NC STATE UNIVERSITY

Using Land-Use Change, Soil Characteristics, and a Semi-Automated on-Line GIS Database to Inventory Carolina Bays

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Introduction

- Carolina Bay wetlands and lakes are numerous NW – SE oriented elliptical geomorphic features widely distributed over much of the southeastern US Coastal Plain (Fig. 1).
- Bays are important to: wetland conservation and restoration; water quality; C sequestration; ecosystem diversity; and habitat for diverse and unique flora/fauna.
- Other than a few Bay lakes, most Bays were originally forested, but many Bays have been logged and drained for agriculture, forestry, and other land uses (Fig. 2).
- While generally productive, converted Bays are good candidates for restoration, although there are concerns about agrichemical (e.g., P) release to ground and surface waters.
- Only South Carolina and Georgia have statewide (and likely incomplete) inventories.
- There has been little systematic effort to inventory Bays, and digitizing them by hand is very laborious.

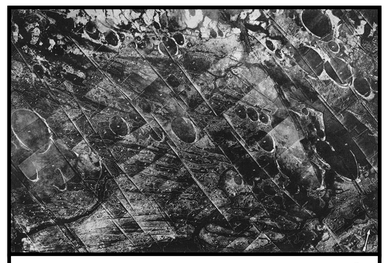

Fig. 1. 1930 aerial photo mosaic, ~118 km² near Myrtle Beach, SC : "discovery" of the Carolina Bays (Fairchild Aerial Survey)

Fig. 2. Mixed land-use of Carolina Bays with "vestigial" or "ghost" Bays visible even after substantial land-use change.

Objectives

- Develop novel methods to locate/identify Carolina Bays
- Delineate Bays using a semi-automated on-line digitizing tool
- Characterize attributes of delineated Bays

Materials & Methods

- Postulated: Land use in many, if not most, Bays had changed during the past 40 years.
- Postulated: Bays comprise a limited number of soil map units.
- Used Bladen, Co., NC as the test bed, characterized in the literature as "Bay-dense"
- Supervised classification of land-use from decadal Landsat imagery: 1972 - 2010 (Table 1)
- Quantified land-use change decade to decade
- Downloaded the 812 (31,409 ha) "existing" Bladen Co. Bays from a supervised wiki database, the Cintos Research: "Collaborative Survey of Carolina Bay Landforms"
- Defined "Common Bay Soils" as any SSURGO soil map unit present in >1% of existing Bay coverage
- Developed Land-Use Change/Common Carolina Bay Soil algorithm (Fig. 3a) to find Bays
- Used Cintos Research semi-automated digitizing tools to delineate new Bays in Google Earth (Fig. 3b & 3c) (http://www.cintos.org/Survey/Process/index.html)

Table 1. Landsat satellites and sensors used in the study along with sensor bands, spectral properties, and spatial resolutions.

Satellite/Sensor Year	Bands	Wavelength (µm)	Spectrum	Resolution (m)
Landsat 1 Multispectral Scanner 1972	4	0.5 - 0.6	Green	60 resampled from 79 X 57
	5	0.6 - 0.7	Red	
	6	0.7 - 0.8	Red edge	
	7	0.8 - 1.1	NIR	
Landsat 5 Thematic Mapper 1984, 1991, 2000, 2010	1	0.45 – 0.52	Blue	30
	2	0.52 – 0.60	Green	
	3	0.63 – 0.69	Red	
	4	0.76 – 0.90	NIR	
	5	1.55 – 1.75	Shortwave IR	
	6	10.4 – 12.5	Thermal IR	30 resampled from 120

