SAVANNA OF 3 FERN SPECIES RECTANGULAR SAVANNA
LAGUNETA OF 3 CONJOINED CENOTES

Parque Nacional Yaxha, Nakum and Naranjo (PNYNN)
Reserva de la Biosfera Maya (RBM)
Peten, Guatemala

Nicholas Hellmuth

Hasselblad Camera
Drone Photographs

FLAAR

FLAAR MESOAMÉRICA

2021

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FLAAR (USA) AND FLAAR MESOAMERICA (GUATEMALA)

SEPTEMBER 2021

APPRECIATION FOR ASSISTING THE RESEARCH PROJECT

FOR COOPERATION, HOSPITALITY, AND ASSISTANCE AT PARQUE NACIONAL YAXHA,
NAKUM AND NARANJO PROJECT (August 2018 through July 2019)
Ing. Jorge Mario Vazquez (CONAP, Santa Elena, Peten)
Arq. Jose Leonel Ziesse (IDAEH, Santa Elena, Peten)
Biolg. Lorena Lobos (CONAP)

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Lic. Apolinario Córdova, CONAP Petén
Ing. Jorge Mario Vazquez (CONAP, Santa Elena, Peten)

FOR COOPERATION, HOSPITALITY, AND ASSISTANCE AT PARQUE NACIONAL YAXHA, WE THANK
all the helpful and knowledgeable guides of IDAEH CONAP at PNYNN who accompanied us each day. It is essential to have either an IDAEH and/or CONAP guardabosque or comparable when doing flora and fauna research in a national park.

GUIDE AND EQUIPMENT PORTER FOR SEPT. 9, 2021
Gildardo de Jesus Canales, helpful lanchero.

GUIDES AND EQUIPMENT PORTERS FROM LA MAQUINA AND NEARBY DURING SEPT. 10, 2021
Jeremias Gonzales Aguilar, Alcalde de Yaxha, guide and helped carry equipment
Ricardo de Jesus Herrera Marroquin, guide and helped carry digital camera equipment
Gildardo de Jesus Canales, helpful lanchero and guide and helped carry equipment

LANCHA COURTESY OF GABRIELLA MORETTI, ECOLODGE EL SOMBRERO, SEPT. 9 and 10, 2021
Gildardo de Jesus Canales, helpful lanchero from the hotel Ecolodge El Sombrero; he also assisted in hiking the endless kilometers and carrying the needed equipment.

CREDITS

The helpful individuals listed below are part of the FLAAR Mesoamerica research and field work team. The office research team is additional individuals in the main office in Guatemala City.

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	Nicholas Hellmuth
LAYOUT OF THIS ENGLISH EDITION	David Arrivillaga

Cover photo: Drone photo by Haniel Lopez, FLAAR Mesoamerica, showing the Laguneta of 3 Conjoined Cenotes and the north end of the Savanna of 3 Fern Species.

Note that this entire area of Parque Nacional Yaxha, Nakum and Naranjo is perfectly preserved and protected. You can see the bajo vegetation extending for many kilometers to the north.

Our drone is licensed and registered. We donate all the photographs to the park and to CONAP. We keep track of where we hike every minute with Garmin GPSMAP equipment. These maps (showing where we were each minute every hour) will be in the FLAAR reports on each individual ecosystem. Plus we have local guides with us the entire time.

About frontispiece photo:

These drone photos help show that the Parque Nacional Yaxha, Nakum and Naranjo (PNYNN) is well preserved around the north, south, and east sides of Laguneta Lancaja. These drone photos help show the beauty of the hillside forests and the bajo forests: pristine flora, fauna, and biodiverse ecosystems.

Parque Nacional Yaxha, Nakum and Naranjo is a location worth visiting.

We show Laguneta Lancaja because the Laguneta of 3 Conjoined Cenotes and the Savanna of 3 Fern Species is one to two kilometers north of the north side.

INTRODUCTION TO AERIAL PHOTOGRAPHY

Aerial photography is especially helpful for studies of biodiverse ecosystems. The areal photographs of IGN (Instituto Geografico Nacional de Guatemala) are much more precise than the easy to find aerial satellite views of Satellites.com which are better than Google Maps or Google Earth. Google satellite views have vertical defects, rectangular areas that are darker than adjacent areas.

Every remarkable previously unstudied wetland (seasonally inundated savanna or cibal) that we find each month in the Reserva de la Biosfera Maya I find from satellite photographs. But to see individual trees, to study a wetland or forest in detail, it helps hugely to have good drone photos. LiDAR would be useful also, but LiDAR does not show the vegetation. And LiDAR is not available for Parque Nacional Yaxha, Nakum and Naranjo or other remote areas that we have been asked to study. However LiDAR is the most remarkable aerial technology of the recent decade and would be greatly appreciated for areas of Peten that are not yet readily available.

We have donated the drone photographs of September 9th and 10th, 2021, to PNYNN, delivered in person on September 11th, on a USB to Ing. Mario Vasquez) who in turn will provide these to park co-administrator Arq. Leonel Ziesse.

This field trip of September was intended to be based at El Ramonal, on the shore of Laguna Champoxte, but a COVID outbreak the day we were scheduled to arrive necessitated that we not drive to El Ramonal. So we stayed at our base camp Ecolodge El Sombrero south of Yaxha lake, took a boat from there to far end of Lake Yaxha and then hiked steep hills to the lagoons and savannas from the west (instead of hiking east from El Ramonal). Our GPS mapping team has processed the GPS data and these maps we show in our separate reports on each individual lake.

The present report is to show the drone photographs of this initial aerial photography field trip. Lots more detail is needed in the future but this first field trip is a good first step. The camera that we acquired to do aerial photography of two tasistal seasonally inundated solid-palm-tree-savannas (upstream Arroyo Petexbatun) is significantly better than any GoPro (which is really just for hikers and bikers on weekend and vacation trips). The DJI Mavic 2 Pro is definitely better than lower-resolution DJL drones. Most important, our drone lens is not excessively wide-angle. GoPro and low-budget drone cameras tend to be too wide-angle (so they distort everything). So we quickly realized that the entry-level DJI drones were inadequate to record trees and ecosystems, so we got the higher resolution DJI Mavic 2 Pro drone with its Hasselblad L1D-20c camera. We have checked with three other drone pilots and each one of them also selected a DJI Mavic 2 Pro as better than other cheaper models (yes, there are even better cameras but they are very expensive).

So in the recent six years we have tested four drones; the DJI Mavic 2 Pro drone with its Hasselblad L1D-20c camera is definitely the best, but we estimate the 100 megapixel Phase One would be 100% better in all respects

- especially because the Phase One camera has several lenses to select from
- Obviously because 100 MP is better than 48 MP
- and Phase One is clearly more experienced in digital photography than Hasselblad

I can say that because I have been using pre-digital Hasselblad cameras since circa 1966. But I literally dumped all three of my medium format Hasselblad film cameras and all their lenses once Nikon and Canon had better digital processing. And now that Sony has in-lens stabilization and in-camera stabilization, I am dumping my digital Nikon D810, Nikon D5, and Canon EOS 1D X, Mark II. Fortunately the 45 megapixel Canon EOS R5 has in-lens stabilization and in-camera stabilization comparable to Sony so we also acquired this Canon and will be tempted by the newer albeit heavier Canon EOS R3. The lower resolution, 24MB, is so you can achieve burst shooting (to show details of a bird's feathers in flight).

But the aerial camera that is essential for documenting wetlands (swamps, marshes, seasonally inundated savannas) is the 100 Megapixel Phase One iXM-100 Geospatial UAV camera which is especially made to be easily carried by the DJI M600 PRO. The essential lenses are specially made for medium format sensors and specially made to be carried by the drone camera:

- RSM 80mm AF f/5.6 Lens
- RSM 150mm AF f/5.6 Lens

As soon as a helpful benefactor can kindly donate the funding to FLAAR so we can obtain this Phase One iXM-100 Geospatial UAV camera, the pertinent two lenses and Capture One Pro 21 software, we will show you the awesome images. Capture One software, developed by Phase One in Denmark, is significantly better than Adobe Photoshop or Lightroom for processing high-resolution photographs.

