NC STATE UNIVERSITY

Aquatic Plant Management

An Overview of Hydrilla in Lake Waccamaw

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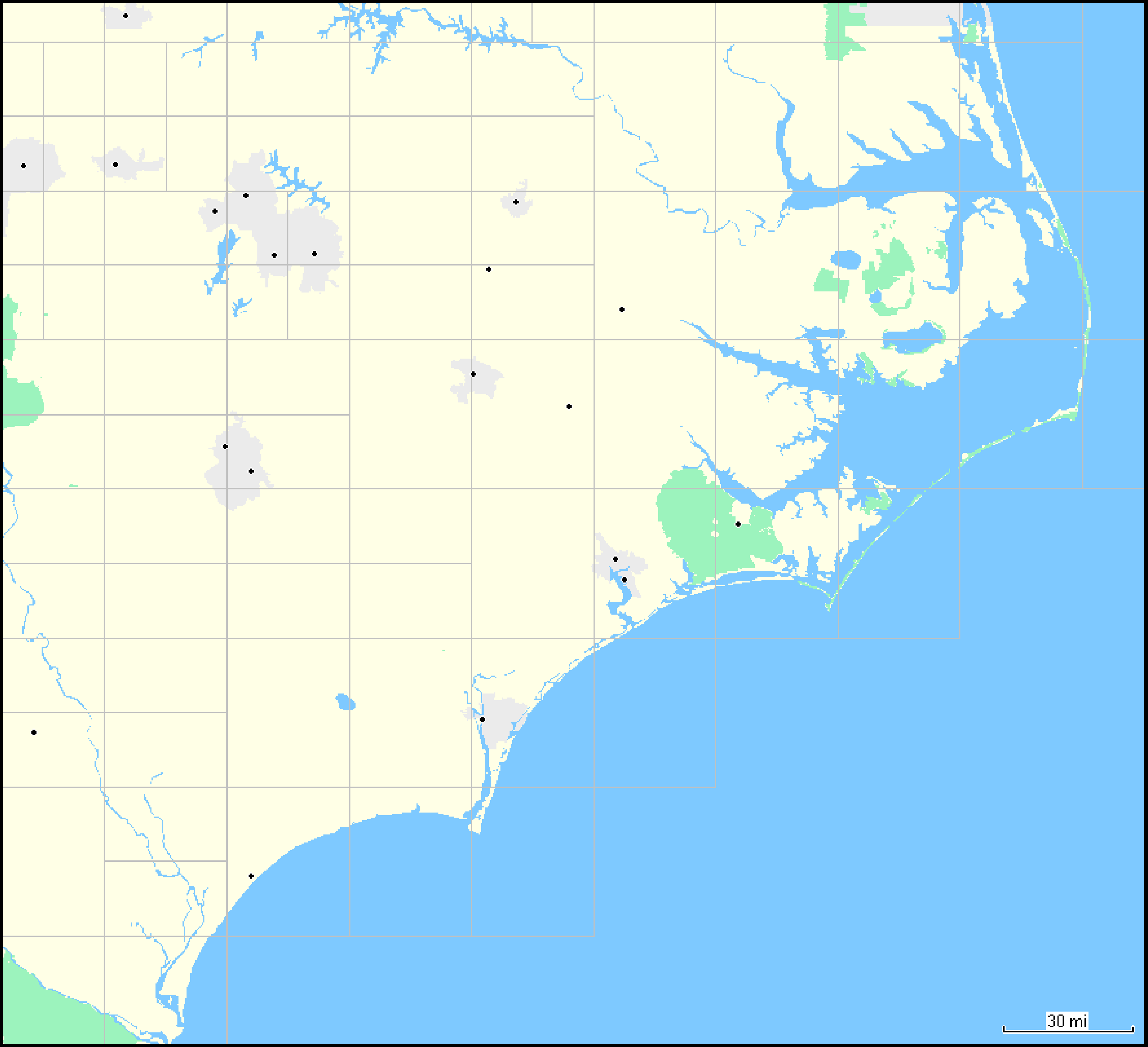
NC STATE UNIVERSITY
A&T STATE UNIVERSITY
COOPERATIVE EXTENSION
Helping People Put Knowledge to Work

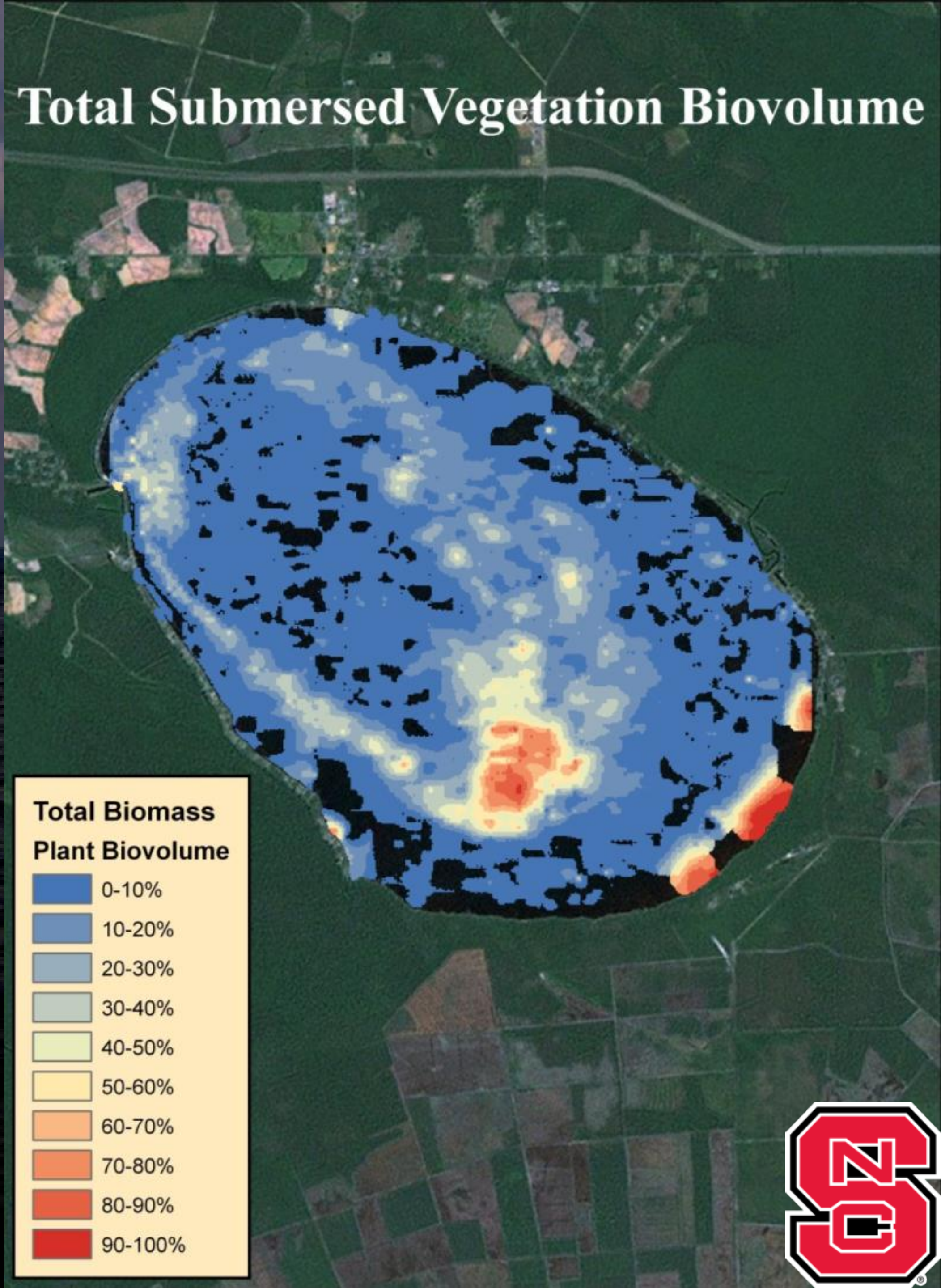
Hydrilla

- Called the “perfect aquatic weed”
- #1 aquatic weed in U.S.
- Leaves in whorls of 3-10+
- Serrated leaf margins
- Tubers can remain in sediment for over 7 years
- Very shade tolerant
- Low CO_2 compensation


