BULLFROG CREEK AQUATIC RESOURCE PROTECTION AREA MANAGEMENT PLAN UPDATE

Prepared for

PORT TAMPA BAY

ENVIRONMENTAL DEPARTMENT

1101 CHANNELSIDE DRIVE

TAMPA, FL 33602

By

AUDUBON FLORIDA

FLORIDA COASTAL ISLANDS SANCTUARIES PROGRAM

And

LEWIS ENVIRONMENTAL SERVICES, INC.

September 2015

PREFACE

This document provides an update to the Bullfrog Creek Aquatic Resource Protection Area (ARPA) Management Plan and has been prepared by Audubon Florida's Florida Coastal Islands Sanctuaries (FCIS), Tampa, FL. It updates the earlier plan prepared by FCIS and Lewis Environmental Services, Inc., Salt Springs, FL under contract to the Tampa Port Authority (now Port Tampa Bay) through its Sovereign Lands Management Initiatives Program.

Several business affiliations and organizational name transitions and changes have occurred since the original plan was prepared in 1998. In this updated version, we have included the business and institutional names and business affiliations and location names that are currently in use, replacing the outdated names.

In addition, we have updated data and survey information relating to the environmental features located within the Bullfrog Creek ARPA and the study area.

We are pleased that several of the recommendations presented in the original plan have been implemented in the intervening years by the many organizations and institutions involved in the management of Tampa Bay. For example:

- There are currently no sewage residual or septage disposal operations within the Bullfrog Creek watershed. Hillsborough County no longer permits sewage residual disposal within the county's boundaries.
- Year-round boating regulations have been adopted to reduce harm to manatees within the shallower areas of the Bullfrog Creek ARPA.
- Shoreline protection/restoration structures have been placed along the highly impacted shorelines of Whiskey Stump and Green Keys, Port Redwing and portions of the Alafia Bank.
- Land acquisition for restoration and protection has occurred, and some restoration has been completed.

However, much work remains to be done.

Tampa Bay's regional natural resource management community - government agencies and private entities - have worked in an exemplary fashion over the years to protect the natural resources of Hillsborough Bay. Together, we have a mutual responsibility to make choices and undertake actions that will have long-lasting impacts on this special section of Tampa Bay. Working together, with innovation and best intentions, based on scientifically designed considerations for the resources in this area of Hillsborough Bay, we can ensure a future that protects the habitats and wildlife for generations to come.

September 2015

Roseate spoonbill adults and young of the year resting on a mudflat in Hillsborough Bay, Florida

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The Bullfrog Creek Aquatic Resource Protection Area Management Plan was first drafted in the mid-1990s for the Tampa Port Authority pursuant to the Port's enabling legislation requiring management plans for the Aquatic Resource Protection Areas in Tampa Bay. In 2015, Audubon Florida's Florida Coastal Islands Sanctuaries and Lewis Environmental Services, Inc. undertook a much needed update to the Bullfrog Creek ARPA management plan.

List of Authors

Suzanne T. Cooper, was Principal Environmental Planner of the Tampa Bay Regional Planning Council and Director of the Tampa Bay Agency on Bay Management from 1993-2013 and, as an Audubon volunteer, led the revision of the updated Bullfrog Creek Aquatic Resource Protection Area Management Plan.

Ann F. Paul is the Florida Coastal Islands Sanctuaries' Tampa Bay Regional Coordinator, and collaborating author on the original and updated plans.

Richard T. Paul (*posthumously*) was the Florida Coastal Islands Sanctuaries' Sanctuaries Manager from 1979-2004, and primary author of the original plan.

Mark L. Rachal is the Florida Coastal Islands Sanctuaries' Sanctuaries Manager and collaborating author on the updated plan.

Roy R. Robin Lewis, III, is President of Lewis Environmental Services, Inc. and collaborating author on the original and updated plans.

Ann B. Hodgson was Florida Coastal Islands Sanctuaries' Gulf Coast Research Director and Sanctuaries Manager from 2006-2010, presently President of Resource Designs Inc., Natural Resource Research & Planning, and collaborating author on the updated plan.

EXECUTIVE SUMMARY

The Tampa Port Authority (TPA; presently Port Tampa Bay) is authorized by the State of Florida under Section 6, Chapter 95-488, Laws of Florida, as amended, to establish Aquatic Resource Protection Areas in the waters of Hillsborough County, Florida. The Bullfrog Creek Aquatic Resource Protection Area (BCARPA) is one of ten ARPAs established based on Section D of the TPA's Submerged Lands Management Rules (adopted April 1, 1994 and subsequently revised on May 1, 1998). The BCARPA encompasses much of southeastern Hillsborough Bay and contains some of the most significant natural resources in Florida: the spectacular bird colony of the Richard T. Paul Alafia Bank Bird Sanctuary; "The Kitchen", an extensive, biologically productive sub-bay of Hillsborough Bay that includes the Hog and Hominy Cove estuary; the most productive bull shark nursery known along Florida's west coast located at the natural or "south mouth" of the Alafia River; mudflats, seagrass flats, and oysterbars that provide an important migratory stopover and over-wintering area for shorebirds, white pelicans and ducks; and the extensive needlerush marshes, mangroves and salt barrens of Bullfrog Creek, Gardenville Beach, the Davis property, and the South Parcel. For these reasons, the Tampa Port Authority (now Port Tampa Bay) chose to prepare this Sovereign Lands Management Plan to ensure the continued ecological integrity, protection, and enhancement of the BCARPA.

This updated management plan includes descriptions of the natural resources of the BCARPA, adjacent upland areas, and upstream watershed activities. These descriptions allow a logical targeting of current management problems and their solutions. We outline cooperative efforts and partnerships and actions that have been accomplished to-date to address previously identified concerns, suggest strategies for implementation of specific management activities, and identify appropriate responsible agencies and regional stakeholders.

The recommendations made in this updated management plan focus generally on the types and locations of future activities in and adjacent to the BCARPA. Future site development should be compatible with the goals of the ARPA, and should be located considering environmental concerns. These considerations are particularly relevant concerning the future Port Tampa Bay development of Port Redwing.

We reviewed general information available regarding the water quality of Bullfrog Creek. Recently published data concerning nutrients, dissolved oxygen and fecal coliform within the Bullfrog Creek marine segment justify the federal designation of "Impaired". The water quality of surface water drainage into the ARPA continues to significantly affect the resources within the ARPA. As in the original plan, this updated plan includes recommendations for areas outside of the defined boundaries of the ARPA to the extent that such areas affect the resources within the ARPA.

We emphasize the protection and enhancement of natural resources in this plan, and also encourage habitat restoration activities. These should be pursued as joint efforts of Port Tampa Bay; local, regional, and state agencies; and the private sector, including the National Audubon Society/Audubon Florida. There have been many successful examples of such ventures in and near the BCARPA in recent years, and we anticipate that restoration projects will continue into the future. Specific recommendations made in this updated plan have positive implications for more than one documented concern:

- Support recovering and maintaining the extent of seagrass beds, and decreased propeller scarring;
- Enhance and restore freshwater wetlands and vegetated marine habitats;
- Improve water quality;
- Enforce existing boating regulations;
- Increase efforts to combat establishment of non-native plant species;
- Protect bird colonies and their foraging, roosting, and nesting habitats;
- Protect and enhance nursery habitat and conditions for economically and recreationally important fisheries; and
- Reduce serious threats to protected species and other native wildlife populations.

Synopsis of Recommendations

In the following sections, we discuss key management issues that specific groups and agencies may be responsible for, and approaches to implementing these recommendations. The recommendations are summarized here by major category and specific issues.

Water Quality Issues:

Stormwater Treatment

1. Work with Hillsborough County and the Southwest Florida Water Management District (SWFWMD) to improve treatment of stormwater from industrial, residential, roadway and agricultural areas, and to design and construct cleansing marshes for Bullfrog, Dug and Kitchen creeks;
2. Continue to monitor creeks to identify and address local point sources of pollution; and
3. Investigate highway drainage at specific sites and its contribution to pollution of the BCARPA.

Runoff from Residential Areas

1. Sponsor seminars or distribute educational materials, through the University of Florida's Institute of Food and Agricultural Sciences (UF/IFAS) and the County, to homeowners about environmentally beneficial landscape design and lawn maintenance procedures, especially regarding fertilizer use and pet waste disposal;
2. Increase citizen and student stewardship of natural areas through participation in trash cleanups, saltmarsh plantings, and other environmental habitat management projects; and
3. Work with the Hillsborough County Solid Waste Management Department (HCSWMD) to restructure trash pickup and tipping fees to discourage illegal dumping, to investigate the existing used tire disposal procedures to determine if similar restructuring is necessary and to place dumpsters in convenient locations to facilitate proper trash disposal at parks, shopping centers, and public facilities.

Runoff from Agricultural/Commercial Areas

1. Sponsor seminars and distribute educational materials, through the UF/IFAS Extension Service and the County, to commercial farmers, growers and commercial land managers about environmentally safe/beneficial crop and land management practices, especially regarding fertilizer use, irrigation and waste disposal; and
2. During the development of the Basin Management Action Plan (BMAP) or other Total Maximum Daily Load (TMDL) implementation approaches for reaching required nutrient and fecal coliform loading rates and dissolved oxygen levels, use the measures in the BMAP adopted by the U.S. Environmental Protection Agency and FL Department of Environmental Protection for the Alafia River Basin, as appropriate.

Poorly Designed and Maintained Septic Tanks and Sewage Plants

1. Connect households in the Bullfrog Creek watershed to a central sewer service;
2. Inspect and upgrade septic systems as necessary; and
3. Require local sewage treatment plants to have operational on-site electric generators or other back-up facilities so that, even during severe storm events, untreated sewage is not discharged to waterways leading to the BCARPA.

Runoff from Tropical Fish Farms

1. Work with the Florida Department of Agriculture and Consumer Services (FDACS) to investigate the need for National Pollutant Discharge Elimination System (NPDES) permitting of tropical fish farms;
2. Design and install stormwater treatment systems at the outfalls of fish farms within the Bullfrog Creek watershed; and
3. Provide education and information about environmental protection issues and Best Management Practices to area fish farmers and workers.

Land Application of Septage

Encourage Hillsborough County to deny any future permit applications for septage disposal within the Bullfrog Creek watershed, and to study the feasibility of septage disposal through advanced wastewater treatment facilities as an alternative to land disposal.

Habitat/Wildlife Management Issues:

<u>Loss of Seagrass/Seagrass Propeller Scarring</u>

1. Install gated channel-markers at strategic locations to protect seagrass beds from boat propeller impacts;
2. Increase enforcement of boating speed limitations and restrictions on the use of internal combustion engines in (already) designated areas in the BCARPA; and
3. Support periodic assessment of propeller scarring of seagrasses within the BCARPA and amend regulation as needed.

<u>Erosion of Island/Shoreline Habitats</u>

Implement additional projects to reduce and control erosion on key bird habitat islands within the BCARPA.

<u>Long-term Protection of Bird-nesting Colonies</u>

1. Continue cooperative efforts of Audubon Florida, Port Tampa Bay, the state of Florida, and Mosaic Fertilizer LLC to post, protect, and monitor the bird-nesting colonies and sanctuary islands;
2. Continue the development of a community education program about the importance of the major nesting colonies; and
3. Encourage the Florida Fish and Wildlife Conservation Commission (FFWCC) to modify the Critical Wildlife Area rules for the Richard T. Paul Alafia Bank Bird Sanctuary to increase protection of nesting, roosting and foraging birds.

<u>Threats to Manatees, Wading Birds and Diamondback Terrapins</u>

1. Implement the channel marking program recommended for seagrass protection. This will prevent propeller scarring of seagrass beds, which provide vital feeding habitat for manatees, as well as reduce the chance of boat collisions with manatees;
2. Increase enforcement of boat speed and access restrictions;
3. Work with tropical fish farmers and fish hatcheries to investigate non-lethal methods to deter bird predation at fish farms, using Best Management Practices;
4. With Florida Fish and Wildlife Conservation Commission and Florida SeaGrant cooperation, recruit volunteer crabbers to use readily available by-catch reduction devices and provide these devices free to commercial and recreational crabbers, with explanations of how to use the devices and their importance to preventing mortality of diamondback terrapins; and
5. Encourage the State of Florida to require use of these devices by commercial and recreational crabbers.

<u>Loss of Freshwater Wetland Habitats</u>

1. Continue acquisition of restorable uplands and wetlands within the BCARPA and its watershed to create connections between existing preserves for viable long-term habitat management;
2. Create habitat mosaics that includes construction of freshwater wetlands and ephemeral “frog ponds” in future restoration projects; and
3. Create small wetlands along drainage ditches to provide stormwater cleansing and wetland habitat.

<u>Loss of Vegetated Marine Habitats</u>

1. Develop, fund, and implement a prioritized list of restoration projects; and
2. Utilize suitable dredged material from channel and port maintenance to enhance and restore habitat whenever feasible.

<u>Invasion of Native Habitats by Non-native Plants</u>

Support the work of the Suncoast Cooperative Invasive Species Management Area, the large-scale effort among agencies, community groups, and private landowners to remove non-native plants and animals and replant treated areas with native vegetation.

ARPA Resource Management Standards of Use:

With regard to the development of ARPA Resource Management Standards of Use, we recommend the following addition to Section V.A.3.e of the General Resources Management Standards, Boat Ramps:

> [Boat ramps] shall be located only in areas where an existing natural or man-made channel provides continuous unimpeded water depths of no less than –4.0 ft. MLLW and has or will have gated channel markers installed as part of an application for a new or improved boat ramp.

In accordance with Section V.B.3.m.(1) of the ARPA Resource Management Standards, it is also recommended that any form of aquaculture or mariculture, including submerged aquatic vegetation (SAV) farming, be prohibited within the BCARPA.

INTRODUCTION

Port Tampa Bay (PTB) is authorized by the State of Florida under Section 6, Chapter 95-488, Laws of Florida, as amended, to establish Aquatic Resource Protection Areas in the waters of Hillsborough County, Florida. The Bullfrog Creek Aquatic Resource Protection Area (BCARPA) is one of ten ARPAs established based on Section D of PTB's Submerged Lands Management Rules (adopted April 1, 1994 and subsequently revised on May 1, 1998).

Tampa Bay is the largest estuary on Florida's gulf coast (Figure 1).

Hillsborough Bay, including East Bay and McKay Bay, is the northeastern sub-bay of Tampa Bay. The BCARPA is highlighted in the square on the east side of Hillsborough Bay (Figure 2).

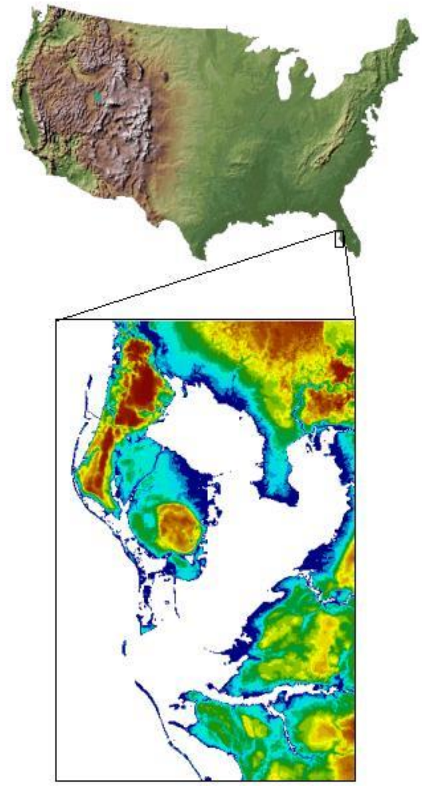


Figure 1. Location of Tampa Bay on the Florida peninsular west coast.

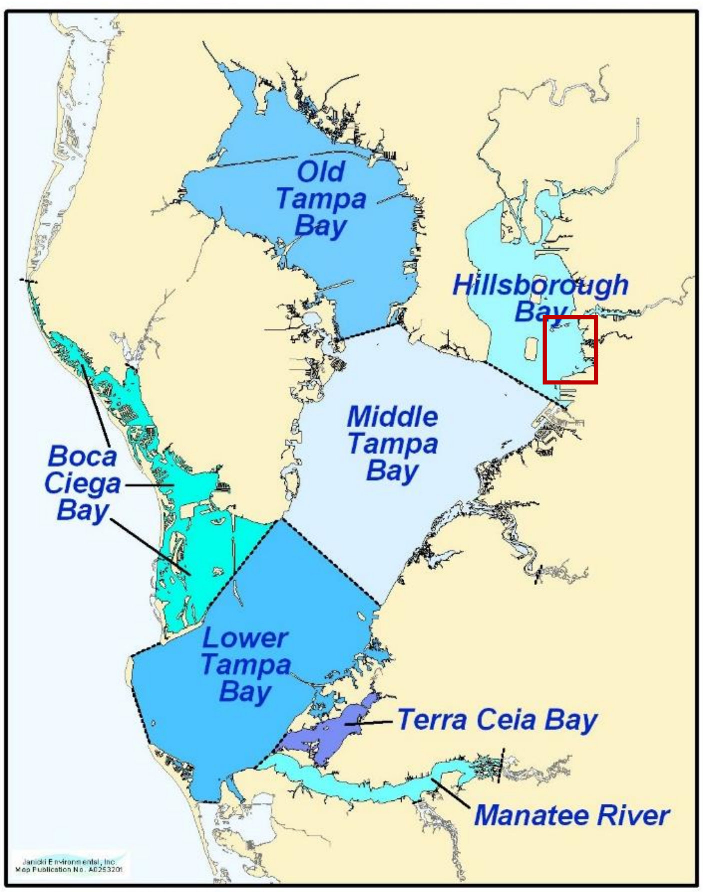


Figure 2. Geographic subdivisions of Tampa Bay (Janicki et al. 1995).

The BCARPA lies within the red square.

The BCARPA lies south of the Alafia River shipping channel, west of Highway 41 (Figure 3). Bullfrog Creek is the first tributary creek system entering Hillsborough Bay south of the Alafia River (Figure 4). The creek discharges enough flow that pioneer settlers of Gibsonton, Gardenville, and Adamsville (Jeannie and Pete Johnson, pers. comm.) originally named it the "Roosevelt River" in the 1920s.

Figure 3. Aerial photograph of BCARPA (Source: Google Maps 2015).

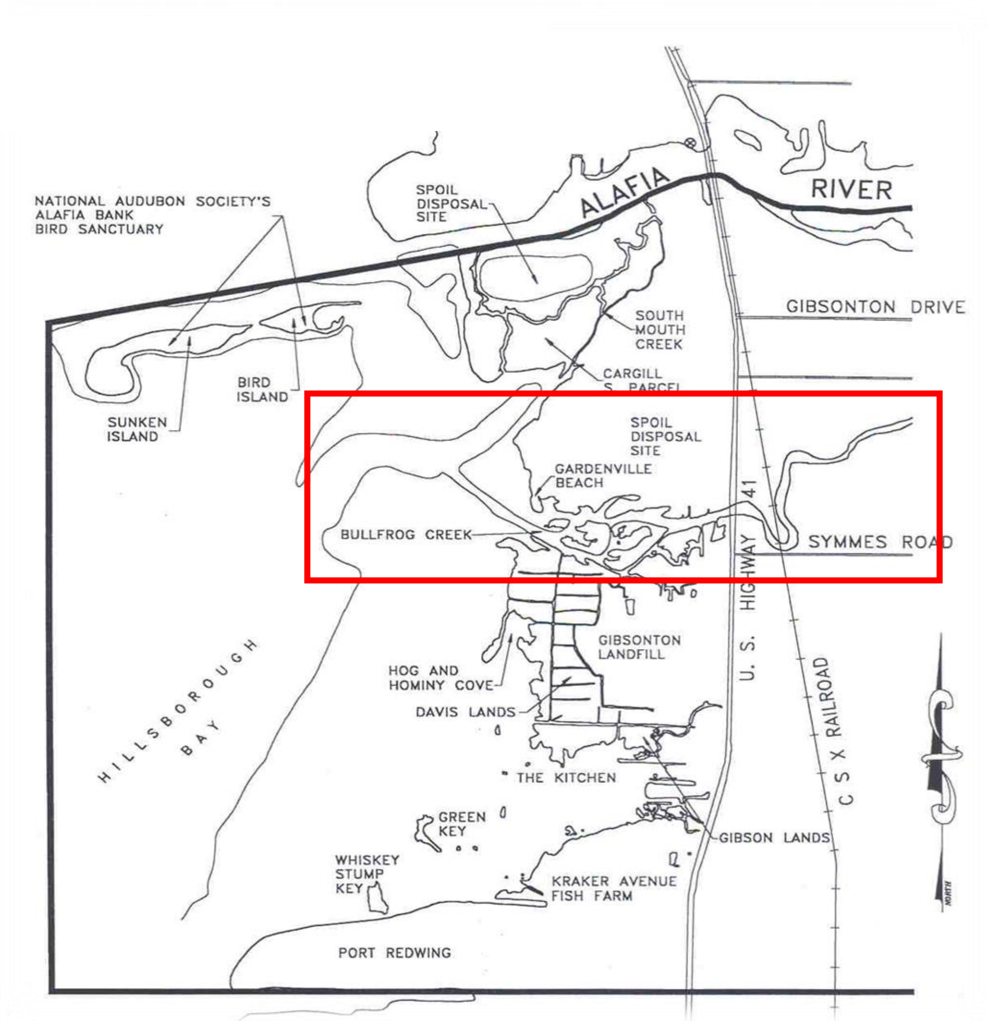


Figure 4. Location of Bullfrog Creek mouth and lower reach within southeastern Hillsborough Bay.

The legal boundary of the BCARPA includes the sovereign waters of eastern Hillsborough Bay lying adjacent to and just north and south of the mouth of Bullfrog Creek (Appendix A). The ARPA study area encompasses 2,629 acres of submerged land, wetlands, and uplands (Figure 5) owned by PTB, Mosaic Fertilizer LLC, Hillsborough County through its Jan K. Platt Environmental Lands Acquisition and Protection Program (ELAPP), the Southwest Florida Water Management District's (SWFWMD) Save our Rivers (SOR) program, the National Audubon Society, and several private landowners. Tributaries to the BCARPA include Dug Creek, Kitchen Creek, "south mouth" and Little Bullfrog Creek (major branch of Bullfrog Creek).

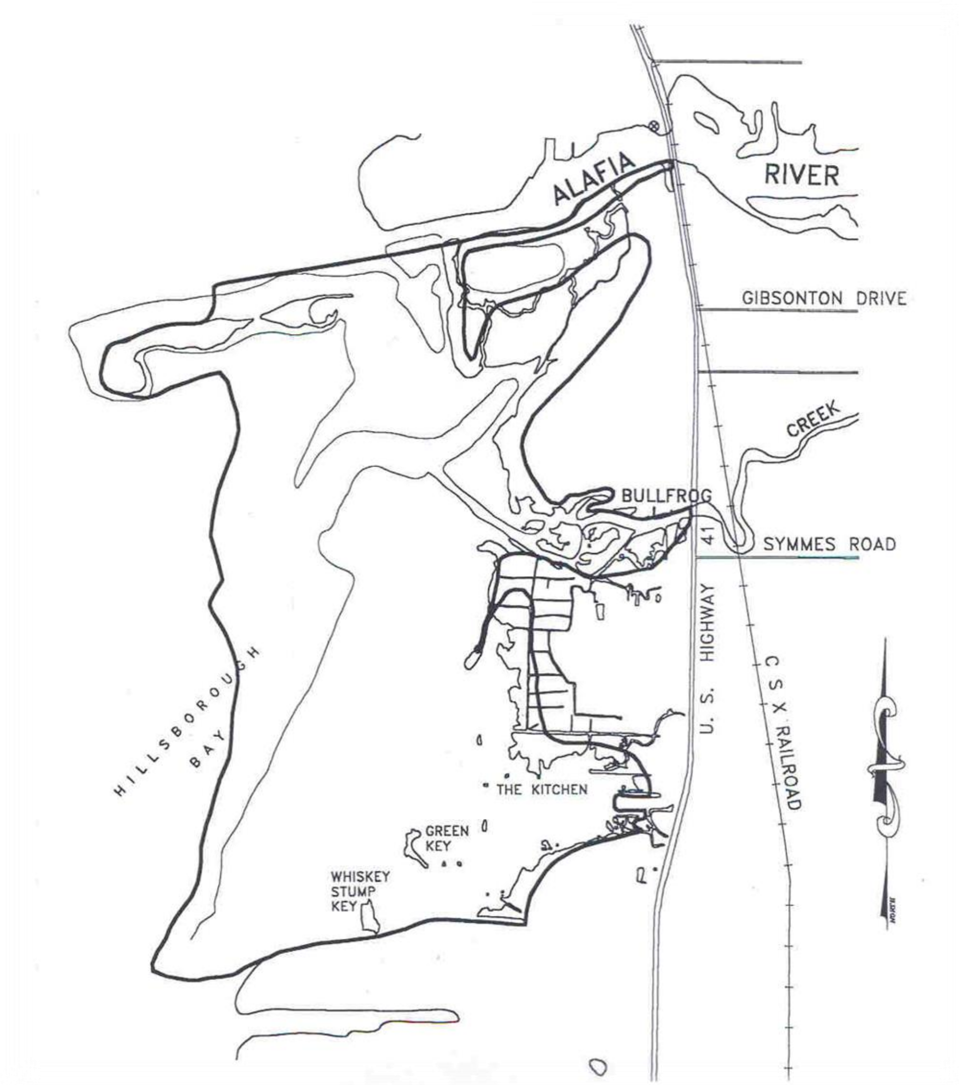


Figure 5. Boundaries of the BCARPA.

Surface water drainage into the BCARPA has a substantial impact on the resources within the BCARPA (USEPA 2013). It is clear that land use and other influences originating outside the BCARPA boundaries affect habitats within the BCARPA. Therefore, recommendations are included in this management plan regarding areas outside of the defined boundaries of the BCARPA to the extent that such areas affect the resources within the BCARPA.

Primary, secondary and tertiary study area boundaries were established, with the understanding that most of the study would emphasize the primary BCARPA study area (Figure 6).

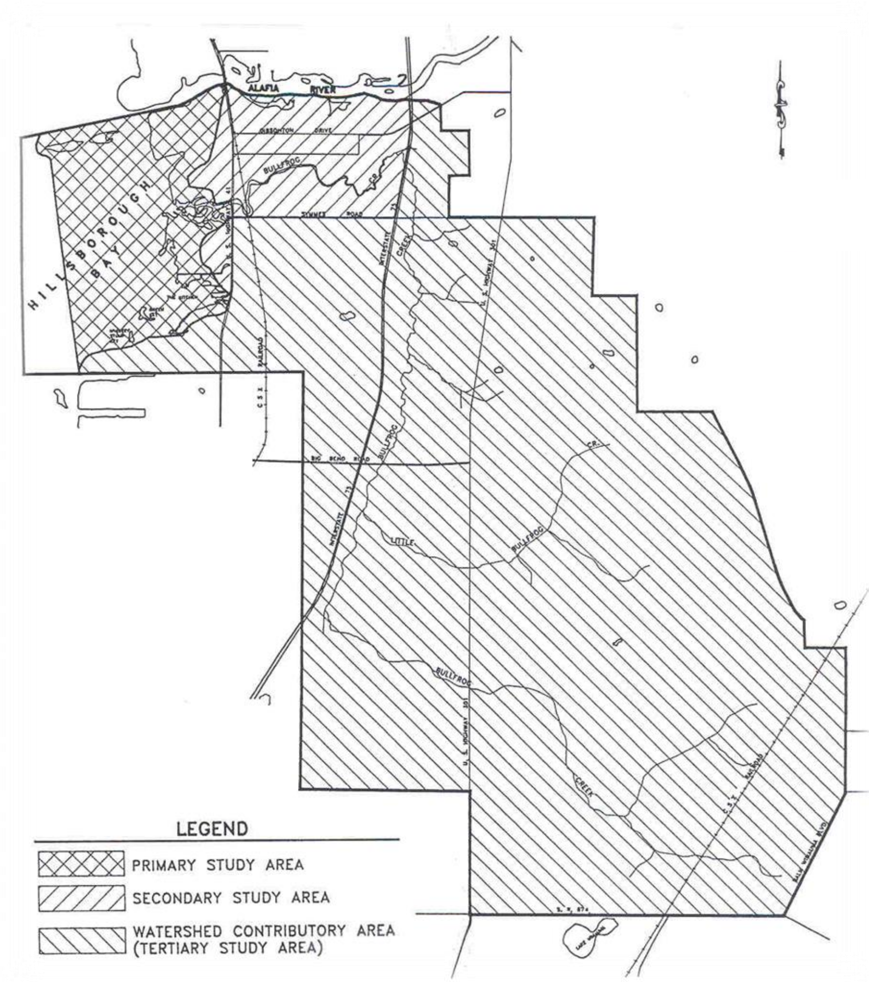


Figure 6. Primary, secondary, and tertiary BCARPA study areas.

Purpose

The purpose of preparing a specific management plan was twofold: 1) to assess the existing conditions of the ARPA, and 2) to recommend to PTB specific actions necessary to ensure that the general management goals contained in Section B(1) of PTB's Submerged Lands Management Rules Permitting Guidelines are implemented.

The Section B(1) general management goals are:

- To preserve, protect, and enhance exceptional areas of sovereign submerged lands by reasonable regulation of human activity on sovereign submerged lands within these areas;
- To protect and enhance the waters of these areas so that the public may continue to enjoy the traditional uses such as swimming, boating and fishing;
- To encourage the protection, enhancement or restoration of the biological, aesthetic, or scientific values of these areas including, but not limited to, the modification of existing manmade conditions back toward their natural condition and to discourage activities which would degrade the aesthetic, biological or scientific values of these areas;
- To preserve, promote and protect indigenous life forms and habitats of these areas;
- To maintain the beneficial hydrologic functions of these areas;
- To provide navigational access to these areas only to the extent required by riparian rights; and
- To ensure compliance of all uses of sovereign lands with applicable management plans and policies.

EXISTING CONDITIONS

General Description

The Bullfrog Creek ARPA contains some of the most significant natural resources in Florida. The area consists of upland and wetland habitats and is dominated by medium density and agricultural land uses. The wetland habitats, in particular, provide ecological functions critical to the ecological integrity of the Tampa Bay estuary. These wetland habitats include the Richard T. Paul Alafia Bank Bird Sanctuary, formed of two bird nesting islands; Whiskey Stump Key and Green Key, the original National Audubon Society bird island sanctuaries in Hillsborough Bay; a biologically productive shallow embayment known as The Kitchen; the most productive bull shark (*Carcharhinus leucas*) nursery known along Florida's West Coast; the Hog and Hominy Cove estuary; and the extensive needlerush marshes, mangroves and salt barrens of Bullfrog Creek, Dug Creek, Kitchen Creek, and the southern mouth of the Alafia River. Although much of this area has been negatively impacted by past land use and agricultural practices, many acres within the watershed have been purchased by ELAPP and SWFWMD and habitat restoration or stormwater management projects have been accomplished, are underway or are planned.

Bullfrog Creek lies south of the Alafia River watershed in southern Hillsborough County on the eastern side of Hillsborough Bay. It enters Tampa Bay on the east side of Hillsborough Bay approximately one mile south of the realigned channel mouth of the Alafia River. The Tampa Bay Regional Planning Council (1986) described the Bullfrog Creek watershed as:

> "The drainage basin is about 40 square miles and the creek flows in a northwest direction approximately 17.5 miles to Hillsborough Bay.
>
> The mouth of Bullfrog Creek meanders through an extensive tidal marsh containing mangrove islands. Upstream of the marsh, the creek maintains the meandering alignment through low-density residential areas, agricultural plots, and tropical fish farms. The middle segment maintains a natural path with a wooded overstory. Agriculture and open pastures on either side of the creek floodplain dominate the creek. The creek is dendritic with the majority of the branches traveling toward the east, the largest of which is Little Bullfrog Creek.
>
> Little Bullfrog Creek branches at about middle length [*sic*] of Bullfrog Creek. Little Bullfrog drains toward the west through an agricultural (tomato fields) area, open pastures, and forested areas. The upper segment is connected to many freshwater marshes for agricultural drainage.
>
> Bullfrog Creek flows south [*sic*; in fact, it flows north and west] from the Little Bullfrog Creek confluence and maintains a forested floodplain surrounded predominantly by tomato farms. The upper dendritic branches travel through intensive agricultural development and are channelized through marsh systems to facilitate drainage. The small town of Wimauma lies within the drainage area near the extreme southern branch of Bullfrog Creek."

The Bullfrog Creek channel ranges from 9 to 60 m wide and 0.2 to 2 m deep, narrowing upstream of US Highway 41. Flow measured near Wimauma, 13.5 km upstream of the bay, averages 35.4 cubic feet per second (cfs) with a range of zero to 2,360 cfs. Stream flow responds quickly to rainfall, causing a wide range in conductivity (300 – 42,000 µmhos/cm) at U.S. 41 and minimal stratification of dissolved oxygen and salinity (Wolfe and Drew 1990).

Meteorology

The Tampa Bay Region falls within two climatic divisions and is essentially in a zone of climatic transition between a temperate continental climate and a subtropical Caribbean climate (Wooten 1985). The mild subtropical conditions prevailing over much of the bay area are a result of its low latitude, proximity to the Gulf of Mexico and Atlantic Ocean, and low elevations. Warm humid summers are followed by relatively dry, mild winters. Rainfall and seasonal conditions are affected in summer by the presence of the Bermuda high-pressure system and in winter by continental frontal systems.

Rainfall is influenced by temperature differences of the land and water and by seasonal climatic conditions. Summer rains are usually the result of differential air pressures produced by the daily warming of air masses over the land. Convectional summer showers result from cumulonimbus clouds formed over the land, frequently in the form of thundershowers. Winter showers are primarily carried along ahead of cold fronts as colder, drier air comes in contact with warmer, moister air along the frontal boundary. These showers depend on the temporal movement of the front and are usually not heavy or particularly long, unless the front becomes stationary.

Infrequent hurricanes, tropical storms and associated storm surges can result in dramatic effects on the hydrology and sediments of the region.

Lewis and Estevez (1988) distinguished three periods of seasonal climatic change: a warm, dry period lasting from April to mid-June, a warm wet period lasting from mid-June to November, and a cool dry period lasting from November to April. A detailed description of rainfall and wind patterns, temperature, relative humidity, solar radiation, evapotranspiration, and hurricanes is given in Wolfe and Drew (1990).

The annual rainfall totals for 1974–2014 and monthly rainfall totals for selected years between 1992 and 2014 in Tampa Bay reflect inter-seasonal and inter-annual variation (Figures 7a, 7b).

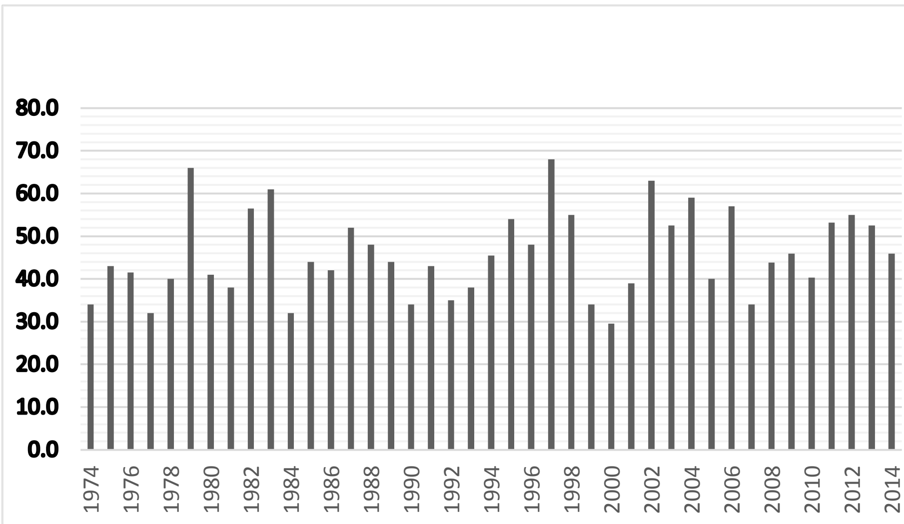


Figure 7a. 1974–2014 annual rainfall totals in inches (NCDC 2015).

