

South Florida/Caribbean Network

National Park Service
Inventory and Monitoring Division



Standard Operating Procedure FVM02

Sampling Design and in Office Review—Version 1.0

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Summary

This standard operating procedure (SOP) provides the steps used to implement the sampling design for *South Florida/Caribbean Network Forest Vegetation Monitoring: Protocol Implementation Plan* (Whelan et al. 2020), including the creation of appropriate target population and sampling frame polygons in a GIS, spatially balanced generalized random-tessellation stratified (GRTS) draws in R, and in-office review of the generated points. These procedures apply to all parks, but the proposed plot locations have only been included for the focal forest communities in the three parks that will be visited in panel one of the sampling rotation: Big Cypress National Preserve (BICY), Biscayne National Park (BISC), and Salt River Bay National Historical Park and Ecological Preserve (SARI). This SOP will be amended to include the plot locations for the remaining parks.

Revision Log

Revision Date	Author	Changes Made	Reason for Change	New Version #

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Overview

Generalized random-tessellation stratified (GRTS) sampling methodology (Stevens and Olsen 2004) was used to create a spatially-balanced, random set of monitoring sites for each of the focal forest communities within the SFCN parks. The GRTS technique uses reverse hierarchical ordering to map two-dimensional space (e.g., locations of plots in a park) into one-dimensional space, by giving each plot an ordered spatial address. Then, the program uses restricted randomization to order the addresses into a random, spatially balanced list of plots (McDonald 2004; Stevens and Olson 2004). The GRTS technique for SFCN forest plot allocation is performed in the statistical program R v3.5.1, utilizing the spsurvey library (Kincaid and Olsen 2017). Shapefiles of plot centroid points are produced for each focal forest type. These points are placed in a spatially-balanced GRTS order as described above. Any consecutive sub-sample of points on this list will maintain spatial balance. Here we provide an overview of the steps used to implement the sampling design for this protocol. These steps include the creation of appropriate target population and sampling frame polygons in ArcMAP GIS from recently created vegetation maps. We describe the R code used to make the spatially-balanced GRTS draws and finally we list the criteria used for the in-office review of the potential plot locations.

SOP Source and How It Was Modified

This SOP is based loosely on the narrative of the *Cumberland Piedmont Network Vegetation Monitoring Protocol* (White et al. 2011). For a general explanation of how the South Florida/Caribbean Network modified the Cumberland Piedmont Network (CUPN) protocol and its SOPs, see *South Florida/Caribbean Network Forest Vegetation Monitoring: Protocol Implementation Plan* (Whelan et al. 2020). The South Florida/Caribbean Network made two specific modifications to CUPN procedures: (1) parks were stratified into focal forest communities, and (2) those focal forest polygons had road, trail, building, park inholding, steep (greater than 30°) slope, habitat edge, and park boundary buffers applied to create a sampling frame that was used for the GRTS draw. For this SOP, the South Florida/Caribbean Network relied heavily on the detail provided in *SOP 1.4.10 Site Selection, Plot Establishment, and Return Visits—Version 1.0* (Boyle 2019) of the *Terrestrial Vegetation Monitoring in Southeast Coast Network Parks: Protocol Implementation Plan* (Boyle et al. 2019).

Sample Design

Random Plots

The sampling design for the South Florida/Caribbean Network's forest vegetation monitoring begins with the selection of focal forest community polygons from the most recent vegetation maps. These polygons represent the spatial coverage of focal forest communities and are buffered by 15 meters (49.2 feet [ft]) to ensure that plots do not contain roads, trails, buildings, park inholdings, steep (greater than 30°) slopes, and park boundaries. In Biscayne NP there is an additional rule that plots must be within 1,000 meters (3,281 ft) of a road or a trail to limit travel time within this large park. Internal buffers from focal forest polygons were not applied to any parks because small and linear polygons are substantially reduced by such a buffer. By leaving these polygons unbuffered there should be situations where the field crew can move plots up to 10 meters (32.8 ft) and ensure they fit these small polygons. The buffered vegetation map polygons represent the sampling frame of vegetation monitoring in SFCN parks.

The selection of plot centroids was based on a continuous draw of points across each sampling frame utilizing the Generalized Random Tessellation Stratified (GRTS) sampling methodology to maintain spatial balance. The GRTS technique uses reverse hierarchical ordering to map two-dimensional space (e.g., locations of plots in a park) into one-dimensional space, by giving each plot an ordered spatial address. The GRTS technique for the SFCN forest plot allocation is performed in the statistical program R v3.5.1, utilizing the *spsurvey* library. Shapefiles of plot centroid points are produced for each focal forest type. These points are placed in a spatially balanced GRTS order as described above. Any consecutive sub-sample of points on this list maintains spatial balance. Additional plots are provided by the GRTS draw, which represent alternate (or replacement) points in case we need to exclude any of the original selected points or if we need to expand monitoring in the future.

Forest Communities of Special Management Concern

Additionally, there are four forest communities of special management concern that are relatively rare in their corresponding park. These communities will contain one to three index (subjectively placed) plots at locations recommended by park resource management staff. Because the plots are subjectively placed, there is no larger population of inference for applying the results from these plots. Index plot data only represent the focal forest community at these specific sample locations. These forest communities of special management concern, along with a justification for monitoring them, are:

- BUIS—Tropical Dry Forest (one plot)—Rare tropical dry forest formation dominated by manchineel (*Hippomane mancinella*) and threatened by beach erosion.
- DRTO—Mangrove Forest (two plots)—Rare mangrove formation dominated by black mangrove (*Avicennia germinans*) and utilized by the only Magnificent Frigatebird (*Fregata magnificens*) colony in the continental United States.

- SARI—Mangrove Forest (two plots) —Rare mangrove formation located within the main flow of the Salt River. It directly links the upland forest to the estuarine bay communities.
- VIIS—Mangrove Forest (three plots)—There is relatively little mangrove forest left in the park to support local estuarine fish recruitment and to filter overland flow discharge to the near shore marine community.

Procedure

The following four phases are used to generate random plots within each park/focal forest combination. The sample size by focal forest type is presented in the Sample Size Determination and Power Analysis section of the Protocol Implementation Plan (PIP) and outside the scope of this SOP.