Hydrilla
verticillata

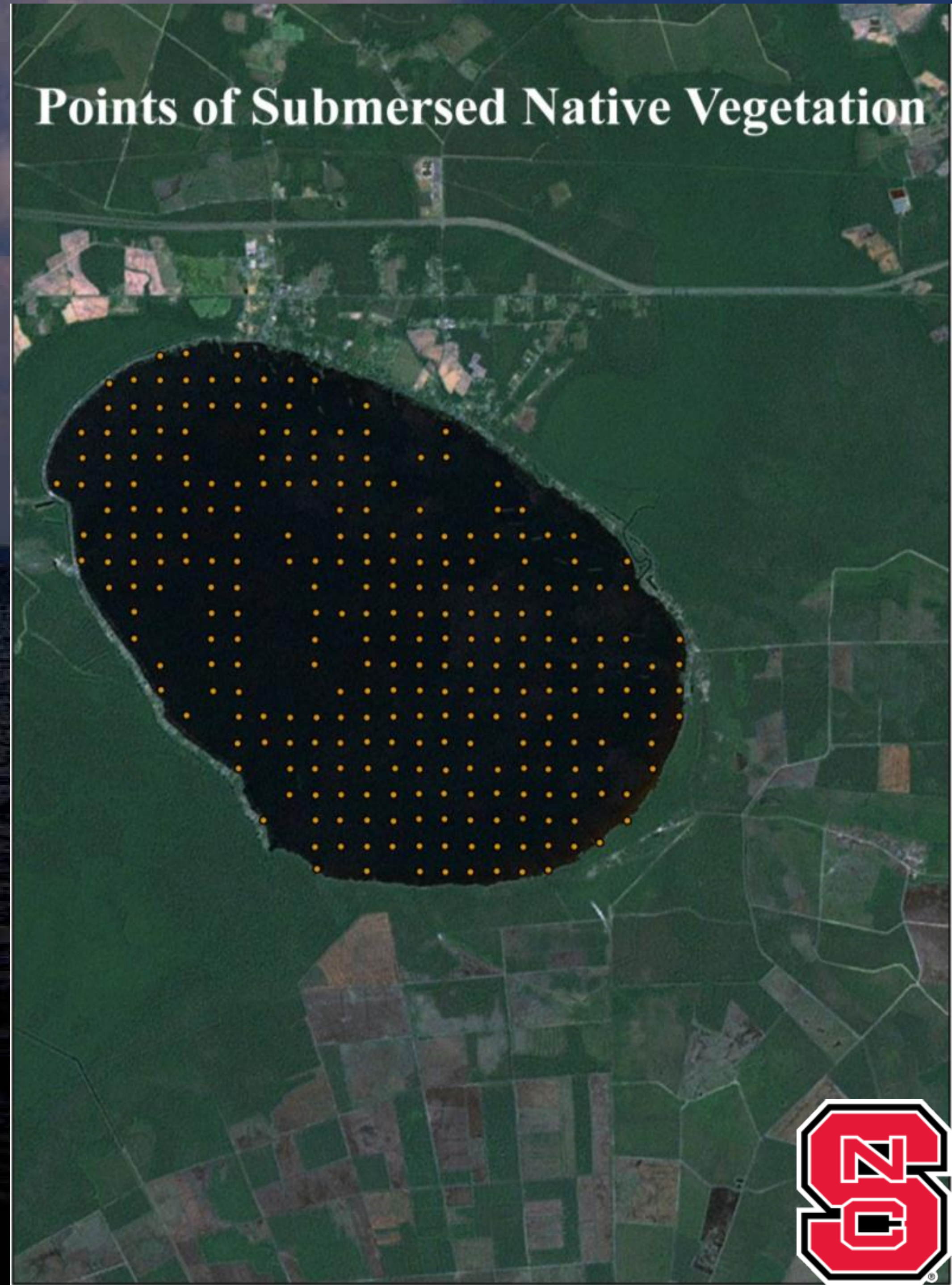

30 mi

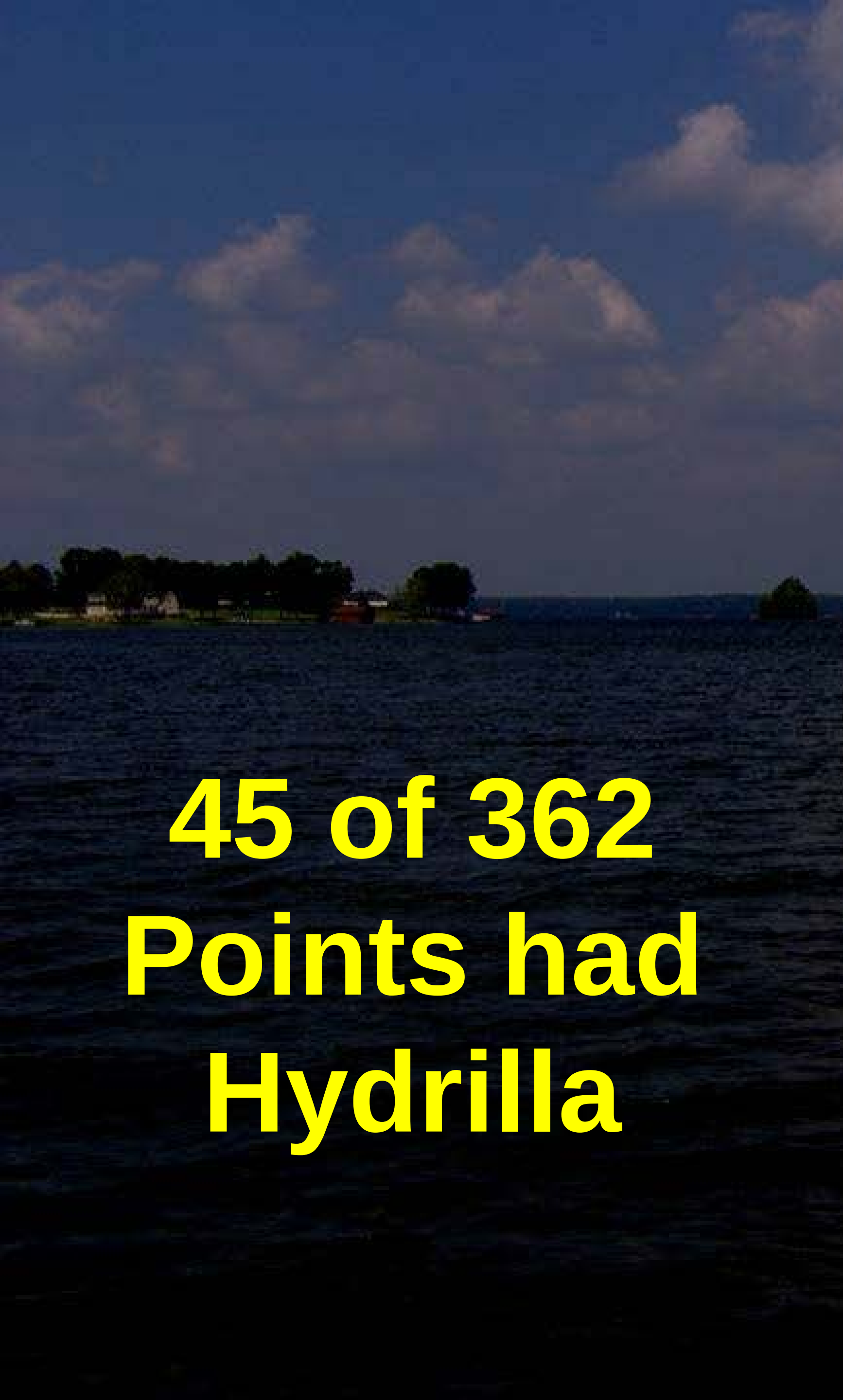
Volume of Plant Biomass Across the Lake (SONAR identified)



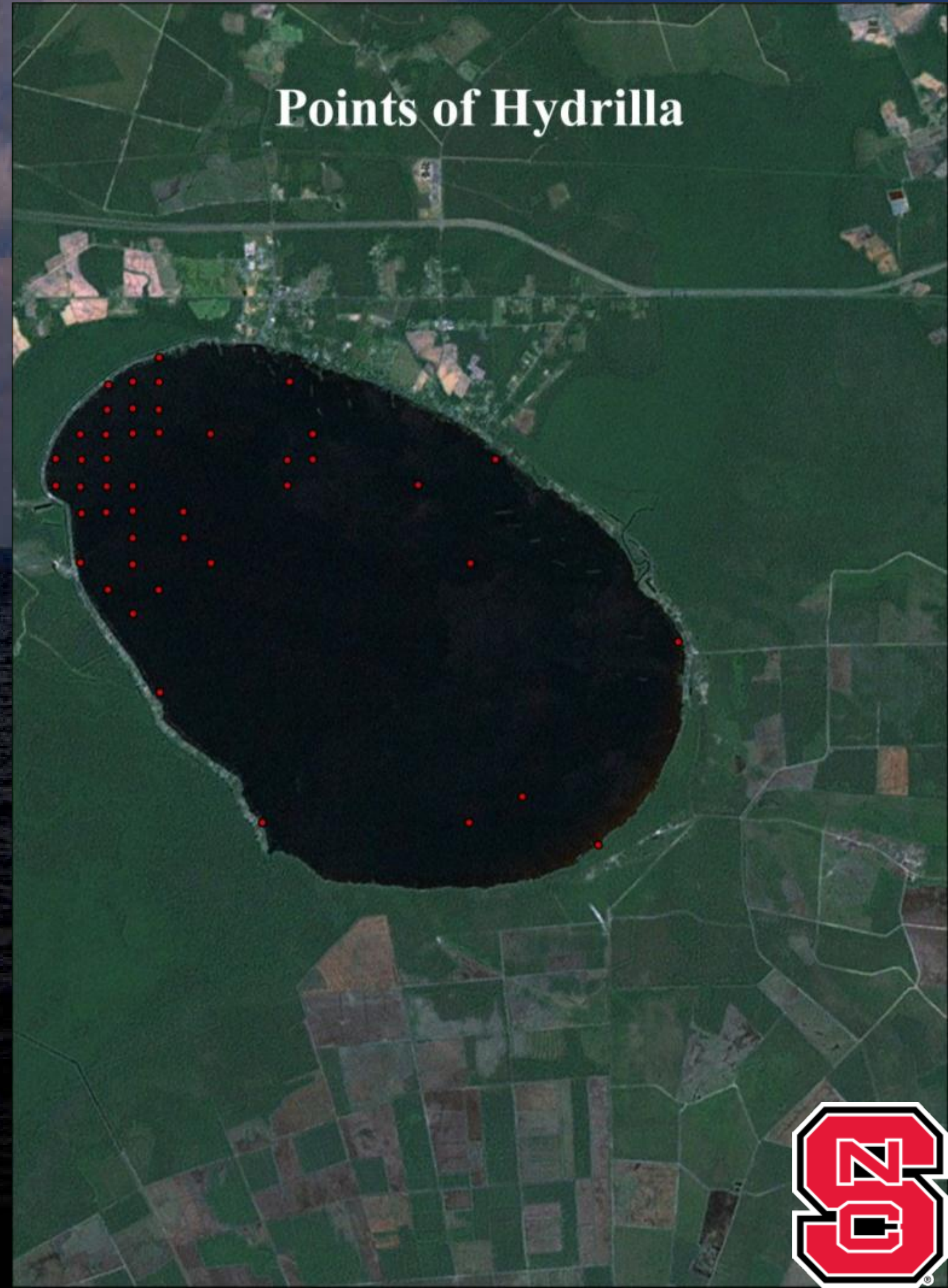
362 Total Survey Points (non-SONAR)

279 of 362 points had native plant species

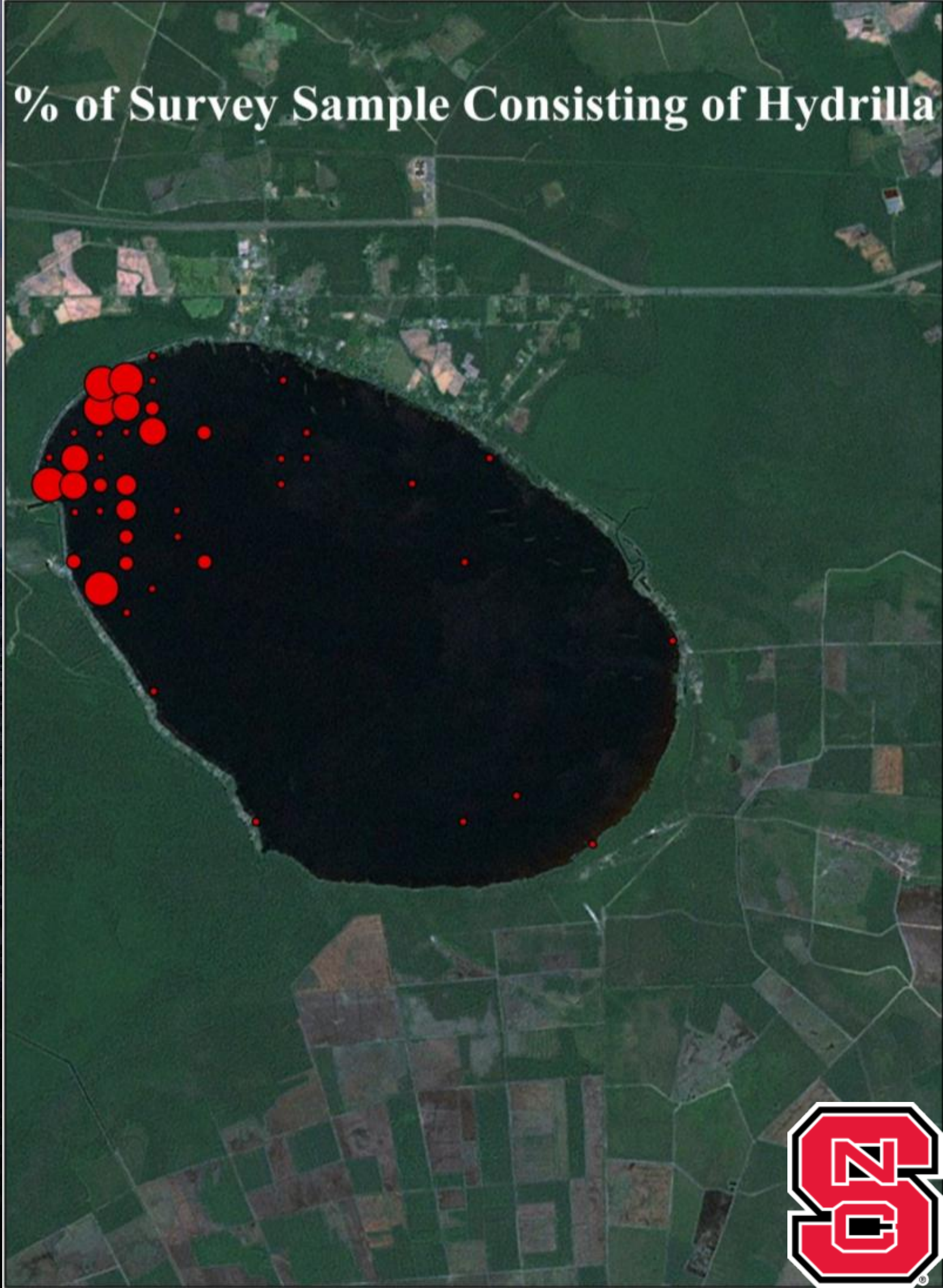




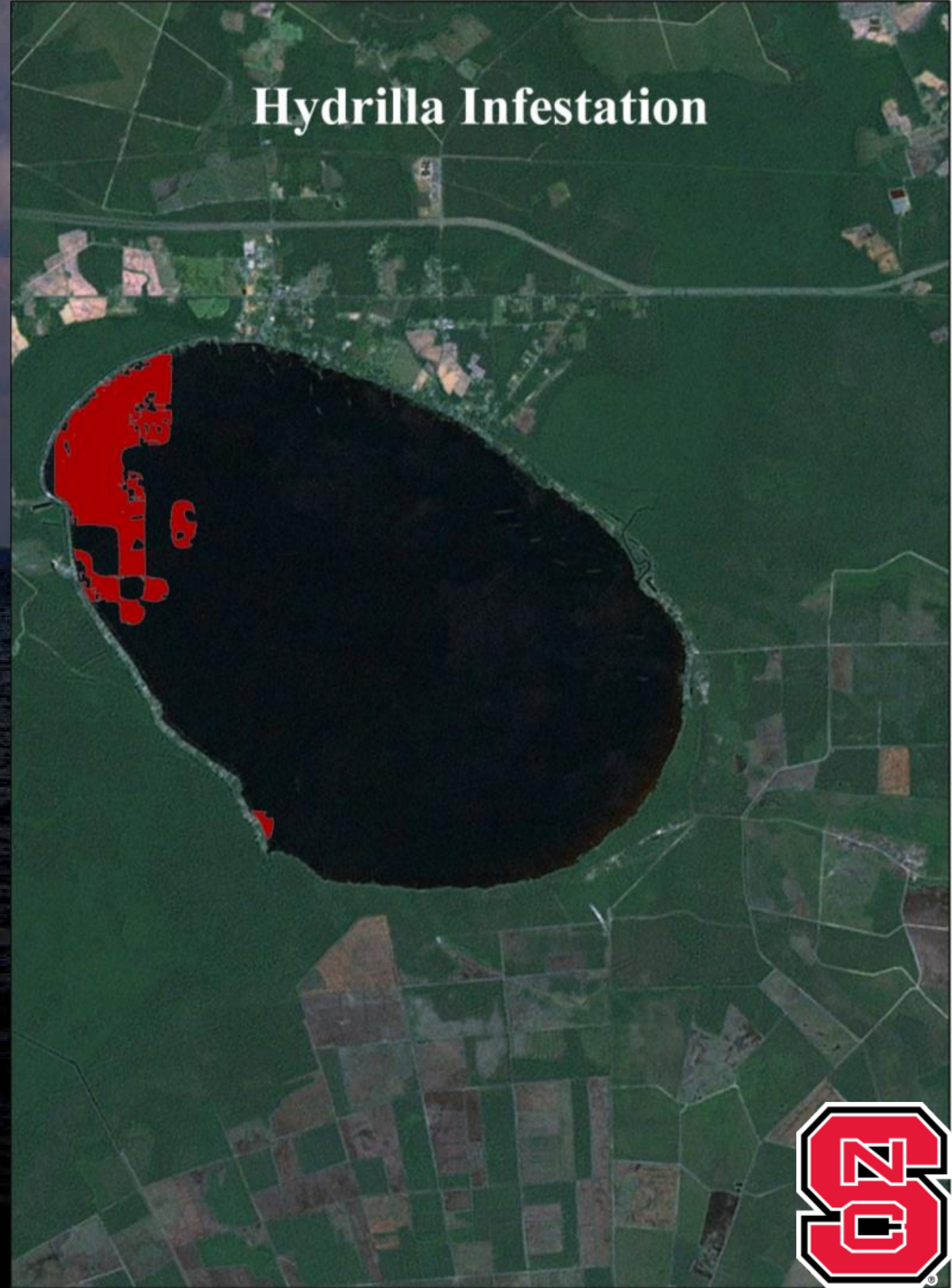
45 of 362 Points had Hydrilla



20 of 45 points had 5% or greater hydrilla coverage on rake



Based on Hydrilla presence, % on rake, and biovolume, estimated 608 acres infested



