

Letting the **SUN** in

Open canopy wetlands are critical to our amphibians



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Question

- How does amphibian diversity differ among different wetland types?
 - Natural, open-canopy wetlands (Reference)
 - Enhanced wetlands (NCWRC, USFS)
 - Natural, closed-canopy wetlands (Reference)
 - Re-established wetlands (Various groups)

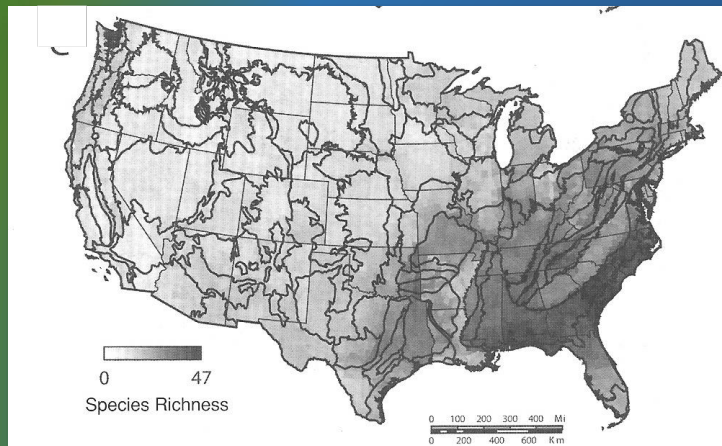


Spadefoot toad

Why focus on amphibians?

North Carolina ranks among the top in amphibian diversity in North America and amphibians play an important role in ecosystem health.

Many species have dramatically declined and continue to decline.





Background

- Most isolated wetlands on the Coastal Plain were likely open-canopy types (long hydroperiods and frequent fire when dry)
- NCWRC began restoration of closed-canopy wetlands in 2009
- Wetlands re-established for mitigation are meant to replace lost wetlands due to development, but are often very large, not necessarily replacing small wetlands

Why are open grassy ponds so important?



Tiger salamander egg masses



Gopher frog egg mass

What keeps ponds open and grassy?



Long hydroperiod keeps trees from growing

What keeps ponds open and grassy?



Periodic fires during growing seasons, when ponds are dry, discourages trees from growing and promotes herbaceous growth.

Usually a combination of both hydroperiod AND fire.



Many wetlands were intentionally cut off by fire lines, keeping fires out of lowland areas

Wetlands were thought of as “refugia” for quail and other game species, and fire was discouraged

Many ditched and drained

Smoke also an issue

Remove fire from the system, and...



Examples of wetland types sampled

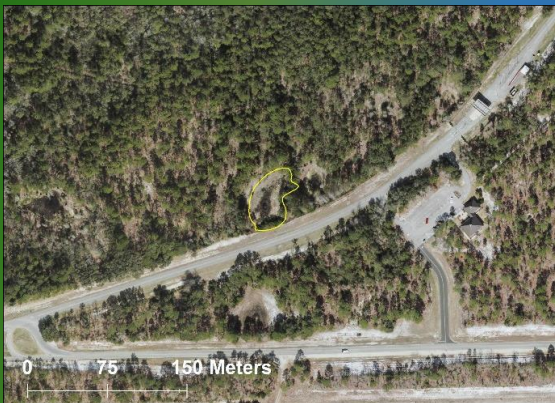
Open-canopy reference (<20% cover)

Brandon's Pond – Croatan National Forest



Open-canopy reference (<20% cover)

Swain Pond – Brunswick County



Enhancement/Restoration Wetland

Block-T Pond – Sandhills Game Land



Pre-restoration 2009



Post-restoration 2014

Enhancement/Restoration Wetland

Slate Circle Pond – Sandhills Game Land



Pre-restoration 2010



Post-restoration 2015

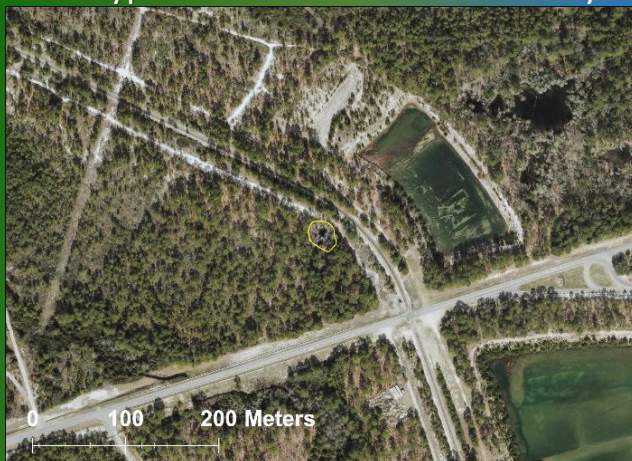
Closed-canopy reference (>60% cover)