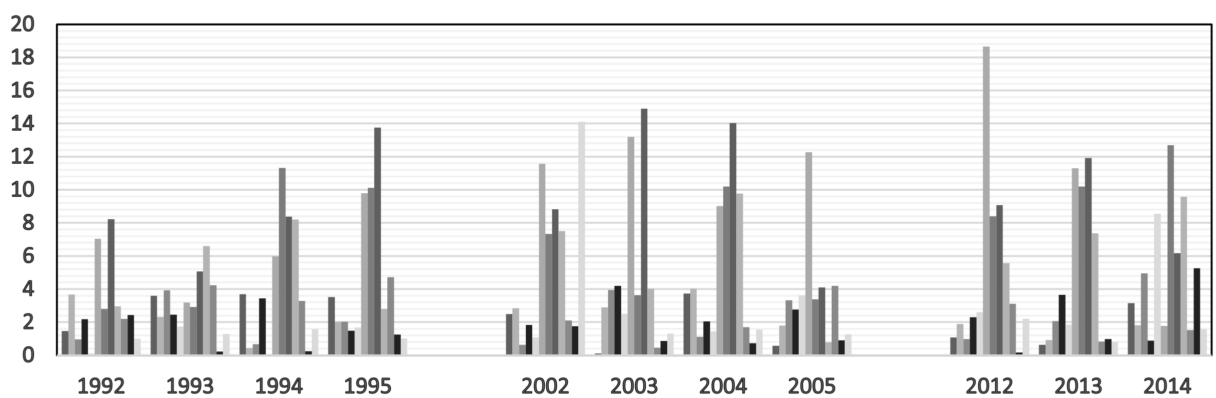


Figure 7b. 1992–2014 monthly rainfall totals in inches for selected periods (EPCHC 2007, NCDC 2015).

Hydrology

Groundwater

Groundwater in this region is present in two distinct aquifers—the Floridan Aquifer, confined to the area below the Hawthorn Geologic Formation, and a surficial aquifer in the unconsolidated sediments above (Figure 8). The Floridan Aquifer consists of 300–400 m of water-bearing geologic formations. Recharge occurs primarily northeast of Tampa Bay where the aquifer is not confined. To the southwest, the confining layer runs under Tampa Bay, allowing mixing of fresh and salt waters in the surficial aquifer. The surficial aquifer occupies sand and mixed sediments from 6 m to 30 m thick above the confining layer. It discharges laterally into Tampa Bay and its contributing rivers and creeks.

There is some exchange of water between the Floridan and surficial aquifers where sinkholes or manmade features (i.e., canals, dredged channels, and uncased boreholes) allow. Downward leakage occurs farther inland and is important for recharge of the Floridan Aquifer while upward leakage occurs where the potentiometric surface is above the surficial aquifer surface. Overall, lateral flow of groundwater follows general drainage patterns towards Tampa Bay.

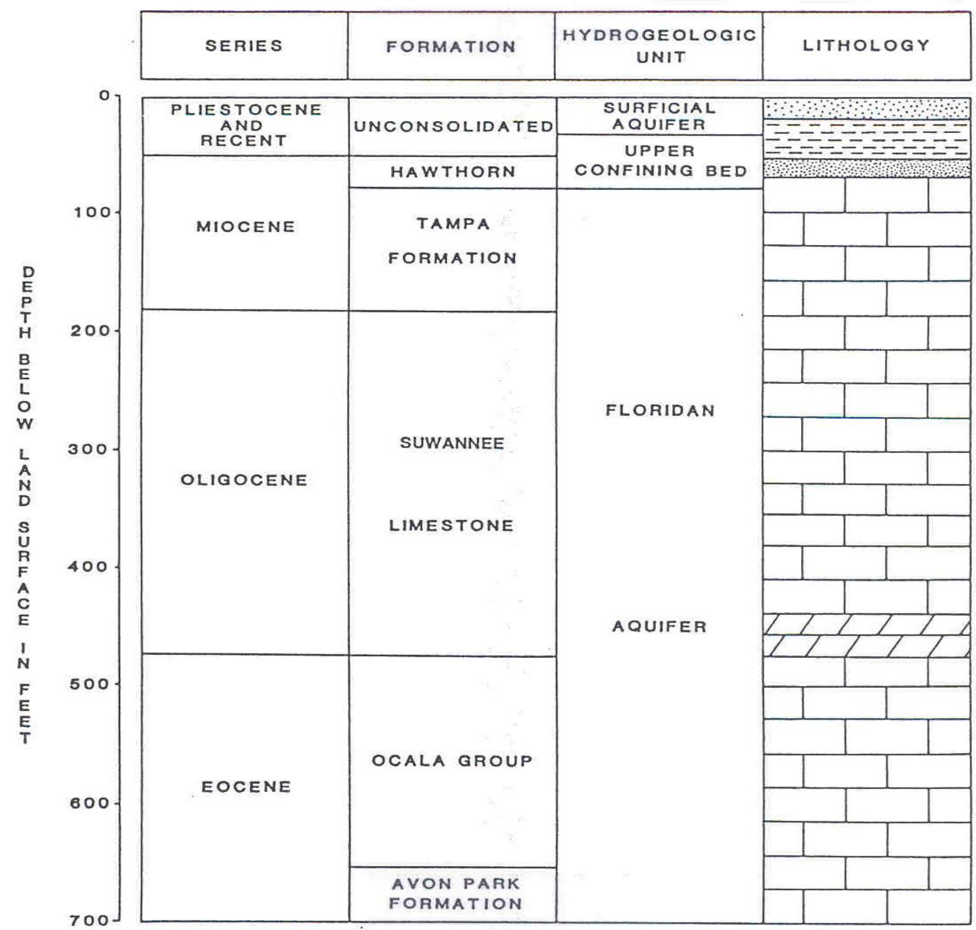


Figure 8. Hydrogeology of the Tampa Bay area (Culbreth et al. 1985).

Surface Water

The entire Tampa Bay watershed includes several major river basins and drainage areas. The Bullfrog Creek drainage area is south of the Alafia River watershed, both of which drain into eastern Hillsborough Bay (Figure 9). The Tampa Bay Regional Planning Council (1986) identified fish pond sludge and two private wastewater treatment plants as being the major anthropogenic nutrient inputs to Bullfrog Creek, and that numerous antiquated septic systems also contribute to declines in water quality of the watershed. The TBRPC report classified Bullfrog Creek as a “restorable tidal tributary”.

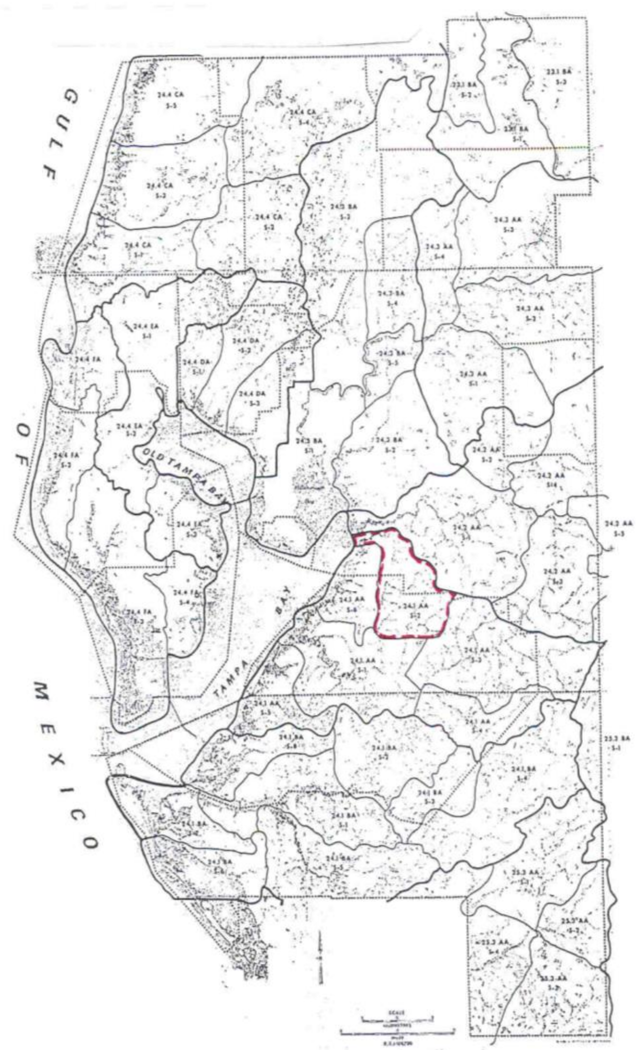


Figure 9. Boundaries of the Bullfrog Creek watershed in relation to all other watersheds draining to Tampa Bay.

Water Quality

The Environmental Protection Commission of Hillsborough County (EPCHC) analyzed water quality in the BCARPA for the original management plan. Bullfrog Creek was found to have high total and fecal coliform bacteria counts as well as elevated nutrient levels (Boler 1995). The creek received high nutrient loading (probably from agricultural runoff, tropical fish farms, septage and sewage sludge fields located along Bullfrog Creek). It was determined that efforts to reduce nutrient loading would benefit the ARPA (R. Boler, pers. comm. 1998). Monthly sampling has continued within Tampa Bay, including the BCARPA (Figure 10).

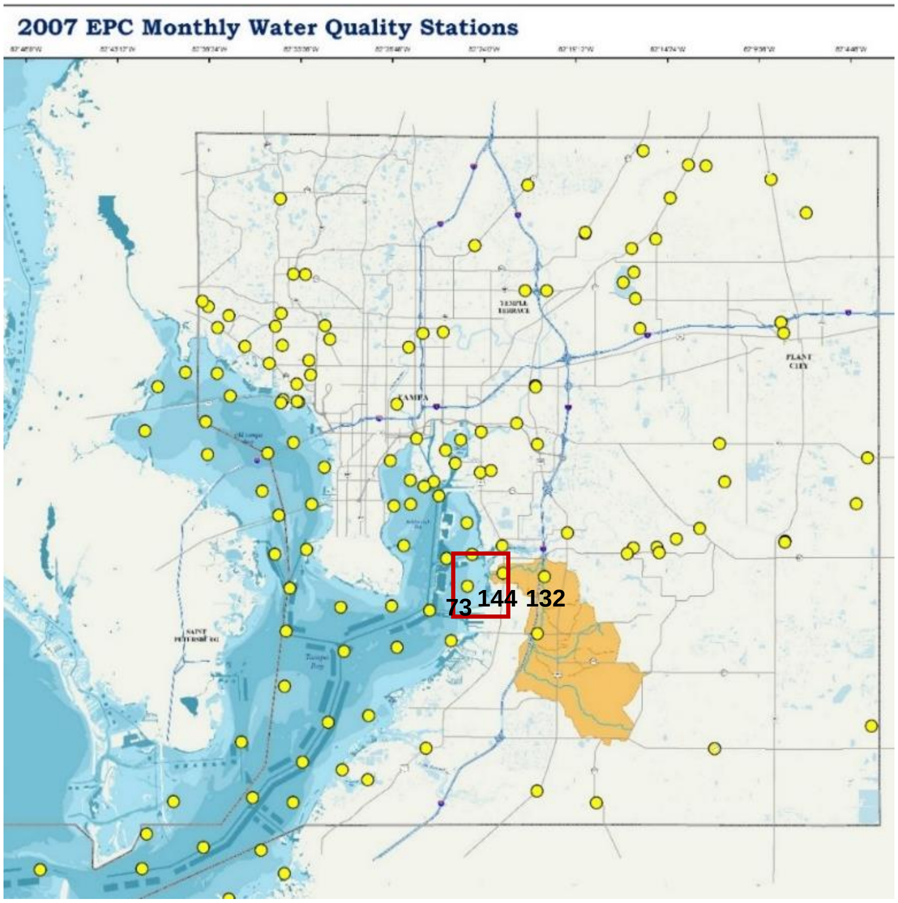


Figure 10. Water quality monitoring stations sampled by the EPCHC (from Boler 1995, re-portrayed by EPCHC 2007).

Orange polygon = Bullfrog Creek watershed. Red square = Bullfrog Creek ARPA.

Data for 1994, 2004 and 2014 are included in this updated management plan for the three sampling stations in the BCARPA and the study area: Station 73, located in Hillsborough Bay at the western edge of the ARPA; and Stations 144 and 132, located where Bullfrog Creek intersects U.S. Highway 41 and Symmes Road, respectively (Table 1). These data were used in the following descriptions and analyses. Overall, the data indicates improved water quality over the 20-year record at all three stations.

Table 1. Water quality data (annual average values), EPCHC Stations 73, 132 and 144, for 1994, 2004 and 2014 (Boler 1995, EPCHC 2015).

	STATION 73 (offshore)			STATION 144 (creek mouth)			STATION 132 (upstream)		
PARAMETER	1994	2004	2014	1994	2004	2014	1994	2004	2014
Depth B	7.9	2.5	2.4	6.5	2.2	1.9	2.0	1.0	1.0
Color (Pt-Co)	12.4	---	6.8	47.1	---	27.9	59.5	---	43.8
Turbidity (NTU)	5.3	1.5	2.5	10.6	11.4	6.3	11.3	7.7	6.6
Secchi (inches)	59	62.0	79.4	31	28.2	38.6	19	19.5	26.3
Water Temp., surface (°C)	25.4	25.0	25.4	23.5	22.6	24.5	23.8	23.4	23.7
Water Temp., mid-depth	25.2	24.7	25.4	23.8	22.6	24.5	21.9	19.8	22.4
Water Temp., bottom	25.1	24.7	25.3	24.2	22.7	24.5	23.8	23.4	23.7
Air Temperature	27.0	26.3	26.0	25.2	26.3	26.7	26.3	20.7	28.2
Conductivity, surface (µmhos/cm)	39258	34589	38745	11994	12563	22806	159	270	304
Conductivity, mid-depth	40700	36925	39018	15596	16289	24204	462	347	338
Conductivity, bottom	40950	37187	39027	21740	18303	24895	158	270	303
pH, surface	7.9	8.1	8.0	7.0	7.5	7.5	6.5	6.6	7.5
pH, mid-depth	7.9	8.1	8.0	7.0	7.4	7.5	7.2	7.0	7.4
pH, bottom	7.8	8.0	8.0	7.1	7.4	7.5	6.5	6.7	7.5

	STATION 73 (offshore)			STATION 144 (creek mouth)			STATION 132 (upstream)		
PARAMETER	1994	2004	2014	1994	2004	2014	1994	2004	2014
Dissolved oxygen, surface (mg/L)	7.3	7.3	6.2	4.9	6.3	4.2	6.9	6.3	6.5
Dissolved oxygen, mid-depth	7.1	6.6	6.3	4.5	5.7	4.0	7.2	7.8	7.5
Dissolved oxygen, bottom	6.4	6.0	6.1	3.8	5.1	4.1	5.7	6.2	6.6
Salinity, surface (ppt)	25.9	21.8	24.6	7.0	7.5	14.0	1.0	0.13	0.15
Salinity, mid-depth	26.1	23.4	24.8	9.3	9.9	14.9	2.0	0.17	0.16
Salinity, bottom	26.2	24.0	24.8	12.8	11.1	15.4	1.0	0.13	0.15
Chlorophyll a (µg/L)	7.0	11.0	7.7	9.4	32.5	12.7	2.7	4.5	3.4
Chlorophyll b	0.1	2.0	2.6	0.4	2.8	2.7	0.3	2.0	2.6
Chlorophyll c	1.2	2.0	1.6	0.8	5.5	2.4	0.2	2.0	1.8
Total chlorophyll	8.3	3.8	9.5	10.6	39.0	17.7	3.2	7.3	6.6
Total coliforms (MF #/100 ml)	72	8.8	20.5	1733	1516	1224	5242	3769	2751
Fecal coliforms	6	9.3	3.5	928	645	337	1550	3984	1585
Kjeldahl nitrogen (mg/L)	0.60	0.53	0.38	1.45	1.12	0.61	0.69	0.83	0.82
NH_3 nitrogen	0.02	0.44	0.02	0.09	0.11	0.09	0.07	0.55	0.06
NO_3.NO_2 nitrogen	0.001	0.013	0.004	0.183	0.286	0.127	0.462	0.548	0.531
Organic nitrogen	0.58	0.49	0.35	1.36	1.01	0.51	0.62	0.78	0.76
Total nitrogen	0.60	0.54	0.38	1.63	1.41	0.73	1.15	1.38	1.35
Orthophosphorus (mg/L)	0.21	0.19	0.11	0.29	0.25	0.17	0.25	0.21	0.14
Total phosphorus (mg/L)	0.33	0.27	0.21	0.40	0.45	0.28	0.34	0.30	0.25

Station 73 is located in approximately 8’ of water and had an average annual salinity of 23.1 to 26.1 parts per thousand (ppt), pH averaged 8.0 and dissolved oxygen (DO) levels averaged 6.2 to 6.9 milligrams/liter (mg/L). Secchi disk depths averaged approximately 5.6’. Over the 20-year record shown in Table 1, color and turbidity decreased significantly, as did Secchi depth. Total phosphorus and nitrogen levels also dropped. Water clarity allowed adequate sunlight penetration for seagrass establishment in this depth of water (Figures 22, 23 and 24 later in this document show the progression of seagrass regrowth since 1950).

Station 144 is in approximately 6.5’ of water where U.S. Highway 41 crosses Bullfrog Creek. This station had an average annual salinity of 9.5 to 14.7 ppt, depending on rainfall; pH averaged 7.1 to 7.5 and DO levels were fairly stable, ranging from 4.1 to 5.7 mg/L. Over the 20-year record, color and turbidity decreased, total coliform counts dropped, and total nitrogen was reduced. The Station 144 readings for Secchi depth and chlorophyll-a indicated greater nutrient enrichment and phytoplankton productivity than at the offshore Station 73.

Station 132 is approximately 2.5 miles upstream of Station 144, where Bullfrog Creek intersects Symmes Road. Average salinities were low there: 0.15 to 1.8 ppt. Over the 20-year record, color and turbidity improved, Secchi depth increased, total coliform counts decreased and total phosphorus was reduced. Water depth is about 2.5’, pH averaged 6.7 to 7.5 and DO levels were more stable (6.6 to 6.9 mg/L) than at Station 144. Total Nitrogen (TN) and Total Phosphorus (TP) levels at Station 144 were substantially higher than at Station 132 (up to almost double for TN and up to 50% higher for TP). This indicates substantial impact from upland sources between Stations 132 and 144.

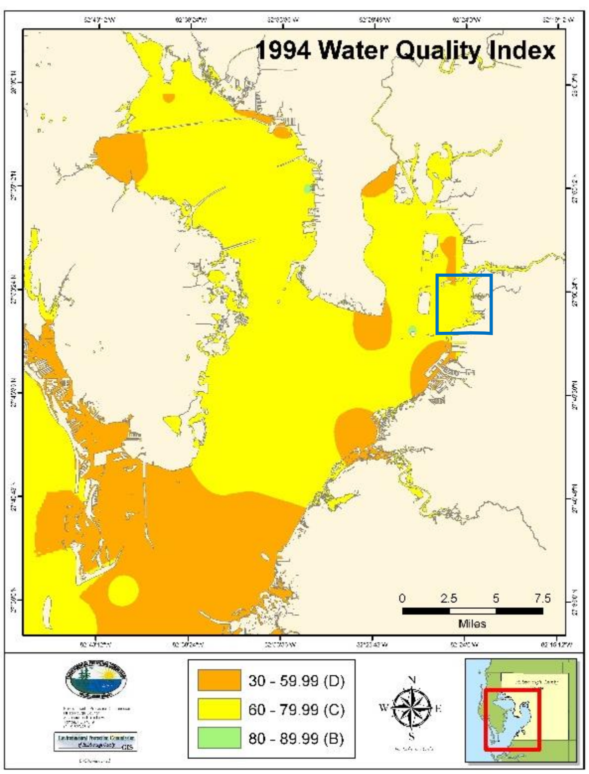
Water quality assessment work performed in 2012 and 2013 targeted the tidal segment of Bullfrog Creek as part of the federally required Total Maximum Daily Load (TMDL) program within the federal Clean Water Act. A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities (Tyler 2009). The segment is designated “Impaired” for dissolved oxygen and nutrients. Urban, residential, and commercial developments, pastures including cropland, and improved and unimproved pasturelands such as non-tilled grasses, woodland pastures, feeding operations and nurseries are often significant nonpoint sources of nutrients and oxygen-demanding substances. As of the 2013 assessment, within the tidal segment of Bullfrog Creek 29% of the contributing land use was developed, of which about 12% was in high intensity developments; and 23% was in pasture, indicating that these land uses likely play a part in the impairment. Additionally, it was determined that leaking septic systems could be a relevant source of organic and nutrient loading in the watershed (USEPA 2013). The entire watershed of Bullfrog Creek contributes to the tidal segment’s water quality as well. The TMDL establishes the nutrient loadings to Bullfrog Creek (tidal segment) that would restore the waterbody so that it meets its water quality criteria for nutrients and dissolved oxygen. Substantial reductions in the nutrient loading rate is required to achieve the goal rate. The next step is development of a Basin Management Action Plan (BMAP) or other TMDL implementation approaches to set forth the actions that will be specifically undertaken and the parties responsible for those actions.

In addition, in 2008 the fresh and marine segments of Bullfrog Creek, and Little Bullfrog Creek - a tributary of Bullfrog Creek, were assessed and designated as "Impaired" for fecal coliform (Tyler 2009). Potential nonpoint sources of coliform include loadings from surface runoff, wildlife, livestock, pets, leaking sewer lines and leaking septic tanks. The TMDL establishes the allowable fecal coliform loadings to Bullfrog Creek (both fresh and marine portions) and Little Bullfrog Creek that would restore these waterbodies so that they meet their applicable water quality criterion for fecal coliform. Substantial reductions in the fecal coliform loading rate are required to achieve the goal rate. The next step is development of a BMAP or other TMDL implementation approaches to set forth the actions that will be specifically undertaken and the parties responsible for those actions. This has been accomplished for several segments of the Alafia River and its tributaries which have nutrient, dissolved oxygen and fecal coliform impairments (FDEP 2014), and could serve as a starting place for development of a recovery plan for the Impaired segments of Bullfrog Creek and for Little Bullfrog Creek.

The overall improvement in water quality in Tampa Bay began with management actions taken since the mid-1970s (Johansson 1991). In 1972, the City of Tampa's Howard F. Curren Wastewater Treatment (AWT) Plant went into operation at Hooker's Point. Secondary treatment of sewage began in 1978, and the plant began operating advanced treatment in 1979 (Garrity et al. 1985).

By the mid-1980s, reduced nutrient loadings to Tampa Bay, due to the installation of the advanced wastewater treatment plant, resulted in water quality sufficiently improved to sustain seagrass growth. The initial survey of seagrasses conducted by the City of Tampa's Bay Study Group (BSG) and Mangrove Systems, Inc. in 1986 showed that 80% of the 2,000 m^2 of seagrasses in Hillsborough Bay were in The Kitchen (Johansson and Lewis 1992).

As seagrass growth increased in and near the BCARPA, the biomass of attached algae decreased. Algal biomass declines were attributed to reduced nutrient loading (Johansson and Lewis 1992), as well as increased competition from seagrasses for nutrients (Johansson 1991).



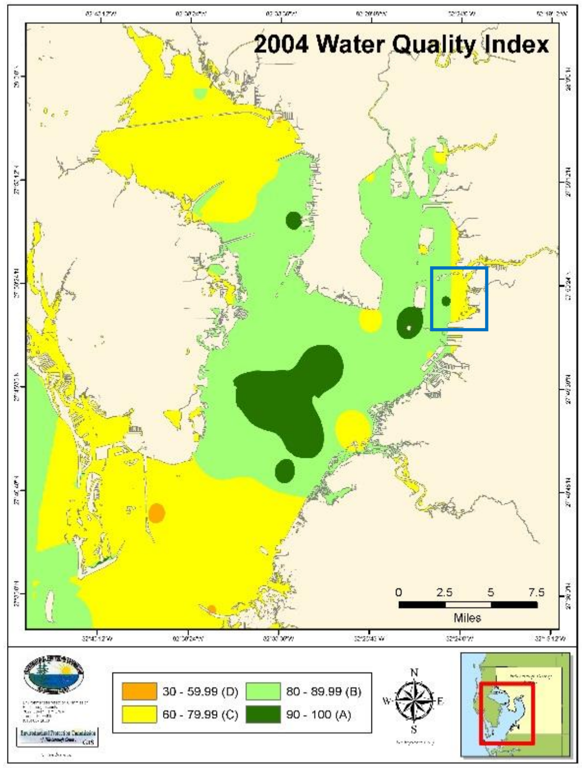
Figures 11, 12 and 13 represent the Water Quality Index (WQI) formulated to graphically illustrate the compiled water quality data for each site monitored in Tampa Bay. The parameters chosen (fecal coliform, dissolved oxygen, chlorophyll a, Secchi depth, turbidity, total nitrogen and total phosphorus) are good indicators of potential anthropogenic impacts and either have regulated or proposed state water quality criteria, or have proposed restoration target levels set by the TBEP (Karlen 2014). The color-coding of the combined scores for each location allows easy comprehension of changes over the years. The BCARPA mostly rated a "C" WQI in 1994 along with the majority of Hillsborough Bay. By 2004 almost all of Hillsborough Bay rated a "B" WQI except for parts of the BCARPA. By 2014 the BCARPA had achieved a "B" WQI along with all but two heavily industrialized areas of Hillsborough Bay.

Figure 11. 1994 general water quality in Tampa Bay (EPCHC 2015).

Blue square = BCARPA.

Figure 12. 2004 general water quality in Tampa Bay (EPCHC 2015).

Blue square = BCARPA.



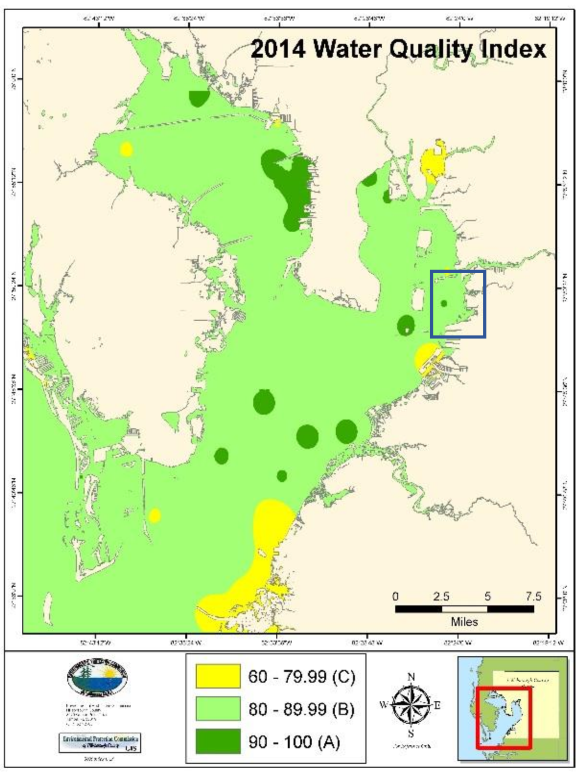


Figure 13. 2014 general water quality in Tampa Bay (EPCHC 2015).

Blue square = Bullfrog Creek ARPA.

Graphs of annual (1973 – 2014) average concentrations of several important parameters, and including notations of the target values set by the Tampa Bay Estuary Program (TBEP) for the protection of seagrass resources in each segment (Figures 14, 15 and 16) show dramatic improvement within all segments of Tampa Bay (Greening et al 2014).

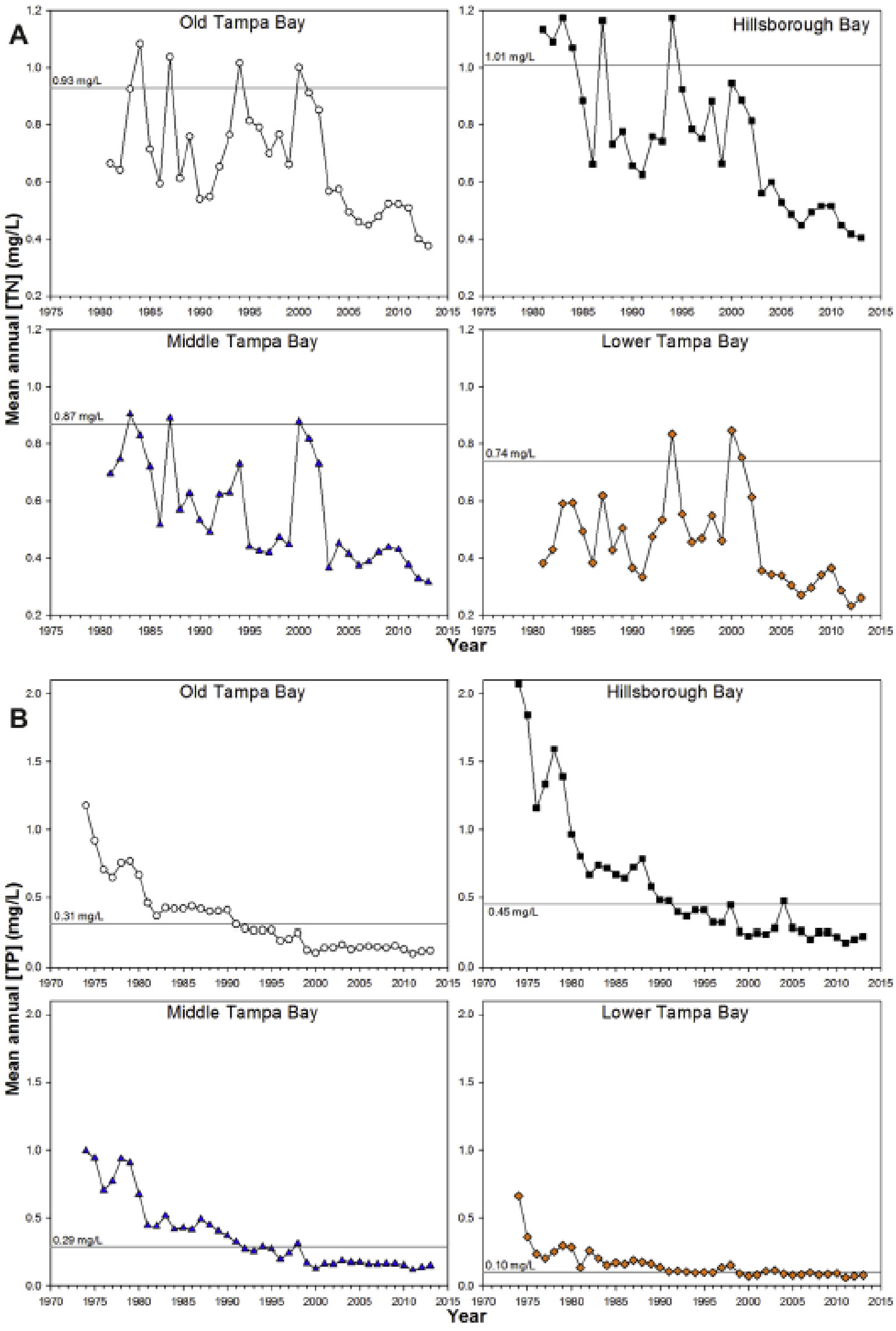


Figure 14. Trends in Mean annual Total Nitrogen (TN) (A) and Total Phosphorus (TP) (B) concentrations (mg/L) in the 4 major segments of Tampa Bay (Greening et al. 2014).

Horizontal lines = target values established by the TBEP for the protection of seagrasses in the bay.

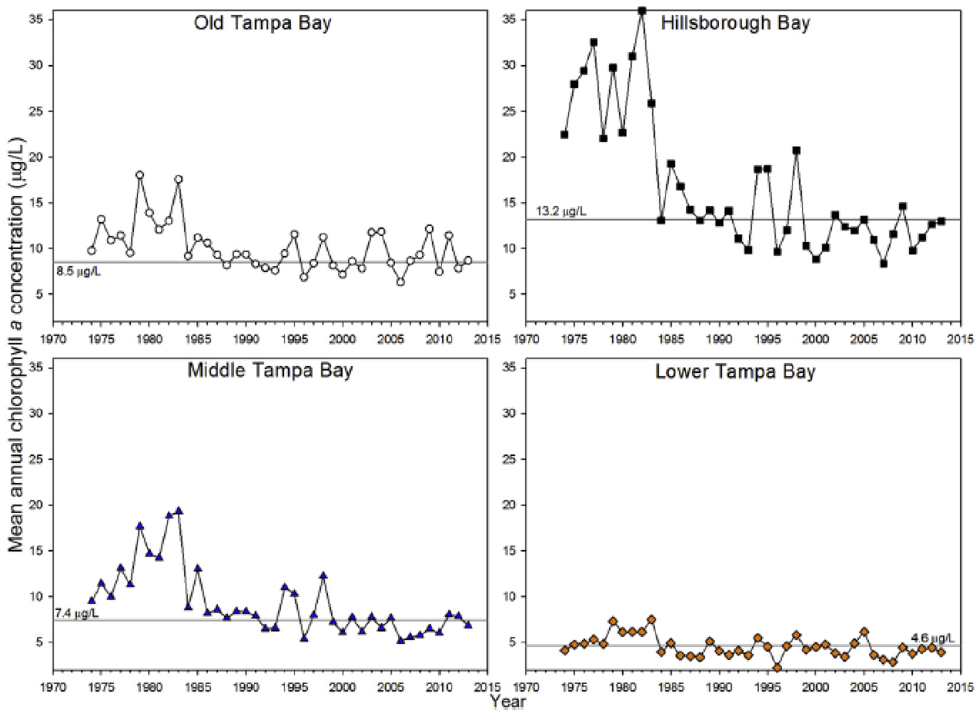


Figure 15. Trends in mean annual chlorophyll a concentrations in the 4 major bay segments of Tampa Bay (Greening et al. 2014).

Horizontal lines = target values established by the TBEP for the protection of seagrass resources in the bay.

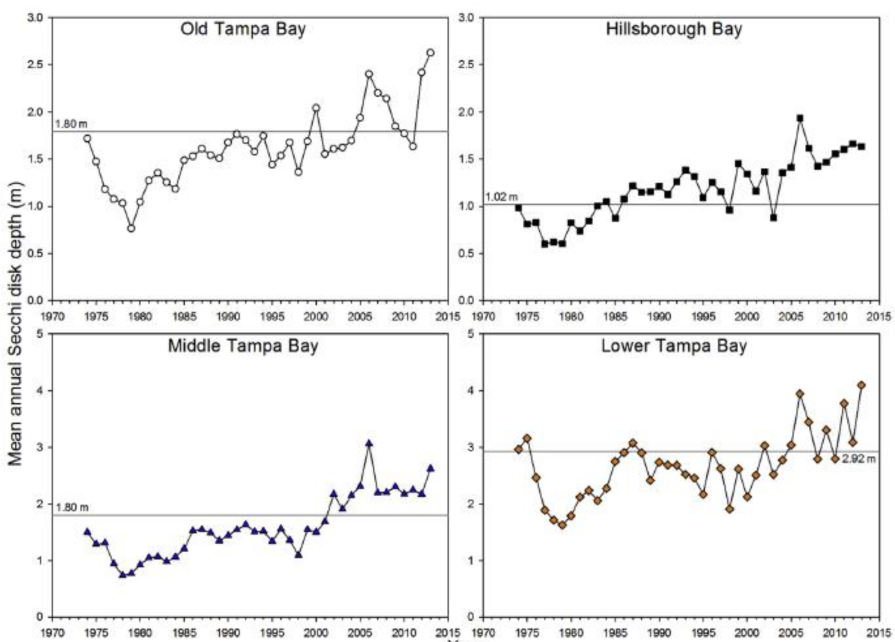


Figure 16. Trends in mean annual Secchi disk depth (m) for the 4 major bay segments of Tampa Bay (note different y-axis scales) (Greening et al. 2014).

Horizontal lines = target values established by the TBEP for the protection of seagrass resources in the bay.

Nutrient loading from rainfall and stormwater runoff is an important factor influencing Hillsborough Bay water quality. In urbanizing parts of the Tampa Bay watershed this has been somewhat abated since the early 1980s when stormwater treatment became a requirement of new development (Lewis and Estevez 1988, Lewis et al. 1991). Data (Figure 17) shows a relationship between rainfall and chlorophyll-a concentrations, and it is surmised that the reduction in chlorophyll-a is probably related to improved stormwater management and enhanced by controls on atmospheric nitrogen generation in the Tampa Bay watershed.