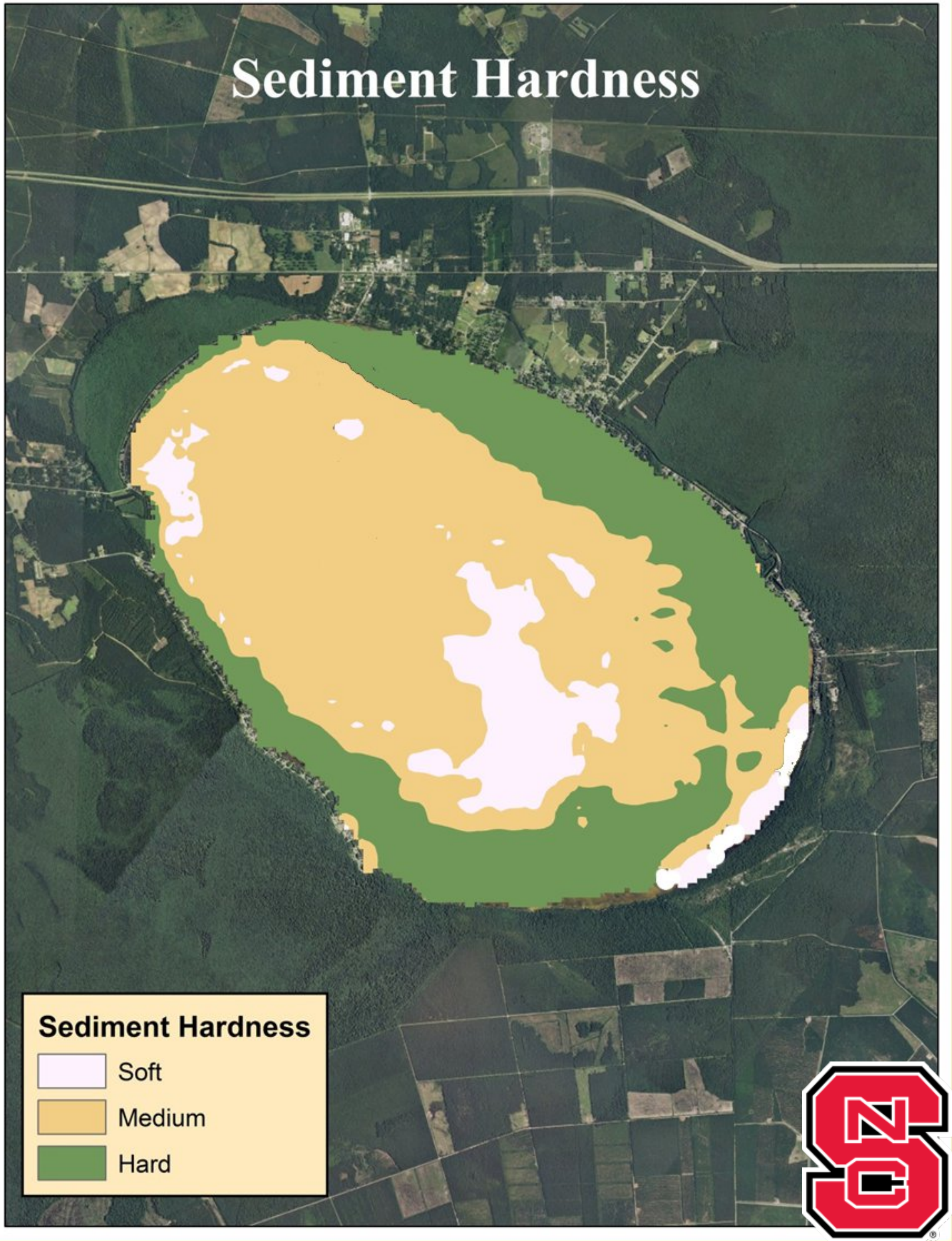
3633 A of submersed native vegetation

Species recovered:

- Southern naiad*
- Slender pondweed*
- Nitella*
- Maidencane*
- Narrowleaf spatterdock*
- Floating heart (native aquatica)
- Native primrose
- Slender naiad
- Cabomba