Block-O Pond – Sandhills Game Land



Closed-canopy reference (>60% cover)

Cypress Pond – Brunswick County



Re-establishment Wetland

Juniper Bay – Robeson County



Re-establishment Wetland

Parker Farms – Beaufort County



Average (Min/Max) Sizes

Open Canopy Reference sites (4) – 1.9 acres
(0.4 – 4.3 ac)

Enhancement sites (4) – 3.4 acres
(0.1 – 12.0 ac)

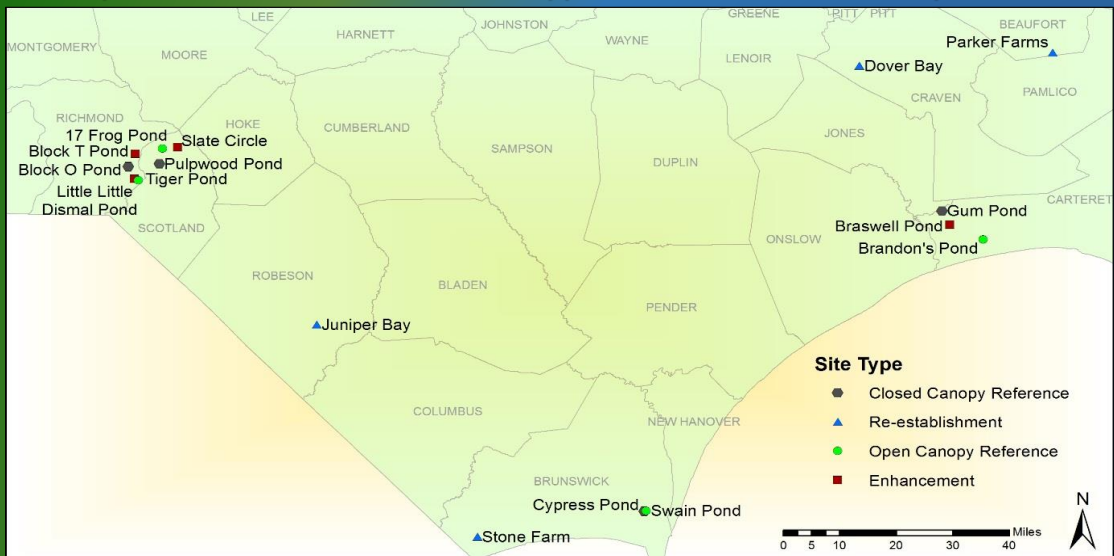
Closed Canopy Reference sites (4) – 0.98 acre
(0.2 – 2.0 ac)

Re-establishment sites (4) – 2.2 acres
(0.7 – 3.5 ac)(assessment areas)
(145 acres - 2,971 acres total size)



Study Methods

4 replicates of each wetland type selected = 16 study sites



Data collected

- rapid assessments (NC WAM, Ohio RAM)
- landscape setting analysis
- vegetation structure
- water quality - meter
(pH, specific conductivity, temp.)
- hydrology monitoring with wells
- macroinvertebrate sampling
- amphibian sampling



Amphibian Sampling

- 3 years of monitoring each wetland (2013-2015)
- Frogloggers at all wetlands mid-winter to mid-July
- Recorded frog calls for 5 minutes, from sunset + 7 hours each night
(35 minutes/night) = total of ~ 4,000 hours
- Data analyzed by ear and through the use of Songscope (Wildlife Acoustics)
- Some loggers failed (equipment failure, fire ants, burned, bear shenanigans), but all sites recorded for at least 2 full years