In the Bullfrog Creek watershed, land uses are shifting from agricultural to residential/commercial so the ARPA will receive the benefits of modern stormwater regulation as this continues. Additionally, the institution of Best Management Practices by agricultural operations and reduced air emissions of nitrogen certainly have assisted in improving the quality of runoff.

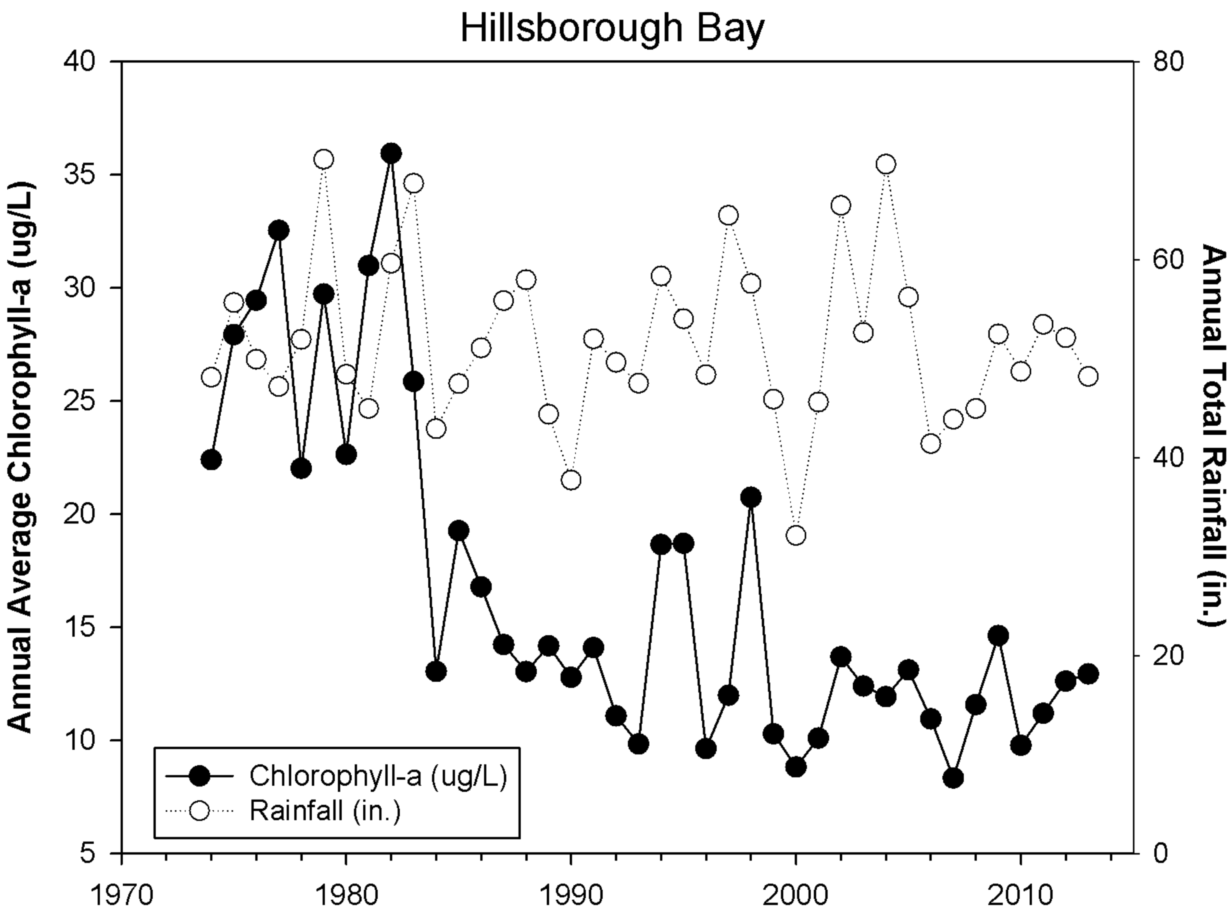


Figure 17. Relationship between annual rainfall over the Hillsborough Bay basin and Hillsborough Bay annual average chlorophyll a concentrations 1972-2012 (Water quality data from EPCHC; Rainfall data from SWFWMD).

The high density of tropical fish farms in the Bullfrog Creek watershed is likely to have a direct effect on water quality in the creek. A water quality characterization of Bullfrog Creek performed by the U.S. Fish and Wildlife Service (Wolfe and Drew 1990) showed that sludge buildup from fish pond drainage caused increases in biological oxygen demand (BOD) and elevated levels of coliform bacteria. Boler (1995) listed fish farms, as well as domestic effluent sources (septic tanks) and pasture lands used by cattle, as sources of coliform bacteria. In addition, the presence of septage fields, a Hillsborough County sewage sludge disposal area, several small, privately operated sewage treatment plants (all with recurrent failures during periods of heavy rainfall), and a reliance on private residential septic tanks within the watershed likely contributed a significant nutrient loading problem for the Bullfrog Creek watershed in the past. The most current information on the state of the tropical fish industry in central Hillsborough County is discussed on page 23 of this document under Developed Land/Agriculture/Tropical Fish Farms.

Several small, non-municipal domestic wastewater treatment plants are located within the Bullfrog Creek watershed, and though none of these facilities are permitted to discharge wastewater to surface waters, all utilize percolation ponds which are typically designed to have an emergency discharge device in order to preserve the integrity of the pond berms when pond levels get high. The wastewater is treated by aeration and disinfection before release into percolation ponds to remove organics and live bacteria. The treatment system does not remove nutrients such as nitrogen, however. Nitrogen is the limiting nutrient in the Tampa Bay ecosystem; excess nitrogen causes eutrophication, excess algal growth, and reduced light penetration which inhibits seagrass growth. Figure 18 is a map of the non-municipal domestic plants within the BCARPA study area. Table 2 provides the details and recent compliance history of each operating facility. The "Hillsborough Correctional" plant, located near Little Bullfrog Creek, has not been operational since 2013 and no longer has a valid permit (P. Noblitt, pers. comm.)

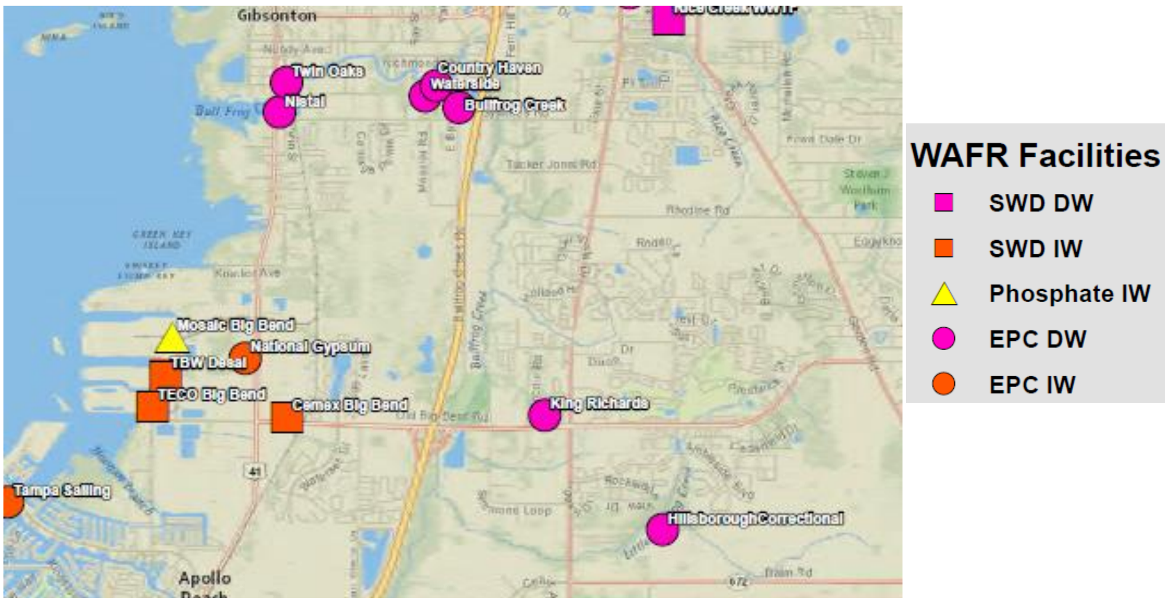


Figure 18. Private domestic wastewater treatment plants within the BCARPA study area (EPCHC 2015).

Table 2. Privately owned sewage treatment plants in the Bullfrog Creek watershed (EPCHC 2015).

Facility Name	Permit Expiration	Disposal Capacity	Disposal Type	Compliance History as of August, 2015
Twin Oaks Plaza WWTP	10/2016	0.010 MGD	Percolation ponds	Inspected 6/2015; out of compliance but not for disposal capacity/ discharge issues.
HideAway Hills/ Nistal	11/2017	0.016 MGD	Drainfield & percolation ponds	Under enforcement under the previous owner; new owner is having compliance difficulty. There appears to have been unpermitted discharges recently, before the heavy rainfalls of July & August.
Country Haven	12/2017	0.015 MGD	Percolation pond	Reported discharges to the Creek in 9/2014. During most recent inspection (7/2015) the ponds were not discharging.
Waterside	12/2015 (under renewal review)	0.012 MGD	Percolation pond	Inspected 6/2015; out of compliance but not for disposal capacity/ discharge issues.

Facility Name	Permit Expiration	Disposal Capacity	Disposal Type	Compliance History as of August, 2015
Bullfrog Creek MHP	4/2019	0.020 MGD	Percolation pond & drainfield	Inspected in 6/2015; issues with high flows, operational and maintenance issues resulted in high pond levels and possible offsite discharge. Facility is under a Warning Notice.
King Richards Court	8/2017	0.025 MGD	Percolation ponds	Inspected 8/2015; no disposal issues were identified.

Geology and Topography

Bullfrog Creek and its tributaries lie within the Bone Valley and Hawthorn Geologic Formations. The Bone Valley Formation includes the headwaters of the Alafia, Manatee, and Little Manatee Rivers and portions of Bullfrog Creek. It is a geologically young formation of the late Miocene or Pliocene Epoch (25–10 million years before present - myBP) and consists most notably of phosphate, sand and other material. This poorly drained plateau is a major source of commercial phosphate, with deposits located 20 to 30 meters (m) in depth. The Bone Valley Formation overlies the Hawthorn Formation, which becomes exposed to the west. The Hawthorn Formation (also a late Miocene deposit) is characterized by a plain consisting of quartz and clay mineral deposits, gradually sloping with an approximate 21 m drop across the exposed formation toward Tampa Bay.

The Alafia, Manatee, and Little Manatee watersheds, including the Bullfrog Creek drainage area, lie within a region of flatwoods and wetlands. Terracing can be observed along some shoreline areas where sea level changes forced alternating patterns of sediment deposition and erosion (Figure 19).

The Bullfrog Creek basin has elevations of up to 145 feet NGVD which decreases rapidly to the west to sea level (Dames & Moore 2000). Its drainage is vegetated with flatwoods and wetlands, including cypress swamps that slow surface water drainage.

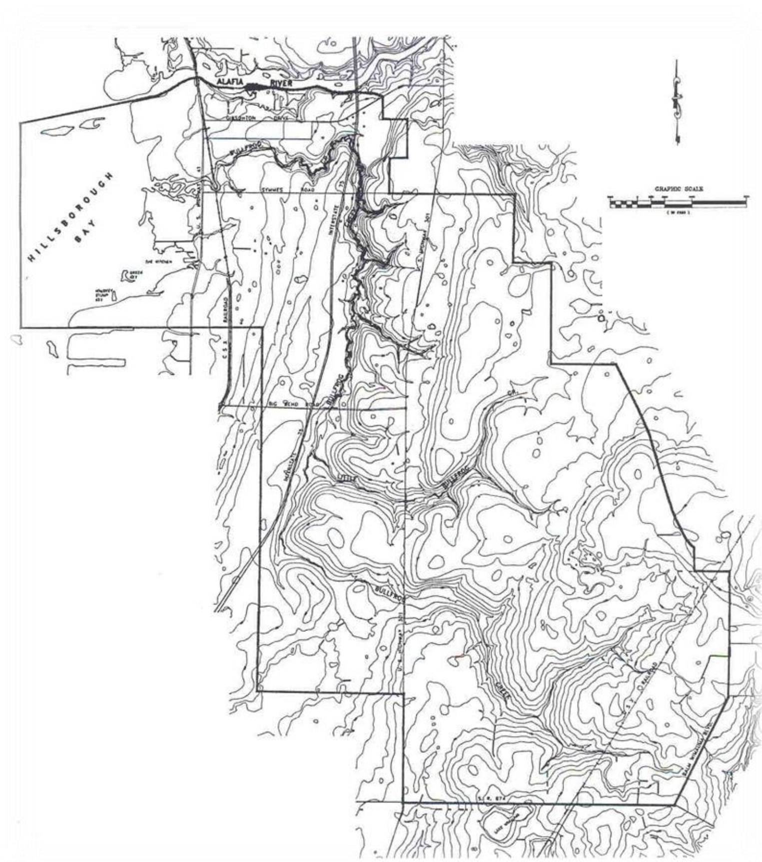


Figure 19. Topographic contours of the Bullfrog Creek watershed (USGS topographic quadrangle Gibsonton, FL).

Soil Types

Soil types within the study area warrant consideration because they determine potential natural vegetation and because of their relationship to land use practices, septic tank placement, and other factors. The Hillsborough County Soil Survey (Soil Conservation Service - SCS 1987) shows 28 soil series within the study area (Figure 20, Table 3).

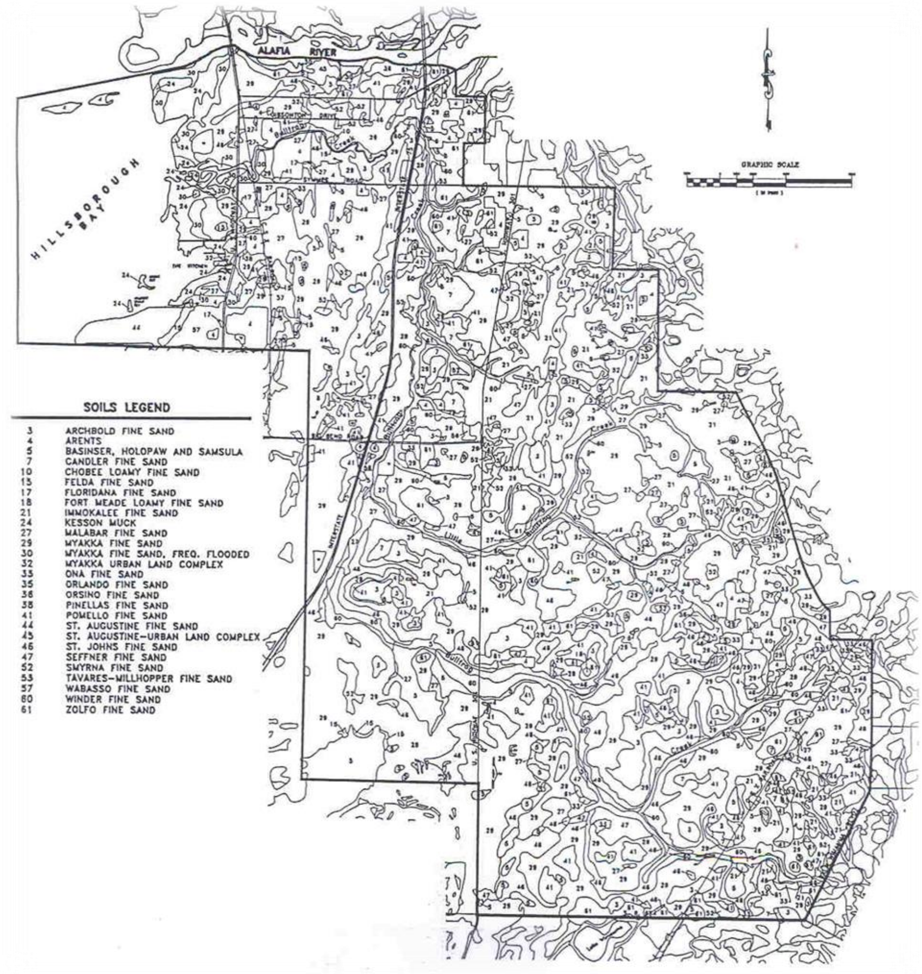


Figure 20. Soils of the Bullfrog Creek ARPA study area (SCS 1987).

Table 3. Soil types of the Bullfrog Creek watershed (SCS 1987).

SOIL CODE	SOIL TYPE	HYDRIC CATEGORY	DRAINAGE GROUP	COMMUNITY TYPE
3	Archbold fine sand	MW	A	Sand Pine-Scrub Oak
4	Arents	NT	NT	NT
5	Basinger, Holopaw and Samsula	VP	D	Freshwater Marches/Ponds
7	Candler fine sand	E	A	Longleaf Pine-Turkey Oak
10	Chobee loamy fine sand	VP	B/D	Freshwater Marshes/Ponds
15	Felda fine sand	P	B/D	Slough
17	Floridana fine sand	VP	B/D	Sloughs and Swales
18	Fort Meade loamy fine sand	W	A	Hardwood Hammocks
21	Immokalee fine sand	P	B/D	Flatwoods
24	Kesson muck	VP	D	Saltwater Marsh
27	Malabar fine sand	P	B/D	Slough
29	Myakka fine sand	P	B/D	Flatwoods
30	Myakka fine sand, freq. flooded	VP	D	Saltwater Marsh
32	Myakka Urban land complex	P	B/D	Flatwoods
33	Ona fine sand	P	B/D	Flatwoods
35	Orlando fine sand	W	A	Longleaf Pine–Turkey Oak

SOIL CODE	SOIL TYPE	HYDRIC CATEGORY	DRAINAGE GROUP	COMMUNITY TYPE
36	Orsino fine sand	W	A	Sand Pine Scrub
38	Pinellas fine sand	P	B/D	Cabbage Palm Flatwoods
41	Pomello fine sand	MW	C	Sand Pine Scrub
44	St. Augustine fine sand	P	C	Coastal Ridge
45	St Augustine-Urban land complex	P	C	NT
46	St Johns fine sand	P	B/D	Flatwoods
47	Seffner fine sand	P	C	Oak Hammocks
52	Smyrna fine sand	P	B/D	Flatwoods
53	Tavares-Millhopper fine sands	MW	A	Longleaf Pine–Turkey Oak
57	Wabasso fine sand	P	B/D	Flatwoods
60	Winder fine sand	P	B/D	Flood Plain
61	Zolfo fine sand	P	C	Hardwood Hammocks

Primary Study Area

The dominant soils in the primary study area are classified as hydric soils. The U.S. Dept. of Agriculture's Natural Resource Conservation Service (NRCS) defines hydric soils as "soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in the upper part" (SCS 1987). Hydric soils have slow infiltration rates, as these soils usually retain a high water potential. As a result, hydric soils have a high runoff potential. Near the surface of these soils, a layer of claypan or clay material is found. The NRCS rates soil units based on these factors. Group A (non-hydric) soils have high infiltration rates and low runoff potentials. These soils are composed of sandy or gravelly materials. Conversely, Group D (hydric) soils have the lowest infiltration rates and the highest runoff potentials.

The dominant soil type of the primary study area is classified as Kesson muck (24). This poorly drained soil type is found in tidal swamps and marshes with a slope of usually less than 1%. Kesson muck soils have a surface layer of black muck usually about five inches deep with rapid permeability. The underlying soil drains moderately rapidly to rapidly. The high water table fluctuates seasonally to about six inches in depth, and is tidally dependent. The natural plant community associated with this soil type is saltwater marsh. Due to the high salt content of the soil and the high flooding potential, cultivation of crops, timber or pasture is not suitable (SCS 1987).

Myakka fine sand, frequently flooded (30), is the second most commonly found soil type in the ARPA primary study area. This soil type is also found in tidal swamps and marshes having a slope similar to Kesson muck. Myakka fine sand soils have an organic layer of 51 inches or more in depth. Permeability is high in surface and subsurface layers. The available water capacity is low, and the water table fluctuates seasonally to a depth of 10 inches, also dependent on tidal fluctuations. The natural vegetation type is also categorized as saltwater marsh (SCS 1987).

Secondary and Tertiary Study Areas

The dominant soil type in the secondary and tertiary study areas is Myakka fine sand (29). This soil type is poorly drained and nearly level. It has a high water table that fluctuates seasonally to a depth of 10 inches for as long as four months, receding to a depth of 40 inches during droughts. This soil type is found in Florida pine flatwoods where the natural vegetation consists of longleaf and slash pines (*Pinus palustris*, *P. elliottii*), with an undergrowth of oaks (*Quercus* spp.), saw palmetto (*Serenoa repens*), and wax myrtle (*Myrica cerifera*). The principal land use in these study areas is agriculture, with most development occurring closer to the coast (USEPA 2013).

The Arents soil type (4) consists of heterogeneous soils that have been reshaped by excavation or earth moving. Arents have no sequential soil layers and are typically blended fill. Permeability and available water capacity are widely variable.

Land Uses and Habitats of the BCARPA and associated study area

We mapped land use and habitats in the primary study area and sections of the secondary and tertiary study areas (Figure 21). Using aerial photographs (SWFWMD 1995), we identified and delineated existing plant communities, then conducted ground-truthing at representative locations in the primary and secondary study areas in November 1995 and January 1996. We used the Florida Land Use, Cover and Forms Classification System (FLUCCS; FDOT 1985) to classify land use and habitats (Table 4), as described by two major categories, Developed Land and Undeveloped Land.

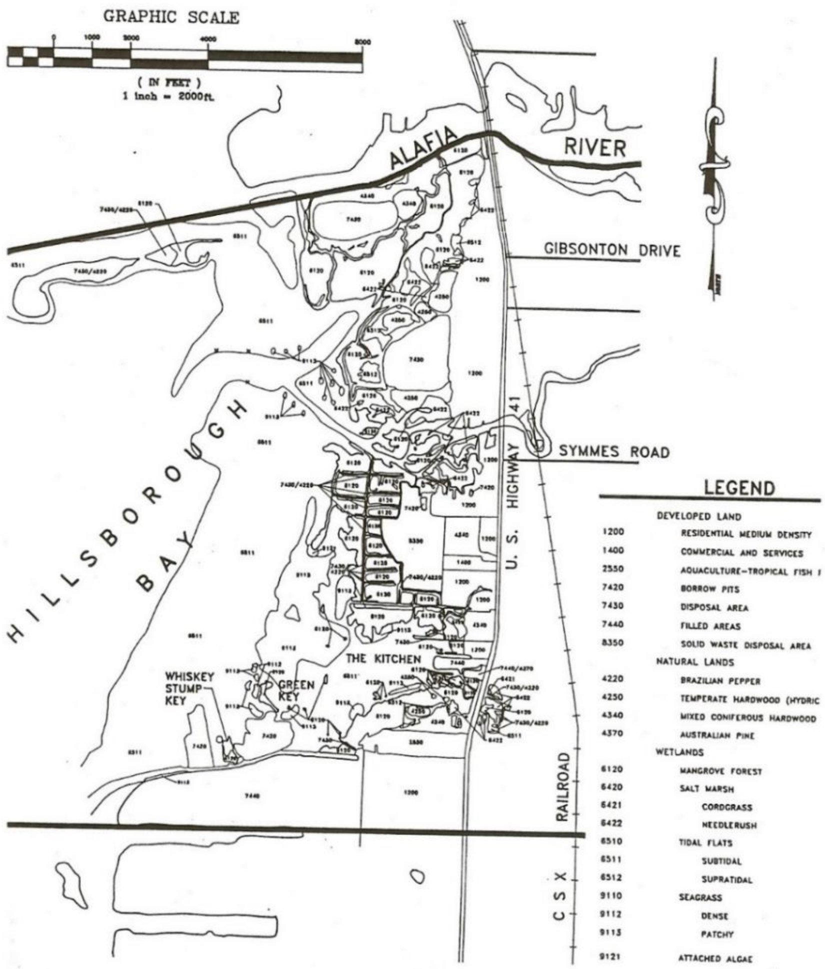


Figure 21. Land use and habitats map of the Bullfrog Creek ARPA, 1996.

Table 4. Habitat and land use categories, with acreages, in the Bullfrog Creek ARPA and portions of the secondary and tertiary study areas in 1995 (FDOT 1985).

FLUCCS CATEGORY	SUBCATEGORY	LAND USE	DESIGNATION	ACREAGE
Developed Land	Urban and Built-up	Residential, Medium Density	1200	386.8
		Commercial and Services	1400	10.7
		Other Open Lands	1940	0
	Agriculture	Row crops and Tomatoes	2142	0
		Tropical Fish Farms	2550	38.1
	Barren Land	Borrow Pits	7420	48.5
		Disposal Areas	7430	145.7
		Filled Areas	7440	237.0
	Utilities	Solid Waste	8350	68.8
Undeveloped Land	Upland Hardwood	Brazilian Pepper	4220	42.0
		Temperate Hardwood/Hydric Hammock	4250	50.8
		Mixed Coniferous/Hardwoods	4340	105.6

FLUCCS CATEGORY	SUBCATEGORY	LAND USE	DESIGNATION	ACREAGE
		Australian Pine	4370	1.4
	Wetlands	Mangrove Swamps	6120	417.2
		Salt Marsh	6420	61.8
		Cordgrass	6421	5.0
		Needlerush	6422	56.8
		Tidal Flats	6510	1,480.9
		Subtidal	6511	1,461.6
		Supratidal	6512	19.3
	Special Classification	Patchy Seagrass	9113	147.1
		Continuous Seagrass	9116	1.2
		Attached Algae	9121	2.2

Tyler (2009) provided land use inventories for the Bullfrog Creek tidal and fresh segments and Little Bullfrog Creek as part of the analysis for the TMDL Report regarding fecal coliform (Table 5). This updated inventory is not directly comparable to the 1996 work done for the original management plan, but provides a general idea of how land use has changed in west-central Hillsborough County.

Table 5. Level 1 FLUCCS land uses, codes and acreages in Bullfrog Creek (fresh and tidal segments) and Little Bullfrog Creek watersheds in 2008 (Tyler 2009).

LAND USE	FLUCCS CODE	ACREAGE
Urban and Built-up	1000	2,348
Low-density Residential	1100	1,669
Medium-density Residential	1200	815
High-density Residential	1300	1,575
Agriculture	2000	9,307
Rangeland	3000	1,179
Forest/Rural open	4000	2,957
Water	5000	680
Wetlands	6000	2,241
Barren Land	7000	57
Transportation, Communication & Utilities	8000	505

Developed Land

Urban and Built-up

Residential, Medium Density (1200): Medium density residential is the most common type of residential use in the secondary study area. Two to five dwelling units per acre is the average density. Remnants of natural plant communities can be found but, more often, ornamental species, exotics, grasses, or bare ground dominate residential areas.

Commercial and Services (1400): Buildings, parking lots, light industry and storage areas are present in these areas. This is the second most common urban land use type in the secondary study area. These areas often harbor fringing stands of Brazilian pepper (*Schinus terebinthifolius*) or Australian pine (*Casuarina* spp.). Some sites include stormwater ponds that are typically rectangular ponds surrounded by mowed grass and a few trees. Otherwise, no significant vegetation occurs in these areas.

Other Open Lands (1940): Undeveloped land without structures or any indication of present use. These areas are usually intended for future urban land use.

Agriculture

Row Crops and Tomatoes (2142): Land managed for crops, including tomatoes, strawberries, cucumbers, onions, green peppers, and Chinese vegetables. In the mid-1990s, some tomato fields were converted to fish farms or residential.

Tropical Fish Farms (2550): Tropical fish are the agricultural product with the highest total economic impact/acre in Hillsborough County. In terms of bulk and value, tropical fish are the largest commodity shipped from Tampa International Airport. The highest density of tropical fish farms in the U.S. is within the Bullfrog Creek watershed. Annual sales from the County's 125 tropical fish farms totaled $44.2 million in 1995, using 1,000 acres of land. In January, 2010 the area's tropical fish farmers experienced the worst freeze and associated fish kill ever reported. Estimated stock losses were 60-90% (Fletcher 2010). In 2012, 101 operators in Hillsborough County reported sales totaling $27.3 million and using 929 acres, almost entirely within the Bullfrog Creek watershed. Pressure from land developers and from overseas production have resulted in a decline in the number of operators and sales (USDA 2013; D. Boozer, pers. comm.) Most farms are 20 acres or less in size, and most are family operations with the exception of two large corporate operations. Modern fish farm pools average 30 feet wide, 8 feet deep and 100 feet long. FDACS has adopted an Aquaculture Best Management Practices Manual (2007) which dictates operational and maintenance measures. Water discharged from pools is diverted into treatment ponds and ditches, which feature elevated outfalls allowing pool sludge to settle. Sludge collected from sedimentation sites and ditches is spread over dikes or elsewhere on fish farm property. The pools are refilled by groundwater seepage through the pool sides, or by pumping from groundwater to add water if necessary. The fish farms in Hillsborough County are within a short flying distance of the cormorants and wading birds that nest at the Alafia Bank Bird Sanctuary and other nearby bird colonies (TAS 1999). Predation by piscivorous birds is considered a serious problem and a variety of measures, including screening the fish pools to prevent birds from foraging in them and using loud noise to frighten birds away from the area are common deterrence techniques. Although cormorants, wading birds, ducks, and other native bird species are protected under the Migratory Bird Treaty Act, the U.S. Fish and Wildlife Service is authorized to issue depredation permits for the taking of wildlife to protect agricultural interests. Many of the fish farms have depredation permits that allow taking predatory birds to protect their fish.

Barren Land

Borrow Pits (7420): Two large underwater sedimentation basins lie on either side of Whiskey Stump Key and Green Key. The basins were constructed after dredging at Port Redwing caused a turbidity plume in 1968-69, which covered most of The Kitchen and deposited a collar of silt around Green Key and Whiskey Stump Key. The basins were intended as "sinks" for silt and sediments brought in by current flow. However, due to low current velocity, the basins never filled in. As a result, the depth of the basins precludes seagrass growth, due to insufficient light penetration, and production of anoxic hydrogen sulfide fumes from the decomposition of accumulated organic matter. Fishery habitat is provided by these deeper holes though, and they are popular local fishing spots (Sargeant 1992; TBEP 2005).

***Disposal Areas (7430)*:** Historical dredged material disposal sites in the study area include Bird and Sunken Islands, (combined they form the Richard T. Paul Alafia Bank Bird Colony), Disposal Areas A and B in the Gardenville Beach and Cargill Fertilizer South Parcel areas, Port Redwing, other port facilities at TECO's Big Bend and mounds from mosquito control ditching on the Davis Property in the 1950s. Most of these have not been used for decades.

***Filled Areas (7440)*:** Areas at Port Redwing and two small fill fingers in The Kitchen were filled to provide uplands for port and residential development. Invasive non-native plant communities (mostly Brazilian pepper) characterized the sites in the early 1990s. County and SWFWMD efforts, begun in 1995 with the purchase of the northern half of Port Redwing, now called the Fred and Idah Schultz Nature Preserve, have resulted in 120 acres of restored estuarine and freshwater wetlands, artificial reefs, transitional communities and uplands abutting the southern boundary of the BCARPA. Restoration was completed in 2004 (A. Schnapf 1996; SWFWMD undated).

Utilities

Solid Waste (8350): A large, closed Hillsborough County landfill is located along Williams Street on the eastern portion of the Davis property (see Areas of Special Interest). A SWFWMD Surface Water

Improvement and Management (SWIM) project has properly capped the old landfill, removed the non-native plants and established an upland coastal hammock vegetative habitat (now part of The Kitchen Nature Preserve).

Natural Land
Upland Hardwood

Brazilian Pepper (4220): The non-native Brazilian pepper tree is typical of disturbed sites in the Tampa Bay region. In moist to wet conditions, this aggressive species invades natural communities such as hydric and tropical hammocks, mixed hardwoods, and coastal scrub. Other non-natives that occur with Brazilian pepper are Australian pine, lead tree (*Leucaena leucocephala*), air potato (*Dioscorea bulbifera*, *D. floridana*), and chinaberry (*Melia azedarach*). In 1997 the Gibson Lands, Gibsonton Landfill, Port Redwing, abandoned Kitchen fish farm areas, and neighboring properties were choked with dense, monospecific stands of Brazilian pepper. Interspersed among the peppers were some surviving cabbage palm (*Sabal palmetto*) patches and dispersed native oaks and hackberry (*Celtis laevigata*). Currently lands purchased by ELAPP and SWFWMD have been largely cleared of non-native vegetation. See "Areas of Special Interest, pages 43-51 of this updated management plan for the current status of these areas.)

Temperate Hardwood (Hydric) Hammock (4250): Dense hardwood forests that are usually surrounded by wet pine forests and marshes of the coastal plain. Dominant tree species are live oak (*Quercus virginiana*), swamp laurel oak (*Quercus laurifolia*), cabbage palm, southern red cedar (*Juniperus silicicola*), sweetgum (*Liquidambar styraciflua*) and hornbeam (*Carpinus caroliniana*). The dense vegetation of this community slows surface water flow, including stormwater, allowing nutrients and contaminants to be filtered out before entering the estuary.

Mixed Coniferous/Hardwoods (4340): This habitat type is found scattered throughout the uplands of the entire study area. The dominant plant species are slash pine, live oak, cabbage palm, southern red cedar, wax myrtle, red maple (*Acer rubrum*), and pignut hickory (*Carya glabra*). Brazilian pepper, Australian pine, lead tree, and air potato are common invaders that can be found in high density, especially along forest margins except where active exotic control programs are in place.

Australian Pine (4370): Australian pine is a non-native tree species that occurs along roadside ditches, fields, drainage areas, disposal sites, and areas where the soil is disturbed or denuded. It completely displaces native vegetation, resulting in eventual displacement of native wildlife as well. The trees are salt tolerant and quick growing. Monospecific stands of Australian pines rapidly establish as the dense, needle-like leaves accumulate on the ground and prevent germination of other species' seeds. Both this species and Brazilian pepper are common invaders in upland areas in the BCARPA. Several privately owned sites adjacent to The Kitchen and Dug Creek are heavily infested with Australian pine.

Wetlands (Figure 22)

Mangrove Swamps (6120): Mangroves are the second most prevalent habitat type in the primary study area, with red, black and white mangroves (*Rhizophora mangle*, *Avicennia germinans*, *Laguncularia racemosa*, respectively) occurring along the shoreline throughout. Mangroves stabilize fine sediments, provide food and shelter to fish, invertebrates, birds and other wildlife, and provide a buffer against storm events (Dawes 1981). Colonies of nesting wading birds utilize mangrove and mixed forests within the ARPA. Lugo and Snedaker (1974) have described three major mangrove community types: 1) riverine forests that occur along tidal creeks and rivers; 2) fringing forests that form thin bands along waterways; and 3) basin forests that occur inland from fringing and riverine forests. Mangrove stands in Tampa Bay are not easily typified in this way. Estevez and Mosura (1982) described the forest type that occurs in the study area as "scrub-marsh". Mangroves of this form are 4-9 feet tall with a decreased leaf size and increased tree density. They opined that repetitive freezes account for this growth habit, and the mangroves in the BCARPA are trimmed by frost, though this has not occurred since the 1989 – 91 winters. The mangroves on the forested estuarine flats (areas flooded in a sheet flow fashion at high tide) are largely black mangroves, while white mangroves occur at slightly higher elevations, including creek, mosquito ditch and channel edges. Red mangroves line estuarine creeks and the mouths of Bullfrog, Dug, and Kitchen creeks where they enter Hillsborough Bay.

Overall, mangrove acreage in Hillsborough Bay decreased by 32% between 1950 and 1990 (LES & CEI 1996) and, within the BCARPA, mangrove coverage decreased 13% between 1950 and 1985, from 479.3

acres to 417.2 acres (Lewis et al. 1985). This net change obscures a number of contradictory factors at work. Due to sea level rise and a generally warmer climate in the last few decades, mangroves have expanded into areas formerly dominated by cordgrass and needlerush marshes. At the same time, mangroves have been lost to invasion by Brazilian pepper along their landward edges, dredge and fill activities, and shoreline erosion. Occasional severe freezes cause temporary declines in mangrove extent. Wave-induced erosion and freeze damage had decreased the amount of mangroves on the Alafia Bank, Green Key, Whiskey Stump Key, Peanut Island, and smaller unnamed islands. A variety of measures have been used to slow the erosion and stabilize the important islands and shorelines. Oyster cultch bags have been placed on the seaward side of Green and Whiskey Stump keys and just off the northern shore of Port Redwing (the Fred and Idah Schultz Nature Preserve), and offshore breakwaters have been placed along the shoreline of the Alafia Bank.