*represent >98% of native vegetation

SONAR derived model of sediment hardness

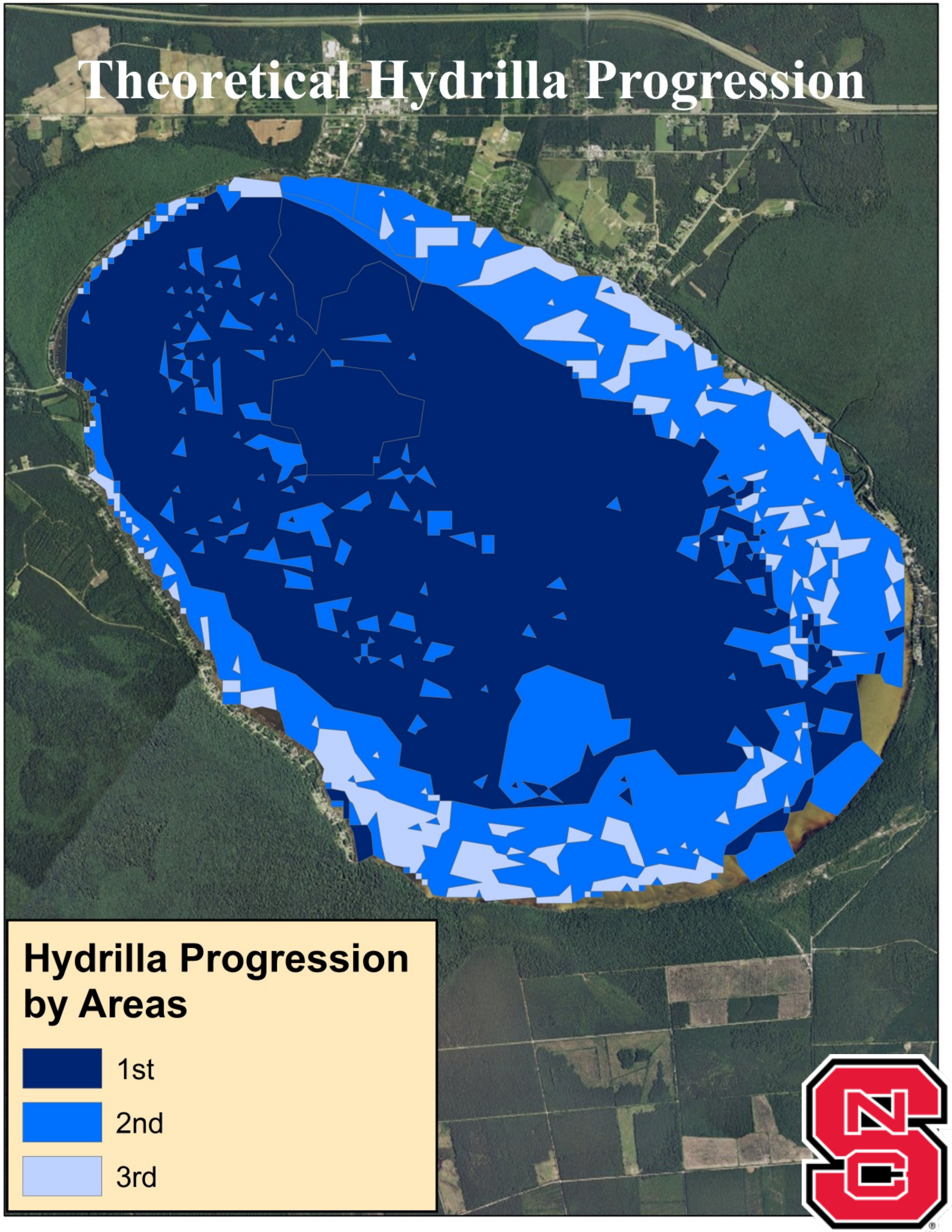


Areas most likely to develop hydrilla

1st - 4736 A

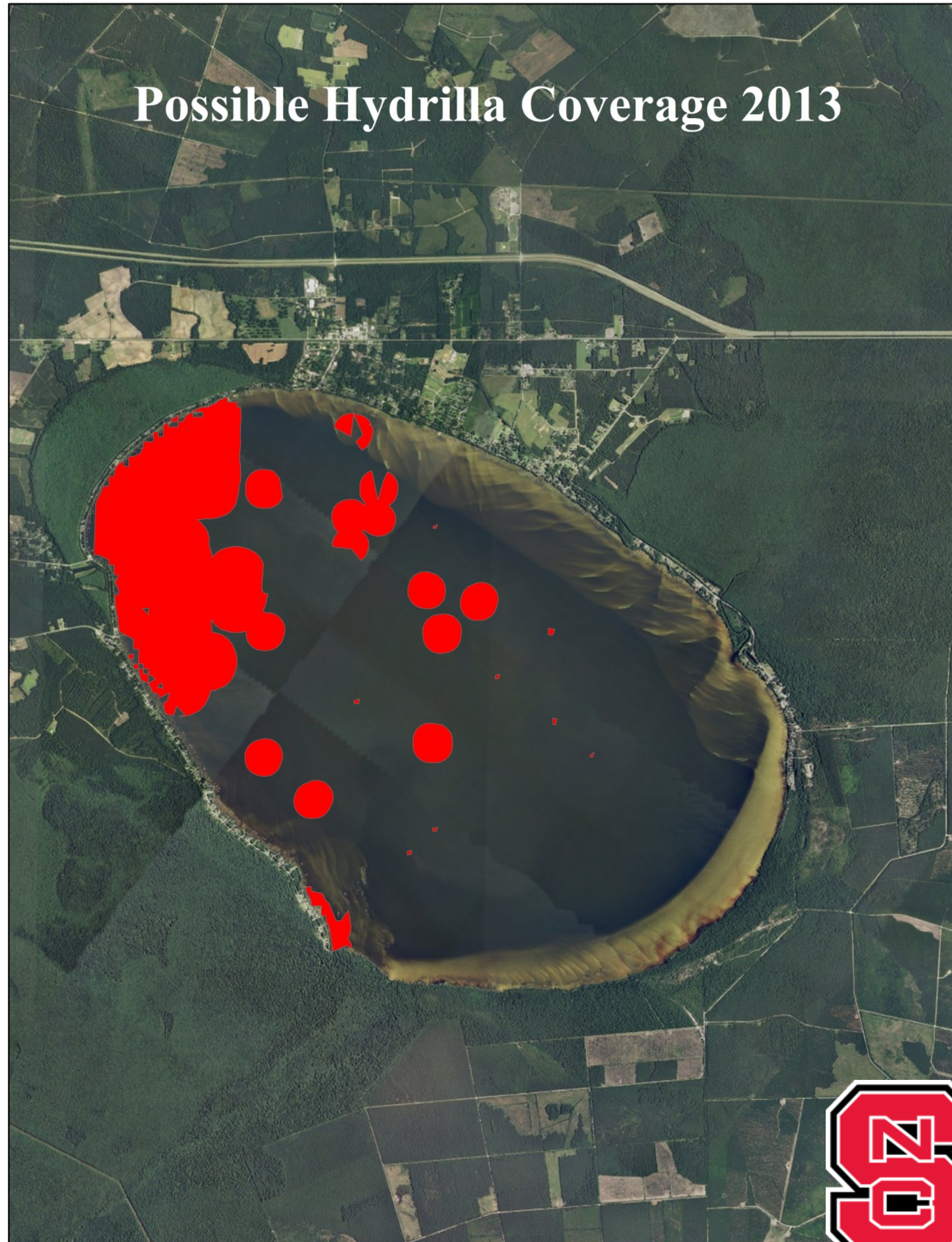
2nd - 2622 A

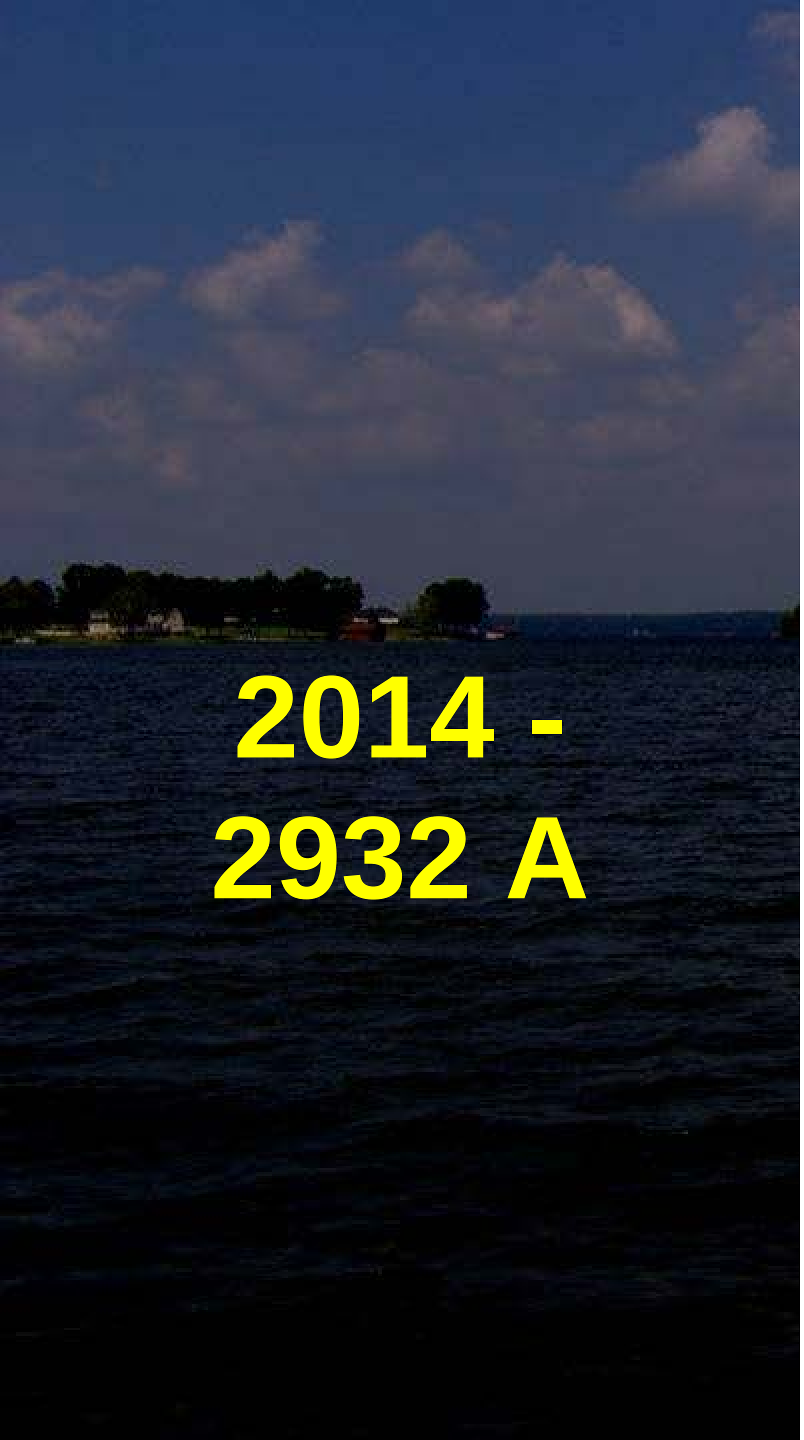
3rd - 770 A



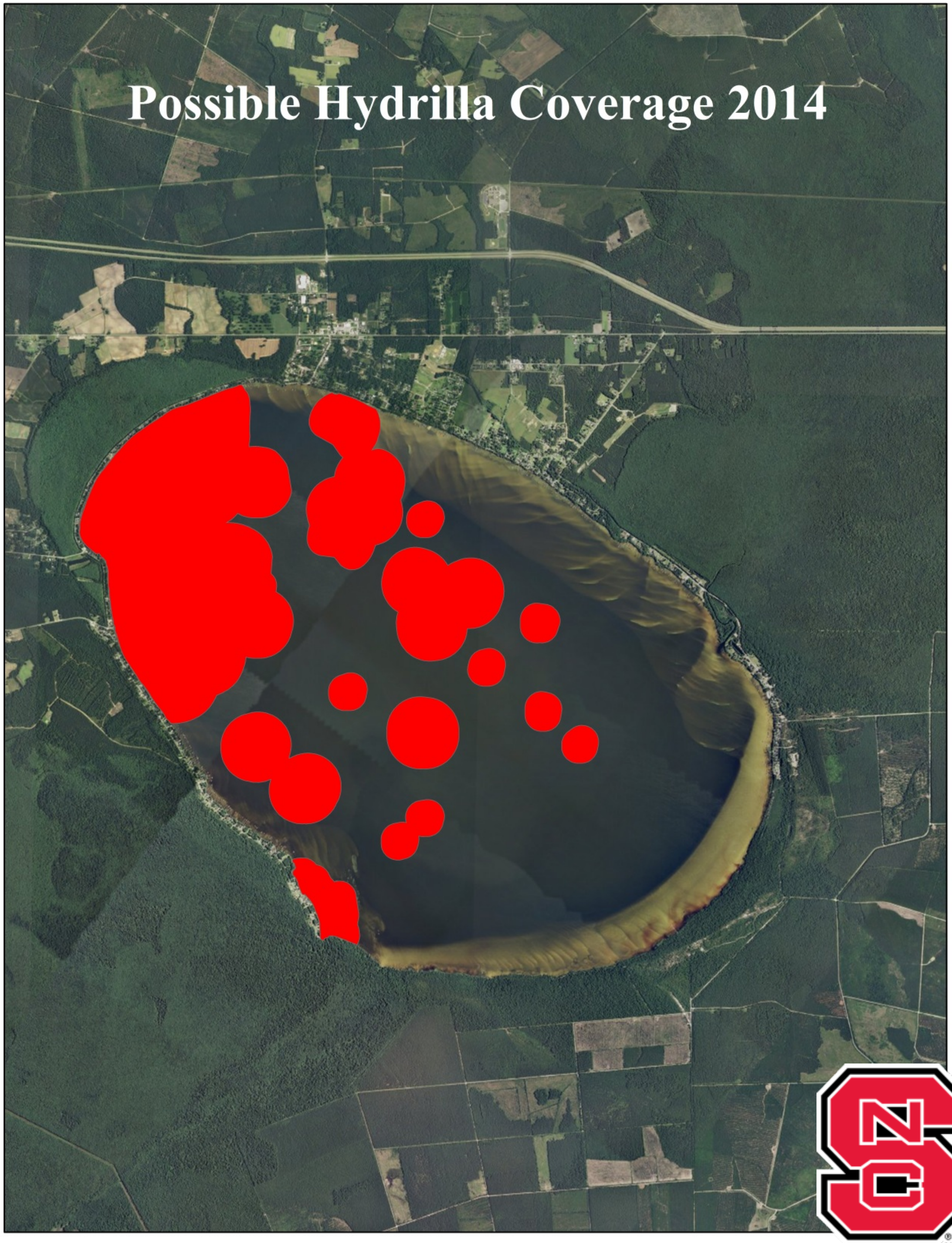
Estimate of Spread if Not Managed

2013 - 1474 A

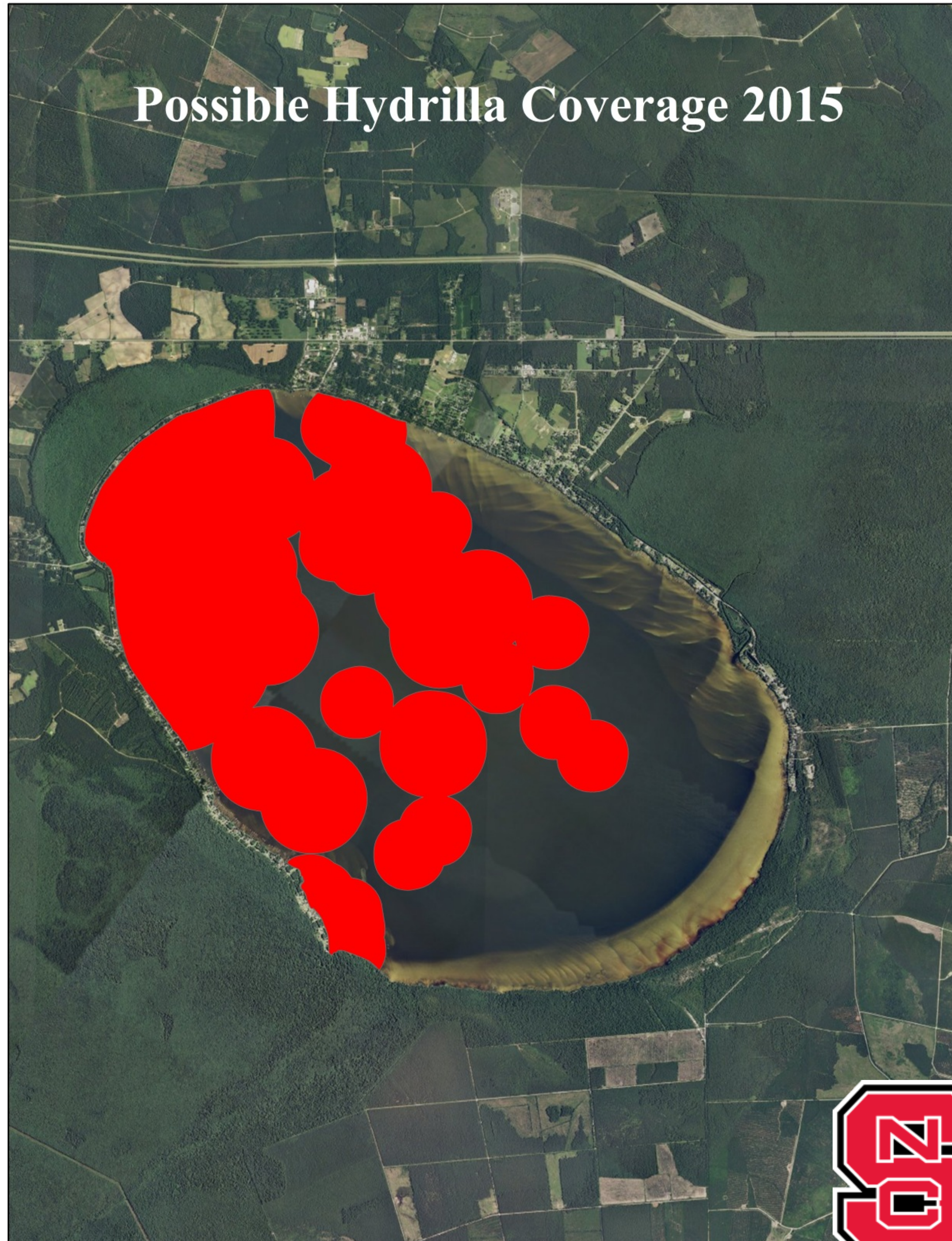


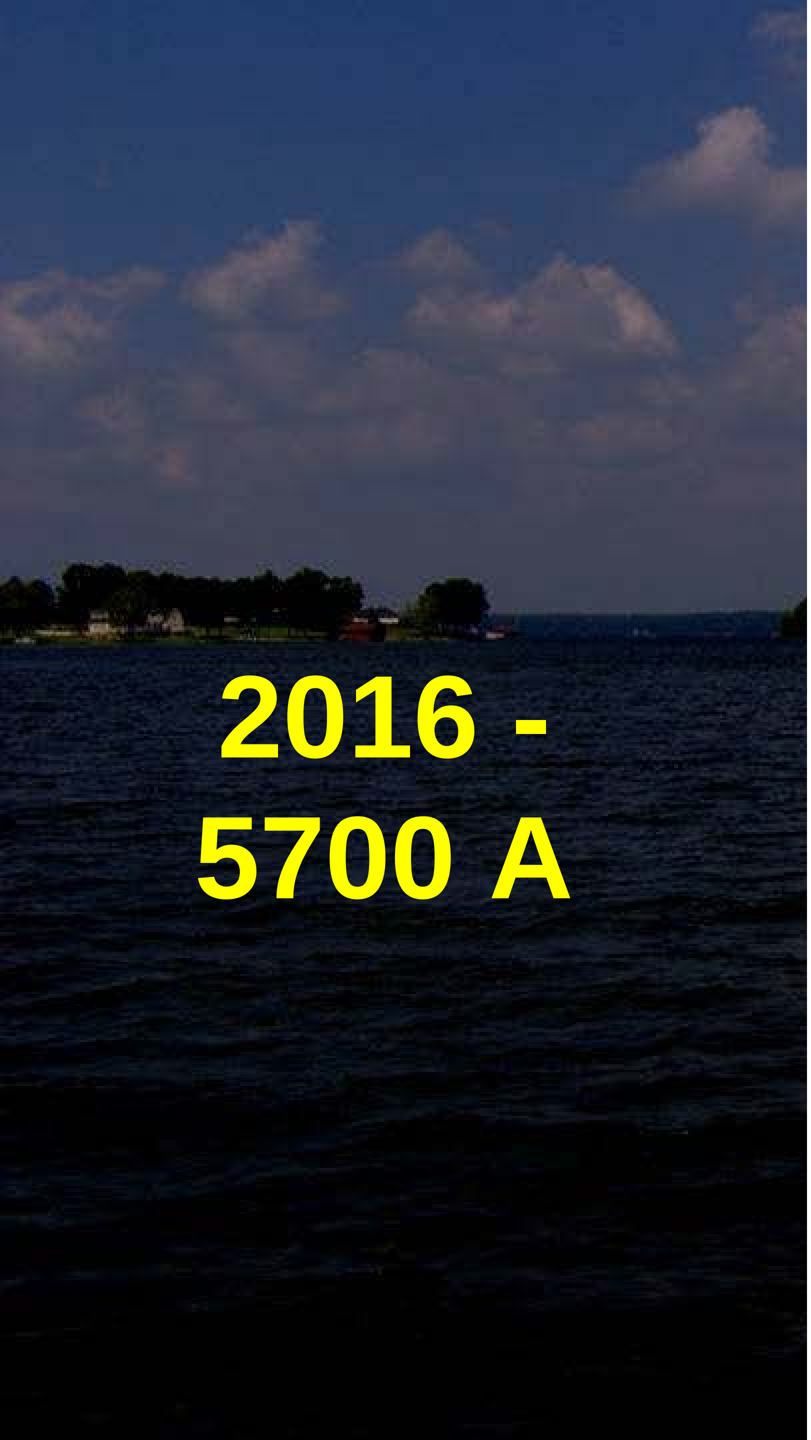


2014 -
2932 A

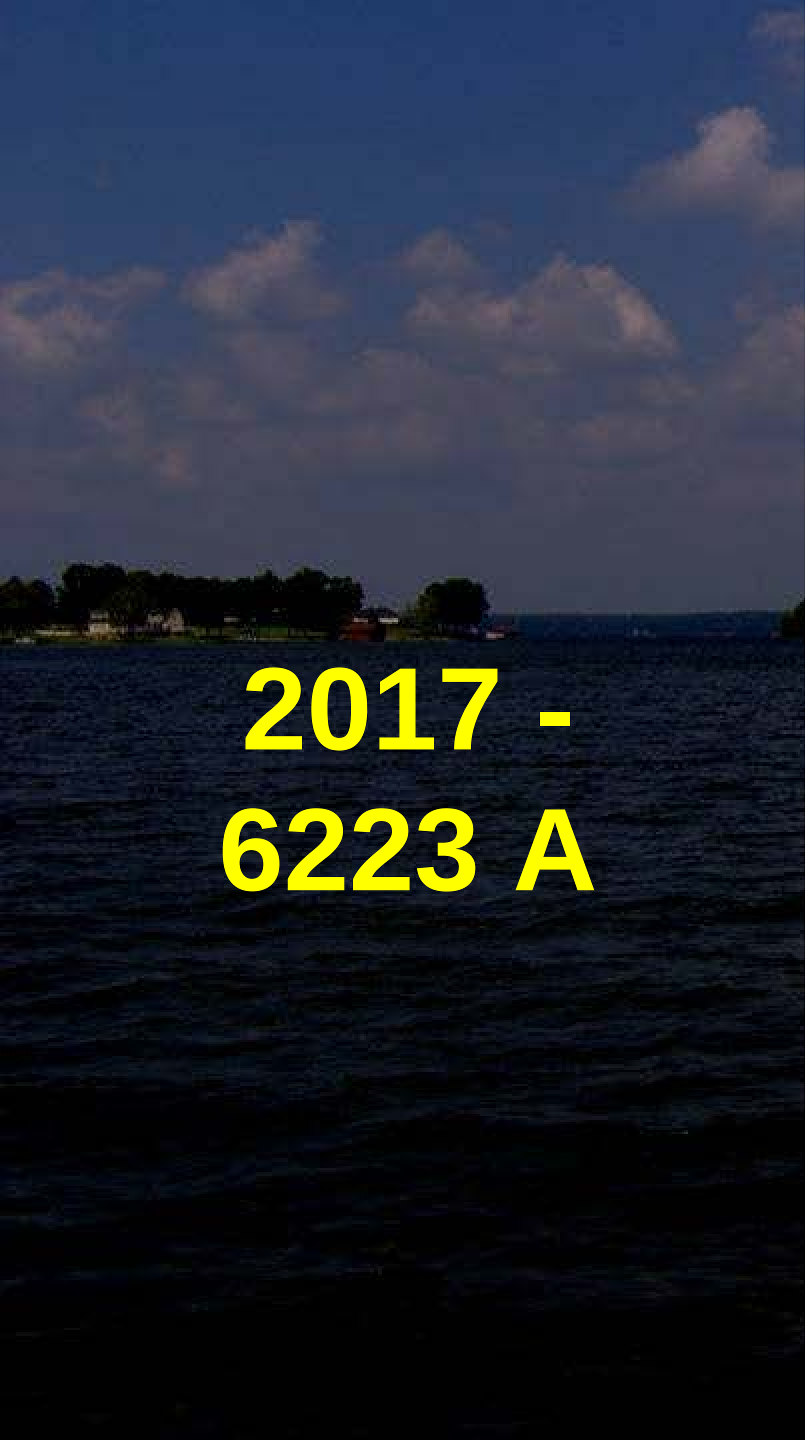


2015 -
4596 A




2016 -
5700 A


Possible Hydrilla Coverage 2016



2017 -
6223 A

Worst Case

