will be established with 10 meter spacing per transect. These transects will be run for two 5-day periods from December to March. Each mammal will be identified to species and released. Birds will be counted along each transect in the Fall, Winter and Spring using ten transect counts per season. Three herpetological arrays will be established in each study area to sample herpetological populations pre and post restoration.
>
> Also, a collaborative project between Mote Marine Laboratory, FDEP and the Charlotte Harbor NEP will evaluate the effects of these restoration projects on the abundance and habitat use by juvenile snook and associated fish communities. Researchers at Mote Marine Laboratory will monitor the change in fish community structure and abundance of target fish species prior to and after the restoration project. Every two months the researchers sample 3 sites (upstream, mid stream and downstream with 5 seines per site) on four tidal creeks to track cohorts as they move downstream and track the changes in habitat utilization over life stages. The monitoring plan should quantify the benefits of this type of habitat and hydrologic restoration and contribute to the creation of

> management strategies for restoration and development projects in the future. The Charlotte Harbor NEP is contributing $19,360 towards this $90,773 monitoring project; Mote Marine Laboratory is contributing the remainder.

Shortly after these commitments were made, FDEP re-organized management of its Aquatic Preserve Buffer Preserves to State Parks management. The underlying land management unit for the Alligator Creek addition was changed from the Charlotte Harbor Buffer Preserve to the Charlotte Harbor Preserve State Park. The transects were not completed.

Further, the restoration construction project required more time than expected. The collaborative project between Mote Marine Laboratory, FDEP and the CHNEP to evaluate the effects of restoration on the abundance and habitat use by juvenile snook and associated fish communities needed to conclude prior to commencement of the restoration project. Sampling was completed from February 2003 through October 2004, as planned. SWFWMD funded Mote Marine Laboratory to continue sampling 2005, 2006, 2007, 2008 and 2009. In 2012, SWFWMD provided funding to CHNEP to contract Mote Marine Laboratory to complete another 2 years of sampling for a better post-restoration assessment.

2007 Baseline Monitoring Plan

Post Buckley Shuh and Jernigan (PBS&J) prepared a baseline monitoring plan in 2007. They stated:

> Pedestrian surveys of Project 16 were performed to document vegetation growing within the work limits of the mosquito ditches. Vegetation within the work limits is dominated by red *(Rhizophora mangle),* black *(Avicennia germinans),* and white *(Laguncularia racemosa)* mangroves. Brazilian pepper *(Schinus terebinthifolius)* was observed growing in areas of higher elevation, typically spoil mounds, adjacent to the mosquito ditches. Other vegetation observed in the work area included wax myrtle *(Myrica cerifera)* and leather fern *(Acrostichum danaeifolium).* Vegetation transitions to species typical of pine flatwoods and hydric hammocks along the eastern boundary of the project area. Vegetation observed included slash pine *(Pinus elliottii),* cabbage palm *(Sabal palmetto),* and saw palmetto *(Serenoa repens).*
>
> Average percent cover within the 50 foot wide work area in wetland areas is estimated to be approximately 85% mangrove species, 10% Brazilian pepper and 5% other native vegetation such as wax myrtle, leather fern, and buttonwood. As noted earlier, Brazilian pepper in the wetland areas was restricted to areas of higher elevation, predominantly on the spoil mounds.
>
> In the upland areas the percent cover of Brazilian pepper is estimated to be 40%, mangroves 40%, and the remainder of the cover comprised of cabbage palm, slash pine, wax myrtle, saw palmetto, and other native species.

Final 2014 Monitoring Plan

The Southwest Florida Water Management District (SWFWMD), in conjunction with the Charlotte Harbor National Estuary Program (CHNEP), prepared the final 2014 Monitoring Plan. Several challenges were encountered:

- The structural monitoring component included transects to be completed by FDEP. However, the unit managing the Alligator Creek project location changed with the transfer from the Charlotte Harbor Buffer Preserve to the Charlotte Harbor Preserve State Park. The change occurred concurrent with the timing for the pre-construction monitoring.
- Hurricane Charley crossed Charlotte Harbor on August 13, 2004. The perturbation affected pre-restoration monitoring.
- The original functional monitoring component using fish abundance in downstream Silcox Creek concluded before construction commenced. SWFWMD funded CHNEP to contract with Mote Marine Laboratory to conduct a year of post-restoration monitoring and analysis with pre-construction monitoring that occurred.

Additional resources were generated that assisted in the Alligator Creek Project 16 Restoration Monitoring:

- Charlotte County acquired aerial imagery every other year or so. The County georeferenced the photos. The imagery provided opportunities to create project shapefiles to assess acreage changes in invasive exotic plants and salt marsh. The imagery also provides an opportunity to see the functional monitoring component (fish abundance and diversity) in the context of the associated landscape.
- CHNEP and SWFWMD contracted pre-development vegetation maps based on General Land Office surveys and other historic information.
- CHNEP contracted development of a historic benthic resources map. One of the products of the effort was georeferenced 1951 aerial photographs, including the project area. Coupled with the pre-development vegetation map and modern maps, a more realistic and long-term vision of salt marsh restoration could be composed, including interactions with sea level rise.
- EPA funded the Southwest Florida Regional Planning Council (SWFRPC) via CHNEP to conduct *Climate Change Vulnerability Assessment and Adaptation Opportunities for Salt Marsh Types in Southwest Florida*. The work included ground-truthed salt marsh mapping by type.

As a result of the additional resources, the structural component of the 2014 restoration monitoring plan is more consistent with the 2005 *Science-Based Restoration Monitoring of Coastal Habitats, Volume Two: Tools for Monitoring Coastal Habitats.*

Photographs During Restoration

Photographs recorded the construction of the Alligator Creek Restoration Project 16. Construction occurred during the spring of 2008. Figures 4 through 11 illustrate construction and some of the changes that occurred on the site.

On March 11, 2008, shallower ditches were cleared and adjacent spoil was used to bring the grade to adjacent levels. According to baseline monitoring, various mangrove species the ditches while Brazilian pepper grew on the spoil piles.

Figure 4: March 11, 2008 Ditch Restoration

During construction, egrets took advantage of prey items that were disturbed and of the open habitats that were created.

As construction progressed, larger ditches were filled to bring them up to adjacent grade. Note that fill includes a variable level of organics.

Figure 5: March 11, 2008 Egrets Utilizing Opening of Habitat

Figure 6: March 18, 2008 Restoration of Larger Ditches

Figure 7: March 18, 2008 Completed fill of Large Ditch

Figure 8: April 4, 2008 Completed Fill of Large Ditch

Figure 9: April 23, 2008 Flooded Works site for Heron.

Figure 10: June 23, 2008 Flooded Works site for Rosette Spoonbills

Figure 11: June 23, 2008 Flooded Works site for Glossy Ibis

Structural Monitoring

Aerial Photograph Series

1951 (Figure 12)

In the late 1940s and early 1950s, aerial photographs were prepared for a consistent coverage of the southwest Florida coast. Aerial photos were taken for the Alligator Creek in 1951. The mosquito ditches were excavated in later decades. The saltern habitat appears as bright white on the 1951 aerial photo. Additional salt marsh habitats (mixed meadow and herbaceous) are associated with the salterns.

2002 (Figure 13)

By 2002, when the Alligator Creek Restoration Project was in design, mosquito ditches crisscrossed the site. From the aerial photos, it is apparent that the open water mosquito ditches were lined with spoil piles. The invasive exotic plant, Brazilian pepper (*Schinus terebinthifolius*), was the predominant plant on the spoil piles.

2008 (Figure 14)

Construction of the Alligator Creek Project 14 tool place in spring of 2008. It occurred weeks after the 2008 aerials were acquired.

2009 (Figure 15)

Construction of the Alligator Creek Restoration Project 16 took place soon before the 2009 aerials were acquired. Open earth is evident where both the mosquito ditches were filled and the spoil piles were leveled.

2011 (Figure 16)

The SWFRPC conducted salt marsh mapping in 2011. Mapping cons conducted using 2011 aerials and ground truthing.

2014 (Figure 17)

When the most recent aerial was taken in 2014, the easternmost restoration areas have developed salt marsh vegetation, matching adjacent native salt marshes. The Brazilian pepper has not returned to the site, because of the hydrologic restoration. Mangrove colonization of the western restoration areas will require additional time.

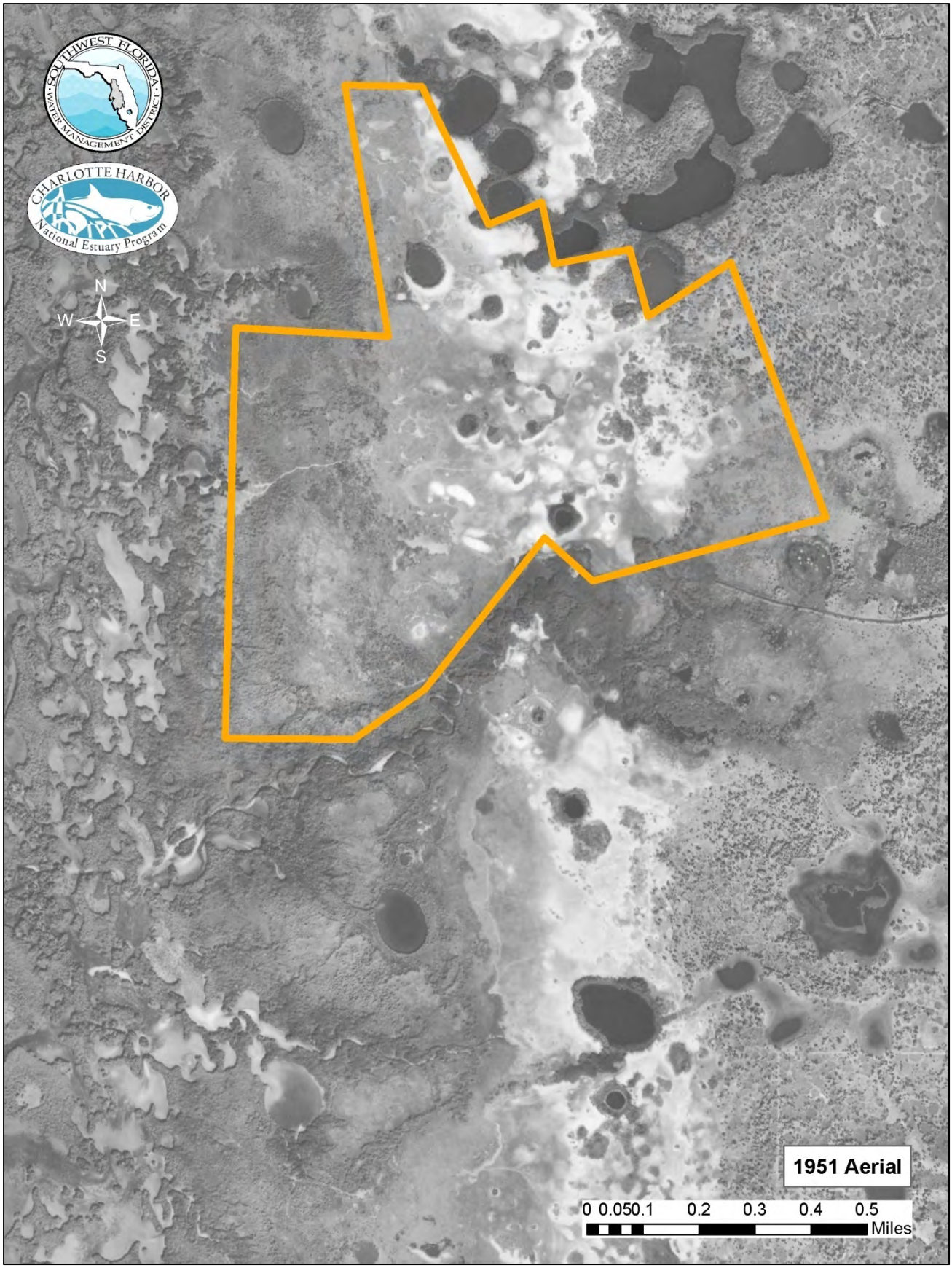


Figure 12: 1951 Aerial Photograph, with project area outlined in orange.

