Status Survey and Monitoring of Cape Sable Thoroughwort, *Chromolaena frustrata* (B.L. Rob.) R.M. King and H. Rob.

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Final report submitted by
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Introduction

Cape Sable thoroughwort, *Chromolaena frustrata* (B.L. Rob.) R.M. King and H. Rob., is an endemic herb in the Asteraceae. Its historical range included the Florida Keys from Key Largo to Boca Grande Key (12 miles west of Key West) and the southern mainland from the Cape Sable or Flamingo area to the Madeira Bay area in what is now Everglades National Park. The taxonomy and full history of the species is discussed in Bradley & Gann (1999).

In 1999, only a few populations were known to exist and *C. frustrata* was recommended for federal listing under the Endangered Species Act (Bradley & Gann 1999). It was reported to have not been seen recently in Everglades National Park (Reimus 1999), apparently having last been seen there in 1977 (Gann et al. 2002, Bradley & Gann 1999). In 1999 It was also known in the Florida Keys from two state parks (Long Key State Park, Lignum Vitae Key Botanical State Park) and three private stations (Big Munson Island, Teatable Hammock on Upper Matecumbe Key [which has now been acquired], and North Layton Hammock on Long Key). The total number of plants at these stations was unknown. Because of the rarity of the species The Institute for Regional Conservation (IRC) listed it as critically imperiled in South Florida (Gann et al. 2002).

This survey was undertaken to determine the current conservation status of *C. frustrata* including the number of occurrences, the number of plants, and threats to the species. In addition, monitoring was initiated at one station in order to track long-term changes in the population and to monitor changes in habitat.

Methods

Historical documentation for *C. frustrata* was collected, including herbarium label data from Fairchild Tropical Garden (FTG), the University of South Florida (USF), the University of Florida (FLAS), Florida State University (FSU), the New York Botanical Garden (NY), and the U.S. National Herbarium (US). We have also studied appropriate literature pertaining to the genus and species, floristic works treating its historical range, and the unpublished botanical notes of the late botanist George N. Avery (who left descriptions of where he observed the species). All pertinent literature used is included in the References section, regardless of whether or not it was cited in this report. We have also communicated with local biologists and naturalists who may be aware of possible localities for the species.

All specific localities where the species had been reported previously were surveyed. Exceptions were made if a locality had been destroyed or had been surveyed previously by IRC staff. Searches were made by at least two field biologists. Positions of plants or colonies were recorded with a Garmin GPS unit. Site descriptions were recorded in the field, including habitat descriptions, associated plant species, threats, and management concerns.

A monitoring program was begun at Long Key State Park. Five plots were established in the coastal rock barren in association with *C. frustrata*. Each plot consists of five, 5 m transects placed at 2 meter intervals across *C. frustrata* habitat. Each plot was centered so that the middle of each 5 m transect was at the ecotone along the edge of an open sunny gap and denser hardwoods, which is the microhabitat where most *C. frustrata* plants are found. At 1 dm intervals, each plant species intercepting the line was recorded. At every 5 dm, the vegetation height was recorded. This will allow for a quantification of the cover of each plant species in the plots, including *C. frustrata*,

natives, and exotics. It will also allow us to track how canopy density changes over time. Plots were marked with drops of marine paint on rocks at the beginning, middle, and ends of each transect, and each of these points was mapped at sub-meter accuracy with a Trimble GPS unit .

Results - Status Survey

C. frustrata was found to be extant on five islands in Monroe County in the Florida Keys, and one area of the mainland in Everglades National Park. It is extirpated on six islands in the Florida Keys. Two historical stations in Everglades National Park were not accessible to us and thus were no surveyed; but there is a high likelihood that plants are still present in those locations. Several other reported stations on the mainland are treated as unconfirmed, as described below.

Approximately 467 plants were observed on four islands in the Florida Keys, and several thousand on Big Munson Island in the Florida Keys. Approximately 150 plants were found on the mainland in Everglades National Park. Each area where plants were historically known are discussed below.

Mainland (Everglades National Park) *(Map 2)*

John Kunkel Small first observed *C. frustrata* in 1916 on the Florida mainland in what is now Everglades National Park (Small, 1919). He observed plants near the west end of Madeira Bay, in a hammock along the edge of Florida Bay. Small apparently did not collect specimens there, as none were found at the New York Botanical Garden or other herbaria. In 1921, Small and others did collect the species to the west in hammocks between West Lake and Flamingo (9995, NY). Bruce Ledin made collections of the species on two days in 1947, one labeled "Cape Sable" (s.n., FTG) and another labeled "Stream Bank, Above Cape Sable" (s.n., FLAS). "Cape Sable" has been used by many collectors to refer to the greater Cape Sable/Flamingo region, so the location of Ledin's collection is uncertain. Both Small (1933) and Ledin (1951) report the species from Cape Sable. George N. Avery observed plants at two localities in this region (Avery 1983). He observed it along the west side of the Buttonwood Canal north of Bear Lake Road, and he also observed plants south of West Lake. Each observation was made in a low hammock.

Our searches in Everglades National Park were concentrated in the Flamingo region. Transportation could not be arranged to areas south of West Lake or to Madeira Bay, which would have required a boat or helicopter. Populations were observed off of the Bear Lake Road and along the Rowdy Bend Trail (Map 2). This large area is along one long narrow hammock, and is the same location were one observation was made by Avery and one collection was made by Small. The species appears to be rare in the Park. Fewer than 150 plants were observed.

In addition to the Bear Lake Road and Rowdy Bend Trail areas brief surveys were conducted by Gann prior to the initiation of this project on coastal berms at the mouth of the Taylor River, along Snake Bight Road, the cotton picker trail east of Snake Bight Road, and along the Coastal Prairie Trail. No plants were found at these stations. No plants were found in surveys by Woodmansee et al. (2003) in several habitats west of the Buttonwood Canal and north of the Main Park Road in the vicinity of a water treatment plant.

The colonies that were observed in Everglades National Park occurred along the ecotone between coastal berm and salt marshes dominated by *Conocarpus erectus* and halophytes (e.g *Sesuvium portulacastrum, Batis maritima, Salicornia perennis*). At all of the locations where *C. frustrata* was observed, the plants were found in a narrow sub-habitat along the ecotone, in areas of scattered

sunlight dominated by *Dicliptera sexangularis* and *Alternanthera flavescens* in the herb layer and by various woody species including *C. erectus, Randia aculeata, Eugenia foetida, Sideroxylon celastrinum,* and *Capparis flexuosa. C. frustrata* was found in nearly all of the localities surveyed where this assemblage was found.

