



FLAAR
MESOAMÉRICA

WETLANDS #7

EDIBLE PLANTS OF WETLANDS

PROVIDED FOOD FOR THE CLASSIC MAYA

Sagittaria species

Swamps and Marshes
of Livingston, Izabal

NICHOLAS HELLMUTH

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Sagittaria species





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Sagittaria latifolia Willd.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston, Izabal, Guatemala.

Camera: Sony Alpha A9 II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.



Edible Wetlands Plants of Municipio de Livingston, Izabal

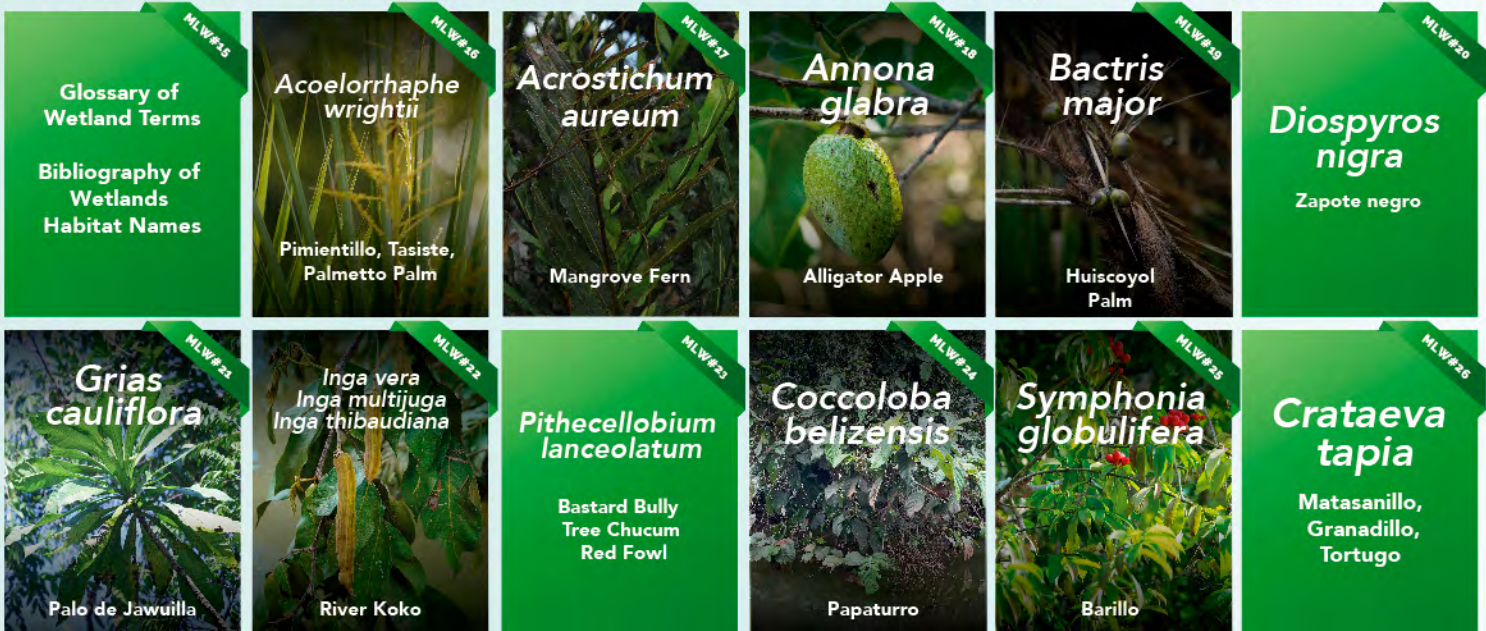
Wetland Series 1: from Swamps, Marshes and Seasonally Inundated Flatlands of Izabal



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References Cited and Suggested Reading on *Sagittaria* _____

Helpful web sites for any and all plants _____



Starting in January 2021, we will have two different series of FLAAR reports on plants of Guatemala.

One series will be focused on the area where we found and photographed the species, with basic list of suggested reading. The purpose of this 1st edition is to help provide our photographs and information on where botanists, students, and interested members of the public can find and visit this plant themselves.

Once our team has time (and funding) we will then do a 2nd edition with comparative comments about the same tree or vine in other areas of Guatemala and adjacent parts of Mesoamerica, especially: Chiapas, Tabasco, Campeche, Yucatan, Quintana Roo, and Belize.



Sagittaria latifolia is pollinated by multiple insects.

Photo by: Víctor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: Sony Alpha Ag II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.



GLOSSARY

Bog, I thought these were primarily in Ireland, but I hiked through a bog within the Savanna “of 3 Fern Species” in Parque Nacional Yaxha, Nakum and Naranjo (PNYNN), Petén. I estimate there were areas of bog within the Savanna “East of Nakum” as well. We (Teco, Lorena, and I) even found “bog moss” all over the ground in one area of the Savanna “of 3 Fern Species”, a savanna I discovered from aerial photographs of IGN.

Marsh usually has water all year but has no total tree cover. Grasses, reeds and low plants are more common; plus, underwater plants and floating plants.

Swamp usually has water all year but has lots of trees. During the rainy season the water simply gets deeper. Petén has more marshes than swamps; Izabal has both. You get mangrove swamps all around the Caribbean coast and parallel to the Pacific Ocean coast (several impressive mangrove swamp areas inland from the Pacific coast of Guatemala).

Wetland, to me is a generic word to cover swamps, marshes, and seasonally inundated areas. Each ecologist and geographer and botanist use their own academic terms. But, Holdridge (life zone systems) never hiked through the Savanna “of 3 Fern Species” nor the Savanna “East of Nakum” nor took a boat up all the rivers entering into El Golfete. And if he cruised up Arroyo Petexbatún, he (and Lundell and all other capable scholars who accomplished fieldwork in Petén) did not get out of their seats on the lancha to hike through the swamps to see what was 100 to 200 meters inland.



Life on land is the Sustainable Development Goal (number 15, proposed by the United Nations) which claims to ensure the conservation of terrestrial and freshwater ecosystems. Municipio de Livingston has multiple natural areas associated to rivers and wetlands, for example.

INTRODUCTION TO EDIBLE PLANTS OF MAYA SWAMPS, BOGS, AND MARSHES

Several species of *Sagittaria* produce potato like tubers that are edible. These are not listed or discussed by Lundell (neither 1937 nor 1938). The edible aspect of this plant is missing from my 13th edition of my years of studying edible foods of the Maya. During November and December 2020 I found several underutilized edible plants in Livingston that I had not paid attention to in the previous half century of my research. So now I am producing quick photo essay reports on all these plants in order to rescue them:

- *Montrichardia arborescens*, Araceae, camotillo, aquatic plant on edges of swamps, with very large fruits with edible seeds.



Sagittaria latifolia, family Alismataceae.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston, Izabal, Guatemala.

Camera: iPhone 11 Pro Max.

Edible Plants of Municipio de Livingston from

Swamps, Marshes, and Seasonally Inundated Flatlands of Izabal

- *Pontederia cordata*, entire marshes of this plant; or thick areas around edge of other aquatic plants. Very common in Izabal wetlands. Edible.
- *Sagittaria*, several species of which several are edible.