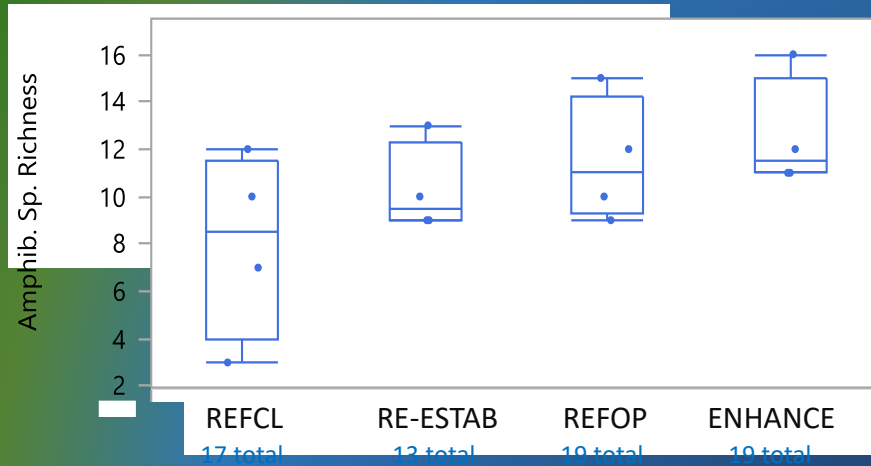
Amphibian Sampling

- Dipnet surveys for larval amphibians every month late winter to mid-summer
- 30 dipnet sweeps each site, different habitats
- Opportunistic surveys for egg masses and amphibians under woody debris at wetland edges



Results

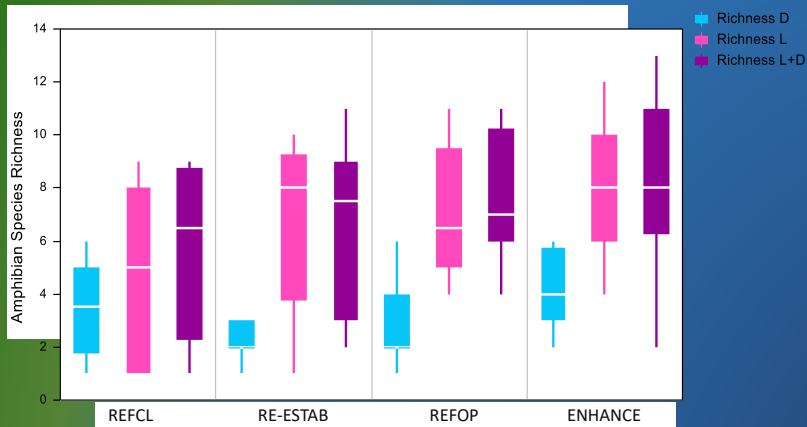
Amphibian Species Richness by site



Amphibian species composition

Common Name	Species Name	Closed Reference	Re-establishment	Open Reference	Enhancement
Southern Cricket Frog	<i>Acris gryllus</i>	X	X	X	X
Mabee's Salamander	<i>Ambystoma mabeei</i>	X			
Eastern Tiger Salamander	<i>Ambystoma tigrinum</i>			X	X
Oak Toad	<i>Bufo quercicus</i>	X		X	X
Southern Toad	<i>Bufo terrestris</i>	X	X	X	X
Eastern Narrowmouth Toad	<i>Gastrophryne carolinensis</i>	X	X	X	X
Pine Barrens Treefrog	<i>Hyla andersonii</i>				X
Cope's Gray Treefrog	<i>Hyla chrysoscelis</i>	X		X	X
Green Treefrog	<i>Hyla cinerea</i>	X	X		X
Pinewoods Treefrog	<i>Hyla femoralis</i>	X	X	X	X
Barking Treefrog	<i>Hyla gratiosa</i>	X		X	X
Squirrel Treefrog	<i>Hyla squirella</i>	X	X	X	X
Red-spotted Newt	<i>Notophthalmus viridescens</i>	X	X	X	X
Atlantic Coast Slimy Salamander	<i>Plethodon chlorobryonis</i>	X			
Spring Peeper	<i>Pseudacris crucifer</i>	X	X	X	X
Little Grass Frog	<i>Pseudacris ocularis</i>		X	X	X
Ornate Chorus Frog	<i>Pseudacris ornata</i>			X	
Carolina Gopher Frog	<i>Rana capito</i>			X	
American Bullfrog	<i>Rana catesbeiana</i>	X	X	X	X
Green Frog	<i>Rana clamitans</i>	X	X	X	X
Southern Leopard Frog	<i>Rana sphenoccephala</i>	X	X	X	X
Carpenter Frog	<i>Rana virgatipes</i>		X	X	X
Eastern Spadefoot	<i>Scaphiopus holbrookii</i>	X		X	X
Total Number of Species		17	13	19	19

Sampling technique mattered



Dipnetting (D) alone did not detect as many species as frogloggers (L) alone.