The narrow habitat where *C. frustrata* has been observed in Everglades National Park is rare in the Park. Only scattered examples exist along the coastal berm edges that we surveyed, and *C. frustrata* is typically rare even when it is present. The edges of coastal berms in Everglades National Park have sustained human impacts such as road construction or clearing and exotic pest plant invasions that have probably caused a decline in the number of *C. frustrata* there. The invasion of exotic pest plants continues to be a significant problem and threat to the species. *Colubrina asiatica* and *Schinus terebinthifolius* have invaded large areas of coastal berm and coastal berm edges. Some mechanical disturbances would have also had an impact on *C. frustrata,* such as the construction of the Rowdy Bend Trail along the edge of a coastal berm. This construction impacted the population not just by clearing habitat, but by creating disturbances that later led to exotic pest plant invasions. The impacts of hydrological changes caused by rising sea level, changes in fresh water deliveries, and the construction of the Buttonwood Canal are unknown.

Florida Keys

C. frustrata was historically known from nearly the entire range of the Florida Keys, from Key Largo near the upper end, to Boca Grande Key, west of Key West. It has never been found on the islands north of Key Largo in Biscayne National Park, despite extensive survey work under a different project by IRC. It has also never been found west of Boca Grande in the Marquesas or Dry Tortugas, areas that have also been well explored by botanists. In this survey, plants were found to be extant on only five islands: Upper Matecumbe Key, Lignum Vitae Key, Big Munson Island, Boca Grande, and Long Key. It is no longer known from six islands where is was previously collected.

Big Munson Island *(Map 3)*

Big Munson Island is owned by the National Council of the Boy Scouts of America and is located just southwest of Big Pine Key. It is accessible only by boat. *C. frustrata* was first observed on Big Munson Island by Bradley, who collected it there in 2001 (2128, FTG). This station was surveyed on May 17, 2003 and the species was found to be more abundant there than anywhere else in its range. Thousands of plants occupy a small rockland hammock near the west end of the island. In many places it forms a dense ground cover, especially along the outer edges of the hammock. Because the population was so dense, it was impossible to accurately determine the population size. The number of plants in this population may be due to thinning of the hammock canopy caused by Hurricane Georges in September 1998, and may decline as the canopy reforms. Species associates at this site are similar to other sites, but many plants here occur in the interior of the hammock, not just along the edge. Much of this population suffered from severe herbivory, but no insects were observed on any plants.

This population is secure from development at present, but foot traffic by Boy Scouts visiting the island should be limited to trails.

Big Pine Key *(Map 4)*

Plants were first collected on Big Pine Key by John Loomis Blodgett (s.n., NY) sometime between 1838 and 1853, the period when Blodgett lived on Key West. His specimen reads only "Woods. Pine Key." In 1955, Frank C. Craighead made a collection on Big Pine Key (s.n., FLAS), but

unfortunately provided no specific locality data. During this study we surveyed several hammock areas on the island. IRC staff had previously surveyed Cactus Hammock and Watson Hammock, so those hammocks were not searched. While suitable habitat does appear to exist not only at Cactus Hammock on the southeast corner of Big Pine as well as at the northern tip of the island, no plants were found.

Boca Grande Key *(Map 5)*
Boca Grande Key is located about 12 miles west of Key West in the Key West National Wildlife Refuge. It is accessible only by boat. *C. frustrata* was collected there by John H. Davis in 1940 (s.n., FLAS). In 1996, the authors surveyed most of this island but did not see the species. In a trip on May 16, 2003 the species was found along the edges of one small hammock in the center of the island. Approximately 25 plants were found. The hammock has formed on limestone and has a low canopy dominated by *Guapira discolor, Eugenia foetida,* and *Metopium toxiferum.* Other associates include *Dicliptera sexangularis, Alternanthera flavescens, Cordia sebestena, Randia aculeata, Capparis flexuosa, C. cynophallophora, Acanthocereus tetragonus,* and *Paspalidium chapmanii.*

Fiesta Key
Sometime in the 1800s (probably 1875) Alvan W. Chapman collected *C. frustrata* on "Jew Fish Key" (s.n., US), writing "plant 2 feet high, exhaling a strong unpleasant odor" (Chapman 1878). This station probably refers to what is now called Fiesta Key, just east of Long Key (see http://keys.fiu.edu/gazetteer) The island is now occupied by a KOA campground and is devoid of natural habitat; aerial photography shows that it is completely developed and bare of vegetation. Thus, this island was not surveyed.

Key Largo
The northernmost island where *C. frustrata* occurred was Key Largo. The species was collected on this large island in 1880 by Allan H. Curtiss in a "rich thicket" (Robinson 1911). It was also collected on the island in 1930 by Walter H. Buswell (s.n., FTG). No other reports are known from Key Largo, despite extensive botanical exploration on that island. In floristic surveys by IRC staff and others at John Pennekamp Coral Reef State Park, Dagny Johnson Key Largo Hammocks Botanical State Park, Crocodile Lake National Wildlife Refuge, and Dove Creek Hammocks no plants of *C. frustrata* were found. This large island has undergone extensive disturbance and development and it is likely that Buswell's station was destroyed.

Key West
John Loomis Blodgett collected *C. frustrata* on Key West sometime between 1838 and 1853 (Robinson 1911), the period of his residence on Key West. Key West, settled by 1821, has been almost completely developed. Only a small fragment of hammock exists at Little Hamaca Park which has been surveyed by IRC staff and other botanists. No other reports of *C. frustrata* have been seen from Key West despite a great deal of botanical activity there since the 1820s.

Knight's Key
Knight's Key lies at the beginning of the Seven Mile Bridge in the middle Keys just west of Vaca Key. *C. frustrata* was observed there by George N. Avery in 1962 around the edge of a hammock and in cleared areas. It was collected there by Donovan S. Correll in 1979 (50973, USF, FTG, NY) along the edge of and in a marsh. No suitable habitat remains on the island, which has been searched by Bradley. Residential development now occupies almost all of the uplands on the island.

Lignum Vitae Key *(Map 6)*
Lignum Vitae Key, part of the Lignumvitae Key Botanical State Park, lies just north of Lower Matecumbe Key and is accessible only by boat. *C. frustrata* was collected there in the late 1800s by Allan H. Curtiss (1195, FLAS, GH, NY). The GH specimen is the type of the species. Subsequent collections have been made there by C.P. Sreemadhavan in 1971 (4906, USF) and Bradley (458, FTG). It was also observed there by George N. Avery in 1964. In surveys on May 6, 2003 we found two discrete subpopulations along the south end of the island, one near its southeast corner and one near its southwest corner. Approximately 81 plants were observed. Both subpopulations occurred in different places along the southern edge of the hammock. Common associates include *Conocarpus erectus, Eugenia foetida, Dicliptera sexangularis, Borrichia frutescens, Blutaparon vermiculare, Sesuvium portulacastrum, Reynosia septentrionalis,* and *Capparis cynophallophora.* A few plants in one of these populations occur in or along the edges of the island's nature trail, including one plant along the edge of the trail to the park manager's house. Plants were formerly present around the Matheson House, but those plants were extirpated due to landscape maintenance practices (Gann et al. 2002).