But for now (September 2021) we start with showing the photos from the DJI Mavic 2 Pro. All photographs are from experienced drone pilot and photographer Haniel Lopez.

Caption: Because it rained upon arrival at the Savanna of 3 Fern Species, there were only a few minutes available to accomplish photography between the two times it rained. So we were not yet able to map the savanna nor accomplish close-up photographs of hoja de sal, tasiste, the several fern species, etc. Nonetheless, the photos here are the first areal documentation, in full color, of the remarkably biodiverse savanna-like oval area ringed with water several kilometers north of Laguneta Lancaja and about 50 meters south of the Cenote of 3 Fern Species.

To reach this remote area it takes time to cross the entire Lake Yaxha in a boat; then hike up several steep hills, then slip and slide down really steep slopes; then hike long distances; then hike up a narrow gully to reach a bajo that is not totally flat: it rises in altitude every 20 or 200 meters. To accomplish further detailed studies of each individual tree, shrub, grass, reed, sedge, bog moss, and especially the remarkable underwater plants it will be super helpful to have a more direct route to reach this area (the present trail curls around Laguneta Lancaja; would save considerable time and effort to hike straight from Laguneta La Guitarra (also named Laguneta El Juleque, not to confuse with the nearby Laguneta El Julequito). But the important fact is that helpful aerial photographs are now available to the park co-administrators and to students and professors.

CHAPTER 1, VIEWS OF THE SAVANNA OF 3 FERN SPECIES
WITH 3 CONJOINED CENOTES TO NORTH

Entire oval Savanna of 3 Fern Species with Laguneta of 3 Conjoined Cenotes in the background. All around the savanna you see relatively mature bajo forest.

All of this is at the top of hills overlooking the chain of lakes and lagoons at a lower elevation further south (a kilometer south of bottom edge of this photo).

Closer, lower, view of the entire savanna but focused on the wetlands reeds, sedges or grasses along the southern portion of the water-logged ring around the outer edge of the savanna.

Note that the vegetation along this south edge is different than along north or northeast edge (all this you will see in the almost 70 drone photos in this FLAAR report).

Which shows more detail, Google Maps satellite view, or using your own drone camera?

Each is helpful in their own way. Google Maps (and Satellites.pro) provides only one view (Google Earth Timelapse shows 37 years but at low resolution with about 5% not usable at all due to cloud cover). With a drone you can see the trees from different angles and get high resolution close-ups (if you have a 100 megapixel Phase One medium format camera made for a special DJI drone). We do not have close-ups due to the two sequential rain storms that hit that afternoon.

Keep in mind that the photo from Google Maps is a different month and different year (and is straight north-south-east-west). Our drone photos have the three conjoined cenotes at the top rather than to the north east as they should be.

Here you can see how close the three conjoined cenote-like lagoon is to the north.

You continue to notice that the wetlands reeds, sedges or grasses along the southern portion of the water-logged ring around the outer edge of the savanna.

Almost identical to the preceding panorama photo.
Panoramas are helpful to show the overall setting and the notable variation of size, shape, color, and species of vegetation every 50 or 100 meters. But what we need in the future are close-ups of each kind of vegetation.

Almost same photo as the previous two.

Now you can see more of the vegetation of the middle. We have an entire series of drone photos of the middle area (with a notable cluster of tasiste palm, Acoelorrhaphe wrightii, and cluster of Hoja de Sal leaves (both plants have edible parts and also useful parts: roof thatch for tasiste and tamal wrap for Hoja de Sal).

Similar to the previous view.

Note the area of low green grass at left; and the larger area of low green grass at the right. The green grass area at the east is outside the ringed oval and is a separate savanna-like ecosystem with several more tasiste palms, *Acoelorrhaphe wrightii*, than the oval area.

Notice the dark gray clouds directly overhead a
nd even more gray clouds in the right background.

The angle here is distorted (the savanna is an circular oval not a long north-south oval). But this photo nicely shows the brownish reed-sedge-grass area giving way to mixture of low trees.

Notice also that the top third has a browner color. This variation of areas within a savanna is typical of every savanna we have hiked to so far:

Savanna-Cibal-Jimbal west of Naranjo ruins (PNYNN), large traditional Savanna East of Nakum (PNYNN), and the Spider Lily Savanna of Parque Nacional Laguna del Tigre (PNLT) that we found on aerial photos and hiked to in August 2021.

All these savannas are in the Reserva de la Biosfera Maya (RBM). The coastal and Rio Dulce-El Golfete lagoon, hill, marsh, and swamp areas of the Municipio de Livingston have no savannas (though surely some exist elsewhere in Izabal). The project of wetland field work in Livingston is a 15 month project requested by local government after they learned that we were willing to visit remote areas, photograph them, and make information available.

Now you can see more of the varied vegetation across the middle. There is even bog moss here (sphaghum moss, probably Sphagnum subsecundum); a few tasiste palm clusters, hoja de sal, Calathea lutea, clusters, and lots of low ferns that create a fern savanna rather than a grassland savanna; the more traditional grassland savanna is at the far right (the “Rectangular Savanna” that is outside the ring-of-water around the oval Savanna of 3 Fern Species).

This is one of the more detailed photographs since it is closer than the panorama concepts. Here you can see the tight cluster of tasiste palm trees in the center of the savanna. These tasiste palm trees are a logo icon of a grassland savanna. The difference is that here instead of grass you have low species of ferns (actually two different low species). There are also taller species of ferns elsewhere (hence my suggested name, Savanna of 3 Fern Species).

The diversity of scattered trees within this oval is NOT bajo vegetation; a bajo in this part of Peten is solid trees and some are quite tall (depends on the kind of bajo).

The Laguneta of 3 Conjoined Cenotes is visible north of the savanna.

Here you see open areas (most of which are covered with low ferns rather than grass).

Here you can also see the ring of low bright green vegetation around the edge. The complete edge of this oval area is a partial ring of water (as you can see from Google Earth Timelapse).

The forest around the savanna and around the Laguneta of 3 Conjoined Cenotes is continuous relatively undisturbed bajo forest.

In the far background you see several ranges of karst hills, typical of Peten. You also see dark gray storm clouds across the upper sky.

Similar view to the previous photograph.

CHAPTER 2, LEFT TOP SIDE
(WEST NORTH PART OF THE SAVANNA OF 3 FERN SPECIES)

This chapter is to show the left side (west side) of the Savanna of 3 Fern Species, especially the bright green grass area.

Part of the ring of water is visible.

Note that nowhere out in the savanna are there trees as thick or tall as in the surrounding bajo forest.

The green ground cover here (and on the far east side also) includes low grass but we need to do close-up ground photography to document which ferns are also present.

Similar area to the previous photograph.

A few meters north of the area covered by the previous two photographs.

Southeast portion; water visible at left.

Close up of portion of the ring around the oval savanna. The vegetation here changes every 100 meters.

An area with lots of hoja de sal.

The bajo forest is below the green ring; the savanna is above and to the right of the green ring which goes around the entire savanna.

When I first hiked into this savanna with Teco and biologist Lorena Lobos, I believe this was the area we entered since we found and photographed lots of hoja de sal with inflorescences. So I could identify it as *Calathea lutea*.

Cropped aerial drone view to make the hoja de sal, *Calathea lutea*,
easier to notice.

These photos show how the bajo forest around this area is a pristine part of Parque Nacional Yaxha, Nakum and Naranjo because of protection by the PNYNN co-administrators, Arq. Leonel Ziesse (IDAEH) and Ing. Mario Vazquez (CONAP) and the park rangers.

CHAPTER 3, BOTTOM WEST, BOTTOM,
BOTTOM EAST OF THE SAVANNA OF 3 FERN SPECIES

Previous page:

The Laguneta of 3 Conjoined Cenotes is visible at top right (this helps you to keep track of where you are in the oval savanna below).