Carolina Bay Search Algorithm

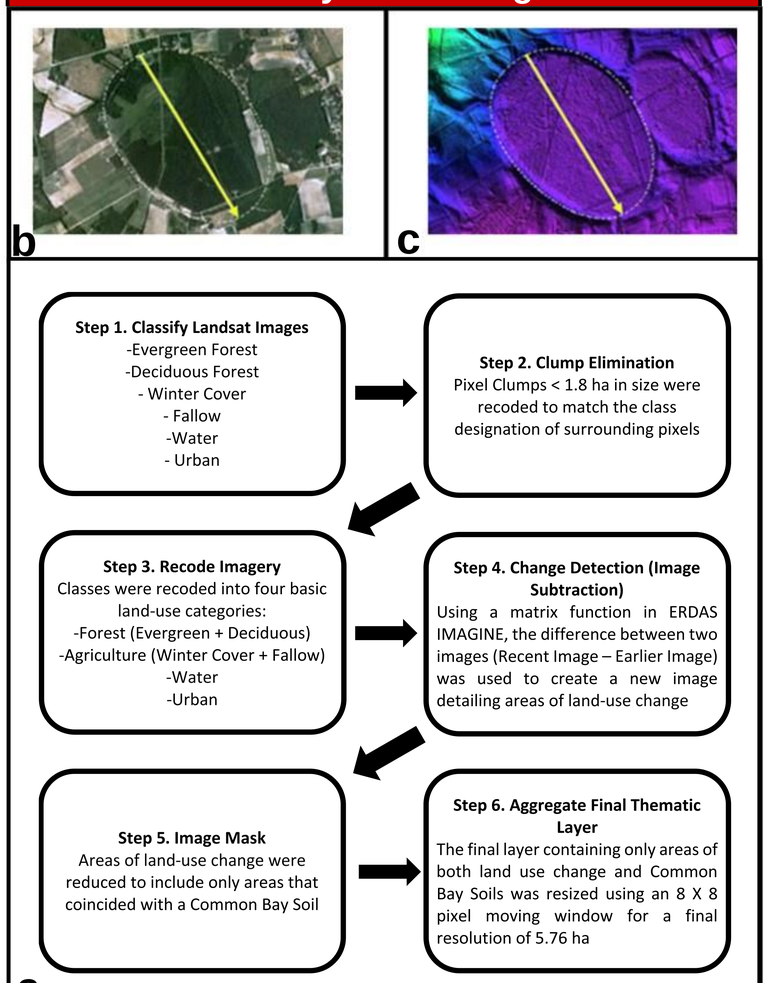

Fig. 3. (a) Land-Use Change / Common Carolina Bay Soil algorithm used to identify Bays; (b) Bay-shaped planform digitizing polygons overlaying an aerial image and (c) hill-shaded lidar (Cintos Research: Google Earth: USDA Farm Service Agency).

Results

Table 2. Common Carolina Bay Soils (soils representing >1% of the Bay coverage), area, percentage of total area (%), and whether hydric. Common Bay Soils present only in the new Bays are *italicized*. Common Bay soils cover ~67% of the county.

Soil Series Name	MuSym	Area (ha)	% of Total	Hydric
Butters fine sand, 0 to 2 percent slopes	*BuA*	*486*	*1.0*	*N*
Autryville loamy sand, 0 to 3 percent slopes	*AuA*	*504*	*1.0*	*N*
Lynchburg fine sandy loam	*Ln*	*574*	*1.2*	*Y*
Croatan muck, frequently flooded	*CT*	*609*	*1.3*	*Y*
Lakeland sand, 1 to 7 percent slope	*LaB*	*789*	*1.6*	*Y*
Norfolk loamy sand, 0 to 2 percent slope	*NoA*	*864*	*1.8*	*Y*
Johnston mucky loam	JO	926	1.9	Y
Foreston loamy sand	Fo	935	1.9	Y
Goldsboro sandy loam, 0 to 3 percent slope	GbA	1,016	2.1	Y
Woodington loamy sand	Wo	1,405	2.9	Y
Pantego loam	Pe	1,552	3.2	Y
Centenary sand	Ce	1,566	3.2	Y
Rains sandy loam	Ra	2,164	4.5	Y
Water	W	2,357	4.9	NA
Croatan muck, rarely flooded	Cr	2,455	5.1	Y
Leon sand, 0 to 3 percent slope	LeA	3,186	6.6	Y
Torhunta mucky sandy loam	Tr	3,457	7.1	Y
Lynn Haven	Ly	6,777	14.0	Y
Pamlico muck, rarely flooded	Pa	11,449	23.6	Y