Long Key *(Map 7)*
C. frustrata was first collected on Long Key by Alvan W. Chapman in 1875 (s.n., US). Ann Buckley and Ted Hendrickson collected it there in 1986 (322, FTG), in a coastal rock barren on the Florida Bay side of Long Key State Park. It was collected at the same station by Bradley in 1995 (281, FTG) and has been observed there by the authors and others (Gann et al. 2002). In 1998, Bradley also observed plants at North Layton Hammock in coastal rock barren and rockland hammock on private property northeast of the town of Layton.

On April 23, 2003 an area between the town of Layton and the north end of Long Key was searched. Approximately 70 plants were found in coastal rock barren, and 92 plants along the edge of rockland hammock. While this area is mostly privately owned, including all of the rockland hammock, a portion of the coastal rock barren has recently been added to Long Key State Park, protecting some plants. The rest of the property is on the state acquisition list. On May 21, 2003 the coastal rock barren in Long Key State Park was surveyed. Approximately 200 plants were found to occur throughout the coastal rock barren, but this is probably an underestimate as the habitat is very difficult to search thoroughly.

Lower Matecumbe Key
C. frustrata was collected on Lower Matecumbe Key by Harold N. Moldenke in 1930 (623, NY) in "dry sandy soil." This is the only known record from this island. While much of Lower Matecumbe Key has been developed, some is now protected within the Lignumvitae Key State Botanical Site. One area, known as the Klopp Tract, has been well surveyed by Gann and Janice A. Duquesnel. No plants have been found there. An addition to the Klopp Tract was acquired and annexed into the park after field work on this project was completed, so it has not been surveyed. Surveys of this station should be conducted.

Upper Matecumbe Key *(Map 8)*
C. frustrata was collected by Joseph H. Simpson on Upper Matecumbe Key in 1892 (565, NY, US). Subsequent collections were made by John Kunkel Small in 1919 (9329, NY; 9333, US), Frank C. Craighead in 1962 (s.n., USF), Olga Lakela in 1968 (31601, FTG, USF), and Bradley in 1998 (1435, FTG).

In a survey on April 23, 2003, 18 plants were found along a disturbed hammock edge near the southwest end of the Choate Tract (formerly Teatable Hammock), newly acquired as part of the Lignumvitae Key Botanical State Park. Plants were growing with the exotic shrub *Cryptostegia grandiflora* which dominated the canopy, as well as the natives *Pithecellobium unguis-cati, Eugenia foetida, Dicliptera sexangularis, Jacquemontia pentanthos, Capraria biflora,* and *Commelina erecta.*

Unconfirmed Reports *(Map 1)*

C. frustrata has been reported from several stations that are suspect. Moldenke (1940) reports it for "Turner's River Hammock" in Collier County, citing collection number 5770. Small (1933) also reports it for hammocks of the 10,000 Islands. Moldenke's specimens were distributed primarily to the New York Botanical Garden, but the specimen was not found. It may have been misidentified. No specimens collected by Small in that region have been found to substantiate his report.

The common name of *C. frustrata*, Cape Sable Thoroughwort, places it in a locality where it may have never occurred. As discussed above, Bruce Ledin made collections labeled Cape Sable, but his usage of this place name may have been referring to the greater Cape Sable/Flamingo area, and not specifically Cape Sable itself. Both Small (1933) and Ledin (1951) also write that the species was present on Cape Sable, but no additional specimens or verifiable reports have been seen placing it on Cable Sable proper. Small may have also been referring to the Flamingo area where he had collected specimens.

Moldenke (1940) also reports it for Buena Vista in Miami-Dade County, citing collection 5459. Again, no specimens from the Buena Vista area were found. Roger Hammer (1995) reports the species to the north of Buena Vista in Greynolds Park, but this seems to be erroneous. Hammer does not recall seeing the species there.

Results - Monitoring

Five plots were established in December 2003 and January 2004 in the coastal rock barren at Long Key State Park (Map 9). Sixty species were recorded. Of these sixty, three are non-native: *Schinus terebinthifolius*, *Evolvulus alsinoides*, and *Fimbristylis cymosa.* Total cover of these three species is 7.5%; *S. terebinthifolius* alone 3.5%. Species that occurred with a cover of over 10% were *Conocarpus erectus* (23.3%), *Jacquemontia pentanthos* (22.5%), *Dicliptera sexangularis* (14.7%), *Cassytha filiformis* (14.0%), *Eugenia foetida* (13.7%), and *Pithecellobium unguis-cati* (12.6%), all natives. *Chromolaena frustrata* occurred at a cover of 0.9%.

Fourteen state-listed plant species occur in the plots (Table 1). One of these, *Chamaesyce garberi,* is listed by the U.S. Fish and Wildlife Service as threatened. In addition, two federal candidates were present, *C. frustrata* and *Indigofera mucronata* var. *keyensis.* The state endangered *Opuntia triacanthos* was also present immediately adjacent to some of the transects.

Discussion

C. frustrata was found on only five islands in the Florida Keys and one small area of the mainland in Everglades National Park. Fewer than 5000 plants are estimated to exist, with all but about 500 of these present on a single privately owned island. It has been extirpated from half of the islands where it once occurred.

Conservation and recovery efforts for this species should focus on habitat management and site acquisition. Exotic pest plants are a threat at each station, especially Brazilian-pepper (*Schinus terebinthifolius*) and lather leaf (*Colubrina asiatica*). As evidenced at Big Munson Island, *C. frustrata* may respond positively to occasional hurricanes or tropical storms that thin hammock canopies, providing more light. If exotic pest plants are present at sites when a storm hits, they may respond similarly, becoming dominant in *C. frustrata* habitat and not allowing for a pulse in the population of the species. This may radically alter the long term population dynamics of the *C. frustrata*, keeping population sizes small or declining, until they eventually disappear.

