Aquatic Invasive Species

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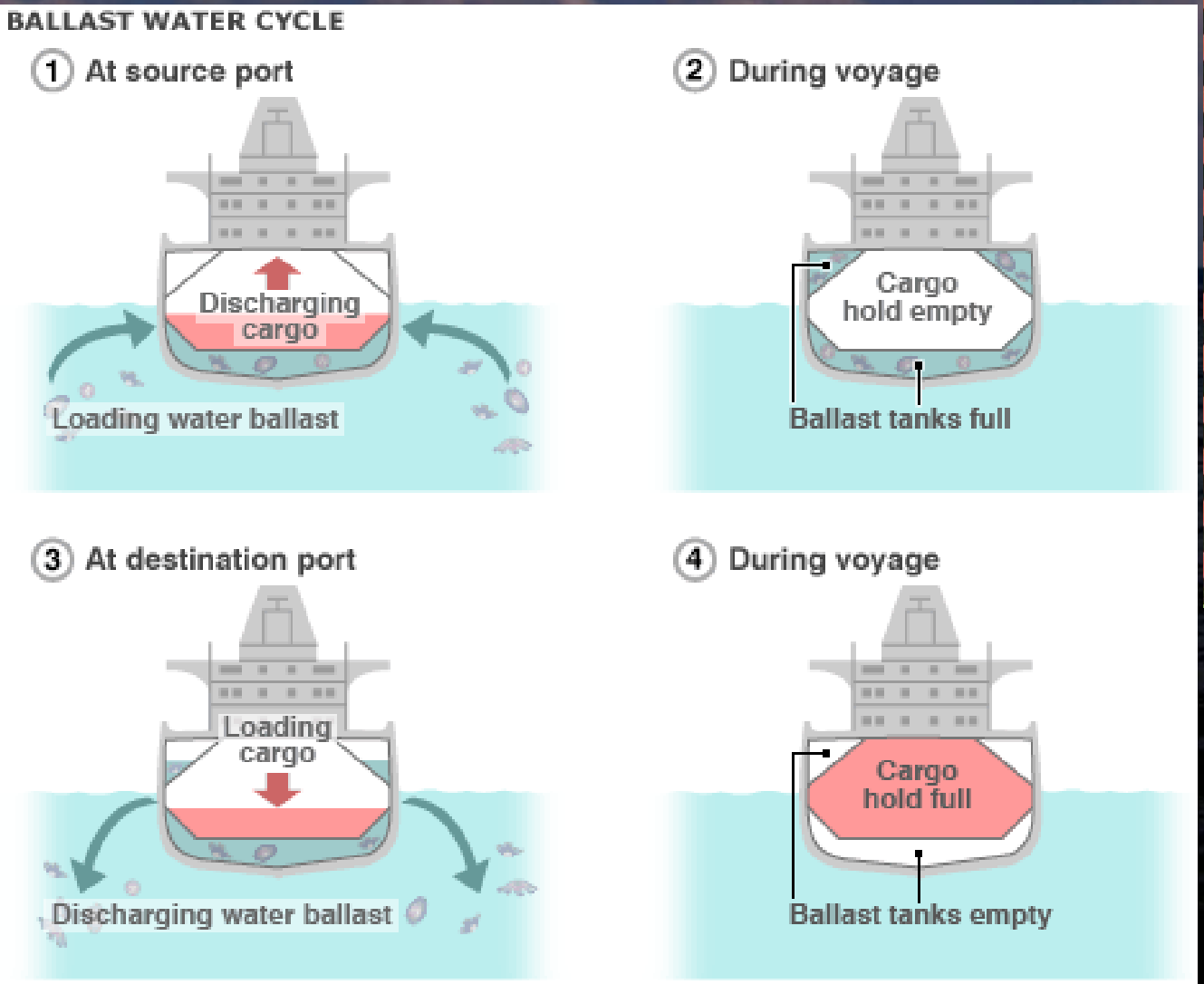
NC STATE UNIVERSITY
A&T STATE UNIVERSITY
COOPERATIVE EXTENSION
Helping People Put Knowledge to Work

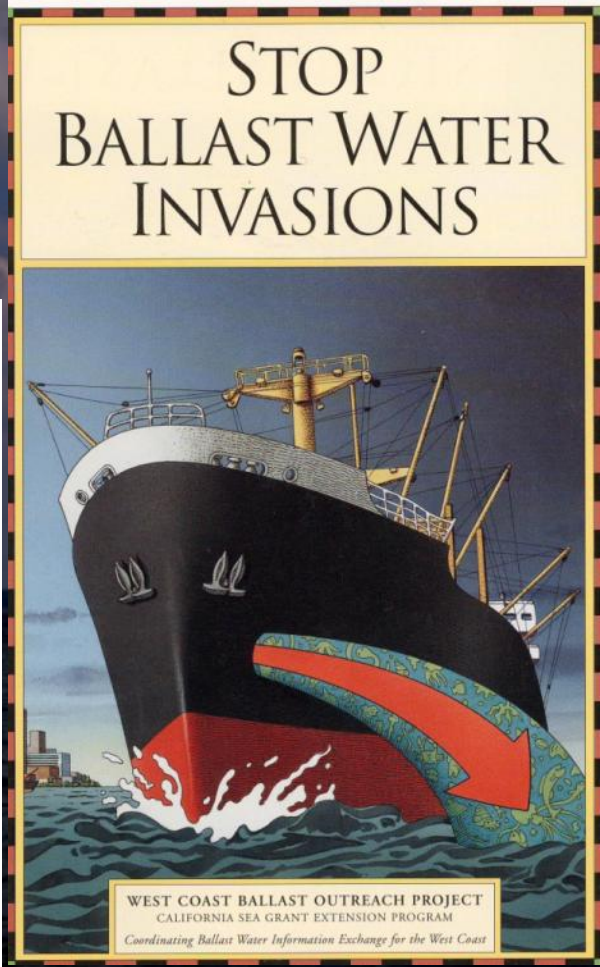
Top Aquatic Invasives

- Plants:
  - **Alligatorweed (*Alternanthera philoxeroides*)**
  - **Brazilian Waterweed (*Egeria densa*)**
  - **Caulerpa, Mediterranean Clone (*Caulerpa taxifolia*)**
  - **Common Reed (*Phragmites australis*)**
  - **Eurasian Watermilfoil (*Myriophyllum spicatum*)**
  - **Didymo (*Didymosphenia geminata*)**
  - **Giant Reed (*Arundo donax*)**
  - **Giant Salvinia (*Salvinia molesta*)**
  - **Hydrilla (*Hydrilla verticillata*)**
  - ~~**Melaleuca (*Melaleuca quinquenervia*)**~~
  - **Purple Loosestrife (*Lythrum salicaria*)**
  - **Water Chestnut (*Trapa natans*)**
  - **Water Hyacinth (*Eichhornia crassipes*)**
  - **Water Lettuce (*Pistia stratiotes*)**
  - **Water Spinach (*Ipomoea aquatica*)**

- Animals:
  - Alewife (*Alosa pseudoharengus*)
  - Asian Carps
  - Asian Swamp Eel (*Monopterus albus*)
  - Bullfrog (*Rana catesbeiana*)
  - Chinese Mitten Crab (*Eriocheir sinensis*)
  - Clubbed Tunicate (*Styela clava*)
  - Eurasian Ruffe (*Gymnocephalus cernuus*)
  - European Green Crab (*Carcinus maenas*)
  - Flathead Catfish (*Pylodictus olivaris*)
  - Lionfish (*Pterois volitans*)
  - Northern Snakehead (*Channa argus*)
  - New Zealand Mud Snail (*Potamopyrgus antipodarum*)
  - Nutria (*Myocastor coypus*)
  - Quagga Mussel (*Dreissena bugensis*)
  - Round Goby (*Neogobius melanostomus*)
  - Rusty Crayfish (*Orconectes rusticus*)
  - Sea Lamprey (*Petromyzon marinus*)
  - Sea Squirt (*Didemnum vexillum*)
  - Spiny Water Flea (*Bythotrephes longimanus*)
  - Veined Rapa Whelk (*Rapana venosa*)
  - Zebra Mussel (*Dreissena polymorpha*)

Aquatic Invasive Spread


BALLAST WATER CYCLE
1 At source port
Discharging cargo
Loading water ballast
2 During voyage
Cargo hold empty
Ballast tanks full
3 At destination port
Loading cargo
Discharging water ballast
4 During voyage
Cargo hold full
Ballast tanks empty
SOURCE: GloBallast


