

Invasive Species



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EO 13112 Definition

“Invasive Species ~ nonnative species whose introduction does or is likely to cause economic or environmental harm or harm to human health.”

Cost to U.S. Economy

- Billions annually.
- 79 animal and plant species, 1906 to 1991: \$79 B.
- 15 recent introductions could cost the U.S. \$134 B by 2050.
- Sea lamprey control costs (U.S. and Canada): >\$12 M/year
- Purple loosestrife management cost and lost forage value: \$45 M/year
- Expenditures by 6 federal agencies related to weeds: \$11 M/year
- Present worth of decreased economic value of sport and commercial fisheries in the U.S. Great Lakes attributable to a fully developed ruffe population: \$119 M.
- Annual zebra mussel control/adaptation costs incurred by major raw water users in the Great Lakes : \$30 M/year
- Lost productivity of rangelands due to weeds: \$3.6 to \$4.5 B annually.
- Lost productivity of 64 crops due to weeds, 1984: \$7.8 B.

Rate of Introductions of NIS

- OTA Report (1993) concluded the rate of harmful introductions appeared stable.
- 1980-1993 (OTA 1993) -- 200
- Number expected to be harmful -- 59
- San Francisco Bay/Inland Delta
 - 1850-1995 -- average of one every 36 weeks
 - 1970-1995 -- average of one every 24 weeks
 - 1985-1995 -- average of one every 12 weeks

Number of non-indigenous species in selected ecosystems:

- San Francisco Bay/Inland Delta, CA--234 species (+ up to 123 others).
- Great Lakes--139 species
- Hudson River, NY--154 species
- Coos Bay, OR--67+ species
- Florida inland waters--154+ species
- Chesapeake Bay--120+ species
- Hawaii--4,465 species
- U.S. (OTA 1993) -- 4,500+
- Proportion causing serious harm -- 15%

Weeds

- 100 million acres infested, infestation expanding at 10 million acres per year.
- Rate of infestation of Federal lands by weeds: 4,600 acres per day.
- Annual expenditures by six Federal agencies related to weeds: \$11 million
- FWS lands outside Alaska infested: 1.4 million acres.

Endangered Species

- 42% of listed species are significantly impacted by NIS.
- Major cause of decline of species and significant impediment to recovery.

Zebra Mussels

Introduced in 1986 into Lake St. Clair near Detroit in ballast water discharges; now infest waters from Vermont to Oklahoma and Ontario to the Gulf of Mexico.

- Great Lakes water users spend \$30 million annually to monitor and control zebra mussels.
- Causing massive changes in the Great Lakes ecosystem, including elimination of native mussels and toxic algae blooms
- Substantial concern about impacts on fishery resources and fishery restoration efforts.

