Chapter 7

Southeast Florida

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In

Oyster Integrated Mapping and Monitoring Program Report for the State of Florida No. 2

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Description of the region

Southeast Florida features some of the most highly altered landscapes in the state, in Broward and Miami-Dade counties, as well as unique habitats in the Florida Keys archipelago. Broward and Miami-Dade are the most populous counties in Florida; the estimated 2022 population for these two counties was over 4.6 million (U.S. Census 2022). Monroe County, which includes the Florida Keys, had an estimated population of 81,708 in 2022 (U.S. Census 2022). Oyster populations are primarily controlled by temperature and salinity, with the magnitude and frequency of salinity fluctuations being a driving force in oyster recruitment, health, and abundance (Parker et al. 2013, Buzzelli et al. 2015). Eastern oyster (*Crassostrea virginica*) salinity requirements are complex and vary geographically, but 10–20 on the practical salinity scale is typically considered optimal for survival and reproduction (USACE 2019, Wingard et al. 2022). Extremely low or high salinity can lead to mortality and the timing of extreme salinity fluctuations can impact oyster reproduction and health (Wingard et al. 2022). While southeast Florida once supported healthy oyster populations (Smith 1896, Meeder et al. 1999, 2001, Gambordella 2007), the canalization and redirection of freshwater inflow in this region altered both the magnitude and frequency of salinity fluctuations in coastal waters, limiting the distribution of oyster reefs (Parker et al. 2013, Geiger et al. 2019). While the presence of some extant oysters has been noted in published sources (FDEP 2013, Geiger et al. 2019, FWC 2023), remaining oyster reefs in southeast Florida are not well mapped due to the difficulty of identifying the reefs using aerial imagery, with high tannin content and turbidity being limiting factors.

Broward County

Before it was developed, much of the coast of Broward County (Fig. 7.1) was dominated by sawgrass (*Cladium jamaicense*) and other freshwater marsh plants (USFWS 1999a, Zahina et al. 2007, FDEP 2012a, 2020). The Intracoastal Waterway was constructed in Broward County in 1912 and the creation of inlets through barrier islands led to a brackish nearshore environment, killing freshwater species (FDEP 2020). The Intracoastal Waterway connects to the Atlantic Ocean north of Broward County at the Boca Raton Inlet, within Broward County at the Hillsboro Inlet and Port Everglades, and south of Broward County at Haulover Inlet. Dense urban development is now found along the coast of Broward County, including thousands of residences lining finger canals in dredge-and-fill developments. Most of this county has a hardened shoreline consisting of seawalls and riprap. Upstream canals and rainfall are the main sources of freshwater to the Intracoastal Waterway (Dausman and Langevin 2005).

The few natural coastal areas remaining in Broward County include Deerfield Island Park, Dr. Von D. Mizell-Eula Johnson State Park, Hugh Taylor Birch State Park (where oysters are uncommon), and the areas around West Lake (some oysters attached to mangrove roots). Small populations of oysters live on many of the

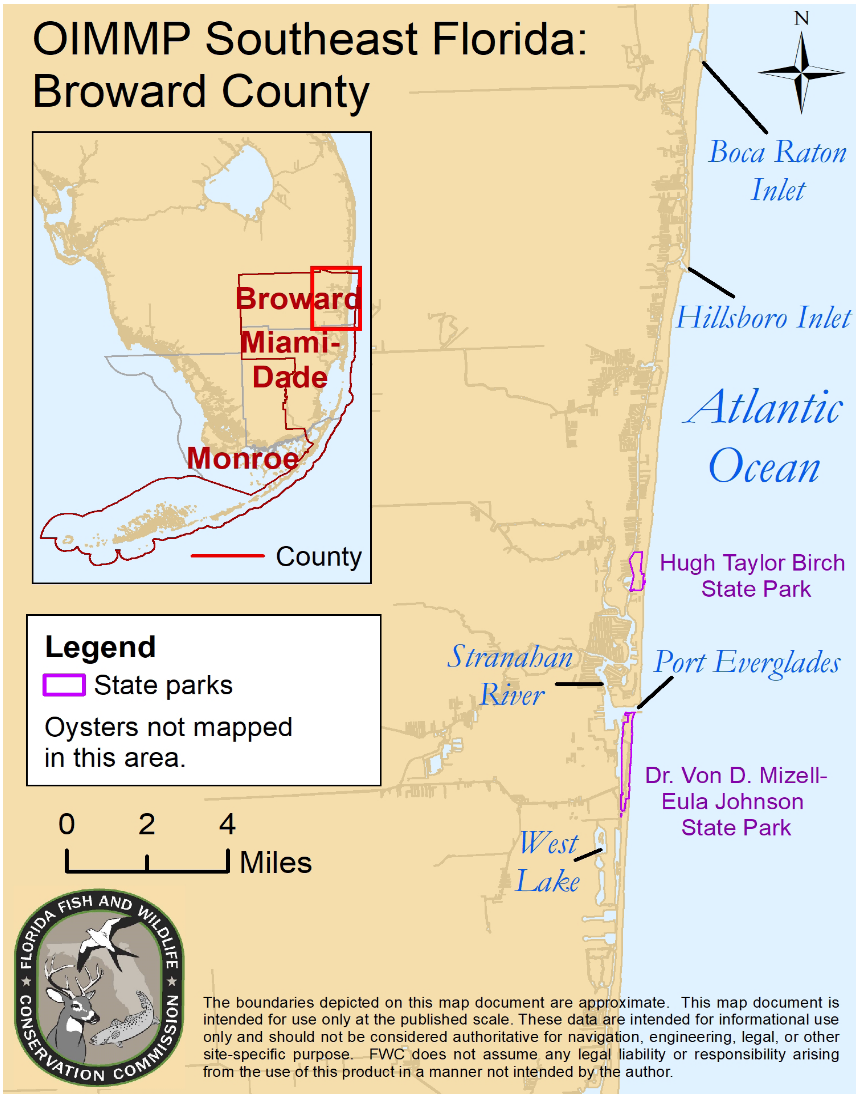

Figure 7.1. Major features of the Broward County coast. There are no mapped oyster reefs in this area.

extensive seawalls in this area. Oyster species include the eastern oyster and the flat tree oyster (*Isognomon alatus*). Oysters have been noted during some seagrass surveys, but oyster mapping efforts in Broward County have been limited. Ongoing subtidal mapping efforts by the South Florida Association of Environmental Professionals (www.SFAEP.org) are described in the mapping and monitoring efforts section below.