Phase 1—Extract Forest Habitat

1. For each park/focal forest combination look for the corresponding row in Table 1, open the ‘Veg Map Feature Class’ listed, and then click the “Select by Attributes” function. Use the information provided in the ‘Veg Map Attribute’ and ‘Veg Map Code(s)’ fields to build and run an appropriate selection query. Export the selected records as a new standalone shapefile and save it with an appropriate name (e.g., SARI_Forest_TropicalDryForests.shp).
2. Apply the “Dissolve” tool to consolidate the new focal forest community shapefile to just one record. Name the new shapefile created in this process appropriately (e.g., SARI_Forest_TropicalDryForests_dissolve.shp).
3. Open the attribute table for the new shapefile.
 - a. Add a text field called “Hectares.”
 - b. Use the “Calculate Geometry” function on this new field to calculate the number of hectares.

Table 1. Vegetation maps, attributes, and codes used for each focal forest community.

Park Code	Focal Forest Community	Focal Forest Community Code	Vegetation Map	Vegetation Map Attribute	Vegetation Map Code(s)
BICY	Cypress Forest	CYP	Draft Western BICY & SFCN Vegetation Maps (Internal) https://irma.nps.gov/DataStore/Reference/Profile/2265445	L4_name	Cypress-Hardwood Forest; Cypress Forest; Cypress-Forest-Dome; Cypress Forest-Strand
BICY	Hardwood Hammock	HAM	Draft Western BICY & SFCN Vegetation Maps (Internal) https://irma.nps.gov/DataStore/Reference/Profile/2265445	L4_name	Temperate Hardwood Hammock; Tropical Hardwood Hammock
BICY	Pineland	PIN	Draft Western BICY & SFCN Vegetation Maps (Internal) https://irma.nps.gov/DataStore/Reference/Profile/2265445	L3_name	Pine Woodland
BISC	Coastal Hardwood Hammock	CHH	Biscayne National Park Vegetation Map https://irma.nps.gov/DataStore/Reference/Profile/2233244	L3	Coastal Hardwood Hammock
BISC	Mangrove Forest	MAN	Biscayne National Park Vegetation Map https://irma.nps.gov/DataStore/Reference/Profile/2233244	L2	Mangrove Forest
EVER	Coastal Hardwood Hammock	CHH	Everglades National Park Vegetation Map – Region 2 https://irma.nps.gov/DataStore/Reference/Profile/2244641	L5_name	Fan Palm Hammock; West Indian Mahogany Hammock
EVER	Cypress Forest (East)	CFE	Everglades Vegetation Map – UGA Version https://irma.nps.gov/DataStore/Reference/Profile/2265442	DOMINANTVEG	FSc; FSd
EVER	Cypress Forest (West)	CFW	Everglades Vegetation Map – UGA Version https://irma.nps.gov/DataStore/Reference/Profile/2265442	DOMINANTVEG	FSc; FSd
SARI	Tropical Dry Forest	TDF	Salt River Bay NHP and ER Vegetation Map https://irma.nps.gov/DataStore/Reference/Profile/2233383	Level_3	Semi-deciduous Forest

Park Code	Focal Forest Community	Focal Forest Community Code	Vegetation Map	Vegetation Map Attribute	Vegetation Map Code(s)
VIIS	Tropical Dry Forest	TDF	Draft Virgin Islands National Park Vegetation Map (Internal) https://irma.nps.gov/DataStore/Reference/Profile/2265468	DESCRIPTION	Drought Deciduous Forest; Gallery Semi-deciduous Forest; Semi-deciduous Forest
VIIS	Tropical Moist Forest	TMF	Draft Virgin Islands National Park Vegetation Map (Internal) https://irma.nps.gov/DataStore/Reference/Profile/2265468	DESCRIPTION	Gallery Moist Forest; Upland Moist Forest

Phase 2 – Park-Specific Preprocessing Steps

1. Only for VIIS:

- a. Add the most recent VIIS LiDAR layer to ArcMap. Use the “Slope” tool to create a raster layer that identifies the slope (in degrees) for each cell in the LiDAR layer. Name this new raster layer with an appropriate name.
- b. Use the “Reclassify” tool to change the values of the slope raster layer created in the previous step. Change raster values less than 30 (degrees) to “1” and values greater than or equal to 30 (degrees) to “0.” Name the resulting raster layer created the tool with an appropriate name.
- c. Use the “Raster to Polygon” tool to convert the reclassified raster layer created in the previous step to a vector polygon. Name the shapefile created from running this tool with an appropriate name (VIIS_LIDAR_slope_delineation).
- d. Open the attribute table for the new slope delineation shapefile.
 - i. Add a text field called “Slope.”
 - ii. Select the records that display “0” for grid code. Use the “Field Calculator” function on this new field to populate the records under the field “Slope” with the statement “> = 30 degrees.”
 - iii. Select the records that display “1” for grid code. Use the “Field Calculator” function on this new field to populate the records under the field “Slope” with the statement “< 30 degrees.”
- e. Use the “Dissolve” tool to consolidate the features to just two records, based on the Slope field. Name the new shapefile created in this process appropriately (e.g. VIIS_slope_delineation_dissolve).
- f. Use the “Select by Attributes” function to select the records in this shapefile that have a slope greater than 30 degrees. Export the selected records as a new standalone shapefile and save it with an appropriate name (e.g. VIIS_slope_delineation_above_30degrees).
- g. Use the “Buffer” tool to create a buffer for the greater than 30 degrees slope delineation shapefile created in Step f. Reference Table 2 to determine the size (in meters) needed for the buffer. Make sure to enable the dissolve option so that only one consolidated feature record is created. Name the new shapefile created in this process appropriately (e.g. VIIS_slope_above_30degrees_15m_buffer).

2. Only for SARI:

- a. Add the SARI parcels ownership layer to ArcMap. Use the “Select by Attributes” function to select the records in the SARI parcel ownership shapefile that are

classified as “Private” under the Ownership attribute. Export the selected records as a new standalone shapefile and save it with an appropriate name (e.g. SARI_parcels_private).