Salt Marsh (6420)

Cordgrass (6421): Smooth cordgrass (*Spartina alterniflora*) and salt meadow cordgrass (*S. patens*) occur in small patches within the ARPA. Smooth cordgrass is present on the north and south sides of Bird Island and in small bands along Bullfrog Creek south to The Kitchen. Cordgrass was planted on Bird and Sunken islands in 1990 to halt erosion and promote mangrove seedling establishment. Larger patches are found in Mosaic's South Parcel area adjacent to South Mouth Creek. Cordgrass was also planted as a major component of the South Parcel Restoration Project. Cordgrass marshes function to stabilize sediments, filter stormwater runoff, and serve as nursery grounds for fish and invertebrates. It is also used as a nursery plant in areas where mangrove establishment is desired as it traps mangrove seeds and propagules.

Needlerush (6422): Several black needlerush (*Juncus roemerianus*) marshes occur in the study area, especially around the estuarine mouths of Bullfrog, Kitchen, and Dug creeks. Black needlerush occurs as a fringe around mangroves and as a monoculture when freezes limit mangrove development. Needlerush marshes function similarly to cordgrass marshes: they stabilize sediments, filter stormwater, and serve as nursery grounds for fish and invertebrates, constituting an ecologically important emergent plant community.

Other plant species occurring in needlerush marshes are cattails (*Typha* spp.), leather fern (*Acrostichum danaeifolium*), smooth cordgrass, and swamp lily (*Crinum americanum*). Invaders include Brazilian pepper and, less frequently in more upland sites, Australian pine. Needlerush marsh acreage decreased by 17% in Hillsborough Bay between 1950 and 1990 (LES & CEI 1996), and decreased in the BCARPA by 27%, from 83.7 acres to 61.8 acres between 1950 and 1985.

Tidal Flats (6510)

Subtidal (6511): This most prevalent habitat type in the primary study area covers approximately 1,462 acres. Although this habitat type is unvegetated, it is very productive. An abundant assemblage of microorganisms (bacteria, protists, meiofauna, and meioflora) and invertebrates exist in these fine, organically rich sediments. The diversity of this community provides food for numerous wildlife species including estuarine-dependent Reddish Egrets (*Egretta rufescens*) and thousands of migratory and wintering shorebirds. These shorebirds concentrate in great numbers in The Kitchen and on the east side of Hillsborough Bay, including the mudflats of the ARPA and Audubon sanctuary islands, to rest and forage to accumulate body fat for long distance migrations and over-wintering.

Supratidal (6512): These upper intertidal flats are inundated typically only by spring tides once or twice a month. This results in hypersaline conditions creating "salterns" (also termed salt flats, salt barrens, or salinas) that are formed when extreme high tides or storm waters flood shallow regions and evaporate, leaving highly saline residues that preclude the growth of most vegetation. Salterns are typically located landward of a mangrove forest or tidal marsh, and are frequently covered with algal mats. Seasonally, salt-tolerant prostrate succulent vegetation expands over salterns during the rainy season, then retreats with less frequent inundation and rainfall. This produces the characteristic open, unvegetated patches across the saltern substrate. Historically, these areas were assumed to have low ecological value due to their lack of structural complexity and faunal diversity (LES & CEI 1996); however, they have unique ecological values as seasonal feeding areas for wading birds when lower elevation mudflats are inundated (Powell 1987), and as night feeding habitat during spring tides for snook (*Centropomus undecimalis*), tarpon (*Tarpon atlanticus*) and ladyfish (*Elops saurus*). Algal mats that grow rapidly after tidal or storm inundation provide a rich food for schools of killifish, chuffs, and other small fish and fry. Insect reproduction is also promoted, providing food for Wilson's Plovers that regularly nest on these flats and other birds.

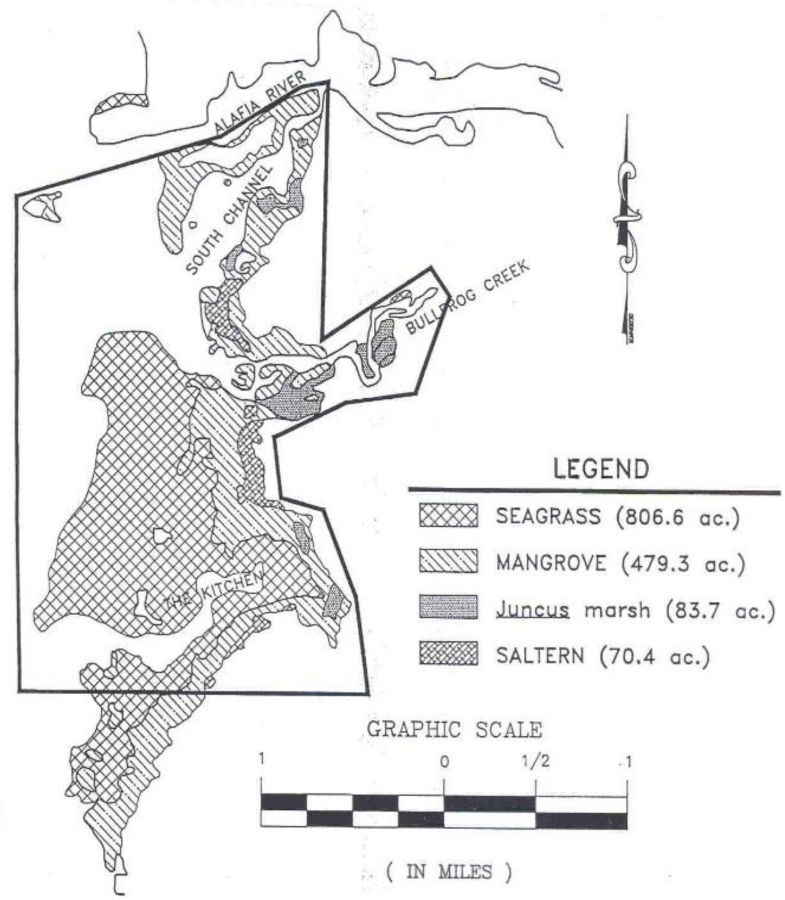


Figure 22. Emergent and submerged habitat distribution in the Bullfrog Creek ARPA, c. 1950 (Lewis et al. 1985).

Special Classification: Seagrasses

Seagrasses are submerged flowering plants that require sufficient light penetration for photosynthesis through the water column to the depth where the seagrass grows. Seagrass beds constitute one of the world's most ecologically significant environments (McRoy and McMillan 1977). Highly productive, seagrasses provide food, shelter and nursery grounds for many fish and invertebrates. Seagrasses also improve water quality by trapping and stabilizing fine sediments (Dawes 1981). The quality of the light reaching the sea bottom directly affects the growth of seagrass, indicating that seagrass growth is limited by phytoplankton growth in the water, which is increased by nutrient enrichment (Anastasiou et al. 2009).

The City of Tampa's Bay Study Group (BSG) maintained a 32-year-long monthly record of phytoplankton production rates and biomass (chlorophyll-a) in Hillsborough Bay (HB). Current (2010) HB concentrations are nearly 70% lower than those measured during 1980-1985. The decreases in phytoplankton production, biomass, and abundance are reflected in a large reduction in anthropogenic nitrogen loading to the bay that primarily occurred during the late 1970s and early 1980s (Johansson 2010).

An expansive turtle grass (*Thalassia testudinum*) meadow was located south of Whiskey Stump Key extending as far south as Piney Point before the dredging occurred that created Port Redwing, the Big Bend terminal, and Apollo Beach. East of Whiskey Stump Key to Peanut Key, dense beds of manatee grass (*Syringodium filiforme*) occurred (Avery 1996). Loggerhead sea turtles (*Caretta caretta*) swimming over the seagrass beds were a common sight (J. Youngman, pers. comm.). More recently, shoal grass (*Halodule wrightii*), and widgeongrass (*Ruppia maritima*) - a salinity-sensitive, ephemeral species appearing most frequently at the mouths of freshwater creeks, have been the dominant seagrass species in Hillsborough Bay (Johansson 2010).

Shoal grass is the primary successional species in Tampa Bay. It is not salinity limited and densities can range from very sparse, discontinuous patches to dense, continuous patches. Widgeongrass is a seasonally appearing plant, and can tolerate fluctuating salinities as it occurs in both high and low salinity environments, although it is found most commonly at the mouths of freshwater creeks. Again, densities and continuity vary. R. Johansson (pers. comm.) has noted the ephemeral habit of this population of widgeongrass: the threadlike leaves are present in the spring and persist until mid-summer, when the plants then subsist through storage of nutrients in the below-ground biomass (fleshy roots and rhizomes) until the following spring.

The SWFWMD mapping program does not distinguish species of seagrass and maps seagrass density only. Two categories of seagrass distribution occur in the BCARPA:

***Seagrass, Patchy (9113)*:** Defined as "Isolated patches of seagrasses or extensive areas of patchy seagrass coverage. Usually these areas include small round clumps of vegetation or elongated strands of seagrass coverage. Category appears as singular, isolated patches of seagrass or extensive areas of patch strands mixed with open bottom. Typically areas appear as rounded clumps, or elongated strands mixed with sand." (FLUCCS; FDOT 1985)

Aerial photographs taken in October 1995 showed three hectares of patchy shoal grass in the Bullfrog Creek study area (R. Johansson, pers. comm.). Major anthropogenic impacts over a 30-year period Hillsborough Bay had reduced historical seagrass coverage by 81% in Hillsborough Bay (Lewis et al. 1985). Dredge and fill operations had increased turbidity, decreased light penetration, and removed suitable habitat for seagrasses by increasing depths beyond the light penetration zone and by filling in areas where seagrasses would occur naturally (Lewis 1977). Nutrient inputs from industry and municipalities resulted in algal epiphytes attaching to seagrass blades, increased phytoplankton and extensive macroalgae blooms in the water column, greatly reducing available light for seagrasses growing on the bay floor. In the 1980s, sea lettuce (*Ulva lactuca*) sometimes entirely covered The Kitchen area of Hillsborough Bay, contributing to low pH, low dissolved oxygen concentrations, and poor water quality prohibiting seagrass growth (W. Avery, pers. comm.). After the improvements to the wastewater treatment system at Hookers Point in the City of Tampa in the late 1970s, seagrasses began to recover. By 1997, seagrass cover had increased to 42 hectares in the area of the Kitchen and 0.25 hectares near the mouth of Bullfrog Creek (R. Johansson, pers. comm. 1998).

Continuous Seagrass (9116): Defined as "Seagrass containing areas that exhibit uniform signatures with less than 25 percent of any particular area showing up as unvegetated bottom. Areas exhibit a continuous and uniform signature. Small, (less than 0.25 acre) sandy bottom features may be interspersed within the bed, but these areas are not dominant." (FLUCCS; FDOT 1985) The initial survey of seagrasses conducted by the BSG and Mangrove Systems, Inc. in 1986 showed that 80% of the 2,000 m^2 of seagrasses in Hillsborough Bay were in The Kitchen (Johansson and Lewis 1992). Ten years later, approximately 1.2 acres of shoal grass (*Halodule wrightii*) and 13.5 acres of widgeongrass (*Ruppia maritima*) occurred in The Kitchen area (Johansson 2002) (Figure 23).

By 1987 the BSG, in cooperation with the Florida Department of Natural Resources (now the FL Department of Environmental Protection, FDEP) and the National Marine Fisheries Service's "Tampa Bay Experimental Seagrass Planting Effort" had planted shoal grass in eight areas around Hillsborough Bay. Five sites were located north of Green Key and south of Hog and Hominy Cove in the Kitchen area. Avery (1996) noted that The Kitchen area of Hillsborough Bay experienced particularly rapid revegetation by seagrass – increasing from 1,300 m^2 in 1986 to 108,000 m^2 in 1995.

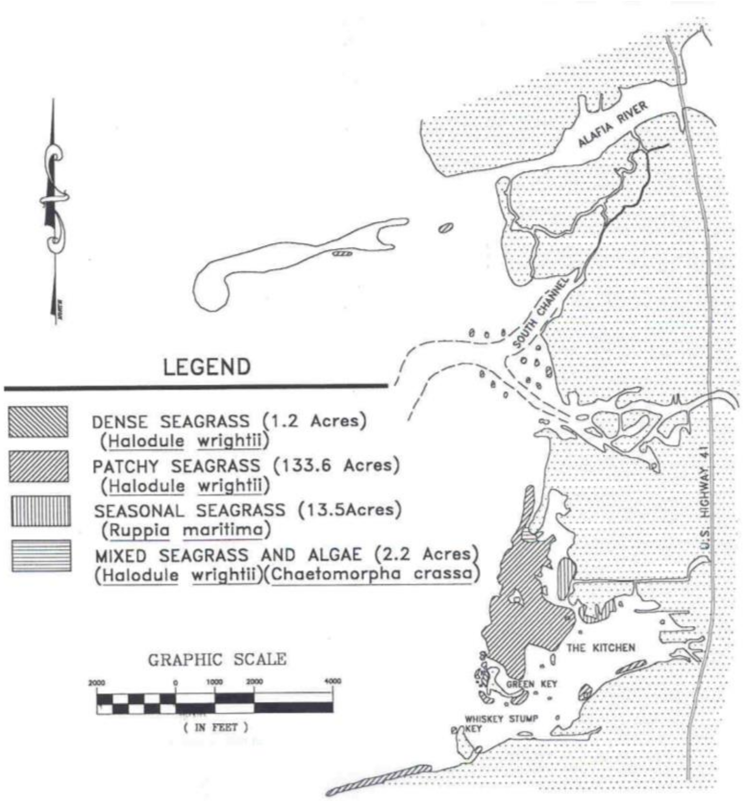


Figure 23. Seagrass distribution in the BCARPA, January 1996 (combined field survey and verification by the BSG).

By 2012, shoal grass and widgeongrass were well-established throughout the mouth of Bullfrog Creek and density had increased dramatically (Figure 24) (SWF WMD). Decreased nutrient loading from land-based and atmospheric sources are believed to have contributed significantly to improved water clarity, resulting in seagrass expansion to greater depths.

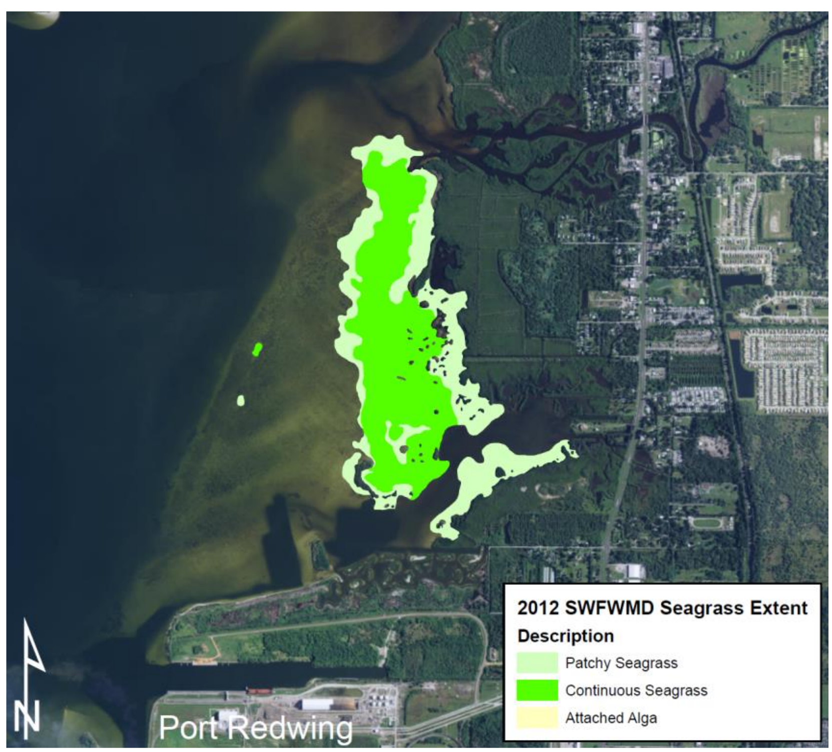


Figure 24. Seagrass distribution in the BCARPA, 2012 (SWFWMD).

The 2014 SWFWMD seagrass survey in Tampa Bay showed a 36.2% increase in seagrass coverage in Hillsborough Bay, and a large increase in seagrass coverage in the BCARPA (Figure 25) (SWFWMD 2015).

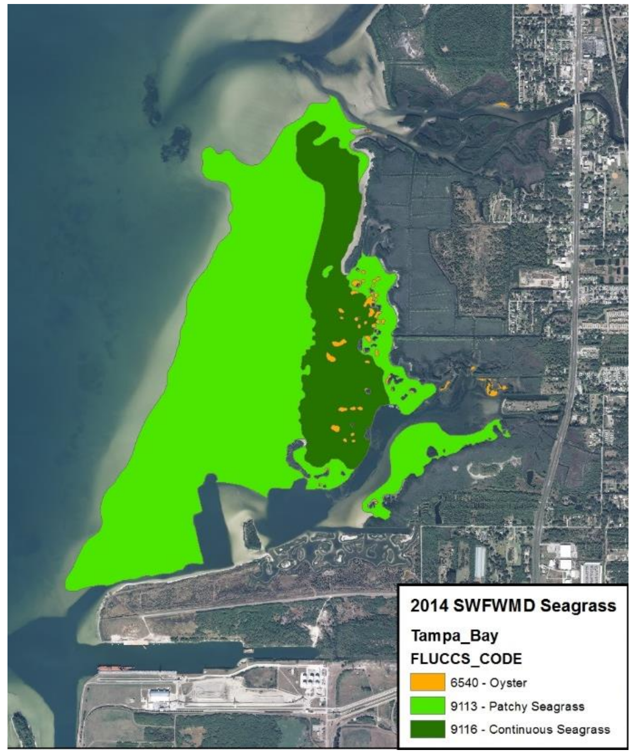


Figure 25. Seagrass distribution in the BCARPA, 2014 (SWFWMD 2015).

Dark green = continuous seagrass; light green = patchy seagrass.

Scarring of seagrass beds by boat propellers has been chronic and impactful. A seagrass assessment study conducted by the Florida Marine Research Institute (Sargent et al. 1995) ranked Hillsborough County 15th among 31 coastal counties in terms of total scarred seagrass acreage, and 7th in terms of total combined severely and moderately scarred seagrass acreage. The BCARPA was among the Hillsborough County areas targeted by the mapping study as having severe to moderate seagrass scarring (Figure 26). There has been no survey work performed since 1995 of propeller damage within the BCARPA. Efforts to control boat speed and access have been undertaken in order to protect manatees with the added benefit of protecting seagrass beds, but it is expected that the scarring continues almost unabated (R. Lewis, pers. comm.)

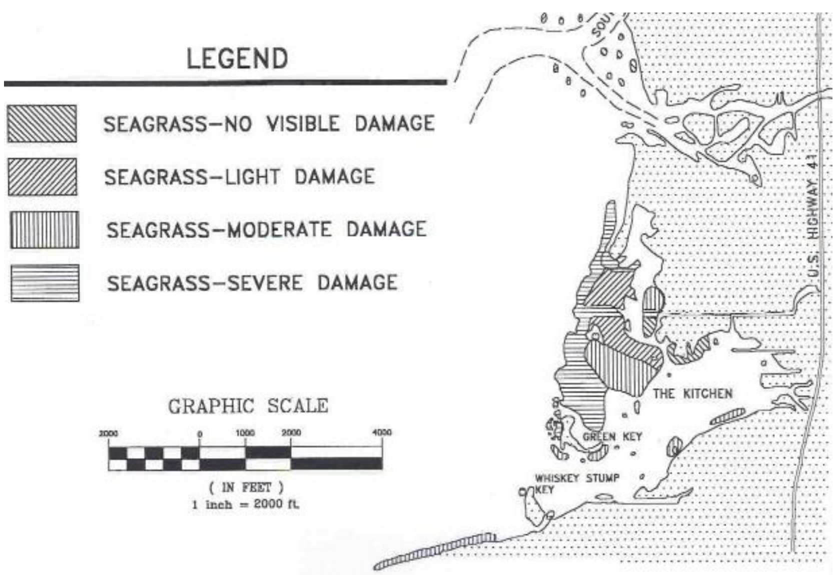


Figure 26. Assessment of boat propeller damage in seagrasses of the BCARPA in1995.

Attached Algae (9121): The City of Tampa BSG conducted monthly macroalgae studies in Hillsborough Bay over the period 1976-2009. The results discussed here are from the 1986-1995 study. A series of five transects were sampled monthly. The most dominant species were *Agardhiella* spp., *Gracilaria* spp., *Spyridia* spp., and *Ulva* spp. As the bay-wide biomass of algae has declined, *Agardhiella* spp., *Gracilaria* spp., and *Ulva* spp. biomasses have declined in Hillsborough Bay since 1986. Although *Ulva* spp. biomass increased in 1991, successive years showed a dramatic total algal decrease (Avery 1997).

The 2014 seagrass survey conducted by SWFWMD detected almost no attached or drift algae within the BCARPA (SWFWMD 2015). The probable causes of the decline of algal biomass include the dramatic reduction in nutrient loading from wastewater to Hillsborough Bay which began in the late 1970s, mandated treatment of stormwater on developed sites, the introduction of Best Management Practices to agricultural lands, and reduced nitrogen emissions from atmospheric sources.

Fauna of the BCARPA

Estuarine Benthic Invertebrates

Benthic invertebrates are often studied because of their usefulness as indicator species. The populations and species richness provide important data with regard to the relative ecological integrity of a particular site. For this reason, early studies of benthic invertebrates in the Tampa Bay area were conducted in conjunction with other objectives, such as the determination of effects of thermal effluents, dredging operations, septage and industrial discharges, and canal and seawall construction (Wolfe and Drew 1990).

Benthic invertebrates in Hillsborough Bay immediately offshore of the mouth of Bullfrog Creek were sampled periodically from 1973 through 1986 (Proctor & Redfern, Inc. 1989). Table 6 lists the benthic sampling studies conducted at Bullfrog Creek and The Kitchen between 1973 and 1996 and the number of taxa identified.

Table 6. Benthic sampling studies conducted at Bullfrog Creek and The Kitchen, 1973–1996, and the number of benthic taxa obtained in each study.

	NUMBER OF BENTHIC TAXA		
REFERENCE	BULLFROG CREEK	THE KITCHEN	COMMENTS
TBE 1973	10	—	tidal channel at mouth of creek
LETCo 1975	18	—	intertidal
	21	—	subtidal
USF 1976	20	—	intertidal
MSI/MML 1982	41	—	April 1981
	39	—	July 1981
GAI 1986	68	381	Station 3Ki, January 1986
	56	281	Station 3Ki, July 1986
	—	69	intertidal stations, January 1986
	—	65	intertidal stations, July 1986
	—	79	subtidal stations, January 1986
	—	84	subtidal stations, July 1986
MSI 1989	—	39	Station 3Ki, January 1989
	—	55	Station 3Ki, July 1988
LES 1994	—	18	Station 3Ki, February 1994
	—	13	Station 3Ki, June 1994
LES 1995	—	14	Station 3Ki, January 1995
	—	23	Station 3Ki, June 1995
LES 1996	—	22	Station 3Ki, January 1996

Notes: Table excludes ostracods and copepods, which are included in all other GAI data (but no others).
Data Sources:

TBE 1973—An ecological study of a proposed tidal zone development site in eastern Hillsborough Bay, Florida. Unpublished report by Teledyne Brown Engineering.

LETCo 1975—Wastewater disposal plan, East Tampa Fertilizer Manufacturing Complex: evaluation of site locations for proposed gypsum disposal field / rainwater retention pond complex. Law Engineering Testing Co., Marietta, Ga. 290 pp., unpubl. [not seen; cited in Upchurch et al. 1976]

USF 1976—The distribution and possible effects of removal of sedimentary contaminants offshore of Gardinier, Inc. in Tampa Bay, Florida. Report by S.B. Upchurch, E.D. Estevez and R.A. Rea, University of South Florida report to Florida Dept. of Environmental Regulation.

MSI/MML 1982—Biogeochemical studies of recolonization at Gardinier, Inc. Report by Mangrove Systems, Inc. and Mote Marine Laboratory.

GAI 1986—Final Report, benthic sampling results offshore of Gardinier's gypsum field, Hillsborough County, Florida. Prepared by Gurr & Associates, Inc.

MSI 1989—Benthic sampling at Gardinier, Inc.: July 1988 and January 1989. Report prepared by Mangroves Systems, Inc. for Gardinier, Inc. submittal to Florida Dept. of Environmental Regulation.

LES 1994, 1995, 1996—Benthic studies conducted for Cargill Fertilizer, Inc. by Lewis Environmental Services, Inc.

Studies conducted by EPCHC at The Kitchen's baseline station recorded 79 benthic invertebrate species (Table 7). This total reflects studies conducted over a 7-year period (1988-1995). The EPCHC has continued to conduct benthic sampling in Tampa Bay and has extensive data on the benthic invertebrates in the immediate area of The Kitchen as well as from a special study of Bullfrog Creek performed in 2007 (D. Karlen, pers. comm.). Many more species have been added to the species list because of the sampling program and special study, and are contained in Appendix C.

In addition, the BCARPA and the tidal segment of Bullfrog Creek support a commercial blue crab (*Callinectes sapidus*) fishery.

Table 7. Taxa obtained in benthic sampling at Station 3Ki (The Kitchen), July 1988 through June 1995.

TAXON	SCIENTIFIC NAME
NEMERTEANS	*Stylochus* sp.
	Nemertea sp.
ANNELIDS	*Eteone heteropoda*
	Eumida sanguinea
	Genityllis castanea
	Neanthes succinea
	Parahesione luteola
	Laeonereis culveri
	Glycera americana
	Glycinde solitaria
	Diopatra cuprea
	Kinbergonuphis simoni
	Leitoscoloplos sp.
	L. foliosus
	Scoloplos rubra
	Scolelepis taxana
	Aricidea philbinae
	A. taylori
	Polydora cornuta
	P. websteri
	Prionospio heterobranchia
	P. steenstrupi
	Paraprionospio pinnata
	Streblospio benedicti
	Carazziella hobsonae
	Magelona corona
	M. pettiboneae
	Capitella capitata
	Heteromastus filiformis
	Mediomastus ambiseta
	Axiothella mucosa
	Cistenides gouldii
	Melinna maculata
	Fabriciola trilobata
	Limnodriloides cf. *rubicundus*
	Tharyx annulosus
	Syllid spp.
	Phoronis architecta
BRYOZOANS	*Ophiophragmus filograneus*
ECHINODERMS	*Acteocina canaliculata*
MOLLUSKS	*Assiminea succinea*
	Haminoea succinea
	Teinostoma lerema
	Amygdalum papyrium
	Astarte subequilatera
	Ensis minor
	Lyonsia hyalina
	Macoma constricta
	Mysella planulata
	Parastarte triquetra
	Pseudomiltha floridana
	Tagelus plebeius
	Tellina sp.
	Bowmaniella sp.
	Taphromysis bowmani
	Oxyurostylis smithi
CRUSTACEANS	*Almyracuma* sp. A
	Cyathura polita
	Xenanthura brevitelson
	Edotea sp. A
	Erichsonella filiformis
	Ampelisca sp.
	A. abdita
	A. vadorum
	A. holmesi
	Acuminodeutopus sp.
	Corophium sp.
	Elasmopus laevis
	Grandidierella bonnieroides
	Gammarus mucronatus
	Monoculodes edwardsi
	Orchestia sp.
	Leptalpheus forceps
	Neopanope texana
	Panopeus herbstii
	Pinnixa pearsi

Sharks and Rays

Mote Marine Laboratory has conducted limited studies in Hillsborough Bay, specifically near the mouth of Bullfrog Creek and the old "South Mouth" area off Mosaic Fertilizer, LLC's South Parcel, south of the Alafia River. These studies show that the BCARPA is an important area for sharks; in fact, it is the most important nursery site for bull sharks (*Carcharhinus leucas*) known on the west coast of Florida. Other sharks reported to use the ARPA are hammerheads (*Sphyrna* sp.), juvenile black-tipped (*C. limbatus*), and bonnethead (*S. tiburo*) sharks. The area is also well known for its large population of rays and skates, specifically cow-nosed rays (*Rhinoptera bonasus*), southern and Atlantic stingrays (*Dasyatis americana*, *D. sabina*, respectively), butter rays (*Gymnura* sp.), and spotted eagle rays (*Aetobatis narinari*) (R. Hueter, pers. comm.). Local fishermen recall that in the past, fishing boats in Tampa Bay were invariably followed by large (8-10 feet) hammerhead sharks (J. Youngman, pers. comm.). Environmental degradation to Tampa Bay has apparently changed the shark population profile; hammerheads now are most likely to be seen at the mouth of Tampa Bay. Water quality declines and subsequent decline in food availability have had important impacts on shark numbers (C. Manire, pers. comm.). Overfishing, a major problem for fish stocks and shark populations all over the world, has had dramatic effects in Tampa Bay as well (R. Hueter, pers. comm.).

Fish

Comp (1985) prepared a list of 202 species collected within Tampa Bay (also in Wolfe and Drew 1990; Appendix D). It was thought that only 125 of these could be considered common inhabitants and, although the list indicates a diverse fish assemblage, ten or fewer species usually made up the majority of the fish caught in sampling programs. Results of the FFWCC's monthly sampling for the 2012 annual Fisheries-Independent Monitoring report showed 101 species within Hillsborough Bay and eastern Middle Tampa Bay (FWRI 2013).

The most common fish in Hillsborough and McKay bays before 1985, in terms of numerical abundance in collections made with standard gear (which is somewhat biased toward capturing smaller, less mobile species), are indicated in the third column of Table 8. The ten most abundant species within Hillsborough Bay and eastern Middle Tampa Bay, as sampled in 2012, are indicated in the fourth column. Fishermen regularly catch spotted seatrout (*Cynoscion nebulosus*), catfish (*Arius felis* and *Bagre marinus*), immature shark, snook, and mullet (*Mugil* spp.) in the vicinity of the study area.

Adults of larger, more predatory species of fish typically depend upon the smaller fish as their main food source. Many of these species are important to recreational and commercial fisheries, especially tarpon, snook, cobia (*Rachycentron canadum*), spotted seatrout, sand seatrout (*Cynoscion arenarius*), and various species of sharks. Other important fish species appear to depend on invertebrates as their main source of food. These include the red drum (*Sciaenops ocellatus*), black drum (*Pogonias cromis*), gag grouper (*Mycteroperca microlepis*), and catfish.

Table 8. The dominant fish species in Tampa Bay, with pertinent areas indicated (Comp 1985 and FWRI 2013).

		HILLSBOROUGH & MCKAY BAYS (1985)	HILLSBOROUGH & EASTERN MIDDLE TAMPA BAY (2013)
SPECIES	SCIENTIFIC NAME		
Tidewater silverside	*Menidia peninsulae*	X	X
Bay anchovy	*Anchoa mitchilli*	X	X
Scaled sardine	*Harengula jaguana*	X	X
Striped mullet	*Mugil cephalus*	X	---
Pinfish	*Lagodon rhomboides*	X	X
Longnose killifish	*Fundulus similis*	X	---
Spot	*Leiostomus xanthurus*	X	---
Silver perch	*Bairdiella chrysoura*	---	X
Silver jenny	*Eucinostomus gula*	---	X
Cuban anchovy	*Anchoa cubana*	---	X
Mojarra	*Eucinostomus spp.*	---	X
Tidewater mojarra	*E. harengulus*	---	X
Striped anchovy	*Anchoa hepsetus*	---	X

Tampa Bay is a nursery area for the larvae and juveniles of both resident and migratory fish species. Seventy-nine species use the bay as a nursery (Lewis and Estevez 1988). During and following spawning periods, larval and juvenile fish typically migrate into shallow, protected, low-salinity nursery areas of the bay, river, and creeks to feed and mature (Comp 1985, Lewis et al. 1985). Upstream, low-salinity habitats of Tampa Bay are critical habitats for economically or ecologically prominent species such as common snook and red drum (Ley et al. 2009).

For example, snook and spotted seatrout larvae seek out seagrass meadows for nursery areas (Figure 27). Unfortunately, during the 1950s and 1960s, seagrass meadows in the lower salinity areas of the bay, including the BCARPA, were significantly reduced by improper dredging practices, severely limiting the primary nursery areas for these species, at least in Hillsborough Bay. However, the recovery of seagrasses in Hillsborough Bay, especially in the area of the BCARPA, may provide a significant increase in nursery habitat for these fish species.

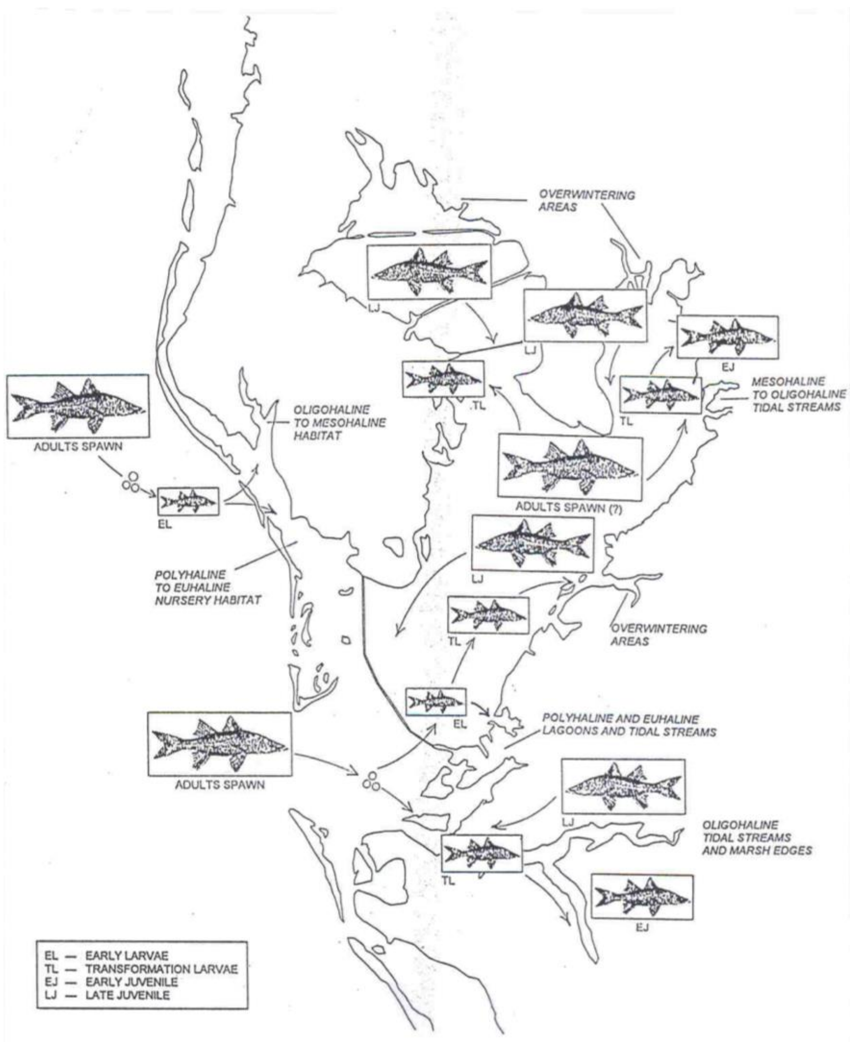


Figure 27. Snook (*Centropomus undecimalis*) life history diagram (from LES & CEI 1996).

The deeper waters east of Peanut Key in The Kitchen, south of Hog and Hominy Cove, were famous for large spotted seatrout. Coastal pothole areas with white sand bottoms, natural depressions on the upland side of the intertidal flats, filled with water by high tides and were used by large redfish. Fishermen looked for cobia and tripletails under the waves' wrack lines. Tarpon were "so thick you could walk across their backs". Snook, mangrove snapper, and all jacks were harvested commonly. "Gator-nosed chubs" (longnose killifish, *Fundulus similis*) were collected near sandbars by beating the water with a large stick. The stunned fish were cooked immediately in a coffee can with lard. Female killifish full of roe were considered especially tasty (J. Youngman, pers. comm.).