Swamp edge plants with edible fruits:

- *Annona glabra* L. Annonaceae, anonillo.
- *Chrysobalanus icaco* L., coco plum, icaco.
- *Grias cauliflora* L., Lecythidaceae, bom-bowood, genip, warreewood, wild mammy.
- *Pachira aquatica* food, medicine, dye colorant (Balick, Nee, and Atha 2000).



This is only the start: there are a lot more edible bog and wetlands plants (based on our discovery of the plants of two seasonally inundated savannas in remote areas of Parque Nacional Yaxha, Nakum and Naranjo (PNYNN)).

Sagittaria latifolia Willd.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.



The two plants showed below were two plants that we documented in humid ecosystems of Livingston. In order to rescue the local knowledge, maybe a recipe with this ingredient, this plant can offer a nice and nutritious meal.



Montrichardia arborescens.

Photo by: María Alejandra Gutiérrez, FLAAR Mesoamerica, Nov. 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: Sony Alpha A9 II.



Pondetaria cordata.

Photo by: David Arrivillaga, FLAAR Mesoamerica, Nov. 2020. Río Cáliz Creek, El Golfete, Livingston.
Camera: Sony Alpha A7R IV..

We have achieved these advances since we hike endless hours, day after day, deep into remote areas. Intelligent university botanists explore near their base centers and in areas of easy access. Popular and well known research areas in Panama and Costa Rica get the most attention. Our goal is to show the biodiversity of Guatemala and since not as many botanists have explored the remote areas here, we welcome and encourage botanists to undertake research here, especially in cooperation with botanists from USAC, UVG, URL and the other Guatemalan universities, plus in cooperation with CONAP, CECON, FUNDAECO and in cooperation with the local Q'eqchi' Maya and Garifuna communities.



Sagittaria latifolia in its natural habitat.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

MY PERSONAL EXPERIENCE **WITH *SAGITTARIA***

We first found *Sagittaria* in Petén in a seldom visited remote part of Parque Nacional Yaxha, Nakum and Naranjo, near Laguna Perdida. Then I believe we found it again elsewhere but we need to return to PNYNN and update our lists. I did not really notice *Sagittaria* plants until I saw a lot of them in the marshes parallel to rivers feeding into El Golfete, in the Municipio de Livingston. Month after month we are doing ethnobotanical field work in the swamps, bogs, marshes, and other wetlands of this Caribbean area of Izabal, Guatemala.

During these field trips we have found several swamp-related plants that are edible. This immediately raised the question of why everyone (including me) is focused on foods of the slash-and-burn milpas, kitchen gardens, and foods of the forests. Why have we forgotten foods of the swamps? I include myself in Mayanists who have skipped foods of the wetlands.



Sagittaria latifolia is an example of edible plants being found in marshes and swamps.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: Sony Alpha A9 II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

FULL BOTANICAL NAME

Sagittaria latifolia Willd. was the specie that we photographed. There are two pertinent species in Belize and at least three in Guatemala. In parts of the Yucatan Peninsula there are four species, so I show all four:

- *Sagittaria guayanensis* Kunth
- *Sagittaria intermedia* Micheli
- *Sagittaria lancifolia* L.
- *Sagittaria lancifolia* subsp. *media* (Micheli) Bogin
- Plant family Alismataceae.



Sagittaria latifolia and its white flower.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: Sony Alpha Ag II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

HERE ARE SYNONYMS FOR FIVE PERTINENT SPECIES OF *SAGITTARIA*

<i>Sagittaria guayanensis</i>	<i>Sagittaria intermedia</i>	<i>Sagittaria lancifolia</i>
<p><i>Alisma ancile</i> Mantell ex Steud. [Invalid] <i>Alisma echinocarpum</i> (Mart.) Seub.</p> <p><i>Alisma pubescens</i> Buch.-Ham. ex Wall. [Invalid] <i>Alisma stellatum</i> Buch.-Ham. ex Wall. [Invalid] <i>Alisma stellatum</i> Buchanan-Hamilton ex Wallich <i>Echinodorus guayanensis</i> (Kunth) Griseb. <i>Echinodorus guianensis</i> (Kunth) Griseb. <i>Lophiocarpus guayanensis</i> (Kunth) Micheli <i>Lophiocarpus seubertianus</i> (Mart. ex Seub.) Micheli <i>Lophotocarpus guayanensis</i> (Kunth) J.G.Sm.</p> <p><i>Lophotocarpus guayanensis</i> (Kunth) T.Durand & Schinz <i>Lophotocarpus guayanensis</i> (Kunth) Griseb. <i>Lophotocarpus guayanensis</i> var. <i>echinocarpus</i> (Mart.) Buchenau <i>Lophotocarpus seubertianus</i> (Mart. ex Seub.) Buchenau <i>Sagittaria bracteata</i> Willd. ex Seub.</p> <p><i>Sagittaria echinocarpa</i> Mart. <i>Sagittaria guayanensis</i> subsp. <i>guayanensis</i> <i>Sagittaria guianensis</i> Schtdl. [Spelling variant] <i>Sagittaria guyanensis</i> Kunth [Spelling variant] <i>Sagittaria parviflora</i> Wall. ex Micheli</p> <p><i>Sagittaria seubertiana</i> Mart. ex Seub.</p>	<p><i>Sagittaria acutifolia</i> L. ex Griseb. [Illegitimate]</p> <p>Not in Chiapas, Tabasco, Petén, Izabal or Belize.</p>	<p><i>Drepachenia lancifolia</i> (L.) Raf. <i>Sagittaria acutifolia</i> L</p> <p><i>Sagittaria angustifolia</i> Lindl. <i>Sagittaria lancifolia</i> var. <i>angustifolia</i> (Lindl.) Griseb. <i>Sagittaria lancifolia</i> subsp. <i>lancifolia</i> <i>Sagittaria lancifolia</i> var. <i>major</i> Micheli <i>Sagittaria ovata</i> Delile</p> <p><i>Sagittaria pugioniformis</i> L. <i>Sagittaria pugioniformis</i> var. <i>acutifolia</i> (L.f.) Kuntze</p> <p><i>Sagittaria sellowiana</i> Kunth <i>Sagittaria trachysepala</i> Engelm. ex M.Michel</p>

Edible Plants of Municipio de Livingston from

Swamps, Marshes, and Seasonally Inundated Flatlands of Izabal

<i>Sagittaria latifolia</i>	<i>Sagittaria lancifolia</i> subsp. <i>media</i>
<i>Sagittaria latifolia</i> f. <i>diversifolia</i> B.L.Rob.	<i>Sagittaria falcata</i> Pursh
<i>Sagittaria latifolia</i> var. <i>glabra</i> Buchenau	<i>Sagittaria lancifolia</i> var. <i>falcata</i> (Pursh) J.G.Sm.
<i>Sagittaria latifolia</i> f. <i>gracilis</i> B.L.Rob.	<i>Sagittaria lancifolia</i> var. <i>media</i> Micheli
<i>Sagittaria latifolia</i> f. <i>hastata</i> B.L.Rob.	<i>Sagittaria plantaginifolia</i> M.Martens & Galeotti
<i>Sagittaria latifolia</i> var. <i>latifolia</i>	Not in Chiapas, Tabasco, Petén, Izabal or Belize.
<i>Sagittaria latifolia</i> f. <i>latifolia</i>	
<i>Sagittaria latifolia</i> var. <i>major</i> Pursh	
<i>Sagittaria latifolia</i> var. <i>obtusata</i> (Engelm.) Wiegand	
<i>Sagittaria latifolia</i> f. <i>obtusata</i> (Muhl. ex Willd.) B.L. Rob.	
<i>Sagittaria latifolia</i> var. <i>pubescens</i> (Muhl.) J.G.Sm.	