- b. Create an outer buffer for the new SARI private parcels shapefile. Reference Table 2 to determine the size (in meters) needed for the buffer. Make sure to enable the dissolve option so that only one consolidated feature record is created. Name the new shapefile created in this process appropriately (e.g., SARI_parcels_private_15m_outer_buffer).
 - c. Apply the “Erase” tool to remove the areas that the SARI private parcel 15 meter outer buffer overlaps with the dissolved focal forest community shapefile (created in Step b). Name the new shapefile created in this process appropriately (e.g. SARI_Forest_TropicalDryForests_dissolve_erase).
3. Only for BICY:
- a. Add the park unit roads and trails layers shapefile to ArcMap.
 - b. Create an outer buffer of 1,000 meters and make sure to enable the dissolve option to create a consolidated feature record. Name the new shapefile appropriately (e.g. BICY_roads_trails_1000m_buffer).

Table 2. Table of buffers, justifications, and distances (in meters) by park. Negative distances indicate internal buffers.

Buffer Type	Buffer Justification	BICY	BISC	EVER	SARI	VIIS
Minimum distance from road or trail	To reduce effects from visitor and vehicle usage, reduce the likelihood that plots impact the visitor experience, and to reduce vandalism.	15	15	15	15	15
Maximum distance from road or trail	To prevent plots from being placed in inaccessible portions of the park.	1,000	–	–	–	–
NPS buildings	To reduce effects from permanent structures and their surrounding landscaping, and to reduce impacts on the visitor experience.	15	15	15	15	15
Park boundary	To ensure the entire plot falls within the park boundary.	-15	-15	-15	-15	-15
Inholdings	To ensure the entire plot falls on federally owned land (where reliable parcel maps exist).	–	–	–	15	–
Slope > 30 degrees	To ensure the entire plot is on safe slope that will not create excessive erosion.	–	–	–	–	15

Phase 3—Sample Frame Creation

1. Add the park boundary for the park of interest into ArcMap. Reference Table 2 to determine the size (in meters) needed for the buffer and create an inner buffer for the park boundary layer. Make sure to enable the dissolve option so that only one consolidated feature record is created. Name the new shapefile created in this process appropriately (e.g. SARI_park_boundary_15m_inner_buffer).
2. Add the park unit roads and trails layers and the NPS SER buildings shapefile to ArcMap.
3. Use the “Select by Attributes” function to select the records in the NPS SER buildings shapefile that are located within a park unit. Export the selected records as a new standalone shapefile and save it with an appropriate name (e.g. BICY_NPS_SER_buildings).
4. Create an outer buffer for the park unit road and trails layer. Reference Table 2 to determine the size (in meters) needed for the buffer. Make sure to enable the dissolve option so that only one consolidated feature record is created. Name the new shapefile created in this process appropriately (e.g. BICY_roads_trails_15m_buffer).
5. Repeat step 4 but apply it to the park unit NPS SER buildings layer. Reference Table 2 to determine the size (in meters) needed for the buffer.
6. Use the “Merge” tool to combine the park boundary buffer, park unit buildings buffer and the smaller size park unit roads and trails buffer shapefiles. Name the new shapefile created in this process appropriately (e.g. BICY_boundary_buildings_roads_trails_buffer).
7. Use the “Dissolve” tool to reduce new park boundary, park unit buildings, roads, and trails buffer shapefile to consolidate the different number of features to just one record. Name the new shapefile created in this process appropriately (e.g. BICY_boundary_buildings_roads_trails_buffer_dissolve).
8. Use the “Erase” tool to remove the area covered by the park buildings, roads, and trails buffer dissolve shapefile that:
 - a. overlaps with the dissolved focal forest community shapefile (this applies to the forest communities in all parks except SARI).
 - b. Or, that overlaps with the dissolved-erased focal forest community shapefile (this applies to the forest communities in SARI) that was created in Phase 2, Step 2.

Name the new shapefile created in this process appropriately (e.g., EVER_Forest_CypressForests_SamplingFrame). The resulting shapefile will represent the sampling frame for the focal forest communities in BISC, EVER, and SARI.

9. Only for Biscayne NP: In this park there is an additional step required to account for the maximum distance we have chosen to sample from roads and trails.

- a. Clip out the area covered by the buffer erased dissolved focal forest community shapefile (created in Phase 3, Step 8a) that overlays with the BICY roads and trails 1,000 meter buffer shapefile (created in Phase 2, Step 3). Name the new shapefile created in this process appropriately (e.g., BICY_Forest_CypressForests_SamplingFrame). This resulting shapefile will represent the sampling frame for the focal forest communities in Biscayne NP.
10. Only for VIIS: Erase the VIIS slope delineation above 30 degrees buffer shapefile from the erased dissolved focal forest community shapefile (created in Phase 2, Step 1). Name the new shapefile created in this process appropriately (e.g., VIIS_Forest_TropicalMoistForests_below_30degrees_slope).
11. Only for VIIS: Turn on the “Editor” toolbar and select the slope buffer erase focal forest community shapefile. In the “Editor” toolbar click on the “Explode Multipart Feature” tool to create individual feature records for this shapefile. Open the attribute table of this shapefile.
 - b. Calculate the geometry of the Area field.
 - c. Select all the records with an area less than 400 square meters (4,306 square feet).
 - d. Delete these records.
 - e. Save the edits and stop the “Editing” session.

Dissolve the slope buffer erase focal forest community shapefile that was just edited. Name the new shapefile created in this process appropriately (e.g., VIIS_Forest_TropicalMoistForests_SamplingFrame). This resulting shapefile will represent the sampling frame for the focal forest communities in VIIS.
12. At this point, there should be a final focal forest community Sample Frame shapefile (this applies to all focal forest communities in all parks).

Phase 4—GRTS Draw

The code below is used by the network to generate forest vegetation monitoring plot centroids. The code utilizes the GRTS technique to provide spatial balance. Primary inputs to the code include a sampling design Comma Separated Value (CSV) file that provides sample size and overdraw sizes per focal forest community, as well as a folder storing the sampling frame shapefiles that were generated using this SOP. For each row in this sampling design input CSV, the script creates a date-stamped shapefile as an output.

The code was originally created by Tom Philippi (NPS I&M Division, Quantitative Ecologist), modified by Ellen Cheng (NPS Southeast Region I&M Division, Quantitative Ecologist) for use by Southeast Coast Network, and then modified again to match the needs of the South Florida Network by Judd Patterson (NPS SFCN, Data Manager). Upon the recommendation of Tom Philippi, the code is set to produce a total number of primary plots plus overdraw locations that were powers of two.