Personal interviews with local residents provided information on fish populations and fishing practices in The Kitchen during the 1940s and 1950s. Blue crab fishermen in the 1940s used trot lines (long strings with bait tied along them at regular intervals) and, by gently pulling the lines in, would lift the attached blue crabs into the boat (Jack and Jenny Pulsipher, pers. comm.). Crabs were also harvested with hand nets and wooden crab traps marked by corks made from cedar trees growing on Indian mounds in the area (J. Youngman, pers. comm.).

Amphibians and Reptiles

At least 28 species of amphibians and reptiles are known or suspected to occur within or adjacent to the BCARPA (Table 9). While this list is likely incomplete, enough is known to identify particular management concerns and opportunities.

Amphibians typically reproduce in small ephemeral, freshwater ponds. Few such ponds occur in the ARPA primary study area, and the list of species thought to be present is correspondingly short. One significant pond creation project is located on Port Redwing within the Fred and Idah Schultz Nature Preserve. Approximately ten acres of freshwater wetlands were created and designed to receive surface runoff from the adjacent PTB property. The freshwater runoff hydrates the ponds and then is slowly released to the saltmarshes on-site, providing a natural community mosaic (B. Henningsen, pers. comm.). Future habitat restoration projects should also include the creation of such ponds.

Reptiles are more common within the study area, with 22 species suspected or confirmed. Diamondback rattlesnakes (*Crotalus adamanteus*) are common residents on the shorelines of the ARPA and the Alafia Bank, and should be expected on all the islands in Tampa Bay. These reptiles are excellent swimmers. They are not considered predators of the nesting birds and therefore numbers are not controlled on the bird sanctuary islands.

The diamondback terrapin (*Malaclemys terrapin*) is of particular interest. It is a small, estuarine turtle that occurs in shallow coastal waters along the eastern seaboard and both coasts of Florida. They are now extirpated from Chesapeake Bay and endangered in Cape May, NJ (R.C. Wood, pers. comm.). Their distribution in Florida is spotty. In Tampa Bay, small populations occur in Terra Ceia, Boca Ciega, and Cockroach bays, as well as a larger population in the BCARPA near the Alafia Bank and in The Kitchen.

Terrapins nest on sandy beach ridges and low spoil mounds associated with mosquito ditching. Carnivores and scavengers, they feed on snails, small crabs and clams, and dead fish. They are often caught in wire crab traps where they drown. In one extreme case near Alafia Bank in the early 1980s, R. Paul (pers. obs.) found a neglected trap containing about 40 dead terrapins. Based upon population and trap survey data, thousands of diamondback terrapins are killed in this manner in Florida each year (G. Heinrich, pers. comm.) Extensive research has been conducted into the use of bycatch reduction devices (BRD) which would permit these air-breathing reptiles to escape crab traps. It was found that 4.5 x 12 cm BRD are effective at reducing terrapin mortality by 73.2% without affecting crab catch rate (Butler and Heinrich 2007).

Two species of sea turtles, loggerhead (*Caretta caretta*) and Kemp's ridley (*Lepidochelys kempi*), occur in Hillsborough Bay and undoubtedly traverse the ARPA. Discarded plastic bags and monofilament fishing line are a common cause of mortality in these species (A. Meylan, pers. comm.).

Green anoles (*Anolis carolinensis*) are the native Florida anole. Brown anoles (*A. sagrei*) were introduced from the Caribbean in the 1960s and are displacing green anoles. Several of the heron species, including Great Egrets, Cattle Egrets, Little Blue Herons, and Snowy Egrets and Gull-billed Terns, have been observed preying on brown anoles, so they appear to be functioning as a prey species.

Table 9. Herpetofauna and terrestrial mammals known or expected to occur within or adjacent to the BCARPA.

TAXON	COMMON NAME	SCIENTIFIC NAME	OBSERVATIONS	
			Reported	Expected
AMPHIBIANS	Southern toad	*Bufo terristris*	X	
	Cuban toad	*B. marinus*	X	
	green treefrog	*Hyla cinerea*	X	
	squirrel treefrog	*H. squirella*	X	
	Cuban treefrog	*H. septrionalis*	X	
	Southern leopard frog	*Rana sphenocephala*	X	
REPTILES	box turtle	*Terrapene carolina*	X	
	diamondback terrapin	*Malaclemys terrapin*	X	
	gopher tortoise	*Gopherus polyphemus*	X	
	Atlantic loggerhead	*Caretta caretta caretta*	X	
	Kemp's ridley turtle	*Lepidochelys kempi*	X	
	Florida softshell turtle	*Trionyx ferox*	X	

TAXON	COMMON NAME	SCIENTIFIC NAME	OBSERVATIONS	
			Reported	Expected
	banded water snake	*Nerodia fasciata*	X	
	Eastern garter snake	*Thamnophis sirtalis*		X
	Eastern indigo snake	*Drymarchon corais couperi*	X	
	Florida kingsnake	*Lampropeltis getulus*	X	
	Eastern diamondback rattlesnake	*Crotalus adamanteus*	X	
	mangrove water snake	*Nerodia clarkii*	X	
	ring-neck snake	*Diadophis punctatus*		X
	black racer	*Coluber constrictor*	X	
	Eastern coral snake	*Micrurus fulvius*	X	
	green anole	*Anolis carolinensis*	X	
	brown anole	*A. sagrei*	X	
	ground skink	*Scincella lateralis*		X
	Southeastern five-lined skink	*Eumeces inexpectatus*		X
	green iguana	*Iguana iguana*	X	
	tegu lizard	*Tupinambis merianae*	X	
	alligator	*Alligator mississippiensis*	X	
MAMMALS	Virginia opossum	*Didelphis virginiana*	X	
	bats	unidentified species	X	
	nine-banded armadillo	*Dasypus novemcinctus*	X	
	wild pig	*Sus scrofa*	X	
	marsh rabbit	*Sylvilagus palustris*	X	
	Eastern cottontail rabbit	*S. floridanus*	X	
	Eastern gray squirrel	*Sciurus carolinensis*	X	
	rice rat	*Oryzomys palustris*	X	
	hispid cotton rat	*Sigmodon hispidus*	X	
	black rat	*Rattus rattus*	X	
	nutria	*Myocastor coypus*	X	
	gray fox	*Urocyon cinereoargenteus*	X	
	raccoon	*Procyon lotor*	X	
	river otter	*Lutra canadensis*		X
	bobcat	*Lynx rufus*	X	
	coyote	*Canis latrans*	X	

Notes: Adapted from Paul (1982), Wolfe and Drew (1990), and unpublished observations of A. Burdett, R. Paul, A. Paul, and J. Youngman.

Birds

Birds are the most diverse and most highly visible wildlife taxon of the area, with more than 160 species known or likely to occur in the BCARPA (Appendix D). A relatively high proportion of the species that occur are not generally common; in fact, 12 of the resident species are listed by the state as threatened, endangered, or species of special concern. FFWCC is currently reviewing the status of all listed species and retire the "endangered" classification. The revised list is expected to have only "threatened" species, although any species federally listed as "endangered" will be state-listed as "endangered" as well. Some listed species, including the White Ibis (*Eudocimus albus*), Roseate Spoonbill (*Ajaia ajaja*), and American Oystercatcher (*Haematopus palliatus*), for example, are locally abundant, which makes the BCARPA an important area in terms of those species' populations. Migrant and wintering species, occurring seasonally, make up another significant segment of the region's avifauna.

The Hillsborough Bay bird colony, formerly located at Audubon's Green Key Sanctuary and now at the Richard T. Paul Alafia Bank Bird Sanctuary, accounts for a major portion of the breeding bird population in this area. Audubon Florida's sanctuary islands within the BCARPA include the Alafia Bank Bird Sanctuary, Whiskey Stump Key and Green Key. Under a cooperative agreement with Port Tampa Bay, sanctuary staff also monitors and protects important colonies of another 40,000 pairs of nesting birds on two islands west of the BCARPA (Port Tampa Bay Dredged

Material Management Areas [DMMA] 2D and 3D) and on Fishhook Spoil Island, south of the Bullfrog Creek and the Big Bend shipping channel (AOF 2009).

The Alafia Bank Bird Sanctuary (comprised of two dredged-material islands, Bird Island to the east and Sunken Island to the west), is located south of the Alafia Ship Channel. The Sanctuary is about 60 acres in size and supports one of the largest and most diverse bird colonies in the U.S. Approximately 5,000–10,000 pairs of 16 to 20 species of birds nest there annually. The islands provide a variety of nesting habitats, ranging from mangrove trees to barren sand and shell substrate, which are managed and maintained as a bird sanctuary by Audubon Florida's Florida Coastal Islands Sanctuaries Program with the objective of enhancing the bird species diversity and nesting productivity.

Population estimates are based on "flight-line" surveys during peak nesting, supplemented wherever possible by direct nest counts (Brown Pelicans, Great Blue Herons, American Oystercatchers, tern species) or counts of fledged young (Reddish Egrets, Roseate Spoonbills). The 1998 breeding bird survey of the islands showed that more than 18,000 pairs of 18 species nested there that year (Table 10a). The highest number of breeding pairs - 18,710 - on the Alafia Bank was recorded in 2003 (Table 10b). These tables omits songbirds (i.e. Northern Mockingbird, Loggerhead Shrike, Ground Dove, Fish Crow, and Northern Cardinal) and Black Vultures, which also nest on Alafia Bank.

Other resources of the BCARPA are also important to the area's bird life. The flats, shallows and shores of the ARPA are important foraging areas for species such as the Peregrine Falcon (*Falco peregrinus*), an uncommon but regular migrant and winter resident; two or three pairs of Bald Eagles (*Haliaeetus leucocephalus*) forage regularly throughout the BCARPA and adjacent shoreline parcels, and nest within the tertiary study area; and wintering White Pelicans (*Pelecanus erythrorhynchos*), migratory ducks, and shorebirds in general. Although not censused annually, significant shorebird populations use the exposed and shallow flats of the entire ARPA area. Equally important, strong spring and fall migrations occur along the eastern side of Tampa Bay, with heavy use of island and mainland shores, mudflats, and grassflats within ARPA boundaries. Within the Bullfrog Creek watershed freshwater ponds and wetlands provide critical foraging habitat for adult White Ibis feeding nestlings and protection of this habitat benefits a number of other wading bird species, such as Glossy Ibis, Snowy Egret, Little Blue Heron, and Tricolored Heron (TAS 1999). The optimum foraging area is within 9.3 miles of the nesting colony (Figure 28).

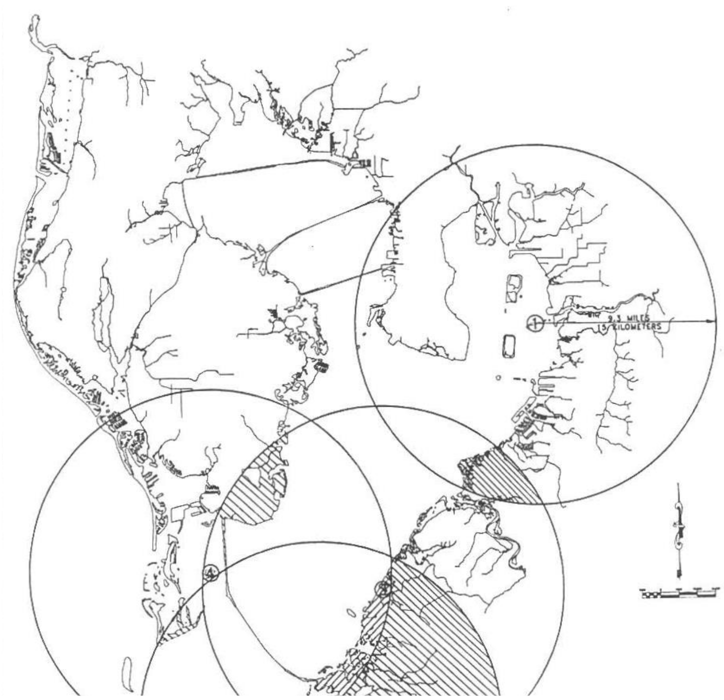


Figure 28. Foraging areas surrounding major wading bird nesting colonies in Tampa Bay (TAS 1999).

Table 10a. Breeding birds at the Alafia Bank Bird Sanctuary, 1990-1998 (Listed/Proposed Status per FFWCC 2013, 2015).

SPECIES	LISTED/ PROPOSED STATUS	BREEDING PAIRS								
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
Brown Pelican	SSC/--	1000	746	581	621	636	730	600	415	643
Double-crested Cormorant		200	200	20	100	200	200	200	100	100
Anhinga		1	1	2	1	0	0	0	0	0
Great Blue Heron		72	60	65	50	90	70	80	50	30
Great Egret		123	123	215	130	190	185	80	95	220
Snowy Egret	SSC/--	171	192	250	125	225	240	200	250	255
Little Blue Heron	SSC/T	78	105	95	110	50	55	90	70	75
Tricolored Heron	SSC/T	217	147	230	240	210	160	230	150	150
Reddish Egret	SSC/T	63	30	48	30	45	60	45	50	40
Cattle Egret		654	1077	500	1300	850	1300	700	850	265
Green Heron		0	1	+	+	+	+	+	+	+
Black-crowned Night-Heron		+	10	40	20	20	100	50+	50	50
Yellow-crowned Night-Heron		+	50	40	50	50	*50	50	50	50
White Ibis	SSC/--	4689	4623	3800	6500	5200	9000	7900	5000	15700
Glossy Ibis		135	302	450	200	325	435	525	265	360
Roseate Spoonbill	SSC/T	45	40	75	100	100	140	100	125	165
Clapper Rail		+	+	+	+	+	+	+	0	+
American Oystercatcher	SSC/T	+10	20	20	15	17	21	20	18	13
Willet		+	+	+	10	10	10	10	0	5+
Laughing Gull		0	0	300	700	2,000	800	2	0	0
Caspian Tern		0	0	0	80	80	84	0	0	0
Royal Tern		0	0	0	70	120	90	0	0	0
Sandwich Tern		0	0	0	40	110	70	0	0	0
Black Skimmer	SSC/T	0	0	0	210	0	0	0	57	0
TOTAL PAIRS		7447	7726	6729	10701	10528	13800	2880	7595	18121

*Notes: * indicates incomplete count; + indicates species present, believed nesting in small numbers (<5 pairs).*

Table 10b. Bird survey results, Richard T. Paul Alafia Bank Bird Sanctuary, 1999-2014 (FCIS data).

SPECIES	NESTS/ PAIRS															
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Brown Pelican	650	397	310	535	310	310	304	414	125	322	150	288	382	344	350	190
D-c Cormorant	100	100	80	115	120	110	100	110	65	100	65	135	70	125	70	140
Great Blue Heron	20	33	34	40	55	24	75	34	36	25	30	36	20	35	25	50
Great Egret	65	96	120	150	160	130	175	240	250	70	225	249	50	50	85	100
Snowy Egret	120	159	80	300	210	240	120	180	72	55	95	108	430	45	35	30
Little Blue Heron	55	36	30	115	120	18	50	70	27	45	65	69	140	35	50	45
Tricolored Heron	115	84	190	270	220	126	50	200	75	90	160	174	200	150	170	110
Reddish Egret	45	50	45	36	30	48	60	40	21	5	10	10	14	8	25	15
Cattle Egret	375	342	850	930	300	125	90	80	48	390	320	150	520	575	175	280
Green Heron	10	+	+	+	+	+	+	+	5	10	+	5	+	+	+	5
B-c Night-Heron	50	50	50	50	50	50	30	40	9	20	50	21	30	20	40	20
Y-c Night-Heron	50	50	50	50	6	50	20	20	10	25	15	10	20	35	30	40
White Ibis	4,615	5,500	4,560	6,050	16,540	7,750	10,475	8,910	5,289	8,870	4,520	7,387	7,375	5,300	3,800	4,650
Glossy Ibis	155	255	205	150	345	300	325	80	168	170	200	105	285	140	125	75
Roseate Spoonbill	130	145	125	230	230	330	345	460	294	260	310	258	190	155	235	170
American Oystercatcher	13	18	16	15	14	13	14	16	16	14	15	10	10	12	8	8
Willet	5+	0	0	0	0	0	3	4	2	3	4	5	4	3	3	4
Laughing Gull	0	0	0	0	0	100	0	150	0	50	0	0	0	0	0	0
TOTAL PAIRS	6,573	7,315	6,745	9,036	18,710	9,724	12,236	11,048	6,512	10,524	6,234	9,020	9,740	7,032	5,227	5,927

Note: Estimates based on direct counts and flight-line surveys

Selected Species Accounts

Brief status summaries are provided below for several species that are particularly dependent on the habitats of the BCARPA, to illustrate the significance of this area.

White Pelican (*Pelecanus erythrorhynchos*): An average of 400 White Pelicans over-winter annually These birds arrive from nesting areas in North Dakota, Minnesota, and Canada in October and remain until mid-March in the BCARPA, using the sandbars of the Alafia Bank as roost sites. During the winter of 1995–1996, an all-time local high of 900 birds was counted. Although they travel widely to forage throughout the area in fresh and salt water, White Pelicans appear to use The Kitchen and other shallows north to Pendola Point more consistently than anywhere else in Tampa Bay.

Brown Pelican *(Pelecanus occidentalis*): In 1990-1999, 600–700 pairs of Brown Pelicans (of the 1400 pairs in the state) nested at the Alafia Bank, one of the five largest colonies in the state. Since 1999, an average of 315 pairs have nested there. Pelicans forage primarily in Hillsborough Bay but range as far as Old Tampa

Bay to the west, Middle Tampa Bay to the southwest, and even inland. Menhaden is probably the key prey species, but anchovies, silversides, mullet and other small fish are also used. Brown Pelicans forage extensively in BCARPA waters. The species is currently listed by FFWCC as a “species of special concern” but under the proposed listing process will no longer be listed.

Reddish Egret (*Egretta rufescens*): The Reddish Egret is the rarest heron species in North America with only 2,000 breeding pairs estimated to occur throughout its range, and only about 400 pairs are estimated to be in Florida (Paul 1996). The FFWCC lists the Reddish Egret as a “species of special concern” but the status is expected to change to “threatened”. The species was likely extirpated from Florida around 1900, and nesting birds did not return to Tampa Bay until 1974 when two nests were found at Alafia Bank (Paul et al. 1975). The local population has spread to eight colonies and has increased to about 40 pairs across Tampa Bay and Pinellas County, but the Alafia Bank Bird Colony remains the key site with 15 pairs nesting there. This species is a habitat specialist, requiring barren, shallow coastal flats for foraging. The virtually uninterrupted flats system from The Kitchen north to the Alafia River and Pendola Point, and additional flats in Hillsborough Bay, including McKay Bay and the region south of MacDill Air Force Base provide critical foraging habitat for this species.

Yellow-crowned Night-Heron (*Nyctanassa violacea*): Estimates of breeding numbers at the Alafia Bank have declined from 400 pairs in the 1970s to 50–100 pairs now. It is difficult to determine whether birds have moved to other small colonies in the area where they escape detection, the nesting surveys underestimate true numbers, or the population has really declined. Surveys among the mangroves and marshes of the Alafia River’s “south mouth”, Bullfrog Creek and The Kitchen confirm that these areas are extremely important foraging areas for the Yellow-crowns nesting at the Alafia Bank. They generally eat crabs, supplemented with small fish and invertebrates.

Other Small Herons: Populations of the Snowy Egret (*Egretta thula*), Little Blue Heron (*E. caerulea*), and Tricolored Heron (*E. tricolor*) have all declined significantly in Florida in recent decades and these species are listed by the state as “species of special concern”. Under the proposed listing regime, the Snowy Egret will no longer be listed while the Little Blue Heron and the Tricolored Heron will be listed as “threatened”. At the Alafia Bank, where breeding populations have been monitored annually since 1981, Snowy Egrets have declined to about 30 pairs, while Little Blue Herons and Tricolored Herons both have declined by approximately 50% (to about 45 and 110 pairs, respectively; Tables 8a, 8b). While regional trends in these species cannot be based on populations at a single colony, factors potentially affecting the local populations can be identified:

1. Loss of foraging habitat: Acquisition, protection and management of regional wetland foraging habitats must be pursued aggressively if the future of these species is to be secured. All three small heron species require freshwater wetland prey year-around, with increased requirements during the nesting season when the adults must provide food for growing young.
2. The highest density of tropical fish farms in the country occurs in southeastern Hillsborough County, within the foraging range of herons nesting at Alafia Bank. Recent studies indicated that the Snowy Egret, Little Blue Heron, and Tricolored Heron are among the most serious predators at tropical fish farms (M. Avery, pers. comm.). As a result, some herons are shot, although population impacts are unknown. The National Wildlife Research Center (USDA) and Tropical Aquaculture Laboratory (University of Florida) have initiated studies to assess the situation further and to design workable, non-lethal solutions and Best Management Practices to limit heron predation at tropical fish farms while protecting heron populations.

White Ibis *(Eudocimus albus)*: At 15,700 breeding pairs, the White Ibis was the most abundant species on Alafia Bank in 1998, although the number had declined to less than 5,000 pairs in 2014. This is one of the largest colonies of White Ibis in the state although numbers vary inter-annually in response to rainfall. 1998 was a year marked by unusually abundant (ENSO or El Niño-driven) winter rains followed by a dramatic spring drought. This weather pattern filled and then drained wetlands in perfect coordination with White Ibis nesting needs. During the drought years of 1988–1992, no more than about 5,000 pairs were present here. The Tampa Bay population has declined by nearly two-thirds since the 1940s, due to urban and suburban development, and countywide loss of pasturelands, wet prairie, and freshwater wetland habitats, all of which provide essential foraging resources, since White Ibis require freshwater wetland prey to feed their nestlings (Johnston and Bildstein 1990). White Ibis feed within the BCARPA boundaries year-round.

Roseate Spoonbill (*Ajaia ajaja*): Like the Reddish Egret, the Roseate Spoonbill is another rare coastal species that only recently (*c.* 1975) has returned to Tampa Bay as a breeder (Dunstan 1976). In the last few years, nesting has spread to several other colonies in the bay but, of the total area population of about 300 pairs, about 75% of the population nests at Alafia Bank. Spoonbills forage extensively on coastal flats, tidal creeks and local wetland habitats. The shallow water and wetland habitats of the BCARPA and Hillsborough County uplands inland as far as Lettuce Lake Park and the Hillsborough River drainage are crucial habitats for this species.

Clapper Rail (*Rallus longirostris*) and Willet (*Catoptrophorus semipalmatus*): These two species breed in high marsh and adjacent upland habitats of islands like the Alafia Bank, and at scattered mainland sites. The mangrove/marsh habitats of the Alafia River's "south mouth", Bullfrog Creek and The Kitchen are especially important. These species are not colonial, and rely on cryptic coloration and behavior to avoid nest predators. In much of Florida, these species no longer nest because of loss of appropriate habitat. Although neither species is listed by the FFWCC, it is worth noting that the islands and natural shorelines of Hillsborough Bay, especially within the BCARPA, sustain a significant "reservoir population" of these species.

American Oystercatcher *(Haematopus palliatus)*: This is an extremely rare species in Florida, with perhaps no more than 400 breeding pairs in the state. Of these, 80 (20%) occur in Hillsborough Bay, nesting primarily on Alafia Bank, Fishhook Spoil Island and DMMA 2D and 3D (Hodgson et al. 2008). Nests are simple "scrapes" in the sand placed just above the high tide line along island shorelines. Oystercatchers forage extensively along the mangrove edges and oysterbars of the eastern side of Hillsborough Bay, and in The Kitchen. Local numbers have doubled since 1980, as new dredged-material islands (DMMA 2D and 3D) have provided new nesting habitat. Oysterbars in The Kitchen historically provided critical foraging habitat for oystercatchers and it still does, as they are found there regularly throughout the year. Throughout Hillsborough Bay oysterbars are important for breeding and foraging oystercatchers. (Hodgson and Paul 2008; Hodgson et al. 2008)

Caspian, Royal, Gull-billed and Sandwich Terns (*Sterna* spp.; Gull-billed Tern *Gelochelidon nilotica*): These three species nest annually at DMMA 2D or 3D (PTB 2014). Fewer than 100 breeding pairs of Caspian's are known for the entire state. From the mid-1970s through 1995 just this one colony was known. In 1996 and 1997, a second colony was found near the Apalachicola River (J. Gore, pers. comm.), and now there is a small colony on Three Rooker Island within the Anclote Key Preserve State Park, but over 65% of the state population still nests within or near the BCARPA. Sandwich Terns number approximately 1,500 pairs in Florida, with 1,200 occurring at two sites in Tampa Bay. Royal Terns are more numerous, with a statewide population of about 6,000 breeding pairs, but only five or six nesting colonies are found annually in Florida. Gull-billed Terns, insect and crab specialists, nest in very low numbers in Florida, probably less than 150 pairs, with the majority nesting in the Tampa Bay area (Parnell et al. 1995, Paul 2002, Rodgers 2012, Molina et al. 2010). All four species have a highly restricted nesting distribution, occurring at 2-6 sites annually, and all four species occur year-round in Hillsborough Bay, commonly foraging within the ARPA.

Black Skimmer (*Rynchops niger*): In recent years, the only Hillsborough Bay nesting colony of Black Skimmers has been on DMMA 2D or 3D where, in 1998, 320 pairs nested. By 2013 that number had declined to 100 pairs. In some years, the western end of Sunken Island at the Alafia Bank was also used for nesting by Black Skimmers. Although highly coastal, this species is widespread in Florida with about 2,000 breeding pairs in at least 20 known colonies (J. Gore, pers. comm.). Most of the state population occurs at eight Tampa Bay colonies. Skimmers make extensive use of protected sandbars for resting, and the shallow waters of the BCARPA and adjacent protected inshore areas are foraging sites for this species. Disturbance of nesting colonies and nest site selection close to bay and Gulf water leaving the colony prone to flooding of nests have impacted skimmer nest success.

Mammals

At least 15 species of mammals are known or suspected to occur within the BCARPA study area (Table 9). Among the terrestrial mammals, one management issue is critical: the impact of raccoons (*Procyon lotor*) on the nesting birds of any sanctuary. Raccoons commonly forage along mangrove shorelines and shallow flats and readily climb trees to reach bird nests. They are excellent swimmers and occasionally reach island bird colonies like the Alafia Bank. The results are immediate: many or all of the nesting birds abandon the site. Several colonies in Tampa Bay have been affected by raccoon predation over the past decade, some more than once. The Alafia Bank is among them. Audubon staff routinely monitor the islands for signs of raccoon activity, live-trap them and remove them from the islands. FDACS studies show that the mainland population of raccoons is ten times that of pre-settlement times.

Two marine mammals, bottlenose dolphins (*Tursiops truncatus*) and Florida manatees (*Trichechus manatus*), are well known residents of the BCARPA. Dolphins forage on small fish extensively in the shallows of the ARPA and can usually be seen during visits to the area. Manatees feed on the seagrasses there and rest in quiet areas near deep holes to which they retreat from boats. They rely even more on the ARPA's rich seagrass beds during the winter when they gather in the warm water outfall of the Tampa Electric Company's Big Bend power plant close by and venture out during the day to feed (Table 11) (FWRI 2015). Manatees are particularly vulnerable to boat collisions, and considerable attention is devoted statewide to their protection. The state of Florida enacted seasonal slow-motor zones for much of the Tampa Bay shallows, including the BCARPA (Figure 29).

Table 11. Annual average winter counts of manatees using the TECO Big Bend plant warm water outfall 1991 - 2015, and as the percentage of all manatees counted in Tampa Bay concurrently (FWRI 2015).

YEAR	AVG. COUNT AT TECO BIG BEND	% OF TOTAL COUNT IN TAMPA BAY	YEAR	AVG. COUNT AT TECO BIG BEND	% OF TOTAL COUNT IN TAMPA BAY
1991	60	55%	2003	333	82%
1992	111	88%	2004	247	75%
1995	96	46%	2005	133	55%
1996	103	77%	2006	212	99%
1997	94	61%	2007	345	96%
1998	121	76%	2009	139	90%
1999	100	61%	2010	328	89%
2000	108	89%	2011	632	94%
2001	312	91%	2014	496	87%
2002	80	85%	2015	566	76%

Figure 29. Manatee protection areas within the BCARPA, and map legend (Audubon Florida 2014).

Protected Species

Plant and animal species that receive special protection by the U.S. Fish and Wildlife Service through the Endangered Species Act, or through listing by the FFWCC or the FDACS, and which are known or likely to occur in the BCARPA are listed in Table 12. As discussed previously, the FFWCC is currently reviewing the status of all listed species and the revised list is expected to retire the "endangered" classification and have only "threatened" species, although any species federally listed as "endangered" will be state-listed as "endangered". All native species are protected from harm and harassment by Chapter 379, Florida Statutes.

Table 12. Endangered and threatened species known or likely to occur in the Bullfrog Creek ARPA study area (Species classified according to FFWCC 2013 and FDACS 2010; 2015 proposed FFWCC listing included).

TAXON	SCIENTIFIC NAME	COMMON NAME	Current FFWCC	Proposed FFWCC	FDACS	USFWS	CITES
Amphibians & Reptiles							
	Alligator mississippiensis	*American alligator*	*T*	*T*	—	*T(S/A)*	*II*
	Drymarchon corais couperi	*Eastern indigo snake*	*T*	*T*	—	*T*	—
	Gopherus polyphemus	*Gopher tortoise*	*T*	*T*	—	—	—
Birds							
	Ajaia ajaja	*Roseate spoonbill*	*SSC*	*T*	—	—	—
	Circus cyaneus	*Marsh hawk; northern harrier*	—	---	—	—	*II*
	Egretta caerulea	*Little blue heron*	*SSC*	*T*	—	—	—
	E. rufescens	*Reddish egret*	*SSC*	*T*	—	—	—
	E. thula	*Snowy egret*	*SSC*	---	—	—	—
	E. tricolor	*Tricolored heron*	*SSC*	*T*	—	—	—
	Eudocimus albus	*White ibis*	*SSC*	---	—	—	—
	Falco sparverius paulus	*Southeastern American kestrel*	*T*	*T*	—	—	*II*
	Grus canadensis pratensis	*Florida Sandhill crane*	*T*	---	—	—	—
	Haematopus palliatus	*American oystercatcher*	*SSC*	*T*	—	—	—
	Haliaeetus leucocephalus	*Bald eagle*	—	---	—	—	*I*
	Mycteria americana	*Wood stork*	*E*	*T*	—	*T*	—
	Pandion haliaetus	*Osprey*	*SSC*	---	—	—	*II*
	Pelecanus occidentalis	*Brown pelican*	*SSC*	---	—	—	—
	Rynchops niger	*Black skimmer*	*SSC*	*T*	—	—	—
	Sterna antillarum	*Least tern*	*T*	*T*	—	—	—
Mammals							
	Lutra canadensis	*River otter*	—	---	—	—	*II*
	Lynx rufus	*Bobcat*	—	---	—	—	*II*
	Trichechus manatus	*West Indian manatee*	*E*	*FE*	—	*E*	*I*
Plants							
	Acrostichum danaeifolium	*Giant leather fern*	—		*T*	—	—
	Encyclia tampensis	*Butterfly orchid*	—		*T*	—	*II*
	Opuntia stricta	*Prickly-pear*	—		*T*	—	*II*
	Tillandsia balbisiana	*Wild-pine*	—		*T*	—	—
	T. fasciculata	*Common wild pine*	—		*CE*	—	—
	T. flexuosa	*Twisted airplant*	—		*T*	—	—
	T. setacea	*Wild pine*	—		*T*	—	—
	T. simulata	*Wild pine*	—		*T*	—	—

Notes:
FFWCC - Florida Fish and Wildlife Conservation Commission (Current list published by FFWCC in January 2013; Proposed FFWCC classification as of June 5, 2015).
E – Endangered FE – Federally Endangered T – Threatened SSC – Species of Special Concern
FDACS - Florida Department of Agriculture and Consumer Services (listed in Weaver and Anderson, 2010).

T – Threatened CE – Commercially Exploited
USFWS - United States Fish and Wildlife Service (list published in List of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11-12), updated 2015. E – Endangered T – Threatened T(S/A) - Threatened due to similarity of appearance
CITES - Convention on International Trade in Endangered Species of Wild Fauna and Floras (UNEP-WCMC 2015).
I - Appendix I Species II - Appendix II Species

AREAS OF SPECIAL INTEREST

Within the Bullfrog Creek ARPA

Whiskey Stump Key and Green Key Audubon Sanctuaries

Whiskey Stump Key and Green Key are two small natural islands located north of Port Redwing and west of The Kitchen in Middle Hillsborough Bay (#2, Figure 30). Whiskey Stump Key is about 3.9 acres in size, and Green Key is approximately 3.1 acres. The National Audubon Society leases Whiskey Stump Key from the state of Florida, and owns Green Key. The two islands are the original National Audubon Society Tampa Bay Sanctuaries islands, established in 1934 for the protection of persecuted bird colonies.

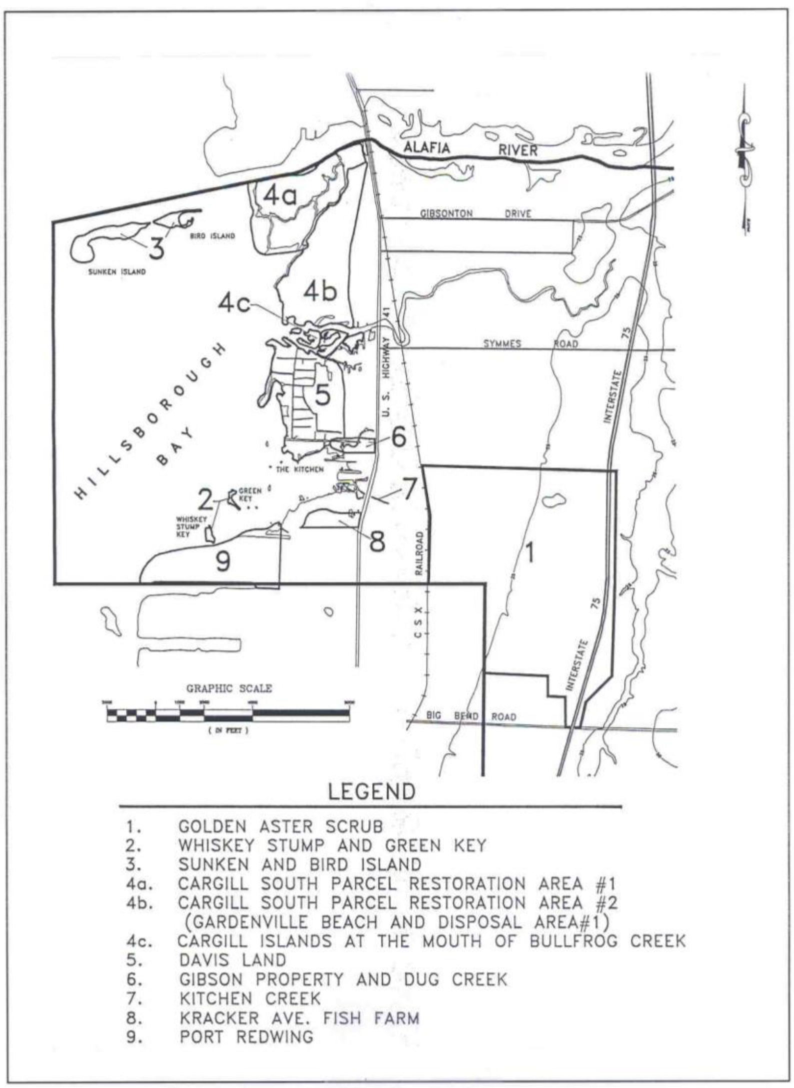


Figure 30. Areas of special interest, BCARPA.