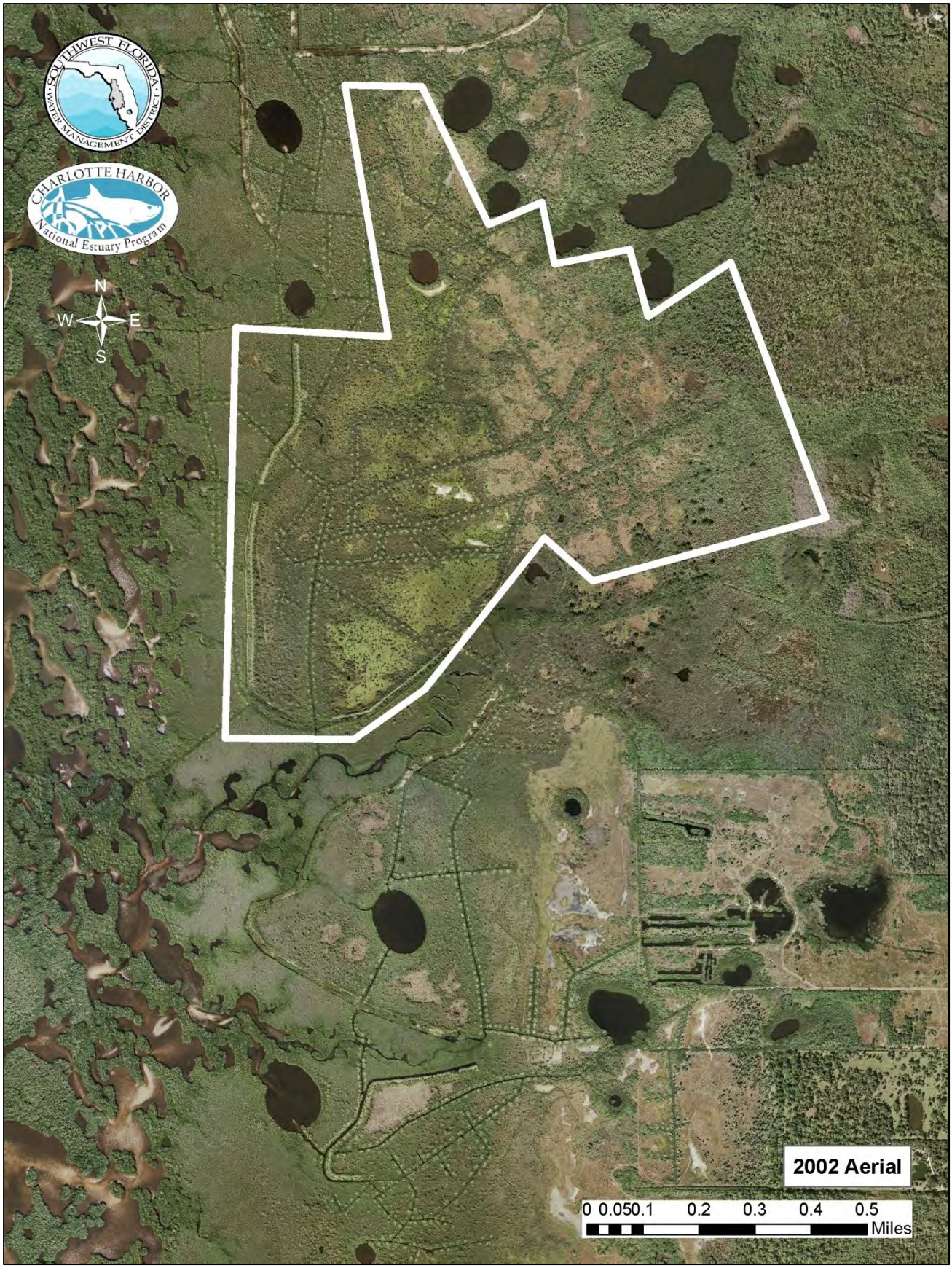


Figure 13: 2002 Aerial Photograph, year of project development

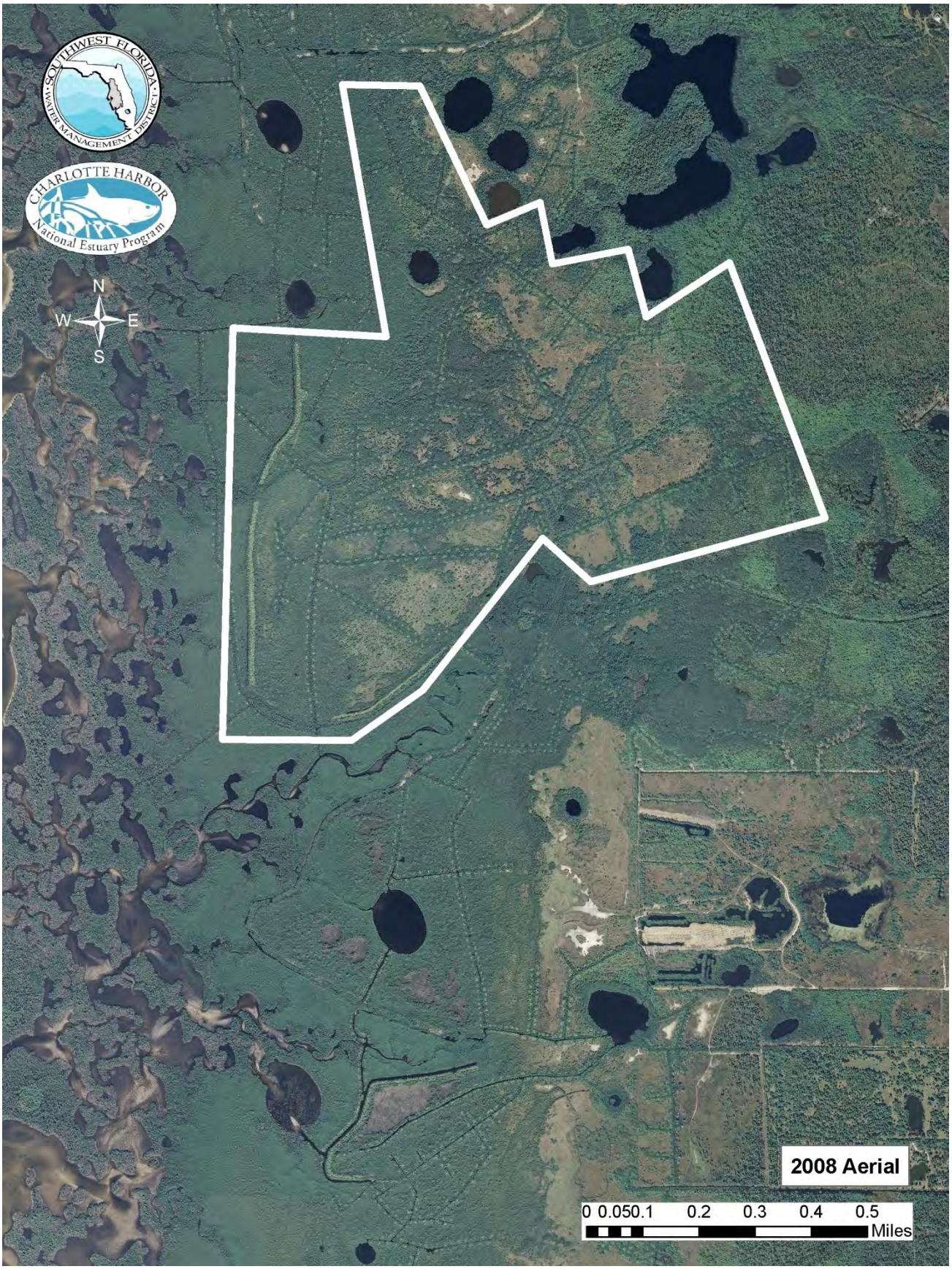


Figure 14: 2008 Aerial Photograph, weeks prior to restoration construction

Figure 15: 2009 Aerial Photograph, after restoration construction completed

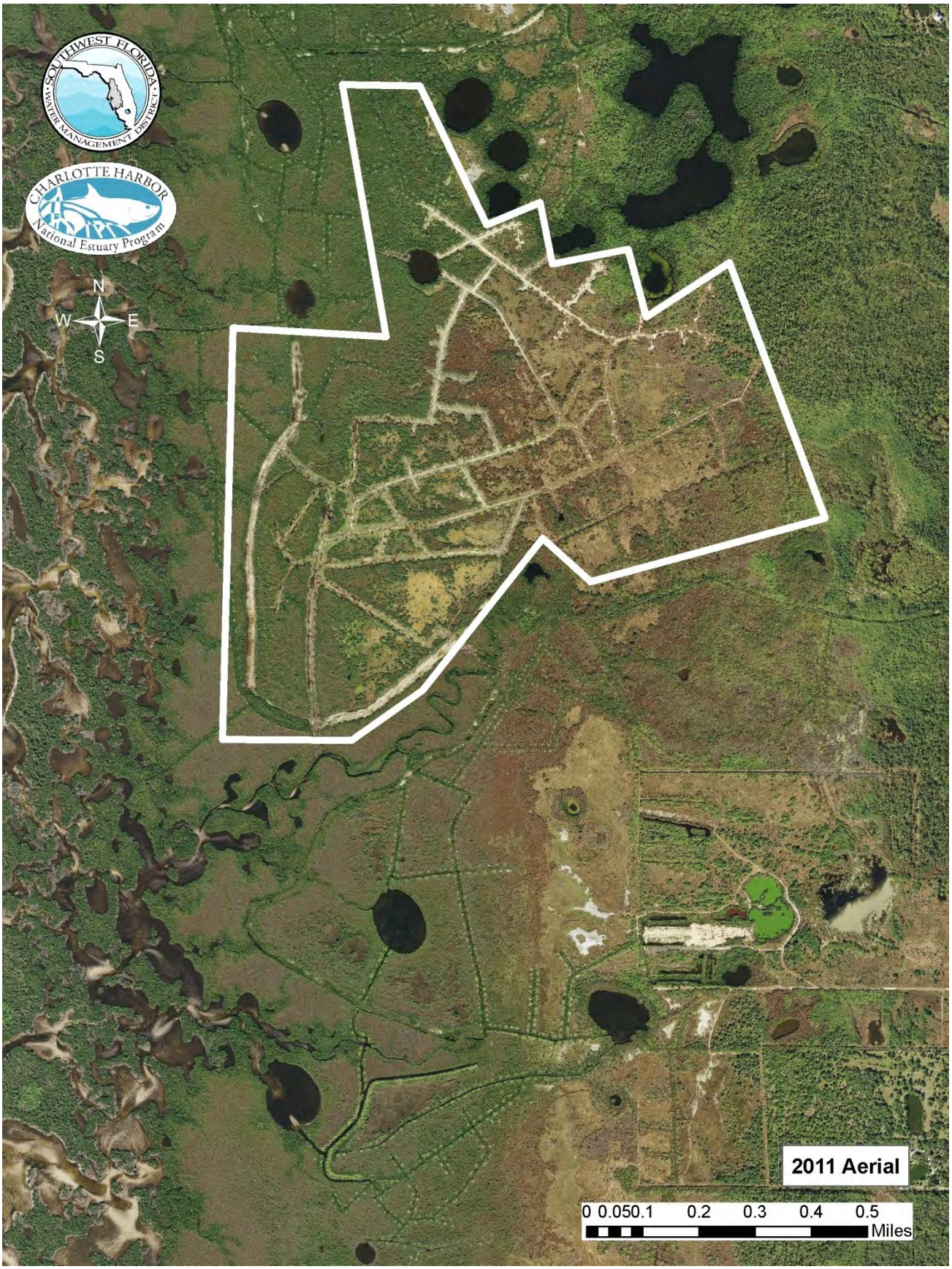


Figure 16: 2011 Aerial Photograph, year of salt marsh mapping

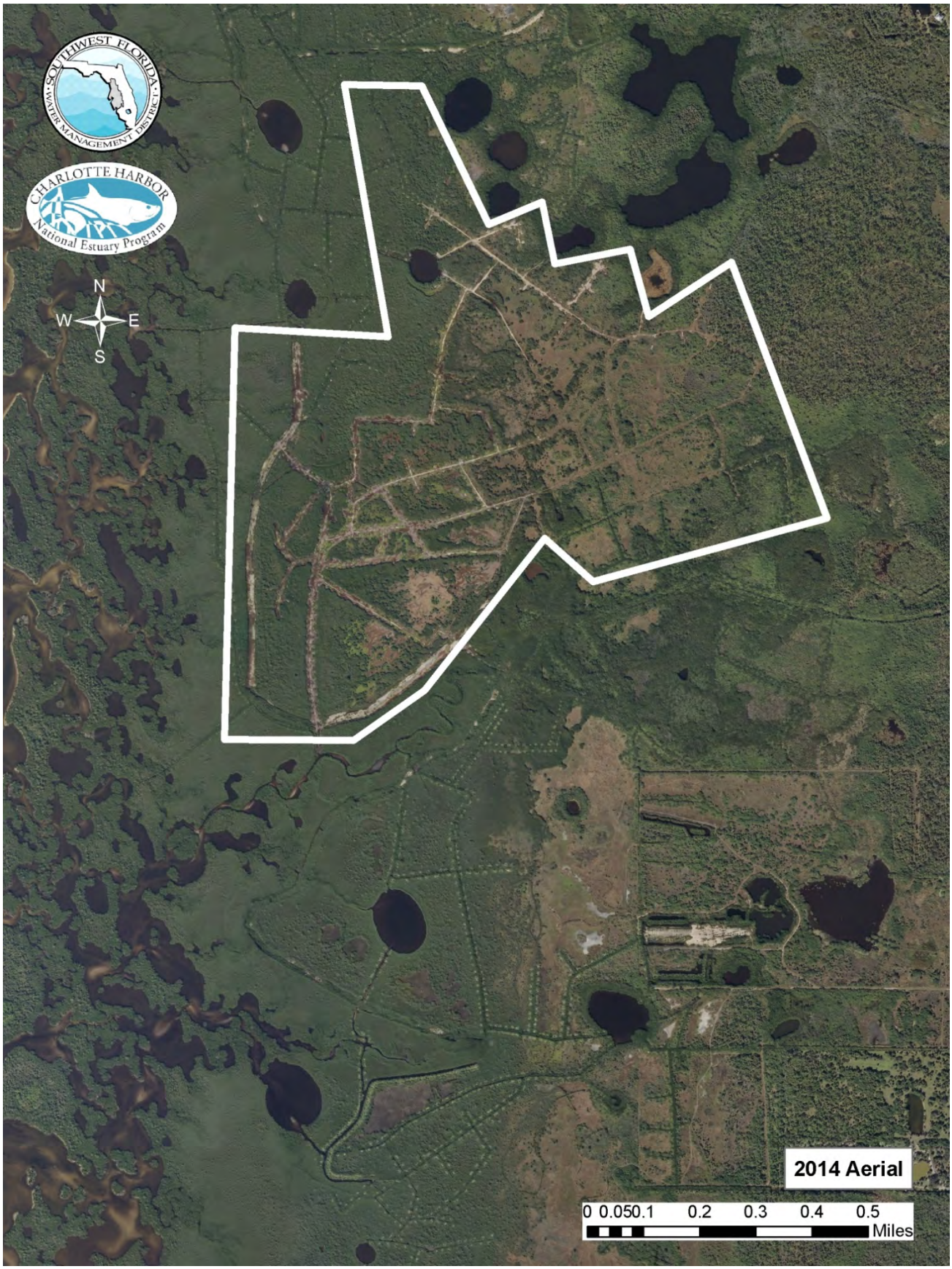


Figure 17: 2014 Aerial Photograph, most recent imagery

Brazilian Pepper Removal

After construction of the mosquito ditches, spoil piles and linear features were cast in the project area. These became sites for invasion of Brazilian pepper (*Schinus terebinthifolius*). Approximately 18 acres of spoil was removed as a function of the restoration project.

Figure 18 illustrates the areas where Brazilian pepper was removed in red.

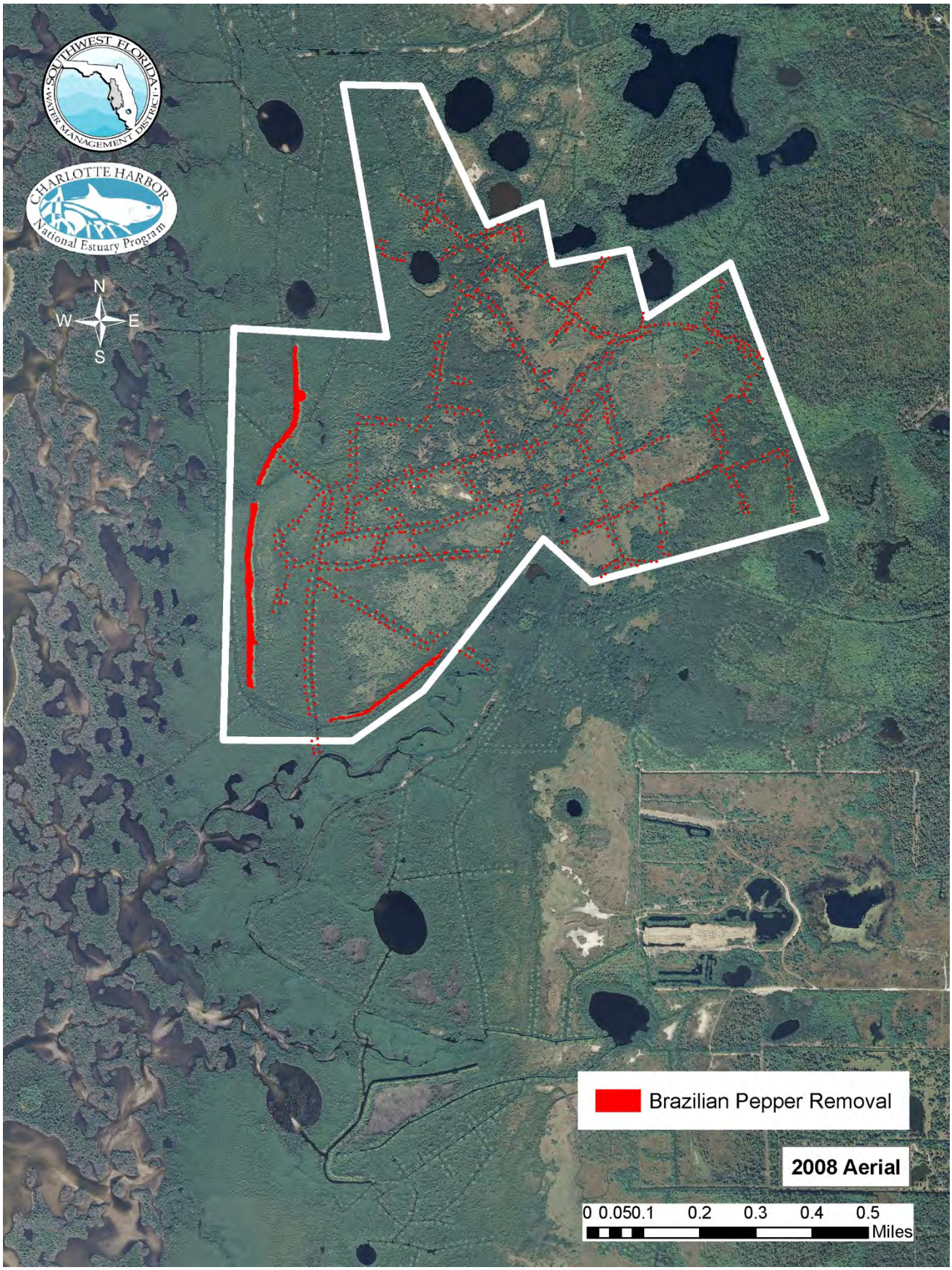


Figure 18: 2008 Brazilian Pepper Removal

Salt Marsh Changes

Pre-Development

In 1819, Spain ceded Florida to the United States. In preparation for Florida's statehood, the General Land Office (GLO) surveyed Florida's land. The survey included maps, section line assignments and notes.

