

APGA – USFS Gene Conservation Partnership

2015-2016 Scouting / Collecting Trip for *Zamia integrifolia*

Phase 1 Report

M. Patrick Griffith

Montgomery Botanical Center
11901 Old Cutler Road
Coral Gables, FL 33156
patrick@montgomerybotanical.org

Michael Calonje

Montgomery Botanical Center

Doug Goldman

USDA - NRCS - ENTSC - NPDT
2901 E. Gate City Blvd. (E. Lee St.)
Suite 2100
Greensboro, NC 27401

Adam Black

Peckerwood Garden
20571 Farm to Market 359
Hempstead, TX 77445

April 8, 2016



Summary

Fieldwork was performed in February and March 2016 for collections development and survey of *Zamia integrifolia*. This project was focused on populations at the extreme northeast and northwest of the reported range of the species, both of which were not yet represented in living collections. Documented localities were visited, as well as other accessible sites with suitable habitat.

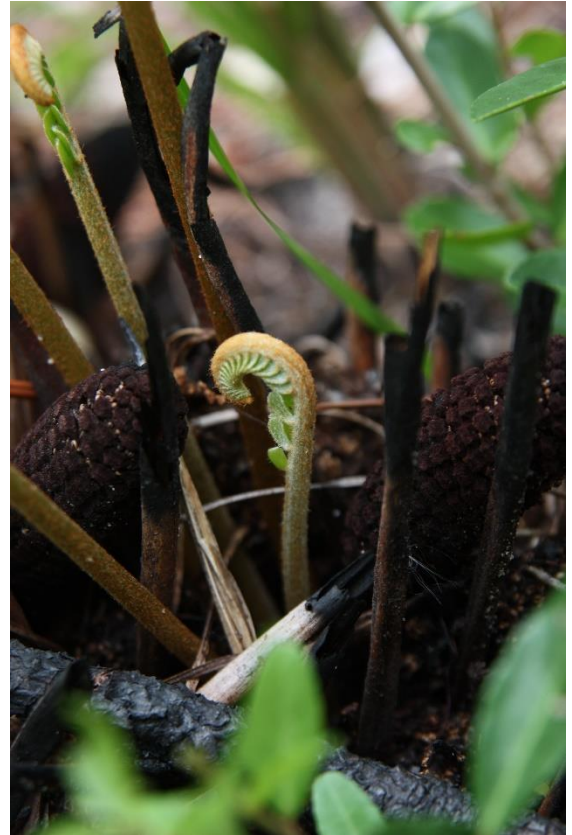
The westernmost known population (Taylor County, FL), was located, surveyed, documented and collected. In addition, a small population even further to the west was also discovered, further extending the known range of this species.

The northeasternmost location (Glynn County, GA), documented only once in 1971, was re-surveyed. This population was not found.

A unique lineage

Zamia integrifolia L.f. is the only cycad native to the continental United States. It has great ornamental appeal and is also of great interest to science, coming from the most ancient lineage of extant seed plants. It is quite variable in habit and morphology throughout its range, from forms with narrow leaflets and few leaves in the south of its range to large specimens with wider leaflets and holding many leaves in the north-central part of its range and many other variants in between.

Montgomery Botanical Center (MBC) houses the largest documented germplasm collection of this taxon in the world, largely due to intensive collecting efforts from 2005 expeditions in Florida. Nevertheless, important populations at the northern limits of the species' range are missing from our collection. These include the northwesternmost and northernmost populations. If still extant, the northernmost population in coastal Georgia may be the most northern population of any cycad and may be a source of particularly cold-hardy germplasm of this beautiful and unique plant.



A history of extirpation

Zamia integrifolia is considerably less common in Florida than it once was. In the last 200 years the ecosystems of Florida have been heavily transformed by urban and agricultural development (Myers and Ewel, 1990), leading to a decline in *Zamia integrifolia* habitats. And while habitat loss is a factor, it is the prior direct extraction of *Z. integrifolia* as a commercial food product that has led to its present rarity (Burkhardt, 1952; Ward, 1993; Whitelock 2002). Sale of industrially extracted starch from roots of wild collected plants was one of the most important factors behind the population decline of *Zamia integrifolia*.