Green Key was the original site of the Hillsborough Bay bird colony. In 1934, Dr. Herbert R. Mills, a pathologist practicing in Tampa, hired Audubon warden Fred Schultz to protect the badly disturbed bird colony at Green Key. Schultz built a cabin on nearby Whiskey Stump Key, which was leased from the state to provide the warden's seasonal residence. The landowners of Green Key, Crowell and Josephine Dawkins, gave permission to Audubon to protect the birds there. In 1946, they donated Green Key to the National Audubon Society. A memorial to Dr. Mills, containing his cremated remains, was installed on Whiskey Stump Key in 1951 amid a Sabal palm grove.

Under this arrangement, Brown Pelicans, White Ibis and heron species reproduced successfully until Port Redwing was dredged in 1968. The disturbance of dredging caused the colony to move to the Alafia Bank islands. Although few birds nest there today, Green Key and its shallow surroundings remain significant foraging and roosting habitat for a variety of species, including Reddish Egret, Roseate Spoonbill, American Oystercatcher, migrating Ruddy Turnstone (*Arenaria interpres*), Black-bellied Plover (*Pluvialis squatarola*) and Short-billed Dowitcher (*Limnodromus griseus*).

Audubon sanctuary managers have periodically controlled Brazilian pepper on both keys using FDACS-recommended herbicides. Tampa Electric Company staff participated in this effort. Whiskey Stump Key is slowly receding to the southeast, pushed by storms and tide and eroding into the deep water sedimentation basin located east of it.

Vegetation on the islands consists of mangroves, live oaks, Sabal palms on the uplands of Whiskey Stump Key, and patches of smooth cordgrass (*Spartina alterniflora)* marsh are surrounded by shallow sand and mudflats, with seagrasses in the shallows offshore. Tampa Bay Watch and FCIS volunteers installed oyster bag reefs along the shorelines of the keys to reduce erosion in multiple volunteer-participation projects in the early 2000s (Figure 31).

Figure 31. Oyster bag reef placed along the shoreline of Whiskey Stump Key.

The Tampa Bay Dredged Hole Habitat Assessment Project concluded that the dredged holes around Whiskey Stump Key provide sufficient habitat and recreational use to warrant a recommendation that they not be filled to average surrounding depths (TBEP 2005). However, both holes had excess metals contamination and allow excess wave formation which exacerbates erosion of the islands. These holes could be economically feasible and ecologically beneficial deposition sites for dredged spoil material created during future local dredging operations or restoration projects. Filling the basins would re-establish shallow water areas, allowing seagrass recovery in areas now too deep for seagrass recruitment and slowing the loss of Whiskey Stump Key.

The Richard T. Paul Alafia Bank Bird Sanctuary (Sunken Island and Bird Island)

Sunken Island and Bird Island are located about one-quarter mile west of the mouth of the Alafia River on the south side of the dredged channel (#3, Figure 30). The islands, collectively called the Richard T. Paul Alafia Bank Bird Sanctuary, consist of approximately 60 acres of dredged material. Audubon Florida has installed breakwaters to protect the shoreline from erosion caused by storm waves and ship wakes. An oyster reef habitat breakwater using 800-pound pH-balanced reefball arrays was installed in Spring 2011 with plans to add additional reefballs along the balance of the south side of Bird Island. On the north side of the Alafia Bank and the west end of Sunken Island, 8,000-pound pH-balanced concrete pyramids were installed in fall of 2011 and late summer of 2014, with additional arrays planned for the entire north shoreline of the Alafia Bank facing the Alafia Ship Channel (Figure 32). Placing material near shore to construct a breakwater that intercepts wave energy, creating a quiet water “living” shoreline, is an environmental approach to erosion control that has proven its effectiveness. The breakwater structures facilitate accretion of accumulated sediments and reduce local bay water total suspended solids, increase filtration of water by sessile filter-feeding mollusks at the mouth of the Alafia River in Hillsborough Bay, enhance essential fishery habitat, provide foraging habitat for resident and migratory shorebirds including American Oystercatchers, Willets, Ruddy Turnstones, Spotted Sandpipers, and other waterbirds including herons, egrets and ducks, and protect habitat for other taxa, including sandy beach habitat for egg-laying horseshoe crabs and haul-out habitat for resident diamondback terrapins.

Figure 32. Concrete pyramid oyster reef habitat installed on north and west sides of Sunken Island.

Both islands are owned by Mosaic Fertilizer LLC (previously Cargill Fertilizer, Inc.), leased to the National Audubon Society, and managed by the Florida Coastal Islands Sanctuaries program. Portions of the south side of the islands and the west end, known as the Extension, which was added to Sunken Island during the Alafia River channel widening and deepening project in the late 1980s, are owned by Port Tampa Bay and are also leased to NAS for management as a bird sanctuary by FCIS. These islands are the primary sanctuary in the Florida Coastal Islands Sanctuaries network. The vegetation consists of black mangroves, smooth cordgrass, hackberry, sea grape, Florida privet, Brazilian pepper and lead tree; the latter two species being undesirable exotics. These islands support one of the largest wading bird colony in Florida and one of the most diverse bird colonies in the continental United States. Between 10,000 and 20,000 pairs of birds of up to 23 species nest here annually (Table 10b). Many species also utilize the islands for feeding and as an important migratory stop or over-wintering location.

The Kitchen

This shallow embayment and its surrounding shoreline of dense mangrove stands, oysterbars, mud and sand flats, and seagrass meadows, encompassing approximately 377 acres, is a critical migratory bird feeding area (Figure 30). The area is characterized by exceptional habitat diversity and high biological productivity. As its name indicates, it was so rich in food that early residents of the area used to say they had only to go to "the Kitchen" to find something to eat (J. Youngman, pers. comm.). The oysterbars in The Kitchen and at the mouth of Bullfrog Creek produced oysters "as large as a man's hand" (G. Graves, pers. comm.). The Kitchen remains a popular fishing area (J. Platt, pers. comm.).

At low tide, large areas of sand and mud flats and numerous oysterbars are exposed, providing feeding areas for thousands of wading and shorebirds. Hundreds of wintering White Pelicans herd fish here, and Brown Pelicans, Bald Eagles, Ospreys and terns dive for fish on higher tides. Resident American Oystercatchers and migrating Black-bellied Plovers, Ruddy Turnstones, dowitchers, and sandpipers feed and rest on the oysterbars and shorelines.

The orientation of The Kitchen allows it to function as a natural sheltered harbor protected from harsh winter winds and wave action, and its shoreline has remained essentially unaltered except for the addition of Port Redwing to the south. The shallow waters of The Kitchen were the first area in Hillsborough Bay to be recolonized by returning seagrasses as a result of improving water quality in Tampa Bay. (R. Johansson, pers. comm.)

Bullfrog Creek

Meandering about 22 miles through southern Hillsborough County, Bullfrog Creek is a tidally influenced tributary of Tampa Bay that, while impacted heavily by surrounding agricultural, industrial, and residential development, nevertheless retains a high ecological value for fish and wildlife (Figure 10). The mouth of the creek is bordered by an extensive tidal black needlerush marsh, mangrove shorelines and islands. Upstream of the marsh, the creek passes through low-density residential areas, agricultural lands, and tropical fish farms. Midway along the creek's main artery, a smaller tributary known as Little Bullfrog Creek branches southward through farm fields, open pastures, residential development and forested areas. In addition to activities directly along the creek, it also is impacted by tropical fish farms, agricultural fields and rapidly developing residential communities throughout its watershed, which drains approximately 40 square miles. Because of their intrinsic importance for water quality, fisheries and wildlife, tidal streams such as Bullfrog Creek have been identified as the highest priority for restoration and protection in the Habitat Restoration Master Plan developed by the TBEP (1997).

Original or "South" Mouth of the Alafia River

The current or "new" mouth of the Alafia River is approx. 500 m north of its natural mouth and was formed by a ship channel dredging project completed in the early 1930s which altered the river's historical course. Material from the dredging was side cast into the old river mouth (the southern or "south" mouth), reducing the broad channel to a narrow creek. The south mouth and the old river channel are within Mosaic South Parcel.

Adjacent to the Bullfrog Creek ARPA

Mosaic South Parcel

The Mosaic South Parcel is located on the south side of the Alafia River, from just west of U.S. Highway 41 all the way to Hillsborough Bay (#4a, Figure 30). It consists of approximately 535 acres of mangroves and mixed coniferous hardwoods and surrounds the Alafia River's original, or "south mouth". A restoration project within this parcel, conducted in the early 1990s by the FDEP, re-established a system of waterways. About 125,000 cubic yards of silt and clay were excavated to create approximately 14,000 linear feet of shoreline. The original "south mouth" channel tidal creek was connected to the main channel of the Alafia River, increasing tidal circulation and shallow water habitats using large culverts that pass under a roadbed. Nearly 20 acres of shallow waterways were created or enhanced to provide nursery and feeding areas for marine life such as mullet, redfish and blue crabs. Extensive tidal mangrove flats and salt marshes are present, providing useful fisheries and wildlife habitat. A second restoration project was undertaken by Mosaic in 2013-14 to provide additional flushing of the mangroves in mitigation for an acid-water spill that occurred 2004 and affected mangroves lining nearby Archie Creek. During the spring and summer Prairie Warblers, whose nesting habitat is restricted in Florida to mangrove forest sites, nest in the South Parcel.

Additionally, upland beach strand and cabbage palm hammocks have been preserved via conservation easements donated by Mosaic Fertilizer LLC to the State of Florida. Approximately five acres of upland, previously dominated by Brazilian pepper, have been transformed into wetlands.

Mosaic's Coastal Education Center, an open-air classroom and boardwalk located on the South Parcel just south of the Riverview plant and the Alafia River, opened in 2004. A team of interested community members and Mosaic employees worked together to create an environmental curriculum called "Where the River Meets the Bay" approved by the Hillsborough County schools. The Center hosts over 1,500 south county fourth grade students each year for a field science study opportunity.

Mosaic Gardenville Property and Tidal Islands at the mouth of Bullfrog Creek

The Mosaic Gardenville property is located south of the South Parcel property (#4b, Figure 30). The site consists of hydric hammocks, mangrove forest, needlerush marshes, and tidal flats. A large portion of this property consists also of a spoil dike to hold excavated dredge material (Disposal Area #1). Non-native invasive plants, dominated by Brazilian pepper, heavily overgrow the diked walls of the spoil site. In addition, salt barrens are present landward of the mangrove fringe. Historically, these salt barrens were extensive enough to allow car races by early residents of the Gibsonton-Adamsville community. A palm grove once lined the coastal shoreline of Gardenville Beach and a casino and village of "beach-front cabins" were located here through the 1930s (Pete and Jeannie Johnson, pers. comm.).

Kitchen Nature Preserve (Davis Land and Gibson Property [Hillsborough County ELAPP property] and the mouth of Dug Creek)

The Kitchen Nature Preserve, now 555.8 acres, is located south of the mouth of Bullfrog Creek and along the north shore of The Kitchen in Hillsborough Bay (#5, Figure 30). This property was purchased in Fall, 1997 by ELAPP. It includes the biologically productive areas known as Hog and Hominy Cove, the closed Gibsonton Landfill (a Hillsborough County facility) and a 13-acre parcel of upland pine/oak hammock west of Williams Street and south of Isabel Street in Gibsonton.

White mangroves densely cover the tidally flooded flats (about 280 acres). Occasional black and red mangroves are also part of the plant community. Mosquito ditches crossing the mangrove forest flats provide deep water access and refuge for fishes, and increase tidal flushing of the mangrove zone. The mosquito ditch spoil mounds host black mangroves, marsh elder (*Iva frutescens*), oaks, and Brazilian peppers, and provide higher perches for birds including White Ibis, Little Blue Herons, Gray Kingbirds, and Prairie Warblers (R. Paul, pers. obs., 1982-1998).

The 60-acre Gibsonton Landfill was not properly capped during or after closure in 1976. As a result of an agreement with the Florida Department of Environmental Protection to investigate the county's 11 closed landfills, Hillsborough County's Solid Waste Management Department (HCSWMD) conducted a Closed Landfill Investigation Program. Studies by the U.S. Geological Survey (USGS), which installed three surficial aquifer wells at the landfill site, showed low levels of aluminum, chromium, zinc, copper, manganese, iron, and zinc, and no detectable organic contamination. USGS data also indicated that groundwater was contaminated with tidally influenced saltwater. HCSWMD and FDEP staff suspected that the amount of leaching of landfill contaminants into Hillsborough and Tampa bays that would be expected to occur had already occurred in the 20 years since the landfill has been closed (D. Adams, M. Yeargin, pers. comm.).

The landfill was capped and the uplands restored after a proposal by Audubon Florida, the Concerned Citizens of Gibsonton, Hillsborough County's Resource Management Dept. and Dames & Moore, Inc. was funded by the Gardinier Trust Fund and conducted by SWFWMD's Surface Water Improvement and Management (SWIM) program. Management at present consists primarily of exotic plant control and includes prescribed fire (HCCELM 2015).

The 40.3-acre Gibson Property site is located west of U.S. Highway 41, approximately one mile south of Bullfrog Creek, bordered to the west by The Kitchen in Hillsborough Bay (#6, Figure 30). It was purchased by ELAPP in September 1991.

The eastern section of the tract consists of a small upland area approximately seven acres in size. The upland area contains a slash pine/cabbage palm/live oak community which needs prescribed fire management and continued eradication of Brazilian pepper. Some melaleuca and Australian pine trees are also present. This upland is an important remnant native coastal hammock community in the Gibsonton area because so much of this community type has been lost to residential and commercial development. Squirrels, marsh rabbits and diamondback rattlesnakes have been observed there (A. Paul, pers. comm.).

The tidal wetlands of the property are noteworthy too, with a dense needlerush marsh, a flourishing mangrove community, and a shallow flat on the western portion of the tract. Oysterbars are also present in the open water area. An unnamed creek formerly drained the area, crossing the shallow flats in a natural course that can still be seen on aerial photographs, before finally emptying into The Kitchen.

Dug Creek

Draining 807 acres of the Gibsonton area (#6, Figure 30), land uses in the watershed include agriculture (Chinese vegetable and tomato fields), tropical fish farms, and single-family homes and mobile home parks. The original course of Dug Creek, both upstream and at its mouth, has been highly altered. Upstream, the creek is diverted through straight, steeply banked ditches that border agricultural fields and residential properties. The mouth of the creek has been channelized into a 4-foot-deep ditch directly to the west, hence the name "Dug Creek". The channel empties into The Kitchen. Spoil material from the ditch was piled to the south along the channel on a mangrove flat, formerly owned by A. B. "Jim" Davis and his family. Today, Brazilian pepper dominates that lateral spoil mound. This diversion deflects the creek outflow from its original channel, which meandered across salt marshes, oyster beds, and shallow tidally exposed flats, into The Kitchen. A restoration project contracted by the SWIM program failed to fully remove the spoil mounds and non-native species along the creek's south side, and no further action is planned at this time (B. Henningsen, pers. comm.).

Kitchen Branch or Creek

Kitchen Branch/Creek drains approximately 1,043 acres south of Gibsonton (#7, Figure 30). The headwaters are located in the sandy soils of the Golden Aster Scrub Preserve purchased by Hillsborough County ELAPP to protect important wildlife populations and plant communities (#1, Figure 30). Kitchen Branch spreads across a black needlerush marsh before it crosses under U.S. Highway 41 and empties into the southeastern corner of Hillsborough Bay at The Kitchen. Because Kitchen Branch travels through an undeveloped area of Hillsborough County, water quality is good except for localized impacts associated with roadway runoff from the U.S. Highway 41 crossing.

The well-developed needlerush marsh of Kitchen Branch is located on the east side of U.S. Highway 41. This area has been nominated for ELAPP purchase also, as it acts as a natural stormwater filter and is vital habitat for birds and commercially and recreationally important fish. This area also contains mangroves bordering Kitchen Branch and its floodplain. It makes a natural community greenway connection to the Golden Aster Scrub Preserve.

Kracker Avenue Fish Farm

The Kracker Avenue Fish Farm site is located south of Kitchen Branch, west of U.S. Highway 41 and north along Kracker Avenue (#8, Figure 30). Approximately 260 acres in size, the dug ponds of the abandoned fish farm are heavily vegetated with Brazilian pepper. The SWFWMD SWIM 5-year plan for this ELAPP property includes utilizing the abandoned fish farm for a habitat enhancement project and as a stormwater filter. The mangrove area located just north of the farm has also been considered for purchase by the county through ELAPP. Vegetation here consists of dense mangroves bordering The Kitchen. A small tropical hardwood hammock, with a salt barren perimeter and an Indian mound, is located near the center of the site. There is a black needlerush marsh just west of U.S. Highway 41 adjacent to the salt barren.

Port Redwing

In 1966 construction began on the 265-acre Port Redwing creation project on the east side of lower Hillsborough Bay near Gibsonton (#9, Figure 30), adjacent to The Kitchen and south of two National Audubon Society Tampa Bay Sanctuaries islands - Green Key and Whiskey Stump Key (#2, Figure 30). As previously discussed, violations of the permit terms and conditions occurred. The dikes broke and silt spilled onto Whiskey Stump Key and across The Kitchen, reaching depths of two feet and covering more than 200 acres of biologically productive submerged land. Seagrasses in The Kitchen died and important wildlife habitat was damaged. Two sedimentation basins were created in an attempt to provide places where the spilled silt could accumulate, one south of Green Key and east of Whiskey Stump Key, and another west of Whiskey Stump Key. Local observers (J. Youngman, pers. comm.) noted that, over time, some material settled into the sedimentation basins, but most of the silt material was decomposed by the benthic organisms of The Kitchen and washed away with the tides. Clean sand once again became the substrate in The Kitchen and seagrasses re-established slowly (Figure 33).

The sedimentation basins remain, and have resulted in the net loss of land on Whiskey Stump Key as winds and waves push the island to the east and it erodes into one of the sedimentation basins.

Figure 33. Port Redwing in 1968 (Lewis 1976)

Fred and Idah Schultz Nature Preserve

In 1995, the northern 134 acres of the Port Redwing peninsula were purchased by SWFWMD's Save Our Rivers program and Hillsborough County through its ELAPP. In 2000, the County and the SWFWMD entered into a cooperative agreement for the ecosystem restoration of 95 acres of the site, funded by SWIM and the Gardinier Trust Fund. SWFWMD was responsible for the design and construction, and the County provides post-construction management of the restoration area. Construction was started in September 2003. The restoration project created a complex matrix of coastal habitats including tidal flats, seagrass beds, oyster bars, marsh/mangrove shorelines and islands (Figure 34). In addition, the design included the creation of freshwater wetlands identified by the TBEP as severely limited in the fringe around Tampa Bay. The created freshwater wetlands also provide treatment of stormwater draining from the surrounding watershed prior to discharge to Tampa Bay. Additionally, the Preserve was established to provide wildlife habitat and limited public use. The restoration project was completed in September of 2004. The public beach portion of the plan was eliminated after 9/11/01 due to increased security regulations on the adjacent PTB lands. Subsequently, SWFWMD and Tampa Bay Watch received permits and installed oyster cultch bags and saltmarsh grasses along the shoreline from the western edge to Whiskey Stump Key to abate erosion, stabilize the shoreline and restore estuarine habitat. The southern portion of Port Redwing is being actively marketed and developed by Port Tampa Bay.

Figure 34. Fred & Idah Schultz Nature Preserve in 2004, shortly after restoration work was completed.

Outside the BCARPA but within the Bullfrog Creek Watershed

Bullfrog Creek Scrub Nature Preserve

Located between US 301 and I-75 midway between Big Bend Road and Sun City Center, the 1,620-acre tract was purchased by Hillsborough County in 1996. It is managed by two entities. The western 833 acres are a FFWCC gopher tortoise mitigation park. The eastern 778 acres are managed by Hillsborough County as a mitigation bank through the upland habitat protection provision of the County's land development code and also includes wetlands associated with Bullfrog Creek and its tributaries. Plant communities in this area include predominantly bottomland forest (275 acres), pasture (364 acres), pine flatwoods (61 acres) and mesic forest (44 acres). The pasture is slated for restoration as pine flatwoods, sandhill, sand pine and oak hammock. Prescribed fire, exotic species management and feral hog removal are integral to the success of the project. In an effort to keep exotic species at bay while habitat restoration is underway, portions of the site have been leased to the Florida Cracker Cattle Association. (R. Dickinson, pers. comm.)

Golden Aster Scrub Preserve

The 1,200-acre Golden Aster Scrub Preserve was purchased by ELAPP in May 1995. It is located adjacent to the I-75 corridor, west of Interstate 75 and north of Big Bend Road (#1, Figure 30). The Hillsborough County Parks and Recreation Department Resource Management Team mapped the site to determine the natural communities and described the site (R. Heath, pers. comm.) as follows:

> This site includes a large, isolated stand of sand pine scrub, which is surrounded on all sides by pine flatwoods and dry prairie, except for the southeast corner, which borders a large borrow-pit lake. The remainder consists of mature stands of sand pine. The habitat is in good condition, the only noticeable impact being from cattle grazing and dirt roads which crisscross the site.
>
> A small population of the endangered Florida Golden Aster occurs along the southeast edge of the scrub, where it borders the borrow pit. The plants grow in an area where the scrub meets a cleared strip of sand that slopes down to the water's edge. Gopher tortoises (a state-listed species of special concern) are very common on the site as well.
>
> Sand pine scrub is the least common natural community in the state and very rare in Hillsborough County, yet it supports the highest number of endangered and threatened species, many of which can live in no other habitat. This site contains one of the largest remaining undisturbed stands of scrub in the county.
>
> The presence of sand pine scrub habitat, the large size of that habitat (200 acres), and its relatively undisturbed condition, makes this site important. Presence of the Florida Golden Aster increases the site's significance. Because of the ... deep, sandy soils .... present, the site functions as an aquifer recharge area.

Sixteen state-listed species are known or likely to occur on the Golden Aster Scrub Preserve (Table 13). Two families of Florida Scrub Jays reside and nest on the site and Florida Sandhill Cranes also nest there. In addition to the site's importance as rare habitat and associated value for wildlife, the headwaters of Kitchen Branch, which drains into the BCARPA, are located on this site. This property helps to protect the natural flow and water quality of Kitchen Branch.

Table 13. State-listed species known or likely to occur at the Golden Aster Scrub Preserve.

TAXON	COMMON NAME	SCIENTIFIC NAME	CURRENT STATUS
PLANTS	Florida golden aster	*Chrysopsis floridana*	E
	Bonamia	*Bonamia grandiflora*	T
	Curtiss milkweed	*Asclepias curtissii*	E
	Butterfly orchid	*Encyclia tampensis*	T
AMPHIBIANS	Gopher frog	*Rana capito aesopus*	SSC
REPTILES	Gopher tortoise	*Gopherus polyphemus*	SSC
	Eastern indigo snake	*Drymarchon corais couperi*	T
	Short-tailed snake	*Stilosoma extenuatum*	T
	Florida Pine Snake	*Pituophis melanoleucus mugis*	SSC
BIRDS	Florida Scrub-Jay	*Aphelocoma coerulescens*	T
	Florida Sandhill Crane	*Grus canadensis pratensis*	T
	Roseate Spoonbill	*Ajaia ajaja*	SSC
	Little Blue Heron	*Egretta caerulea*	SSC
	Snowy Egret	*Egretta thula*	SSC
	Tricolored Heron	*Egretta tricolor*	SSC
	White Ibis	*Eudocimus albus*	SSC
MAMMALS	Florida mouse	*Podomys floridanus*	SSC

Notes: E — endangered; T — threatened; SSC — species of special concern

Ekker Nature Preserve

Located between Spivey and Ekker Roads north of Symmes Road and Bullfrog Creek, this 84-acre tract is about 1.5 miles upstream of the mouth of Bullfrog Creek. Upland mixed forest (39 acres) was the only natural community when the County purchased the site. The 22 acres of pine plantation have been clear-cut, and native recruitment and exotics control are continuing. Open marsh, high and low marsh, forested wetlands and ephemeral frog ponds replaced the 24 acres of tropical fish ponds. (R. Dickinson, pers. comm.)

KEY MANAGEMENT ISSUES

Introduction

This section identifies current management issues affecting the BCARPA and offers specific recommendations for protecting and enhancing its outstanding natural resources. In the BCARPA, proactive management is especially important because of the imending port-related development at Port Redwing, which may present new conservation and restoration challenges.

Maintaining and improving the quality of habitat for seagrasses, mangrove and marsh vegetation and associated fish and wildlife are key objectives of the management plan for the BCARPA. Since water quality plays a pivotal role in improving and maintaining habitat values, and since water quality within the BCARPA may be affected by activities in the watershed of the creeks that drain to the BCARPA - including Bullfrog, Dug, Kitchen, and “south mouth” creeks - it is important to address existing and potential sources of stormwater and groundwater pollution throughout the entire watershed.

General Management Issues

In general, the following recommendations are relevant to the entire watershed and should be used to guide overall management of the BCARPA:

1. Future projects within the ARPA or the watershed should be considered with respect to the environmental resources of the surrounding areas that are at risk. Appropriate site development should avoid areas of outstanding habitat or water quality and be compatible with the overall goals of the ARPA as adopted by Port Tampa Bay. Additionally, future development should avoid degradation of existing water quality values throughout the ARPA. Ensuring that proposed activities are compatible with these goals is especially important for Port Redwing, which is slated for future port-related development.

2. Port Tampa Bay and local, regional, and state agencies should continue to pursue habitat restoration opportunities wherever applicable, through cooperative ventures that maximize both cost and environmental benefits. Additionally, these agencies should continue to purchase and manage, through land-buying programs or less-than-fee-simple mechanisms, and manage, additional appropriate natural areas in the watershed for preservation in their natural state.

Specific Management Issues

Water Quality Issues:

<u>Problem: Runoff from Residential, Industrial, Agricultural and Other Land Uses</u>

Background: In 1990, the population of the BCARPA study area was 9,189; in 2010 it was 14,234 (City-Data 2015), mostly in low- to medium-density residential neighborhoods. The population is expected to increase slowly but steadily in the future. The average household income increased more than 26.6% between 2000 and 2013 (City-Data 2015), and the housing profile of the area has shifted from predominantly mobile homes to single-family residences. Within the BCARPA study area there is increasing pressure for light and heavy industrial development associated with PTB. Trash dumping is also a problem in ecologically sensitive areas. Municipal waste pickup has not been implemented county-wide.

Excessive use of fertilizers and lawn care chemicals by homeowners and commercial land managers can be a significant source of nutrients and toxic contaminants within a water body. Pet waste is also a significant source of nutrients and fecal coliform. Research sponsored by the TBEP indicates that nonpoint sources contributed 60% of the total nitrogen loadings to Hillsborough Bay in 2011 (Janicki 2013). Residents, especially those who do not live on or near the water, often do not associate their lawn care and pet waste practices with environmental impacts. Commercial landscape managers use fertilizers, pesticides and other chemicals liberally. In 2010 the Environmental Protection

Commission of Hillsborough County adopted a fertilizer use and landscape maintenance rule (Chapter 1-15) in order to reduce the amount of nutrients reaching surface waters. Hillsborough County Ordinance No. 00-26, as amended by Ordinance 03-8, requires pet owners to remove their pet waste from public and private property.

The TBEP has lead the effort region-wide to educate the public about the impacts of fertilizer and pet waste impacts on Tampa Bay fisheries, birds and water quality. Educational programs that emphasize environmentally friendly lawn care practices and responsible land stewardship can be highly successful in reducing harmful impacts. Additionally, the tidal segment of Bullfrog Creek as well as Little Bullfrog Creek and the freshwater segment of Bullfrog Creek have been designated "Impaired" by the USEPA. A basin management action plan or other TMDL implementation approaches is required to identify the steps which will be taken to reduce the fecal coliform and nutrient loading in order to achieve the appropriate water quality standards in these water bodies. This has been accomplished for several segments of the Alafia River and its tributaries which have nutrient, dissolved oxygen and fecal coliform impairments (FDEP 2014), and could serve as a starting place for development of a recovery plan for the "Impaired" segments of Bullfrog Creek and for Little Bullfrog Creek.

Recommendations:

- PTB should distribute educational materials or sponsor, in conjunction with the Cooperative Extension Service and the TBEP, seminars on environmentally beneficial landscape design and lawn maintenance practices to homeowners adjacent to the BCARPA. Civic associations in the area and local conservation groups such as the Concerned Citizens of Gibsonton, Inc. and Tampa Audubon Society can be enlisted to help distribute information.
- Increase citizen "stewardship" of natural areas by sponsoring or encouraging participation in volunteer workday events, such as trash cleanups and salt marsh plantings; and/or creating an Adopt-A-Creek program which would raise the awareness of the streams' value to the surrounding landowners.
- HCSWMD, Concerned Citizens of Gibsonton, Inc., Audubon Florida, Tampa Audubon Society and local citizens should work together to investigate the feasibility of restructuring garbage pickup fees to allow pickup regardless of "customer status" to discourage illegal dumping and tire disposal.
- HCSWMD should place county dumpsters in convenient locations to facilitate proper trash disposal.
- PTB, local citizens and Audubon Florida should involve students from area schools in land stewardship activities.
- Stormwater treatment structures, such as natural swales and berms, should be constructed to capture and treat runoff within the drainage basins of the BCARPA tertiary area, especially those located in the watersheds of Bullfrog and Dug Creeks.
- Stormwater treatment impoundments, sinks and advanced secondary stormwater treatment marshes should be designed and constructed for Bullfrog and Dug Creeks. The purchase of an abandoned fish farm south of Dug Creek and east of Highway 41 to treat stormwater runoff from neighboring fish farms should be accomplished. Projects for Dug Creek (the abandoned fish farm site east of U.S. 41 and Bullfrog Creek) and other projects could be cooperatively undertaken between these agencies and Hillsborough County's Stormwater Management Department.
- The FDEP and the EPCHC, along with volunteers from the surrounding community and area schools, should monitor creeks at points along the drainageways to identify and then address local point sources of pollution.
- The FDEP, EPCHC, Florida Department of Transportation (FDOT), Hillsborough County Stormwater Management and Engineering, and local citizen volunteers should investigate drainage from highways and its contribution to pollution of the BCARPA. Specific sites that should be monitored include the U.S. Highway 41 bridge, the Alafia River behind Davis Street, and the Gray Street Trailer Park.
- During the development of the BMAP or other TMDL implementation approaches for reaching required nutrient and fecal coliform loading rates and dissolved oxygen levels in Bullfrog and Little Bullfrog Creek, use the measures in the BMAP adopted for the Alafia Basin, as appropriate.
- Sponsor seminars and distribute educational materials, through the Extension Service and the County, to commercial farmers, growers and commercial land managers about environmentally safe/beneficial crop and land management practices, especially regarding fertilizer use, irrigation and waste disposal.

- ♦ Sponsor seminars or distribute educational materials, through the Extension Service and the County, to homeowners about environmentally beneficial landscape design and lawn maintenance procedures, especially regarding fertilizer use and pet waste disposal.

<u>Problem: Poorly Designed and Maintained Septic Tanks and Sewage Treatment Plants</u>

Background: There are nearly 100,000 septic tanks in the Tampa Bay watershed, and septic tanks are the wastewater disposal method for most residences and businesses within the BCARPA. However, the soils and high water tables within the ARPA are ill-suited for septic systems. Twenty of the 28 soils identified in the watershed are characterized as poorly drained (SCS 1987). Additionally, most of the septic systems in the BCARPA are antiquated, having been installed before modern rules that require adequate drainage and location a designated distance from water bodies. In combination with the relatively high water table, the density of septic systems within the ARPA is cause for concern, since improperly sited or maintained septic tanks can be a major source of fecal coliform and nutrient pollution of groundwater and surface water drainages providing input to Dug Creek, Bullfrog Creek, the Alafia River, and ultimately the BCARPA. Septic tanks have been identified as a source of fecal coliform in the tidal segment of Bullfrog Creek, in the freshwater segment of Bullfrog Creek and in Little Bullfrog Creek - waterbodies which have been designated “Impaired” for fecal coliform by the USEPA (Tyler 2009).

Additionally, several small, non-municipal domestic wastewater treatment plants are located within the Bullfrog Creek watershed, and though none of these facilities are permitted to discharge wastewater to surface waters, all utilize percolation ponds which are typically designed to have an emergency discharge device in order to preserve the integrity of the pond berms when pond levels get high. The wastewater is treated by aeration and disinfection before release into the percolation ponds.

Recommendations:

- ♦ Households within the Bullfrog Creek watershed should be connected to central sewer service. Septic systems should be inspected and upgraded as necessary. Overflows into surrounding waterways should be investigated and corrected.
- ♦ Inspect and upgrade septic systems as necessary.
- ♦ Investigate and correct septic system and sewage treatment plant or pipe overflows into adjacent waterways.
- ♦ Require local sewage treatment plants to have operational on-site electric generators and other back-up facilities so that, even during severe storm events, untreated sewage is not discharged to waterways in the BCARPA watershed.

<u>Problem: Runoff from Tropical Fish Farms and Bird Predation Control</u>

Background: Tropical fish farming is an important industry in south Hillsborough County. Approximately 544 acres of fish farms are still located within the Bullfrog Creek watershed. Runoff from these enterprises contains excess nutrients, liquid antibiotics, chemicals used to repel birds and various other toxic chemicals. Additionally, non-native fish occasionally escape from these facilities, posing a potential threat to native species. Fish farmers in Hillsborough County are required to meet state water quality standards for discharged water. Responsibility for water quality compliance and enforcement at fish farms has been delegated to the EPCHC. Fish farms currently are required to treat and contain their runoff on-site, although some discharge off-site does occur.

According to USEPA monitoring studies carried out in the early 1980s, water discharged from fish farms in Hillsborough County was of better quality than the waters that received them. Chemicals used in the fish farming industry are reputed to have a short half-life. Therefore, fish farmers require a general permit to discharge water but not a National Pollutant Discharge Elimination System (NPDES) permit. Escape of non-native tropical fish from farms in Florida is the responsibility of the farmer and the FFWCC (C. Watson, pers. comm.).

Predation of tropical fish by waterbirds is a problem faced by farmers. In Hillsborough County, a variety of techniques is used to discourage birds from eating tropical fish, including pool covers, fireworks, a “Scary Man-Fall Guy” (a human-shaped bag filled periodically by a fan), inflated beach balls, Mylar strings suspended over pools, sirens, and whistles (Fowler 1996). The USFWS issues depredation permits to allow shooting some predatory birds (particularly Double-crested Cormorants). An unknown number of herons and egrets are killed annually without a permit.

Recommendations:

- The FDEP should investigate whether NPDES permits should be issued for tropical fish farms. If the regulations are changed, those farms without permits should be required to obtain them.
- The FDEP and EPCHC should work with tropical fish farmers to design and install stormwater treatment systems at the outfalls of fish farms within the Bullfrog Creek/Dug Creek watersheds to cleanse runoff before it enters the creek.
- Fish farmers, the EPCHC and the FFWCC should investigate the potential of trapping escaped non-native fish to prevent introduction to natural communities, possibly within the stormwater treatment ponds recommended above.
- The EPCHC and FDEP should determine the prevalence of the practice of emptying ill or unmarketable fish into creeks and drainages during the cleaning of fish tanks, and develop a Best Management Practice, with assistance from the Cooperative Extension Service, to prevent fish dumping.
- Audubon Florida, the Cooperative Extension Service, the FFWCC, and the FDA Aquaculture Laboratory in Ruskin should work with fish farmers to develop information and implement education for area fish farmers and farm workers about environmental protection issues and Best Management Practices to deter bird predation on tropical fish.

Problem: Land Application of Wastewater Residuals and Septage

Background: Formerly, data collected by Ayres Associates (1995) identified 88 wastewater residual land application sites within the Tampa Bay watershed, totaling approximately 16,260 acres. Of these known sites, only 48 (about 55%) were reported as being active since 1993, while the remaining sites had been reported to be inactive for an unknown period. The 48 active sites included 16 used primarily for land application of domestic wastewater treatment plant (WWTP) residuals and 32 sites used for land application of septage sludge or food wastes. High rainfall periods affect sheet runoff from septage disposal sites, increasing potential “pulse” pollution events. These waste disposal activities likely contributed to excess nutrient pollution in the BCARPA and, subsequently, Tampa Bay. Recent information was obtained that there are no longer any wastewater sludge or septage disposal sites in the Bullfrog Creek watershed. (M. Dyer, pers. comm.).