With funding from SWFWMD, CHNEP contracted with HDR to prepare pre-development vegetation maps for Charlotte County and eastern Manatee County, using the GLO materials. The GLO Survey notes included changes of habitats along section lines. Two section lines crossed the project site, representing 1840's era ground-truthing.

In the 1840s, 382 acres of the 489 acre site were salt marsh, 78% of the project site. Figure 6: Pre-development Vegetation shows that most of the project area probably had been salt marsh.

Figure 19 provides a map of the pre-development habitats as reconstructed from the 1840s information. Figure 20 provides this map as a transparency over the 1951 aerial photograph.

1951

Though there is no salt marsh mapping for 1951, aerial photographs suggests that salt marsh retreat had occurred in response to sea-level rise. The oldest tide station in Florida was established January 18, 1913 at Key West. Long term trends suggest a sea-level rise rate of 2.24 +/- 0.16 millimeters per year, as shown in Graph 1.

Between 1913 and 1951, sea level had risen by approximately 3 inches. Between 1840 and 1951, sea level may have risen between 9 and 10 inches. Given the dark mangrove register shown in the project area on Figure 20: Pre-Development Vegetation over 1951 Aerial, it appears that there was natural salt marsh retreat, prior to hydrologic alteration.

Figure 21 shows the location of salt marsh loss due to advancing mangroves.

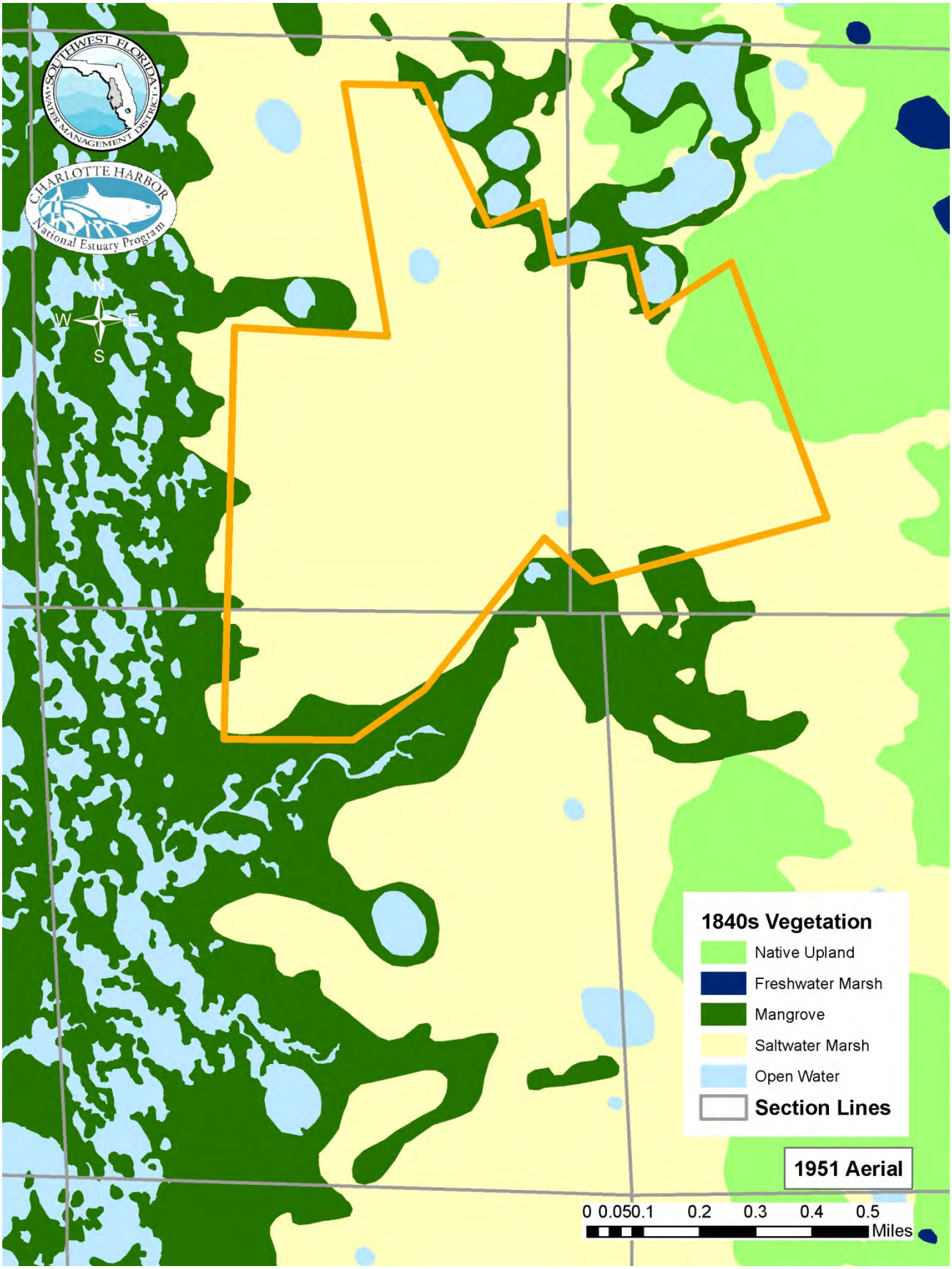


Figure 19: Pre-Development Vegetation

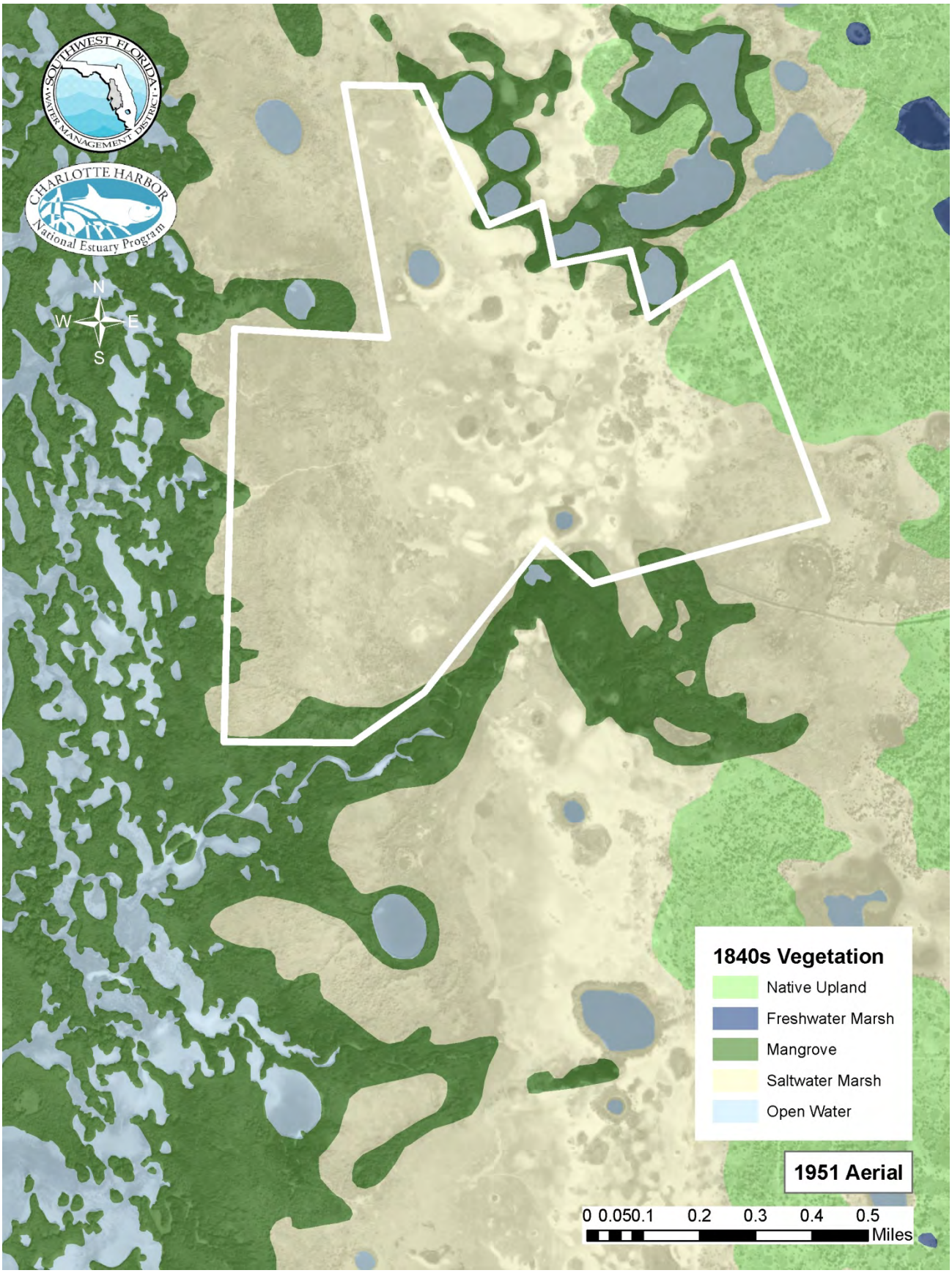


Figure 20: Pre-Development Vegetation over 1951 Aerial

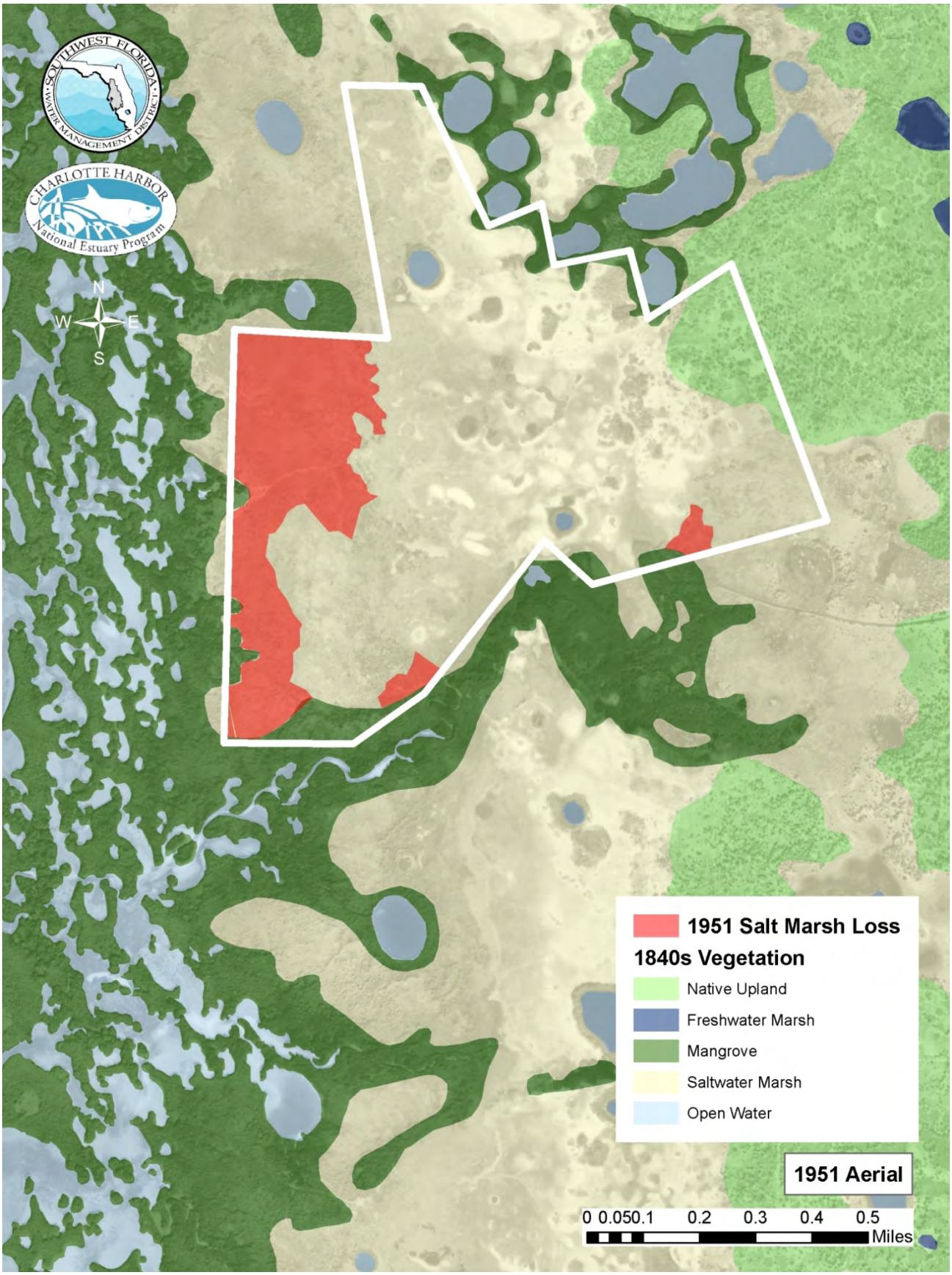
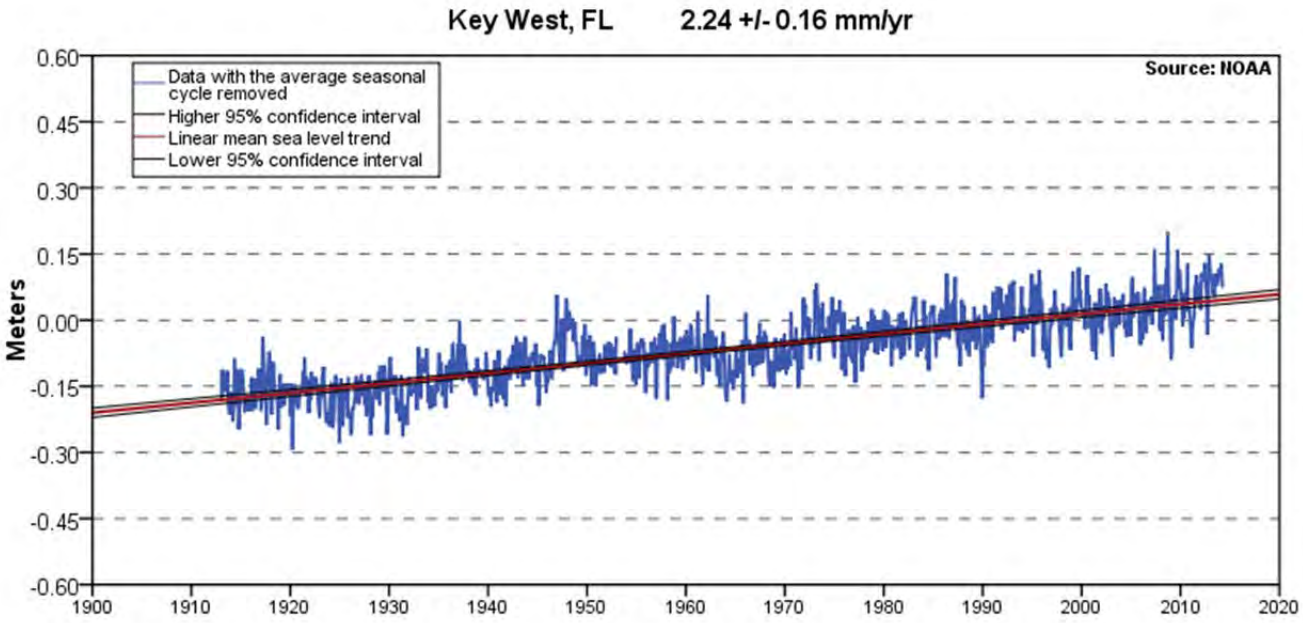


Figure 21: Salt Marsh Loss between 1840 and 1951



Graph 1: Sea Levels at the Key West Gauge from 1913 to Present

By 1951, 79 acres of what had been salt marsh habitat in the 1840's transitioned into mangrove habitat, a 20% loss.