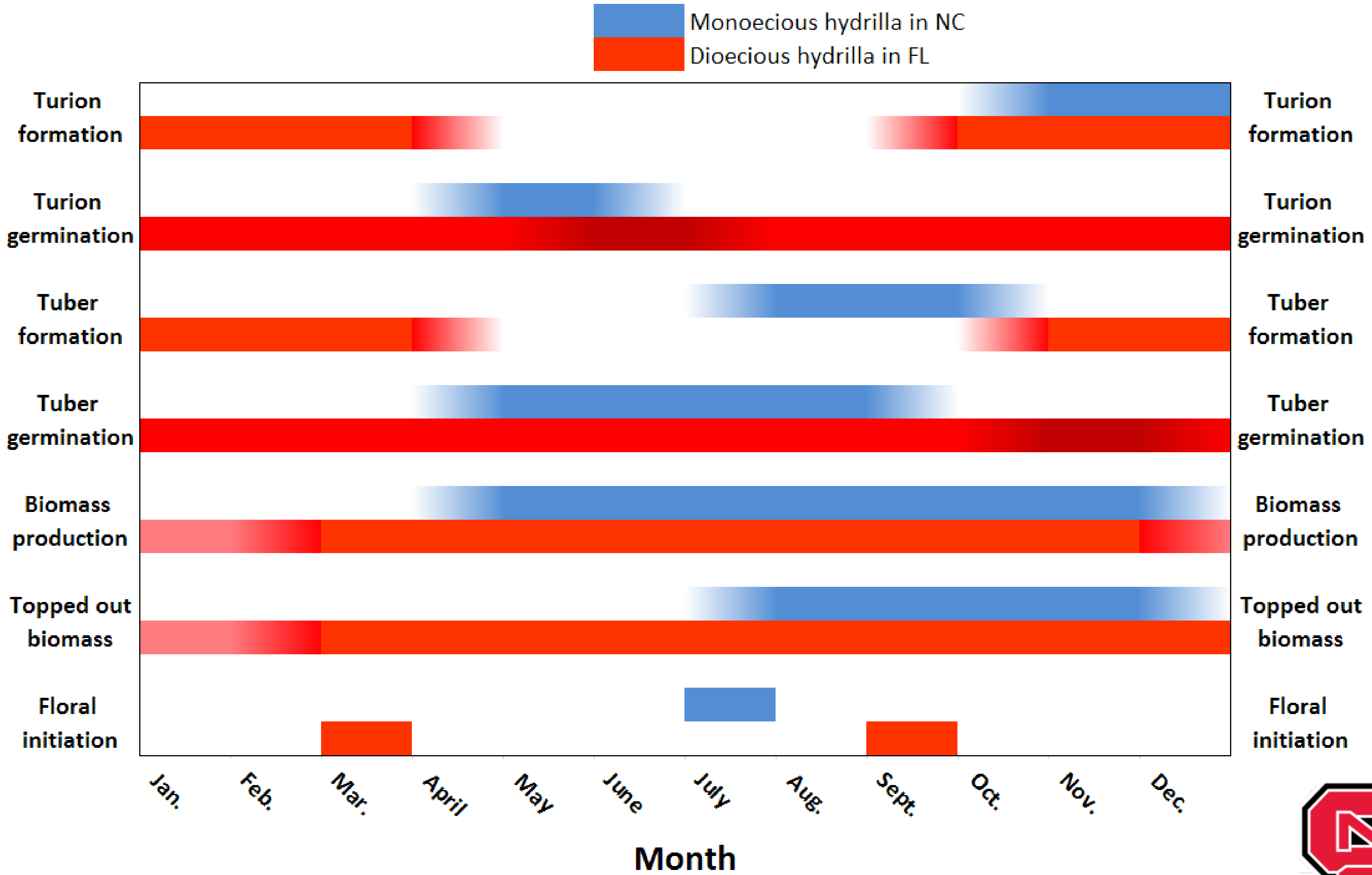

Hydrilla at Wakulla Springs, Florida
Hydrilla verticillata
Photo by Vic Ramey
Copyright 1998 Univ. Florida

An Overview of
Hydrilla Management Options

How Do We Make Weed Management Decisions?

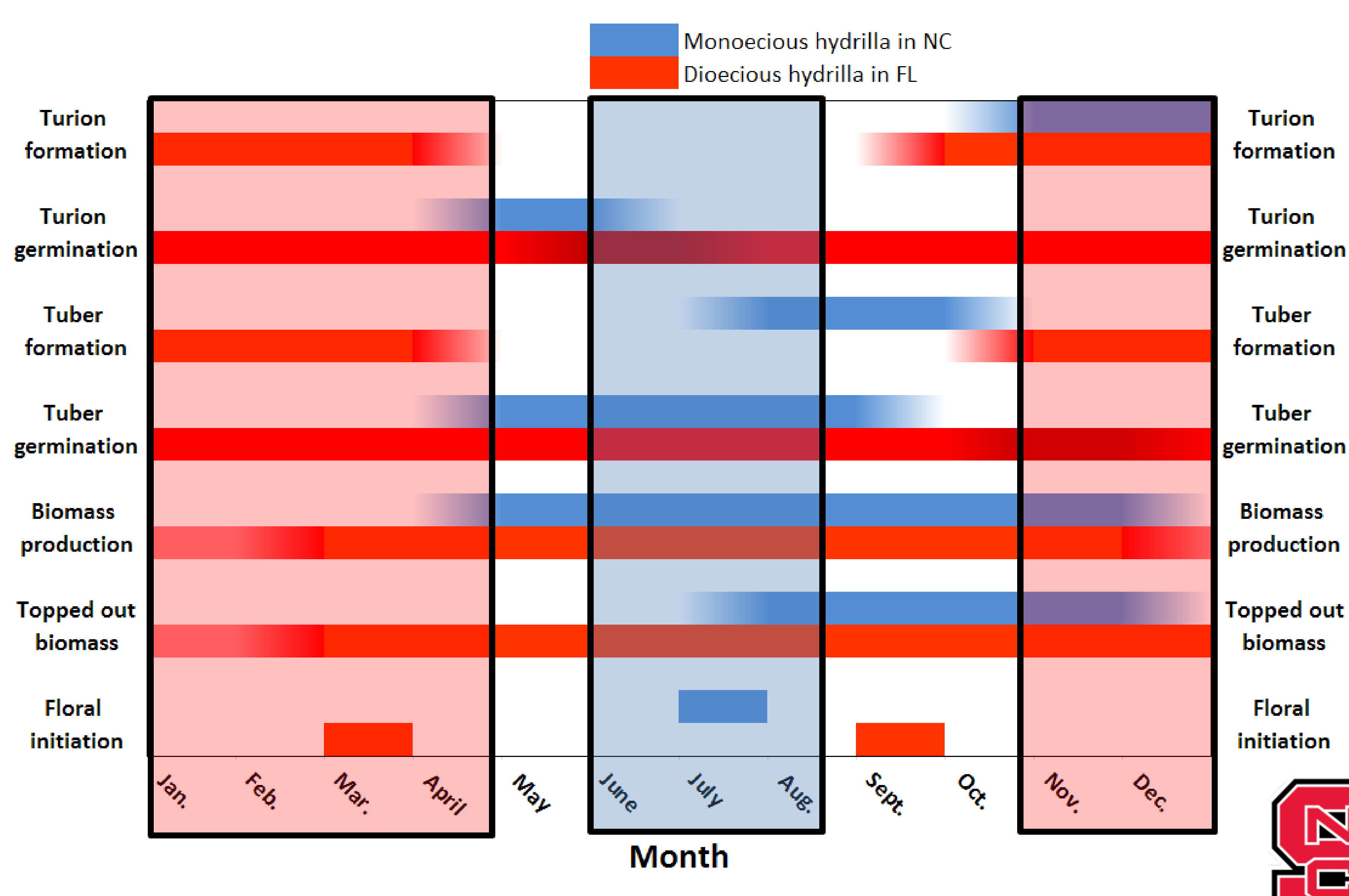
- Use of the body of water
  - Irrigation, consumption, livestock, etc.
- Plant identification
- Fish and wildlife populations
- Water quality
- Physical, environmental, and economic limitations

Hydrilla Biotype Phenology



Modified from Harlan et al. (1985. J. Aquat. Plant Manage. 23:68-71) and the brain of Mike Netherland.