STOP
BALLAST WATER
INVASIONS
WEST COAST BALLAST OUTREACH PROJECT
CALIFORNIA SEA GRANT EXTENSION PROGRAM
Coordinating Ballast Water Information Exchange for the West Coast

AQUARIUM
Plants
Habitat Packages
Fish
The Algae Squad
The Shrimp Factory
Snails
Picotopes
Driftwood
Tools
CO2 Systems
Lights
Additives/Supplements
Fertilizers
Substrates/Heater
Filters & Pumps
Test Kits
Food
Medications
POND
Plants
Lilies & Lotus
Koi & Other Pond Fish

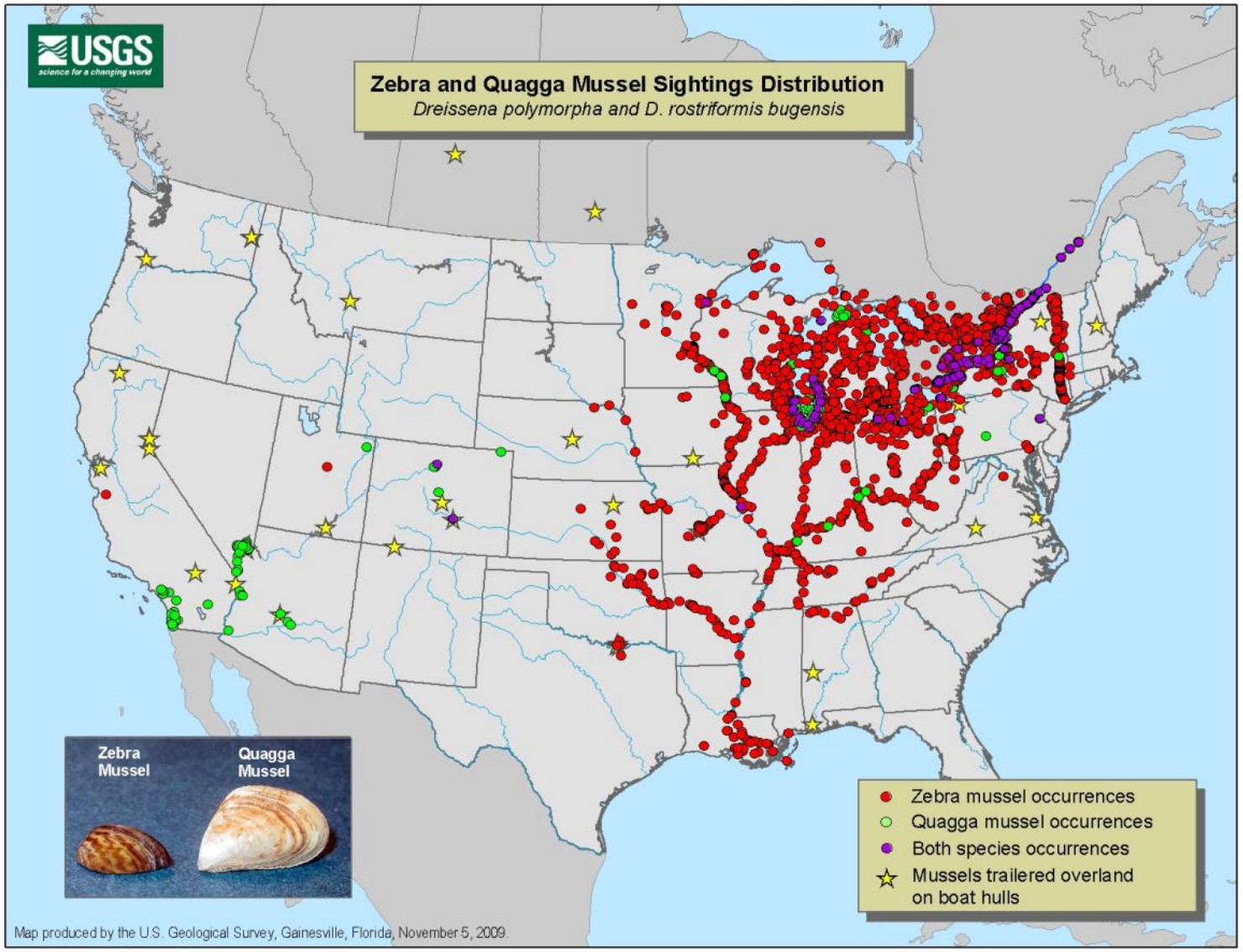
1	remove	Anacharis-XLG FORM	1	$2.49	$2.49
2	remove	Egaria najas	1	$1.98	$1.98
3	remove	Cabomba, Green	1	$1.58	$1.58
4	remove	Glossostigma	6	$1.98	$11.88
5	remove	Parrot's Feather	2	$0.98	$1.96
6	remove	Brazilian Pennwort	1	$1.98	$1.98
7	remove	Rotala, Indica	2	$0.98	$1.96
8	remove	Temple Plant	1	$1.98	$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

Zebra Mussels
(*Dreissena polymorpha*)

- Native to Eurasia
- Arrived in ballast water
- Prolific breeders
- Planktonic larval stage
- Each mussel can filter 1 gal. water/day
- Rapidly clears water
- 1 million/m^2 in portions of Lake Erie

Zebra Mussels

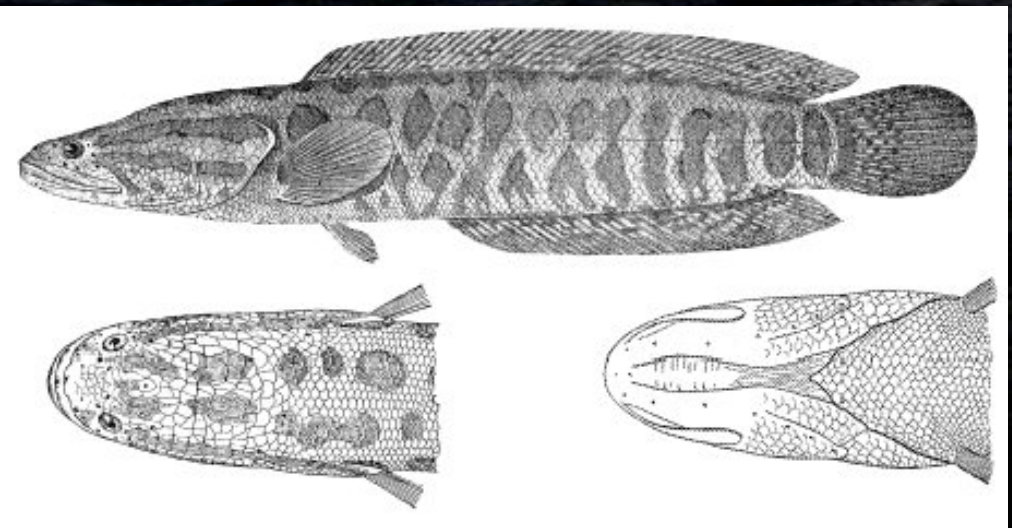
Zebra Mussels



Northern Snakehead

(*Channa argus*)

- Air-breathing
- Predatory
- 28 other snakehead spp.



