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What do we do with all of the data?

Charlotte Germain-Aubrey – <u>cgermain@ufl.edu</u> March 9, 2015

Using big data for big questions

- Distribution of biodiversity over landscape?
- Distribution of characteristics over landscape?
 (trees, herbs, endemics, xeric-adapted, etc...)
- How will climate change impact this distribution?
- Will the impact be the same for all species/communities?
- Has it started already?

..... etc, etc.....

• Combine with other sources of big data





Research applications of museum data: The past, present and future of Florida plants

Julie Allen, Charlotte Germain-Aubrey, Douglas Soltis, Robert Guralnick, Jose Miguel Ponciano, Lucas Majure, Kurt Neubig, Pamela Soltis



Florida



Road Map

- Collect museum data
- Ecological niche models for each species
 - understand diversity of Florida
 - Past, Present, Future
- Phylogenetic Tree of these same species
 explore the phylogenetic diversity of Florida





America into 15 ecological regions, whereas at Level II the continent is subdivided into 50 classes (CEC 1997). Level III is the hierarchical level shown on this map. For portions of the United States (see map inset) the ecoregions have been further ne treatment acts in seven in the map. For persons in the same basis (see map more) are company non-tere term inter-solidividad in LeviP TD, applications of the company on a person and philotanis from for state and a legislant present (a.g., Bryce et al., 1998, 2003). Chapman et al., 2004, 2000, Honson et al., 2004, Ganta et al., 1999, 2002, doi: 10.1199, 2002. 2004. Of company of the company 2004, For additional information, contrast hances M Chapman, 2004, Distance Handlin and Environmental Effects 2004, Distance Handling, 2004 MM Streec, contrast, Longello, et al., 2004, Distance Handlin and Environmental Effects 2004, Distance M Streech and Contrast, Co BIBLIOGRAPHY

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Noods, A.J., J.M. Omernik, W.H. Martin, G.J. Pond, W.M. Andrews, S.M. Call, J.A. Comstock, and D.D. Taylor. 2002. Ecoregions of Kentucky. (map poster). U.S. Geological Survey. Reston. VA. Scale 1:1,500,500.

The names and identification r al maison are given in CEC 1997

Data collecting

- Florida Plant Atlas
- Florida Native Area Inventory
- Global Information Facility
- Florida State University Herbarium
- Louisiana State University Herbarium
- University of North Carolina Herbarium
- Alabama Plant Atlas
- Mississippi State University Herbarium
- Florida Museum of Natural History Herbarium
 - >500,000 georeferenced points

Data collecting

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- Florida Plant Atlas
- Florida Native Area Inventory
- Global Information Facility
- Florida State University Herbarium
- Louisiana State University Herbarium
- University of North Carolina Herbarium
- Alabama Plan Atras
- Mississiphinate University Herbarium
- Floridation of Natural History Herbarium 500,000 georeferenced points