Timeframe for Management



Control Options

- Prevention
- Cultural
- Mechanical/Physical
- Biological
- Chemical

Prevention


Copyright 2002 Univ. Florida
Photo by Jeff Schardt
Hydrilla
Hydrilla verticillata


BIRD SHOALS
TRADING CO.
BIRD SHOALS
AQUATIC NURSERY
Pond Plants & Products
105
CHANNEL
ROCK ROAD
OPEN

January 22, 2007

1	remove	Anacharis-XLG FORM	1	$2.49	$2.49
2	remove	Egaria najas	1	$1.98	$1.98
3	remove	Cabomba, Green	1	$1.58	$1.58
4	remove	Glossostigma	6	$1.98	$11.88
5	remove	Parrot's Feather	2	$0.98	$1.96
6	remove	Brazilian Pennwort	1	$1.98	$1.98
7	remove	Rotala, Indica	2	$0.98	$1.96
8	remove	Temple Plant	1	$1.98	$1.98
9	remove	Water Velvet or Salvinia	1	$6.99	$6.99
10	remove	Floating Heart	3	$2.98	$8.94
11	remove	Snowflake, Large White (loose)	3	$6.99	$20.97
12	remove	Water Hyacinth	1	$0.00	$0.00
13	remove	Water Lettuce	1	$1.98	$1.98
14	remove	Water Poppy	3	$2.99	$8.97
15	remove	Aquatic Morning Glory	3	$4.59	$13.77
16	remove	Golden Mystery Snail	1	$1.99	$1.99
17	remove	Apple Snail	1	$3.99	$3.99
18	remove	Giant Striped Colombian Ramshorn Snail	1	$1.79	$1.79
19	remove	Mosaic Plant	1	$4.99	$4.99
				Subtotal:	$100.19

Hand Removal

- Most common management form
- Highly labor intensive/inefficient
  - Aquatic plants may be up to 98% water
  - Volunteers are cost effective
- Plants may reproduce as fast as removed
- Plant identification is critical
- Generally for special situations:
  - Active water intakes
  - Active irrigation intakes

Cultural/Physical Mgt.

- Modify the environment to create less favorable conditions
- Environmental impacts vary by the technique used

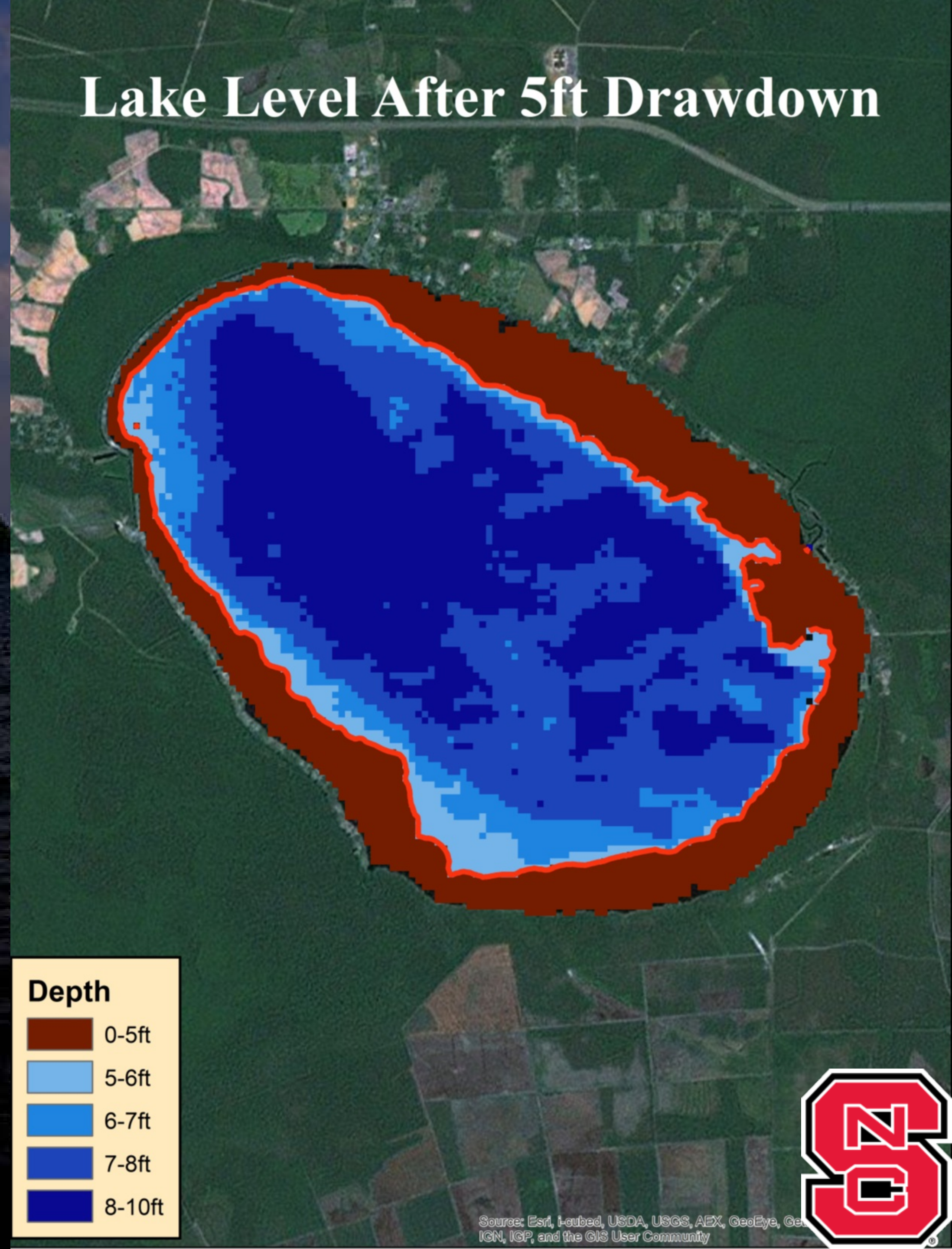
- Fertilization
- Liming
- Pond dyes
- Benthic barriers
- Water level manipulation

Water Drawdown

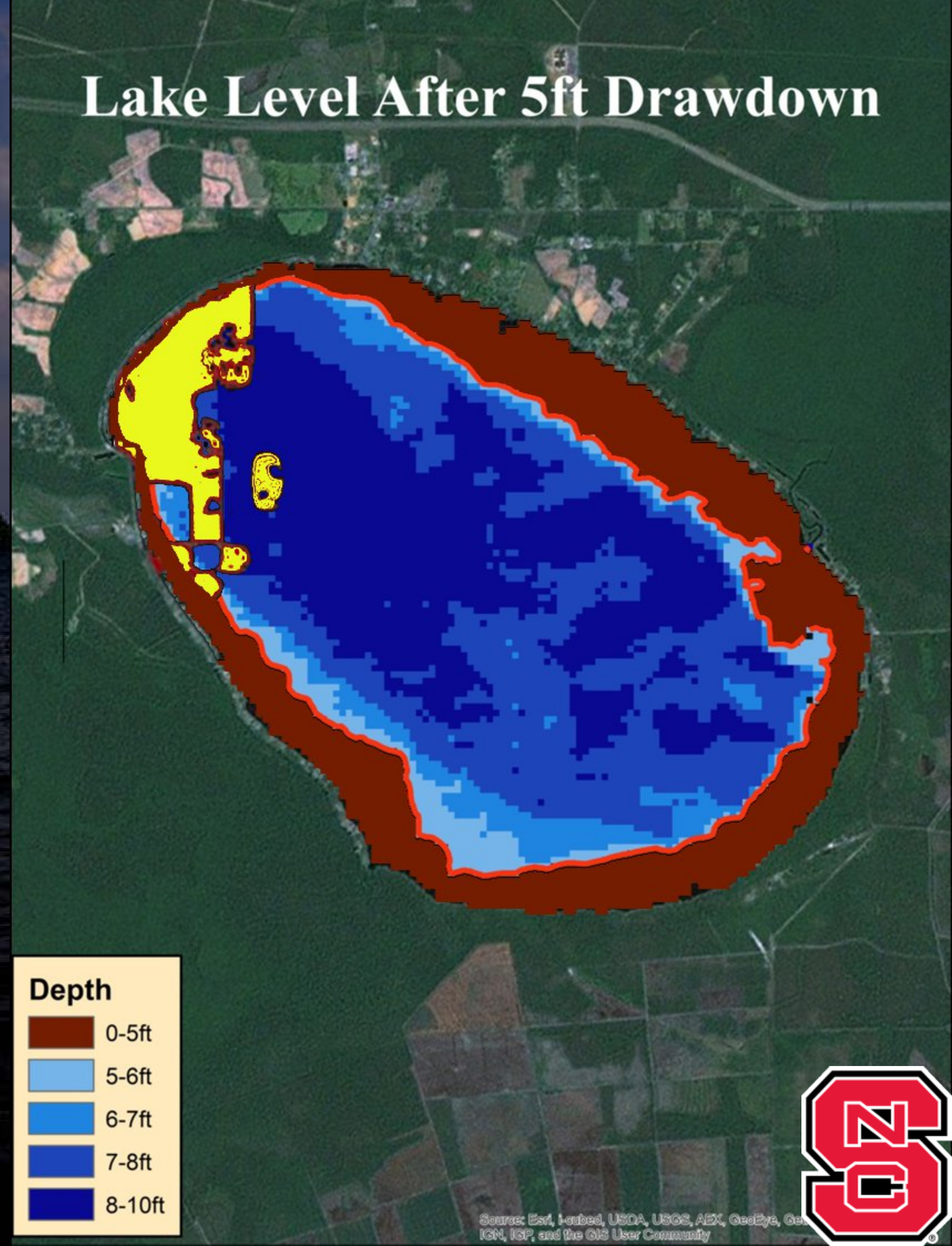
- Advantages
  - Effective on many species
  - Very inexpensive (~$0/acre?)
  - Moderate-term
  - Stimulates germination or sprouting of native plant species
  - May be used to complement other tools
- Disadvantages
  - Not very selective
  - Impacts on other organisms (?)
  - Impacts on human uses
  - Need water control structure
  - Heavy snow cover may impede success