Acquisition of the privately-owned North Layton Hammock, including areas of coastal rock barren and rockland hammock on Long Key, should be a priority (Map 7). A small portion of this area has been acquired by the State of Florida, but further acquisitions are necessary. Acquisition of these areas would also protect populations of the federally endangered *Pilosocereus robinii*, the federally threatened *Chamaesyce garberi*, and a suite of state listed plant species. Rather than trying to acquire Big Munson Island from the Boy Scouts, the Service or another agency should work with the group to manage the rockland hammock on the island and limit foot traffic. The Boy Scouts are interested in protecting rare plant species on the island and would be willing cooperators.

Reintroductions to islands where *C. frustrata* has been extirpated could be attempted. On Big Pine Key, suitable habitat was observed in the National Key Deer Refuge in Cactus Hammock and at the north end of the island. On Key Largo, suitable habitat may exist at John Pennekamp Coral Reef State Park, Dagny Johnson Key Largo Hammocks Botanical State Park, Crocodile Lake National Wildlife Refuge, or Dove Creek Hammocks. If necessary, the species could be introduced to other islands in the species' historical range between Key Largo and Boca Grande.

Monitoring at Long Key State Park should be continued annually. This monitoring will allow for the detection of changes in the *C. frustrata* population there, as well as vegetation change within it's habitat. The ecology of the coastal rock barren ecosystem is poorly understood, and monitoring these plots will help us to broaden our understanding of the ecosystem. We will also be able to detect changes due to habitat management, storm events, exotic pest plant invasions, and possibly sea level rise. Monitoring of other populations should also be conducted.

Additional surveys are needed on Lower Matecumbe Key and in Everglades National Park. The region from West Lake to Madeira Bay should be surveyed, as plants were historically present there. These areas are very difficult to reach and special permissions must be obtained from the National Park Service to visit some areas. Transportation by helicopter or boat must also be arranged.

Acknowledgments

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of the Boy Scouts of America provided us with transportation to Big Munson Island. Bob Zepp of Everglades National Park provided us with a permit to conduct surveys in the Flamingo area. Melissa Abdo of IRC participated in all field surveys and Abdo and Jimi Sadle (IRC) participated in plot establishment. Abdo also provided useful comments on this report.