Over 79 of the 382 pre-development salt marsh acres (20%) were lost by 1951. In other words, 303 salt marsh acres were remaining.

1995

By 1995, the effects of the mosquito control ditching on the salt marshes was evident. Based on SWFWMD 1995 Land Use mapping (see Figure 22), salt marsh cover had been reduced from 1951 acreage by 60% to 127 acres. Please note that the specific SWFWMD cover categories have been combined to present consistent information through this salt marsh change series. For example "Wet Prairie" was a term used for herbaceous salt marsh.

2004

Based on SWFWMD 2004 Land Use mapping (see Figure 23), salt marsh cover had been reduced from 1995 acreage by another 16% to 107 acres.

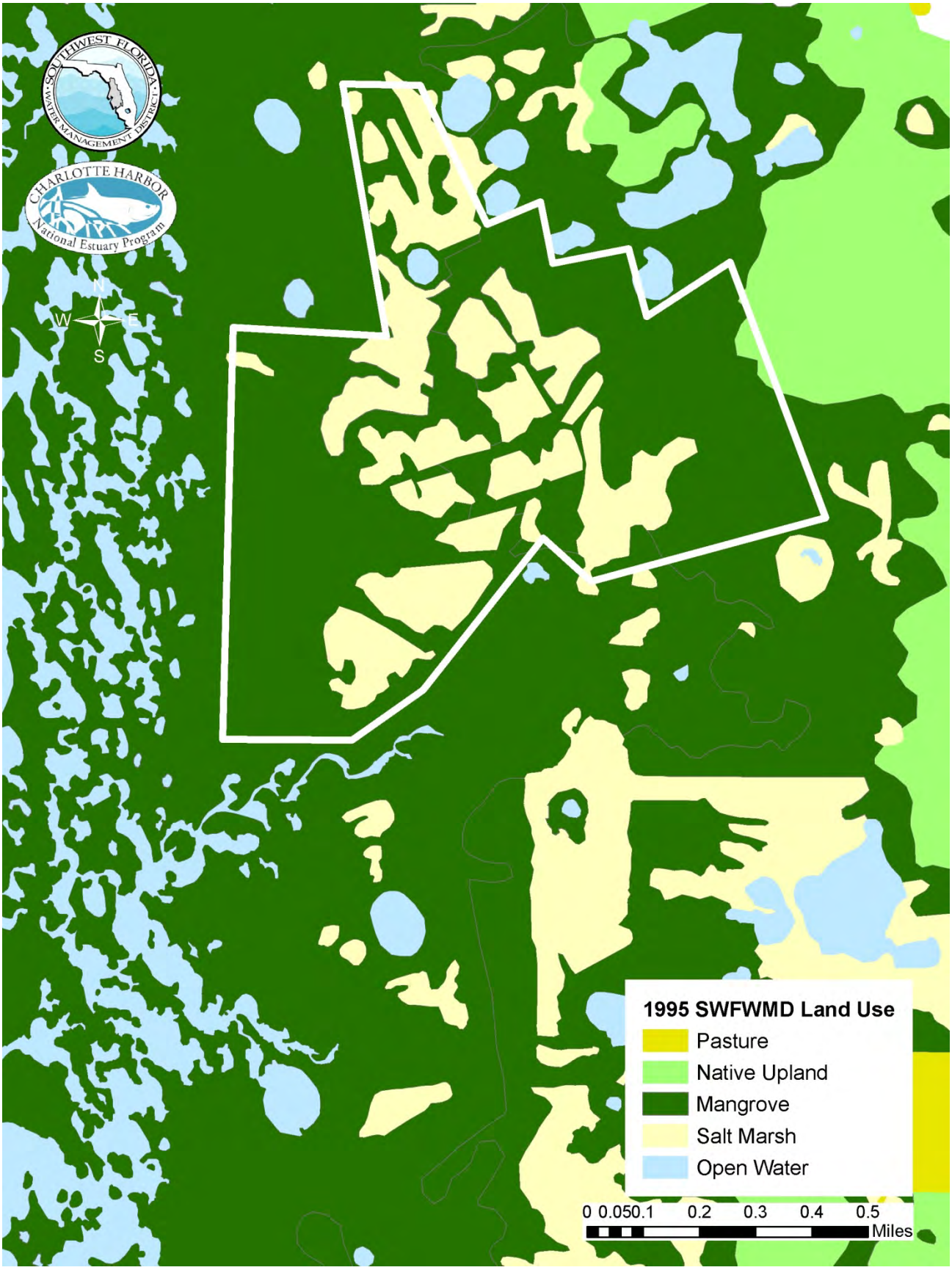


Figure 22: 1995 Land Cover

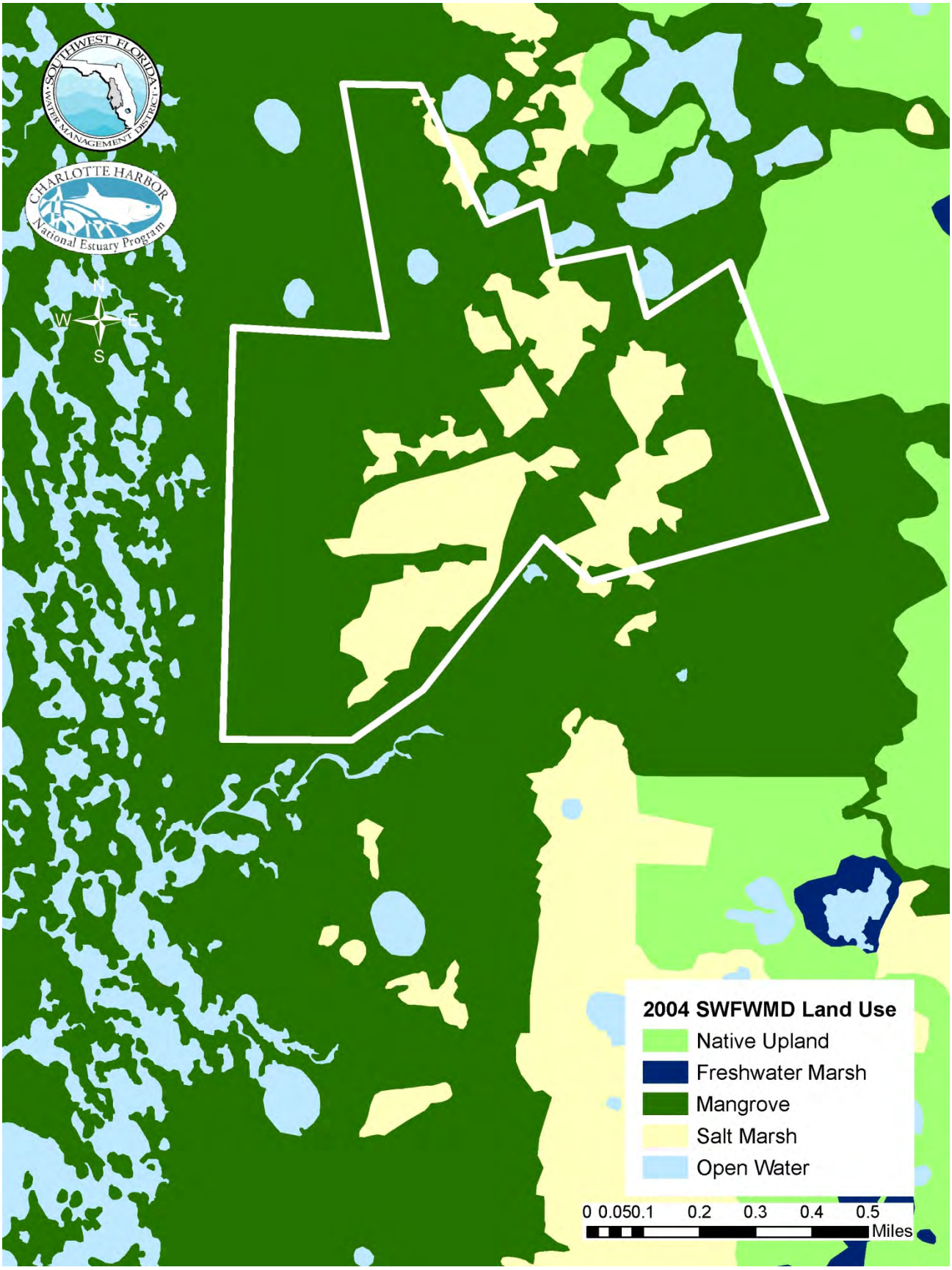


Figure 23: 2004 Land Cover

SWFRPC/CHNEP Salt Marsh Maps

Beginning in 2009. the US EPA Wetland Program Development Grant funded the Southwest Florida Regional Planning Council (SWFRPC) to prepare a study of salt marshes in the CHNEP study area. The study included a fine map of identified salt marsh completed for the study area in 2011. It is the most accurate map of salt marshes prepared in the Charlotte Harbor area and shown on Figure 24. Though the SWFWMD land use map continue to show the same polygons and classifications within the Alligator Creek Restoration Project 16 area, the more precise mapping shows 64 acres rather than the 107 acres captured in the SWFWMD mapping in 2011. This is an example of blocking. The SWFWMD land use map was created at a larger scale for purposes other than restoration monitoring.

Using aerial photography, areas of 2011 salt marshes that were obviously not-existent before restoration were removed. By the same token, salt marshes that were apparent in the 2014 were added. The changes that occurred between 2008 and 2011 and again between 2011 and 2014 are shown on Figure 25.

As a result, it appears that there were 58 acres of salt marsh habitat in the project area prior to restoration in 2008. By 2011, 64 acres were documented. By 2014, 68 acres were identified. The 10 acre (17%) increase of salt marsh was accomplished with hydrologic restoration only. No salt marsh plants were added to the site as part of the restoration.

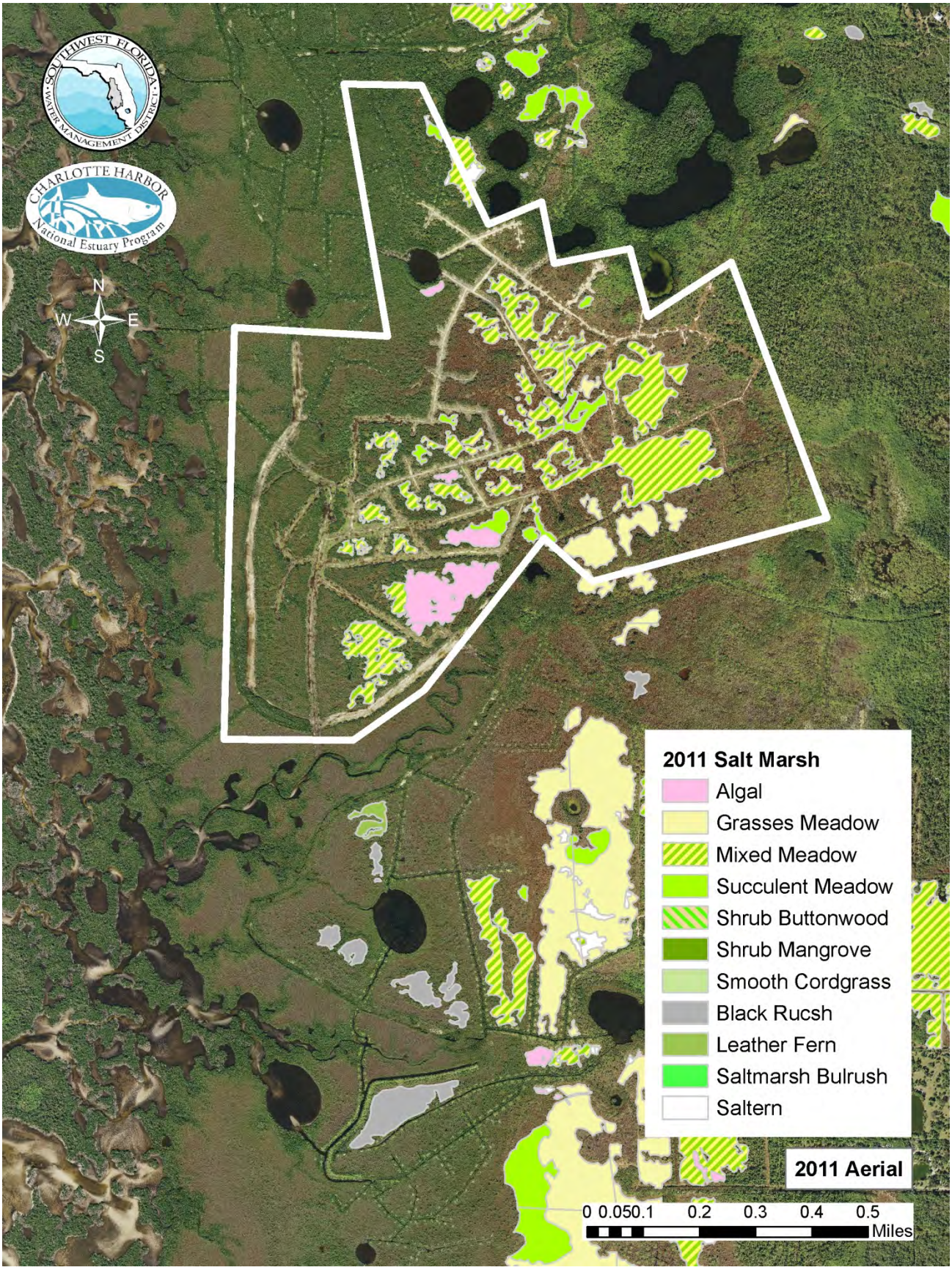


Figure 24: SWFRPC 2011 Salt Marsh Map.