Results

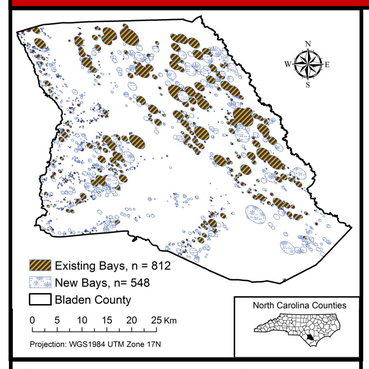

Fig. 4. "Existing" Bays and "new" Bays identified using the Land-Use Change / Common Bay Soil algorithm.

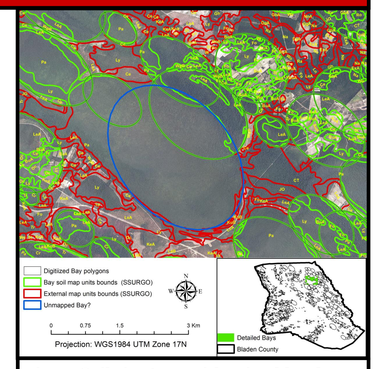

Fig. 5. Soils in Bays with mixed land use typically have been mapped more intensively than in other Bays.

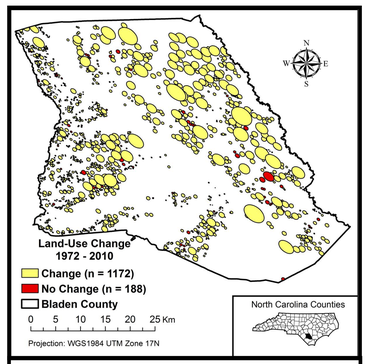

Fig. 6. Land use changed in 43% of Bay complexes, 91% of Bay area. Unchanged Bays tended to be small, ~10 ha.

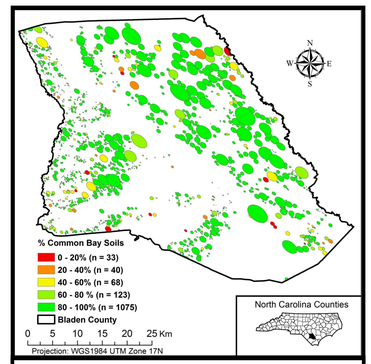

Fig. 7. Nearly all Bays comprised Common Bay Soils, which typically constituted >76% of a Bay's total area.

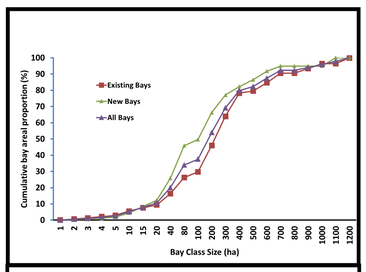

Fig. 8. Existing and new Bays had similar cumulative areal distribution. New Bays shifted slightly to smaller size.

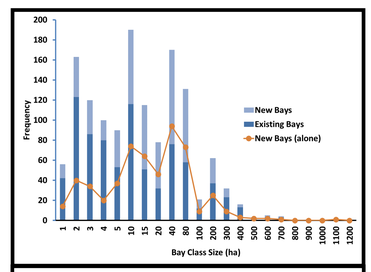

Fig. 9. New and Existing Bays had different modal size classes: New: 20 to 40 vs. Existing: 1 to 2 ha.

Conclusions

- Methods proved effective and could be used to more rapidly and accurately inventory and characterize Bays across their full extent, but doing so remains a formidable task: we estimated that as many as 478 small Bays remain undiscovered in Bladen Co. alone.
- Data used for inventory (SSURGO/Landsat) are readily available, as are digitizing tools at the Cintos Research "Collaborative Survey of Carolina Bay Landforms".
- Carolina Bays provide many crucial ecosystem services. Of the converted Bays, many are in non-urban land uses and prime candidates for wetland restoration.
- Given the potential impact that Bay conservation/restoration can have on soil/water quality and ecosystem diversity, a detailed Carolina Bay inventory is a necessity.

Acknowledgements

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