Miami-Dade County: Biscayne Bay

The Intracoastal Waterway connects to the Atlantic Ocean at Haulover Inlet and Government Cut. South of Haulover Inlet, the Intracoastal Waterway passes through Biscayne Bay, which has more direct and open connections to the Atlantic Ocean. Biscayne Bay is a semi-enclosed basin in Miami-Dade County that is approximately 75 km (47 mi) long and 16 km (10 mi) across at its widest point. The bay includes two aquatic preserves: Biscayne Bay Aquatic Preserves and Biscayne Bay National Park (Fig. 7.2). Biscayne Bay has an average depth of 1.8 m (6 ft) and serves as a major shipping port with incised channels often exceeding 15 m (49 ft) in depth that are maintained with regular dredging (Harlem 1979, Comp and Seaman 1985, Caccia and Boyer 2005, Thomas et al. 2021). Biscayne Bay was historically connected to the Everglades watershed via rivers and creeks that ran through and around the Atlantic Coastal Ridge, a ridge of limestone that runs along part of Biscayne Bay's western shore. Wetlands surrounded Biscayne Bay and surface water entered the bay as a diffuse sheet of freshwater and through numerous small creeks and groundwater springs (Browder et al. 2005). Northern Biscayne Bay, which is partly enclosed and separated from the Atlantic Ocean by a series of barrier islands, used to be a brackish estuary because of freshwater input from the Everglades. Eastern oysters were relatively abundant in northern Biscayne Bay in those moderate-salinity waters, as evidenced by remnant oyster shells in sediments and historical accounts (Smith 1896, Meeder et al. 1999, 2001, CERP 2011). Shell middens along Biscayne Bay provide evidence of oyster harvesting by Native Americans (Gambordella 2007, FDEP 2013). The northern part of the bay supported numerous oyster reefs and even a small oyster fishery in the late 1890s (Smith 1896, Meeder et al. 2001). Smith (1896) described oysters as being abundant on mangrove roots, pilings, boats, and submerged logs. Dense reefs also existed in the bay and near rivers, particularly close to Little River and Indian Creek.

Central Biscayne Bay is broadly connected to the Atlantic Ocean, but is separated by a submerged ridge of Pleistocene-age coral reef, which is emergent at Key Biscayne, Elliott Key, and several smaller keys. Southern Bis-

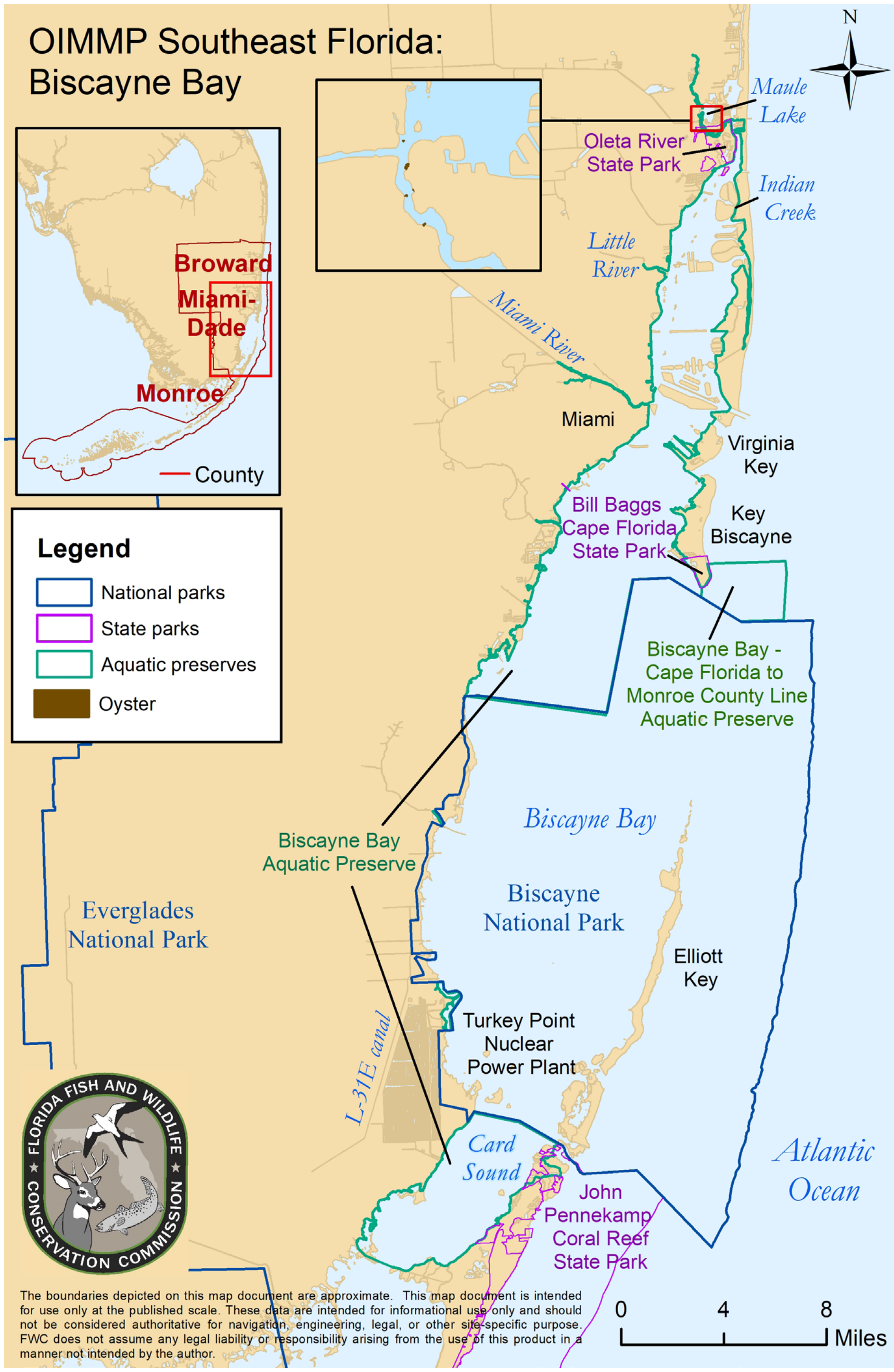

Figure 7.2. Map of oyster reefs (see inset map) and major features of Biscayne Bay. Oyster mapping source: FWC (2023), made from 2022 ground truthing.