The hallmark of the southern (bottom) of the savanna is the tall but wilted brownish colored band of plants (lower middle and left).

The hallmark of the northwestern, northern, and eastern top ring of the oval savanna is the low flat green plants (upper middle).

Relatively large pool of water in the “ring of water” around the area.

Same isolated cluster of tasiste palm is in the middle to the right (same palms as in other photos in other chapters).

Southwest area of the oval Savanna of 3 Fern Species.

You can see Haniel (drone pilot) in the middle. He is outside the edge of the savanna. Everything in front is water soaked often with water below the plants (even when not visible).

Note the bajo vegetation all around the savanna is in pristine condition, a nice documentation of our drone photos to congratulate the park co-administrators.

In the lower half of this photo you see the brownish-green plants of this area.

Far south you can see cattle pastures on the hillsides.
But the area around the oval savanna is pristine, protected mature bajo forest.

South portion of the ring around the savanna.
Bajo forest around the savanna is nicely preserved.

Lots of individual guano palms in the bajo noticeable at the right third of the forest.
The “ring” around the oval savanna is clearly a ring, albeit changing every hundred meters or so.

Another angle of south segment of the ring plus the variable vegetation within the savanna.

Southeast corner; the "dry green" ring of plants continues northward but then ends and low level green cover starts. In the bajo forest you can see tall guano palms, *Sabal* species, though probably not tall enough to be named botan. These palms are 99% never inside any savanna of PNYNN because guano can't survive fires.

Almost identical to the other view.

More of the bottom brown-green partially fried vegetation around the ring encircling the oval savanna.

Brown-green vegetation is lower half going south east.

You can see the outside of the PNYNN (with cattle ranches all over the hills).

This view documents that the south side (actually all sides) of this savanna are protected.

This view shows the entire south band of brown-green vegetation that we saw in segments in the previous aerial photographs.

The vegetation of the Savanna of 3 Fern Species is very different than the more "encroaching forest" kind of trees of the Rectangular Savanna.

It has been suggested by geographers, ecologists, and soil scientists that fire is needed to maintain many types of savannas. I feel that if a savanna is literally never ever burned that some will be gradually forested at least around the edges by trees from adjacent hills or bajos. This is not a suggestion that burning is good (though in Belize there are special programs to teach how to pre-burn a savanna so it can be controlled, since they realize that if there is no burning the savanna will revert to forest and if there is uncontrolled burning the savanna fire will roast the adjacent mature forest around it).

www.nature.org/en-us/about-us/where-we-work/united-states/maryland-dc/stories-in-maryland-dc/international-fire-training/

and

https://vimeo.com/328829970

I was very pleased that the Savanna East of Nakum was not burned in 2019 (at least not that I am personally aware of).

There are at least four clusters of tasiste palm visible here (and in other photos of same area from different angles). At least two of the clusters are surrounded by trees, suggesting that in a past year the tasiste were in an open grassland, but because this area has not been burned, the surrounding bajo forest began to regenerate.

Towards the bottom of the Savanna of 3 Fern Species is a wide clump of hoja de sal, *Calathea lutea*, (and a smaller clump directly above it).

I estimate that much, if not most, of the ground cover of the oval savanna here are species of ferns. Reeds or sedges or grasses are also present but more on the left side of the ring of water

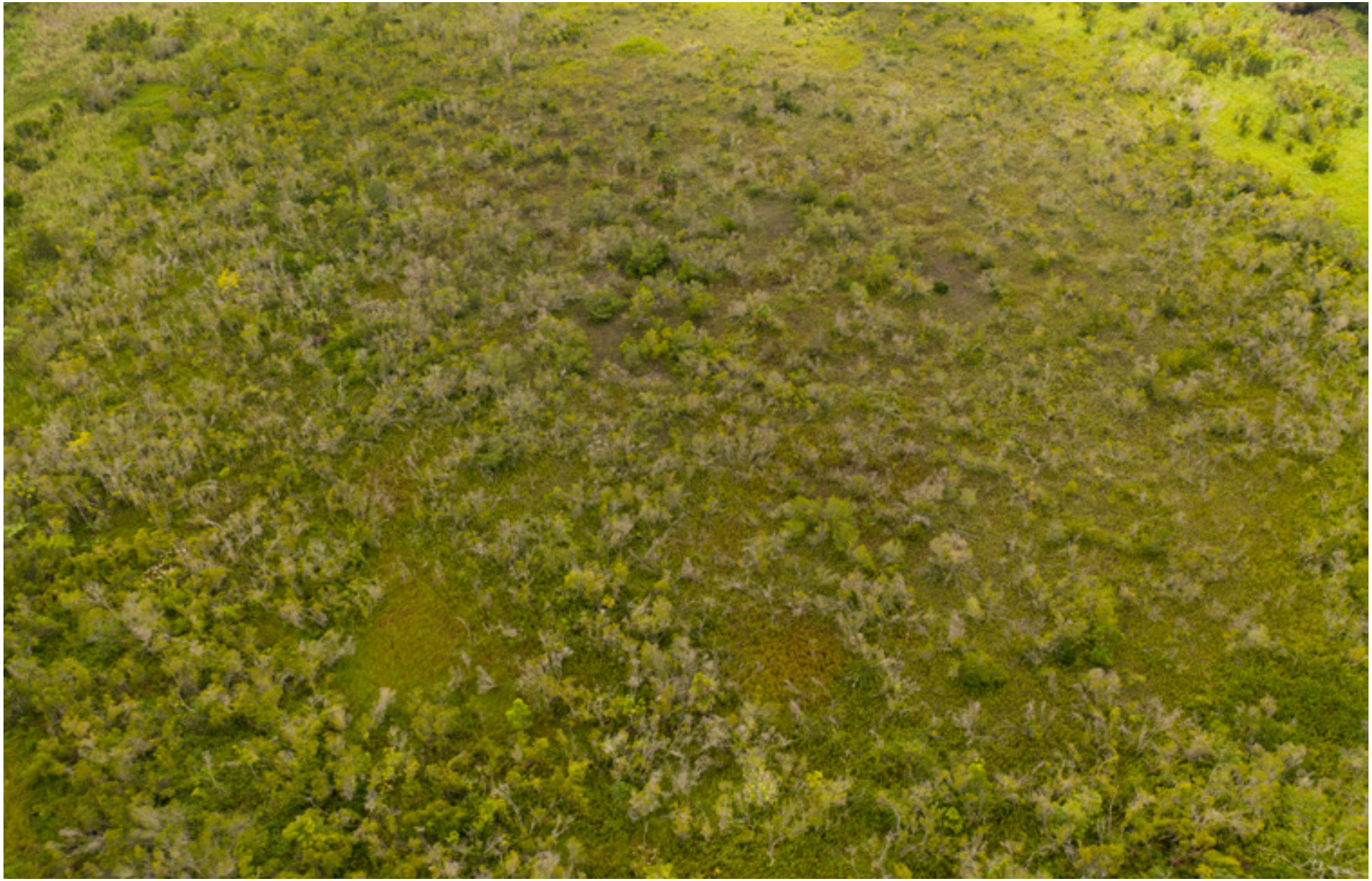
In this photo you can see the same two areas of hoja de sal.

You can see the largest cluster of tasiste palms of the entire area (here surrounded by “regenerating forest” (my estimate)). Tasiste palms grow in clusters with up to a dozen or more stems from a single “root mass.” This is why they tend to be clumped tightly together.

I close the chapter on the Rectangular Savanna to show again its position relative to the 3 conjoined cenote mouths at the north.

Note the gray rain clouds above. At the middle and right side of the forest in the background you can see it is raining. We were lucky that our capable drone pilot, Haniel Lopez, was able to accomplish the drone photography. He also did short videos that we will be posting.