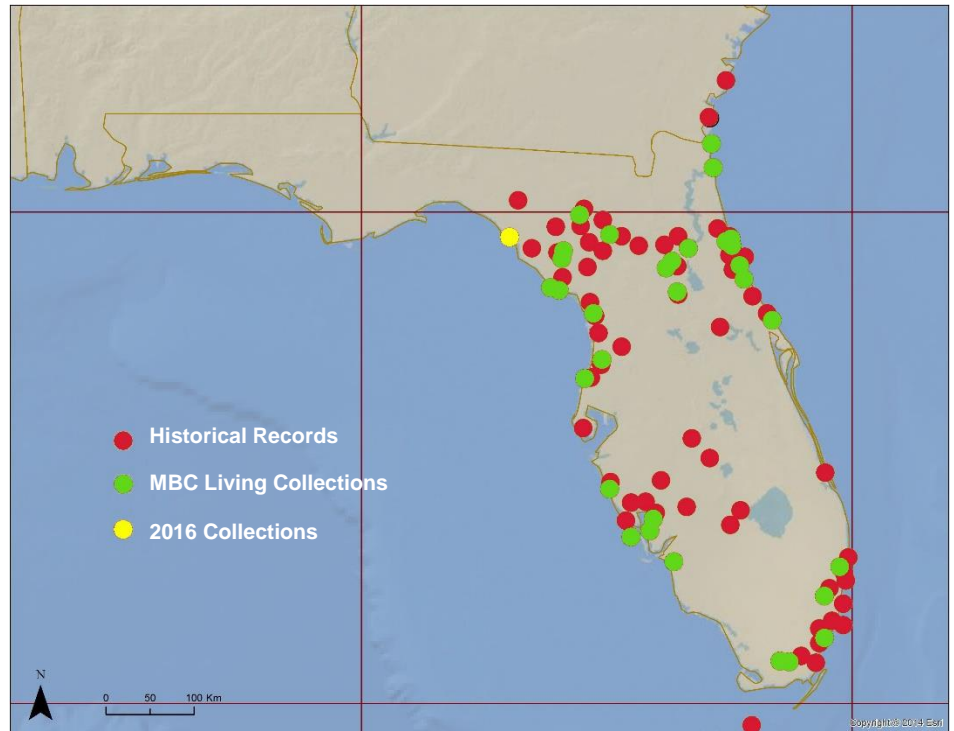


Harvested *Zamia integrifolia* at the Hurst Starch Mill, Miami, Florida, 1924.

Review of current living and preserved collections

The seeds of *Zamia* are recalcitrant and thus conservation requires ex situ conservation as living plants, rather than traditional seedbanking methods. For this work, MBC uses a geographic and population-based collections strategy, which emphasizes geographic breadth and genetic depth. Therefore, to determine priorities for collecting on the current project, review of provenance was emphasized. The maps here indicate documented MBC living collections of (US) *Z. integrifolia* and also preserved collections from various herbaria (FAU, FLAS, FTG, GA, MO, NCSC, NCU, NY, TEX, USF).

Red dots represent historical records (i.e. herbarium specimens), and green dots represent MBC living collections. Comparing these two distributions, MBC's overall representation of living collections from throughout the species' range is good, but there are two populations of special note that are not represented:



Comparison of historical records and current living collections

1. West of the Suwanee River in Taylor County, Florida:

Populations in Taylor County have been documented since 1920. An extant population planned for fieldwork in Taylor County was known to MBC. This location appeared to be further west than the most definitively documented (Landry & Lafrankie 40, LSU) plants at this end of the species' range.