Northern Snakehead
Distinguishing Features
Long dorsal fin • small head • large mouth • big teeth • length up to 40 inches • weight up to 15 pounds

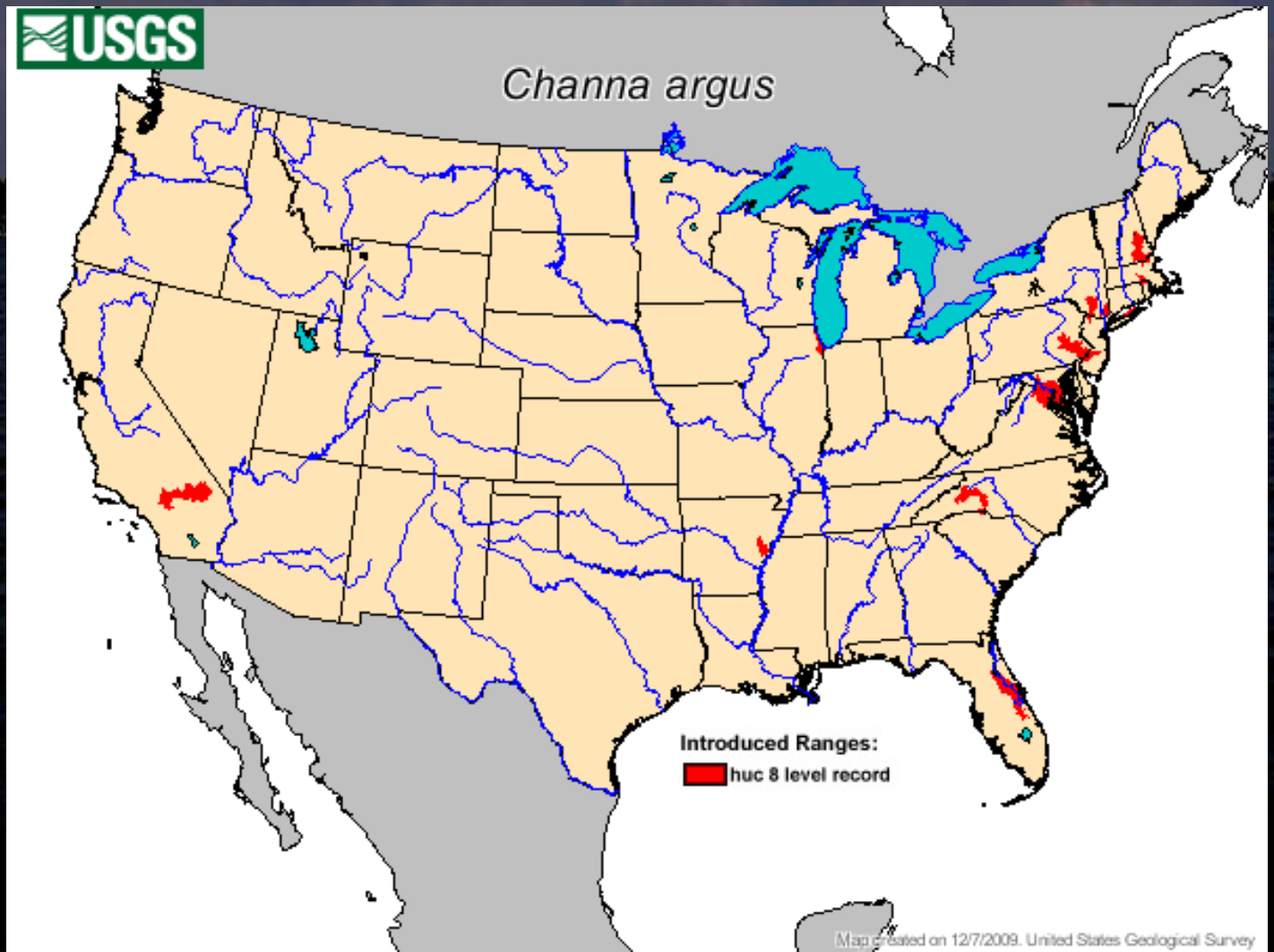
HAVE YOU SEEN THIS FISH?

The northern snakehead from China is not native to Maryland waters and could cause serious problems if introduced into our ecosystem.

If you come across this fish,
PLEASE DO NOT RELEASE.
Please KILL this fish by cutting/bleeding as it can survive out of water for several days and REPORT all catches to Maryland Department of Natural Resources Fisheries Service. Thank you.

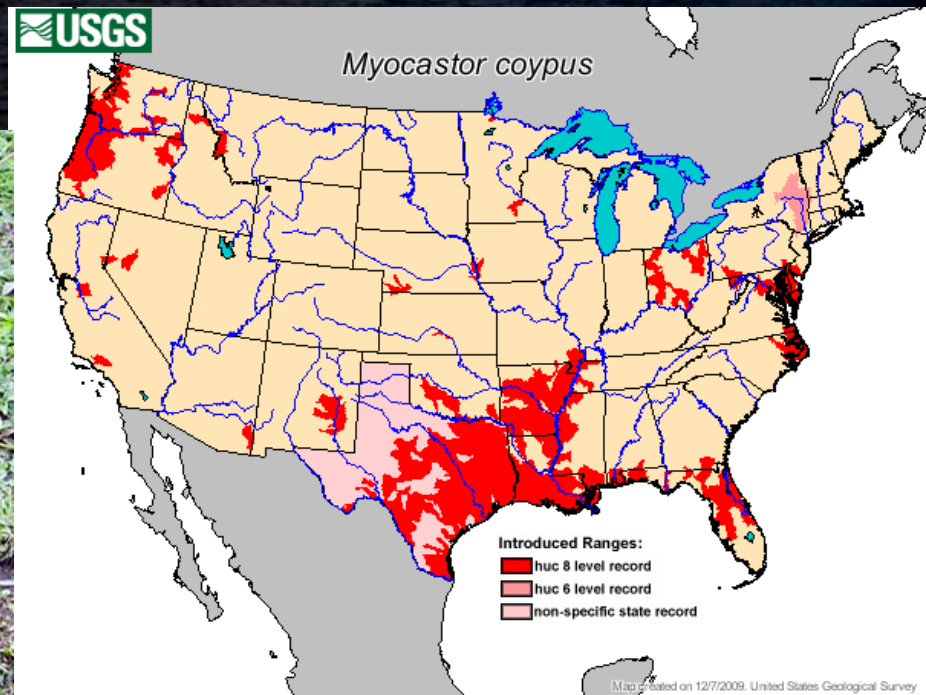
Phone: 410 260 8320
TTY: 410 260 8835
Toll Free: 1 877 620 8DNR (8367) Ext 8320
E-mail: customerservice@dnr.state.md.us

Northern Snakehead
(*Channa argus*)



Nutria
(Myocastor coypus)

- Large, semi-aquatic rodent
- Native to South America
- Destroy vegetation, crops, banks, etc.