CHAPTER 5: AERIAL PHOTOS OF BIODIVERSITY OF PLANTS
WITHIN THE OVAL AREA



Previous page:

At the top right is the edge of the grassland in the ring around the savanna. Now we will explore the inside of the Savanna of 3 Fern Species.

A single very thick clump of tasiste palms is surrounded by the low ferns.

As you move west (left) you see more low open forest cover but still thousands of low ferns covering the ground.

Two clumps of hola de sal are visible (a large wide clump and a smaller clump with mostly green leaves a few meters NW).

90% of the ground cover is upright ferns of nearly identical height. Only towards the edge do you get reeds or sedges or grasses.

Thousands upon thousands of low ferns cover the surface of this shrub-filled east side of the Savanna of 3 Fern Species. Then you get reeds, sedges and/or grasses and then on the other side of the "ring of water around the oval savanna" you get grasses.

One mass of tasiste palms is visible (and then a lot more in the grassland of the Rectangular Savanna).

Considering how dark and solid the cloud cover is (rain storm approaching), it's notable how well the drone pilot Haniel Lopez was able to set the camera exposure so all the plants are nicely illuminated.

Shows more of the inner area of the oval savanna of ferns.
More ferns as you move inside.

The cluster of tasiste palms is clearly visible at the left.

More grasses, sedges or reeds in this area.

If you have a crisp 27" computer monitor and the original RAW image you can "see ferns everywhere." Several species are visible.

Our obvious goal is to photograph them up close so they can be identified.

This photograph is above (north a meter or so) from the top edge of the "rectangular" savanna.

This photograph starts a few meters back (closer to the rectangular savanna).

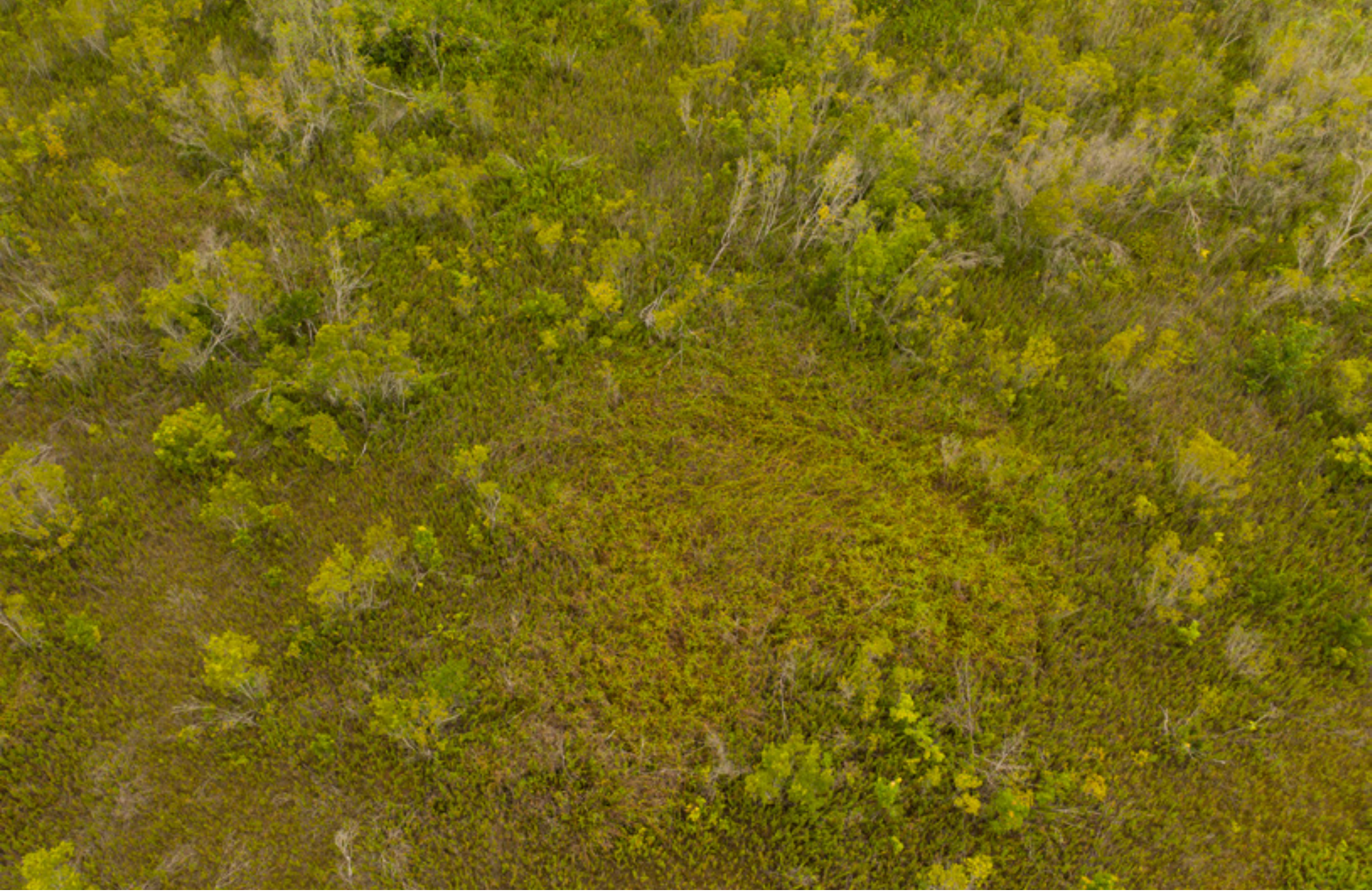
The ground cover is almost solid ferns, one species is “straight up” but never tall here. The other species wanders around more than growing straight up.

One of the previously mentioned clusters of hoja de sal is visible if you learn what to look for.

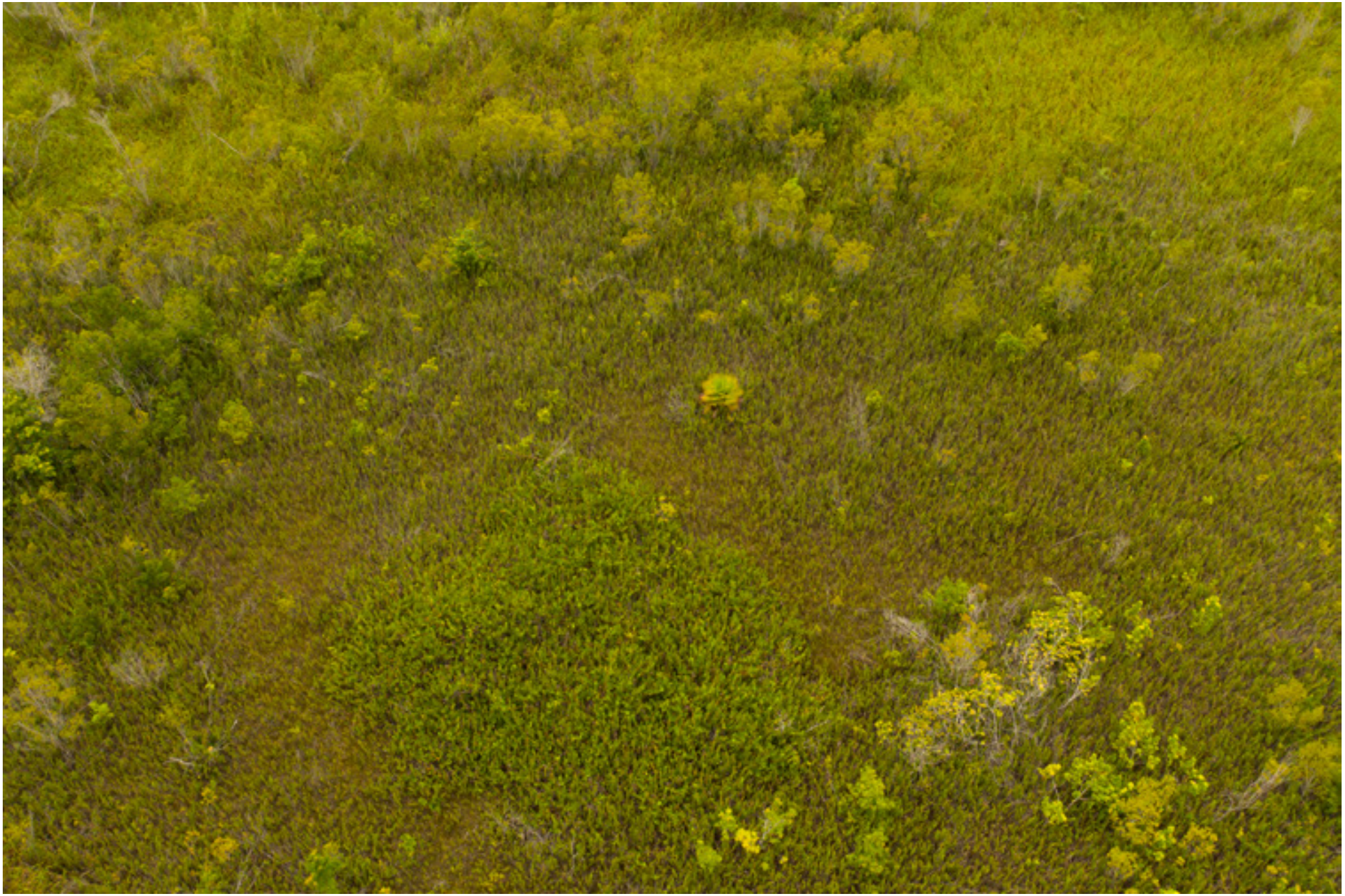
This is the area that encouraged me to name this a "fern savanna" and not a grassland savanna. Almost all the ground of this area is covered with ferns of the identical height.