2. St. Simons Island, Glynn County, Georgia.

A single specimen (Duncan 26359) was collected in 1971, north of the town of St. Simons. An accompanying paper (Duncan, 1979) mentions that only 3 plants were seen in this location at that time. Communication with biologists from St. Simons Island suggested that these plants have not been recently seen there.

These two populations are the northeastern and northwestern extremes of the range of the species, and thus are important collections to develop. Additional populations not yet represented at MBC include Gilchrist County, Polk County, and Lake County; these will be the focus of future fieldwork.

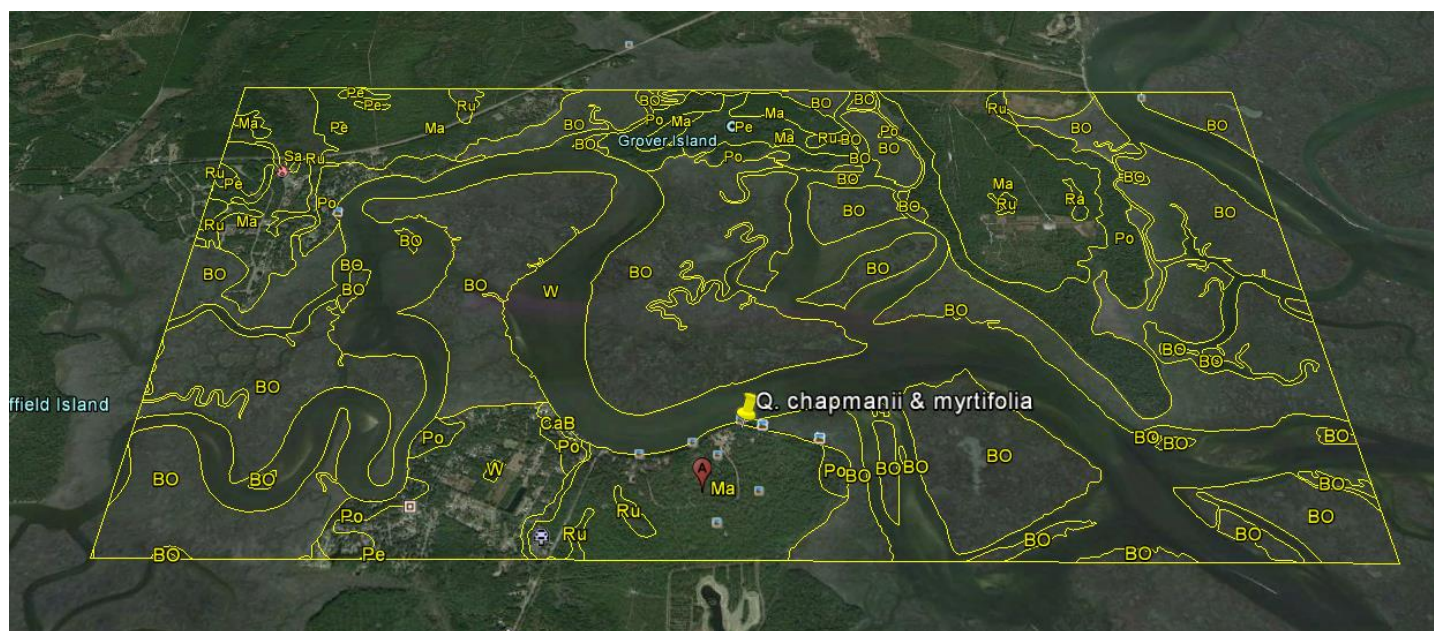
Planning, permitting and logistics

During late 2015 and early 2016, communication was established with the Georgia Department of Natural Resources (GDNR), the Florida Fish and Wildlife Conservation Commission (FFWCC), and the Florida Division of Plant Industry (FDPI), for the purposes of permission to survey and collect plants. Permits were obtained for fieldwork and collecting in the Big Bend Wildlife Management Area Tide Swamp Unit (FFWCC Permit SUO-50625), and, as *Zamia integrifolia* is listed as a *Commercially Exploited Species* under Florida law, an FDPI permit (#1254) to harvest seeds was renewed.