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1	CollectionDa	CollectionDa	Family	Genus	Species	Infraspecies	AcceptedNa	r State	County	Locality		Barcode	Endangered	NamedPlace	Longitude	Latitude	
2	11-Aug-80	11-Aug-80	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	a Florida	Monroe Co.	Big Pine Key; Port Pine Heights.		151806	0	NULL	NULL	NULL	
3	20-Oct-85	20-Oct-85	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Monroe Co.	Near N end of Big Torch Key, 6.	5 mi. N of US 1 along main	188761	0	NULL	NULL	NULL	
4	20-Oct-85	20-Oct-85	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Monroe Co.	Cudjoe Key, middle section off	Asturiano Avenue; 0.8 mi.	188850	0	NULL	NULL	NULL	
5	16-Sep-79	16-Sep-79	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Monroe Co.	No Name Key, NE of Big Pine Ke	ey. 1665, K30E, Sec. 18.	144947	0	NULL	NULL	NULL	
7	15-Sep-79	15-Sep-79	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Miami Dada	Tropical Park between Bird Ro	of US 1. ad (SM/ 40th Streat) and M	144121	0	NULL	NULL	NULL 25 725	
8	15-Aug-58	15-Aug-58	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Elorida	Citrus Co	8 mi WSW of Inverness	au (SW 40th Street) and W	233131	0	NULL	*00.321	23.723	
9	21-Sep-59	21-Sep-59	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Hernando C	Chinsegut Hill		13126	0	NULL	NULL	NULL	
10	11-Aug-92	11-Aug-92	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Monroe Co	Ca. 0.2 mi NW of end of Miami	i Avenue (Higgs Lane) ca. (223717	0	Key Deer Nat	-81 385833	24 7066667	
11	16-May-07	16-May-07	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Monroe Co.	Big Torch Key: Monroe Co. own	ed preserve (unnamed): 8	249035	0	NULL	NULL	NULL	
12	31-Aug-00	31-Aug-00	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Monroe Co.	Big Torch Hammocks, Big Torch	Key: Big Torch Road, ca. 3	233321	0	Florida Keys	-80.425278	24.6986111	
13	NULL	s.d.	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	Florida	Monroe Co.	Big Pine Key.		79612	0	NULL	NULL	NULL	
14	13-Aug-63	13-Aug-63	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	a Florida	Miami-Dade	SW of Homestead; near interse	ction of Redland and 308t	55022	0	Everglades N	NULL	NULL	
15	6-Aug-66	6-Aug-66	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	a Florida	Monroe Co.	Big Pine Key; Watson's Hammo	ck.	75800	0	NULL	NULL	NULL	
16	22-Oct-65	22-Oct-65	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	a Florida	Monroe Co.	Big Pine Key, N end.		67278	0	NULL	NULL	NULL	
17	20-Oct-85	20-Oct-85	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	a Florida	Monroe Co.	W end of Ramrod Key, along S	side of US 1. T66S, R28E, S	188878	0	NULL	NULL	NULL	
18	1-Sep-54	1-Sep-54	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	a Florida	Monroe Co.	Near N end of Big Pine Key.		10841	0	NULL	NULL	NULL	
19	12-Nov-64	12-Nov-64	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	a Florida	Monroe Co.	Big Pine Key, N end.		61567	0	NULL	NULL	NULL	
20	6-Aug-66	6-Aug-66	Cyperaceae	Abildgaardia	ovata	NULL	Abildgaardi	a Florida	Monroe Co.	Intersection US 1 and C-940, Bi	g Pine Key.	261298	0	NULL	NULL	NULL	
21	26-Sep-85	26-Sep-85	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	St. Lucie Co.	Ca. 2 mi. S of C-712 on C-707, S	of Fort Pierce. T36S, R40E	188387	0	NULL	NULL	NULL	
22	19-Sep-86	19-Sep-86	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Lee Co.	Railroad tracks E of Iona Road,	N of Bonita Springs Road, I	190430	0	NULL	NULL	NULL	
23	22-Mar-68	22-Mar-68	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Hillsborough	h Northgate, Tampa.		82442	0	NULL	NULL	NULL	
24	25-Sep-76	25-Sep-76	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Pinellas Co.	Dunedin Hammock, Dunedin Tu	urtle Trail.	126031	0	NULL	NULL	NULL	