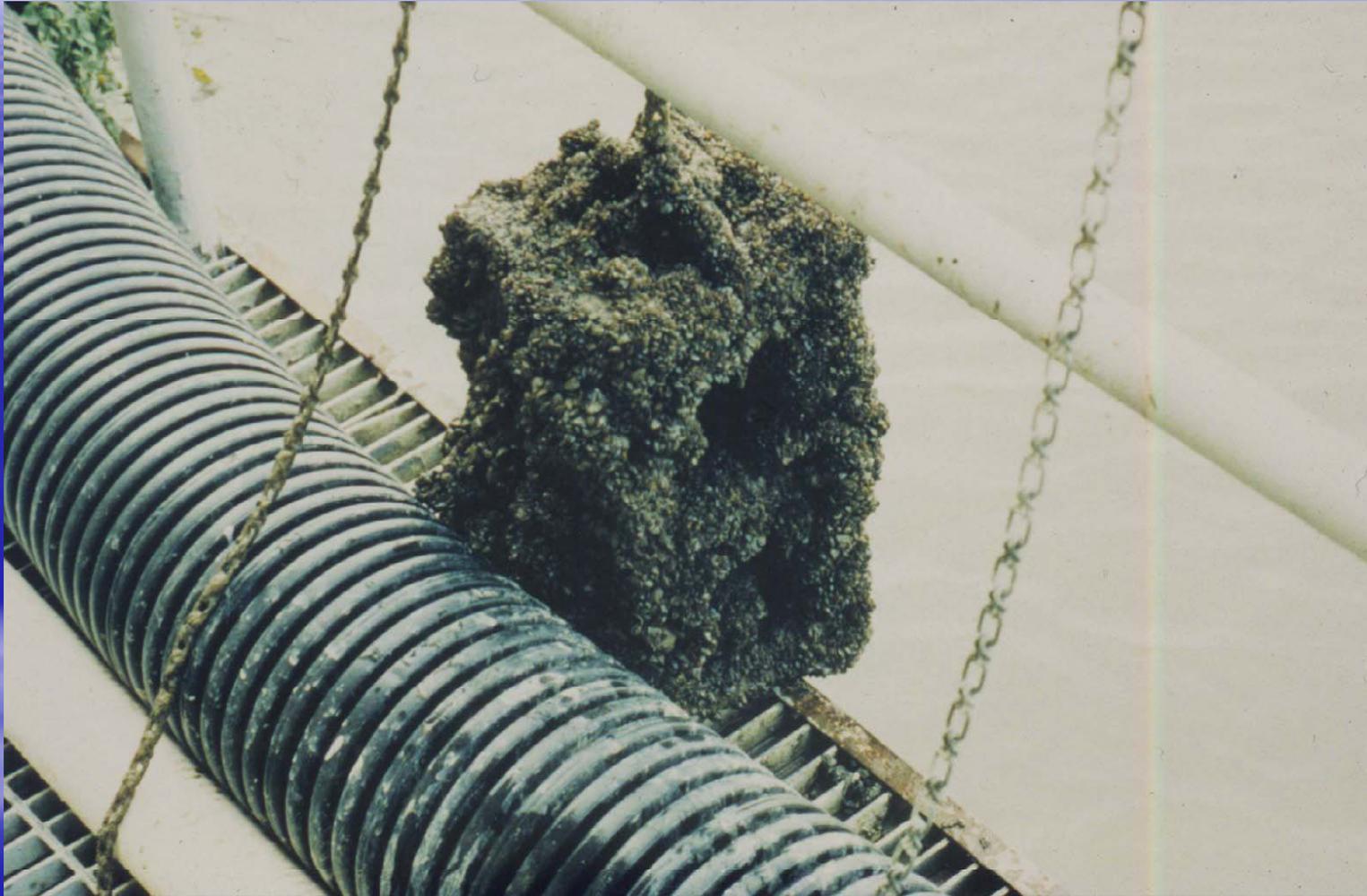
Byssal Threads



Inside Pipe



Recovered Concrete Block



Recovered Car



Oologah Lake ~ Native Mussel



Zebra Mussel on Crayfish



Oologah Lake ~ Shells on Shoreline



Oologah Lake ~ Toy Watergun



Authorities

- Nonindigenous Aquatic Nuisance Prevention & Control Act of 1990 (Amended through P.L.106-580, 29 Dec 2000)
- National Invasives Species Act of 1996 (P.L. 104-332)
- Invasive Species Executive Order 13112, 3 Feb 1999

Zebra Mussel Environmental Tolerances

VARIABLES	HIGH	MODERATE	LOW	VERY LOW
Dissolved Oxygen (ppm)	8 – 10	6 – 8	4 – 6	<4
Water Temperature (C/F)	18/64 – 25/77	16/61 – 18/64 25/77 – 28/82	9/48 – 25/77 28/82 – 30/86	<8/46 >30/86
Total Hardness (mg CaCO₃/l)	90 – >125	45 – 90	25 – 45	<25
Calcium (ppm)	25 – 125	20 – 25	9 – 20	<9
pH	7.5 – 8.7	7.2 – 7.5 8.7 – 9.0	6.5 – 7.2	<6.5 >9.0
Salinity (ppt)	0 – 1	1 – 4	4 – 10	10 – 35
Conductivity (μ Siemens)	83 – >110	37 – 82	22 – 36	>22
Turbidity (secchi disk cm)	40 – 200	20 – 40	10 – 20 200 – 250	<10 >250
Water Velocity (m/sec)	0.1 – 1.0	.09 – 0.1 1.0 – 1.25	.075 - .09 1.25 – 1.5	<.075 >1.5