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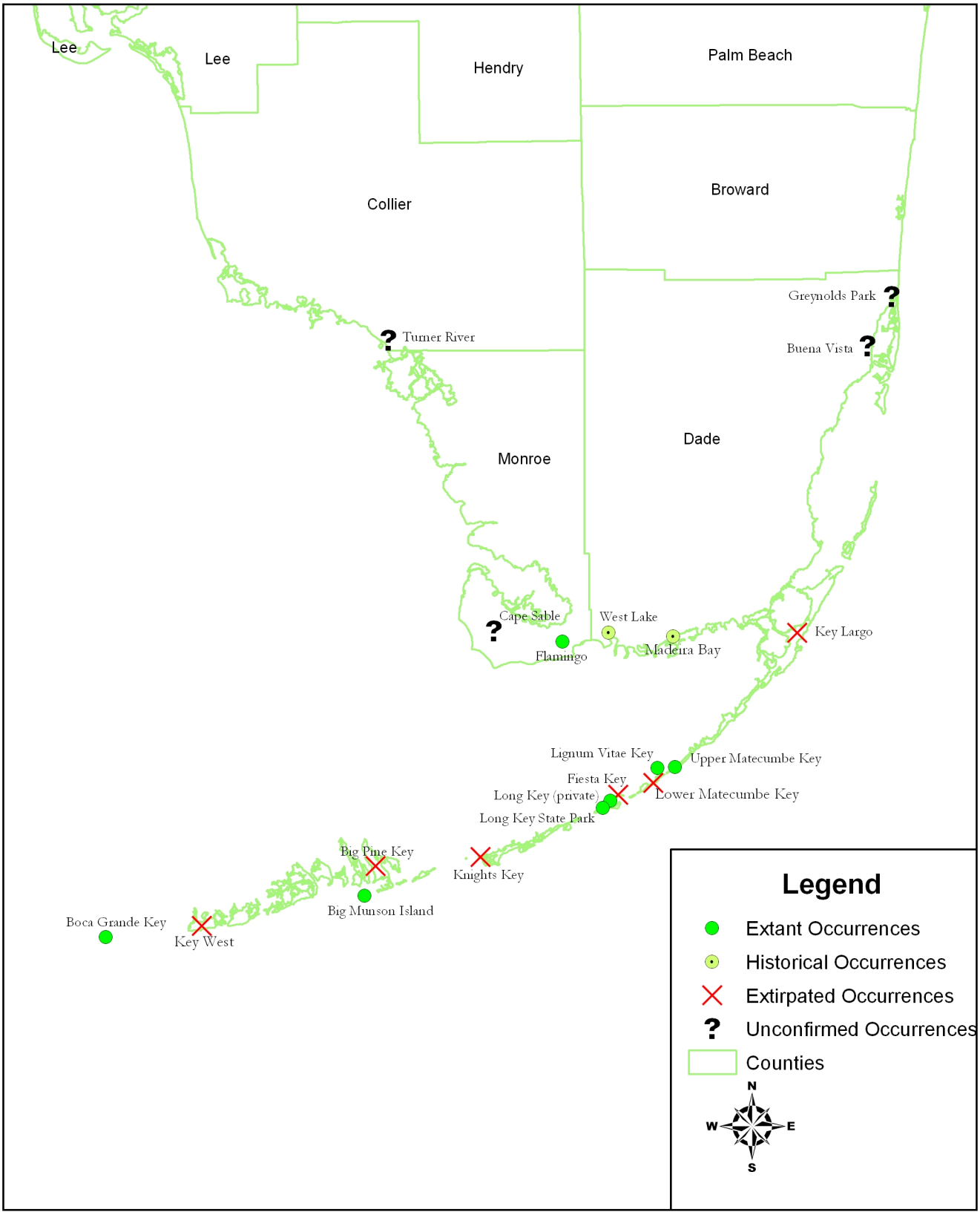
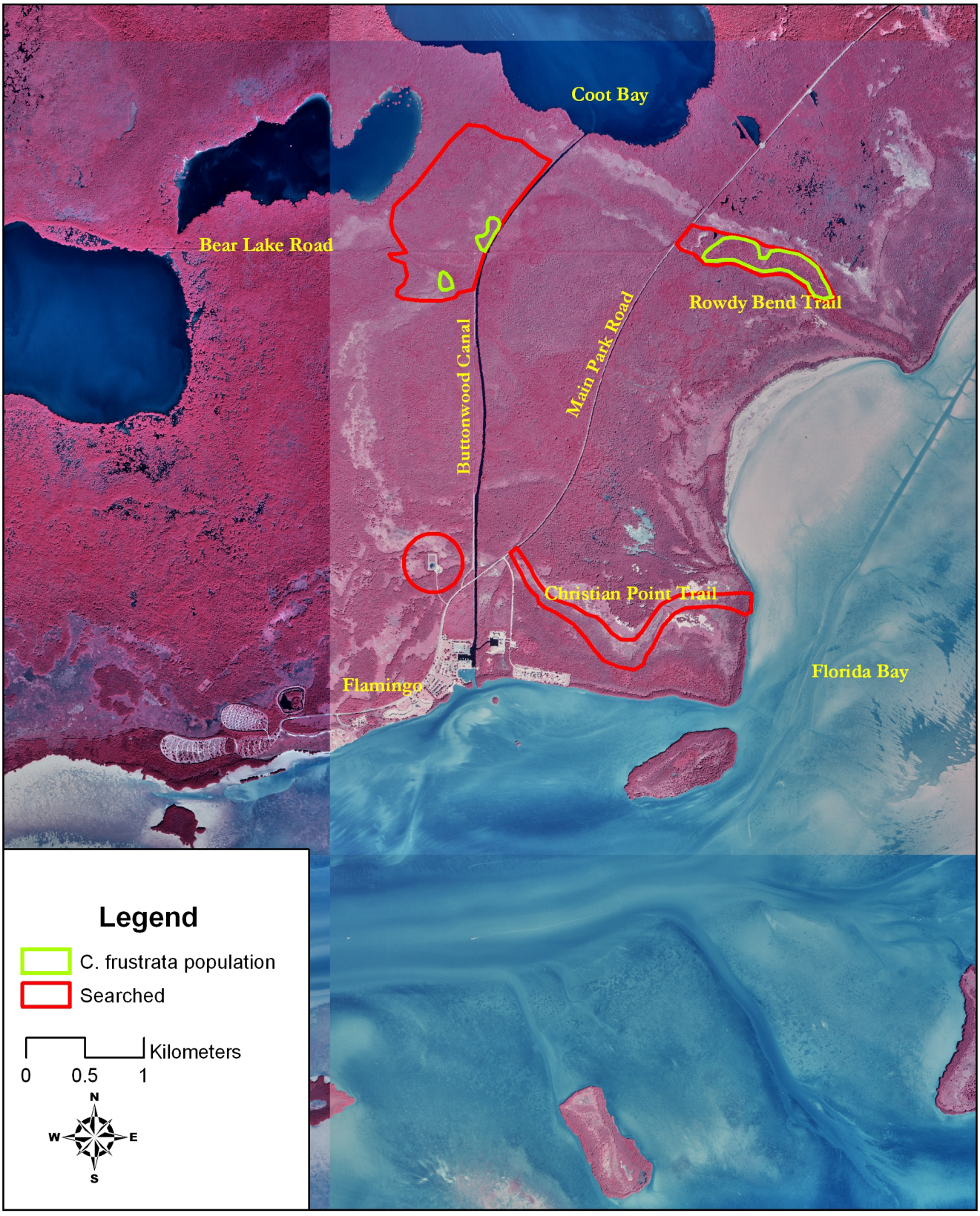
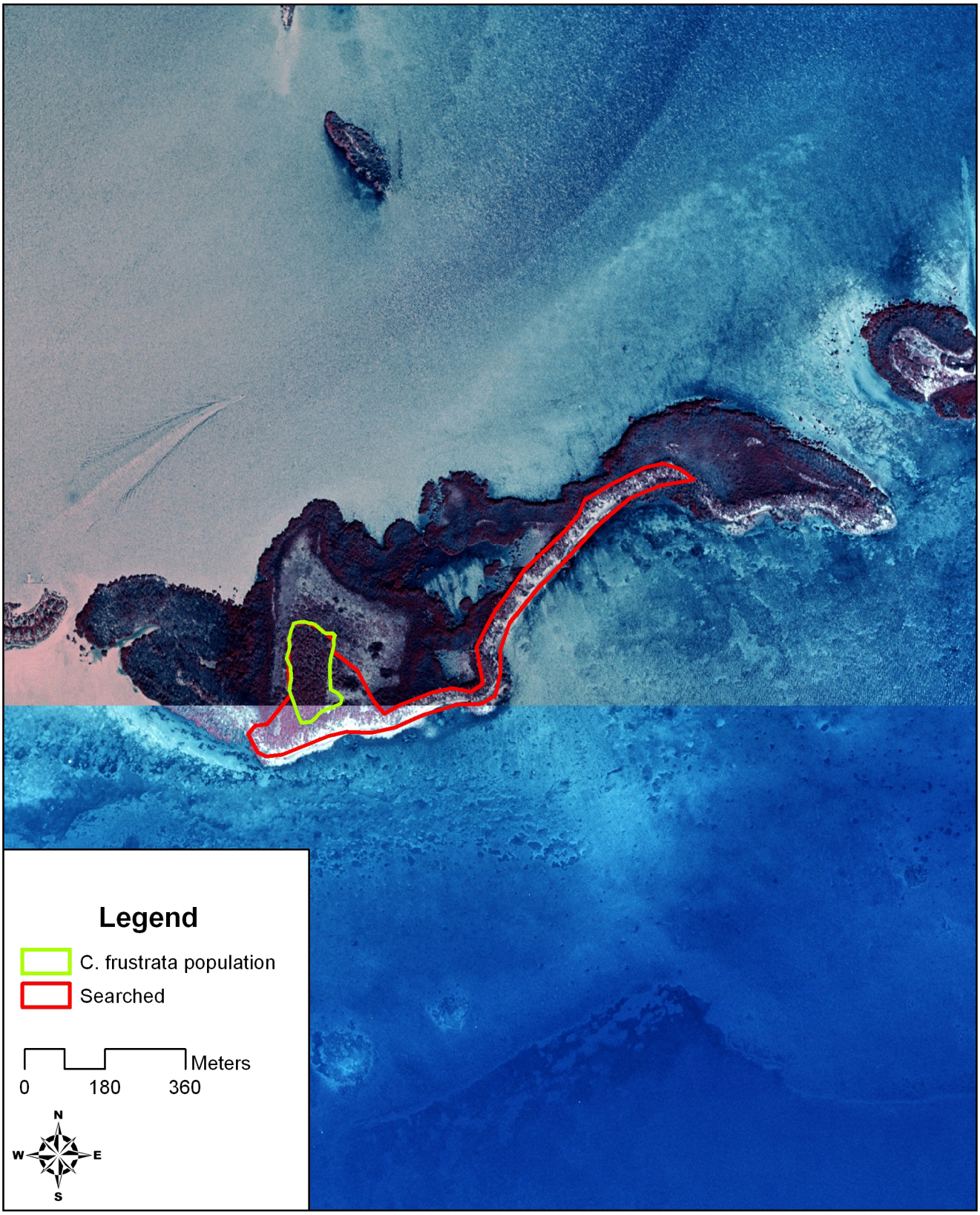
Map 1: Range of Chromolaena frustrata