cayne Bay is partly sheltered from the Atlantic by Elliott Key and other islands in the northernmost extent of the Florida Keys. The central and southern parts of the bay historically had higher salinity than northern Biscayne Bay, as determined based on the shells of marine mollusk species found in sediment cores from those areas (Stone et al. 2000, Gambordella 2007). Relict oyster reefs have been found at the mouths of mangrove creeks in central Biscayne Bay (Meeder et al. 2001), but central and southern Biscayne Bay were unlikely to host extensive oyster reefs — even before humans altered the watershed (Gambordella 2007).

The construction of canals, ditches, and levees in the 1800s and 1900s drastically altered the hydrology of Biscayne Bay and concentrated freshwater flow into constructed canals. This led to the loss of many of the mangrove creeks and resulted in large seasonal fluctuations in salinity due to the variable freshwater input (Browder et al. 2005). The high-velocity release of fresh water does not readily mix with salt water in the bay, resulting in rapid changes in salinity that may kill estuarine organisms (Chin-Fatt and Wang 1987, CERP 2011). The Biscayne Aquifer, which contributes fresh groundwater to Biscayne Bay, is found in highly permeable limestone and sand from Miami-Dade County through Broward to southern Palm Beach County and supplies water for much of the population of southeast Florida (USFWS 1999b, CERP 2010). Canal construction in the early 1900s lowered the water table and groundwater levels continue to decline due to urban and agricultural freshwater withdrawal (FDEP 2013).

The western shore of the southern half of the Biscayne Bay is largely lined with mangrove forests that are often cut through by tidal creeks. Historically, these creeks drained a small watershed, but as the area was developed, many of the creeks were disconnected by a series of water management canals and mosquito control ditches. The main waterflow is bisected by the L-31E canal, which disrupts the coastal sheet flow that once fed the creeks. The canal system still diverts most of the local watershed flow into a small number of canals, such that sheet flow from land into the bay was largely eliminated by 1962 (Buchanan and Klein 1976). Near the southernmost point of the bay, the Turkey Point nuclear power plant dispenses water into an impoundment containing a large series of dredged canals, with the intent of cooling the thermal effluent (Parker 2003).

Under the present hydrological regime, salinity often exceeds 30 in Biscayne Bay but varies spatially and temporally relative to freshwater runoff and flows from the canals. Salinity at two continuous monitoring sites (BBCW8 and BBCW10) ranged from 9 to 45 or higher over the long-term period of record (March 2009–May 2023), but that range has decreased to 12 to 40 in recent years (2021–2023) (Fig. 7.3). An average of 97% of days at BBCW8 and 94% of days at BBCW10 over the past three years have had 7-day mean salinities below 35, which is considered ideal for most estuarine organisms, compared to the period of record of 88% and 86%, respectively.

Oysters were once sufficiently abundant to support a fishery in northern Biscayne Bay. Today, oysters are only found occasionally on mangrove roots, docks, pilings, or in upstream areas of the Oleta River (FDEP 2013, FWC 2023). Oleta River State Park is Florida's largest urban park and contains the only remaining river in Miami-Dade County that has not been dredged or channelized for development (FDEP 2022). Spanning over seven miles, the brackish water of the mangrove-lined Oleta River supports shallow subtidal oyster reefs (FDEP 2022, FWC 2023). The coastline south of Oleta River State Park is mostly urbanized with hardened shorelines. Along this shoreline, eastern oysters and some mussels are found on seawalls, bridges, and riprap, especially in areas that receive urban runoff from storm drains (Voss 1976, H Stewart, personal observation). Flat tree oysters are also found at some creeks, but they do not form reefs or accumulate substrate. In central Biscayne Bay, relict oyster reefs are present near some tidal creeks (Meeder et al. 2001) and a small number of live oysters associated with mangrove roots are occasionally found.

The Comprehensive Everglades Restoration Plan (CERP) includes efforts to redirect freshwater flow from canals into coastal wetlands to restore the hydrology to a more natural state (CERP 2011). Specifically, the goal of the Biscayne Bay Coastal Wetlands Project, Phase 1 has been to restore the natural hydrology to improve the ecology of Biscayne National Park and the Biscayne Bay Aquatic Preserve (OERI 2022). This project is comprised of three components: Deering Estate, Cutler Wetlands, and the L-31E flow-way. Using a spreader canal system, the aim is to redistribute surface water flow to rehydrate coastal wetlands while reducing freshwater point source discharges. Portions of the Deering Estate and the L-31E flow-way have been constructed and are scheduled for completion in November 2024. The Cutler Wetlands construction is scheduled for completion in summer 2024. Once complete, the project will rehydrate 77 hectares (190 acres) of freshwater wetlands and increase the hydroperiod from 70 to 200 days per year, which will improve the health and distribution of wetland vegetation, oysters, submerged aquatic vegetation, and associated biota. Improvements in ecological conditions downstream, as evidenced by decreased salinity and increased recruitment of freshwater tolerant sawgrass, have been observed and documented in recent years (OERI 2022). These changes are expected to increase the abundance and diversity of fishes, reptiles, and wading birds and extend the distribution of oysters and submerged aquatic vegetation. Though these CERP efforts are likely to create a more estuarine salinity regime, the lack of available hard substrate for settlement will limit resurgence of the oyster populations. The addition of substrate will increase the probability of functional oyster reefs reestablishing in the area (Parker et al. 2013).