Sagittaria latifolia detail.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston. Camera: Sony Alpha Ag II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

LOCAL NAMES FOR **SAGITTARIA** PLANTS

- “Water potatoes” (Zepeda and Lot 2006: 282).
- ‘Papas de agua’, ‘flor de papa’, ‘hierba de papa’, ‘pulla’ o ‘guía’ (Zepeda and Lot 2006: 287).

MAYAN NAMES FOR **SAGITTARIA** PLANTS

No data found so far.

HOW MANY OTHER PLANTS OF GUATEMALA HAVE THE SAME SPANISH NAME?

“Guía” is the name commonly given to climbing plants.



Sagittaria latifolia is able to grow many flowers.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Rio Chocón Machacas, El Golfete, Livingston.

Camera: iPhone 11 Pro Max.



Sagittaria latifolia flowers in a developing stage.

Photo by: Víctor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.

Camera: Sony Alpha Ag II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.



HABIT FOR **SAGITTARIA PLANTS**

Ingrained, emerged hydrophytic herbs.

HABITAT FOR **SAGITTARIA PLANTS**

Aquatic; they grow in water or in seasonally inundated areas that are bogs even in the dry season.



It would help if a student could do a thesis or dissertation on *Sagittaria* plants of Guatemala and study the habitats in detail.

Sagittaria latifolia Willd.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica,
Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

BOTANICAL DESCRIPTION OF *SAGITTARIA* IN STANDLEY AND CO-AUTHORS CHICAGO **BOTANICAL MONOGRAPHS**

Lophotocarpus guayanensis (HBK.) J. G. Smith, Kept. Mo.

Bot. Gard. 6: 61. 1894. *Sagittaria guayanensis* HBK. Nov. Gen. & Sp. 1:250. 1816.

In mud or shallow water, 1000 meters or less; Peten; Jutiapa; Santa Rosa. Mexico; Honduras; El Salvador; Panama; northern South America.

Plants sometimes submerged or floating; petioles often much elongate, always much exceeding the blades, nodose-septate; blades broadly ovate to rounded, 5-7 cm. long or shorter, obtuse to rounded and emarginate at the apex, deeply cordate at the base; scapes often shorter than the leaves, bearing only a few close whorls of large flowers; sepals broadly ovate, green, in fruit 8-11 mm. long; fruiting peduncles short and stout, often exceeded by the persistent bracts; fruit heads depressed globose, 12-15 mm. broad; achenes obovate, 2-2.5 mm. long, short-rostrate, the sides tuberculate.

(Standley and Steyermark 1958: 79)



Sagittaria latifolia and its leaves.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

Sagittaria lancifolia L. Pl. Jam. Pug. 27. 1759. Figure 18.

In shallow water or in muddy soil about lakes or along streams, 600 meters or less; Alta Verapaz; Izabal; Jutiapa. Southern United States to Mexico and British Honduras; Honduras; Nicaragua; Costa Rica; Panama; West Indies; South America.

Plants large and coarse, glabrous, often a meter high or taller; leaves borne on long thick spongy petioles, erect, the blades lance-linear to elliptic, 20-50 cm. long, mostly 2-8 cm. wide, acute or acuminate, acute to long-attenuate at the base, conspicuously nerved; scapes simple or usually branched, the flowers on long slender spreading peduncles, the thin bracts lanceolate; corolla pure white, 2-4 cm. broad; fruit heads 1-1.5 cm. in diameter; achenes cuneate or obovate, short-rostrate, with a narrow dorsal wing.

Bogin refers material from Guatemala, British Honduras, Costa Rica, Nicaragua, Panama, Mexico, and eastern United States to subsp. *media* (Micheli) Bogin (Mem. N. Y. Bot. Card. 9:214. 1955).

[Continues on the next page]



Sagittaria latifolia Willd.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.

Camera: iPhone 11 Pro Max.

Sagittaria latifolia Willd. Sp. Pl. 4: 409. 1806.

In marshes, at or little above sea level; Izabal. Southern Canada and United States to Mexico; Honduras; Nicaragua; Costa Rica; West Indies; South America. Hawaii (where introduced).

Plants glabrous, usually 30-60 cm. tall; leaves long-petiolate, the blades narrowly or broadly triangular-sagittate, 10-40 cm. long, acute or acuminate, the large basal lobes acute to attenuate; scapes simple or branched, the peduncles 1-5 cm. long, slender, the bracts ovate; petals large and white; fruit heads 1.5-3 cm. in diameter; achenes very numerous, obliquely obovate, winged, with a horizontal apical beak.

Called "arrow-head" in the United States, in reference to the shape of the leaves. The starchy rhizomes were used as food by many of the North American Indians.

(Standley and Steyermark 1958: 80)



Sagittaria latifolia. "Broadleaf arrowhead" is its common name in English speaking areas.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Rio Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

SAGITTARIA IN BELIZE: STANDLEY AND RECORD

Ford and Nigh mention *Sagittaria lancifolia* as edible for their Petén-Belize border research area (2015: 184).

SAGITTARIA MENTIONED IN TREES AND PLANTS OF MEXICO, STANDLEY

Not mentioned.



Sagittaria latifolia is pollinated by insects.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: Sony Alpha A9 II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

WHERE HAS *SAGITTARIA LANCIFOLIA* BEEN FOUND IN THE MUNICIPIO OF LIVINGSTON?

There is no data of these two species on any list from any protected or main area in the Municipio de Livingston, sadly. Anything for Biotopo Protegido Chocón Machacas, CECON/USAC, nor Tapon Creek Nature Reserve (including Taponcito Creek), FUNDAECO; nor Buena Vista Tapon Creek Nature Reserve; nor Cerro San Gil (south side of Río Dulce); nor El Refugio de Vida Silvestre Punta de Manabique; nor Ecoalbergue Lagunita Creek (Área de Usos Múltiples Río Sarstún), and nothing for Bocas de Polochic.

Not even for the adjacent Sarstoon-Temash National Park (northern side of Río Sarstún), Belize.

So, in effect, the team of FLAAR Mesoamerica is “putting *Sagittaria* plants on the map of the Municipio of Livingston.”