From European & North American Sources
Mar 96

C.O'Neill, NY Sea Grant,

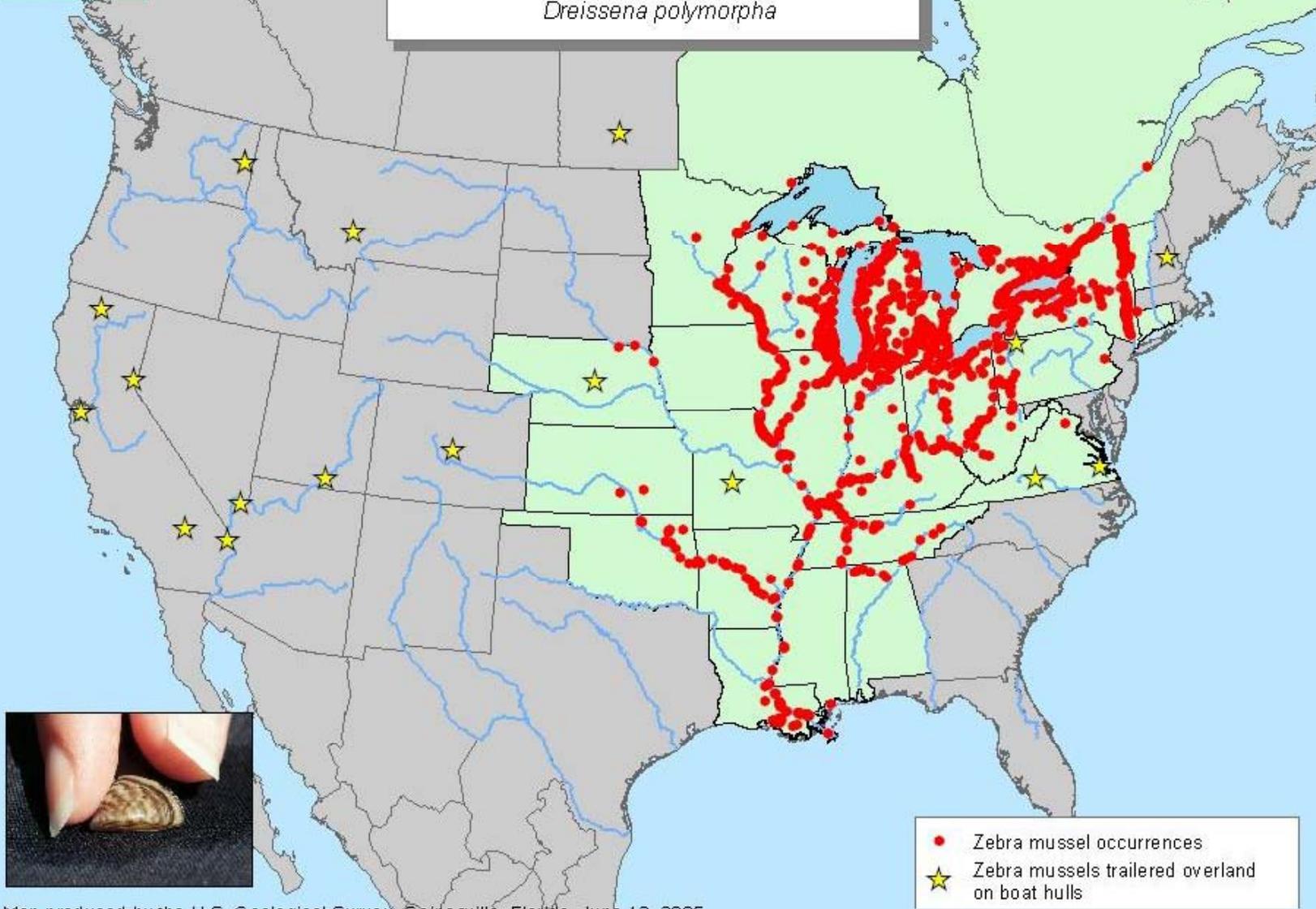
Historical Biology

Cold-water species.

- Spawn 1 or 2 times per season.
- Spawn from 54° to 80° F.
- Become stressed at 86° F, die within a few weeks.
- Die within 5 hours at 90° F.
- Grow @ 3mm/mo w/ @ 1 cm per year.
- Filter 1 liter of water per day.