Bullfrog Creek - Domestic Waste Water Sludge Field: At the time the original BCARPA management plan was prepared, a 34.7-acre domestic waste water sludge field was located on the east side of Bullfrog Creek upstream from the BCARPA. Sludge from approximately 60 wastewater treatment plants (of 136 in Hillsborough County) was spread on the sludge field’s grassy surface, where it decomposed and the organic matter and nutrients leached into the soil. Regular inspections of the site by EPCHC staff inspected the operations and there was no evidence of concentrated runoff or sludge material deposition, which would lead to concerns of ground water contamination. Yearly nutrient loading and metals loading levels were within compliance levels. Metals routinely evaluated included lead, copper, zinc, cadmium, and aluminum (R. Boler, pers. comm.). This former septage field is no longer in service; instead large ponds have been constructed on the site. Additionally, Hillsborough County no longer allows disposal of wastewater sludge within the county.

Bullfrog Creek - Septage Field: A septage field of approximately 30 acres was located on the west side of Bullfrog Creek, in Gibsonton, east of Interstate 75 at the time the originl BCARPA management plan was prepared. This material was collected when septic tanks in Hillsborough County were cleaned, the material’s pH was raised with lime to eliminate bacteria and viruses. The septage material was spread over the grassy field to decompose and leach into the soil. The septage field was monitored regularly by Hillsborough County’s Health Department. The neutralized septage material was screened to remove trash items before being deposited on the fields and spread evenly to minimize odors. The accumulated nutrient spread maximum limit for the field’s continued use was 500 pounds of nitrogen per acre (Hillsborough County Health Department, pers. comm.). Recent information is that there are no longer any permitted septage disposal fields in the Bullfrog Creek watershed.

Recommendation:

Encourage Hillsborough County to deny any future permit applications for septage disposal within the Bullfrog Creek watershed, and to study the feasibility of septage disposal through advanced wastewater treatment facilities as an alternative to land disposal.

Recommendations in the original management plan that have been accomplished or are no longer relevant:

- ♦ Hillsborough County should consider the feasibility of disposal of sludge through its normal advanced wastewater treatment facilities, as an alternative to surface disposal.
- ♦ PTB should work with EPCHC and Health Department staff to ensure that effluent, stormwater runoff and sheet flow leaving septage and sewage residual discharge sites meets state water quality standards. High rainfall periods may affect sheet runoff from septage and sludge disposal sites, increasing potential "pulse" pollution events.

Habitat/Wildlife Management Issues:

Problem: Loss of Seagrasses/Propeller Scarring and Dredging

Background: The continuing recovery of seagrass in The Kitchen area and the occurrence of denser patches located south of the Alafia Bank are encouraging, since all of the seagrasses that had existed in the ARPA in the 1950s had disappeared by 1981 (Lewis et al. 1985). However, this good news must be tempered by the facts that septic tanks, non-municipal wastewater treatment plants, tropical fish farms and agricultural activities remain in the Bullfrog Creek watershed and that residential and commercial areas contribute to nutrient and chemical pollution via pet waste and pesticide and fertilizer overuse. As a result, the tidal segment of Bullfrog Creek has been designated as "Impaired" for dissolved oxygen and nutrients, and both the tidal and freshwater segments of Bullfrog Creek as well as Little Bullfrog Creek (a tributary) have been designated as "Impaired" for fecal coliform (Tyler 2009).

Further recovery of seagrasses also is threatened by physical impacts, such as continuing propeller scarring and dredging. A seagrass assessment study conducted by the Florida Marine Research Institute (Sargent et al. 1995) ranked Hillsborough County 15th among 31 coastal counties in terms of total scarred seagrass acreage, and 7th in terms of total combined severely and moderately scarred seagrass acreage. The BCARPA was among the Hillsborough County areas targeted by the mapping study as having severe to moderate seagrass scarring (Figure 25). Sargent et al. (1995) recommended that "[a] statewide management program should be developed to protect seagrasses from scarring while still allowing for traditional water-related recreational and commercial activities. Combined with county programs, statewide management of seagrass scarring could effectively protect seagrass habitat". There has been no survey work performed since 1995 of propeller damage within the BCARPA. Efforts to control boat speed and access have been undertaken in order to protect manatees with the added benefit of protecting seagrass beds, but it is expected that the scarring continues almost unabated (R. Lewis, pers. comm.).

FCIS has produced the "Hillsborough Bay Boater's Guide" which identifies the year-round and seasonal restricted boat speed zone areas, marked channels, seagrass beds, and critical wildlife areas as well as educational information about the resources of the area.

Recommendations:

- ♦ PTB, FDEP, and EPCHC should aggressively pursue water quality improvements through better stormwater treatment (see Septic Tanks, Fish Farm, Wastewater, and Residential Runoff issues below for more detailed recommendations).
- ♦ PTB, the Hillsborough County Public Safety Department, and the U.S. Coast Guard should initiate a channel-marking program to delineate boating channels within the BCARPA, and install signs at boat ramps and other strategic locations within and near the BCARPA informing boaters of the need to protect seagrasses from seagrass propeller scarring. The preliminary proposed locations of boat ramp signs and gated channel markers are shown in Figure 35, which is along the six-foot bathymetry line. Existing channels should have gated channel markers to help prevent propeller damage to seagrasses.
- ♦ The map showing restricted speed zones and other critical resources within the BCARPA (which has been produced by FCIS) should be displayed at local boat ramps, provided without charge to boaters and to citizens when they apply for a saltwater fishing license and boat and trailer registration renewals.
- ♦ The Florida Marine Patrol (FFWCC) and the Hillsborough County Sheriff's Office should provide increased enforcement of the speed zone areas.
- ♦ Seagrass scientists should continue carefully planned efforts in an attempt to restore the offshore bar system that historically existed in this area of the bay.

- Periodic surveys of seagrasses should be conducted to identify impacts of propeller scarring. Boating access regulations should be modified as needed to reduce impacts.

Recommendations in the original management plan that have been accomplished:

- Enact boating speed limitations or restrictions on the use of internal combustion engines in waters less than 3 feet deep within the ARPA to protect seagrasses as well as manatees.
- Prepare a map showing the restricted speed zones within the BCARPA (see Figure 29 on page 48 of this document).
- Existing seagrass areas should be marked with warning signs noting "Shallow Water" (Figure 35).
- Mark the 6' bathymetry line.

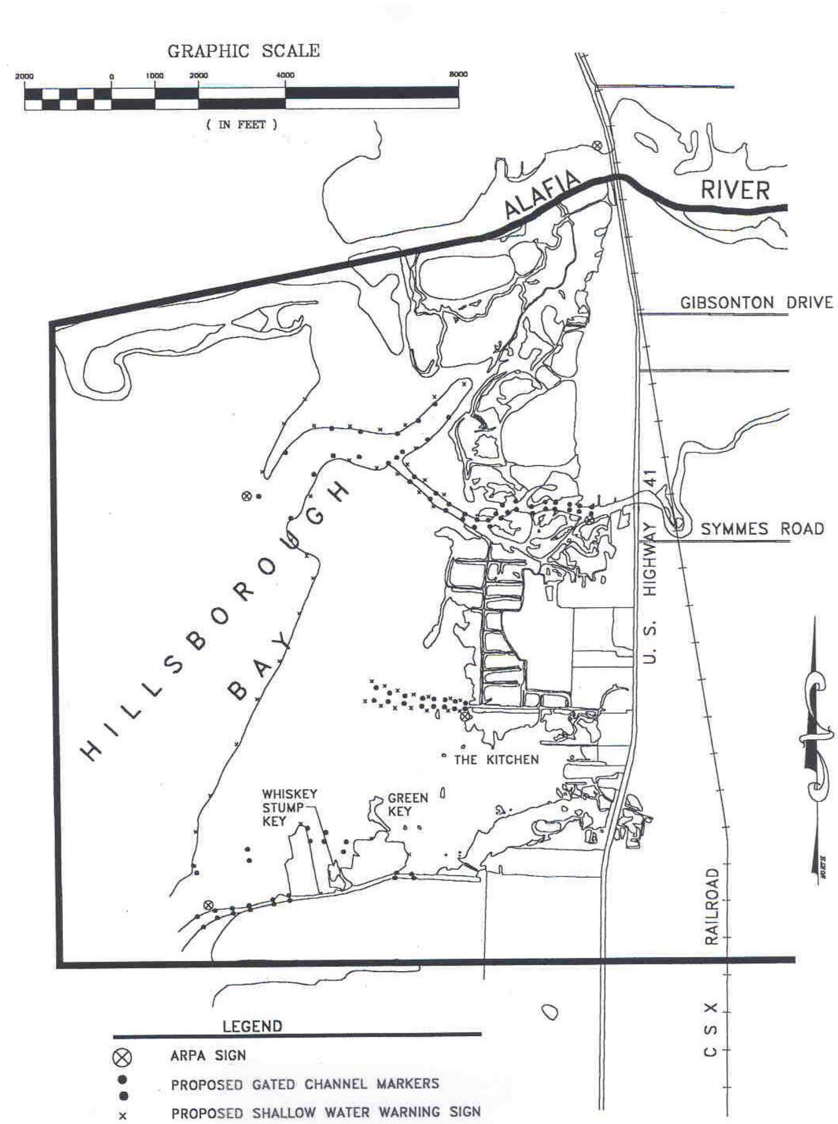


Figure 35. Proposed channel and sensitive area marking system.

Problem: Erosion of Island/Shoreline Habitats

Background: The bird nesting colonies and other islands within the BCARPA are among the most important bird habitat in Florida, but erosion is reducing the area of available habitat. At the Alafia Bank, shoreline erosion affects the long-term stability of this significant breeding colony. Both Green Key and Whiskey Stump Key have been substantially reduced in size in the past 20 years, with losses of foraging and roosting habitat. Furthermore, in the case of Green Key and Whiskey Stump Key, these islands appear to serve as barrier islands, protecting The Kitchen from excessive wave amplitudes. Audubon Florida installed oyster reef habitat breakwaters along portions of the northern and western sides of the Alafia Bank, with additional arrays planned for the entire north shoreline of the Alafia Bank facing the Alafia Ship Channel (Hammett 2011). The breakwater structures facilitate accretion of accumulated sediments and reduce local bay water total suspended solids, increase filtration of water by sessile filter-feeding mollusks at the mouth of the Alafia River in Hillsborough Bay, enhance essential fishery habitat, provide foraging habitat for resident and migratory shorebirds including American Oystercatchers, Willets, Ruddy Turnstones, and Spotted Sandpipers, and other waterbirds including herons and egrets and ducks, and protect habitat for other taxa, including sandy beach habitat for egg-laying horseshoe crabs and haul-out habitat for resident diamondback terrapins.

Recommendations:

- Implement additional projects to reduce and control erosion on key bird habitat islands within the ARPA. Where appropriate, use materials suitable for oyster attachment.
- When construction-grade dredged material is available, the U.S. Army Corps of Engineers (USACOE) and the PTB should use it to supplement habitat on Bird and Sunken Islands, Green Key and Whiskey Stump Key, and fill the sedimentation basins in The Kitchen. This beneficial use of dredged spoil material would result in stabilized shorelines and coves that are ideal feeding, nesting and resting areas for birds, and provide additional potential substrate for seagrass colonization. Restoration of the beach ridge shoreline east of Bird Island could provide diamondback terrapin nesting habitat.

Recommendation in the original management plan that has been accomplished:

Install near-shore breakwater to provide protection of Green Key and Whiskey Stump Key islands from on shore wave energy and create quiet water lagoons, living-shoreline habitat.

<u>Problem: Long-term Protection of Bird Nesting Colonies</u>

Background: The bird nesting colonies of the Alafia Bank, along with Whiskey Stump Key and Green Key, annually support between 10,000-20,000 pairs of up to 16-20 different species of wading and shorebirds. West and northwest of the Alafia Bank, the PTB Spoil Islands (Dredged Material Management Areas - DMMA) 2D and 3D annually support as many as 10,000-20,000 pairs of birds including listed species and important tern, American Oystercatcher, and Black Skimmer colonies. However, constant disturbance from the growing numbers of boaters in Tampa Bay poses a serious threat to the long-term survival of the colonies. The birds are exceptionally vulnerable to disturbance during the nesting season. Boaters who picnic or stroll on the islands flush birds from their nests, exposing the chicks or eggs to predators or deadly high temperatures. Although these islands are posted and patrolled by the FCIS, the small staff cannot adequately monitor all the nesting areas in the ARPA all the time, especially during the critical nesting season.

In 1977 the Florida Gane and Fresh Water Fish Commission (now FFWCC) designated Bird Island a Colonial Bird Nesting Site, and changed it to a Critical Wildlife Area (CWA) in 1982, prohibiting entry or molestation of birds from December 1 until September 1. At the time the nesting bird colony was located on Bird Island. Since that time wading and shorebirds have been using both Bird and Sunken islands extensively for nesting, roosting and foraging, with activity year-round. The critical courtship and nesting periods actually commence in early November and continue into mid-October (FCIS 2012). Numerous instances of trespass onto Bird Island as well as harassment of nesting and foraging birds by boaters and wildlife photographers have been documented (Ebersole 2015). A 2012 request to the FFWCC to extend the status to year-round "No Entry", to increase the CWA to include Sunken Island, and to allow posting of a 100-foot offshore "No Entry" buffer zone has not yet been granted (A. Paul, pers. comm.).

Recommendations:

- PTB, Mosaic and community representatives should continue to work with Audubon Florida to post, protect and monitor the bird colonies.
- PTB and Audubon Florida should develop a community education program about the importance of the nesting colonies on the Alafia Bank and DMMA 2D and 3D for the boating public.
- Audubon Florida, PTB, TBEP, and cooperators should continue to publish and distribute the Hillsborough Bay Boater's Guide to educate the boating and fishing public about bird colony protection.

- ♦ Encourage designation of bird nesting islands as Imperiled Habitat to increase buffer, and institute Critical Wildlife Area status for the entire Alafia Bank Bird Sanctuary that includes an off-shore buffer zone.

Problem: Threats to Manatees

Background: According to manatee researchers with the FFWCC's Florida Wildlife Research Institute, manatees regularly use the deep water basins in The Kitchen and Cargill South Parcel areas as a departure point for their regular travel corridor between Tampa Electric Company's Big Bend plant and Duke Energy's Bartow Plant on Weedon Island in Pinellas County. The Kitchen is the closest feeding site to the Big Bend plant where 566 manatees, 76% of all Tampa Bay manatees, were counted on one day in 2015 (B. Ackerman, pers. comm.; FWRI 2015).

Preservation of seagrass habitat, providing a protected area of various water depths so that manatees can avoid propeller-driven boats, and instituting boating speed limits, especially in shallow water, are all critical components of a management plan to protect manatees that frequent the Bullfrog Creek ARPA.

Recommendation:

- ♦ PTB and Hillsborough County should implement the channel marking program recommended for seagrass protection. This will prevent propeller scarring of seagrass beds, which provide vital feeding habitat for manatees, as well as reduce the chance of boat collisions with manatees.
- ♦ The Hillsborough County Sheriff's Office and the Florida Marine Patrol should increase enforcement of boat speed and access restrictions.

Recommendation in the original management plan that has been accomplished:

Implement boating speed restrictions for seagrass protection.

Problem: Loss of Freshwater Wetland Habitats

Background: Freshwater wetlands and ephemeral "frog ponds" provide critical feeding habitats for a variety of bird species that nest in the BCARPA, particularly the White Ibis, Roseate Spoonbills, and several of the smaller heron species, which rely on freshwater habitat as foraging areas for food to feed their growing young. Historically, these ephemeral wetlands have been poorly protected and rapidly lost to development.

Recommendations:

- ♦ PTB, SWFWMD's SWIM, Audubon Florida and Hillsborough County should incorporate the creation of freshwater wetlands and ephemeral frog ponds in future habitat restoration projects such as the Kracker Avenue Fish Farm, as was accomplished at the Fred and Idah Schultz Preserve on the north side of Port Redwing.
- ♦ The Hillsborough County Stormwater Department and the FDOT should work with Audubon Florida and EPCHC to create small wetlands along drainage ditches to provide stormwater cleansing and wetland habitat.
- ♦ Wetlands in Hillsborough County should be protected aggressively by regulatory agencies, especially EPCHC.

Problem: Loss of Vegetated Marine Habitats

Background: Vegetated marine habitats such as mangroves, salterns, and seagrasses are critical to the ecological integrity of the BCARPA. Losses in each of these communities were documented between 1950 and 1996. Mangrove acreage had declined the least with a reduction of 13%, followed by tidal marsh with a loss of 27.2%, salterns with a loss of 72.6%, and seagrass with a 91.7% loss. Seagrasses have rebounded significantly in Tampa Bay and Hillsborough Bay, including the BCARPA, due to improved water quality, as previously discussed and shown in Table 14. Changes in acreage of mangrove, tidal marsh and saltern habitats since 1996 have not been calculated for the BCARPA, but given past trends it is fully anticipated that saltern habitat has been further reduced due to mangrove encroachment and water quality/circulation changes. Future restoration efforts should be directed toward increasing the acreage of salterns in the BCARPA, following the paradigm outlined in *Setting Priorities for Tampa Bay Habitat Protection and Restoration: Restoring the Balance* (LES & CEI 1996) and updated in Robison (2009).

Table 14. Change in acres of vegetated marine habitats in the BCARPA study area, c. 1950–2015 (Lewis et al. 1985, SWFWMD 2015).

HABITAT	ACRES		
	c. 1950	1996	2015
Mangrove	479.3	417.2	?
Tidal Marsh	83.7	61.8	?
Saltern	70.4	19.3	?
Seagrass	806.6	148.3	730.2

Recommendations:

- PTB, in conjunction with the Audubon Florida, SWFWMD's SWIM, FDEP, USFWS, other agencies and Mosaic Fertilizer, LLC should develop and implement a prioritized list of restoration projects that all entities can support, and distribute the list for information on funding options.
- Utilize suitable dredged material from channel and port maintenance to enhance and restore habitat whenever feasible.
- Mangrove trimming rules should be strengthened and enforced to protect mangroves.
- Illegal dredging and filling of ARPA shorelines should be prevented. Restoration of shorelines should be pursued as a priority.

Recommendation in the original management plan that is no longer needed:

Implement large-scale seagrass restoration as supported by the results of pilot projects.

Problem: Impacts to Diamondback Terrapins from Crab Traps

Background: The diamondback terrapin is a long-lived, slow-reproducing estuarine turtle that frequents shallow, mangrove-fringed coves and bayous. Due to commercial overharvesting for the restaurant trade, the precipitous decline of the terrapin populations led to the formal designation of terrapins as a protected species in most of the Atlantic coastal states where they occur. A locally significant population resides in the Bullfrog Creek watershed, although specific population size estimates are not available. Diamondback terrapins become trapped and drown in standard crab traps (Figure 36). The effect of this mortality on the overall Bullfrog Creek population is unknown, but could be substantial.

Recommendations:

- Recruit volunteer crabbers to use readily available by-catch reduction devices which prevent terrapins from entering traps or allow them to escape once inside.
- With FFWCC and Florida SeaGrant cooperation, provide these devices free to commercial and recreational crabbers, with explanations of how to use the devices and their importance.
- Encourage the State of Florida to require use of these devices by commercial and recreational crabbers.

Figure 36. Drowned diamondback terrapins in blue crab trap near the Alafia Bank Sanctuary (photo by Carol Cassels 2015).

Recommendation in the original management plan that has been accomplished:

Sponsor research to determine the impact of the blue crab fishery on diamondback terrapins, and recruit volunteer crabbers to test available methods or devices that prevent terrapins from entering crab traps or allow them to escape once inside.

Problem: Invasion of Native Habitats by Non-native Plants

Background: Displacement of native plants with invasive non-native species such as Brazilian pepper, lead tree, and Australian pine is a serious threat to the integrity of Florida habitats. Brazilian pepper is the dominant invasive non-native plant in the BCARPA. Invasion by Brazilian pepper is especially severe in areas where soils have been disturbed as a result of dredging and filling projects, agricultural and fish farm abandonment or other disturbance of natural vegetative structure. Australian pine covers a much smaller area. In some parts of the BCARPA, Brazilian pepper has formed a dense monoculture excluding all other vegetation. It also takes over shoreline areas where existing mangrove fringes are severely damaged by freezes. The Suncoast Cooperative Invasive Species Management Area (Hillsborough Pinellas, Manatee and Sarasota counties), is one of 17 public-private partnerships in Florida that works to cooperatively control exotic and invasive species on public and private lands. Efforts include prevention, education/ awareness, early detection and rapid response, monitoring and Integrated Pest Management. The expertise of its members is invaluable to managing exotic species on large tracts of land (N. O'Hara, pers. comm.).

Recommendation:

Support the work of the Suncoast Cooperative Invasive Species Management Area, the large-scale effort among agencies, community groups, and private landowners to remove non-native plants and animals and replant treated areas with native vegetation.

Recommendation that is no longer appropriate:

Initiate a cooperative effort between Hillsborough County's Resource Management Team, TPA, the FDOT, Cargill Fertilizer, Inc., Audubon of Florida, other agencies, community groups and adjacent private landowners to remove invasive non-native plants.

Problem: Potential development of aquaculture or mariculture operations in the BCARPA or contributing freshwater creeks.

Background: Interest has been expressed, from time to time, in establishing in-water aquaculture and mariculture operations in the southwestern Tampa Bay area involving seagrasses, marsh grasses, clams, oysters, shellfish and various fin fish. The shallow, poorly-flushed waters, the fragile yet highly productive sea grass beds and the high importance of the habitat for nursery fish, shore and wading birds render the BCARPA unsuitable for such uses.

The effects of commercial farming of mutton snapper (*Lutjanus analis*) and cobia (*Rachycentron canadum*) on water quality, native fishes and benthic fauna and chemistry in the Caribbean waters of Puerto Rico were studied by Alston et al. (2005). After one year of culture a nitrogen budget indicated 3800 kg of nitrogen (in feed) fed to caged fish resulted in 18% retained in the fish crop, 66% excreted as ammonia, 3% from fish mortality, and 13% unaccountable (but assumed to be feces and feed wastes). The strong currents in the 28 m-deep water at the site assisted with the dispersion of solid and dissolved nutrients released from the cages.

Wastes from open-ocean aquaculture facilities located in areas with relatively shallow or relatively weak currents can cause environmental damage (Goldburg et al. 1996). Accumulated wastes beneath cages produce changes in sediment chemistry and physical characteristics leading to a shift in the macrobenthic faunal diversity and biomass.

A much higher diversity and abundance of fish were found near the cages within a few months of stocking the cages, including commercially valuable species and reef species; possibly benefiting directly or indirectly from additional nutrients from the aquaculture activity or attracted to the organisms growing on the cages. Additional research is needed to determine the positive or negative impacts to wild fish attracted to the cages.

Because cages are essentially ecologically open systems, wastes are inevitably released into the surrounding environment (Chen et al. 2000). Wastes from intensive aquaculture systems primarily consist of uneaten food, metabolic waste (feces and urine), chemical wastes, and feral animals (Chen et al. 2000). Semisolid wastes are discharged directly into the environment from marine cage systems. They may settle on the sea bottom or a portion may be attached to particulate material, thus increasing sedimentation. Sedimentation is dependent on the settling velocity of solids, which in turn is dependent on their physical properties (i.e. food pellet shape and density), current velocity, water turbulence, and depth at cage sites. The sedimentation may result in ecological issues such as the impact of bioactive compounds, interactions with the food web, perturbations on local wildlife, habitat destruction, interaction between escaped farm stock and wild species, and alteration of the biodiversity of the area (Civili and Caparis 2000). Waste loading beneath the cages may produce changes in sediment chemistry and physical characteristics leading to a shift in the macrobenthic faunal diversity and biomass.

Many chemicals used in the aquaculture industry have not been evaluated in relation to their effects on the marine environment. Antibiotics and antifouling agents also need to be studied (Goldburg et al. 1996).

Additionally, the state of Florida has recognized the potential impacts of aquaculture on native species and habitats. The Aquaculture Best Management Practices Manual (FDACS 2007) identifies several potential and serious effects of improperly located or operated facilities, including:

- Use of brood stock from areas far removed may introduce genetic strains that bring unexpected and deleterious features;
- Potential introduction of pathogens and parasites;
- Preventative measures used for wildlife depradation;
- Impacts of antibiotics and growth-promoters on native species; and
- Introduction of excess nutrients into natural systems.

PROPOSED AMENDMENTS TO GENERAL AND ARPA STANDARDS OF USE

In addition to the prohibitions of Section V.A.2 of the Port Tampa Bay Submerged Land Management Rules, the following activities are **prohibited** in ARPAs (Section V.B.2.):

1. New construction of seawalls waterward of the mean or ordinary high water line, or new filling waterward of the mean or ordinary high water line. This prohibition shall not apply in the case of public road and bridge projects where no reasonable alternative exists, or for maintenance and repair of existing structures.
2. Crossing sovereign submerged lands to provide private or public water supply or telephone or electrical services to islands where such utilities did not previously exist.
3. The taking of indigenous life forms for sale or commercial use that are not subject to the exclusive jurisdiction of the FFWCC or the Marine Fisheries Commission. This shall not preclude a person from exercising his right to commercial and recreational fishing, subject to other applicable regulatory criteria.
4. Discharge of wastes or effluent into an ARPA which degrade the biological, aesthetic, or scientific values of the preserve.
5. New dredging to obtain navigable depths, and only minimum dredging of any type may be allowed where damage to natural resources will not occur, and where spoil disposal is in compliance with the provisions of these rules.
6. Disposal of dredged materials, unless for wildlife habitat creation, or shown to be in the public interest.
7. Any regulated use of sovereign submerged lands without specific written authorization from PTB appropriate to the type of use.
8. Sundecks over submerged lands shall be prohibited.

Recommendations:

These rules also contain General Resources Management Standards (Sec. V.A.3) and ARPA Resource Management Standards (Sec. V.B.3) (See Appendix B). We have reviewed these and find that these existing Standards of Use provide adequate protection for the BCARPA with two exceptions.

- ♦ The first pertains to the rules under Section V.A.3.e, Boat Ramps. We would recommend the addition of Section V.A.3.e.(3), to read as follows:

  (3) Shall be located only in areas where an existing natural or man-made channel provides continuous unimpeded water depths of no less than -4.0 ft MLLW and has gated channel markers at intervals of no less than 200 feet, or will have such channel markers installed as part of an application for a new or improved boat ramp.

- ♦ The second exception pertains to the rules under Section V.B.3.m regarding aquaculture. We do not believe, based on the analyses in this plan, that any form of aquaculture or mariculture would be compatible with the resource needs of the Bullfrog Creek ARPA and would therefore recommend that it be prohibited in ARPAs. Such prohibition is in accordance with Section V.B.3.m.(1), which reads:

  (1) Aquaculture activities will not be allowed in areas of special or unique importance.

  Because the BCARPA is an area of special and unique importance, we recommend that Section V.B.m.(1) be amended to read as follows:

(1) Aquaculture activities will not be allowed in areas of special or unique importance; including:
   (a) the Bullfrog Creek ARPA.

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ACRONYMS

ARPA	Aquatic Resource Protection Area
BCARPA	Bullfrog Creek ARPA
BSG	City of Tampa's Bay Study Group
ELAPP	Hillsborough County's Jan K. Platt Endangered Lands Acquisition and Protection Program
EPCHC	Environmental Protection Commission of Hillsborough County
FCIS	Florida Coastal Islands Sanctuaries
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FFWCC	Florida Fish and Wildlife Conservation Commission
HCCELM	Hillsborough County Conservation and Environmental Lands Management Department
HCPRD RMT	Hillsborough County Parks and Recreation Dept., Resource Mgmt. Team
HCSWMD	Hillsborough County Solid Waste Management Department
MLLW	Mean Lowest Low Water
NPDES	National Pollutant Discharge Elimination System
NRCS	U.S. Department of Agriculture's Natural Resource Conservation Service
PTB	Port Tampa Bay
SCS	Soil Conservation Service
SWFWMD	Southwest Florida Water Management District
SWIM	Surface Water Improvement and Management Program
TBEP	Tampa Bay Estuary Program
TBRPC	Tampa Bay Regional Planning Council
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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Clark, Peter. Executive Director, Tampa Bay Watch, Tierra Verde, FL.

Dyer, Michael. Hillsborough County Public Health Department, Tampa, FL.

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Graves, Googie. Long-time Gibsonton resident, pioneer Adamsville/Gibsonton family, Gibsonton, FL.

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Muench, Gus. Crab fisherman, eastern Tampa Bay and Cockroach Bay, Ruskin, FL.

Noblitt, Paula. Compliance Enforcement Manager, Water Management Division, EPCHC, Tampa, FL.

Oberne, Paul. Hillsborough County Public Health Department, Tampa, FL.

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Rocco, Serina. Environmental Supervisor, Division of Aquaculture, FDACS, Bartow, FL.

Watson, Craig. Cooperative Extension Office, Tropical Aquaculture Laboratory, FDACS, Ruskin, FL.

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Wood, Roger C. The Wetlands Institute, Stone Harbor, NJ.

Youngman, Jimmy. Tampa Bay Sanctuaries (Florida Coastal Islands Sanctuaries) Seasonal Warden, 1984-1985 and 1987-1988; long-time Gibsonton resident who lives on Kracker Ave. His uncle did the moonshining on Whiskey Stump Key, pioneer Adamsville/Gibsonton family, Gibsonton, FL.

APPENDIX A

LEGAL DESCRIPTION OF THE BULLFROG CREEK AQUATIC RESOURCE PROTECTION AREA

(Tampa Port Authority Submerged Lands Management Rules, IV.D.2, December 1, 2003)

Those sovereign lands lying within the following boundaries:

> Beginning at the center of Bullfrog Creek at the west side of the U.S. 41 bridge in Section 23, Township 30 south, Range 19 east, Hillsborough County, thence generally west and north along the line of mean high water of Bullfrog Creek and Hillsborough Bay to its intersection with the Alafia River; thence westerly along the south side of the Alafia River Channel a distance of approximately 5,000 feet to its intersection with the 1-fathom [6-foot] contour of Hillsborough Bay; thence southerly around the western end of Sunken Island and along the 1-fathom contour of Hillsborough Bay to its intersection with the north boundary of the Big Bend Channel; thence easterly along the northern boundary of the Big Bend Channel and the channel bordering the north side of Port Redwing to its intersection with the mean high water line of Hillsborough Bay; thence northerly and easterly along the mean high water line of Hillsborough Bay to the point of beginning.

APPENDIX B

TAMPA PORT AUTHORITY (PORT TAMPA BAY) SUBMERGED LANDS MANAGEMENT RULES; PERMITTING STANDARDS FOR AQUATIC RESOURCE PROTECTION AREAS

B. AQUATIC RESOURCE PROTECTION AREAS

1. Management Goals
   a. To preserve, protect, and enhance exceptional areas of Sovereignty Lands by reasonable regulation of human activity on Sovereignty Lands within these areas.
   b. To protect and enhance the waters of these areas so that the public may continue to enjoy the traditional uses such as swimming, boating, and fishing.
   c. To encourage the protection, enhancement or restoration of the biological, aesthetic, or scientific values of these areas, including but not limited to the modification of existing manmade conditions toward their natural condition and discourage activities which would degrade the aesthetic, biological, or scientific values of these areas.
   d. To preserve, promote, and protect indigenous life forms and habitats of these areas.
   e. To maintain the beneficial hydrologic functions of these areas.
   f. To provide navigational access to these areas only to the extent required by riparian rights.
   g. To ensure compliance of all uses of Sovereignty Lands with applicable management plans and policies.
2. Prohibited Activities

In addition to the prohibitions of Section V.A.2. of these rules, the following activities are prohibited in Aquatic Resource Protection Areas (ARPA):

   a. New construction of seawalls waterward of the mean or ordinary high water line, or new filling waterward of the mean or ordinary high water line. This prohibition shall not apply in the case of public road and bridge projects where no reasonable alternative exists, or for maintenance and repair of existing structures.
   b. Crossing Sovereignty Lands to provide private or public water supply or telephone or electrical services to islands where such utilities did not previously exist.
   c. The taking of indigenous life forms for sale or commercial use that are not subject to the exclusive jurisdiction of the Florida Game and Fresh Water Fish Commission or the Marine Fisheries Commission. This shall not preclude a person from exercising his right to commercial and recreational fishing, subject to other applicable regulatory criteria.
   d. Discharge of wastes or effluent into an ARPA which degrade the biological, aesthetic, or scientific values of the preserve.
   e. New dredging to obtain navigable depths, and only minimum dredging of any type may be allowed where damage to natural resources will not occur, and where spoil disposal is in compliance with the provisions of these rules.
   f. Disposal of dredged materials, unless for wildlife habitat creation, or shown to be in the public interest.
   g. Any regulated use of Sovereignty Lands without specific written authorization from the Authority appropriate to the type of use.
   h. Sundecks over Sovereignty Lands shall be prohibited.
3. Resource Management Standards

The following standards for use supplement those in Section V.A.3., and, to the extent they are more stringent, they shall prevail:

   a. Each proposed activity in an ARPA having a state or local management plan must be consistent with the management plan.

b. No dock or pier shall extend waterward of the mean or ordinary high water line more than 50 feet or twenty percent of the navigable width of the waterbody at that particular location, whichever is less.

c. Certain docks or piers may fall within areas of special or unique biological, scientific, historic and/or aesthetic value and require special management consideration. Conditions for approval may be more restrictive than the normally accepted criteria. Such conditions shall be determined on a case-by-case analysis, and may include, but shall not be limited to, changes in dock or pier location, configuration, length, width and height and the number, lengths, drafts and types of vessels.

d. All piers shall be constructed in accordance with the following applicable criteria:
   (1) Railings shall be placed around the entire perimeter of the pier.
   (2) Dredging is strictly prohibited when associated with pier construction or maintenance.

e. Where aquatic resources may be adversely impacted by the effects of shading, access walkways to docks and piers shall be constructed to a minimum height of 3.5 feet above mean or ordinary high water; planking shall be no more than eight inches wide and spaced no less than one-half inch apart.

f. Arthropod control practices within the ARPA are restricted to those activities approved or adopted in Public Lands Arthropod Control Management Plans, pursuant to Section 388.4111, F.S.

g. Restoration, repair or replacement of seawalls is limited to their previous location, or upland of, or within twelve inches waterward of their previous location.

h. Private single-family residential docks and covered boatslips shall conform to the following standards and criteria:
   (1) The width of the main access dock walkway shall not exceed four feet;
   (2) The size of a terminal platform shall not exceed 160 square feet;
   (3) A covered boatslip if constructed:
      (a) Must have a roof with a slope between 4:1 and 6:1, run over rise;
      (b) The total covered area shall not exceed 160 square feet.
      (c) Shall not include a catwalk inside the covered area that is more than three feet wide;
   (4) If a dock is to have both a terminal platform and a covered slip, the total area covered by both shall not exceed 160 square feet; and
   (5) The area of Sovereignty Land preempted by the docking facility shall not exceed ten square feet for each linear foot of shoreline owned by the applicant along the affected waterbody.

k. Private multi-family docking facilities shall conform to the following specific standards and criteria:
   (1) The area of Sovereignty Land preempted by the docking facility shall not exceed ten square feet for each linear foot of shoreline owned by the applicant along the affected waterbody.
   (2) The docking facility and any mooring areas, turning basins or associated dredging shall not occur within an area of special or unique importance; however, main access walkways may pass through such an area provided that such crossing will generate only minimal environmental impact.
   (3) Main access dock walkways and connecting crosswalks shall not exceed six feet in width;
   (4) Finger piers shall not exceed four feet in width, and 25 feet in length; and
   (5) Pilings may be utilized as required to provide adequate mooring capabilities.

l. Commercial, and other revenue generating docking facilities shall conform to the following specific design standards and criteria:

(1) Docking facilities and any associated dredging shall not occur within an area of special or unique importance, however, main access docks may be allowed to pass through such areas to reach a terminal mooring area provided that such crossing will generate only minimal environmental impact; and
(2) Docking facilities shall only be located in or near areas with good water circulation and flushing abilities.

m. Aquaculture activities may be authorized, subject to the following conditions:
(1) Aquaculture activities will not be allowed in areas of special or unique importance;
(2) Lease sites will be subject to approval based upon their compatibility with overall existing commercial and recreational uses and resource management plans;
(3) Aquaculture activities shall not preempt traditional uses of the aquatic preserve or infringe on riparian rights of ingress and egress;
(4) Lease sites shall not include the installation of any fixed offshore structures or accommodate any liveaboard or permanent mooring of any vessel; and
(5) The aquaculture activity shall not impede the natural flow of waters.

n. There shall be no lease or transfer of interest of Sovereignty Lands in ARPA's, except when such lease or transfer is in the public interest.

o. In evaluating applications for activities within ARPA's or activities that may impact the ARPA's, the Authority recognizes that, while a particular alteration of the ARPA may constitute a minor change, the cumulative effect of numerous such changes often results in major impairments to the resources of the ARPA. Therefore, the Authority shall evaluate a particular site for which the activity is proposed with the recognition that the activity, in conjunction with other activities may adversely affect the ARPA. The impact of a proposed activity shall be considered in light of its cumulative impact on the ARPA's natural system. The Authority shall include as a part of its evaluation of an activity:
(1) The number and extent of similar human actions within the ARPA which have previously affected or are likely to affect the ARPA;
(2) Similar activities within the ARPA that are currently under consideration by the Authority;
(3) Direct and indirect effects upon the ARPA that may reasonably be expected to result from the activity;
(4) The extent to which the activity is consistent with a management plan for the ARPA, if applicable;
(5) The extent to which the activity is in accordance with comprehensive plans adopted by affected local governments, pursuant to Section 163.3161, F.S., and other applicable plans adopted by local, state, and federal governmental agencies; and
(6) The extent to which the loss of beneficial hydrologic and biologic functions would adversely impact the quality or utility of the ARPA.