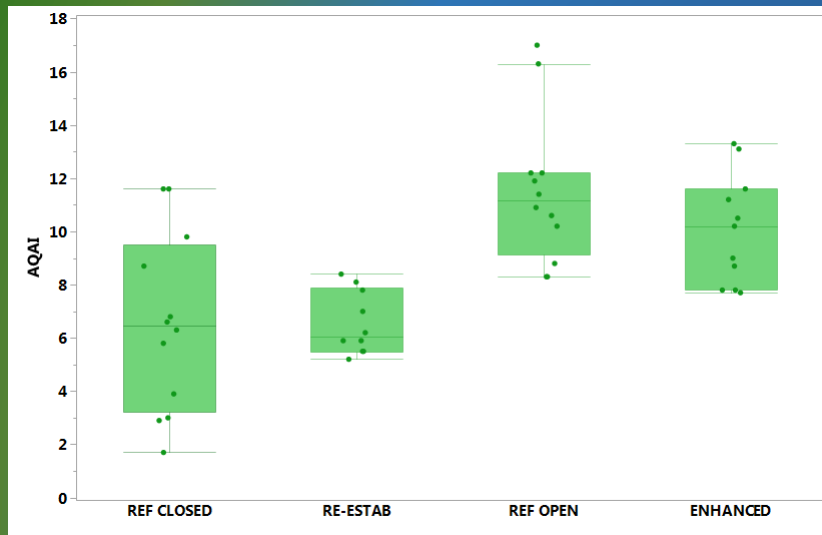
Important to remember non-calling species.

Species rated by dependence on high quality habitat (Coefficient of Conservatism – C value)

Mountains	Piedmont	Coastal Plain	Scientific Name	Common Name	Average C Value
x	x		<i>Acris crepitans</i>	Eastern/Northern Cricket Frog	2.0
		x	<i>Acris gryllus</i>	Southern Cricket Frog	2.6
		x	<i>Ambystoma mabeei</i>	Mabee's Salamander	7.9
x	x	x	<i>Ambystoma maculatum</i>	Spotted Salamander	5.8
x	x	x	<i>Ambystoma opacum</i>	Marbled Salamander	5.6
x	x		<i>Ambystoma talpoideum</i>	Mole Salamander	7.1
		x	<i>Ambystoma tigrinum</i>	Eastern Tiger Salamander	8.8
		x	<i>Amphiuma means</i>	Two-toed Amphiuma	4.1
x	x	x	<i>Bufo americanus</i>	Eastern American Toad	2.0
x	x	x	<i>Bufo fowleri</i>	Fowler's Toad	2.0
		x	<i>Bufo quercicus</i>	Oak Toad	7.5
		x	<i>Bufo terrestris</i>	Southern Toad	2.0
x			<i>Cryptobranchus alleganiensis</i>	Hellbender	10.0
x			<i>Desmognathus aeneus</i>	Seepage Salamander	7.0
		x	<i>Desmognathus cf. auriculatus</i>	Southern Dusky Salamander	7.0
x			<i>Desmognathus carolinensis</i>	Carolina Mountain Dusky Salamander	5.6
x	x		<i>Desmognathus conanti</i>	Spotted Dusky Salamander	5.6
x			<i>Desmognathus folkertsi</i>	Dwarf Black-bellied Salamander	7.0
x	x	x	<i>Desmognathus fuscus</i>	Northern Dusky Salamander	4.4
		x	<i>Siren lacertina</i>	Greater Siren	4.3
		x	<i>Stereochilus marginatus</i>	Many-lined Salamander	7.0

Full table in final report appendices

Amphibian Quality Assessment Index



Site ranks - best to worst (richness and AQAI)