In the left 25% of this area the ground cover is almost 100% low ferns.

The ground is literally covered with low ferns. It is like walking through a low grass pasture; except it's all ferns (almost no grass noticeable). Yes, there are shrubs everywhere, and a few stunted trees (no logwood inside the oval). But when you are standing here, and see what's around you, you realize you are in a fern savanna. This is the deep impression that is in my memory from the first hike here in 2019.



Good view of the grasses in the middle area but lots of low ferns covering the ground around. In between the bushes and saplings are thousands of “ground ferns” (my nickname for ferns that stay about the same height across wide areas).

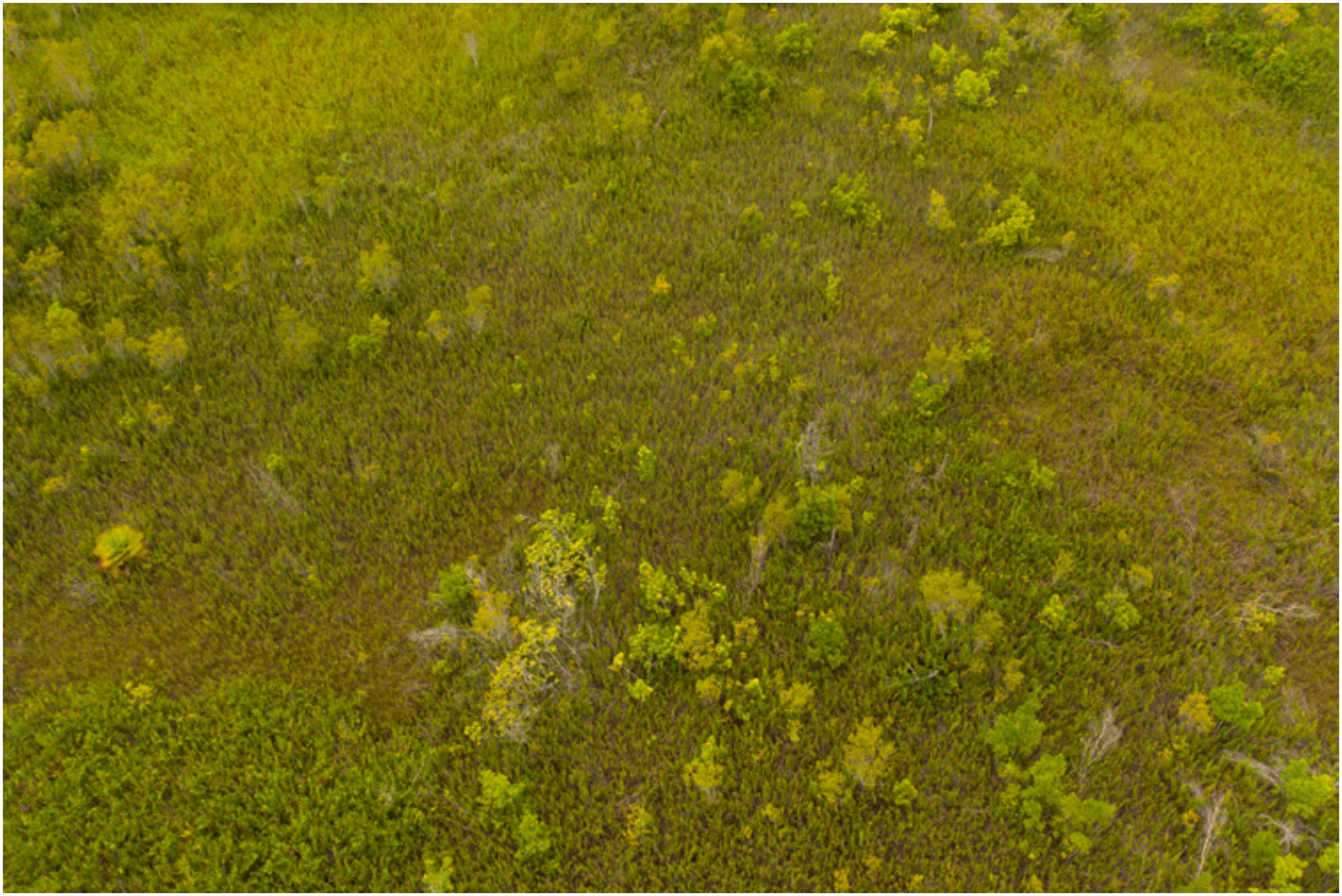


Previous page.