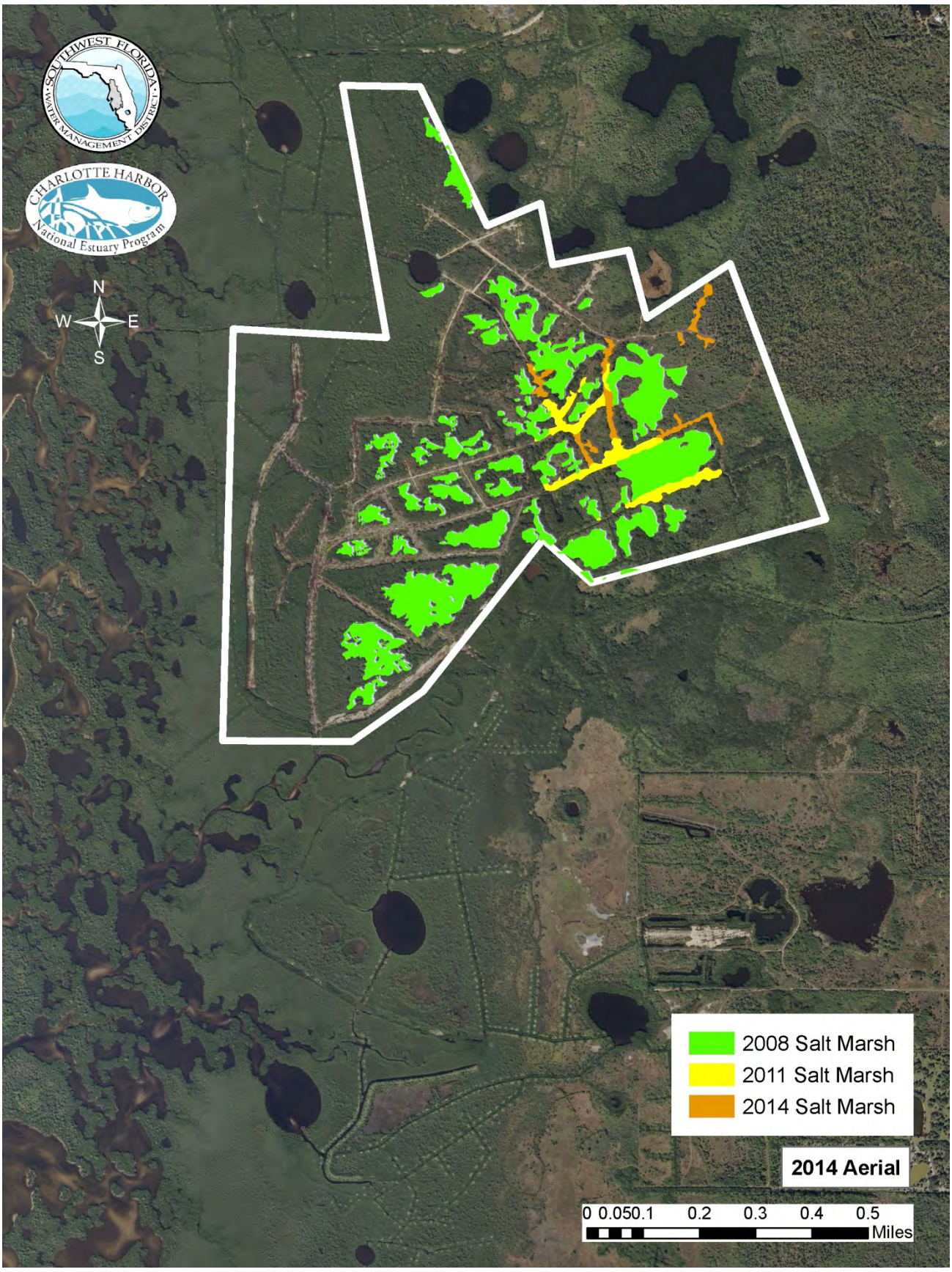


Figure 25: Salt Marsh Changes.

Conclusions

The original project description called for restoration and enhancement of 350 acres of salt marsh habitat. Prior human alteration of the site, salt marshes totaled 303 acres. The original estimate was accomplished without historic information generated by CHNEP since the project was proposed in 2003 prior to the completion of the pre-development mapping. Such tools developed in the last decade will assist CHNEP and its partners to develop more realistic restoration goals in the future.

Pre-construction salt marsh acreage totaled 58 acres, based on more specific and project-level mapping. The restoration project repaired hydrology and relies on natural recruitment for salt marsh expansion. In the three years after restoration, salt marshes expanded by 6 acres. In the course of the next three years, salt marshes expanded by another 4 acres. The 10 acres of added salt marsh represent a 17% increase. This small but steady expansion of the target habitat suggests a successful hydrologic restoration.

The mosquito ditches provided a pathway for an expanding mangrove forest, taking advantage of human alteration. The mature mangrove trees can survive restore hydrology. However, mangrove recruitment will suffer at the expense of the target habitat, salt marsh. In southwest Florida, natural mangrove forest turnover is about 100 years in duration. Hurricanes and freezes will reduce the turnover duration by increasing mangrove mortalities, providing salt marshes additional opportunities for expansion.

The focus of the restoration was salt marsh expansion. Hydrologic restoration of the site included removal of spoil. These spoil sites provided habitat for exotic Brazilian pepper. The Brazilian pepper was eliminated. By removing the spoil, opportunities for Brazilian pepper re-establishment were also removed.

Remaining scars of the more western former mosquito control ditches have not had the opportunity to enter into successive vegetation communities to date. These areas are improved feeding areas for bird and other wildlife populations. Long term observation of these areas will yield interesting results.

References

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Thayer, Gordon W., Teresa A. McTigue, Russell J. Bellmer, Felicity M. Burrows, David H. Merkey, Amy D. Nickens, Stephen J. Lozano, Perry F. Gayaldo, Pamela J. Polmateer, and P. Thomas Pinit. 2003. Science-Based Restoration Monitoring of Coastal Habitats, Volume One: A Framework for Monitoring Plans Under the Estuaries and Clean Waters Act of 2000 (Public Law 160-457). NOAA Coastal Ocean Program Decision Analysis Series No. 23, Volume 1. NOAA National Centers for Coastal Ocean Science, Silver Spring, MD. 35 pp. plus appendices.

Thayer, Gordon W., Teresa A. McTigue, Ronald J. Salz, David H. Merkey, Felicity M. Burrows, and Perry F. Gayaldo, (eds.). 2005. Science-Based Restoration Monitoring of Coastal Habitats, Volume Two: Tools for Monitoring Coastal Habitats. NOAA Coastal Ocean Program Decision Analysis Series No. 23. NOAA National Centers for Coastal Ocean Science, Silver Spring, MD. 628 pp. plus appendices.

Appendix: Functional Monitoring

Fish Abundance

From 2003-2009, fish number and species were sampled in North and South Wilcox Creek, as a pre-monitoring measure. CHNEP, with SWFWMD funding, contracted Mote Marine Laboratory to complete 2013 to complete the functional monitoring portion of the restoration monitoring plan. The Final analysis was completed by Mote and submitted under separate cover.

With data available from 2003-2009, CHNEP mapped the sample location and results by year on the aerial photo nearest the age of sample. The map series is presented as Figures A-1 through A-7.