Nutria Damage

Focus on 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

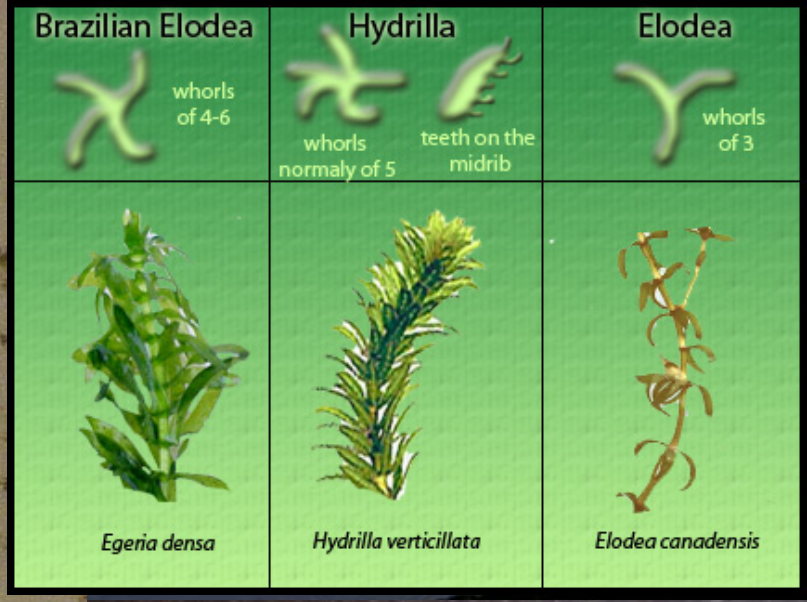
Hydrilla

Hydrilla verticillata

Egeria densa

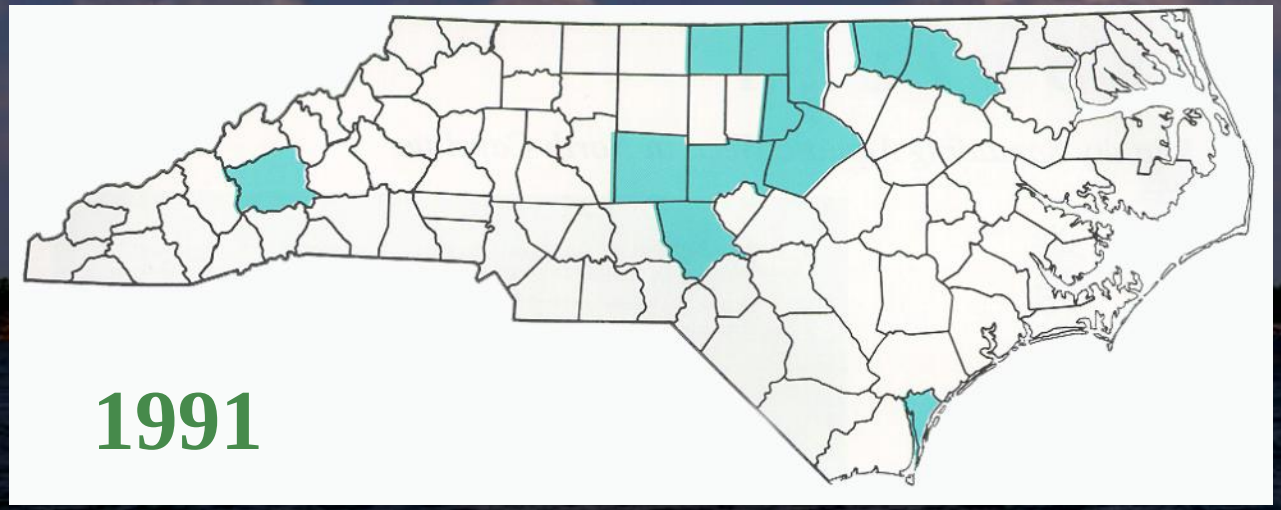
Hydrilla verticillata

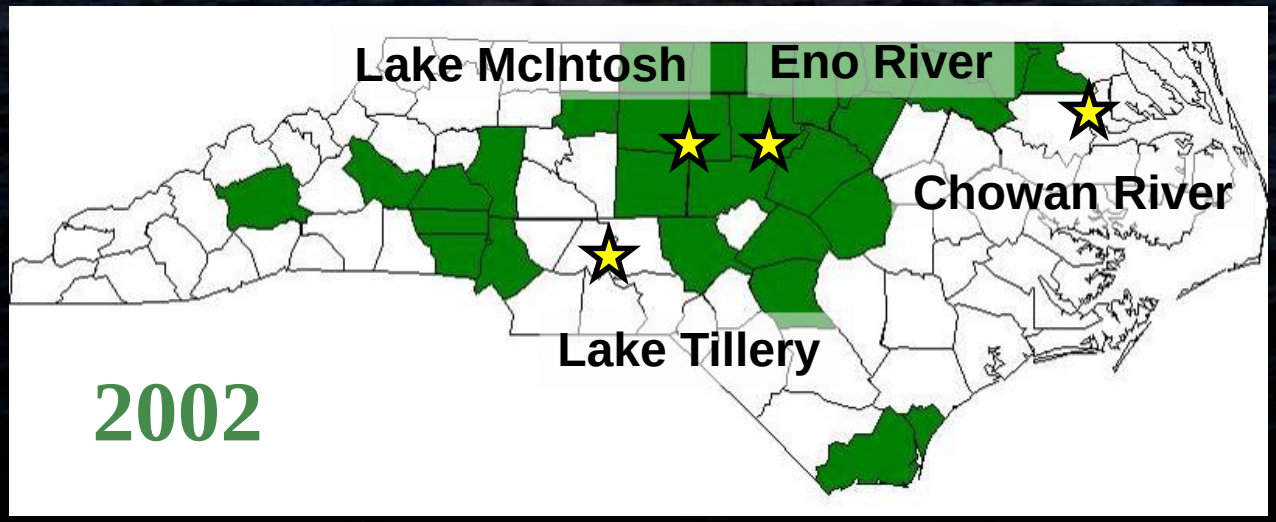
Hydrilla

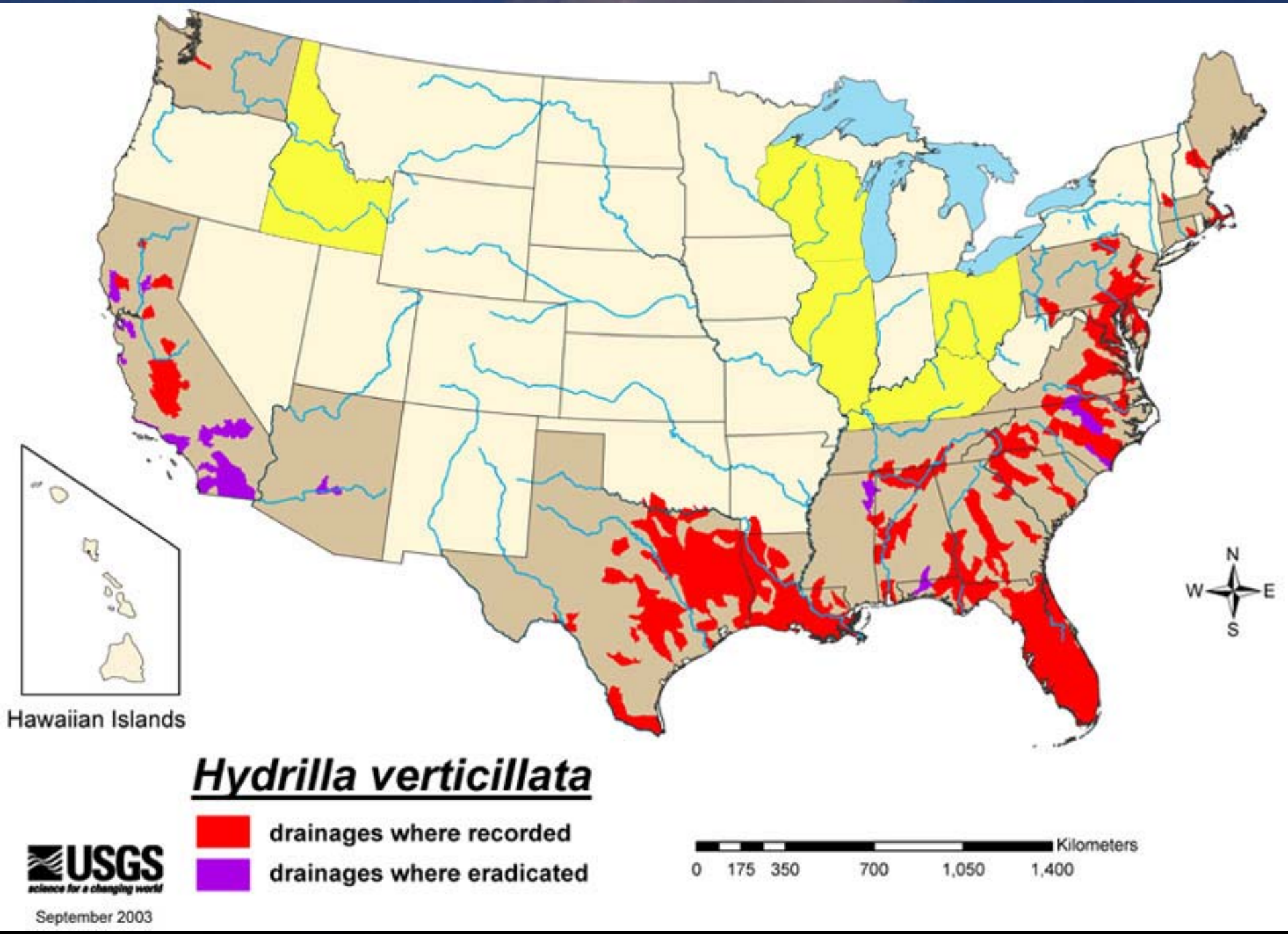


Egeria densa
(Brazilian Elodea)