Effect of a 5 ft Drawdown 6,300 A of water left



Most hydrilla in water > 5ft depth

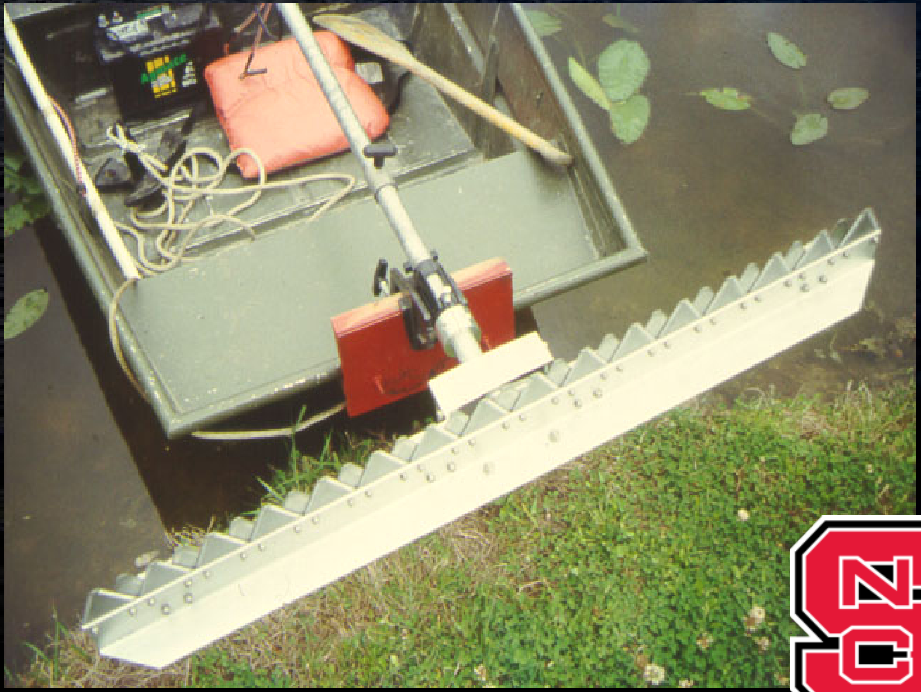


Mechanical Techniques

- Short-term control only
- May actually spread problems
- Expensive
- May destroy “fishing structure”

- Chains/cutters
- Backhoe
- Diver suction
- Weed harvesters
- Cutter boats
- Dredges



Let’s Clip the Sprouts and…

Watch Them Sprout…

Shoot Removed From Tuber

Cutting / Harvesting

- Advantages
  - Direct relief
  - Immediate efficacy
  - Moderately expensive (~$400/acre)

- Disadvantages
  - Not selective
  - Short-term control (2-3 harvests per season)
  - May aid spread of some species like hydrilla
  - Slow
  - Disposal

Diver-operated Suction Harvester

- Advantages
  - Selective (dependent on operator and environment)
  - Longer-term control
- Disadvantages
  - Very limited areas
  - Very slow
  - Moderately expensive (~$1,000/acre)
  - Disposal

Rotovating

- Advantages
  - Longer term than other mechanical (on Eurasian watermilfoil)
  - Moderately inexpensive

- Disadvantages
  - High disturbance
  - Turbidity
  - Spreads fragments
  - Limited environmental range by depth, sediment
  - Free-floating plant material

Dredging

- Advantages
  - Very effective
  - Very long term

- Disadvantages
  - Very expensive (~$6,000/acre)
  - Not selective
  - Impacts on other organisms?
  - Dredge spoils

Advantages of Classical Biological Control

- Permanence (classical or inoculative approach)
- Low maintenance costs, not necessary to repeat every growing season
- No chemical residues
- Minimal environmental damage
- Desirable species usually unaffected (classical)
- Usually perceived by the public as acceptable

Disadvantages of Classical Biological Control

- Effective control may require several growing seasons, even under the best circumstances.
- Initial costs are relatively high (when amortized over the long term, costs usually are low, compared with other methods of aquatic weed management).
- Biological control agents are susceptible to a wide variety of human and environmental interferences.

Grass Carp

- Relatively non-selective, not classical
- Main hydrilla control method in NC ponds
  - Cost-effective over lifetime (16+ years)
  - Other vegetation not wanted
- Used extensively in Santee-Cooper Reservoirs in SC
- Not desired in many lakes due to feeding on native vegetation and resulting environmental impacts

Triploid Grass Carp
Ctenophyrangodon idella

Table 4.—Apparent food preferences of grass carp in four Florida lakes over a 10-year period. Data from Van Dyke et al. (1984).

RANK	SPECIES
Preferred	
1	*Hydrilla verticillata*
2	*Lemna sp.*
3	*Filamentous algae*
4	*Brasenia schreberi*
5	*Ceratophyllum demersum*
6	*Myriophyllum laxum*
7	*Potamogeton illinoensis*
8	*Utricularia sp.*
Intermediate	
9	*Salvinia rotundifolia*
10	*Typha sp.*
11	*Sagittaria lancifolia*
12	*Eichhornia crassipes*
13	*Panicum hemitomon*
14	*Pontederia cordata*
15	*Eleocharis sp.*
16	*Panicum repens*
Non-preferred	
17	*Myriophyllum spicatum*
18	*Alternanthera philoxeroides*
19	*Vallisneria americana*
20	*Nymphaea odorata*
21	*Ludwigia octovalis*
22	*Hydrocotyl sp.*
23	*Cladium jamaicense*

Filizadeh et al. http://iirc.narod.ru/4conference/Fullpaper/50031.pdf

Table 1. Mean consumption of ten macrophytic plants by grass carp (*Ctenopharyngodon idella*) in tank conditions at duration of 196 hours.*

Species	Mean consumption (g)
Lemna minor	504[a]
Chara sp	485[a]
Najas guadalupensis	480[a]
Hydrilla verticillata	473[a]
Potamogeton pectinatus	155[b]
P. perfoliatus	146[b]
P. crispus	135[b]
Azolla filiculoides	128[bc]
Ceratophyllum demersum	109[c]
Myriophyllum spicatum	85[c]

*Means with a common superscript were not significantly different at P<0.05 as determined by Tukey's Least Significant Difference test to separate means.

The variation of plant biomass and cover in the ponds are presented in Table 2. At the end of experiment, the total vegetation cover was significantly higher in the control pond (P<0.05). *P. crispus*, *Azolla filiculoides*, *Ceratophyllum demersum*, and *Myriphyllum spicatum* cover and weight in the trail ponds were no different from the control. These results suggested that grass carp with the average weight of 60 grams did not eat properly these species. The final biomass and cover of *Lemna minor*, *Chara* sp, *Najas guadalupensis* and *Hydrilla verticillata* showed a great difference between test and control ponds (P<0.05).

Sutton and VanDiver http://edis.ifas.ufl.edu/fa043

Table 1. A few common Florida aquatic plants eaten by grass carp in the approximate order of preference.

Order of preference	Common name	Scientific name
1	**Hydrilla**	Hydrilla verticillata [L.f] Royle
2	Musk-grass	Chara spp.
3	**Southern naiad**	Najas guadalupensis (Spreng,) Magnus
4	Brazilian elodea	Egeria densa Planch.
5	Water-meal	Wolffia spp.
6	Duckweeds	Lemna spp. and Spirodela spp.
7	Azolla or water-fern	Azolla caroliniana Willd.
8	Pondweeds	Potamogetan spp.
9	Coontail	Ceratophyllum demersum L.
10	Torpedograss	Panicum repens L.
11	Cat-tail	Typha spp.
12	Water-aloe	Stratiotes aloides L.
13	Watercress	Nasturtium officinale R. Br.
14	Eurasian watermilfoil	Myriophyllum spicatum L.
15	Tapegrass or eel-grass	Vallisneria americana Michx.
16	Parrott-feather	Myriophyllum aquaticum (Vell.) Verdc.
17	Water hyacinth	Eichhornia crassipes (Mart.) Solms
18	Water-lettuce	Pistia stratiotes L.
19	Water-lillies	Nymphaea spp.
20	Spatterdock	Nuphar luteum (L.) Sibth. & Sm.

Effect of grass carp on plant coverage in four hydrilla infested and four Southern naiad infested lakes in Florida. (Derived from Hanlon et al. 2000)

	Stocking rate	Initial vegetation	Vegetation decline	Years
	carp/veg A	% coverage	% points	#
Hydrilla	10.5 ± 0.6	26.5 ± 6.6	3.5 ± 13.2	6.0 ± 0.4
Southen naiad	9.5 ± 0.7	76.5 ± 20.6	42.5 ± 26.8	3.5 ± 0.3

Grass Carp Summary

- Grass carp should be expected to feed on naiad species and hydrilla at approximately the same rate
- Lack of selectivity means that stocking densities would need to be based on total vegetated acres or biomass
- Expectation that grass carp would eliminate 99% of submersed vegetation

3633 A of submersed native vegetation

Species recovered:
- Southern naiad*
- Slender pondweed*
- Nitella*
- Maidencane*
- Narrowleaf spatterdock*
- Floating heart (native aquatica)
- Native primrose
- Slender naiad
- Cabomba

*represent >98% of native vegetation

~~3633~~ A of submersed native vegetation

Species recovered:

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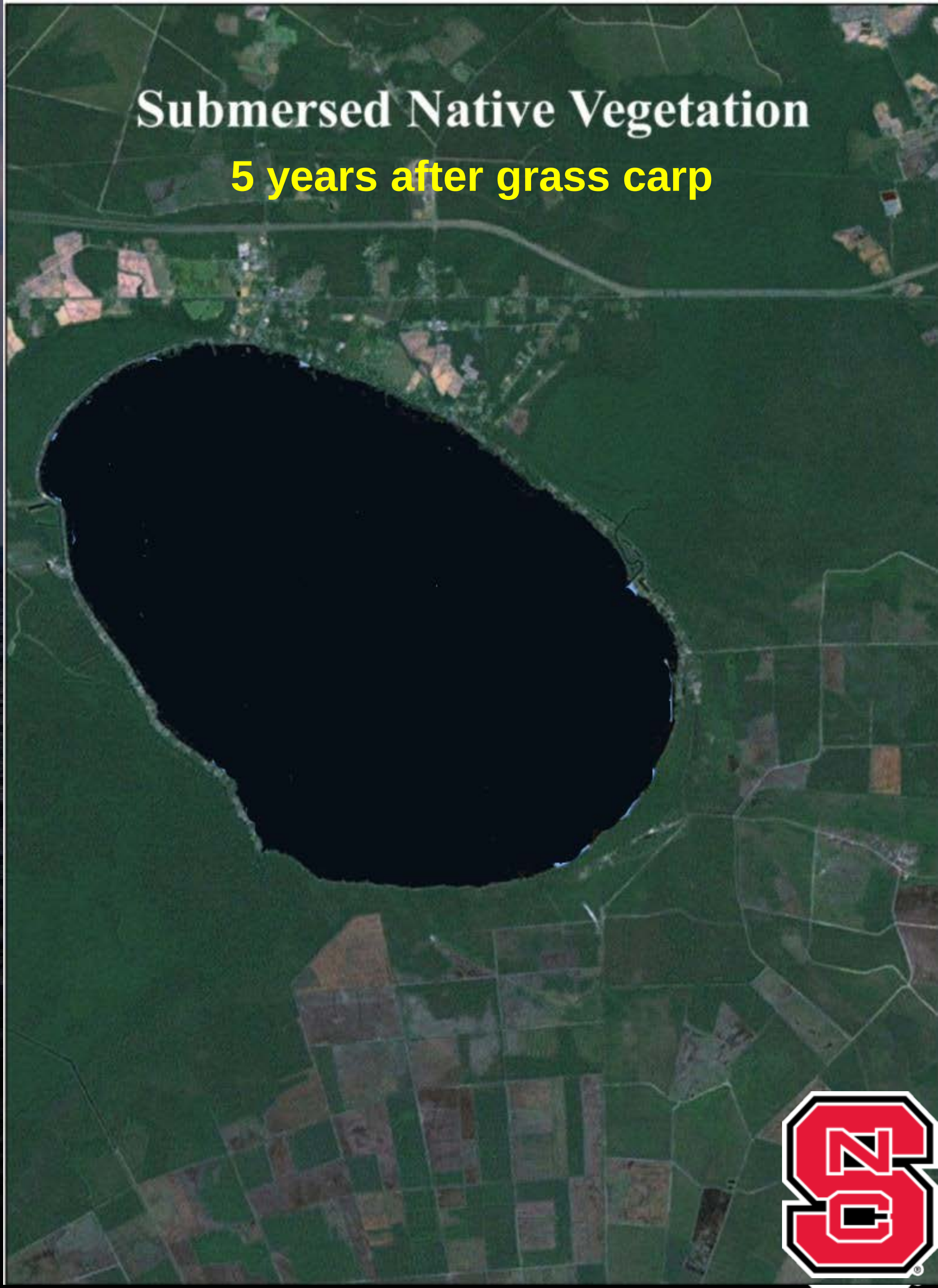
- ~~Cabomba~~