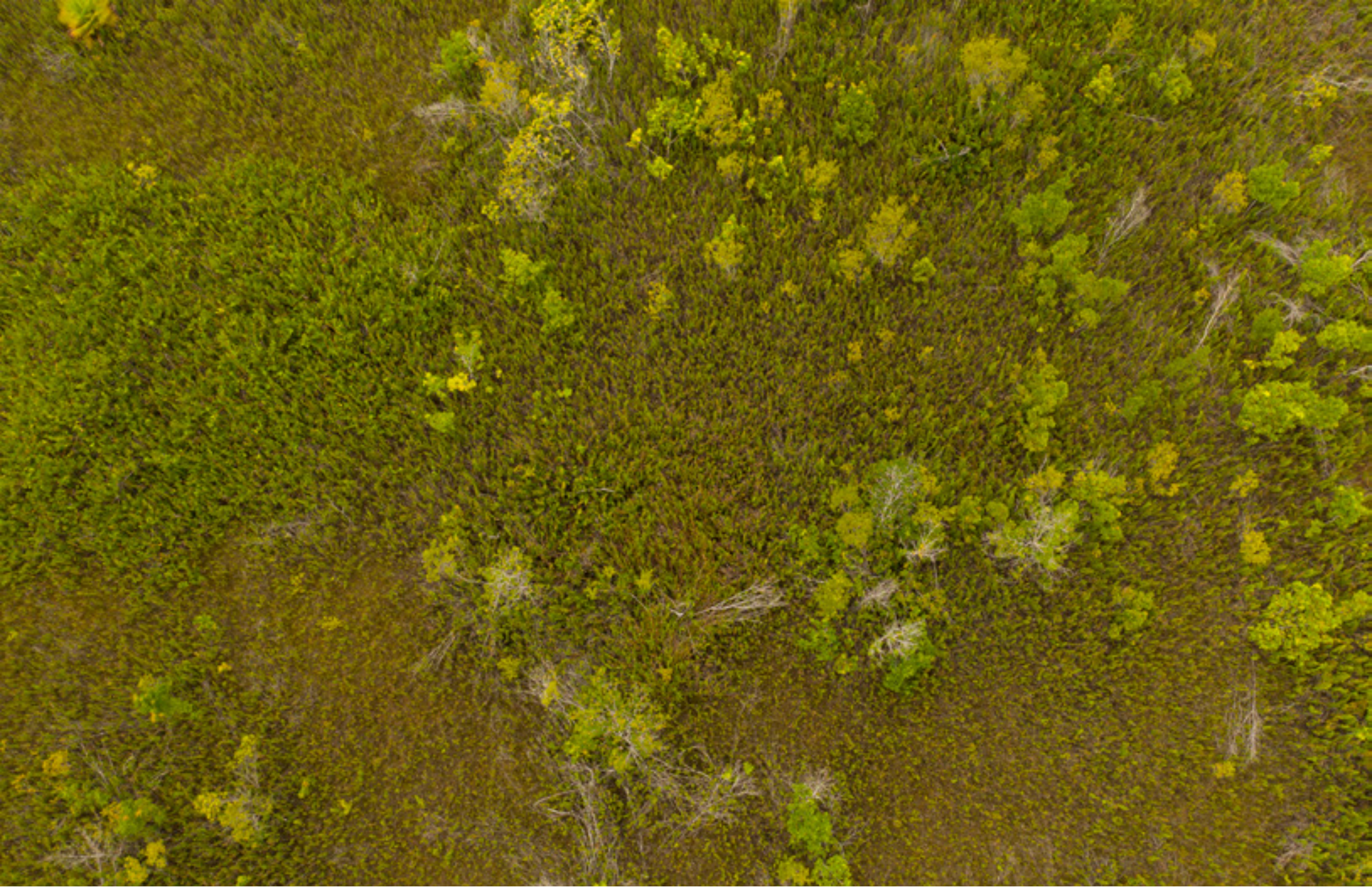
Notice the "islands" of different plants (or different thickness due to different underground moisture). We found the same in the several kilometer long Savanna East of Nakum: islands of different plants in different areas of this large savanna (the largest of PNYNN. We just found comparable very large savannas in the southeast area of Parque Nacional Laguna de Tigre.

In this photo, if you enlarge the RAW original, you can see thousands of ferns. It is this unexpected ground cover that inspired me to consider this a fern savanna and not a grassland savanna (the adjacent Rectangular Savanna has the grassland aspect but is outside the oval ring of water).

In the middle is a young cluster of tasiste palm, *Acoelorrhaphe wrightii*.

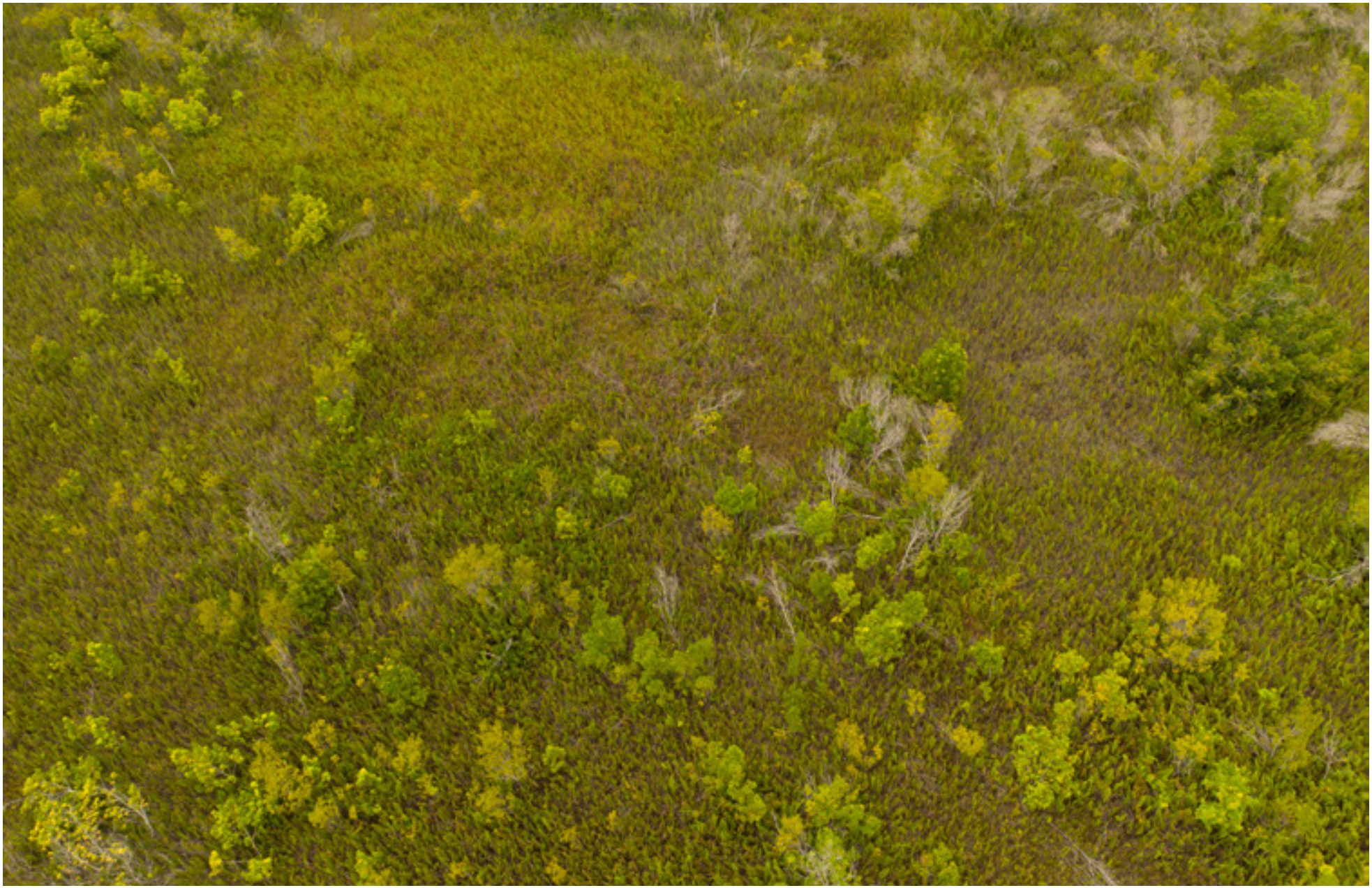


Same tasiste palm is at far left (this allows you to know where you are in the savanna). Thousands of ferns as ground cover.