Sagittaria latifolia. "Papa de agua" is its common name in some Spanish speaking countries.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

ARE THIS *SAGITTARIA* SPECIES FROM THE HIGHLANDS OR FROM THE LOWLANDS (OR BOTH)?

In Guatemala and in Mexico only found in the Lowlands.



Sagittaria latifolia Willd.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: Sony Alpha A9 II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

SAGITTARIA IN PETÉN

On June 4, 2013, we found *Sagittaria* near Laguna la Perdida, an unexpected lake area because it is at the top of a hill. So I estimate that the water of the three segments of the laguna comes from underground. Elena Siekavizza estimated it was *Sagittaria lancifolia* L.

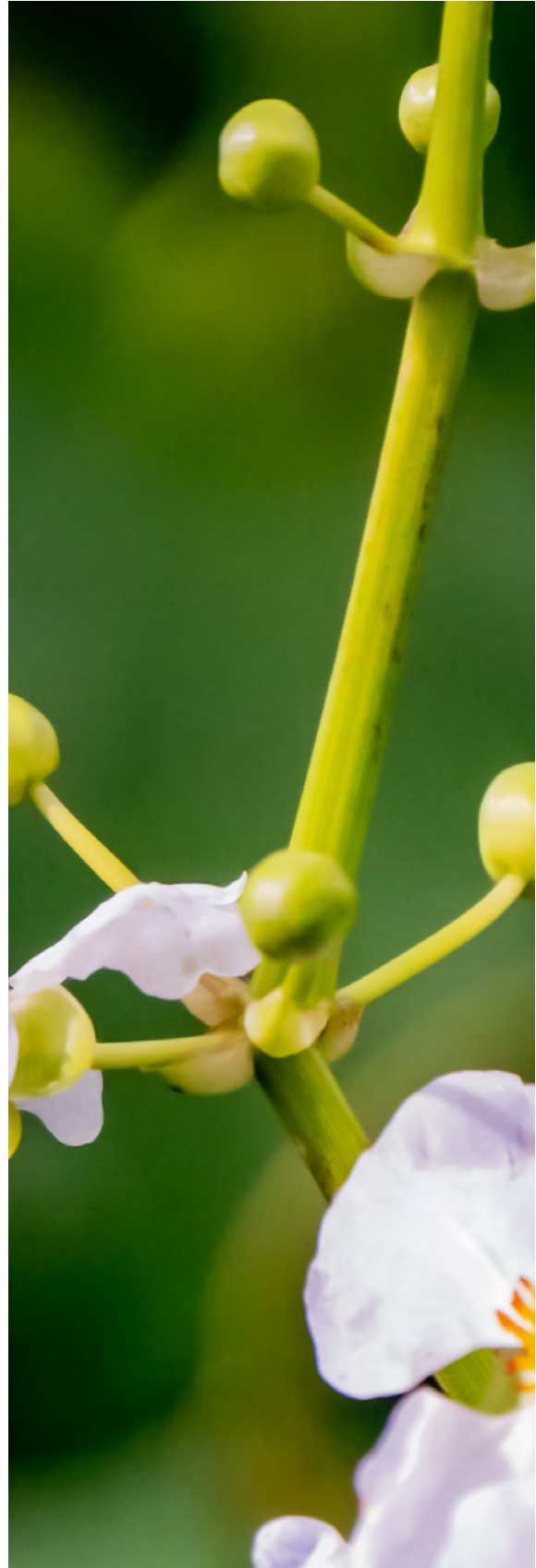
But I have not yet been able to find a single mention by Lundell of *Sagittaria* in his 1937 *The Vegetation of Peten*. I also looked for the older synonyms; not present. Yet we found one species so far in PNYNN and three species have been documented for Tikal.

There is a report on Peten Neotropical Flora where we made a list of all plants for Tikal. This was unfortunately not noted where this list came from, but it includes three species for Tikal:

- *Sagittaria guayanensis*
- *Sagittaria lancifolia*
- *Sagittaria lancifolia* subsp. *media*

Sagittaria latifolia is an edible plant.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: Sony Alpha Ag II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.



SAGITTARIA PLANTS IN BELIZE: BALICK, NEE AND ATHA 2000

Four species to the west and north sides of Petén, yet on the east side of Petén, only two species are noted for Belize, and both are subspecies of one species,

- *Sagittaria lancifolia* L. subsp. *lancifolia*
— Ref: FG 1: 80. 1958; FM 6: 7. 1994. —
Habit: Herb, aquatic.
- *Sagittaria lancifolia* L. subsp. *media*
(Micheli) Bogin — Ref: FG 1: 80. 1958; FM
6: 7. 1994. — Loc Use: MED. — Reg Use:
MED. — Nv: kibix. — Habit: Herb, aquatic.



Sagittaria macrophylla Zucc. is an accepted name, family Alismataceae. But, *Sagittaria macrophylla* Zucc. is not listed in the Belize checklist (Balick, Nee and Atha 2000: 173).

Sagittaria latifolia and its white flower.
Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov.
7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.



SAGITTARIA PLANTS IN MEXICO

- *Sagittaria demersa* J.G. Sm.
AGS, CHIH, DGO, GTO, HGO, JAL, QRO
- *Sagittaria guayanensis* Kunth
CAM, CHIS, GRO, JAL, MEX, MICH, NAY, OAX, PUE, SIN, **TAB**, VER
- *Sagittaria intermedia* Micheli
CAM, YUC
- *Sagittaria lancifolia* L.
AGS, **CAM, CHIS**, COL, GRO, JAL, MICH, NAY, OAX, PUE, QRO, **QROO, TAB**, TAMS, VER, **YUC**
- *Sagittaria latifolia* Willd.
CAM, CHIS, CDMX, DGO, GTO, HGO, JAL, MEX, MICH, MOR, NAY, OAX, PUE, QRO, SIN, **TAB**, TAMS, TLAX, VER
- *Sagittaria longiloba* Engelm. ex J.G. Sm.
AGS, BCN, BCS, DGO, GTO, GRO, HGO, JAL, MEX, MICH, MOR, NAY, OAX, PUE, QRO, SIN, SON, TAMS, VER
- **Sagittaria macrophylla* Zucc.
COL, CDMX, HGO, JAL, MEX, MICH, SON, TLAX
- *Sagittaria montevidensis* Cham. & Schtdl.
CHIS, CHIH, COAH, COL, JAL, MICH, NAY, SIN, SON, TAB
- *Sagittaria platyphylla* (Engelm.) J.G. Smith
MICH, NLE, TAMS

(Villaseñor 2016: 597)



Sagittaria latifolia Willd.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

From my research experience, if a plant is found in Chiapas, Tabasco, Campeche, and Quintana Roo, it is probably also findable in Petén. So four species are in the Maya Lowlands of Mexico and these should be looked for in Petén:

- *Sagittaria guayanensis* Kunth
CAM, CHIS, GRO, JAL, MEX, MICH, NAY, OAX, PUE, SIN, **TAB**, VER
- *Sagittaria intermedia* Micheli
CAM, YUC
- *Sagittaria lancifolia* L.
AGS, **CAM, CHIS**, COL, GRO, JAL, MICH, NAY, OAX, PUE, QRO, **QROO, TAB**, TAMS, VER, **YUC**
- *Sagittaria latifolia* Willd.
CAM, CHIS, CDMX, DGO, GTO, HGO, JAL, MEX, MICH, MOR, NAY, OAX, PUE, QRO, SIN, **TAB**, TAMS, TLAX, VER

Of these, three are listed for Tikal:

- *Sagittaria guayanensis*
- *Sagittaria lancifolia*
- *Sagittaria lancifolia* subsp. *media*

Sagittaria lancifolia L. is listed for the Lacanha Chansayab part of the Lacandon area of Chiapas (Levy et al. 2006: 96). No use is mentioned. Is not in index of Cook 2016.