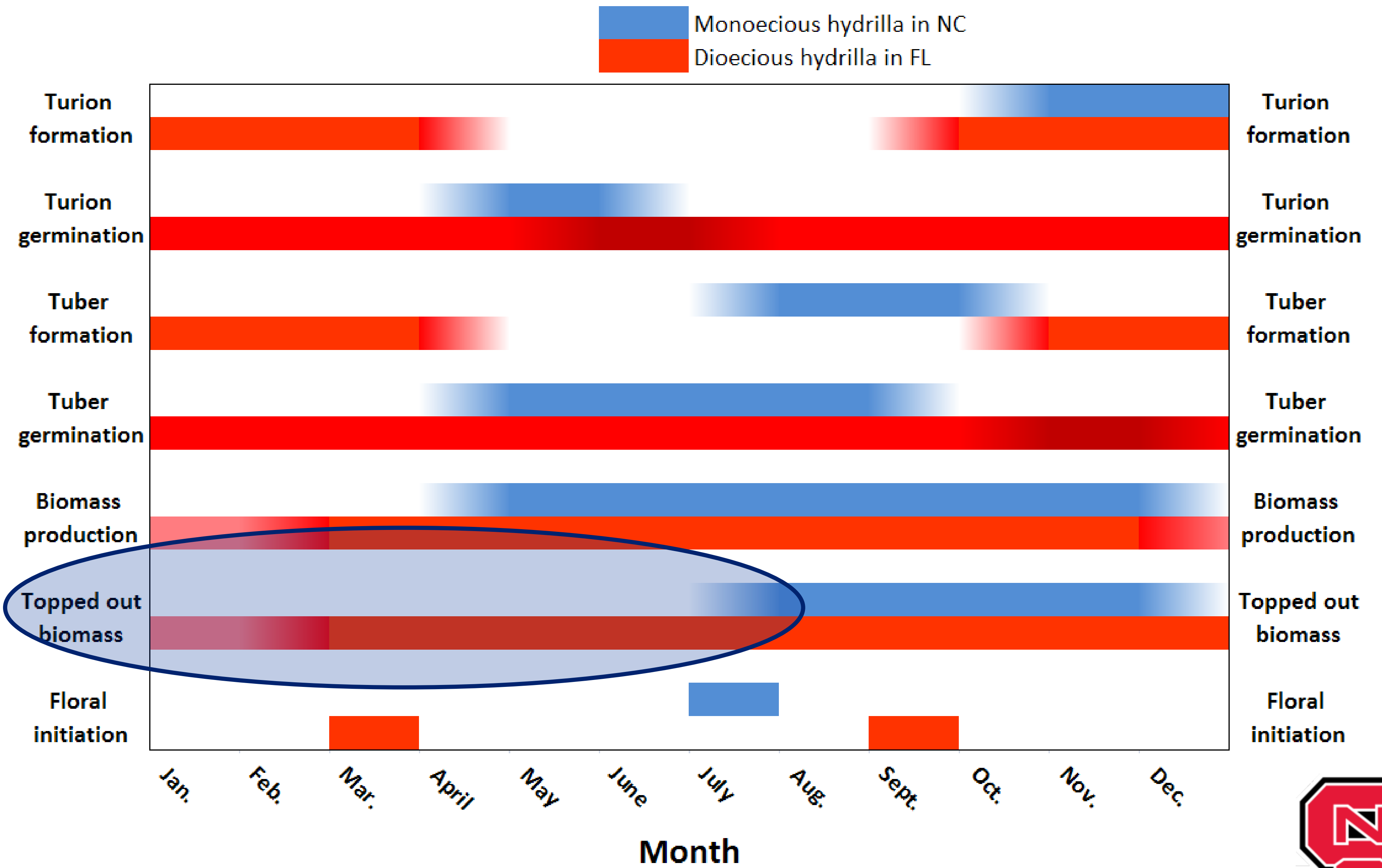
*represent >98% of native vegetation



Biological - Insects

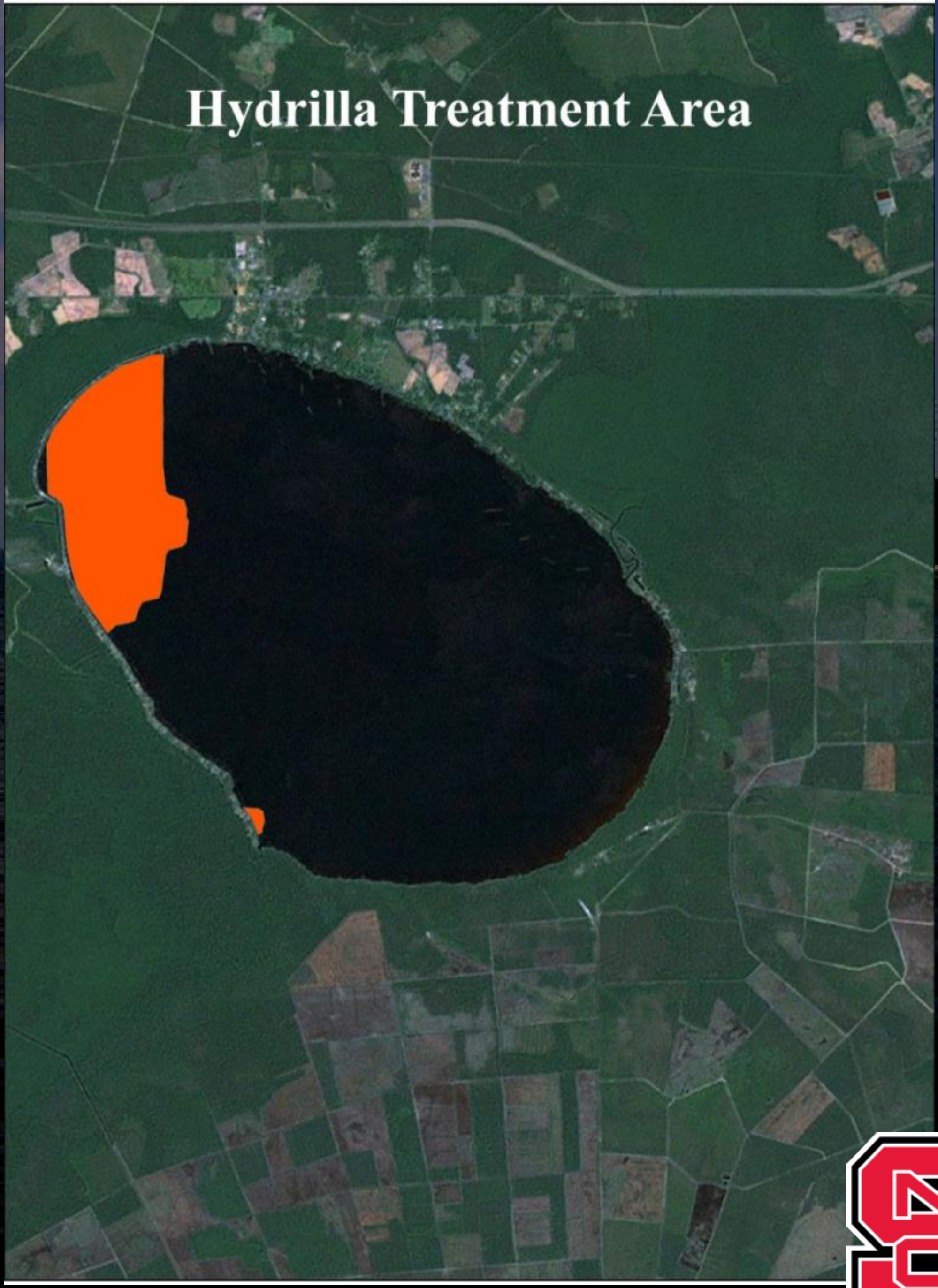
- No success to date in establishing insects for control of monoecious hydrilla
- Reasons:
  - No hydrilla biomass January – April
  - Hydrilla only topped out July – Dec.
  - Colder climate limits overwintering and reproduction
- Insects that require hydrilla biomass to overwinter should not be expected to control monoecious

Biotype Phenology



Modified from Harlan et al. (1985. J. Aquat. Plant Manage. 23:68-71).

2013 Herbicide treatment area of 959 A to control all known rooted infestations



337 acres of overlapping hydrilla and native species

416 acres of native plants in treatment area

Overview

- Aquatic herbicides are applied to water
- EPA considers this to be a “food use”
- Major considerations:
  - Off-target movement (water flow-through)
  - Irrigation
  - Drinking
  - Fishing
  - Swimming/recreation
  - Livestock use
  - Fish kills

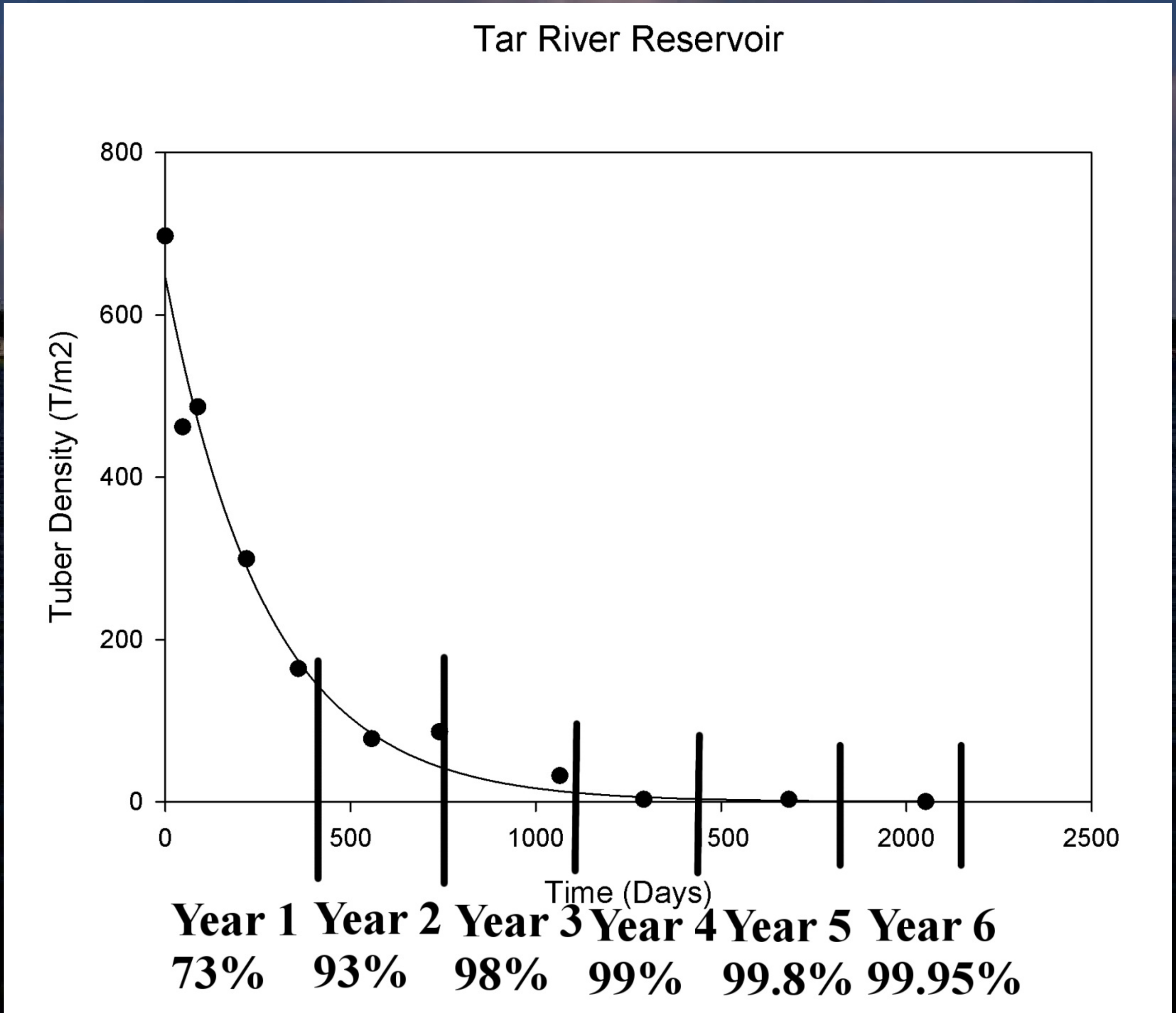
Chemical Options

- 2,4-D products
- Bispyribac
- Carfentrazone
- Copper products
- Diquat
- Endothall
- Flumioxazin
- Fluridone
- Glyphosate
- Imazamox
- Imazapyr
- Penoxsulam
- Peroxide products
- Triclopyr

Sonar (Fluridone)

- Historically, most used herbicide for hydrilla management
- Slow acting systemic herbicide that can kill whole plants
- Only ~5ppb required for hydrilla control
- Some plant selectivity at hydrilla rates
- Inhibits phytoene desaturase enzyme in plants, essentially non-toxic to non-plants
- Yearly applications documented to deplete tuber bank
- Difficult to use in flowing water
- Resistance now developing in Florida

Monoecious Tuber Declines



Contact Herbicides

- Diquat (Reward), Endothall, Flumioxazin, and copper products
- Burn back foliage, no affect on roots; hydrilla requires multiple treatments per year
- Especially useful for small areas around boat landings and docks; can be used for large scale treatments
- Copper may be toxic to mollusks so probably not an option for Waccamaw
- Good compliment for other methods

Cayuga Lake, NY

- Natural, glacial lake with important native submersed plants
- Hydrilla found late summer 2011
- NY and Ithaca started an eradication program
- Marina and boating access closed promptly
- Contact herbicide treatment fall 2011
- Fluridone herbicide treatment 2012
- Frequent, intensive surveys to detect spread
- Program effective so far with minimal impact outside of treatment area

Cayuga Lake, NY

Questions?

NC STATE UNIVERSITY

Aquatic Plant Management

Hypothetical Tuber Longevity