For fieldwork in Georgia, the State Botanist (GDNR), Tom Patrick, indicated that he saw “no reason to issue any special permit for this research since the data is not considered sensitive, has already been published, and the plant likely is naturalized anyway.” To gain landowner permission to work on St. Simons Island, the St. Simons Land Trust was contacted, and a permit to survey on preserve land applied for and obtained. Through these conversations, plans to meet and collaborate with a Preserve Manager and two GDNR Botanists were arranged.

Plans for travel were based on access permission granted by FFWCC for the Big Bend -- Tide Swamp Unit Wildlife Management Area, specifically: “ACCESS IS ONLY ALLOWED FROM FEBRUARY 29th THROUGH MARCH 11th DURING DAYLIGHT HOURS AND FROM MARCH 12TH THROUGH MARCH 31 FROM 1:00 P.M. UNTIL SUNSET”. These access dates were safety provisions based on the Small Game Season (centerfire rifle) ending on February 28, and the Spring Turkey Season (bow, crossbow, or shotgun) beginning on March 12.

Based on the specimen range, plans to also survey on accessible land in Camden County, Georgia were made. Camden County is in between Nassau County (FL) and Glynn County (GA), where reliable specimens have been made. Herbarium specimen review targeted scrub oak species *Quercus chapmanii* and *Q. myrtifolia*, both species often associated with *Zamia* in the northeastern parts of its range. This was overlaid with SoilWeb (California Soil Resource Lab, 2016).



Soil map and potential specimen localities overlaid on an area near Crooked River State Park, Georgia.

Based on the confluence of adequate soil, presence of associated species, and public access, survey at Crooked River State Park was added to the schedule.

Also in Camden County, general survey around Woodbine, Georgia was planned. While soil types around Woodbine do not appear ideal for *Zamia integrifolia*, Duncan (1979) discusses a 1928 specimen from Woodbine (GA18054). The chain of custody for that specimen is incompletely known, but scouting for habitat in the area was planned.

Based on the above parameters, a trip plan was developed, which was followed closely (see below).

Trip Report

February 29, 2016:

Travel by Patrick Griffith, via truck, from Miami to Old Town, Dixie County.

March 1, 2016:

Travel to Tide Swamp Unit of Big Bend Wildlife Management Area.

Survey of suitable habitat throughout the landsite located two populations of *Zamia integrifolia*.

Population 1: 41 plants counted. 15 males, 5 females noted. Plants in sandy soil under mixed canopy of *Liquidambar*, *Magnolia*, *Quercus* spp. *Carya* and *Pinus*, with *Sabal*, *Serenoa*, *Ilex* and *Smilax*. Herbarium specimen from this location: Griffith 380 (FTG, NY). Seed from this population: MBC accessions 20160115, 20160116. See map, page 3.

Population 2: 3 plants counted. 1 male, 1 female noted. Plants in sandy soil in open grassland with *Yucca*, *Opuntia*, *Ilex*, and *Serenoa*, at edge of mixed canopy forest. Herbarium specimen from this location: Griffith 381 (FTG, NY). Seed from this population: MBC accession 20160117. See map, page 3.

Travel to Yulee, Florida to position for next day.

March 2, 2016:

Travel to Crooked River State Park, Camden County, Georgia.

Survey of potential habitat on foot, with emphasis on *Quercus chapmanii* and *Q. myrtifolia* habitat. No *Zamia* located.

Travel to Tabby Sugar Works (historic monument). Survey potential habitat on foot. No *Zamia* located. Learned of prominent arrowroot production in the local area in 19th Century (page 9 and 10).

Travel to Woodbine, Georgia.

Researched history of area by consulting at Bryan-Lang Historical Archives. Discussed project and history of 1928 *Zamia* specimen with Judy Buchanan, Archivist. Through Mrs. Buchanan, located former home of Gertrude Proctor, collector of the 1928 specimen. No *Zamia* were observed at this address.