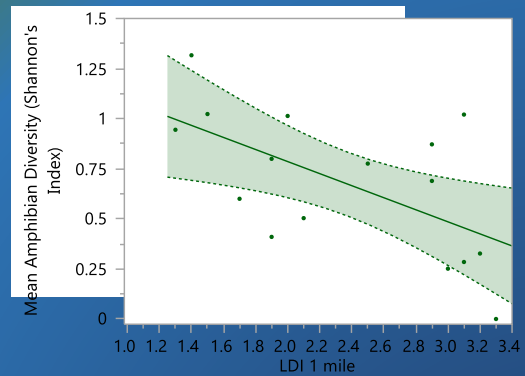
	Site Name	Site Type	Mean Amphib. Sp. Richness	Mean AQAI	Richness Rank	AQAI Rank	Mean Rank
Best sites – reference and enhancement	17 Frog Pond	REFOP	9.7	13.5	3	1	2
	Block T Pond	ENHANCE	11.7	11.7	1	3	2
	Little Little Dismal Pond	ENHANCE	8.7	11.1	5	4	4.5
	Pulpwood Pond	REFCL	8.7	11.0	5	5	5
	Brandon's Pond	REFOP	8.0	13.3	8.5	2	5.3
Middle sites – all types	Juniper Bay	RE-ESTAB	10.0	7.8	2	9	5.5
	Slate Circle	ENHANCE	8.5	9.6	6	7	6.5
	Gum Pond	REFCL	8.3	6.6	7	11	9
	Tiger Pond	REFOP	5.7	9.8	12.5	6	9.3
	Swain Pond	REFOP	6.3	9.5	11	8	9.5
	Braswell Ponds	ENHANCE	6.7	7.7	10	10	10
	Parker Farms	RE-ESTAB	8.0	5.5	8.5	15	11.8
	Stone Farm	RE-ESTAB	5.7	6.4	12.5	12	12.3
Worst sites – closed canopy reference and re-establishment	Cypress Pond	REFCL	3.7	6.1	15	13	14
	Dover Bay	RE-ESTAB	5.5	5.9	14	17	14
	Block O Pond	REFCL	1.3	2.5	16	16	16

*Note – these sites do not represent the full spectrum of disturbance

Landscape Development Intensity Index (LDI)

Continued persistence of amphibian populations depends on upland habitat available

Development of uplands was correlated with lower diversity

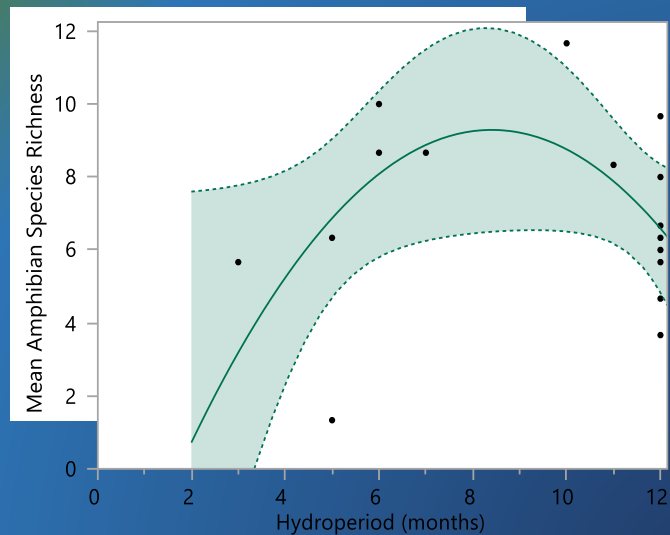


*Note – these sites do not represent the full spectrum of disturbance

Hydroperiod Length

Fish exclusion (by dry periods) is important for many amphibian species

Re-establishment/mitigation sites all had permanent water (and fish)



Take-home message

- Amphibian diversity was highest in open-canopy and enhancement sites; community quality was lowest in re-establishment sites
- *Specialist species* were more tied to open-canopy natural wetlands (some species *e.g.*, Gopher Frog, Tiger Salamander, Ornate Chorus Frog only occupied open-canopy wetlands)
- Re-establishment (mitigation) wetlands were large and always had fish, and planted with trees, and did not replace losses from smaller, isolated wetlands
- Restoring small seasonal wetlands can, over time, play a major part in creating metapopulations of rare species and enhance long-term species diversity

Questions or comments?

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Tiger salamanders, spadefoot toads, gopher frog, and a southern leopard frog at a natural open canopy reference wetland