For strata with 8 final plots we drew 64 total plots. For strata with 12 or more final plots we drew a total of 256 total plots.

```
## Project: SFCN Forest Vegetation Monitoring
## Date:      8/1/2019
## Author:    Tom Philippi (original code)
## Ellen Cheng (modified code for SECN)
## Judd Patterson (modified code for SFCN)
## Purpose: This script is used to draw random GRTS points for
##focal forest communities in SFCN parks. This is done
## by reading in a CSV file where each row represents
## a GRTS draw to complete, and the columns provide the
## habitat name, sample size, overdraw size, and
## shapefile to use for the draw.

# Clear the global environment
rm(list=ls())

# Set the working directory for the input/output files
setwd("Z:\\SFCN\\Vital_Signs\\Forest_Vegetation\\analysis\\scripts\\
\\GRTS\\")

# Load necessary packages
pkgList <- c('rgdal', 'rgeos', 'gdalUtils', 'maptools', 'spsurvey',
'plyr')
inst <- pkgList %in% installed.packages()
if (length(pkgList[!inst]) > 0)
{install.packages(pkgList[!inst],repos = 'https://cloud.r-
project.org/')}
lapply(pkgList, library, character.only = TRUE)

# Set subfolder for random draw frames
mapdir <- "sample_frames" # folder with random draw frames (veg
maps already buffered in ArcGIS)

# Import the table of sample sizes
sample_sizes <-
read_csv("SFCN_SampleSize_By_FocalForestCommunity_BICY_BISC_SARI.cs
v")

# Create shortcut habitat name
sample_sizes$HAB_SHORT = gsub(" and ", " ", sample_sizes$HABITAT)
sample_sizes$HAB_SHORT <- sapply(strsplit(sample_sizes$HAB_SHORT, "
"), FUN = function(x)
  toupper(paste(substring(x, 1, 1), collapse = "")))
draws <- sample_sizes %>%
  mutate(sname = paste0(UNIT, "_", HAB_SHORT)) %>%
  rename(MU = UNIT, fname = SHAPEFILE, SampleSize = SAMPLE_SIZE,
Broad_Habi = HABITAT)
```

```

draws$fname <- as.character(draws$fname)

# Load in the shapefiles
maplist <- vector("list", length = length(sample_sizes$SHAPEFILE))
names(maplist) <- as.character(sample_sizes$SHAPEFILE)
# options(warn=0)
for (i in names(maplist)) {
  tmp <- readOGR(mapdir, i, stringsAsFactors = FALSE)
  tmp$MU <-
as.character(sample_sizes$UNIT[sample_sizes$SHAPEFILE==i])
  tmp2 <- tmp
  tmp2@data <- tmp2@data[,c("Habitat", "MU")]
  tmp2$Area <- gArea(tmp2, byid = TRUE) # calculate area for each
broad habitat type (w/in each MU), in sq.m. (10,000 sq.m. = 1 ha)
  maplist[[i]] <- tmp2
}

# Remove these temporary objects
rm(tmp,tmp2)

# Loop through each of the shapefiles
Habdraw <- vector("list", length = length(maplist))
names(Habdraw) <- names(maplist)
for (i in 1:length(maplist)) {
  nam = names(maplist)[i] #could have used names directly in for-
statement, but easier this way for trouble-shooting with
options(warn=2)
  Equaldsgn <- list(Habitat = list(panel = c(PanelOne =
sample_sizes$SAMPLE_SIZE[i]),
    seltype = "Equal",
    over = sample_sizes$OVERDRAW_SIZE[i]))

  Habdraw[[nam]] <- grts(design= Equaldsgn,
    DesignID =
paste(sample_sizes$UNIT[i],sample_sizes$HAB_SHORT[i],sep="_"),
    SiteBegin = 1,
    type.frame = 'area',
    src.frame = 'sp.object',
    sp.object = maplist[[nam]],
    att.frame = NULL,
    shift.grid = TRUE,
    shapefile = TRUE,
    out.shape = paste(format(Sys.time(),
"%Y%m%d_%H%M"), "_",nam,sep=""))
  # Draw is complete
  cat(i, paste("Completed GRTS draw for ",sample_sizes$UNIT[i],"
",sample_sizes$HABITAT[i],"\n",sep=""))
  plot(Habdraw[[i]], spframe = maplist[[i]]) #, main =
sample_sizes$UNIT[i])

```

```

}

str(Habdraw, max.levels = 2)
save(Habdraw, maplist, sample_sizes, file =
"SFCN_forest_TEP0.Rdata")

for (i in 1:length(maplist)) {
  plot(Habdraw[[i]], spframe = maplist[[i]])
}

```

In-office Review

After generating the ordered list of GRTS points for each of the SFCN parks, maps of the primary (selected) and overdraw (alternate) plot locations are reviewed internally by comparing them to the highest resolution, and most recent aerial imagery to determine if any plots fall in exclusion areas. Reasons for plot exclusion include:

- any of the plot occurs within marsh habitat or open water
- greater than 50% of the plot falls outside the focal forest community as defined in Table 1
- sampling the plot would pose a safety risk (e.g., plot occurs along a cliff face or abundance of unstable snags)
- any of the plot occurs on privately owned land
- the plot includes non-vegetated surfaces (e.g., transportation corridors, built-up lands, roads, swamp buggy trails, open water or beaches) to minimize vandalism and avoid negative visual impacts to park visitors
- the plot includes heavily used trails
- the plot includes sensitive archaeological resources or cultural sites
- the plot is inaccessible (estimated travel to and from the plot, and sampling the plot, cannot be accomplished in a 10-hour day) by boat or foot travel

Final field maps for each park targeted for sampling during a given year are printed and provided to field crews. These maps include (at a minimum) selected and alternate plots, most recent trails, roads, and aerial image layers. Selected and alternate plots are downloaded into field GPS units using the Open Source DNRGPS application. The datum for all coordinate values is NAD83, and the coordinate system is Universal Transverse Mercator (UTM). Florida parks (BICY, BISC, DRTO, EVER) are in UTM zone 17; and Virgin Islands parks (BUIS, SARI, VIIS) are in UTM zone 20. Immediately after uploading the plot coordinates, it is critical to check the GPS map to ensure that the plot locations are shown correctly on the screen.