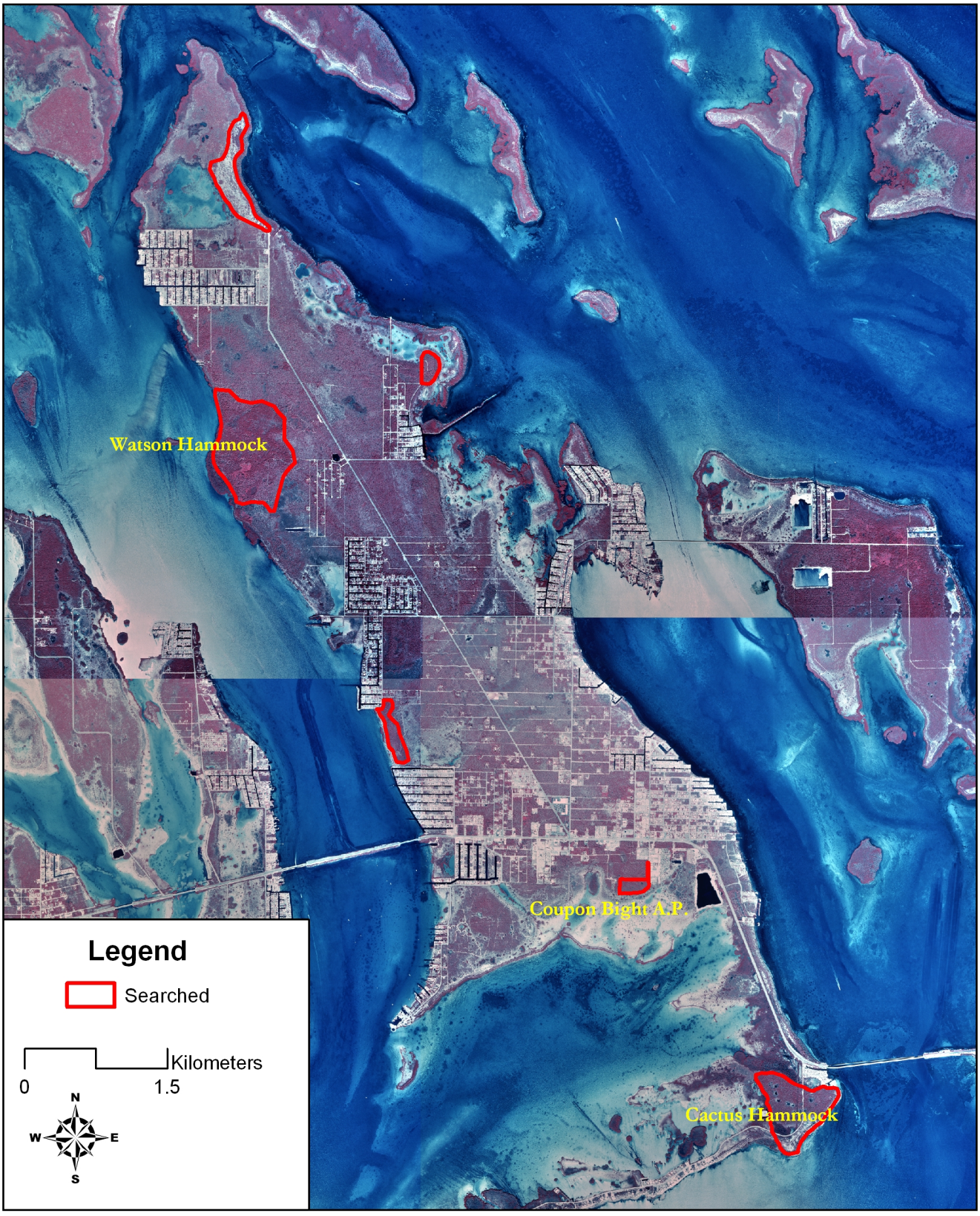
Map 2: Everglades National Park



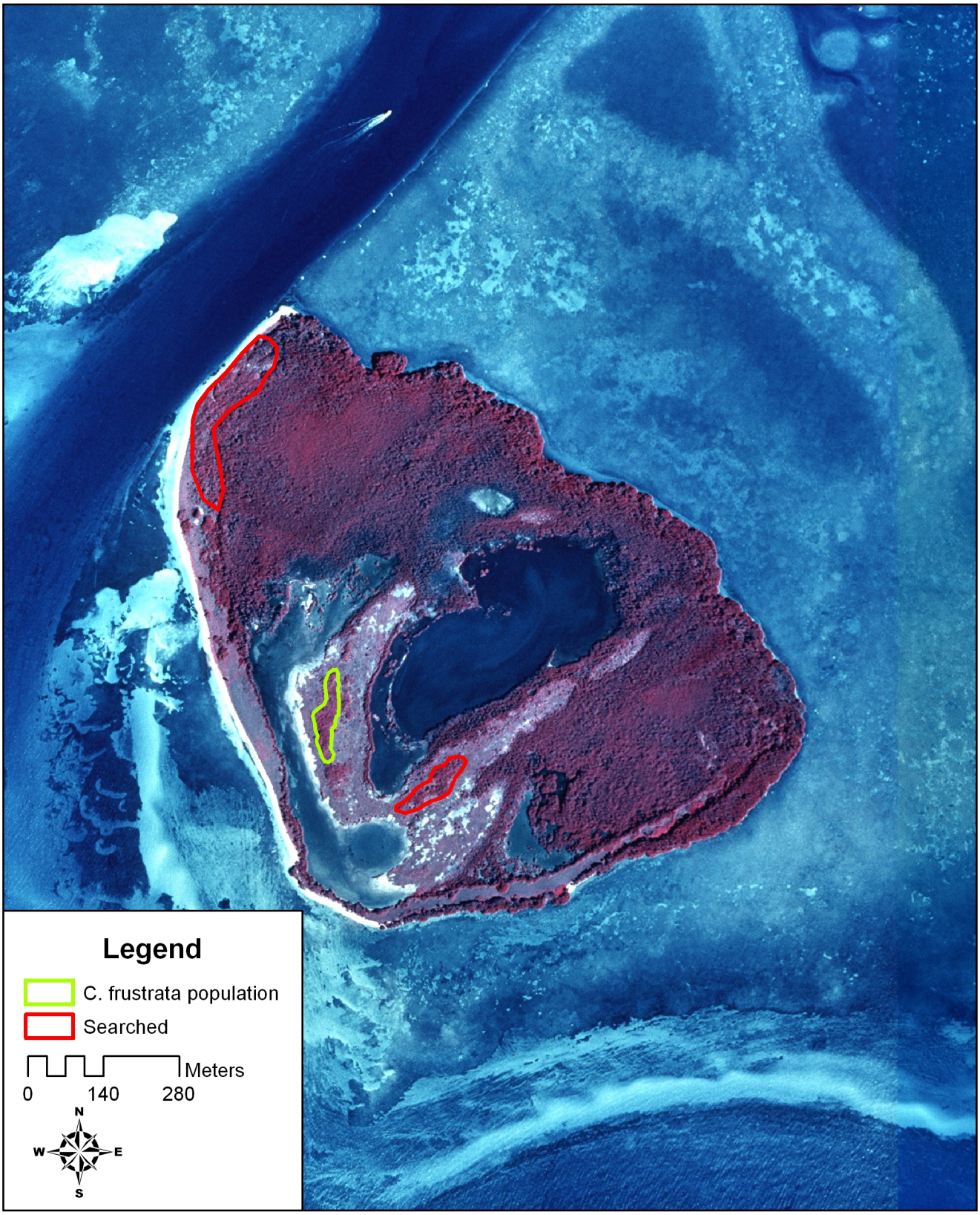
Map 3: Big Munson Island