Hydrilla Spread





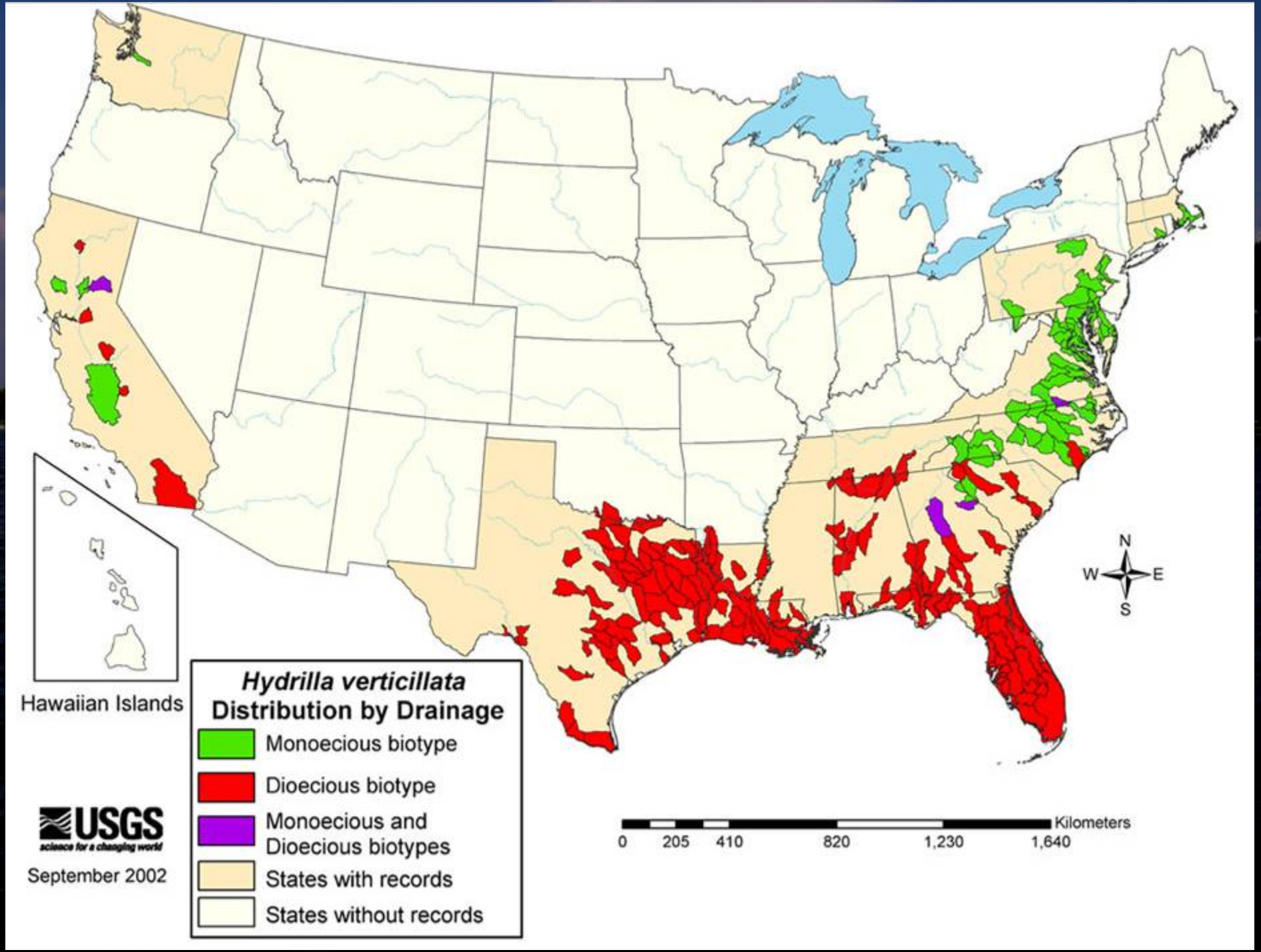

Hawaiian Islands
N
W
E
S
Hydrilla verticillata
drainages where recorded
drainages where eradicated
USGS
science for a changing world
September 2003
Kilometers
0 175 350 700 1,050 1,400

Hydrilla Turions

- Form main challenge to management
- Turion – an overwintering bud structure
- Hydrilla forms both axillary turions or subterranean turions (tubers)
- Tubers more commonly formed than turions
- Tuber longevity estimated to be 4+ years, but turions only 1 year
- Long-term management plans must consider and monitor the tuber bank

Biotypes

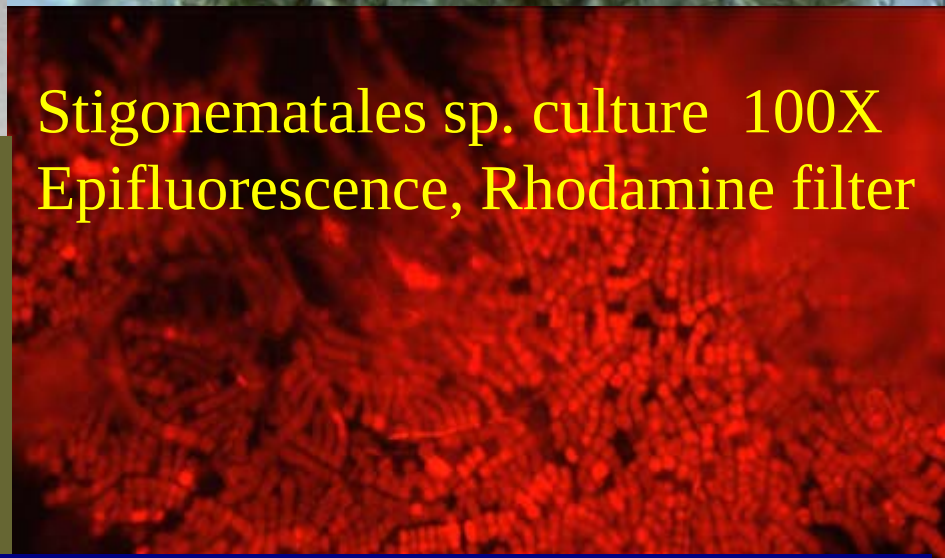
- Monoecious
  - Native to tropics
  - Introduced 1980's
  - Invading NC north
  - Less robust
  - Herbaceous perennial
  - May produce seed
  - Tubers:
    - Formed June – Nov.
    - Weight 36 to 77 mg
    - 200 – 1,228 / m^2
- Dioecious
  - Native to temperates
  - Introduced 1950's
  - Invading SC south
  - More robust
  - Root crown persists
  - No seed production
  - Tubers:
    - Formed Oct. – April
    - Weight 160 to 376 mg
    - 20 – 600 / m^2


Hawaiian Islands
Hydrilla verticillata
Distribution by Drainage
Monoecious biotype
Dioecious biotype
Monoecious and
Dioecious biotypes
States with records
States without records
USGS
science for a changing world
September 2002
N
W
E
S
0
205
410
820
1,230
1,640
Kilometers

Avian Vacuolar Myelinopathy

- Disease complex associated with dead of coots, bald eagles, and other birds
- Coots die within 5 days of first symptoms
- Bioaccumulates in birds
- Believed to be connection between hydrilla, cyanobacteria, and waterfowl
- Documented throughout southeastern US
- No long-term impact on grass carp