Park Maps of Potential Plot Locations

Figures 1 to 6 depict the targeted sampling frames for the three SFCN park-units that will be visited in the year one rotation and the randomly located points that were selected for forest vegetation monitoring. Across all figures, the GRTS-identified potential primary (selected) plot locations are shown as red triangles with a yellow outline and GRTS-identified potential overdraw (alternate) plot locations are shown as blue circles. North is towards the top of each map page.

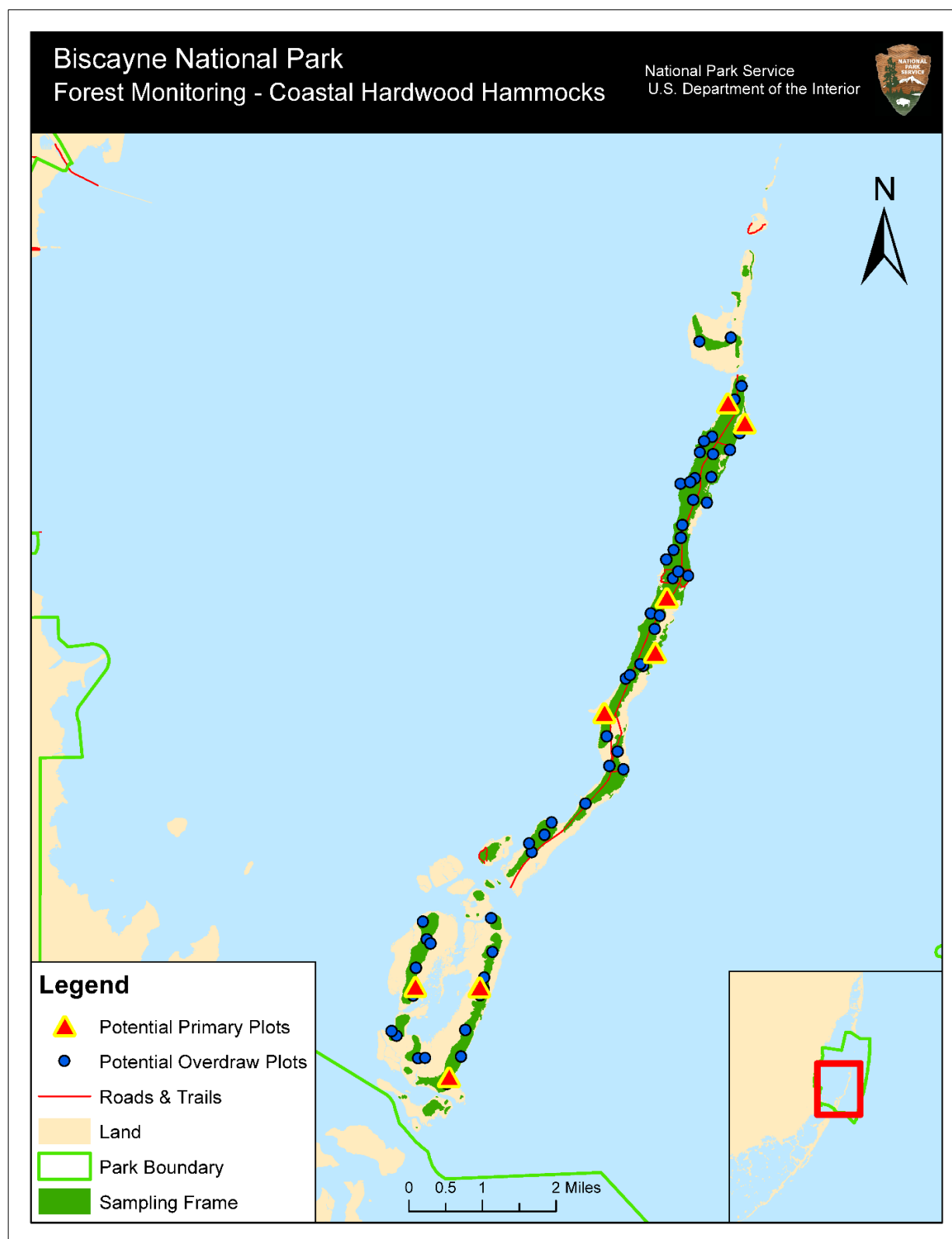


Figure 1. Sampling frame and proposed plot locations for Coastal Hardwood Hammocks in Biscayne National Park. There are eight potential primary (selected) plots and 56 potential overdraw (alternate) plots for the park.