25	31-Dec-62	31-Dec-62	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Miami-Dade	e Near Old Cutler Road at 164th	Trace, Miami. T56S, R41E,	57712	0	NULL	NULL	NULL	
26	14-Jan-70	14-Jan-70	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Pasco Co.	River Road, New Port Richey.		88909	0	NULL	NULL	NULL	
27	1-Sep-99	1-Sep-99	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Hillsborougr	n N OF N NIKING TRAIL, LITTIE Manato	ee River State Park. 1325,	230364	0	NULL	NULL	NULL	
28	24-Jun-94	24-Jun-94	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Sarasota Co.	Burn zone 4A W, Oscar Scherer	State Park. 1385, K18E, S. Avakka Biver State Bark	214094	0	NULL	NULL 02.240444	NULL 27 2890556	/
29	18-Sep-95	18-Sep-95	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Sarasota Co	Table Base ST SMV of NMV of	f NET	230425	0	NULL Wingsto Cro	-82.249444	27.2880550	
30	19-Eeb-02	19-Eeb-02	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Brevard Co	Wickham Park NE of main offic	e along Eside of road	224187	0	Wickham Par	NULL	NULL	
32	1-Oct-69	1-Oct-69	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Miami-Dade	Along Old Cutler Road, pear Mr	ontromery Foundation Co	96563	0	NIIII	NULL	NULL	
33	20-lan-98	20-Jan-98	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Martin Co	Ca. 2.5 mi. N of lensen Reach	on old Florida Institute of T	222434	0	NULL	NULL	NULL	
34	3-Jun-94	3-Jun-94	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Lee Co.	Near boat ramp footbridge. Ko	reshan State Historic Site	232642	0	NULL	NULL	NULL	
35	8-Apr-91	8-Apr-91	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Lee Co.	Cavo Costa Island.		206312	0	NULL	NULL	NULL	
36	18-Apr-92	18-Apr-92	Fabaceae	Abrus	precatorius	NULL	Abrus preca	t Florida	Manatee Co	. South Fork State Park. T33S. R2	21E, Sec. 7.	207813	0	South Fork St	NULL	NULL	
37	12-0ct-59	12-0ct-50	Eshaceae	Abrue	precatorius	NUU	Ahrus proce	t Elorida	Hernando C	c S of mansion on Chinsegut Hill	•	00/00	0	Chincegut Hi	MUUT	NUUI	
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88	502201	NULL	19	Oct-08	EUPHORBIA	C Acalvoha	ostrvifolia	NULL	Alabama	NULL	US Hwy 31 at the north side of Pinchony Cre	UWAL00075		-86.417639	32.056861	
89	502234	NULL	21-	Aug-08	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	Butler County Hwy 28 at CSX railroad tracks.	UWAL00075	0 NULL	-86.701556	31.721417	
90	502786	NULL	16-	Sep-08	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	1.78 air mi. SE of Pin Hook. Along N side of A	A UWAL00075	0 NULL	-87.846667	32.343056	
91	502715	NULL	13-	Aug-07	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	Along railroad tracks at junction of CR-9 sour	t UWAL00075	0 NULL	-88.2725	32.220833	
92	502657	NULL	6	Oct-06	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	3.4 air mi. SW of Ariton. Along E side of US I	UWAL00075	0 NULL	-85.760278	31.569167	
93	411074	NULL	9-	Aug-60	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	Agronomy farm. AU.	TROY000030	0 NULL	NULL	NULL	
94	410981	NULL	16-	Sep-08	EUPHORBIA	C Acalypha	ostryifolia	NULL	Alabama	NULL	1.78 air mi SE of Pin Hook. Along N side of A	TROY000018	0 NULL	-87.846667	32.343056	
95	410920	NULL	13-	Aug-07	EUPHORBIA	C Acalypha	ostryifolia	NULL	Alabama	NULL	Jct. of CR-9 south of CR-32 and south of Cron	1 TROY000029	0 NULL	-88.2725	32.220833	
96	410923	NULL	15	-Jun-02	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	Near old station in Lafayette. Near junction	(TROY000018	0 NULL	-85.404444	32.898611	
97	410935	NULL	31	-Jul-02	EUPHORBIA	C Acalypha	ostryitolia	NULL	Alabama	NULL	In Anniston near junction of 4th Street near	t TROY000018	0 NULL	-85.831944	33.648889	
98	410891	NULL	0	Oct-06	EUPHORBIA	C Acalypha	ostryifolia	NULL	Alabama	NULL	5.4 air mi Sw of Ariton. Along E side of US H	TROY000018	0 NULL	-85./602/8	31.569167	