Stigonematales sp. culture
100X Light

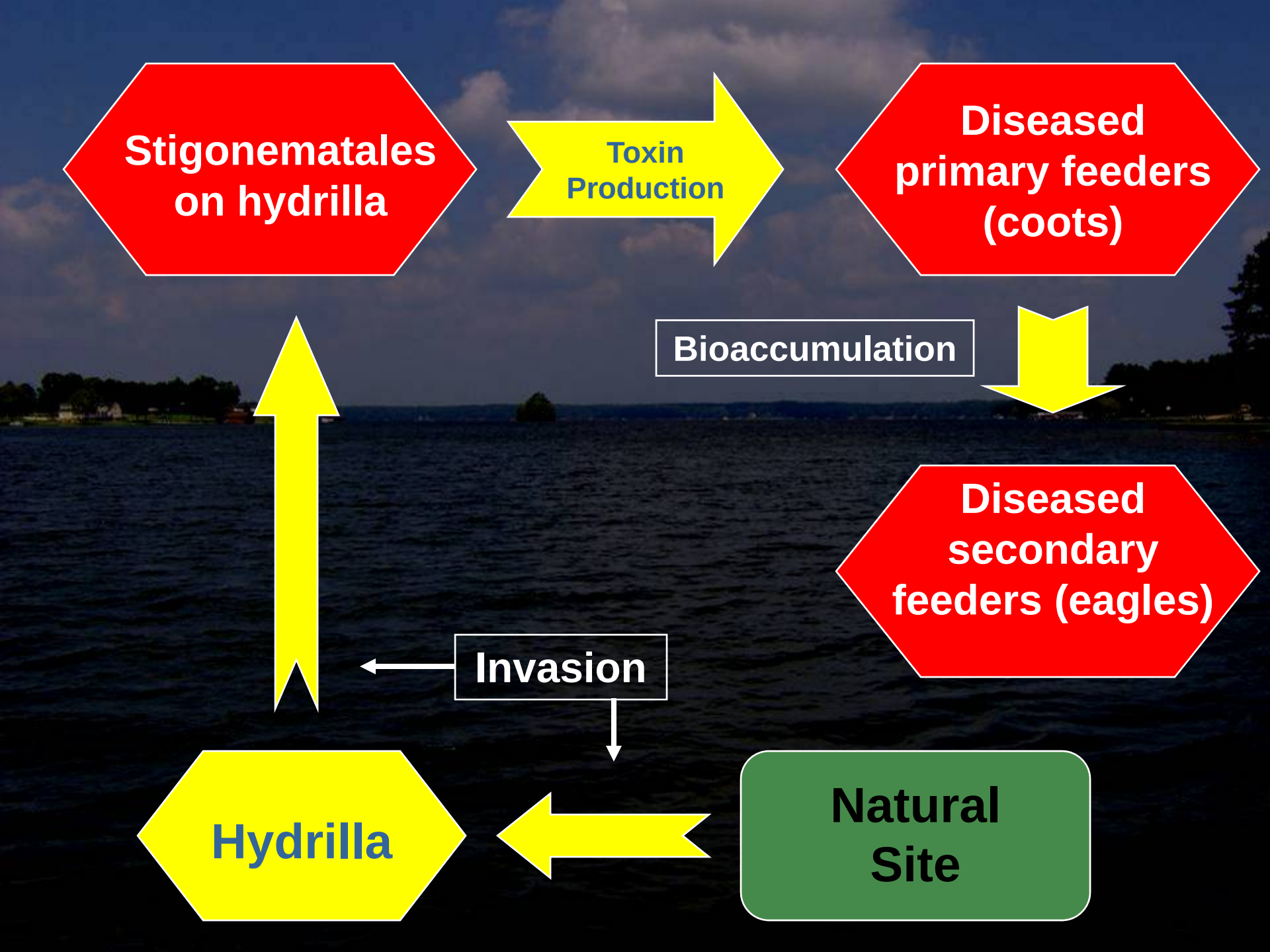


Stigonematales sp. culture 100X
Epifluorescence, Rhodamine filter

--Prime Suspect--

Stigonematales species--
Morphologically similar to 3 genera:
Hapalosiphon, *Fisherella*, or
Thalpophila

Williams, S.K., S.B. Wilde, J. Kempton, and Alan J. Lewitus. (in prep) A novel epiphytic cyanobacterium associated with reservoirs affected by Avian Vacuolar Myelinopathy. To be submitted to Phycologia.


Stigonematales on hydrilla
Toxin Production
Diseased primary feeders (coots)
Bioaccumulation
Diseased secondary feeders (eagles)
Invasion
Hydrilla
Natural Site

Hydrilla Management

- Ponds:
  - Stock grass carp
  - Use herbicides to supplement
- Lakes:
  - Can carp be used?
  - Use Sonar
  - Mechanical removal of floating mats
  - Hydrilla fly
  - Other methods

Grass Carp

- Main hydrilla control method in ponds
  - Cost-effective over lifetime (to 10 years)
  - Other vegetation not an issue
- Used extensively in Santee-Cooper Reservoirs in SC
- Cannot be used in all lakes due to feeding on native vegetation and resulting environmental impacts

Sonar (Fluridone)

- Most used herbicide for hydrilla management
- Slow acting systemic herbicide that will kill shoot and roots
- Some selectivity (only 5 ppb required)
- Repeat applications will deplete tuber bank
- Difficult to use in flowing water
- Resistance now developing in Florida

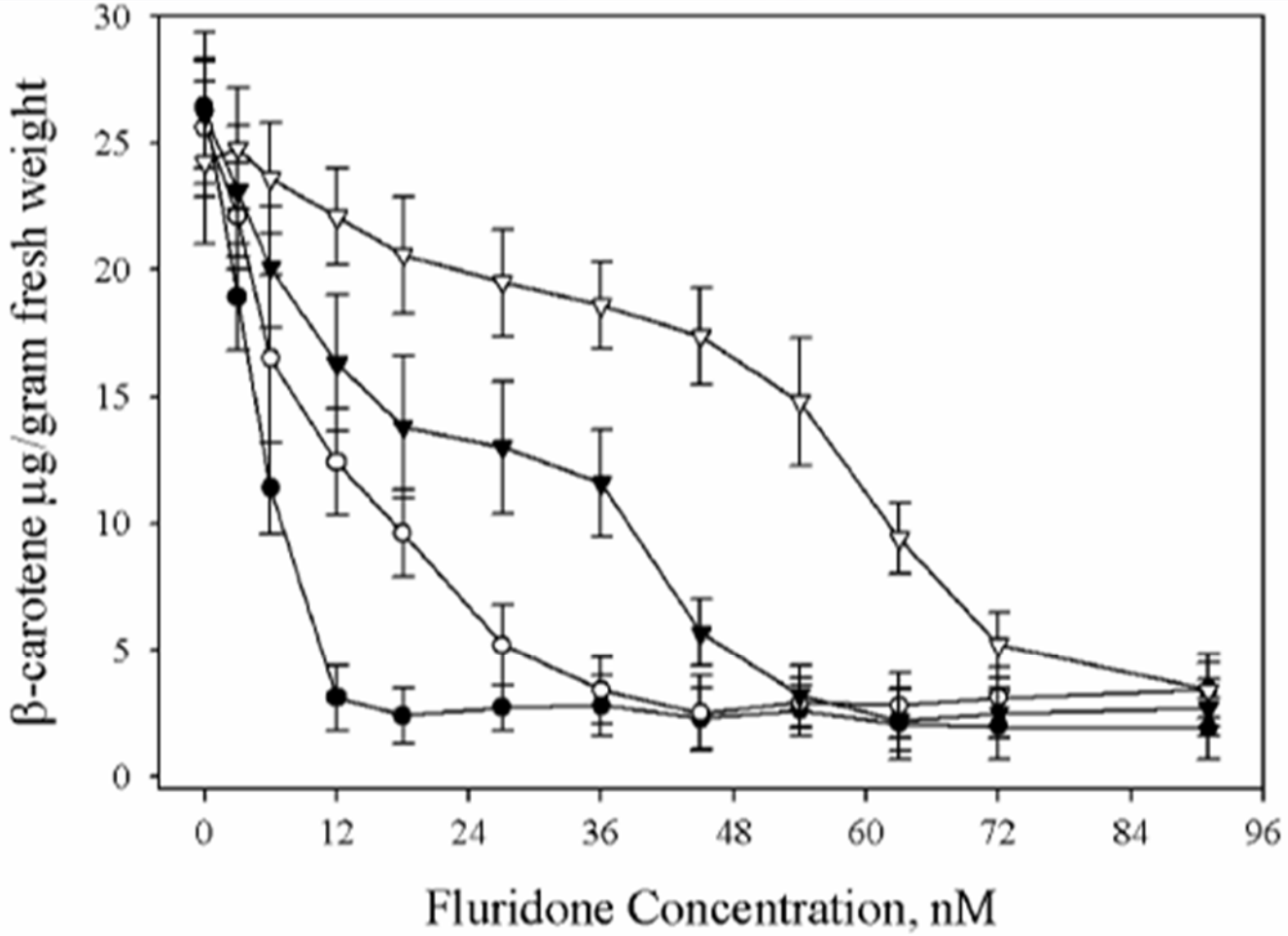


Fig. 3 Mean and standard deviations obtained from laboratory assays. β-carotene content of hydrilla shoot apices following a 14-day exposure to fluridone concentrations ranging from 0 to 91 nM. Phenotypes: ●, susceptible (179 lakes); ○, low resistance (eight lakes); ▼, intermediate resistance (seven lakes); and ▽, high resistance (five lakes).