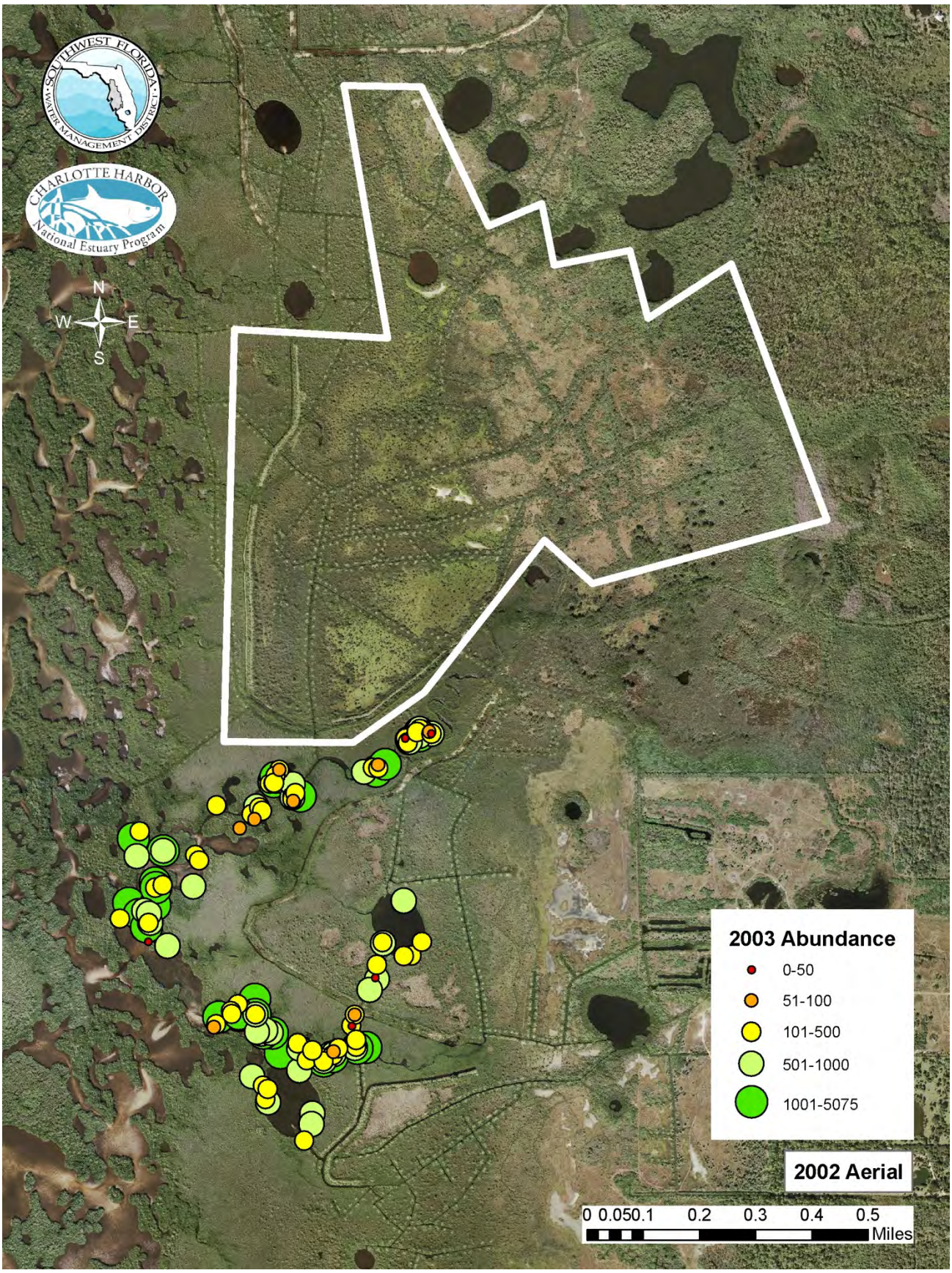

Figure A-1: 2003 Fish Abundance

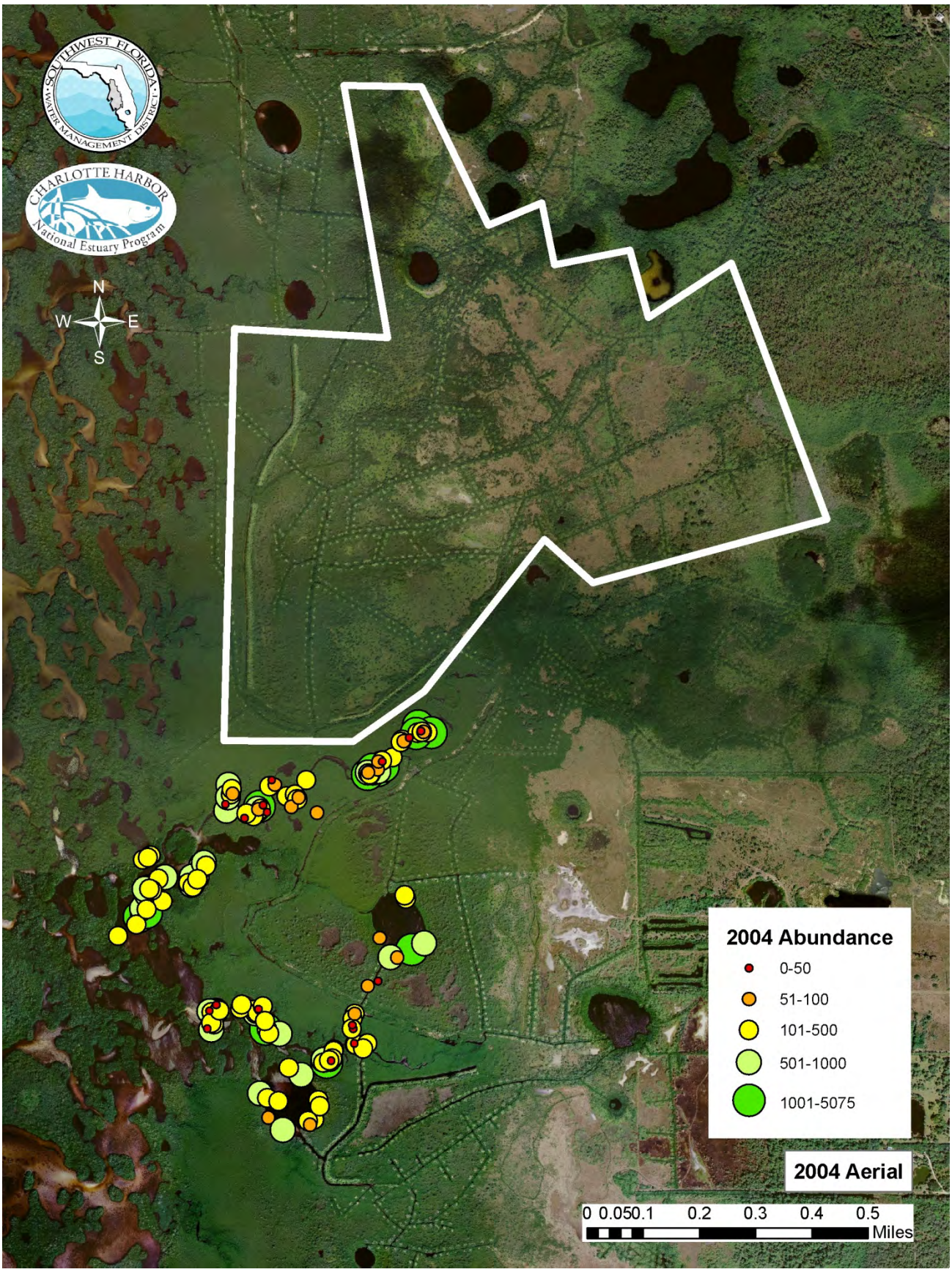

Figure A-2: 2004 Fish Abundance

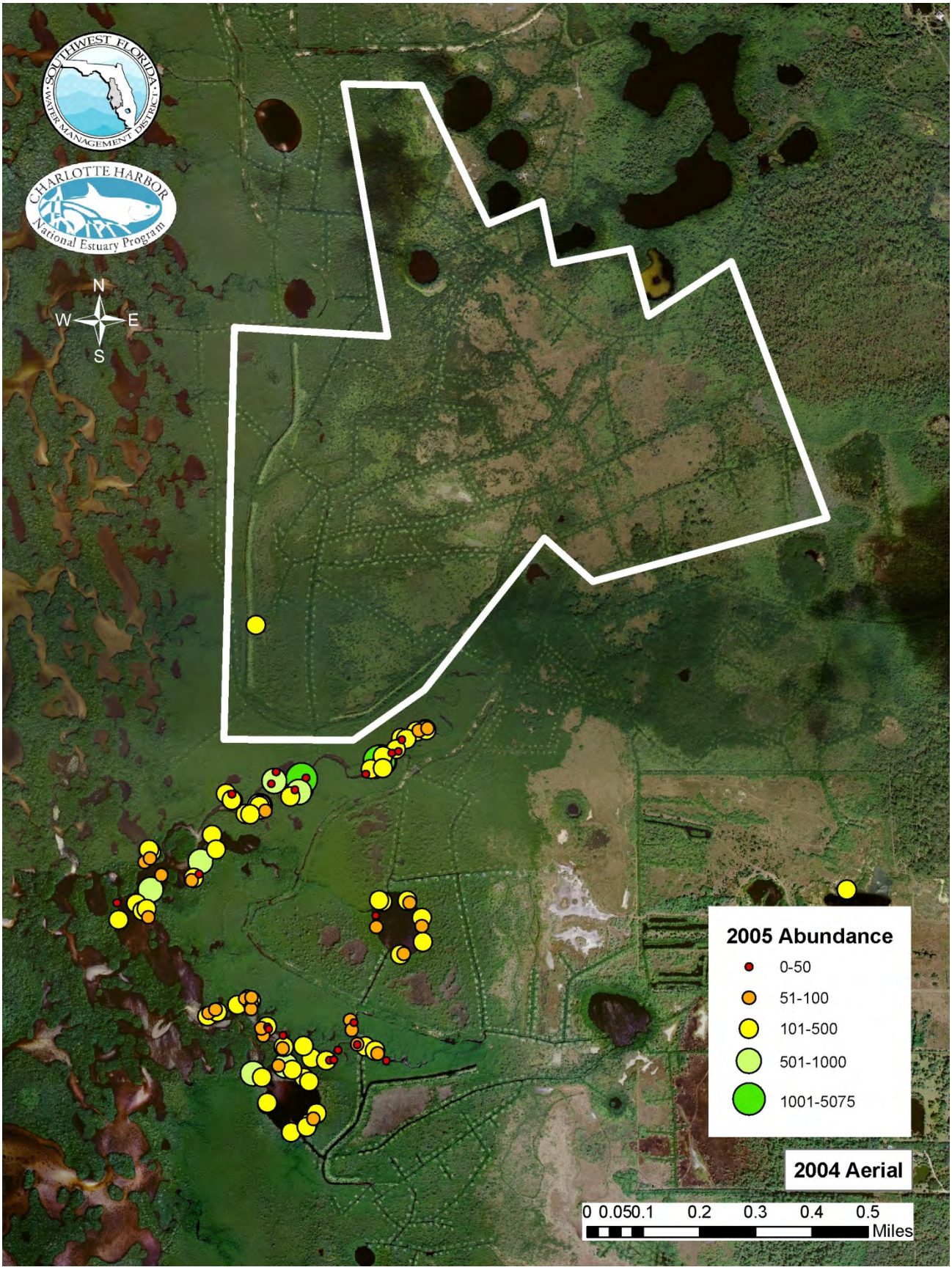

Figure A-3: 2005 Fish Abundance

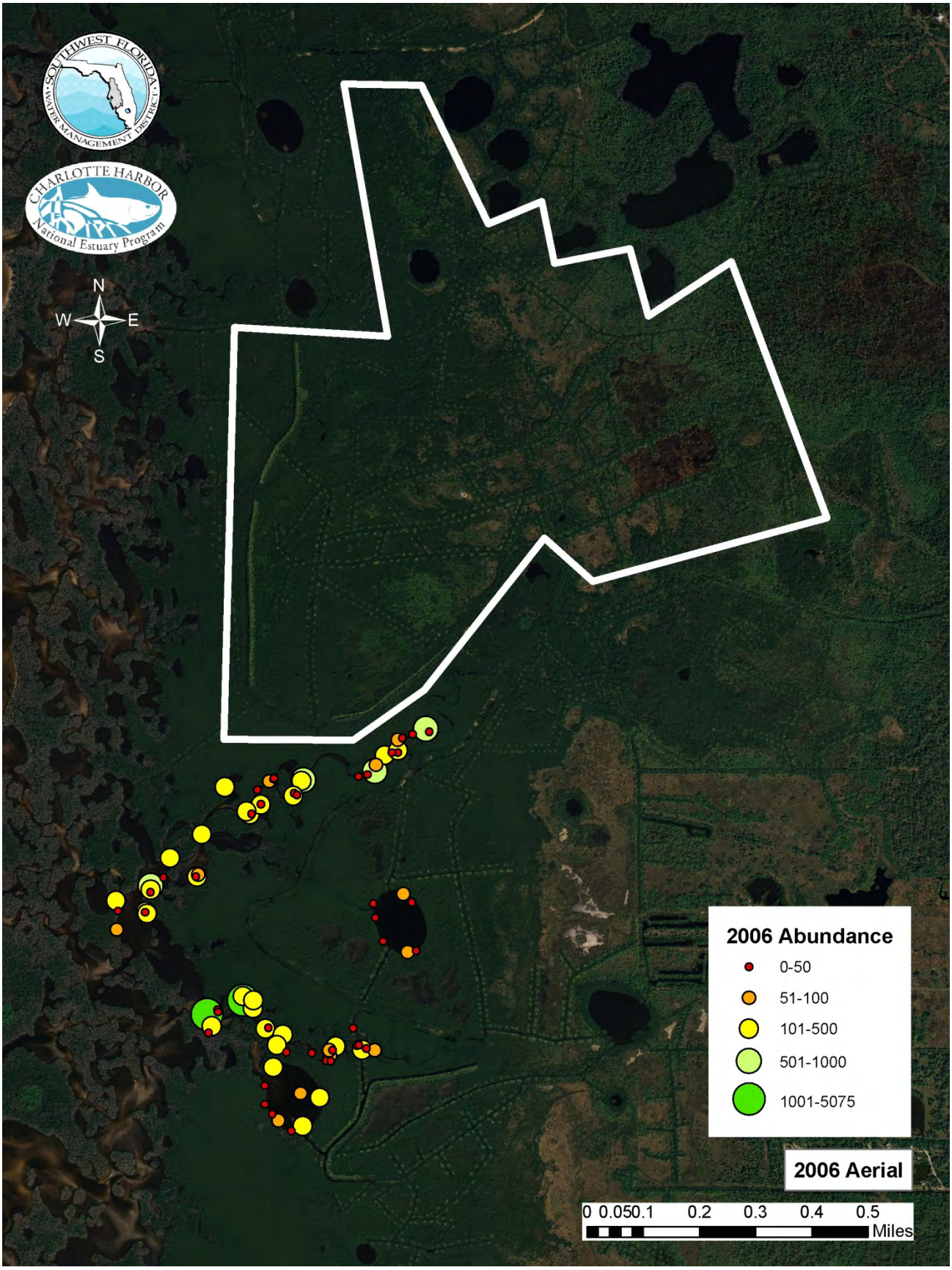

Figure A-4: 2006 Fish Abundance

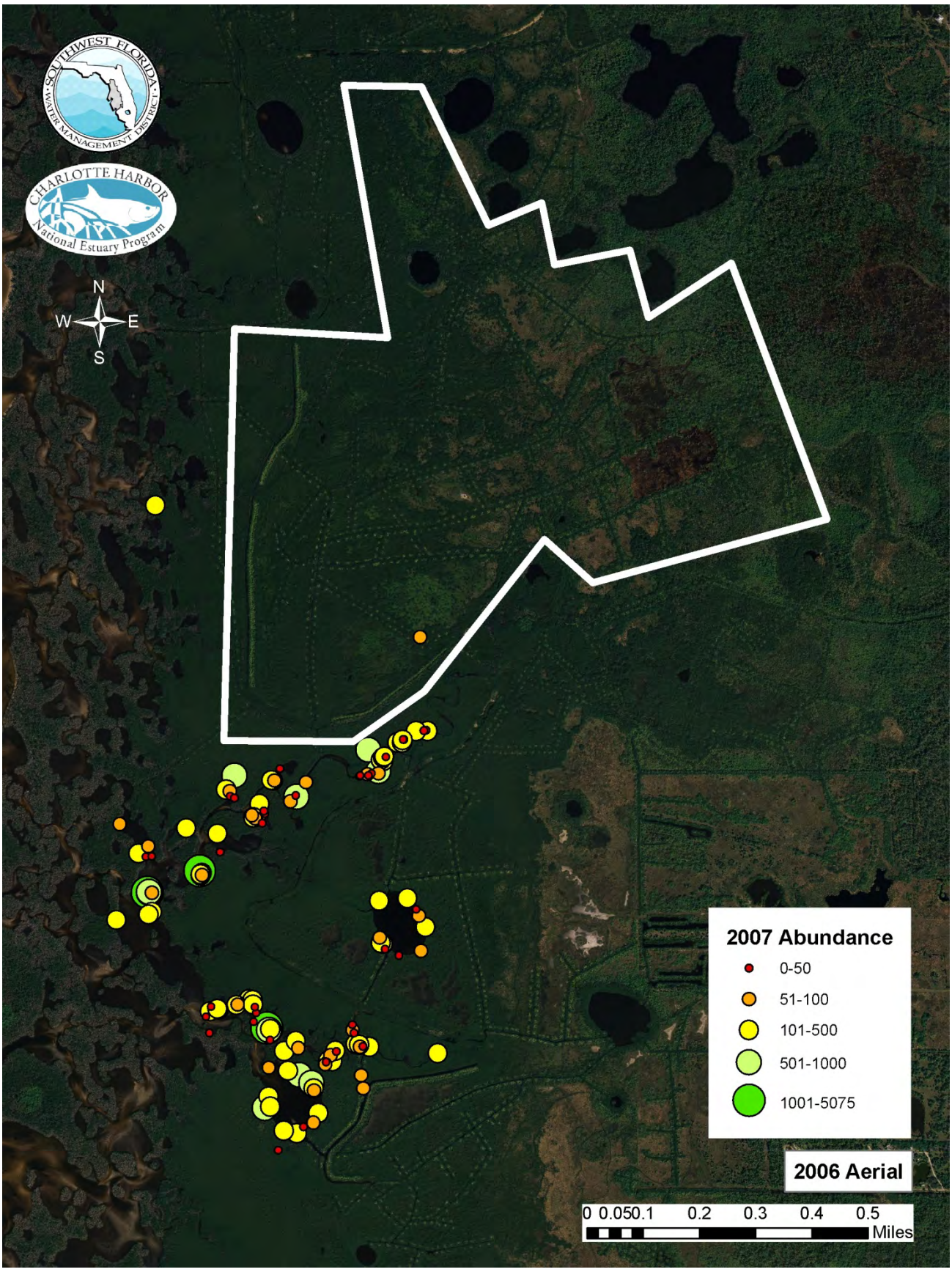

Figure A-5: 2007 Fish Abundance

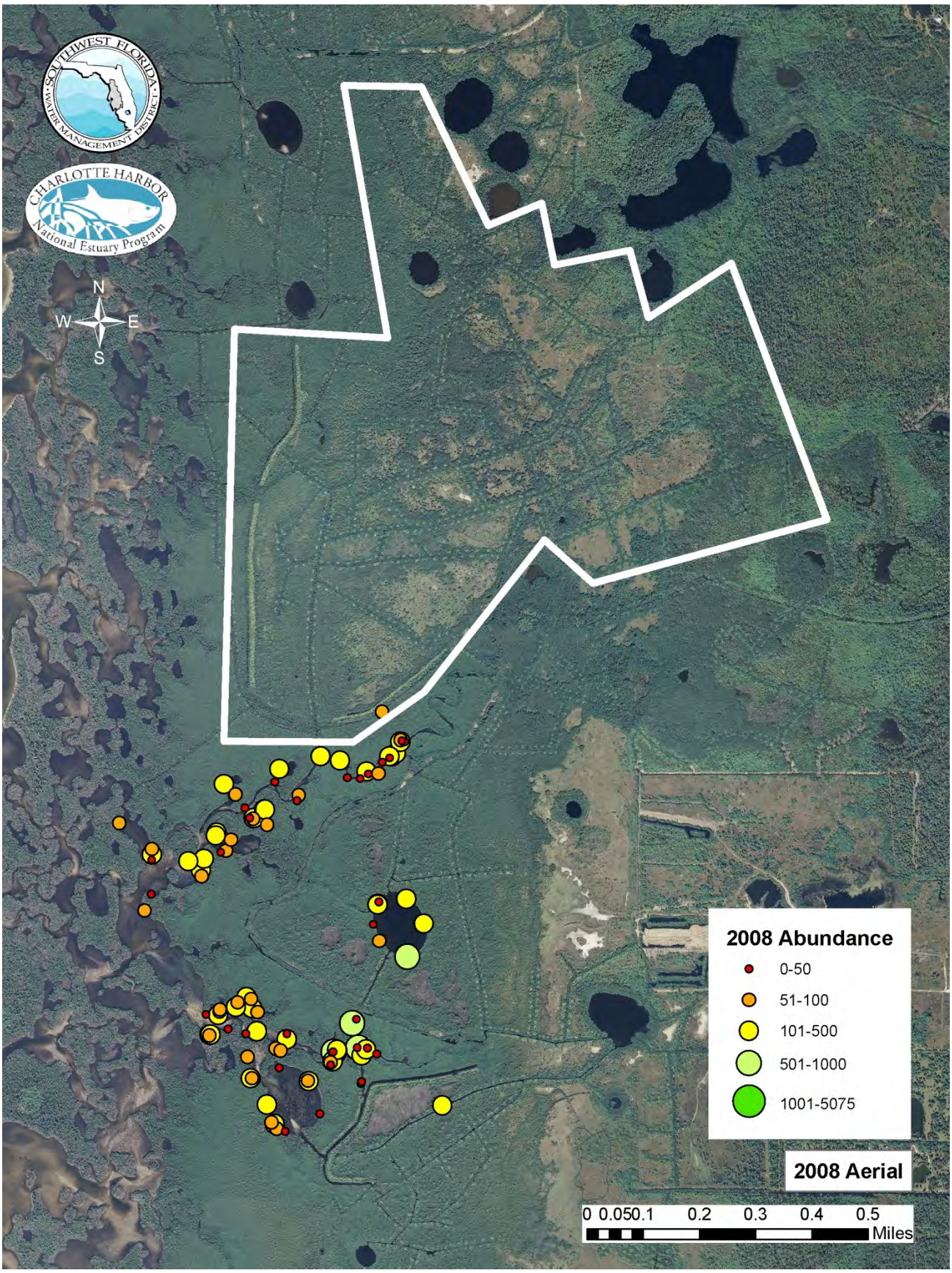