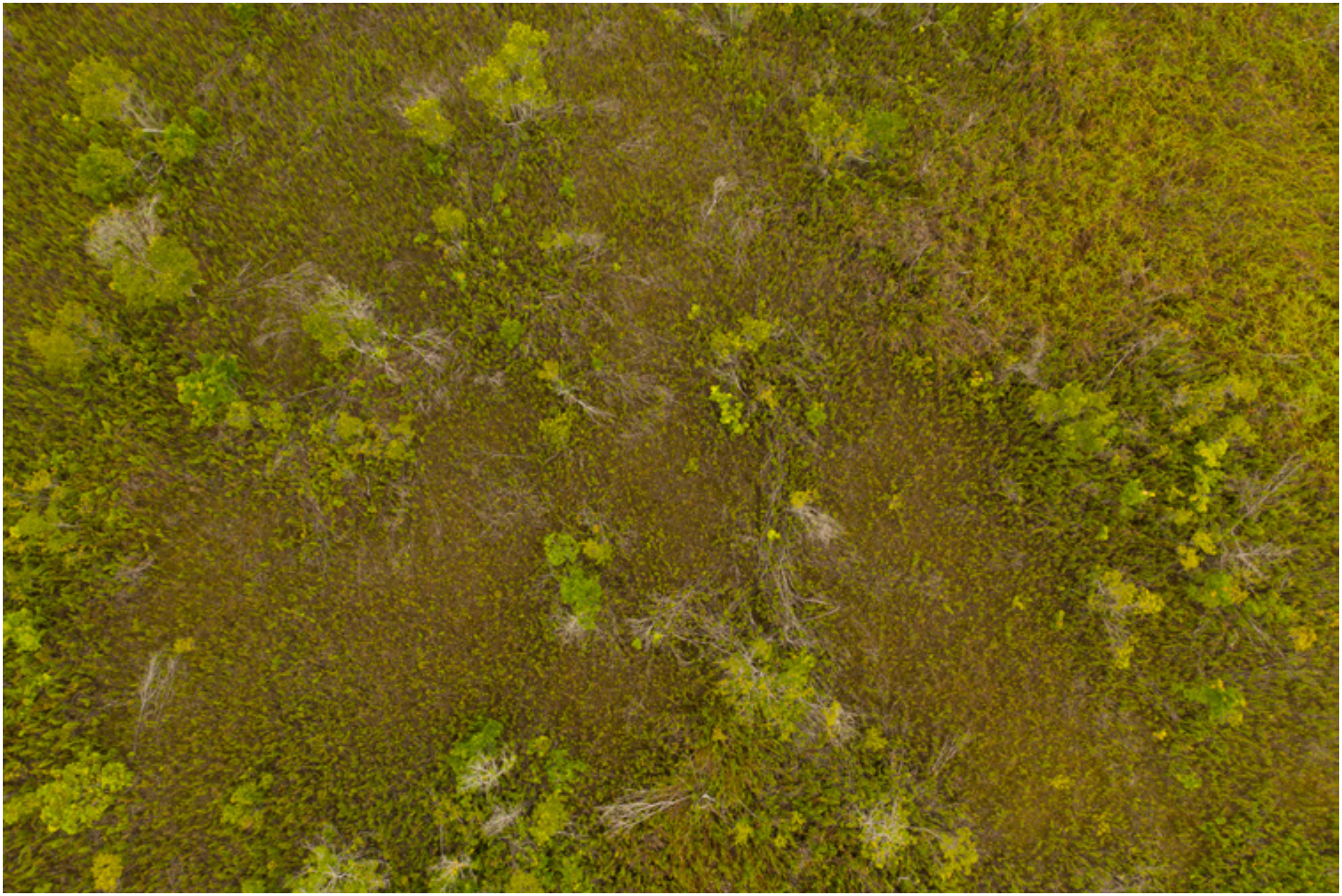
Solitary tasiste cluster is at top left.

Ferns cover close to 90% of the ground. Some areas are dry; other areas hold more moisture (so the ferns are brighter green and more robust in size).

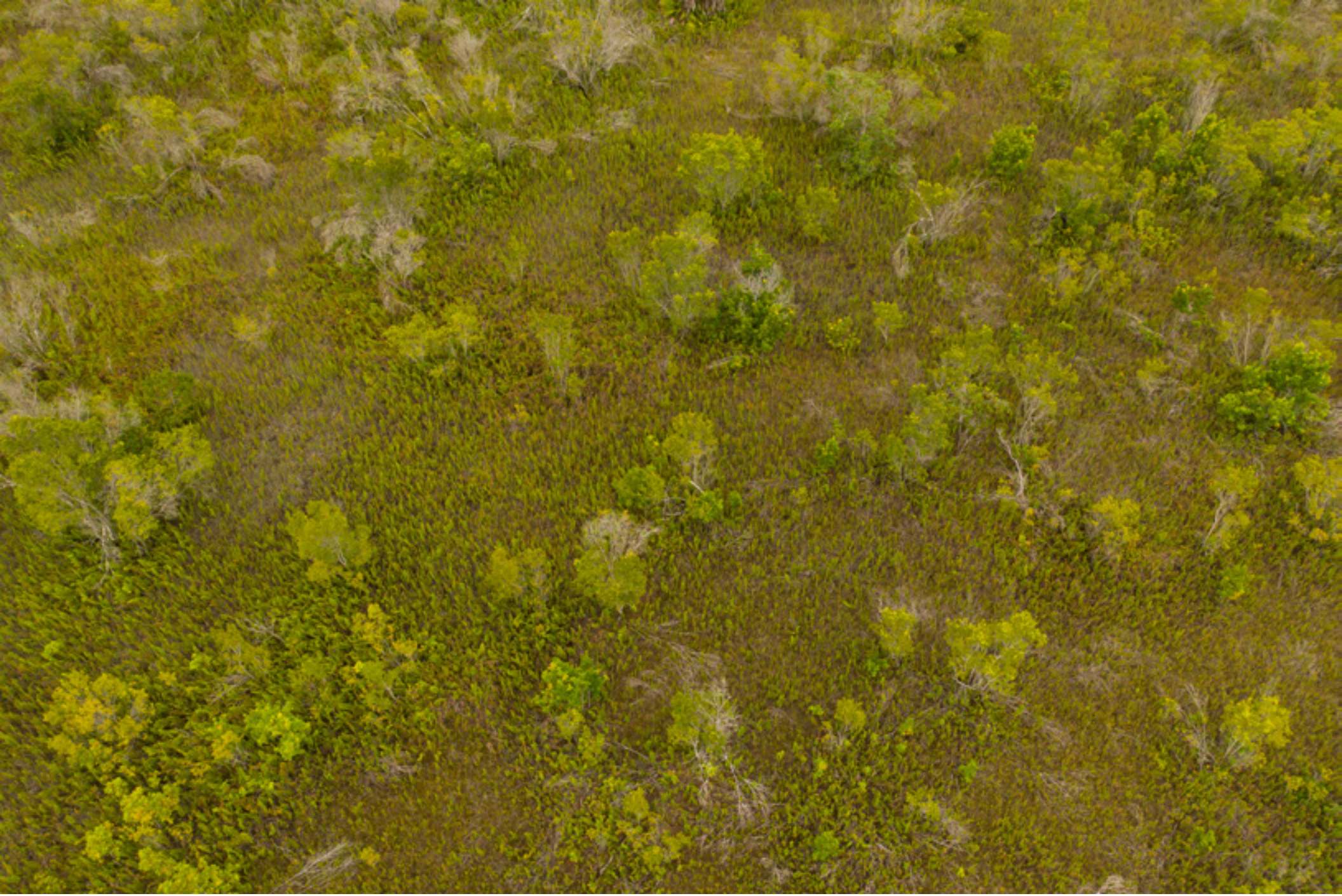


Across the bottom 95% of the ground cover is ferns of nearly identical limited height. I have never before in my life walked through such a “savanna of ground ferns.” The smaller grass area that is also in the previous page is at the top middle.

70% of the ground cover is solid ferns; 30% at the lower right (east) is the grass area we have seen in previous photos.



Grass area is top left; ferns cover literally everywhere else, even under and around the saplings.



Ferns, ferns, everywhere as ground cover. All "the same height." That said, among the thickest area of saplings the ferns may be growing taller.

More ferns, ferns, everywhere as ground cover.