Ethnobotanist Lot has produced multiple helpful reports on aquatic *Sagittaria* plants of Mexico.



Sagittaria latifolia and its multiple flowers.
Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

SAGITTARIA PLANTS IN THE AZTEC WETLANDS OF CENTRAL MEXICO

El Aciitlalpalli: de atl, agua; cuitlac, escreción; palli, tinte negro, planta acuática que se da en nuestros lagos y ha sido identificada por mí como la *Sagittaria macrophylla*, Bge. « Algunas Sagitarias de la América extratropical, naturalizadas en el mediodía, tienen también flores ornamentales. En China, la *Sagittaria chinensis*, Sims. es ampliamente cultivada, por sus rizomas comestibles, bajo el nombre de Tos'ku. En Pekin, según Bretschneider, la especie comestible es más bien la *Sagittaria macrophylla*, Bge. La fécula de estas plantas ha sido comparada con el Arro w-root por sus cualidades alimenticias, y los Kahnouks del V oiga no llevan alguna provisión alimenticia cuando van á cazar en las localidades acuáticas habitadas por las Sagitarias, cuyos tubérculos deben, en este caso, bastar para su alimentación. (Baillon, Hist. des Pl. xn, p. 81.)

(Urbina 1904: 578)



Sagittaria latifolia Willd.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

IN WHAT ECOSYSTEM(S) CAN YOU FIND **NATIVE *SAGITTARIA*?**

Different scholars use different words: I call them Wetlands. Others simply label the plant as “aquatic.”

DO *SAGITTARIA* PLANTS ALSO **GROW IN HOME GARDENS?**

Sagittaria are not common in home gardens, in part because they prefer to live in a marsh.



Sagittaria latifolia in its natural ecosystem, laying over a group of aquatic plants.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.

USES OF **SAGITTARIA** PLANTS

Two species of *Sagittaria* are listed as edible:

Sagittaria latifolia Willd. [also *S. cuneata* Sheldon]

FAMILY: Alismataceae (water plantain)

ENGLISH: arrowhead, arrowleaf, broad-leaved arrowhead, common arrowhead, duck potato, swamp potato, tule potato, wapattoo

SPANISH: wapato

USES/NOTES: White tubers are nutritious and eaten raw, boiled, or roasted over a fire.

NATURAL RANGE: Americas

REFERENCES: Clarke 1977, Gibbons 1962, Harrington 1967, Harris 1972, Holm-Nielsen and Haynes 1986, Mabberley 1987, Peterson 1977, Tomikel 1986, Yanovsky 1936

Sagittaria macrophylla Zucc. [syn. *S. mexicana* Steud.]

FAMILY: Alismataceae (water plantain)

SPANISH: acuitlacpalli

USES/NOTES: Tubers are eaten boiled or roasted over a fire.

NATURAL RANGE: Mexico

REFERENCES: Haynes and Holm-Nielsen 1994, Zepeda and Lot 1999

(Kermath, Bennett and Pulsipher 2013: 692-693)

Kermath, Bennett and Pulsipher do not cite Lot of any year or Zepeda and Lot 2006. The latter document that:

En México sólo se reporta el uso de los tubérculos de *S. longiloba* en Guanajuato (Lot et al., 1999) y de *S. macrophylla*. Respecto al último caso, Martínez y Matuda (1979) y Miranda Arce (1980) mencionan que sus tubérculos se conocen con el nombre de 'papas de agua', y se consumen y venden hervidos en el Estado de México

Then their 2006 report documents the more common species sold as food in native markets of Mexico.



Sagittaria latifolia family Alismataceae

Photo by: Víctor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.

Camera: Sony Alpha Ag II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

IS THERE POTENTIAL MEDICINAL USAGE OF **BY LOCAL PEOPLE?**

Yes, simply Google the plant name and the word medicinal.

ARE ANY PARTS OF *SAGITTARIA* **EATEN BY MAMMALS?**

The leaves are used as fodder for livestock



Sagittaria latifolia Willd.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.

Camera: iPhone 11 Pro Max.

WHAT ARE THE PRIMARY POLLINATORS **OF *SAGITTARIA* FLOWERS?**

They are pollinated by insects and dispersed by water and animals.



Sagittaria latifolia attracts insects to its flowers.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.

Camera: Sony Alpha Ag II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

CONCLUDING DISCUSSION AND SUMMARY ON *SAGITTARIA* PLANTS

Tubers of *Sagittaria latifolia* are still sold today in local markets in Mexico:

Figura 4: Venta de tubérculos de *Sagittaria latifolia* en el mercado artesanal de Almoloya de Juárez, Estado de México. (Zepeda and Lot 2006: 288).

Since *Sagittaria macrophylla* comes from around Mexico City, I estimate it was a food of the Aztecs. This is easy enough to document (with total focused research on Aztec food options). However, *Sagittaria macrophylla* is not native to other parts of Mexico nor to Guatemala, so in Guatemala our focus is on the local native species of *Sagittaria*.

El registro más antiguo del uso de esta planta se encuentra en la información etnobotánica del Códice Florentino (Sahagún, 1926 y 1977), donde se cita que los hombres de alto rango o tlatoque consumían plantas de acuitlacpalli (del náhuatl atl, agua; cuitlac, planta, excreción, y palli, barro negro) o *S. macrophylla* (Urbina, 1903; Zepeda y Lot, 1999). Lot y Miranda-Arce (1983) mencionan que en el códice.

(Zepeda and Lot 2006: 286-287)

Let's initiate comparable research on the Petén and Izabal species of *Sagittaria* and also the species in Chiapas, Tabasco, Campeche, Yucatan and Quintana Roo.

It's very simple: to find out how many edible aquatic plants the Classic Maya had available, invest research funds in wetlands: swamps, marshes, bogs, and seasonally inundated areas, especially savannas. Find, photograph, list, and accomplish research on all the aquatic plants so that you can ascertain which are edible.

Sagittaria latifolia is found associated with multiple rivers, lakes, and lagoons in Petén (Dix and Fernandez 2001); but no mention of it being edible whatsoever. But based on the research for the present FLAAR report, we now realize that *Sagittaria latifolia* is edible and was available to the Classic Maya for thousands of years.

Then check whether these other species of *Sagittaria* plants were available to the Aztec or to native inhabitants of South America.

And remember the “non-plant” species such as hornworts. There are a lot of things growing underwater that are potentially edible.