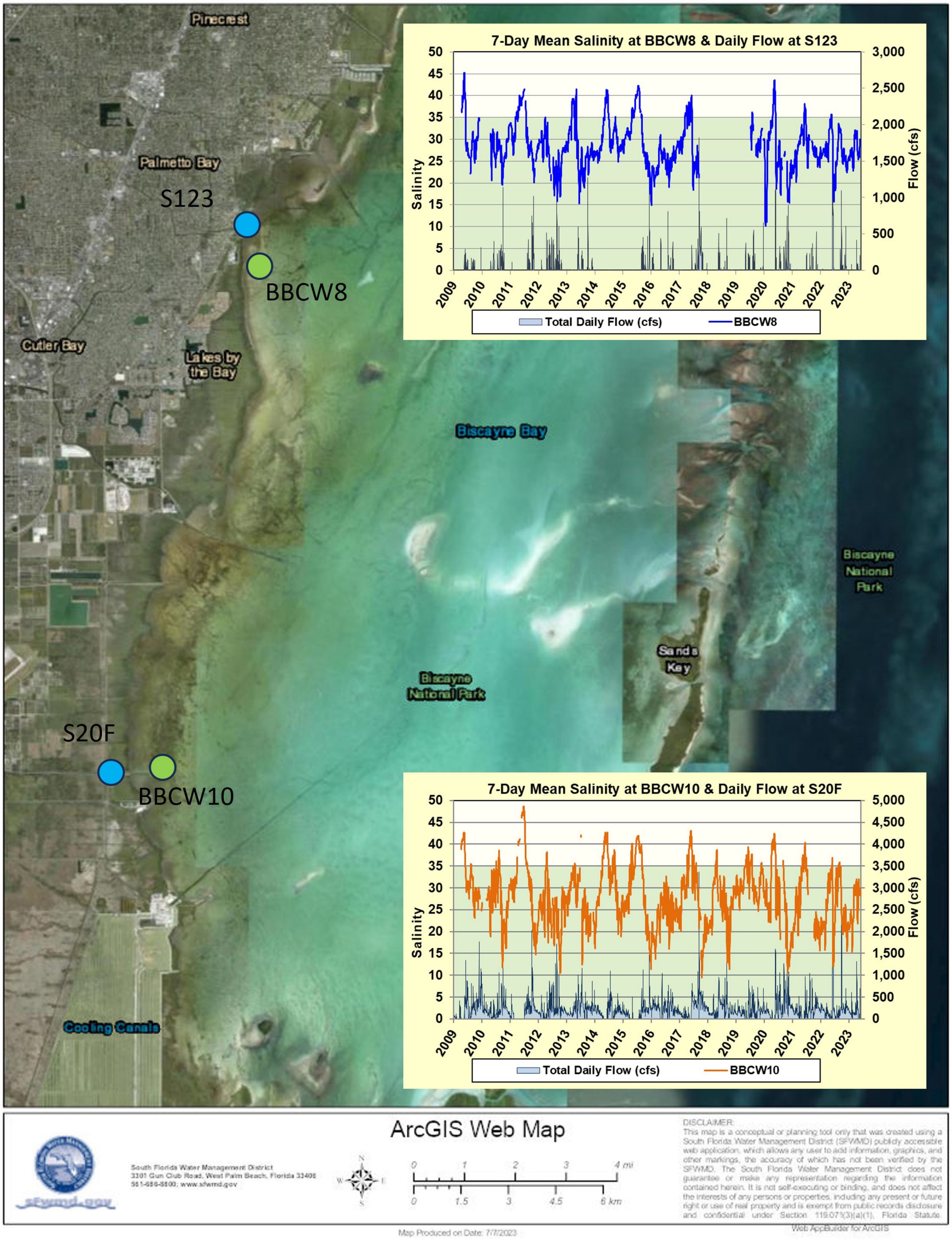

Figure 7.3. Seven-day mean salinity and total daily inflow in Biscayne Bay. The green band indicates salinity < 35, which is considered ideal for most estuarine organisms. Data from March 19, 2009 – August 9, 2021 provided by SFWMD and data from August 31, 2021 onward provided by Biscayne National Park.

Monroe County: Florida Keys

The Florida Keys are a 210 km long (130 mi) archipelago on the southern edge of Florida (Fig. 7.4). The region is encompassed by the Florida Keys National Marine Sanctuary. Additional protected regions in the Sanctuary include Crocodile Lake National Wildlife Refuge (NWR), National Key Deer Refuge, Great White Heron NWR, and Key West NWR, as well as several state parks and aquatic preserves. Beginning near the border of Miami-Dade and Monroe counties, a series of sounds are found between the mainland and the primary tract of the Florida Keys. These sounds are all semi-enclosed and have low tidal amplitudes and minimal exchange with other water bodies. The shoreline in these areas is mostly lined with mangroves. The lack of freshwater input and poor water circulation makes these sounds largely inhospitable to oysters. Oysters in the Everglades and Florida Bay are described in Chapter 6.

Continuing south, the middle and lower Florida Keys are a mix of hardened shorelines, mangroves, and occasional sandy beaches. Sources of fresh water include small amounts of terrestrial runoff, including runoff from watering lawns. Salinity is too high to support extensive populations of the eastern oyster, but small groups of this species are occasionally found on hardened shorelines or mangrove prop roots (Mikkelsen and Bieler 2000). Several species of non-reef-building oysters are present in the Florida Keys, including two other species within the family Ostreidae: the root oyster (*C. rhizophorae*) and the crested oyster (*Ostrea stentina*) (Mikkelsen and Bieler 2000). The morphology of these oysters is plastic, as they often develop around their settlement substrate. The root oyster has a straighter and more elongated hinge than the eastern oyster, as well as an elongated muscle scar. The crested oyster has a series of fine marginal teeth, which are not present in either *Crassotrea* species, and a lighter muscle scar (Mikkelsen and Bieler 2007). The other most common oyster in the Keys is the scaly pearl oyster (*Pinctada longisquamosa*), which can sometimes be abundant in seagrass meadows. Other oyster species present include the sponge oyster (*O. permollis*), Atlantic pearl oyster (*P. imbricata*), black-lipped pearl oyster (*P. margaritifera*), Atlantic wing oyster (*Pteria colymbus*), glassy wing oyster (*P. hirundo*), tree oysters (*Isognomon alatus*, *I. bicolor*, and *I. radiatus*), hammer oyster (*Malleus candeanus*), frond oyster (*Dendostrea frons*), threaded oyster (*Teskeyostrea weberi*), and foam oysters (*Hyotissa mcgintyi*, *H. hyotis*, and *Neopycnodonte cochlear*) (Mikkelsen and Bieler 2000, 2007; FDEP 2012b, 2019).