Zebra Mussel Sightings Distribution

Dreissena polymorpha



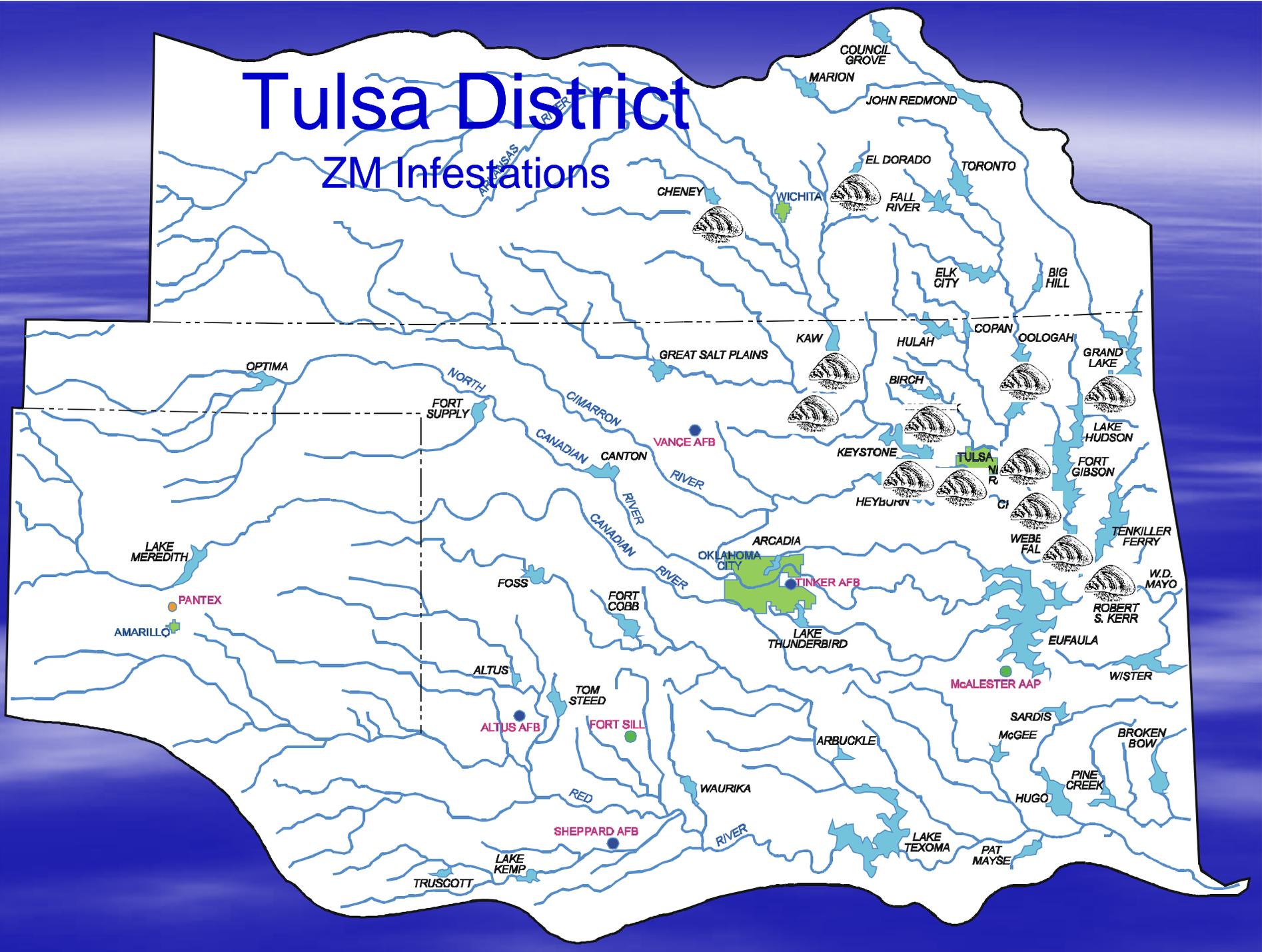
Map produced by the U.S. Geological Survey, Gainesville, Florida, June 13, 2005.

Tulsa District Infestation History

1. Jan 1993 ~ W.D. Mayo, R.S. Kerr, and Webbers Falls locks (Arkansas River)
2. June 1993 ~ Chouteau Lock (Verdigris River)
3. Jan 1994 ~ Newt Graham Lock (Verdigris River)
4. June 2003 ~ Oologah Lake (Verdigris River)
5. June 2003 ~ Lynn Lane Lake & A.B. Jewell Lake (Tulsa water supply)
6. Aug 2003 ~ El Dorado Lake, KS (Walnut River)
7. July 2004 ~ Kaw Lake (Arkansas River)
8. Aug 2004 ~ Cheney Lake, KS (one veliger)(Witchita water supply)
9. Oct 2005 ~ Keystone Lake (Arkansas & Cimarron Rivers)
10. May 2006 ~ OG&E Sooner Lake (cooling-water supply)
11. June 2006 ~ Skiatook Lake (Hominy Creek)(only one at dam)
12. June 2006 ~ Zink Lake in Tulsa (Arkansas River)
13. July 2006 ~ Grand Lake (Grand/Neosho River)(none found since)
14. & GRDA Chouteau Powerplant (cooling-water supply)
15. Oct 2006 ~ Lake Texoma (ZM on boat at Highport Marina)
16. Mar 2007 ~ Lake Texoma (QM shells on boat at Eisenhower Yacht Club)
17. Aug 2007 ~ Skiatook Lake (12 at the dam)
18. Sep 2007 ~ Cheney Lake, KS (Witchita water supply)