All my years at Harvard, Brown, and post graduate fellowships at Yale the focus was about slash-and-burn milpa agriculture; then root crops a bit; then “ramon was everywhere.” I would like to suggest that marshes, swamps, and other wetlands produce edible food without even needing to dig drainage or make any effort. Obviously if these wetlands were worked by the Classic Maya these wetlands could have produced lots more food (it would take engineering to have them produce maize).

Yes, maize, beans, and squash should not be removed from the Maya diet: but let’s explore the full spectrum of what can grow (and be harvested) from swamps, marshes, aguadas, and seasonally inundated areas of Petén and Izabal (to start with). This is a major feature of the current field work and library research of FLAAR (USA) and FLAAR Mesoamerica (Guatemala) in the Municipio de Livingston for the coming months of 2021.

Also, the earliest people to enter these parts of Mesoamerica did not have the engineering capabilities of the Classic Maya. The earliest people would have greatly appreciated anything and everything that could be gathered in the wild, from forests, and from wetlands.



Sagittaria latifolia in flower in a fully developed stage.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.
Camera: iPhone 11 Pro Max.



Sagittaria latifolia with a little visitor to its flowers.

Photo by: Victor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.

Camera: Sony Alpha Ag II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

REFERENCES CITED AND SUGGESTED READING ON *SAGITTARIA*

Most helpful articles on this plant:

Reports by Lot and by Zepeda and Lot are by far the most helpful, since not many other botanists, ethnobotanists, or archaeologists seem aware of the food potential of *Sagittaria* species.

Note: since the present edition is a work-in-progress this bibliography also is a work-in-progress

ATRAN, Scott, LOIS, Mimena and Edilberto UCAN Ek'

2004 Plants of the Peten Itza' Maya. Museum of Anthropology, Memoirs, Number 38, University of Michigan. 248 pages.

Very helpful and nice collaboration with local Itza' Maya people. But would help in the future to have a single index that has all Latin, Spanish, and English plant names so that you can find plants more easily. Suzanne Cook's Lacandon ethnobotany index is significantly easier to use.

Not available as a download.

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1983 Notas sobre la interpretación botánica de plantas acuáticas representadas en Códices mexicanos", en Peterson, J. F. 44 Congreso Internacional de Americanistas, Manchester 1982: Imágenes de flora y fauna de culturas precolombinas: Iconografía y Función. Bar. International Series. 171: 85-91.

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1937 The Vegetation of Peten. Carnegie Institution of Washington, Publ. 478. Washington. 244 pages.

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1938 Plants Probably Utilized by the Old Empire Maya of Peten and Adjacent Lowlands. Papers of the Michigan Academy of Sciences, Arts and Letters 24, Part I:37-59.

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1926 Códice Florentino. Talleres Gráficos del Museo Nacional de Antropología, Historia y Etnografía, México.

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1977 Historia general de las Cosas de la Nueva España. Porrúa, México. 3: 289-332. Sensarma.

STANDLEY, Paul C. and Samuel J. RECORD

1936 The Forests and Flora of British Honduras. Field Museum of Natural History. Publication 350, Botanical Series Volume XII. 432 pages plus photographs.

STANDLEY, Paul C.

1923 Trees and Shrubs of Mexico. Contributions from the United States National Herbarium, Volume 23, Part 3. Smithsonian Institution.

In this one monograph the species are not listed in alphabetical order, so it's a mental adventure finding the species you are looking for.

All monographs by Standley and co-authors can be easily found and downloaded. I would recommend finding the .pdf versions as they are easier to store, easier to copy, and easier to share with students and colleagues.

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Download courtesy of redalyc.org.

HELPFUL WEB SITES FOR **ANY AND ALL PLANTS**

There are several web sites that are helpful even though not of a university or botanical garden or government institute.

However most popular web sites are copy-and-paste (a polite way of saying that their authors do not work out in the field, or even in a botanical garden). Many of these web sites are click bait (they make money when you buy stuff in the advertisements that are all along the sides and in wide banners also. So we prefer to focus on web sites that have reliable information.

<https://serv.biokic.asu.edu/neotrop/plantae/>

Neotropical Flora data base. To start your search click on this page:

<https://serv.biokic.asu.edu/neotrop/plantae/collections/harvestparams.php>

<http://legacy.tropicos.org/NameSearch.aspx?projectid=3>

This is the main SEARCH page.

<https://plantidtools.fieldmuseum.org/pt/rrc/5582>

SEARCH page, but only for collection of the Field Museum herbarium, Chicago.

<https://fieldguides.fieldmuseum.org/guides?category=37>

These field guides are very helpful. Put in the Country (Guatemala) and you get eight photo albums.

<http://enciclovida.mx>

CONABIO. The video they show on their home page shows a wide range of flowers pollinators, a snake and animals. The videos of the insects are great.

www.kew.org/science/tropamerica/imagetdatabase/index.html

Kew gardens in the UK is one of several botanical gardens that I have visited (also New York Botanical Gardens and Missouri Botanical Gardens (MOBOT), in St Louis. Also the botanical garden in Singapore and El Jardín Botánico, the open forest botanical garden in Guatemala City).

www.ThePlantList.org

This is the most reliable botanical web site to find synonyms. In the recent year, only one plant had more synonyms on another botanical web site.

APPENDIX A

A FEW EXAMPLES OF WHERE SAMPLES HAVE BEEN NOTED FOR GUATEMALA

To find any and every plant, simply go to

<https://serv.biokic.asu.edu/neotrop/plantae/collections/harvestparams.php>

Put in the scientific name, click, and you get all the results. We don't waste time filling in any of the other things such as Locality Criteria (since we wish to see Mexico, Belize, Guatemala and nearby countries all at once).

<https://herbanwmex.net/portal/taxa/index.php?taxon=115624> does not have one single solitary specimen from Guatemala.



Sagittaria latifolia Willd. is an accepted name.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston.

Camera: iPhone 11 Pro Max.

LIVINGSTON: THE CARIBBEAN BIODIVERSITY WONDERLAND OF GUATEMALA

Izabal, one of the regional departments of Guatemala that offers a variety of recreational activities, is home to numerous nature parks and diverse natural landscapes. There are white sandy beaches a short boat trip away, with tall jungle-covered mountains in the background, and the Mesoamerican Reef System in the Caribbean Sea on the horizon in front of you. Mangrove swamps, seagrass, islands, cenotes, caves, karst geology canyons and streams of crystal clear water abound along the Rio Dulce and Lake Izabal coast or inland. All this together makes Livingston one of the destinations for tourists wanting to do bird-watching, explore caves, and get healthy exercise hiking through trails in the rainforest. In addition to the incredible flora and fauna that the municipality offers, three different cultures coexist in the ecosystem (Mayan Q'eqchi', Garifuna and Ladinos).