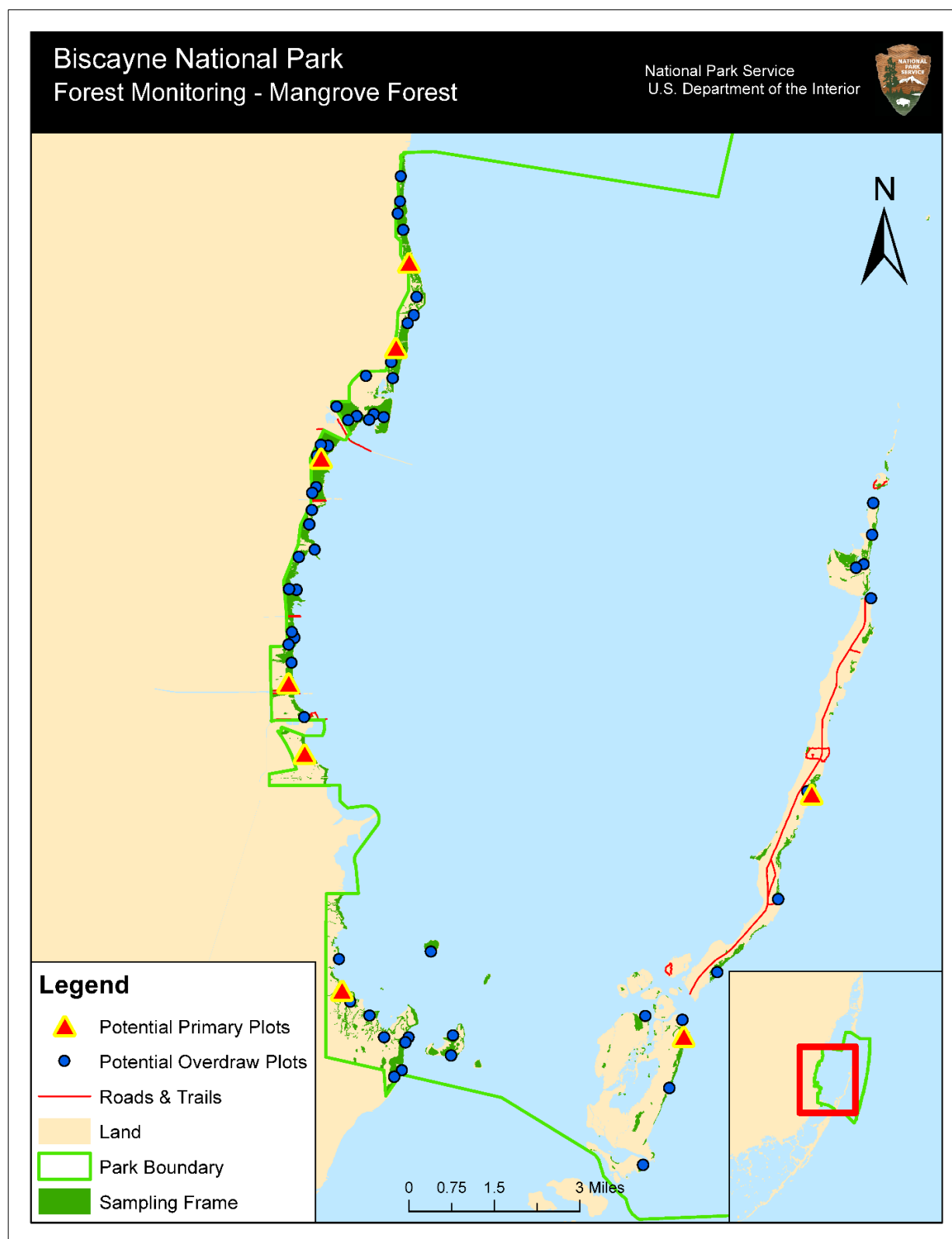


Figure 2. Sampling frame and proposed plot locations for Mangrove Forest in Biscayne National Park. There are eight potential primary (selected) plots and 56 potential overdraw (alternate) plots for the park.

Big Cypress National Preserve Forest Monitoring - Hardwood Hammocks

National Park Service
U.S. Department of the Interior

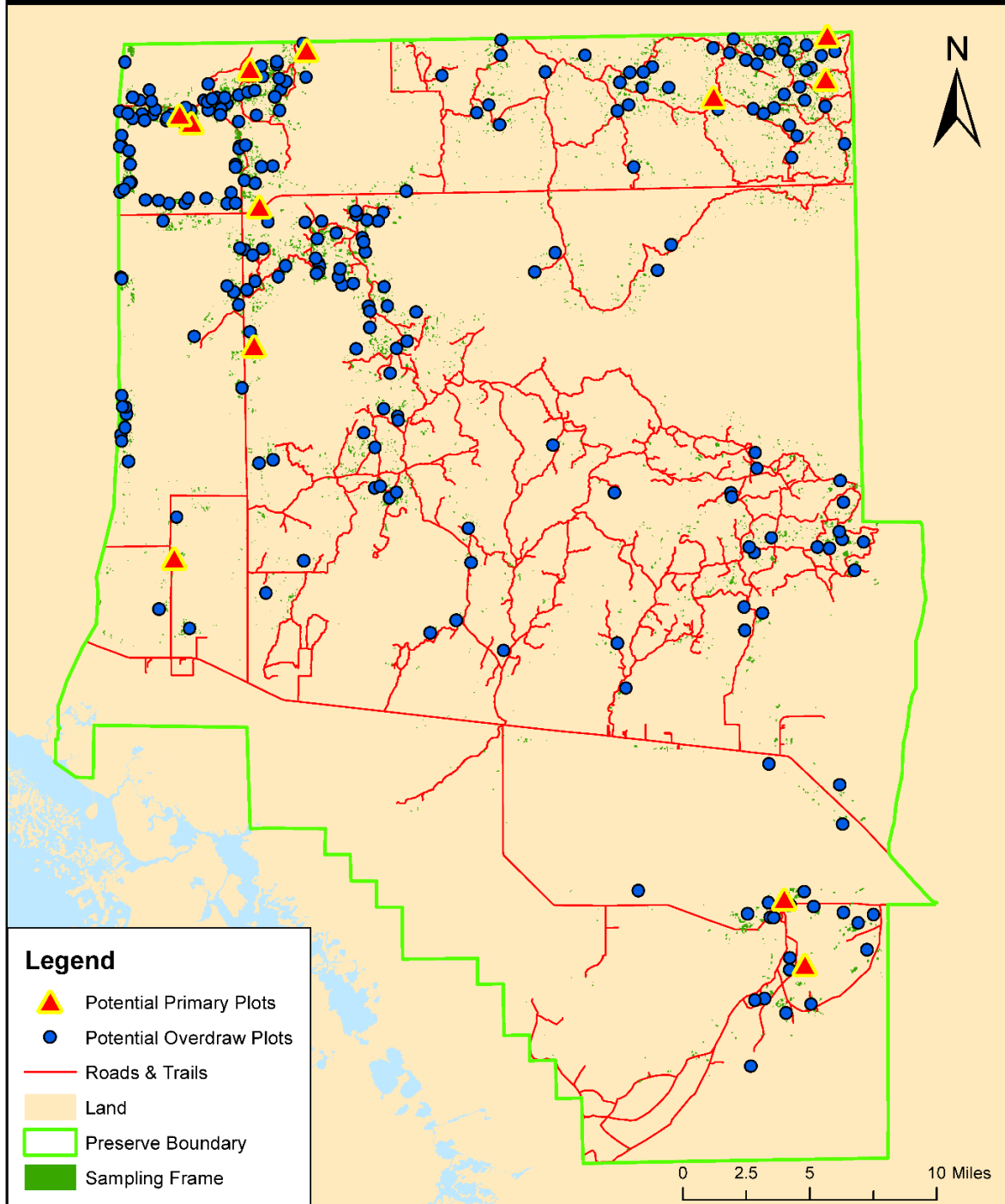


Figure 3. Sampling frame and proposed plot locations for Hardwood Hammocks in Big Cypress National Preserve. There are 12 potential primary (selected) plots and 244 potential overdraw (alternate) plots for the preserve.