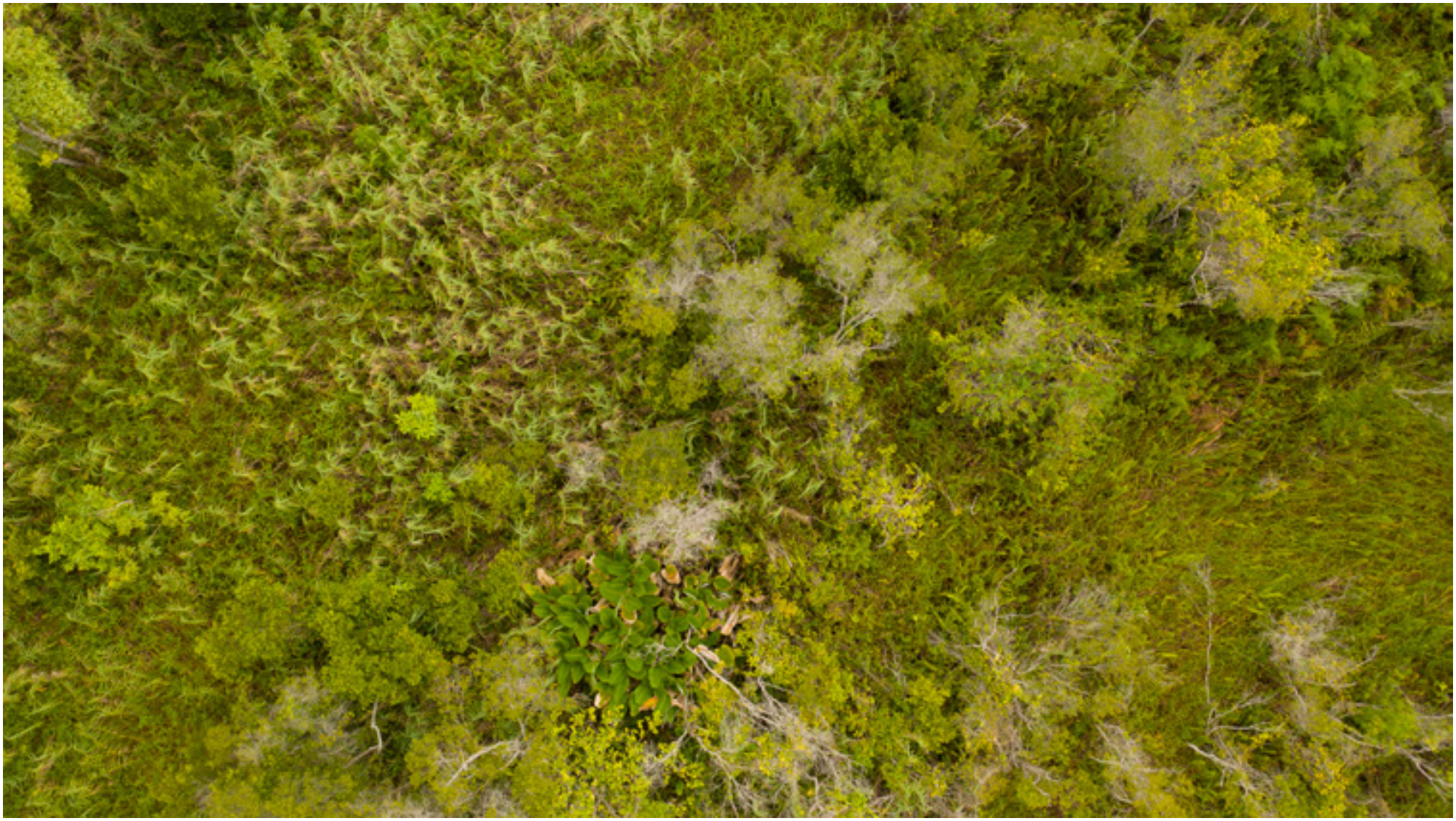
One of the best views of the relatively tall clump of tasiste palms.
All surrounded by shrubs and saplings with thousands of ferns as ground cover.

Here the clump of tasiste palms is at far right (middle height of the image).

The biodiversity of the ground cover is clearly visible here. Plus we need to identify all the shrubs and saplings.

You can tell you are not in the eastern side because of the hills in the distance.

Ground cover is areas of thousands of ferns but also ground cover elsewhere of other plants. Lots more needed to be studied and obviously need a literal quadrant map so we can locate each plant species.



Now we see more of the east. This is the area that park ranger Teco (Moises Daniel Perez Diaz), Biologo Lorena Lobos and I entered during a dryer month of 2019.

Here you see the largest area of solid hoja de sal large leaf plants. Lots of ferns as ground cover but this sector is not an open savanna.

I cropped this photo to reveal the hoja de sal area, *Calathea lutea*.

On the next field trip here it would help to have aerial photos at close-up (so we don't have to crop).

And, would sure help to have a lens that can focus on individual plant clusters such as this. Panorama views help show the entire biodiversity, but next it would help to have every single species photographed at medium format 100 Megapixel Phase One iXM-100 Geospatial UAV quality.

Looking south; lots of low ferns as ground cover.

The shrubs with dark green leaves tend to be not far from the ring of water. We need to identify these shrubs (and all the other plants) by returning in a drier month and photographing the leaves of every shrub (front and back).

CHAPTER 5
LAGUNETA OF 3 CONJOINED CENOTES

Previous page.

Perfect wonderful helpful illumination accomplished by drone pilot Haniel Lopez.

You can tell that the water level is often much higher (in some years rising up to the edge of the forest). But the water level is nonetheless relatively high since there is about 5 linear meters of grasses or other shore plants submerged around the edge (literally 90% under water). And all around the southern edge you can see the water is about 4 or more meters past the edge and into the shore grasses, reeds, or sedges.

The ring of round leaves around the circles of water are *Nymphaea ampla*, common white water lilies. Ironically we have found NONE in Lake Yaxha recently and very few in Laguna Sacnab (whose Maya name means white water lily).

Similar to the previous photo but this shows more of the mature bajo forest that is between the south end of the cenotes and the north top of the Savanna of 3 Fern Species.

Next page: Now you can see why we could not accomplish more than a few minutes of drone photography. Rain clouds came in twice (so we did a bit of drone photos before the first rain hit and then a bit more before the second rain hit). When we saw the second storm coming we packed and left.

We finish with a view of both these never-before-studied wetlands. We at FLAAR (USA) and FLAAR (Mesoamerica) sincerely appreciate the cooperation and coordination of the dual PNYNN park administrators: Ing. Mario Vazquez and Arq. Leonel Ziesse. Our goal is to find, photograph, document, and provide all this information to the park, to assist in future Plan Maestro studies and to help prepare more comprehensive lists of flora, fauna, and ecosystems.

The three conjoined circles warrant geological studies to ascertain whether or not they were cenotes many thousands of years ago.

The oval "savanna" deserves in-depth studies by biologists, ecologists, geologists, botanists, zoologists, and archaeologists. Our three visits help provide these scholars lots of images so they can use these images to prepare research project proposals. For example, this photograph

- reminds us of the "ring of water" around this area
- shows us multiple areas of hoja de sal (useful plants to the Maya people)
- makes it clear that here is a remarkable diversity of different plants to study and to protect

And if the tall palm at the far lower right is a *Sabal* species guano palm, why do these never grow inside a savanna? Where it is growing is a bajo which will be seasonally inundated. Why can't it grow 10 meters away inside the savanna? Seasonally rising water is one of many possible explanations; soil differences between a karst bajo area and soil within a savanna would also be helpful to study. Fire in past epoch is another reason: tasiste palm tuberous roots are remarkably fire resistant.

Tasiste palms can grow (preferably) inside the savannas but also occasionally on the outside (especially the variety that accepts salt water and brackish water of the Municipio of Livingston, Izabal. We have a photo essay on tasiste palms there (and four volumes on tasistal areas upstream Arroyo Petexbatun from Sayaxche, Peten). Tasiste palms are one of the most adaptable plants of the Maya Lowlands. Tasiste palms produce edible seeds and leaves used for thatch. *Acoelorrhaphe wrightii* are called pimento palm in Izabal and Belize, saw palmetto in Florida.

The plants we have already documented last year, such as bog moss, *Sphagnum subsecundum* and Arrowroot, *Maranta arundinaceae*, can be added to the "List of Plants of Parque Nacional Yaxha, Nakum and Naranjo" for their next Plan Maestro of PNYNN. This is why it is helpful to return and do close-up photography of each plant, each shrub, each mushroom (such as the coral-like mushrooms there, is a good example of what needs to be photographed, identified, documented, and published so other researchers know what's here).