In order to conserve the biodiversity found in the municipality and that continues to be of benefit to the ecosystem, it is necessary to have an updated record of the species that inhabit it and thus be able to detect changes in the species population. Thanks to the efforts of different institutions focused on environmental improvement projects at various sites in Livingston (FUNDAECO working in Río Sarstun, CONAP covering Río Dulce, CECON-USAC in Chocón-Machacas, and ARNPG with more than ten private reservers, among many others) are records of species of flora, fauna and ecosystems of this municipality of Izabal.

Using this information in the most efficient way and using the potential of digital technology, the database for the municipality can be supplemented with photographic records of flora, fauna, and ecosystems. The FLAAR Mesoamerica team, in cooperation with the municipal authorities, have begun to produce this educational material using the photographic records generated during the cooperation project to account for the flora, fauna and ecosystems that can be seen in Livingston. This will be accomplished in order to provide information to schools, families and institutions already working to protect the environment.

We hope to attract the attention of professors, botanical garden clubs, orchid and bromeliad societies, students, tourists, experts, explorers, photographers and nature lovers who want to get closer, to marvel at the species of flowering plants, mushrooms and lichen that FLAAR Mesoamerica finds during each field trip each month.



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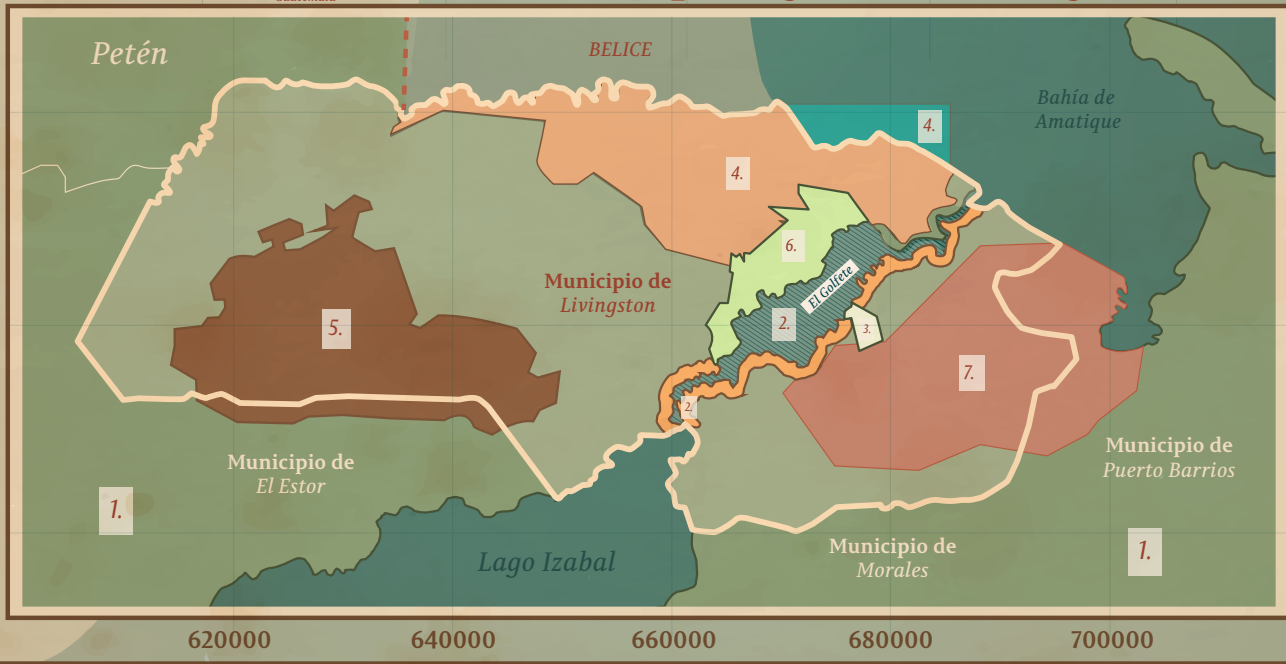
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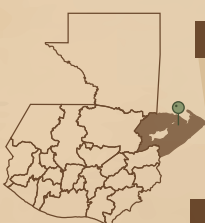
Áreas naturales protegidas de Livingston



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Izabal

- 1. Área sin protección
- 2. Parque Nacional Río Dulce
- 3. El Higuerito
- 4. Área de Usos Múltiples Río Sarstún
- 5. Sierra de Santa Cruz
- 6. Biotopo Protegido Chocón Machacas
- 7. Reserva Protectora de Manantiales Cerro San Gil



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1748000



Reserva Natural Tapón Creek, Livingston

Bahía de Amatique

Área de Usos Múltiples Río Sarstún

Punta Cocolí

Aldea Buena Vista Tapon Creek

San Juan

Reserva Natural Tapón Creek
Municipio de Livingston

Siete Altares

Finca Gangadiwali

Sarstún Creek

Taponcito Creek

El Rosario

Río Cocolí

Río Loro Creek

Río San Martín

Río Tapon Creek

San Martín

La Desmembración

Plan Grande Tatin

Área de Usos Múltiples Río Sarstún

Biotopo Chocón Machacas

Río Cáliz Creek

Río Creek Salvador

Río Tatin

Laguna Salvador

Laguna Cáliz

Laguna Negra

El Golfete

Cayo Grande (Cayo de la Laguna)

Parque Nacional Río Dulce

Canón Río Dulce



Izabal



Información de referencia:

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Elaborado por: Andrea de la Paz; Amanda Estrada Rodas. FLAAR Mesoamerica 2020

Edible Wetlands Plants of Municipio de Livingston, Izabal

Wetland Series 1: from Swamps, Marshes and Seasonally Inundated Flatlands of Izabal

<p>Cyperus esculentus</p> <p>Chufa, Yellow Nutsedge, Earth Almond</p> <p>MLW#1</p>	<p>Eleocharis geniculata Eleocharis caribaea</p> <p>Caribbean Spike-Rush</p> <p>MLW#2</p>	<p>Montrichardia arborescens</p> <p>Camotillo Water Chestnut</p> <p>MLW#3</p>	<p>Nymphoides indica</p> <p>Floating Heart Water Snowflake</p> <p>MLW#4</p>
<p>Pachira aquatica</p> <p>Zapoton</p> <p>MLW#5</p>	<p>Pontederia cordata</p> <p>Pickrel Weed</p> <p>MLW#6</p>	<p>Sagittaria latifolia</p> <p>Water Potatoes</p> <p>MLW#7</p>	<p>Typha dominguensis</p> <p>Cattail</p> <p>MLW#8</p>

Wetland Series 2: plants that grow along the beach shore of Amatique Bay

<p>Amphitecna latifolia</p> <p>Black calabash</p> <p>MLW#9</p>	<p>Coccoloba uvifera</p> <p>Uva del mar</p> <p>MLW#10</p>	<p>Manicaria saccifera</p> <p>Confra, Manaca</p> <p>MLW#11</p>	<p>Chrysobalanus icaco</p> <p>Coco Plum</p> <p>MLW#12</p>	<p>Avicennia germinans</p> <p>Black Mangrove</p> <p>MLW#13</p>	<p>Rhizophora mangle</p> <p>Red Mangrove</p> <p>MLW#14</p>
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Wetland Series 3: plants that grow alongside water: rivers, lagoons, swamps, or ocean