Big Cypress National Preserve Forest Monitoring - Cypress Forest

National Park Service
U.S. Department of the Interior

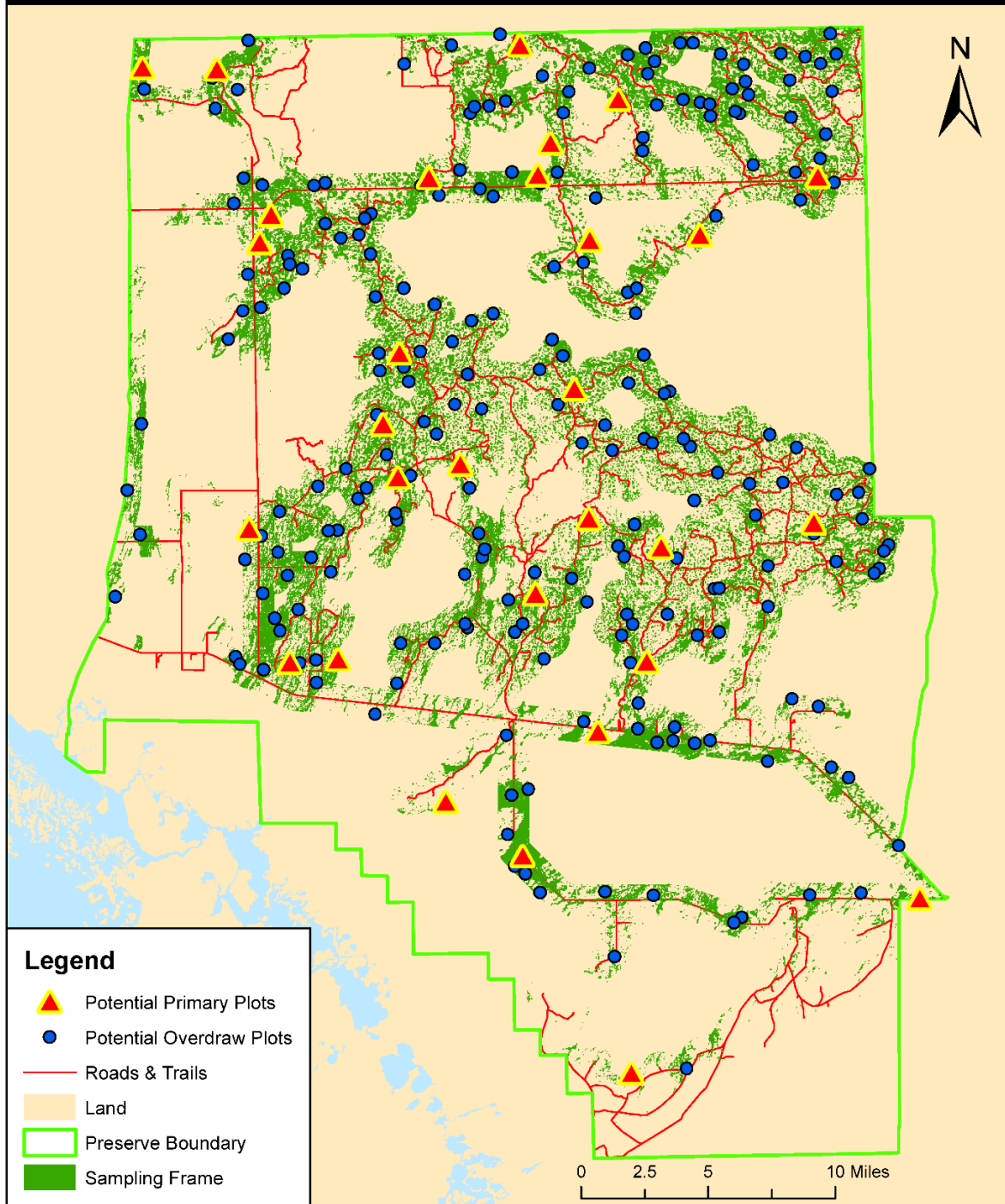


Figure 4. Sampling frame and proposed plot locations for Cypress Forest in Big Cypress National Preserve. There are 30 potential primary (selected) plots and 226 potential overdraw (alternate) plots for the preserve.