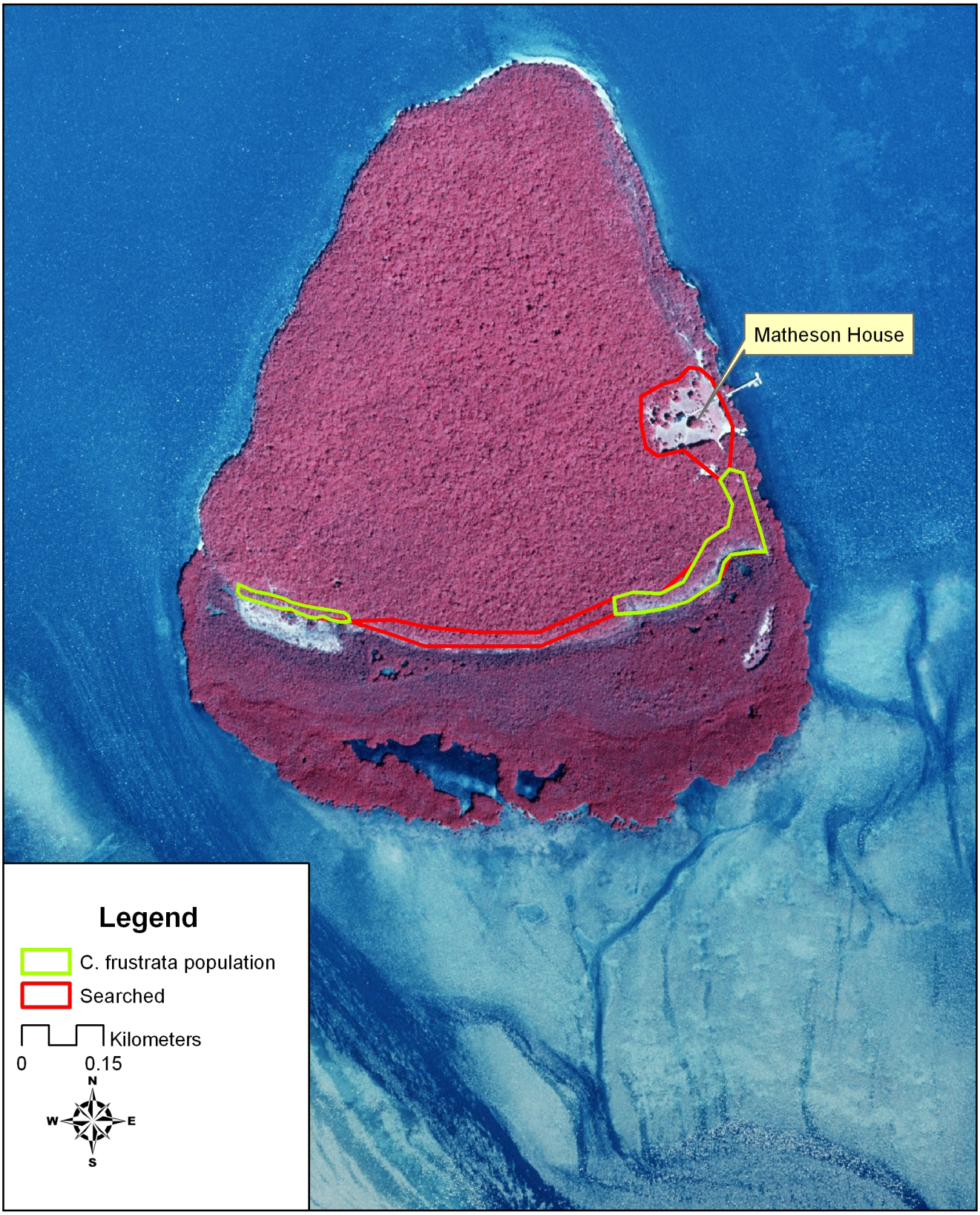
Map 4: Big Pine Key



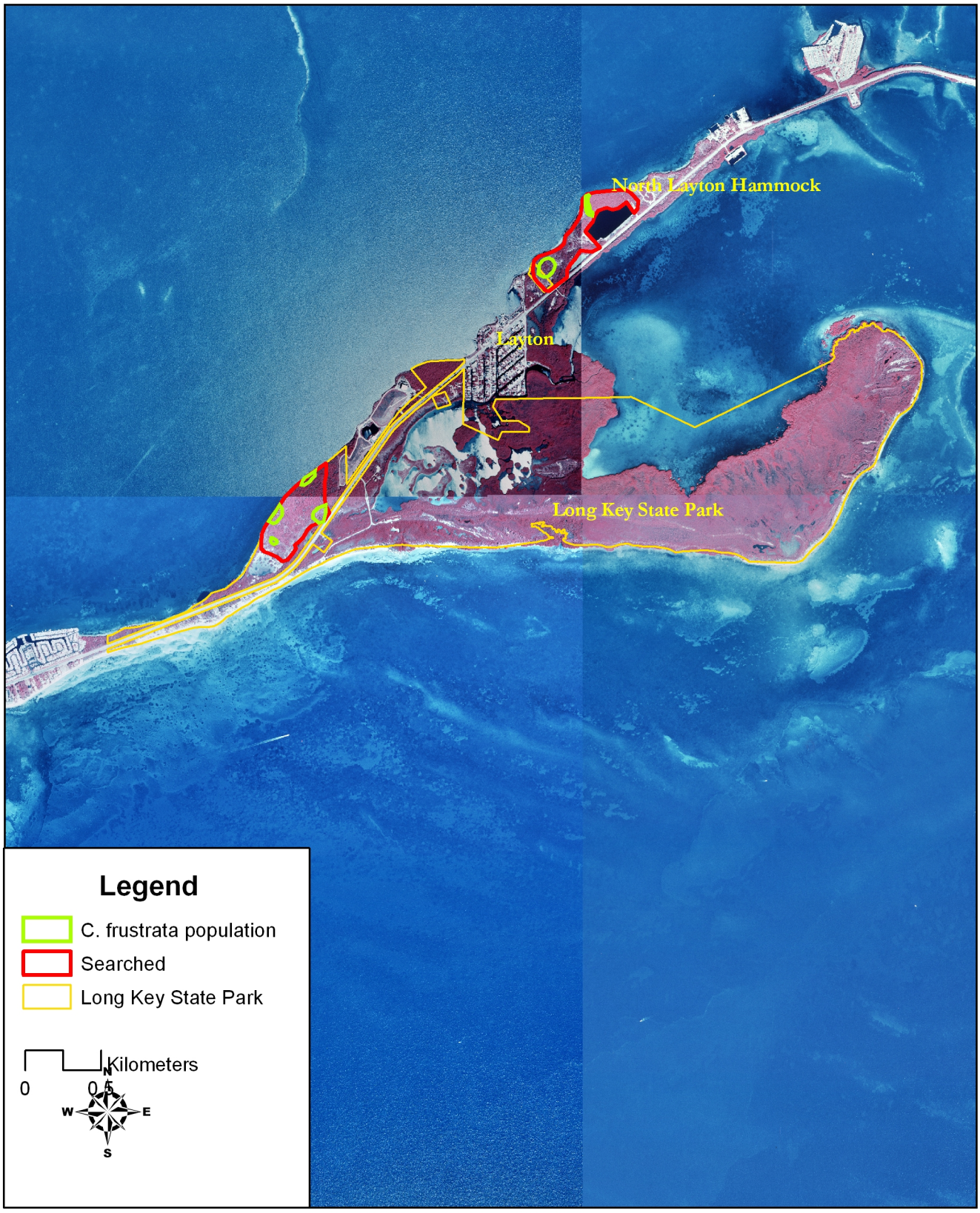
Map 5: Boca Grande Key