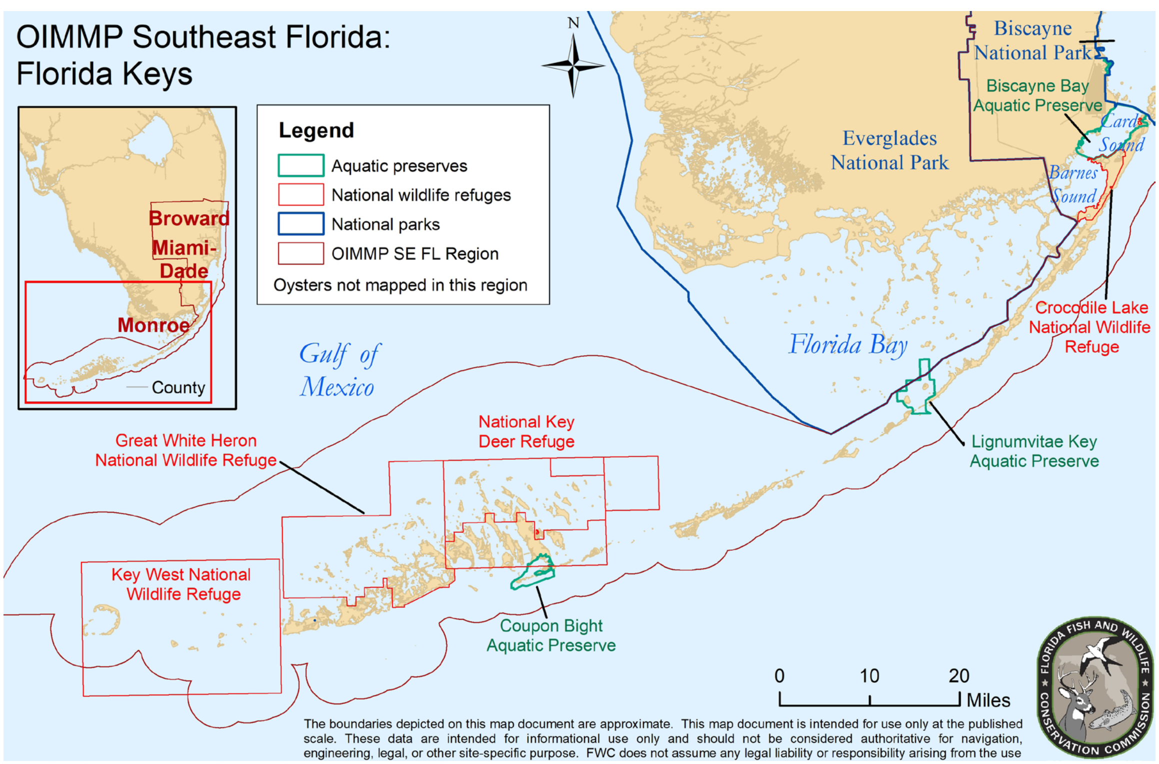

Figure 7.4. Major features of the Florida Keys. There are no mapped oyster reefs in the Florida Keys. Oysters in the Everglades and Florida Bay are mapped and discussed in Chapter 6.

Threats to oysters in southeast Florida

Reef-building eastern oysters are rare in southeast Florida, largely as a result of suboptimal salinity regimes. The threats to oysters listed here are therefore restricted to areas (namely Biscayne Bay) that are known to have hosted significant oyster reefs in the past.

- **Altered hydrology:** The hydrology of Biscayne Bay has been significantly altered by intense urbanization and the construction of drainage canals, which have decreased sheet flow through coastal wetlands and natural creeks. Water management canals preclude natural coastal flow and deliver large pulses of sediment-rich water through a few large canals. Such canals allow rapid delivery of water that is often hypoxic and contaminated with urban runoff (SFWMD 1995). Additionally, the canals are generally steep-walled and linear, so their shorelines offer little habitat value. Restoration of minimal flows to the many mangrove-lined tidal creeks around the bay would enhance their chances of supporting small oyster communities (Meeder et al. 2001).
- **Isolated populations:** The survival and resilience of any remaining oyster populations are of concern due to their isolation from other oyster populations and vulnerability to continued urban development (Arnold et al. 2008). Biscayne Bay oysters are isolated from other oyster reefs on the southeast coast of Florida; the closest significant population of oysters is in the Lake Worth Lagoon in Palm Beach County.
- **Habitat loss:** The coast of Broward County and northern Biscayne Bay is heavily developed and much of the natural shoreline has been replaced by seawalls and other structures. Dredging and alteration of the natural shoreline has greatly reduced habitat availability for oyster settlement and growth.
- **Sea-level rise:** Rises in sea level suppress freshwater influence, further contributing to the current high salinity regime in Biscayne Bay, such that brackish conditions may be eliminated in the bay except for waters adjacent to managed drainage canals. Sea-level rise may also result in increased durations of submergence, which would limit the intertidal exposure time that offers oysters refuge from predation, pests, and disease (Bahr and Lanier 1981). Increased submergence times due to sea-level rise, along with increasing salinity, lead to greater susceptibility to disease (Shumway 1996), predation, and pests (e.g., the boring sponge *Cliona celata*; Carroll et al. 2015).
- **Water quality:** Biscayne Bay continues to show signs of decline with increased occurrences of hypoxia and associated fish mortality events and seagrass die-offs, indicating increased nutrient enrichment and the immediate need for action to improve water quality (Brandt et al. 2022). Water quality, particularly salinity, is directly correlated to the health and distribution of oysters; so much so that eastern oysters are frequently used as indicators of water quality (Brandt et al. 2022).

Oyster reef mapping and monitoring efforts

The compilation of oyster maps used in the figures in this report are available for download at http://geodata.myfwc.com/datasets/oyster-beds-in-florida. This mapping layer is updated as new maps become available. An index of all oyster maps in Florida is available for viewing at https://experience.arcgis.com/experience/4b82f5d17a794543bddf889472a763eb.