Figure A-6: 2008 Fish Abundance

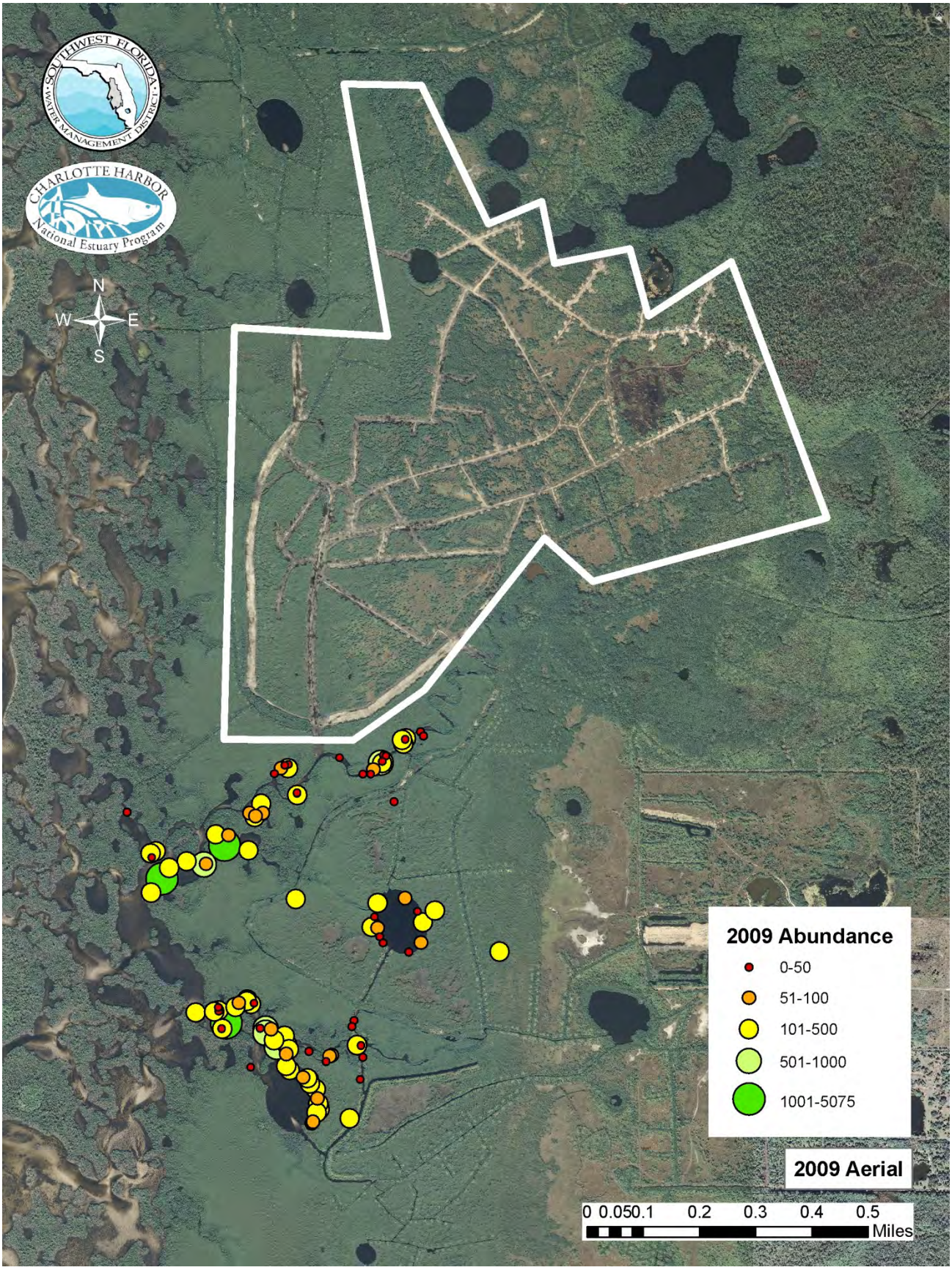

Figure A-7: 2009 Fish Abundance

Fish Diversity

With data available from 2003-2009, CHNEP completed the Shannon-Wiener diversity index for each sample. The results are mapped the sample location and results by year on the aerial photo nearest the age of sample. The map series is presented as Figures A-8 through A-14.