Mechanical Harvesters

- Short-term hydrilla control only
- Fragmentation of plants will cause spread
- Expensive and time consuming
- Must have permit to dispose of hydrilla as it is a state and federal noxious weed
- Most effective for removal of floating mats in fall

Winter Drawdown

- May be used to supplement other management tools, but will not work alone
- Drawdown less effective on hydrilla than other aquatic species
- Tubers/turions can survive desiccation and have some cold tolerance

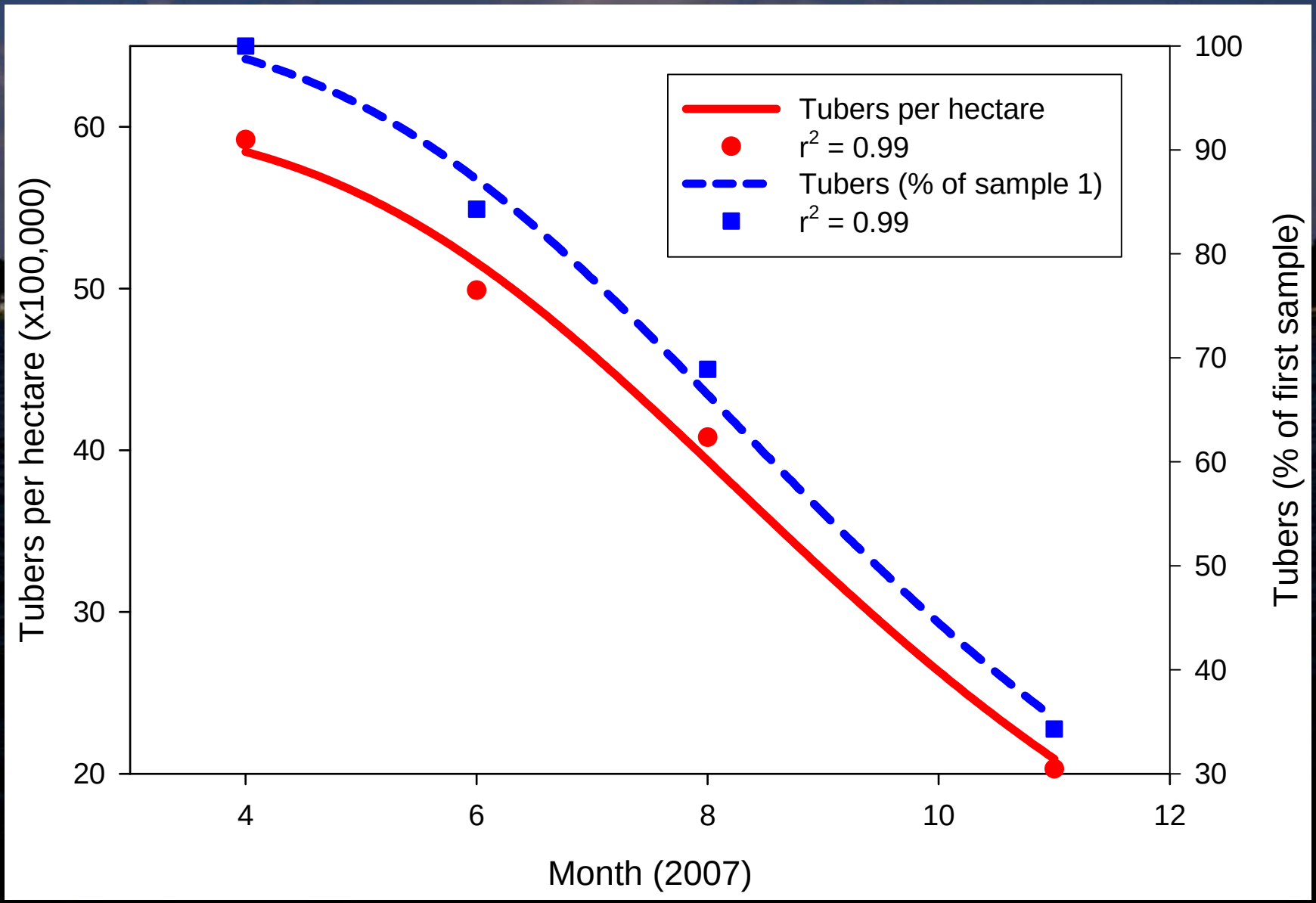
Contact Herbicides

- Diquat (Reward), Endothall, and copper products
- Burns back foliage, no affect on roots
- Can be useful around boat landings and docks
- Copper sulfate is cheap and often misapplied
- Good compliment for other methods

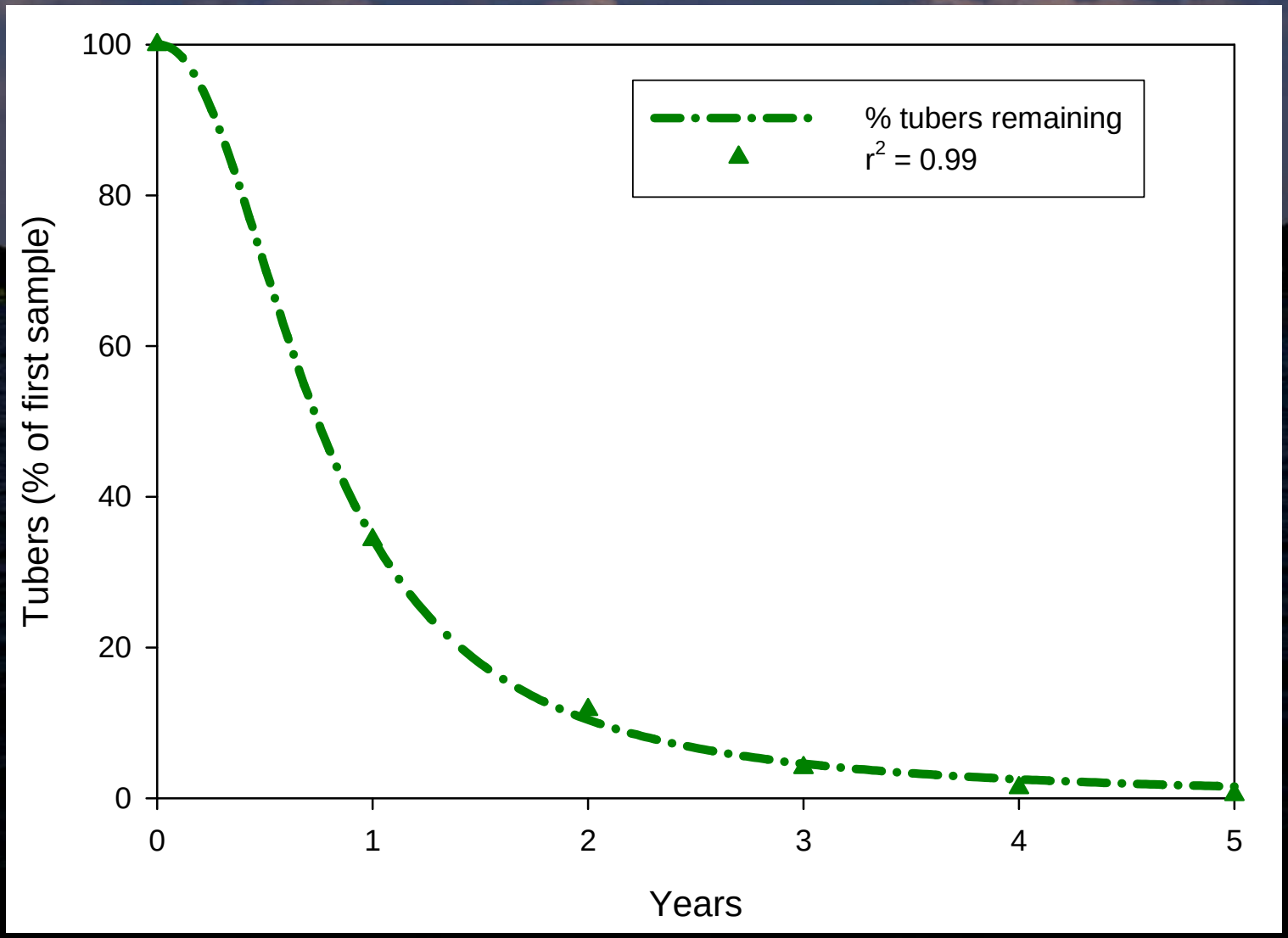
Methods in Development

- New herbicides
  - Other systemic herbicides
  - New labels in 2007
- Bioherbicide
  - Effective on hydrilla and some other submersed invasives
  - Label possibly in 2008
- Other biologicals

2007 Tar River Tuber Counts



Hypothetical Tuber Longevity
Assuming 66% Yearly Mortality



Giant Salvinia

- Free-floating fern
- Descending spore capsules do not produce viable spores
- Pubescent leaves with egg-beater shaped hairs
- May double in biomass in 2 days
- About 10 A infested near Wilmington