South Florida Association of Environmental Professionals eastern oyster mapping

The South Florida Association of Environmental Professionals (SFAEP) used nautical charts and insight from biological resources staff at the Broward County Resilient Environment Department and the Miami-Dade County Division of Environmental Resources Management to identify locations where eastern oyster populations have been documented in Broward County's New River, Middle River, and Cypress Creek. Subsequently, the SFAEP commenced citizen-scientist oyster surveys using a towed-cable underwater camera to survey for oysters and identify submerged areas for potential oyster reef creation.

Historical oyster distribution study

Meeder et al. (2001) completed a study to identify tidal creek sites along western Biscayne Bay that were appropriate for restoration of freshwater discharge to support oyster growth. Site selection was based on evidence of past oyster populations (determined by the presence of oyster shells in sediments) and salinity targets were based upon the physiological requirements of oysters.

FWC baseline mapping and monitoring

In the winter of 2005–2006, FWC and Golder Associates surveyed oyster distribution in the Sebastian River, Saint Lucie Estuary, Lake Worth Lagoon, and Biscayne Bay using a real-time kinematic global positioning system (RTK GPS) (Gambordella et al. 2007). Oyster reefs were identified using earlier oyster maps, helicopter aerial surveys, and sounding lines. Few live oysters and no oyster reefs were found in Biscayne Bay, so no oyster maps were produced for the bay.

Comprehensive Everglades Restoration Program oyster monitoring

Oysters have been monitored as part of the CERP Restoration Coordination and Verification (RECOVER) program by the FWC since 2005 (Arnold et al. 2008, Parker et al. 2013, Parker 2015, Parker and Radigan 2020). Monitored basins included the Saint Lucie Estuary, Loxahatchee River, Mosquito Lagoon, Sebastian River, Lake Worth Lagoon, Biscayne Bay (monitored from 2005 to 2007), and Tampa Bay (Arnold et al. 2008). The metrics included the spatial and size distributions of oyster populations, physiological condition, disease frequency, and rates of reproduction, recruitment, growth, and survival in south Florida estuaries. Too few oysters were present in Biscayne Bay for systematic density surveys. Most oysters existed as rare inhabitants of mangrove roots and others were occasionally found along seawalls, where fresh water was supplied by lawn watering. Relict reefs were found at the mouths of several creeks (Parker et al. 2013). A few oysters did settle on settlement arrays monitored from July to November, but settlement rates were much lower than those in other Florida estuaries. As oysters were found only inconsistently and in small numbers, no clear patterns of either reproductive development or condition indices could be reported (Arnold et al. 2008).

Growth and mortality were monitored in the estuaries mentioned in the paragraph above by monitoring planted juvenile oysters. Oysters in Biscayne Bay had a mean shell height in the low-to-mid range compared with oysters in other estuaries. The condition indices of oysters in Biscayne Bay were in the middle of the range compared with oysters in other south Florida estuaries. A few oysters were collected in 2005 and 2007 for investigation of the disease intensity of dermo (*Perkinsus marinus*) and MSX (*Haplosporidium nelsoni*) (Arnold et al. 2008). The infection intensities and prevalence of dermo were low and mean infection intensity was below 1 on the scale of 0 to 5 developed by Mackin (1962). There were no signs of MSX (Arnold et al. 2008).

The Biscayne Bay and Southeastern Everglades Ecosystem Restoration (BBSEER) planning study, which comprises the C-111 Spreader Canal Eastern Project and Phase II of the Biscayne Bay Coastal Wetlands Project, began in September 2020. The purpose of the BBSEER is to restore nearshore conditions in Biscayne Bay, Biscayne National Park, Card Sound, Barnes Sound, and Manatee Bay (Brandt et al. 2022). The Integrated Biscayne Bay Ecological Assessment and Monitoring (IBBEAM) is part of the CERP RECOVER Monitoring and Assessment Plan and is a multi-entity project of the National Oceanic and Atmospheric Administration's, National Marine Fisheries Service, the University of Miami, and the National Park Service. Salinity and biological data collected by IBBEAM in the southwestern Biscayne Bay nearshore area between Shoal Point and Turkey Point are being used in the BBSEER planning effort to develop performance measures to screen project design alternatives for their ability to help reach BBSEER goals. Eastern oysters are one of the system-wide ecological indicators for the CERP; their abundance and distribution remain well below restoration targets in nearby Lake Worth Lagoon because most projects that will benefit the species have not yet been completed (Brandt et al. 2022, OERI 2022).

NOAA Mussel Watch

The NOAA National Status and Trends Program has analyzed chemical and biological contaminant trends in sediment and bivalve tissue through the Mussel Watch program across the coastal United States since 1986 (https://coastalscience.noaa.gov/science-areas/pollution/mussel-watch/). The Mussel Watch Program currently monitors more than 600 contaminants at a network of over 300 sites nationwide, with seven of those sites located in southeast Florida. Monitored contaminants include legacy contaminants such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), chlorinated pesticides including dichlorodiphenyltrichloroethane (DDT) and tributyltin (TBT), trace elements such as mercury, lead, and cadmium, and contaminants of emerging concern (CECs) such as chlorinated paraffins, per- and polyfluoroalkyl substances (PFAS), flame-retardant polybrominated diphenyl ethers (PBDEs), and pharmaceuticals. Monitoring activities are designed to quantify and assess spatial and temporal trends in coastal contamination and to provide a baseline to assess the impacts of anthropogenic and natural events, including chemical spills, tropical storms, and hurricanes. Monitoring locations in this region include Maule Lake in North Miami, Gould's Canal and Princeton Canal in Biscayne Bay, and Bahia Honda in the Florida Keys (Kimbrough et al. 2008). A subset of these sites was last sampled in 2020.