Was referred to UGA Extension Office. Consulted with Jessica Warren, Agriculture and Natural Resources Agent. No observations of *Zamia* or associated insects in the Woodbine area.

Surveyed via truck and on foot for suitable habitat around outskirts of Woodbine.

Travel to St. Simons Island.

Obtained rental bicycle, to survey highest elevation areas of island at fencelines, based on access limitations. Suitable habitat observed, but no *Zamia* found.



Population 1 (March 1, 2016). Left: Large female *Zamia integrifolia* growing under pine. Right: smaller female *Z. integrifolia* with developing cone.



Population 2 (March 1, 2016). Above: Female *Zamia integrifolia* cone dehiscing with mature seeds. Below: habitat including *Yucca*, *Opuntia*, *Serenoa*, and grasses.

March 3, 2016:

Met with Stephanie Knox (St. Simons Land Trust), Jacob Thompson (GDNR) and Eamonn Leonard (GDNR), who generously offered to help survey for *Zamia*. Performed coordinated survey on Preserve landsites with suitable habitat. No *Zamia* were located. Discussion about land use history indicates that changes since the 1971 specimen may have extirpated that small population.

During the fieldwork on the preserve sites, Griffith was asked to speak with a group of Brunswick High School Students. This was part of an Honors Biology class fieldtrip to the preserve. Griffith spoke about the historical collections, the rarity, and the evolutionary distinction of cycads.

To survey other highly likely habitat and location, and based on access limitations, a trail ride (horse) was contracted. Habitat was highly suitable for *Zamia*, with correct soils and associated vegetation. No *Zamia* were located.



Griffith, Knox, Thompson and Leonard (March 3, 2016).

March 4, 2016:

Travel by Truck from St. Simons Island to Miami.



Griffith speaking with Brunswick High School Students about current project (March 3, 2016).

Results

This scouting and collecting project provides the following results:

1. Three new accessions of *Zamia integrifolia* seed for MBC, from new localities.
2. Living collections of *Z. integrifolia* distributed to UC Berkeley Botanic Garden (CA), Lotusland (CA), and National Tropical Botanical Garden (HI). UCBBG and Lotusland are both members of the Nationally Accredited Cycad Multisite Collection of the APGA Plant Collections Network.
3. Herbarium specimens documenting new locations for the species.
4. Information and firsthand observation of the exceptional rarity or absence of *Zamia* in Southeast Georgia.

Discussion

Literature on *Zamia integrifolia* often touches on the robust and lucrative arrowroot starch trade (Burkhardt, 1952). This extractive harvest, relying on naturally recruited and mature *Zamia* plants, began as subsistence for Native Americans (Ward, 1993) and later settlers. Initial utilization as a marketable commodity in Florida began in small, family, hand-powered mills (Burkhardt, 1952), but rose to an industrial scale around the beginning of the 20th century (Taylor, 1976).

World War I created increased demand for starch. In one example, the Hurst Mill, located in Miami, went from processing 10-12 tons of *Zamia* roots per day in 1910, to processing 15-18 tons of *Zamia* roots per day in 1918 (Burkhardt, 1952). Supposing individual weights from 1 to 20 lbs, this would mean around 3,600 plants of *Zamia* removed from habitat every day at peak production – for just one mill. Such extraction, sustained over many years, eventually exhausted native populations; the Hurst Mill had to close and relocate in 1919 after processing all nearby *Zamia* (Taylor, 1976). As of 1921, it was the final mill in operation in Florida (Clevinger, 1921), and finally closed in 1926 (Taylor, 1976).

The current low numbers of *Zamia* plants observed in many areas of former abundance, such as Miami, is thereby easily explained by the economics of extraction, especially through the increased demand of *wartime* economics. This leads to intriguing conjecture regarding the near absence of plants in suitable habitats of SE Georgia.