100	410834	NULL	0-	Nov-07	EUPHORBIA	C Acalypha	ostryifolia	NULL	Alabama	NULL	Alabama Hwy, 154 and Pea River.	+ TROY000018		-85 74142	31 169963	
101	410010	NULL	27	7-Jul-05	FUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	Un-numbered dirt road at ford on Cobb Cree	TROV000018	0 White Oak V	-86 710004	33 034715	
102	410792	NULL	27-	Aug-05	FUPHORBIA	Acalypha	ostrvifolia	NULL	Alabama	NULL	Crenshaw County Hwy, 59, just north of Dry	(TROY000004	0 NULL	-86,228666	31,891833	
103	410766	NULL	19	Oct-08	EUPHORBIA	(Acalypha	ostrvifolia	NULL	Alabama	NULL	US Hwy, 31 at the N side of Pinchony Creek.	TROY000018	0 NULL	279	32.056861	
104	410758	NULL	17	-Jul-08	EUPHORBIA	Acalypha	ostryifolia	NULL	Alabama	NULL	Barbour County Hwy. 28 intersection with B	a TROY000018	0 NULL	-85.347583	31.920417	
105	410755	NULL	16	5-Jul-09	EUPHORBIA	Acalypha	ostryifolia	NULL	Alabama	NULL	Montgomery County Hwy. 61 at the south si	TROY000028	0 NULL	-86.251278	32.208417	
106	410730	NULL	9	Oct-06	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	Alabama Hwy. 21 at the Lowndes County lin	e TROY000004	0 NULL	-86.858445	32.003278	
107	410702	NULL	30-	Sep-06	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	U.S. Hwy 31 at the south side of Hawkins C	r TROY000004	0 NULL	-86.647389	31.775194	
108	410663	NULL	2-	Aug-03	EUPHORBIA	(Acalypha	ostryifolia	NULL	Alabama	NULL	U.S. Hwy. 84, ca 1.5 miles east of the Sepulg	a TROY000004	0 NULL	-86.703361	31.403944	
109	205648	NULL	_ Jul	1886	EUPHORBIA	(Acalypha	poiretii	NULL	Alabama	NULL	Mobile River	UNA0002080	0 NULL	-88.03333	30.68333	
110	205746	NULL	4 Jul	1893	EUPHORBIA	(Acalypha	poiretii	NULL	Alabama	NULL	Sullivans Wharf and Mills	UNA0000949	0 NULL	-88.03333	30.68333	
111	205511	NULL	11	L-Jul-98	EUPHORBIA	(Acalypha	rhomboidea	NULL	Alabama	NULL	1 mi SE of Oneonta. Off of US 231, about 1 n	n UNA0005429	0 NULL	-86.46194	33.94139	
112	205531	NULL	17	/-Jul-98	EUPHORBIA	(Acalypha	rhomboidea	NULL	Alabama	NULL	U mi of Snead. At Snead Cross Road off of U	S UNA0005437	0 NULL	-86.39472	34.11972	
113	205563	NULL	28	s-JUI-02	EUPHORBIA	(Acalypha (Acalypha	rnomboidea	NULL	Alabama	NULL	U mi of Millport. Kall Crossing on side street	UNA0005865	0 NULL	-88.08278	33.56389	
114	205637	NULL	_ AU§	3 1896	EUPHORBIA	C Acalypha	rhomboidea	NULL	Alabama	NULL	Mobile	UNA0002081	0 NULL	-88.03333	30.08333	
115	205509	NULL	7	Oct-07	EUPHORBIA	C Acalypha	rhomboidea	NULL	Alabama	NULL	2 air mi WSW of Heflin S of US Huw 78 and	UNA0005442		-85 61583	33,52526	
117	205354	NULL	24	Oct-07	FUPHORBIA	(Acalypha	rhomboidea	NULL	Alabama	NULL	Un-numbered dirt road just West of Indian (LINA0006218		-85 96555	31 97611	
118	206632	NULL	Q.	Dec-02	EUPHORBIA	(Acalypha	rhomboidea	NULL	Alabama	NULL	0 mi of Mobile, St. Louis Street: Federal Cou	UNA0006044	0 NULL	-88.04278	30.69417	
119	206526	NULL	28	3-Jul-48	EUPHORBIA	(Acalypha	rhomboidea	NULL	Alabama	NULL	Spanish River in Mobile Delta.	UNA0002082	0 NULL	-88.01667	30.71667	
120	206530	NULL	30	-Jun-60	EUPHORBIA	Acalypha	rhomboidea	NULL	Alabama	NULL	south side of Monument street, Mobile	UNA0002082	0 NULL	NULL	NULL	
121	205862	NULL	13 Ju	1874	EUPHORBIA	Acalypha	rhomboidea	NULL	Alabama	NULL	Prattville	UNA0002081	0 NULL	-86.45	32.45	
122	205787	NULL	27	Oct-84	EUPHORBIA	(Acalypha	rhomboidea	NULL	Alabama	NULL	Creek just east of strip mine at Taft Coal Co.,	UNA0002082	0 NULL	-87.33833	33.69556	
123	205775	NULL		Sep-85	EUPHORBIA	(Acalypha	rhomboidea	NULL	Alabama	NULL	Co. rte 3 at creek; 1.1 mi. N of AL 17. Ca. 2.5	UNA0002081	0 NULL	-87.99583	33.40861	
124	205916	NULL	12	Oct-66	EUPHORBIA	(Acalypha	rhomboidea	NULL	Alabama	NULL	Sipsey Swamp	UNA0002081	0 NULL	-87.75361	33.33556	
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Formatting challenges