Oleta River oyster reef mapping

In November 2022, OIMMP personnel alongside the Watershed Action Lab (https://www.watershedactionlab.com/) and graduate students from the Rosenstiel School of Marine, Atmospheric, and Earth Science (RSMAES) conducted ground truthing surveys of 12 potential oyster reefs in the Oleta River using an RTK GPS (FWC 2023). Oyster reefs were identified by citizen scientists using a mobile citizen science monitoring application (https://watershedactionlab.ushahidi.io) on which oyster reefs can be reported with GPS coordinates and photographs of the oyster reefs can be uploaded (Fig. 7.5). Only sites with live, intact oyster reefs qualified for oyster reef classification and mapping. Sites with scattered shells, scattered oyster clumps, or oysters growing on mangrove roots or artificial substrate were not considered oyster reefs for this effort. Five of the 12 ground-truthed locations were classified as live oyster reefs (Fig. 7.6). When an oyster reef was confirmed, the outline of the reef was mapped with the RTK GPS and the collected datapoints were used to outline the reef. Shapefiles of all mapped oyster reefs are available in the statewide oyster reef map, Oyster Beds in Florida (FWC 2023).

Mollusk survey of the Florida Keys

Mikkelsen and Bieler published an extensive paper on marine bivalves (Mikkelsen and Bieler 2000) and a book on marine mollusks found in the Florida Keys (Mikkelsen and Bieler 2007). These publications include species lists with depth and location distributions throughout the Keys, as well as records of collection dates for museum specimens.

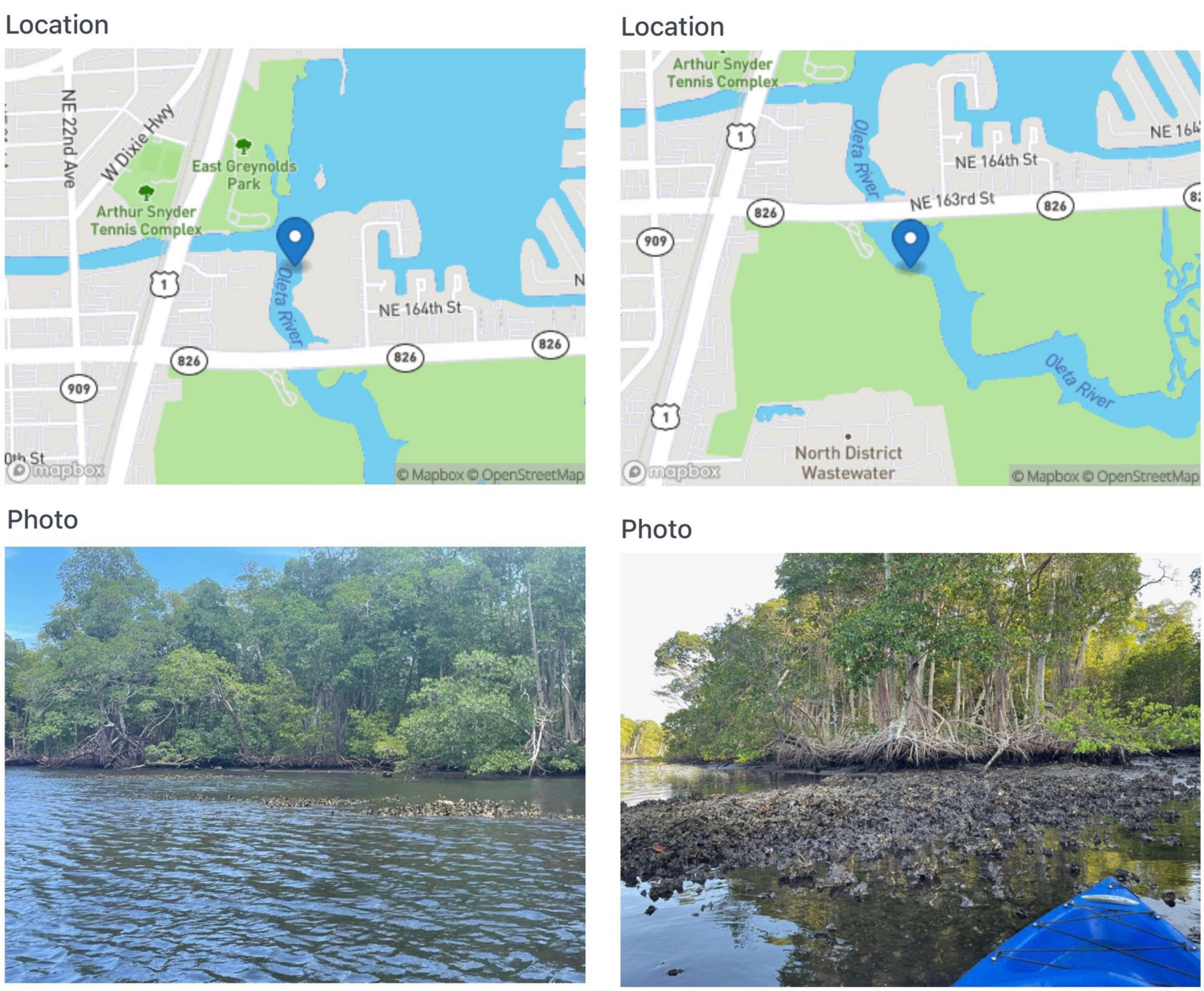

Figure 7.5. Examples of Oleta River oyster reefs reported through the Watershed Action Lab oyster monitoring app (https://watershedactionlab.ushahidi.io).