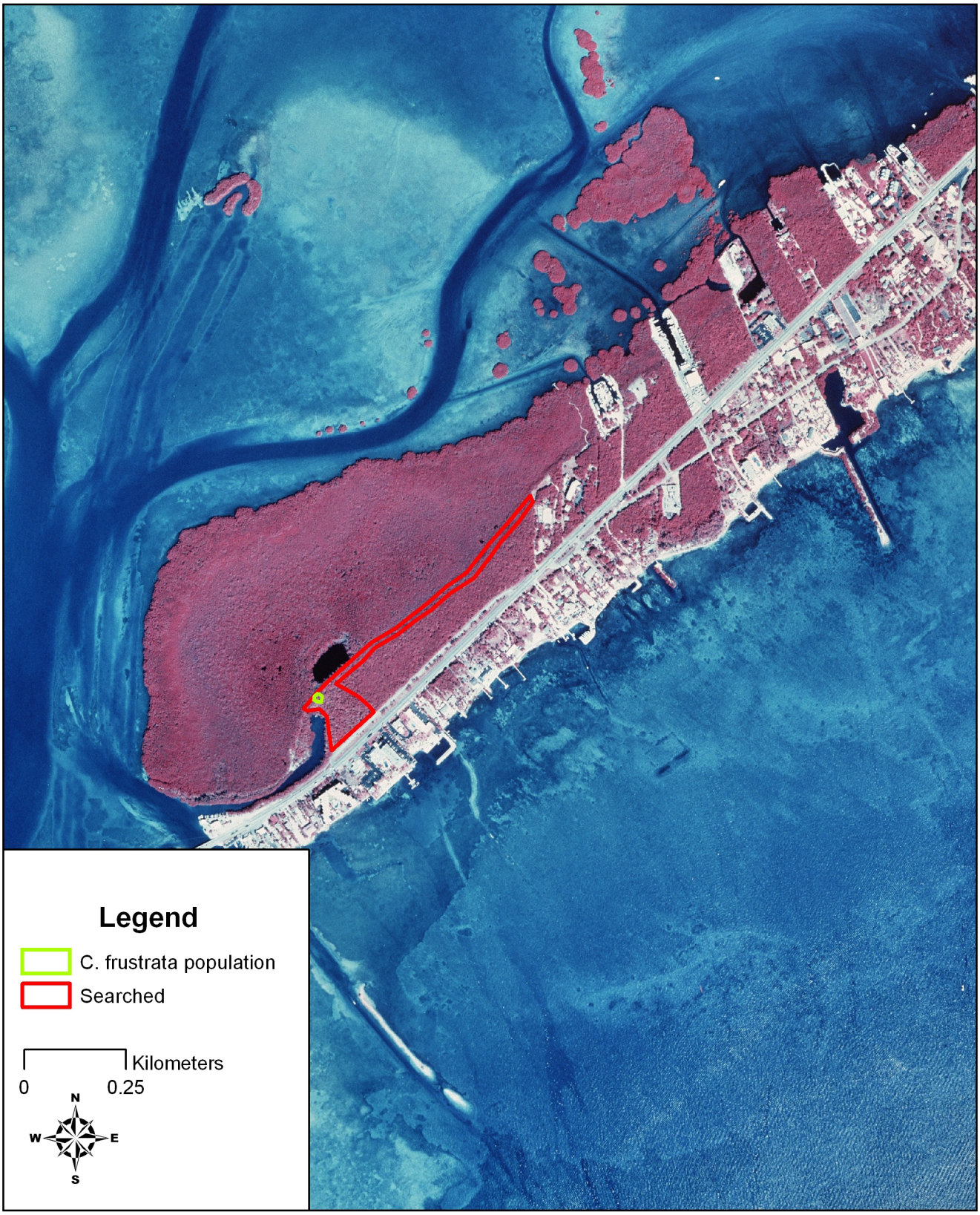
Map 6: Lignum Vitae Key



Map 7: Long Key



Map 8: Upper Matecumbe Key



Map 9: Monitoring Plots at Long Key State Park