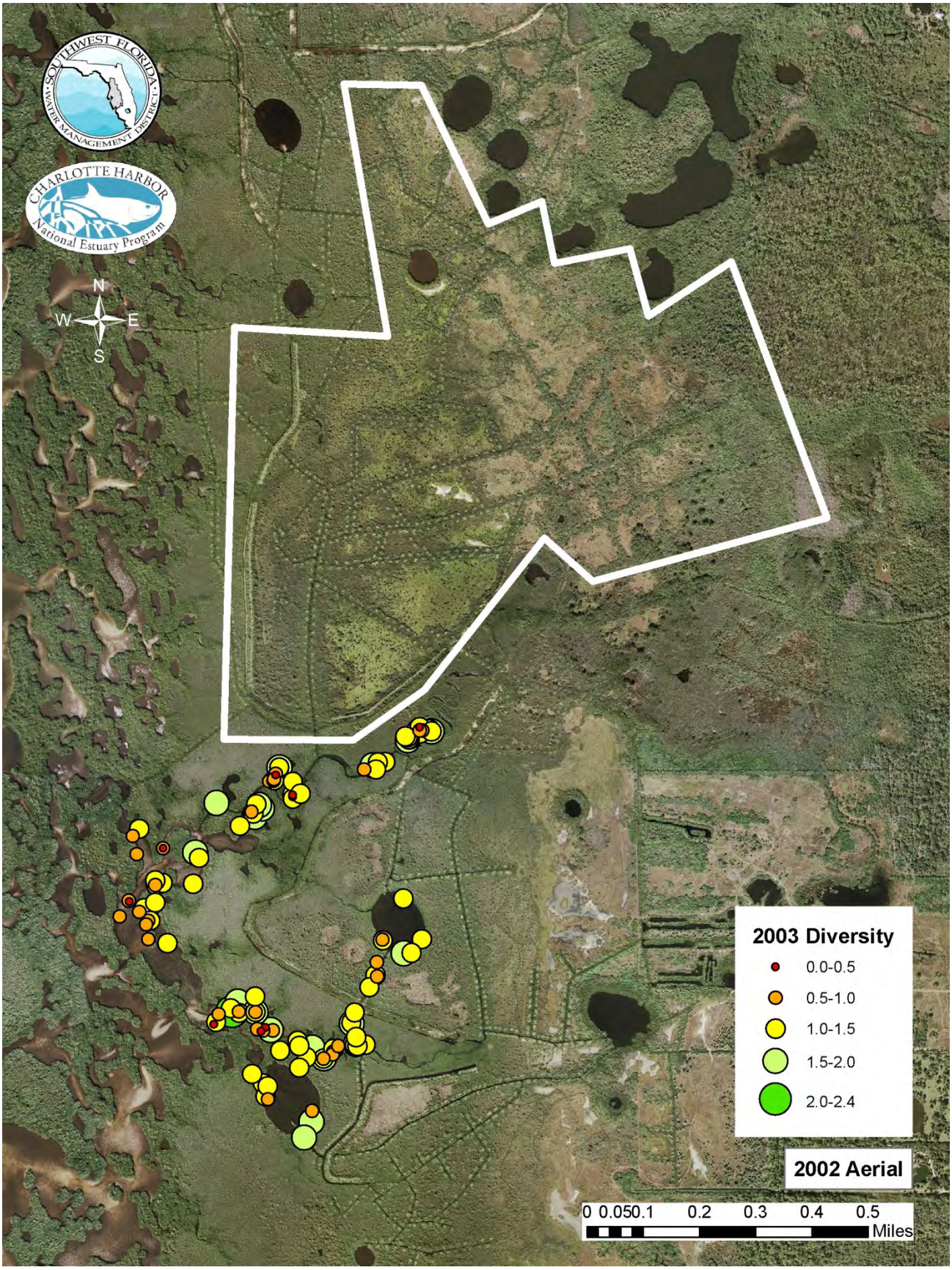

Figure A-8: 2003 Fish Diversity

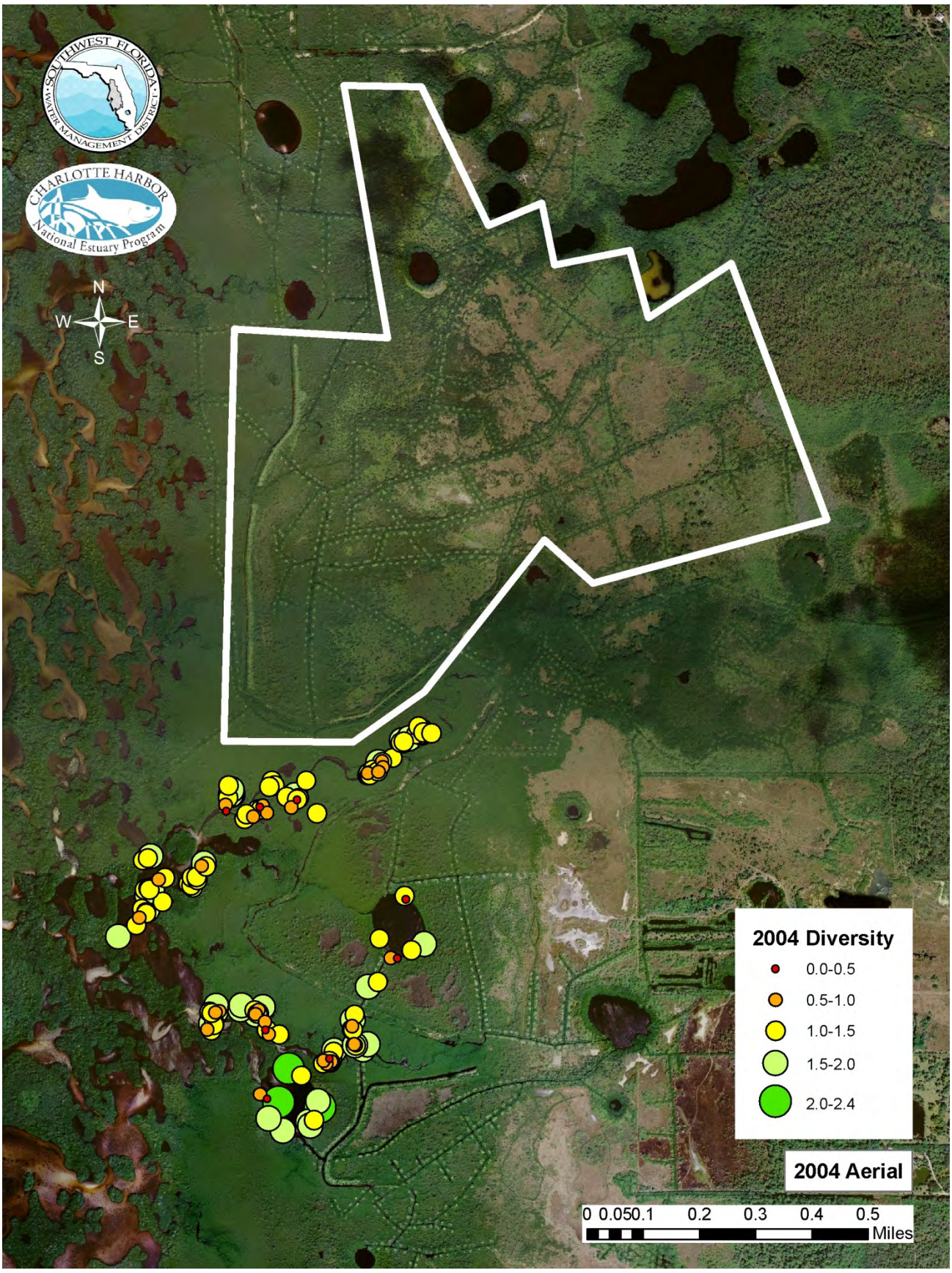

Figure A-9: 2004 Fish Diversity

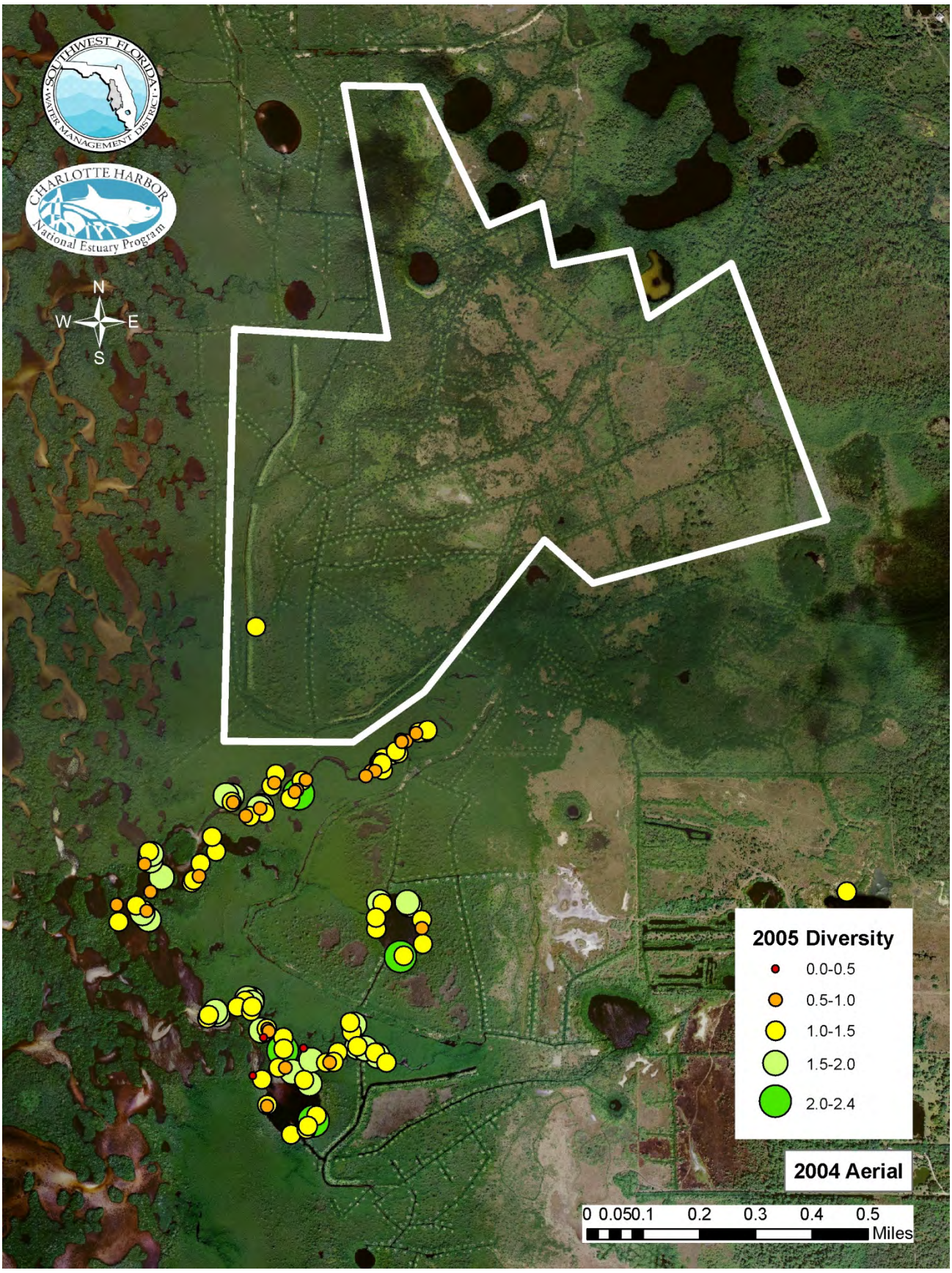

Figure A-10: 2005 Fish Diversity

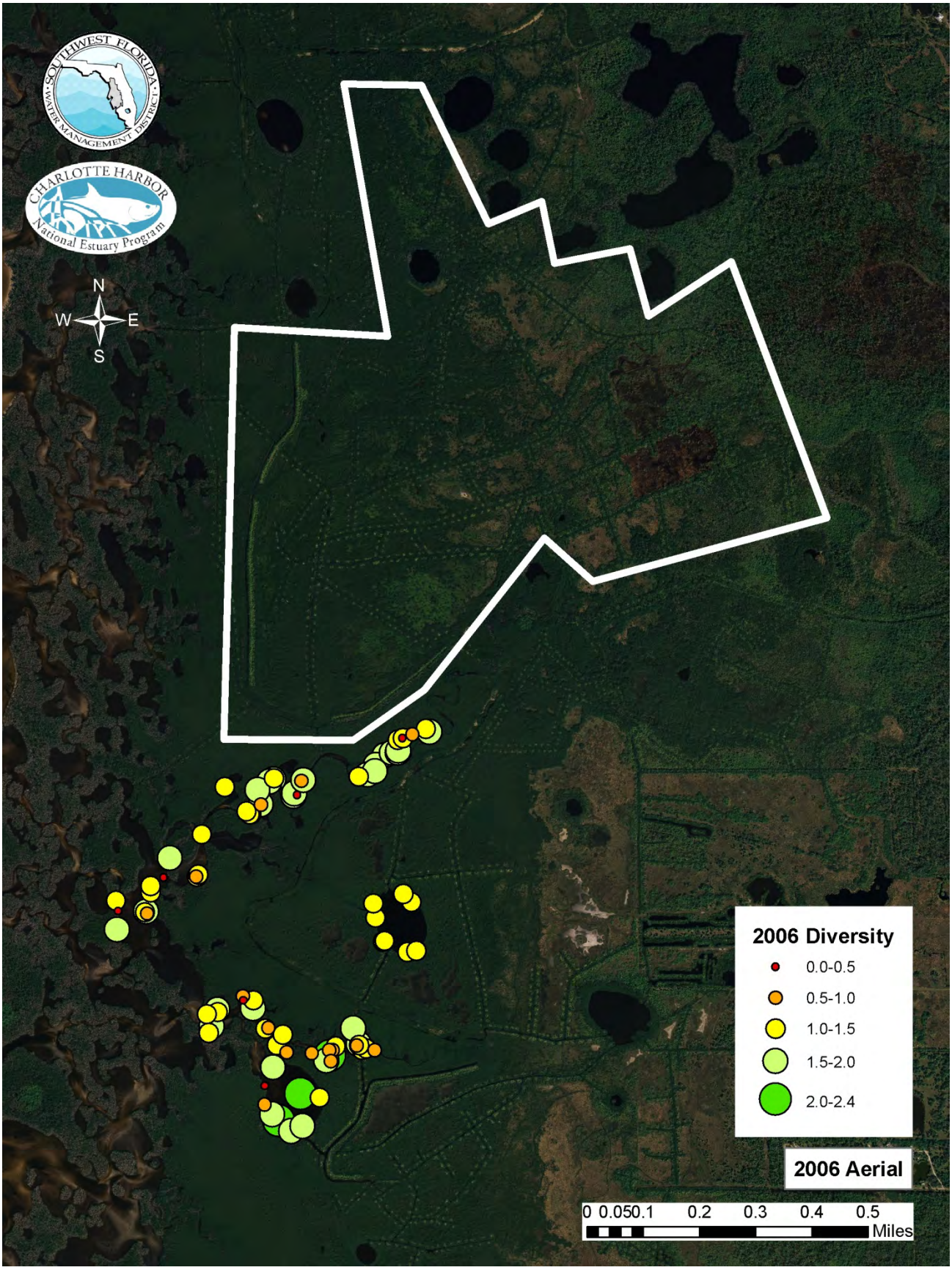

Figure A-11: 2006 Fish Diversity

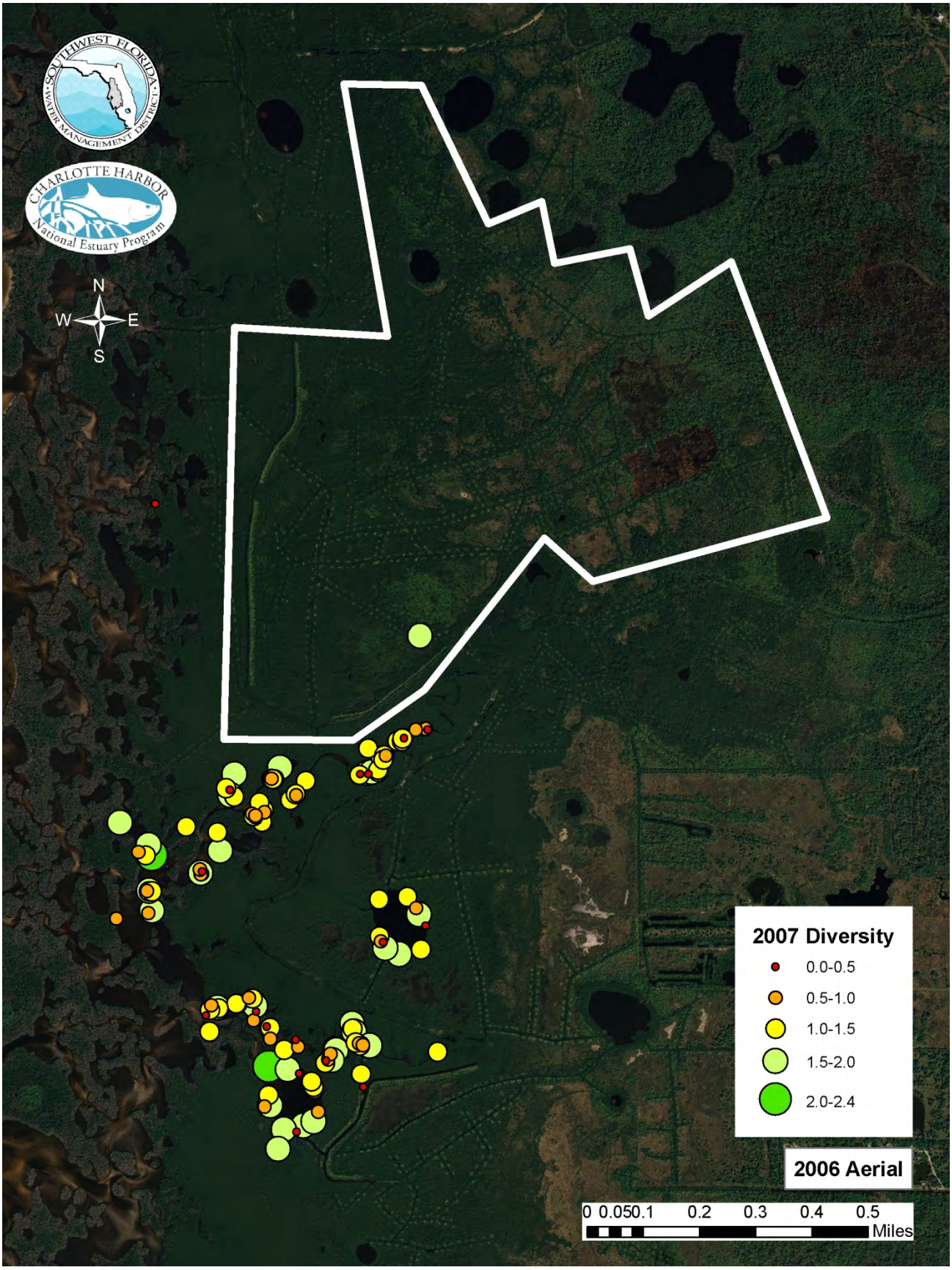

Figure A-12: 2007 Fish Diversity

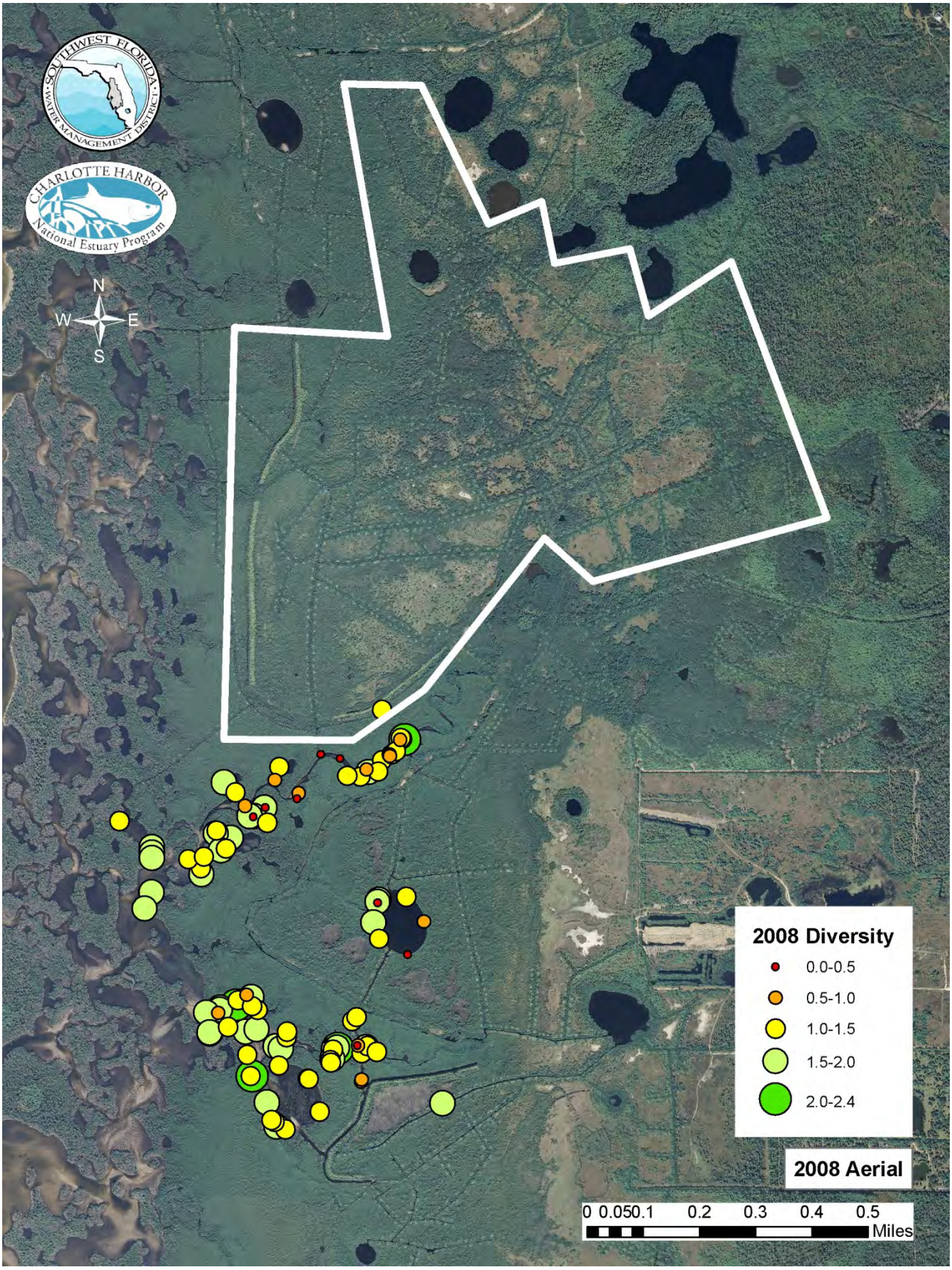

Figure A-13: 2008 Fish Diversity

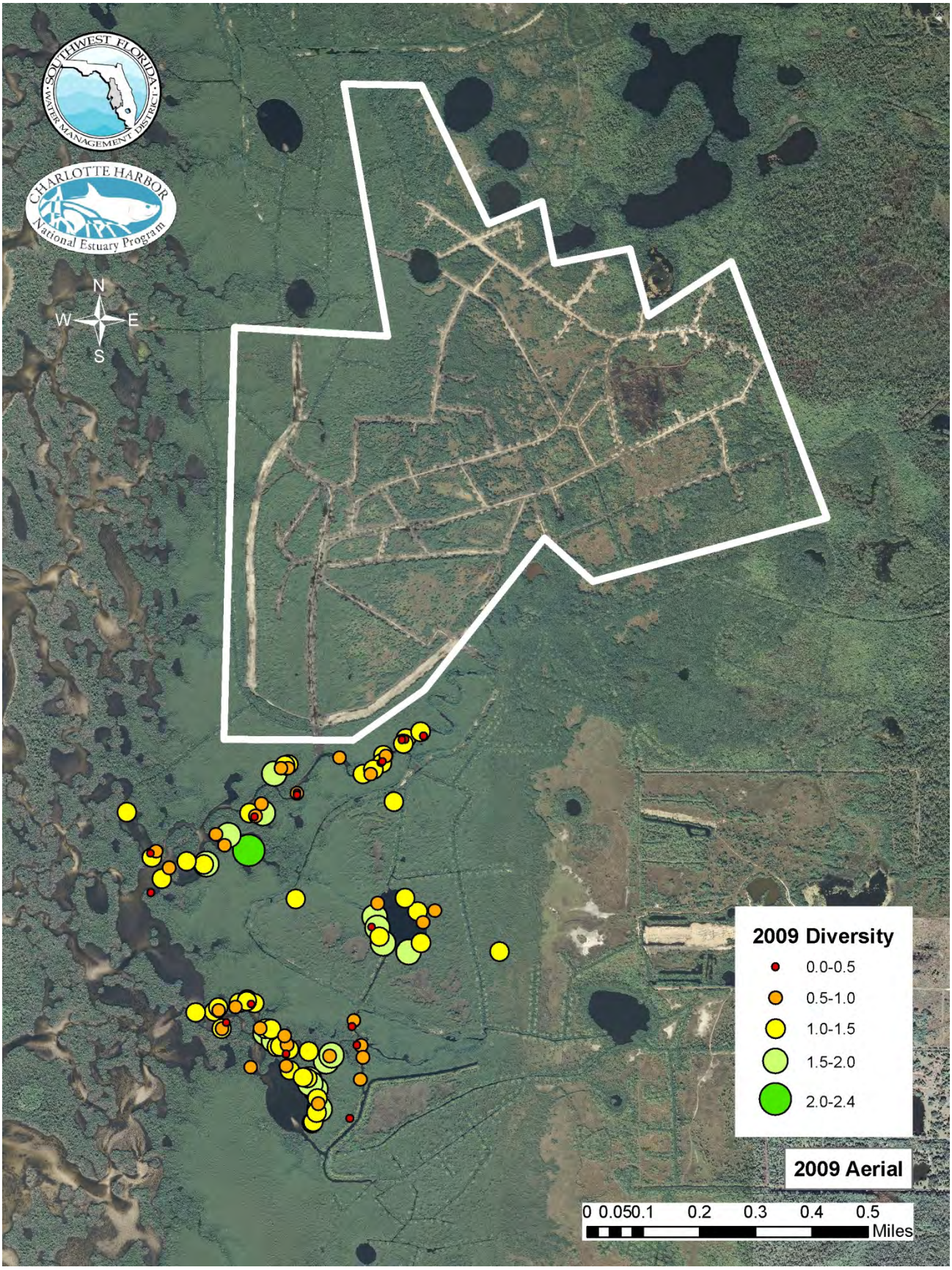

Figure A-14: 2009 Fish Diversity