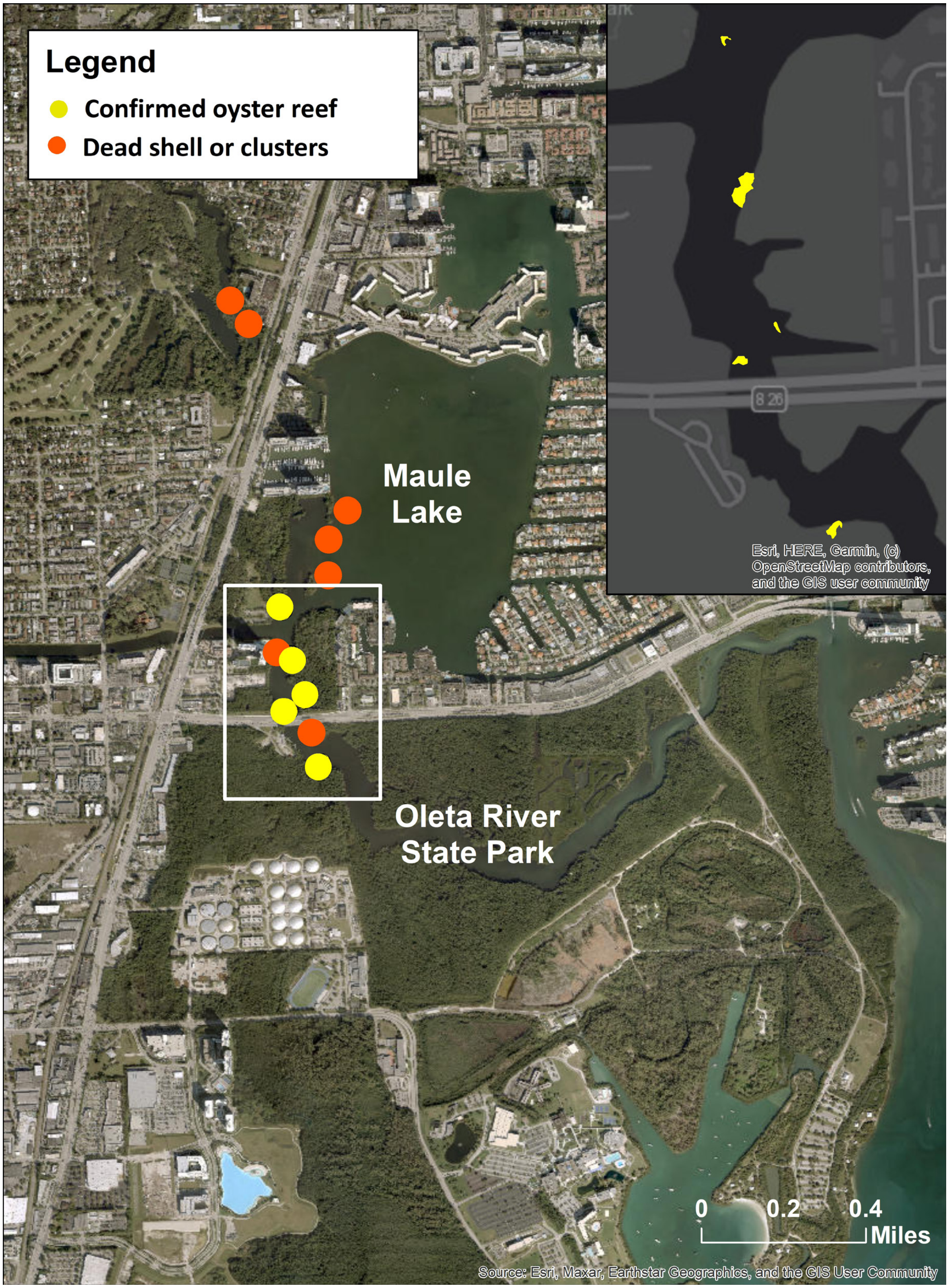

Figure 7.6. Locations of reported oyster reefs in Oleta River that were ground-truthed in November 2022 (FWC 2023). Five subtidal live oyster reefs were mapped (locations shown as yellow dots above; the yellow polygons on the inset map outline the extent of the reefs). Sites that were found to only contain dead shell or sparse clusters (red) were not included in the final oyster map.

Selected restoration efforts

Broward County oyster restoration study

The Coastal Conservation Association (www.ccaflorida.org) Broward Chapter began a pilot study gathering data on salinity, temperature, and oyster species in coastal waters near Fort Lauderdale. In spring 2020, volunteers placed 100 Oyster Catcher™ patties (Fig. 7.7) and rope on almost 100 docks. The citizen science program involved volunteers taking photographs of the patties weekly initially and then once a month until the end of the program. The program found that oyster recruitment became less concentrated along waterways in closer proximity to downtown Fort Lauderdale. The New River, Himmarshee Canal, and Tarpon River were identified as water bodies that formerly supported oysters in the past, but now struggle to propagate new growth.

Figure 7.7. Oyster Catcher™ patties before deployment and one year after deployment in Broward County.

Port Everglades community oyster gardening program

In December 2016, the SFAEP (www.SFAEP.org) started a community oyster gardening program with the goals to promote conservation of native oysters through public outreach, to supplement the distribution of oysters in southeast Florida through distribution of free oyster cultch bags and mats to owners of estuarine properties, and to restore oyster beds on submerged lands in southeast Florida. The program has received support from several local organizations including the Urban Farming Institute (www.discoverufi.org), the Coastal Conservation Association, and Marine Discovery Centers' Shuck & Share Program (www.shuckandshare.org). The first test cultch bag was deployed in the Dania Cutoff Canal in May 2019. In December 2021, SFAEP also began a collaboration with Broward County Port Everglades, which established a drying area for eastern oyster shells provided by a local restaurant.

Native oyster restoration project in Biscayne Bay

The Watershed Action Lab (https://www.watershedactionlab.com/) began a program to engage residents living on the waterway with oyster restoration. In this program, landowners can elect to have vertical oyster lines (mimicking mangrove roots) or native oyster "mother colony" cages added to their property. Additionally, citizen scientists are asked to monitor local water quality. The goal of the program is to increase oyster habitat and community awareness of the threats facing oysters in the region.

Recommendations for mapping, monitoring, and management

- Conduct a rapid assessment to determine if oysters are present in natural areas along Broward and Miami-Dade counties. Natural areas that may be able to support oyster communities include Deerfield Island Park, Hugh Taylor Birch State Park, and numerous tidal creeks along the western shoreline of Biscayne Bay. A presence–absence assessment would enable determination of need for future mapping and monitoring activities. These areas should also be assessed periodically for the presence of oyster larvae in the water column.
- Restore freshwater flow from the L-31E canal to some of the natural tidal creeks in Biscayne Bay. If oyster

larvae are present, the placement of suitable substrate might allow settlement and rebuilding of oyster populations. If no larvae are present, transplanting live oysters from the nearest suitable population, likely Lake Worth Lagoon, may be required. Small-scale efforts should be implemented before broader, large-scale efforts are planned.

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