Giant Salvinia

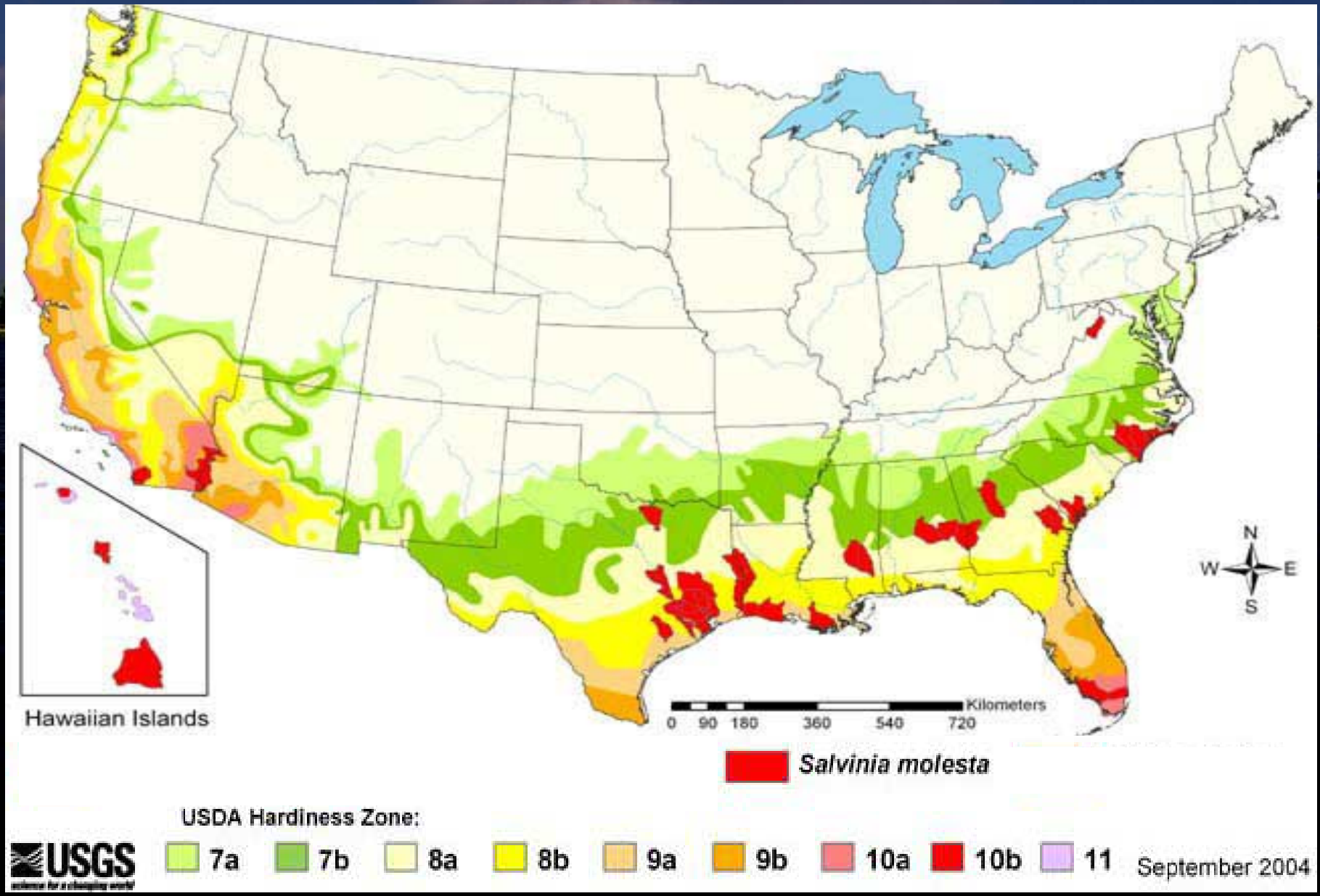
Salvinia molesta

Molesta vs. *Minima*

Characteristic Egg-Beater shaped hairs of *Salvinia molesta*

Leaf hairs of *Salvinia minima* branch but do not rejoin as do *molesta*

US Distribution and Range Prediction



Salvinia On Ice, 1/27/03

NC Salvinia History

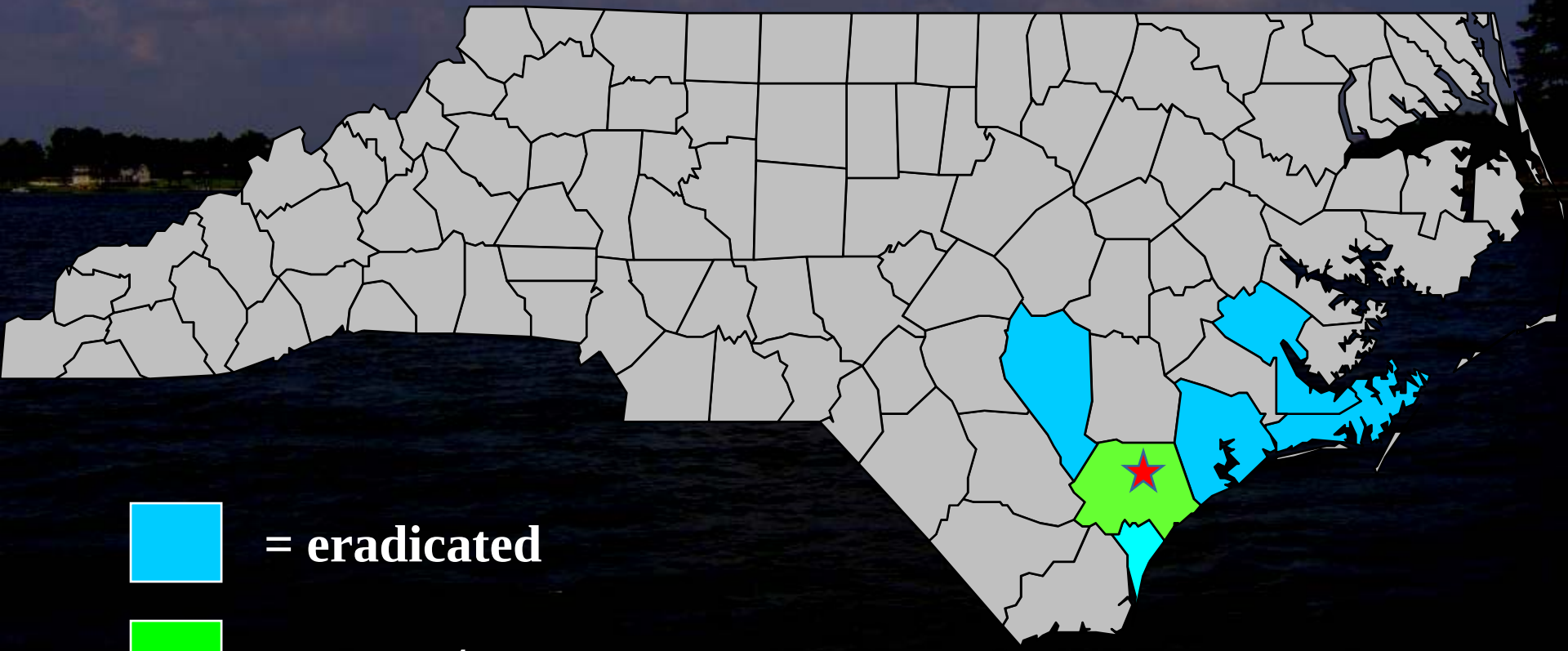
1998: found in Wake County (NC State Fair)

2000: confirmed in Brunswick, New Hanover, Pender, and Onslow counties

2004: Sampson and Craven counties added to infestation list

- Maximum salvinia infestation reached 10 sites and 40 acres
- The Southeast North Carolina Giant Salvinia Task Force was formed to develop and implement an eradication program

North Carolina
Fall 2007 Distribution



= eradicated

= present

* Currently 1 site with <5 acres

NC Giant Salvinia Task Force

- Cooperative effort of:
  - NC Cooperative Extension
  - NCDA
  - NC Dept. of Environment & Natural Resources
  - NCSU
  - SePRO Corporation
  - USGS
- Funding obtained from National Fish and Wildlife Foundation – Pulling Together Initiative

Salvinia Treatment

- Three methods used:
  - Herbicides
  - Biocontrol: salvinia weevil (*Cyrtobagous salviniae*)
  - Limited hand removal
- Infested sites were considered eradicated if no salvinia was found for at least one year after last treatment

Salvinia Weevil

- Weevils collected in TX and shipped to NC by NCDA
- Infested pond adjacent to the Riverbend site was selected for release
- Pond was not treated with herbicides for two years after release
- The salvinia weevil survived and overwintered, but failed to reduce salvinia populations
- Weevils were more effective in controlling salvinia in full sunlight than in shade

Current Site

Questions?

NC STATE UNIVERSITY

Aquatic Weed Management

Asian Carp

- Several species of Asian carp