In SE Camden County are found the ruins of an old Tabby Sugar Works. This old mill was built to process sugar cane using cattle power, in much the same way *Zamia* starch mills in early Florida were powered by livestock. The last line of the text



on the historical marker reads: “During the [Civil] war, Hallowes planted cane and made sugar in the McIntosh sugar house. He also used the tabby sugar works as a starch factory, producing arrowroot starch in large quantities.” This statement demonstrates increased starch demand during the 1861-1865 war years, consistent with the documented increased demand later in 1914-1918.

Arrowroot, in that era, referred to both the native *Zamia* as well as *Maranta arundinacea* in the Marantaceae. *Maranta* was cultivated as a crop primarily in the West Indies. It is known that large export shipments of *Zamia* starch were termed “arrowroot” as a commodity in the 19th century (Burkhardt, 1952). Col. Hallowes had applied for a patent on his arrowroot manufacture, citing his success at producing over 2 tons of starch in 1844 (Anonymous, 1845).

The conjecture: under increased wartime demand for starch, and under the economic pressures of the Union Blockade, perhaps whatever native *Zamia* as occurred in Georgia were extracted during the Civil War, leaving only very few plants, to be later documented by 20th century botanists, as in Duncan (1979). Even if *Maranta* was under cultivation, the well-known privations of that period would have certainly impacted any natural sources of carbohydrate.

Further Work

Current planning is underway for further fieldwork in Central and North Florida, and in Southeast Georgia. It is hoped that the plants can be relocated in other sites where it has historically occurred, and that further living collections can be developed. Thus, the current project is designated as Phase 1, and Phase 2 is currently planned for early 2017.

The other unresolved question: How many *Zamia* met their end at the Tabby Sugar Works? That question may not be answerable, but archaethnobotanical techniques exist which may illuminate whether *Zamia* had been processed at that site (Mickleburgh & Pagán-Jiménez, 2012).



Ruins of the Tabby Sugar Works, Camden County, Georgia (March 2, 2016)

Acknowledgements

The United States Forest Service and the American Public Gardens Association provided generous financial support for this project. Florida Fish and Wildlife Conservation Commission, Florida Division of Plant Industry, and St. Simons Land Trust provided access and permission. Jacob Thompson and Eamonn Leonard of the Georgia Department of Natural Resources, and Stephanie Knox of the St. Simons Land Trust provided very helpful information and participated in Fieldwork on St. Simons Island. Judy Buchanan of the Bryan-Lang Historical Archives provided helpful historical information. Wendy Zomlefer and Steven Hughes of the University of Georgia Herbarium generously provided specimen images and info. Tom Patrick of the Georgia Department of Natural Resources provided very helpful guidance and information.



References

- Anonymous. 1845. The report of the commissioner of patents, for the year 1845. Ritchie & Heiss, Washington.
- H. J. Burkhardt. 1952. Starch making: a Pioneer Florida Industry. Tequesta 12: 47-51.
- California Soil Resource Web. 2016. SoilWeb. <http://casoilresource.lawr.ucdavis.edu/>
- J. L. Clevinger. 1921. A report on the zamia starch situation. Journal of the American Pharmaceutical Association 10: 837-840.
- W. H. Duncan. 1979. Zamia (Cycadaceae) New for Georgia. Sida 8:115-116.
- H. L. Mickleburgh and J. Pagán-Jiménez. 2012. New insights into the consumption of maize and other cultigens in the pre-Columbian Caribbean from starch grains trapped in human dental calculus. Journal of Archaeological Science 39:2468-2478.
- R. L. Myers and J. J. Ewel. 1990. Ecosystems of Florida. University Press of Florida.
- J. C. Taylor. 1976. South Dade's last commercial starch mill. Update 3: 6-12.
- D. Ward. 1993. Rare and Endangered biota of Florida. University Presses of Florida.
- L. Whitelock. 2002. The Cycads. Timber Press.