APPENDIX C

BENTHIC INVERTEBRATE SPECIES OF THE KITCHEN AND BULLFROG CREEK

Cnidaria

HYDRACTINIIDAE [unidentified]
Clytia cf. sp. B of Joyce, 1961
CAMPANULARIIDAE sp. A of EPC
Lovenella gracilis
ACTINIARIA [unidentified]
ACTINIARIA sp. A of EPC
ACTINIARIA sp. B of EPC
ATHENARIA [unidentified]
THENARIA [unidentified]
Aulactinia cf. capitata

Platyhelminthes

Stylochopsis ellipticus

Nemertea

PALAEONEMERTEA sp. A of EPC
Tubulanus pellucidus
Tubulanus sp. B of EPC
Cerebratulus lacteus
Fragilonemertes rosea
Zygeupolia cf. rubens
Paranemertes cf. biocellatus

Annelida

Scoloplos (Scoloplos) rubra
Leitoscoloplos fragilis
Leitoscoloplos foliosus
Leitoscoloplos robustus
Aricidea philbinae
Aricidea (Acmira) taylori
Paradoneis cf. lyra
Armandia maculata
Capitella capitata complex
Capitella jonesi
Heteromastus filiformis
Notomastus cf. tenuis
Notomastus hemipodus
Notomastus americanus
Notomastus n. sp? of EPC
Mediomastus ambiseta
Mediomastus californiensis
Capitomastus aciculatus
Sabaco elongata
Clymenella mucosa
Harmothoe sp. A of Weston, 1984
Malmgreniella maccraryae
Malmgreniella taylori
Sthenelais sp. A of Wolf, 1984
Bhawania heteroseta
Paramphinome sp. B of Gathof, 1984
Eteone heteropoda
Eteone lactea
Nereiphylla castanea
Paranaitis gardineri
Nereiphylla fragilis
Nereiphylla sp. A of Gathof, 1984
Phyllodoce arenae
Gyptis crypta
Parahesione luteola
Podarkeopsis levifuscina
Sigambra tentaculata
Cabira incerta
Exogone (Exogone) dispar
Sphaerosyllis glandulata
Sphaerosyllis taylori
Sphaerosyllis labyrinthophila
Brania wellfleetensis
Brania nitidula
Alitta succinea
Nereis (Neanthes) micromma
Laeonereis culveri
Stenoninereis martini
Nephtys cryptomma
Aglaophamus verrilli
Glycera americana
Glycinde solitaria
Mooreonuphis pallidula
Diopatra cuprea
Kinbergonuphis simoni
Scoletoma tenuis
Lumbrineris nonatoi
Drilonereis sp. E of Uebelacker, 1984
Arabella sp.
Schistomeringos cf. rudolphii
Dipolydora socialis
Polydora cornuta
Prionospio heterobranchia
Apoprionospio pygmaea
Prionospio (Minuspio) perkinsi
Paraprionospio pinnata
Streblospio spp. [gynobranchiata?]
Scolelepis (Scolelepis) texana
Aonides mayaguezensis
Carazziella hobsonae
Boccardiella cf. ligerica
Magelona pettiboneae
Poecilochaetus johnsoni
Spiochaetopterus costarum
Tharyx acutus
Monticellina cf. dorsobranchialis
Cirriformia sp. A of Wolf, 1984
Cirriformia sp. B of Wolf, 1984

Pectinaria gouldii
Hobsonia florida
Melinna maculata
Megalomma pigmentum
Fabriciola trilobata
Limnodriloides barnardi
Limnodriloides baculatus
Tubificoides brownae
Tubificoides wasselli
Thalassodrilides ineri
Erpobdella punctata

Mollusca

Neritina usnea
Littoridinops palustris
Barleeia sp.
Vitrinella helicoidea
Vitrinella floridana
Cyclostremiscus pentagonus
Teinostoma biscaynense
Caecum pulchellum
Bittiolum varium
Epitonium angulatum
Melanella sp.
Vitreolina cf. arcuata
Eulima bifasciata
Polygireulima sp.
Crepidula depressa
Tectonatica pusilla
Astyris lunata
Nassarius vibex
Jaspidella blanesi
Olivella pusilla
Oliva sayana
Prunum apicinum
Pyrgocythara plicosa
Stellatoma stellata
Sayella fusca
Sayella hemphilli
Fargoa cf. gibbosa
Odostomia laevigata
Syrnola cf. producta
Eulimastoma engonium
Turbonilla interrupta
Turbonilla cf. conradi
Turbonilla hemphilli
Turbonilla (Pyrgiscus) sp. B of EPC
Eulimastoma sp.
Boonea impressa
Japonactaeon punctostriatus
Acteocina canaliculata
Cylichnella bidentata
Tornatina inconspicua
Haminoea succinea
TERGIPEDIDAE [unidentified]

Bivalvia

Nucula proxima
Anadara transversa
Modiolus modiolus
Brachidontes exustus
Amygdalum papyrium
Crassostrea virginica
Parvilucina crenella
Phlyctiderma semiaspera
Orobitella floridana
Mysella planulata
Erycina floridana
Laevicardium mortoni
Mulinia lateralis
Ervilia concentrica
Ensis minor
Macoma tenta
Macoma constricta
Angulus cf. versicolor
Eurytellina alternata
Phyllodina squamifera
Angulus cf. tampaensis
Scissula consobrina
Tagelus plebeius
Tagelus divisus
Abra aequalis
Cumingia vanhyningi
Mytilopsis leucophaeata
Anomalocardia cuneimeris
Parastarte triquetra
LASAEIDAE [unidentified]
Sphenia fragilis
Caryocorbula cf. contracta
Caryocorbula caribaea
Cyrtopleura costata
Lyonsia floridana
Asthenothaerus hemphilli

Arthropoda

Amphibalanus improvisus
Nebalia sp.
Mysidopsis furca
Gastrosaccinae
Chlamydopleon dissimile
Taphromysis bowmani
Americamysis alleni
Americamysis bahia
Americamysis stucki
Oxyurostylis smithi
Oxyurostylis lecroyae
Almyracuma bacescui
Cyclaspis pustulata
Cyclaspis varians

Apseudes sp. A of EPC
Halmyrapseudes bahamensis
Alokalliapseudes macsweenyi
Leptochelia/Hargeria sp.[Unid. female specs]
Hargeria rapax
Cyathura polita
Amakusanthura magnifica
Xenanthura brevitelson
Erichsonella attenuata
Edotia triloba
Ampelisca abdita
Ampelisca vadorum
Ampelisca agassizi
Ampelisca holmesi
Ampelisca sp. C of LeCroy, 2002
Ampelisca sp. A of LeCroy, 2002
Hourstonius laguna
Cymadusa compta
Batea catharinensis
Cerapus sp. C of LeCroy, 2007
Monocorophium acherusicum
Apocorophium louisianum
Americorophium ellisi
Erichthonius brasiliensis
Gammarus mucronatus
Acanthohaustorius uncinus
Microprotopus shoemakeri
Listriella barnardi
Lysianopsis alba
Shoemakerella cubensis
Hartmanodes nyei
Metharpinia floridana
Eobrolgus spinosus
Eudevenopus honduranus
Bemlos spinicarpus
Paramicrodeutopus myersi
Grandidierella bonnieroides
Rudilemboides naglei
Deutella incerta
Paracaprella tenuis
Paracaprella pusilla
Lucifer faxoni
Alpheus armillatus
Automate evermanni
Ogyrides alphaerostris
Processa hemphilli
Ambidexter symmetricus
Pagurus gymnodactylus
Pagurus maclaughlinae
Polyonyx gibbesi
Upogebia affinis
Rhithropanopeus harrisii
Dyspanopeus texanus
Pinnixa cf. pearsei
Pinnixa sp. A of LeCroy, unpublished Perdido
Pinnixa sp. F of LeCroy, unpublished Perdido
Stenelmis sp.
TANYPODINAE [unidentified]
Chironomus sp.
Polypedilum scalaenum group
Cladotanytarsus sp.
Ablabesmyia (Ablabesmyia) sp.
Callinectes sapidus

Sipuncula

Phascolion cryptum

Phornida

Phoronis sp.

Bryozoa

Biflustra arborescens
Biflustra cf. denticulate
Conopeum cf. seurati
Conopeum cf. tenuissimum

Brachiopoda

Glottidia pyramidata

Echinodermata

Hemipholis elongate
Amphiodia atra
Amphipholis squamata
Amphipholis gracillima
Ophiophragmus filograneus
Ophiophragmus nr. riisei
Amphioplus thrombodes
Amphioplus (Amphioplus) sepultus
Mellita tenuis
Lytechinus variegates
SYNAPTIDAE sp. A of EPC
SYNAPTIDAE sp. C of EPC
Epitomapta cf. roseola

Hemichordata

ENTEROPNEUSTA [unidentified]

Chordata

Branchiostoma floridae

APPENDIX D

FISH SPECIES OF TAMPA BAY, WITH HABITAT TYPE AND ABUNDANCE (ADAPTED FROM WOLFE AND DREW 1990)

	COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE	ABUNDANCE
Chondrichthyes				
	nurse shark	*Ginglymostoma cirratum*	M	
	whale shark	*Rhincodon typus*	M	X
	sand tiger	*Odontaspis taurus*	M	X
	white shark	*Carcharodon carcharias*	M	X
	blacknose shark	*Carcharhinus acronotus*	M	
	bull shark	*C. leucas*	M	
	blacktip shark	*C. limbatus*	M,E	
	dusky shark	*C. obscurus*	M	
	sandbar shark	*C. plumbeus*	M	X
	lemon shark	*Negaprion brevirostris*	M	X
	great hammerhead	*Sphyrna mokarran*	M	X
	bonnethead	*S. tiburo*	M,E	
	smalltooth sawfish	*Pristis pectinata*	M,E	X
	Atlantic guitarfish	*Rhinobatos lentiginosus*	M	
	southern stingray	*Dasyatis americana*	M,E	
	Atlantic stingray	*D. sabina*	M,E	X
	bluntnose stingray	*D. sayi*	M,E	
	smooth butterfly ray	*Gymnura micrura*	M,E	
	spotted eagle ray	*Aetobatus narinari*	M	
	cownose ray	*Rhinoptera bonasus*	M,E	
	Atlantic manta	*Manta birostris*	M	
Osteichthyes				
	Atlantic sturgeon	*Acipenser oxyrhynchus*	E	X
	longnose gar	*Lepisosteus osseus*	F	X
	Florida gar	*L. platyrhincus*	F	X
	ladyfish	*Elops saurus*	M,E	
	tarpon	*Megalops atlanticus*	M,E	
	bonefish	*Albula vulpes*	M	
	American eel	*Anguilla rostrata*	M,E	X
	ocellated moray	*Gymnothorax saxicola*	M	X
	sooty eel	*Bascanichthys bascanium*	M	X
	spotted spoon-nose eel	*Echiophis intertinctus*	M	X
	stippled spoon-nose eel	*E. punctifer*	M	X
	speckled worm eel	*Myrophis punctatus*	M,E	
	shrimp eel	*Ophichthus gomesi*	M,E	
	palespotted eel	*O. ocellatus*	M	X
	gulf menhaden	*Brevoortia patronus*	M,E	
	yellowfin menhaden	*B. smithi*	M	
	gizzard shad	*Dorosoma cepedianum*	F	X
	threadfin shad	*D. petenense*	F	X
	scaled sardine	*Harengula jaguana*	M,E	
	Atlantic thread herring	*Opisthonema oglinum*	M,E	
	Spanish sardine	*Sardinella aurita*	M	
	Cuban anchovy	*Anchoa cubana*	M	
	striped anchovy	*A. hepsetus*	M,E	

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE	ABUNDANCE
bay anchovy	*A. mitchilli*	M,E	
inshore lizardfish	*Synodus foetens*	M,E	
hardhead catfish	*Arius felis*	M,E	
gafftopsail catfish	*Bagre marinus*	M,E	
brown bullhead	*Ictalurus nebulosus*	F	X
gulf toadfish	*Opsanus beta*	M,E	
leopard toadfish	*O. pardus*	M	
Atlantic midshipman	*Porichthys plectrodon*	M,E	
skilletfish	*Gobiesox strumosus*	M,E	
pancake batfish	*Halieutichthys aculeatus*	M	X
polka-dot batfish	*Ogcocephalus radiatus*	M,E	
southern hake	*Urophycis floridana*	M,E	
longnose cusk-eel	*Ophidion beani*	M	X
blotched cusk-eel	*O. grayi*	M	
crested cusk-eel	*O. welshi*	M	
ballyhoo	*Hemiramphus brasiliensis*	M	X
halfbeak	*Hyporhamphus unifasciatus*	M,E	
Atlantic needlefish	*Strongylura marina*	M	X
redfin needlefish	*S. notata*	M,E	
timucu	*S. timucu*	M,E	
houndfish	*Tylosurus crocodilus*	M	X
diamond killifish	*Adinia xenica*	E	
sheepshead minnow	*Cyprinodon variegatus*	E	
goldspotted killifish	*Floridichthys carpio*	E	
marsh killifish	*Fundulus confluentus*	E	
gulf killifish	*F. grandis*	E	
Seminole killifish	*F. seminolis*	F	X
longnose killifish	*F. similis*	E	
rainwater killifish	*Lucania parva*	E	
mosquitofish	*Gambusia affinis*	F,E	
sailfin molly	*Poecilia latipinna*	E	
rough silverside	*Membras martinica*	E	
tidewater silverside	*Menidia peninsulae*	E	
oarfish	*Regalecus glesne*	M	X
lined seahorse	*Hippocampus erectus*	E	
dwarf seahorse	*H. zosterae*	E	
fringed pipefish	*Micrognathus criniger*	E	
dusky pipefish	*Syngnathus floridae*	E	
chain pipefish	*S. louisianae*	E	
gulf pipefish	*S. scovelli*	E	
bluegill	*Lepomis macrochirus*	F	X
largemouth bass	*Micropterus salmoides*	F	X
snook	*Centropomus undecimalis*	M,E	
black sea bass	*Centropristis striata*	M	X
blackchin tilapia	*Tilapia melanotheron*	E	
sand perch	*Diplectrum formosum*	M	
Jewfish	*Epinephelus itajara*	M,E	
red grouper	*E. morio*	M	X
gag	*Mycteroperca microlepis*	M	
belted sandfish	*Serranus subligarius*	M	X
greater soapfish	*Rypticus saponaceus*	M	X

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE	ABUNDANCE
bronze cardinalfish	*Astrapogon alutus*	M	X
bluefish	*Pomatomus saltatrix*	M,E	
cobia	*Rachycentron canadum*	M,E	
sharksucker	*Echeneis naucrates*	M,E	
remora	*Remora remora*	M,E	
blue runner	*Caranx crysos*	M	
crevalle jack	*C. hippos*	M,E	
horse-eye jack	*C. latus*	E	X
Atlantic bumper	*Chloroscombrus chrysurus*	M,E	
bluntnose jack	*Hemicaranx amblyrhyncus*	M	X
leatherjacket	*Oligoplites saurus*	M,E	
Atlantic moonfish	*Selene setapinnis*	M	X
lookdown	*S. vomer*	M	
Florida pompano	*Trachinotus carolinus*	M,E	
permit	*T. falcatus*	M,E	
palometa	*T. goodei*	M	
schoolmaster	*Lutjanus apodus*	M	X
gray snapper	*L. griseus*	M,E	
lane snapper	*L. synagris*	M,E	
tripletail	*Lobotes surinamensis*	M,E	
Irish pompano	*Diaterus auratus*	M	X
striped majarra	*D. plumieri*	E	
spotfin mojarra	*Eucinostomus argenteus*	M,E	
silver jenny	*E. gula*	M,E	
yellowfin mojarra	*Gerres cinereus*	E	X
tomtate	*Haemulon aurolineatum*	M	X
white grunt	*H. plumieri*	M	
pigfish	*Orthopristis chrysoptera*	M,E	
sheepshead	*Archosargus probatocephalus*	M,E	
grass porgy	*Calamus arctifrons*	M	X
spottail pinfish	*Diplodus holbrooki*	M	
pinfish	*Lagodon rhomboides*	M,E	
silver perch	*Bairdiella chrysoura*	M,E	
sand seatrout	*Cynoscion arenarius*	M,E	
spotted seatrout	*C. nebulosus*	M,E	
high-hat	*Equetus acuminatus*	M	X
cubbyu	*E. umbrosus*	M	X
spot	*Leiostomus xanthurus*	M,E	
southern kingfish	*Menticirrhus americanus*	M,E	
gulf kingfish	*M. littoralis*	M	
northern kingfish	*M. saxatilis*	M,E	
Atlantic croaker	*Micropogonias undulatus*	E	
black drum	*Pogonias cromis*	M,E	
red drum	*Sciaenops ocellatus*	M,E	
spotted goatfish	*Pseudupeneus maculatus*	M	X
Bermuda chub	*Kyphosus sectatrix*	M	X
Atlantic spadefish	*Chaetodipterus faber*	M,E	
slippery dick	*Halichoeres bivittatus*	M	X
hogfish	*Lachnolaimus maximus*	M	X
emerald parrotfish	*Nicholsina usta*	M	
striped mullet	*Mugil cephalus*	M,E	

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE	ABUNDANCE
white mullet	*M. curema*	M,E	
fantail mullet	*M. trichodon*	M,E	
great barracuda	*Sphyraena barracuda*	M,E	
northern sennet	*S. borealis*	M	X
guaguanche	*S. guachancho*	M	X
Atlantic threadfin	*Polydactylus octonemus*	M	X
moustache jawfish	*Opistognathus lonchurus*	M	X
sand stargazer	*Dactyloscopus tridigitatus*	M	X
southern stragazer	*Astroscopus y-graecum*	M,E	
banded blenny	*Paraclinus fasciatus*	E	X
marbled blenny	*P. marmoratus*	E	X
striped blenny	*Chasmodes bosquianus*	M	X
Florida blenny	*C. saburrae*	M,E	
crested blenny	*Hypleurochilus geminatus*	M	X
feather blenny	*Hypsoblennius hentzi*	M,E	
highfin blenny	*Lupinoblennius nicholsi*	M	X
seaweed blenny	*Blennius marmoreus*	M	X
fat sleeper	*Dormitator maculatus*	F	X
frillfin goby	*Bathygobius soporator*	E	
darter goby	*Gobionellus boleosoma*	E	
sharptail goby	*G. hastatus*	E	
naked goby	*Gobiosoma bosci*	E	
twoscale goby	*G. longipala*	E	X
tiger goby	*G. macrodon*	M,E	
code goby	*G. robustum*	E	
clown goby	*Microgobius gulosus*	E	
green goby	*M. thalassinus*	E	
Atlantic cutlassfish	*Trichiurus lepturus*	M	
king mackerel	*Scomberomoros cavalla*	M	
Spanish mackerel	*S. maculatus*	M,E	
harvestfish	*Peprilus alepidotus*	M	X
butterfish	*P. triacanthus*	M	X
barbfish	*Scorpaena brasiliensis*	M	X
horned searobin	*Bellator militaris*	M	X
bluespotted searobin	*Prionotus roseus*	M	X
blackfin searobin	*P. rubio*	M	X
leopard searobin	*P. scitulus*	M,E	
bighead searobin	*P. tribulus*	M,E	
ocellated flounder	*Ancylopsetta quadrocellata*	M	X
spotted whiff	*Citharichthys macrops*	M	X
fringed flounder	*Etropus crossotus*	M	
gulf flounder	*Paralichthys albigutta*	M,E	
dusky flounder	*Syacium papillosum*	M	X
lined sole	*Achirus lineatus*	M,E	
hogchoker	*Trinectes maculatus*	M,E	
blackcheek tonguefish	*Symphurus plagiusa*	M,E	
orange filefish	*Aluterus schoepfi*	M	
fringed filefish	*Monacanthus ciliatus*	M,E	
planehead filefish	*M. hispidus*	M,E	
scrawled cowfish	*Lactophrys quadricornis*	M,E	
trunkfish	*L. trigonus*	M,E	X

COMMON NAME	SCIENTIFIC NAME	HABITAT TYPE	ABUNDANCE
smooth truckfish	*L. triqueter*	M	X
smooth puffer	*Lagocephalus laevigatus*	M,E	X
southern puffer	*Sphoeroides nephelus*	M,E	
striped burrfish	*Chilomycterus schoepfi*	M,E	
balloonfish	*Diodon holocanthus*	M	X

Notes: Occurrence code: M—marine; E—estuarine; F—freshwater; X -- uncommon to rare.

APPENDIX E

BIRD SPECIES KNOWN OR EXPECTED TO OCCUR IN THE BCARPA, WITH NESTING, SEASONALITY AND COMMENTS/HABITAT

COMMON NAME	SCIENTIFIC NAME	NESTS IN BCARPA	SEASONAL STATUS SP	SU	F	W	COMMENTS; HABITAT
Common Loon	*Gavia immer*		O		R	O	Open water
Pied-billed Grebe	*Podilymbus podiceps*					O	
Horned Grebe	*Podiceps auritus*		U			C	Open water
American White Pelican	*Pelecanus erythrorhynchos*		C	O		C	Open water, sandbars, shallows
Brown Pelican	*P. occidentalis*	X	C	C		C	Islands, beaches, open water
Double-crested Cormorant	*Phalacrocorax auritus*	X	C	C		C	
Anhinga	*Anhinga anhinga*		C	C		C	
Magnificent Frigatebird	*Fregata magnificens rothschildi*		O	U			Forages over open water
Least Bittern	*Ixobrychus exilis*		C	C		U	Mainland marshes
Great Blue Heron	*Ardea herodias*	X	C	C		C	
Great Egret	*A. alba*	X	C	C		C	
Snowy Egret	*Egretta thula*	X	C	C		C	
Little Blue Heron	*E. caerulea*	X	C	C		C	
Tricolored Heron	*E. tricolor*	X	C	C		C	
Reddish Egret	*E. rufescens*	X	U	U		U	Forages on shallow flats
Cattle Egret	*Bubulcus ibis*	X	C	C		C	
Green Heron	*Butorides striatus*	X	C	C		C	
Black-crowned Night-Heron	*Nycticorax nycticorax*	X	U	U		U	
Yellow-crowned Night-Heron	*Nyctanassa violacea*	X	C	C		C	Marshes of Cargill South Parcel and Kitchen are extremely important for foraging habitat for crab-eaters
White Ibis	*Eudocimus albus*	X	C	C	C	C	Feeds in marshes and on flats
Scarlet Ibis	*E. ruber*						Rare Accidental
Glossy Ibis	*Plegadis falcinellus*	X	C	C	U	U	Feeds in South Parcel marshes
Roseate Spoonbill	*Ajaia ajaja*	X	C	C	U	U	Llocally common; flats, mangroves, creeks
Wood Stork	*Mycteria americana*		O	O	O	O	Flats, mangroves
Black Vulture	*Coragyps atratus*	X	C	C	C	C	
Turkey Vulture	*Cathartes aura*		C	C	C	C	
Caribbean Flamingo	*Phoenicopterus ruber*		-	-	-	-	Accidental; flats, shallows, sandbars
Gadwall	*Anas strepera*		O		O	U	
American Wigeon	*A. americana*		U		U	C	
Mallard	*A. platyrhynchos*		R		R	U	
Mottled Duck	*A. fulvigula*	X	C	C	C	C	
Blue-winged Teal	*A. discors*		U	R	C	C	
Northern Shoveler	*A. clypeata*		U	R	U	C	
Northern Pintail	*A. acuta*		U		U	U	

			SEASONAL STATUS				
COMMON NAME	SCIENTIFIC NAME	NESTS IN BCARPA	SP	SU	F	W	COMMENTS; HABITAT
Green-winged Teal	*A. crecca*		U	R	C	C	
Lesser Scaup	*Aythya affinis*		C	O	C	C	Large flocks on bay waters in winter
White-winged Scoter	*Melanitta fusca*					R	
Oldsquaw	*Clangula hyemalis*		R			R	
Red-breasted Merganser	*Mergus serrator*		C	U	C	C	
Ruddy Duck	*Oxyura jamaicensis*	X	U	R	U	C	
Osprey	*Pandion haliaetus*		C	C	C	C	Forages throughout area
Bald Eagle	*Haliaeetus leucocephalus*		U	U	U	U	Several nests upstream in Bullfrog Creek; forages throughout area
Northern Harrier	*Circus cyaneus*		U		U	U	
Sharp-shinned Hawk	*Accipiter striatus*		U		U	U	
Cooper's Hawk	*A. cooperii*		R		R	R	
Red-shouldered Hawk	*Buteo lineatus*		U	U	U	U	
Red-tailed Hawk	*B. jamaicensis*		U	U	U	U	
American Kestrel	*Falco sparverius*		U		U	U	
Merlin	*F. columbarius*		O		O	O	
Peregrine Falcon	*F. peregrinus*		O		O	O	
Clapper Rail	*Rallus longirostris*	X	U	U	U	U	
Sora	*Porzana carolina*		U		U	U	
Common Moorhen	*Gallinula chloropus*	X	U	U	U	U	
American Coot	*Fulica americana*		U		U	U	
Black-bellied Plover	*Pluvialis squatarola*		C	U	C	C	
Wilson's Plover	*Charadrius wilsonia*		U	U	U	C	
Semipalmated Plover	*C. semipalmatus*		C	U	C	C	
Killdeer	*C. vociferus*		U	U	U	U	
American Oystercatcher	*Haematopus palliatus*	X	U	U	U	U	Locally fairly common; beaches, shores, flats
Black-necked Stilt	*Himantopus mexicanus*	X	C	C	U	U	
American Avocet	*Recurvirostra americana*		U	U	U	U	
Greater Yellowlegs	*Tringa melanoleuca*		C	U	C	U	
Lesser Yellowlegs	*T. flavipes*		C	U	C	C	
Solitary Sandpiper	*T. solitaria*					O	
Willet	*Catoptrophorus semipalmatus*	X	C	C	C	C	Breeds in high marsh, forages on marsh edges and flats
Spotted Sandpiper	*Actitis macularia*		C	O	C	C	
Whimbrel	*Numenius phaeopus*		O	O	O	O	

			SEASONAL STATUS				
COMMON NAME	SCIENTIFIC NAME	NESTS IN BCARPA	SP	SU	F	W	COMMENTS; HABITAT
Long-billed Curlew	*N. americanus*		O		O	O	
Marbled Godwit	*Limosa fedoa*		C	O	C	U	
Ruddy Turnstone	*Arenaria interpres*		C	U	C	C	
Red Knot	*Calidris canutus*		C	O	C	C	
Sanderling	*C. alba*		U		U	U	
Semipalmated Sandpiper	*C. pusilla*		C	U	C		
Western Sandpiper	*C. mauri*		C	U	C	C	
Least Sandpiper	*C. minutilla*		C	U	C	C	
Dunlin	*C. alpina*		C	O	C	C	
Stilt Sandpiper	*C. himantopus*		U	R	U	U	
Short-billed Dowitcher	*Limnodromus griseus*		C	U	C	C	
Common Snipe	*Gallinago gallinago*		U		U	C	
Laughing Gull	*Larus atricilla*	X	C	C	C	C	Abundant; islands, shores, flats, open water
Bonaparte's Gull	*L. philadelphia*					U	
Ring-billed Gull	*L. delawarensis*		C	O	C	C	
Herring Gull	*L. argentatus*		U	O	U	U	
Gull-billed Tern	*Gelochelidon nilotica*	X	O	O			
Caspian Tern	*Sterna caspia*	X	U	U	U	U	Island shores and sandbars, forages over open water
Royal Tern	*S. maxima*	X	C	C	C	C	Island shores and sandbars, forages over open water
Sandwich Tern	*S. sandvicensis*	X	U	U	U	U	Island shores and sandbars, forages over open water
Common Tern	*S. hirundo*		R	O	O	R	Island shores and sandbars, forages over open water
Forster's Tern	*S. forsteri*		C	U	C	C	*Island shores and sandbars, forages over open water*
Least Tern	*S. antillarum*	X	C	C	U		*Island shores and sandbars, forages over open water*
Black Tern	*Chlidonias niger*		U	C	U		*Island shores and sandbars, forages over open water*
Black Skimmer	*Rynchops niger*	X	C	C	U	U	*Island shores and sandbars, forages over open water and coves, creeks*
Rock Dove	*Columba livia*	X	C	C	C	C	*Nests in manmade structures*
Mourning Dove	*Zenaida macroura*	X	C	C	C	C	
Common Ground-Dove	*Columbina passerina*	X	U	U	U	U	
Yellow-billed Cuckoo	*Coccyzus americanus*		U	U	U		
Mangrove Cuckoo	*C. minor*		R	R			Possibly decreasing locally due to Brown-headed Cowbird nest parasitism
Common Barn Owl	*Tyto alba*		U	U	U	U	
Eastern Screech-Owl	*Otus asio*		C	C	C	C	
Great Horned Owl	*Bubo virginianus*		U	U	U	U	

			SEASONAL STATUS				
COMMON NAME	SCIENTIFIC NAME	NESTS IN BCARPA	SP	SU	F	W	COMMENTS; HABITAT
Short-eared Owl	*Asio flammeus*					R	
Common Nighthawk	*Chordeiles minor*	X	U	U	U		
Chuck-will's-widow	*Caprimulgus carolinensis*	X	U	U	U		
Whip-poor-will	*C. vociferus*				O	O	
Chimney Swift	*Chaetura pelagica*		U	U	U		
Ruby-throated Hummingbird	*Archilochus colubris*		U		U		
Belted Kingfisher	*Ceryle alcyon*		U	O	C	C	
Red-bellied Woodpecker	*Melanerpes carolinus*	X	C	C	C	C	
Yellow-bellied Sapsucker	*Sphyapicus varius*				O	O	
Downy Woodpecker	*Picoides pubescens*		C	C	C	C	
Northern Flicker	*Colaptes auratus*		C	C	C	C	
Pileated Woodpecker	*Dryocopus pileatus*		U	U	U	U	
Eastern Phoebe	*Sayornis phoebe*		U		U	C	
Great Crested Flycatcher	*Myiarchus crinitus*	X	C	C	C	U	
Gray Kingbird	*Tyrannus dominicensis*	X	U	U	U		
Loggerhead Shrike	*Lanius ludovicianus*	X	U	U	U	U	
White-eyed Vireo	*Vireo griseus*	X	C	C	C	U	
Yellow-throated Vireo	*V. flavifrons*		R	R	R		
Solitary Vireo	*V. solitarius*		U	R	U	U	
Red-eyed Vireo	*V. olivaceus*		C	U	C		
Black-whiskered Vireo	*V. altiloquus*		R	R	R		Formerly nested in the ARPA; possibly extirpated
Blue Jay	*Cyanocitta cristata*		C	C	C	C	
Fish Crow	*Corvus ossifragus*	X	C	C	C	C	
Purple Martin	*Progne subis*		C	C	U		
Tree Swallow	*Tachycineta bicolor*		C	U	C	U	
N. Rough-winged Swallow	*Stelgidopteryx serripennis*	X	U	U	U		
Bank Swallow	*Riparia riparia*		U		U		
Barn Swallow	*Hirundo rustica*		C	O	C		
Carolina Wren	*Thryothorus ludovicianus*		C	C	C	C	
House Wren	*Troglodytes aedon*		U		U	C	
Sedge Wren	*Cistothorus platensis*		R		R	R	
Marsh Wren	*C. palustris*		O		O	O	
Ruby-crowned Kinglet	*Regulus calendula*		C		C	C	

			SEASONAL STATUS				
COMMON NAME	SCIENTIFIC NAME	NESTS IN BCARPA	SP	SU	F	W	COMMENTS; HABITAT
Blue-gray Gnatcatcher	*Polioptila caerulea*		C	U	C	C	
Hermit Thrush	*Catharus guttatus*				R	R	
American Robin	*Turdus migratorius*		U		U	C	
Gray Catbird	*Dumetella carolinensis*	X	C		C	C	
Northern Mockingbird	*Mimus polyglottos*	X	C	C	C	C	
Brown Thrasher	*Toxostoma rufum*	X	C	C	C	U	
European Starling	*Sturnus vulgaris*		C	C	C	C	
Cedar Waxwing	*Bombycilla cedrorum*		U			U	
Orange-crowned Warbler	*Vermivora celata*		R		R	U	
Northern Parula	*Parula americana*		C	U	C	R	
Yellow Warbler	*Dendroica petechia*				R	R	
Magnolia Warbler	*D. magnolia*		O		O		
Cape May Warbler	*D. tigrina*		U	R	O		
Black-throated Blue Warbler	*D. caerulescens*		U				
Yellow-rumped Warbler	*D. coronata*		C		U	C	
Yellow-throated Warbler	*D. dominica*		U	R	U	U	
Prairie Warbler	*D. discolor discolor*	X	U	U	U	U	Nests in mangroves
Palm Warbler	*D. palmarum*		U		U	C	
Black-and-white Warbler	*Mniotilta varia*		C		C	C	
American Redstart	*Setophaga ruticilla ruticilla*		U	R	U	R	
Ovenbird	*Seiurus aurocapillus*		U		U	U	
Northern Waterthrush	*S. noveboracensis*		U		U	R	
Louisiana Waterthrush	*S. motacilla*				R	R	
Common Yellowthroat	*Geothlypis trichas*		C	U	C	C	
Summer Tanager	*Piranga rubra*		U	U	U	R	
Scarlet Tanager	*P. olivacea*				O		
Eastern Towhee	*Pipilo erythrophthalmus*	X	C	C	C	C	
Savannah Sparrow	*Passerculus sandwichensis*		C		U	C	
Swamp Sparrow	*Melospiza georgiana*		R			U	
Northern Cardinal	*Cardinalis cardinalis*	X	C	C	C	C	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*		U			R	

			SEASONAL STATUS				
COMMON NAME	SCIENTIFIC NAME	NESTS IN BCARPA	SP	SU	F	W	COMMENTS; HABITAT
Indigo Bunting	*Passerina cyanea*		U			R	
Painted Bunting	*P. ciris*		U			R	
Bobolink	*Dolichonyx oryzivorus*		U		U		
Red-winged Blackbird	*Agelaius phoeniceus*	X	C	C	C	C	
Eastern Meadowlark	*Sturnella magna*		C	C	C	C	
Common Grackle	*Quiscalus quiscula*		C	C	C	C	
Boat-tailed Grackle	*Q. major*		C	C	C	C	
Brown-headed Cowbird	*Molothrus ater*		C	R	C	C	
Orchard Oriole	*Icterus spurius*		U		U		
Baltimore Oriole	*I. galbula*		U		U		
American Goldfinch	*Carduelis tristis*		U			U	
House Sparrow	*Passer domesticus*		U	U	U	U	

Notes: Occurrence code: C – common, O – occasional, U – uncommon, R – rare