- Reconciling datasets within each institution
- Reconciling datasets between institutions
- Georeferencing specimens
- Transforming Lat/Long
- UNCERTAINTY info missing !!!!
- Dates format (had to make assumptions)
- Taxonomic Name Reconciliation
- Pool datasets together large files

Data cleaning

- Wunderlin list of 4,094 species of Florida plants
 Check list against Tropicos accepted names
- All non-Florida species removed
- Duplicates removed
- 3 EPA ecoregions 391,937 points 343,266 dated points
- 30+ points per species
 - 372,241 pts and 1,548 species



Ecological Niche Modeling



Flatspike Sedge





Museum Specimens and Climate Data





 Extraction R – package – dismo to create bioclim layers from monthly PRISM data

• Associate each species record with the climate data for the correct year.

Museum Specimens and Climate Data





 Extraction R – package – dismo to create bioclim layers from monthly PRISM data



Climate Data

- Bioclim correlation 8 layers < 0.85
- Altitude
- Geology

Ran models for all 1,548 species. Combined maps to create a heat map of all species and then cropped it to Florida.

Flatspike Sedge

Scrub Palm











How many species are predicted to reside in this point?

All Plant Diversity





Present Alpha Diversity



2002 - 2012

Endemism hotspots

Present Endemic Hotspot



Endemic diversity / Total diversity

2002 - 2012

Future Models

- Consensus models from 3 hand-picked future scenarios:
 - CCSM4 –Community Climate System Model
 - MPI Max Plank Institute
 - MIROC5 Model for the Interdisciplinary Research on Climate
- Both highest and lowest estimates of CO₂
- 2050 and 2070

12 models for all 1,548 species averaged for a consensus of these models

Future Projections



Species Extinct from Florida

Evolutionary History of Florida Plants

- Genbank and sequenced two genes for 1,440 species
 - RbcL, MatK
 - Missing 108 species
- Many rounds of checking the tree/alignments with botanists.
 - Added missing taxa onto the tree.

Florida Phylogeny

1,548 species 685 genera **183** Families

Ultrametric Non-Ultrametric

Model Selection:

RAxML – Best Tree Bayes - distribution



100.0



Phylogenetic Diversity

min= 0.102 max= 0.557

Phylogenetic div. as a proportion

of total tree length

Phylogenetic Diversity Proportion Ultrametric Tree



Relative Phylogenetic Diversity



sources of uncertainty (things you can do something about...)

Geographical Concepts: Datum



Sources of uncertainty:

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- 20° 30' N 112° 36 W Coordinate Uncertainty
- Map scale
- The extent of the locality
- GPS accuracy
- Unknown datum
- •Imprecision in direction measurements
- •Imprecision in distance measurements (1km vs. 1.1km)

Scale	Uncertainty (ft)	Uncertainty (m)
1:1,200	3.3 ft	1.0 m
1:2,400	6.7 ft	2.0 m
1:4,800	13.3 ft	4.1 m
1:10,000	27.8 ft	8.5 m
1:12,000	33.3 ft	10.2 m
1:24,000	40.0 ft	12.2 m
1:25,000	41.8 ft	12.8 m
1:63,360	106 ft	32.2 m
1:100,000	167 ft	50.9 m
1:250,000	417 ft	127 m

Precision vs. Accuracy Disambiguated

Precision is...

...the level of detail contained in or described by the data.



Precision can help to minimize uncertainty.

Precision vs. Accuracy Disambiguated

Accuracy is...

...a measure of how close a given value is to the true value.*



*We may never actually know the true value in georeferencing,

but we do our best to reproduce the location of

sources of uncertainty (things you can do something about...)

- Precision vs. accuracy
 - High accuracy is important
 - High precision is less important but need to be informed !!!
- Time in species determination/determination update
 - Keep updating species name (in electronic record?)

Other sources of uncertainty (things you can't do anything about...)

Abildgaardia ovata standard deviation of present model replicates



Agalinis obtusifolia Differences in 2050 projection models



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100.0

Phylogenetic Diversity



Phylo Uncertainty











THANK YOU !!!!









Natural Areas INVENTORY









ILLINOIS NATURAL HISTORY SURVEY PRAIRIE RESEARCH INSTITUTE