<p>Glossary of Wetland Terms</p> <p>Bibliography of Wetlands Habitat Names</p> <p>MLW#15</p>	<p>Acoelorrhaphe wrightii</p> <p>Pimientillo, Tasiste, Palmetto Palm</p> <p>MLW#16</p>	<p>Acrostichum aureum</p> <p>Mangrove Fern</p> <p>MLW#17</p>	<p>Annona glabra</p> <p>Alligator Apple</p> <p>MLW#18</p>	<p>Bactris major</p> <p>Huiscoyol Palm</p> <p>MLW#19</p>	<p>Diospyros nigra</p> <p>Zapote negro</p> <p>MLW#20</p>
<p>Grias cauliflora</p> <p>Palo de Jawuilla</p> <p>MLW#21</p>	<p>Inga vera Inga multijuga Inga thibaudiana</p> <p>River Koko</p> <p>MLW#22</p>	<p>Pithecellobium lanceolatum</p> <p>Bastard Bully Tree Chucum Red Fowl</p> <p>MLW#23</p>	<p>Coccoloba belizensis</p> <p>Papaturro</p> <p>MLW#24</p>	<p>Symphonia globulifera</p> <p>Barillo</p> <p>MLW#25</p>	<p>Crataeva tapia</p> <p>Matasanillo, Granadillo, Tortugo</p> <p>MLW#26</p>



ACKNOWLEDGEMENTS TO FLAAR MESOAMÉRICA

The reports are a joint production between the field trip team and the in-house office team. So here we wish to cite the full team:

Flor de Maria Setina is the office manager, overseeing all the diverse projects around the world (including FLAAR-REPORTS research on advanced wide-format digital inkjet printers, a worldwide project for over 20 years). We also utilize the inkjet prints to produce educational banners to donate to schools.

Vivian Díaz environmental engineer, is project manager for flora, fauna projects (field work and resulting reports at a level helpful for botanists, zoologists and ecologists, and for university students). Also coordinates activities at MayanToons, division where educational material for kids is prepared.

Victor Mendoza identifies plants, mushrooms, lichen, insects, and arachnids. When his university schedule allows, he also likes to participate in field trips on flora and fauna research.

Vivian Hurtado prepares the bibliography for each subject and downloads pertinent research material for our e-library on flora and fauna. All of us use both these downloads plus our in-house library on flora and fauna of Mesoamerica (Mexico through Guatemala into Costa Rica).

Andrea de la Paz is a designer who helps prepare the master-plan for aspects of our publications. She is our editorial art director

Senaida Ba is photography assistant for many years. She knows the Canon, Nikon and is learning the two new Sony mirrorless cameras. She prepares, packs, sets-up, and helps the photographers before, during, and after each day's field trip.

Jaqueline Gonzalez is a designer who puts together the text and photographs to create the actual report (we have several designers at work since we have multiple reports to produce).

Roxana Leal is Social Media Manager for flora and fauna research and publications, and MayanToons educational book projects

Maria Alejandra Gutierrez is an experienced photographer, especially with the Canon EOS 1D X Mark II camera and 5x macro lens for photographing tiny insects, tiny flowers, and tiny mushrooms. Work during and after a field trip also includes sorting, naming, and processing. And then preparing reports in PDF format.

David Arrivillaga is an experienced photographer and is able to handle both Nikon and the newest Sony digital cameras. Work during and after a field trip also includes sorting, naming, and processing. And then preparing reports in PDF format.

Juan Carlos Hernandez takes the material that we write and places it into the pertinent modern Internet software to produce our web pages (total network is read by over half a million people around the world).

Paulo Nuñez is a webmaster, overlooking the multitude of web sites. Internet SEO changes every year, so we work together to evolve the format of our web sites.

Valeria Aviles is an illustrator for MayanToons, the division in charge of educational materials for schools, especially the Q'eqchi' Mayan schools in Alta Verapaz, Q'eqchi' and Petén Itzá Maya in Petén, and the Q'eqchi' Mayan and Garifuna schools in the municipality of Livingston, Izabal.

Josefina Sequen is illustrator for MayanToons and also helps prepare illustrations for Social Media posts and for animated videos.

Rosa Sequen is also an illustrator for MayanToons and also helps prepare illustrations for Social Media posts and for animated videos.

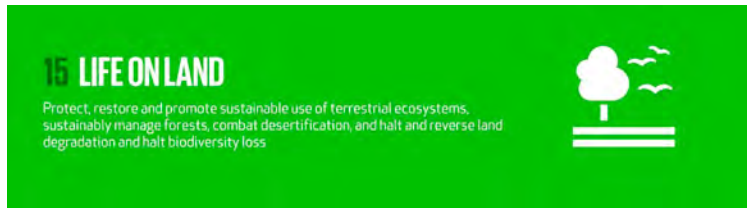
Laura Morales is preparing animated videos in MayanToons style since animated videos are the best way to help school children how to protect the fragile ecosystems and endangered species

Heidy Alejandra Galindo Setina joined our design team in August 2020. She likes photography, drawing, painting, and design.

Maria José Rabanales she is part of the team for editing photographic reports and educational material of Flora and Fauna since September 2020. She works together with others of the team to prepare the finished pdf editions of the material of the Yaxha, Nakum and Naranjo Project.

Alejandra Valenzuela, biology student is now part of Flora y Fauna's photographic report and educational material editing team since September 2020.

Alexander Gudiel: designer who join the editorial design team on December 2020. He will combine the text, pictures and maps into the FLAAR Mesoamerica editorial criteria.



The current Alcalde of Livingston, Mr. Daniel Pinto, together with his team of International Cooperation division, Mr. Edwin Mármol, have set the goal of achieving the municipality development in the years 2020-2024 based on the goals and indicators proposed by the 2030 Agenda for Sustainable Development. From this agenda, FLAAR Mesoamerica will collaborate to achieve Sustainable Development Goal (SDG) number 15 "Life on Land".

Throughout this cooperation project, different materials have been prepared, like this Photo Essay, that helps to collect information on species, different ecosystems: terrestrial, wetlands and fresh water biodiversity. This information would also be useful as part of a strategy to protect threatened species and prevent their extinction. The municipality's goals include to promote the sustainable use, conservation and research of the species of flora and fauna of the terrestrial, wetlands and aquatic shore and coastal ecosystems of the Guatemalan Caribbean. Learn more about this project and the SDG indicators at:

<https://flaar-mesoamerica.org/rain-forests-rivers-lakes-bays-ocean-caves-canyons-livingston-the-caribbean-biodiversity-wonderland-of-guatemala/>

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- www.maya-ethnobotany.org
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BACKCOVER PHOTOGRAPH

Sagittaria latifolia.

Photo by: Víctor Castillo, FLAAR Mesoamerica, Nov. 7, 2020. Río Chocón Machacas, El Golfete, Livingston, Izabal, Guatemala.

Camera: Sony Alpha A9 II. Lens: Sony FE 200-600mm G OSS. Settings: 1/8,000 sec; f/7.1; ISO 6,400.

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