Big Cypress National Preserve Forest Monitoring - Pinelands

National Park Service
U.S. Department of the Interior

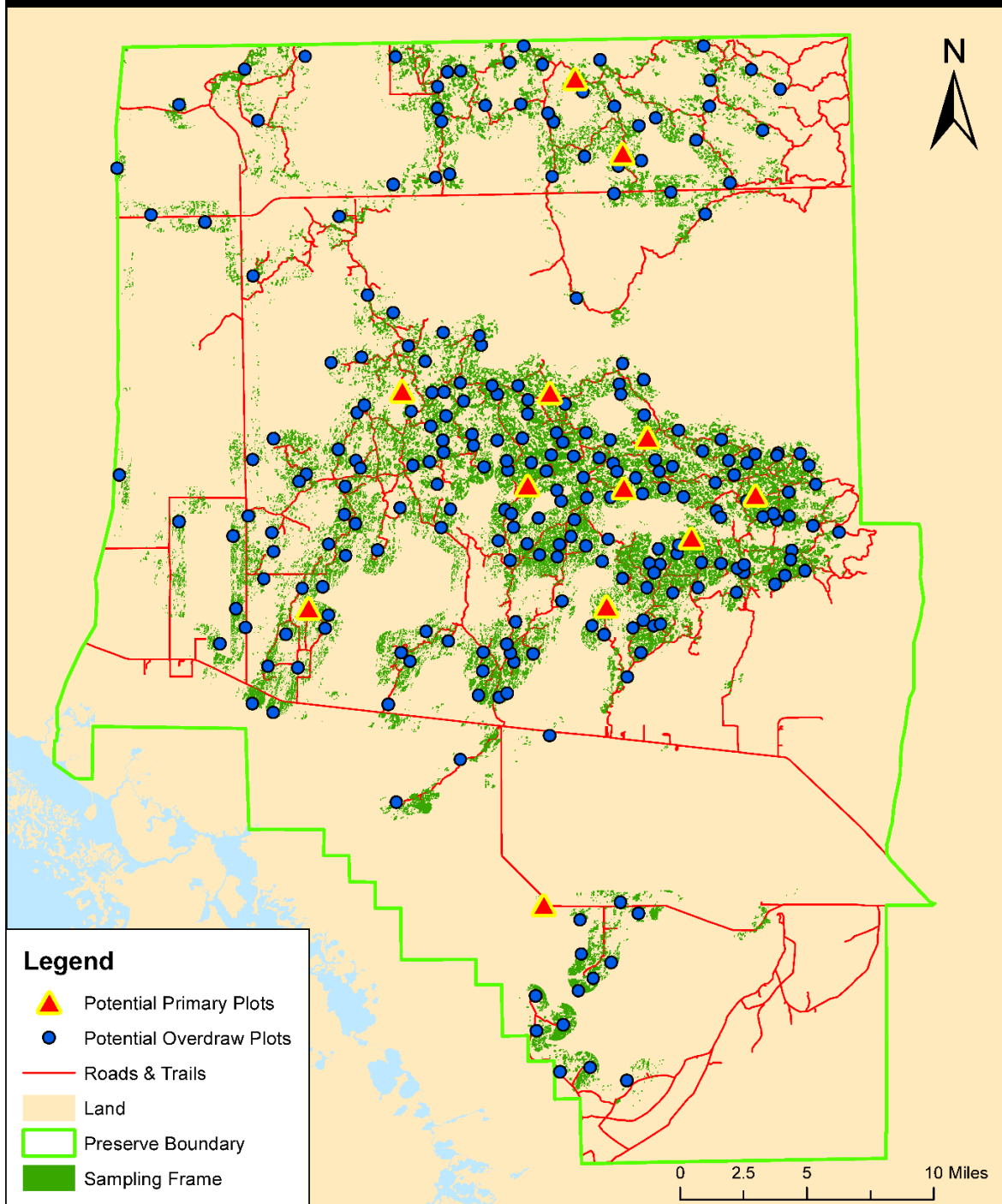


Figure 5. Sampling frame and proposed plot locations for Pinelands in Big Cypress National Preserve. There are 12 potential primary (selected) plots and 244 potential overdraw (alternate) plots for the preserve.

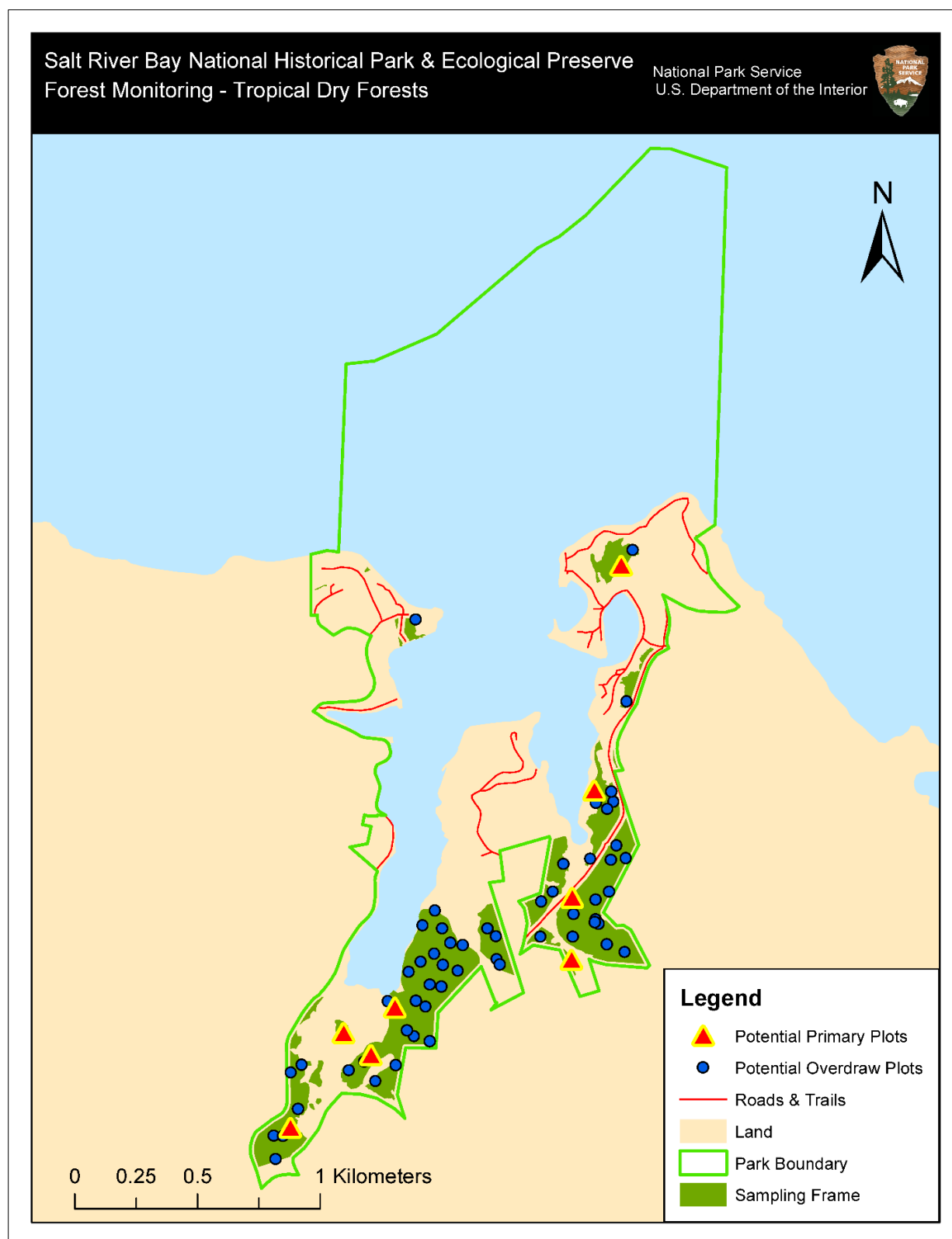


Figure 6. Sampling frame and proposed plot locations for Tropical Dry Forest in Salt River Bay National Historical Park and Ecological Preserve. There are eight potential primary (selected) plots and 56 potential overdraw (alternate) plots for the park unit.

Literature Cited

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