Tulsa District

ZM Infestations

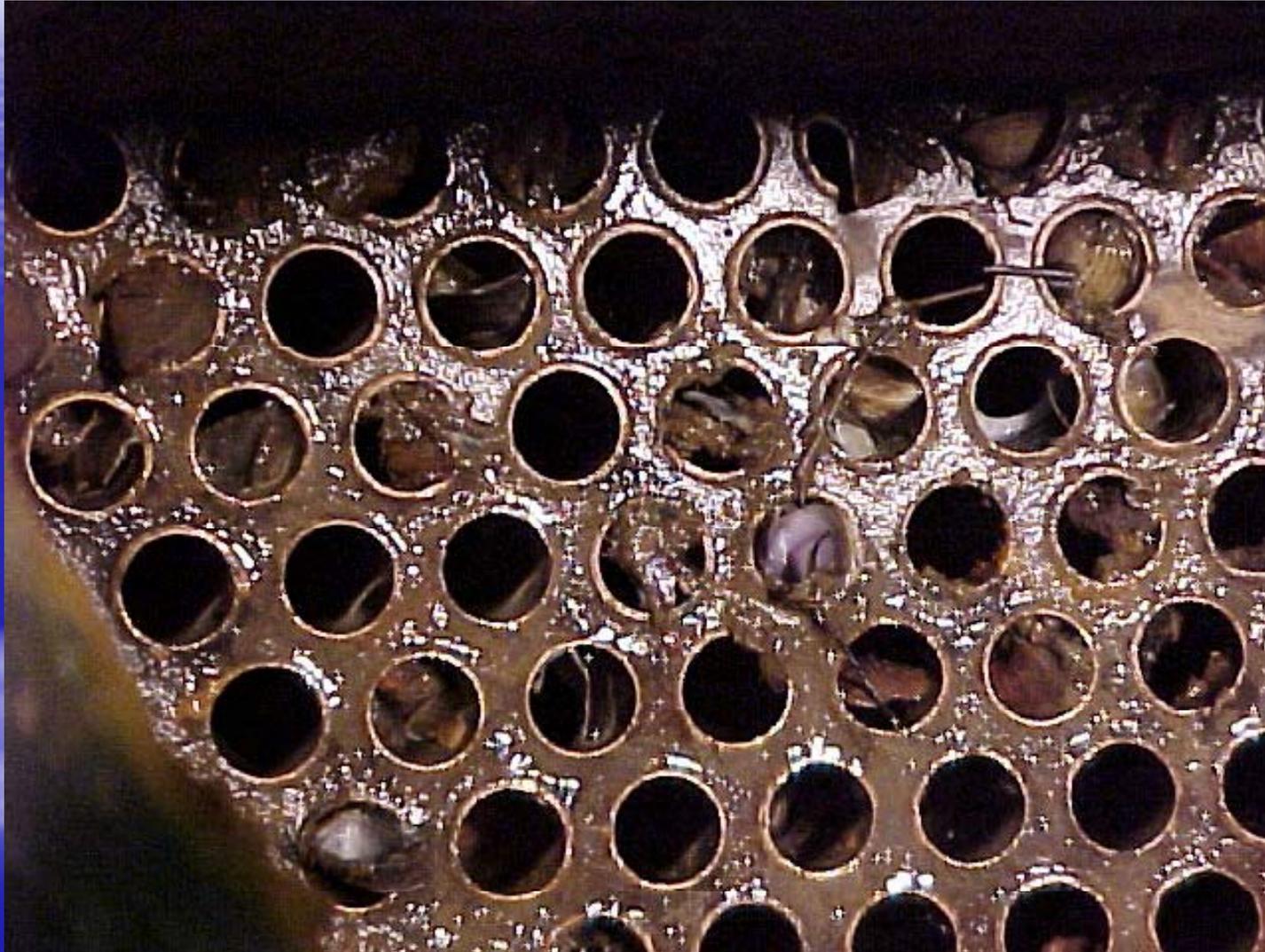


Northeastern State University Study

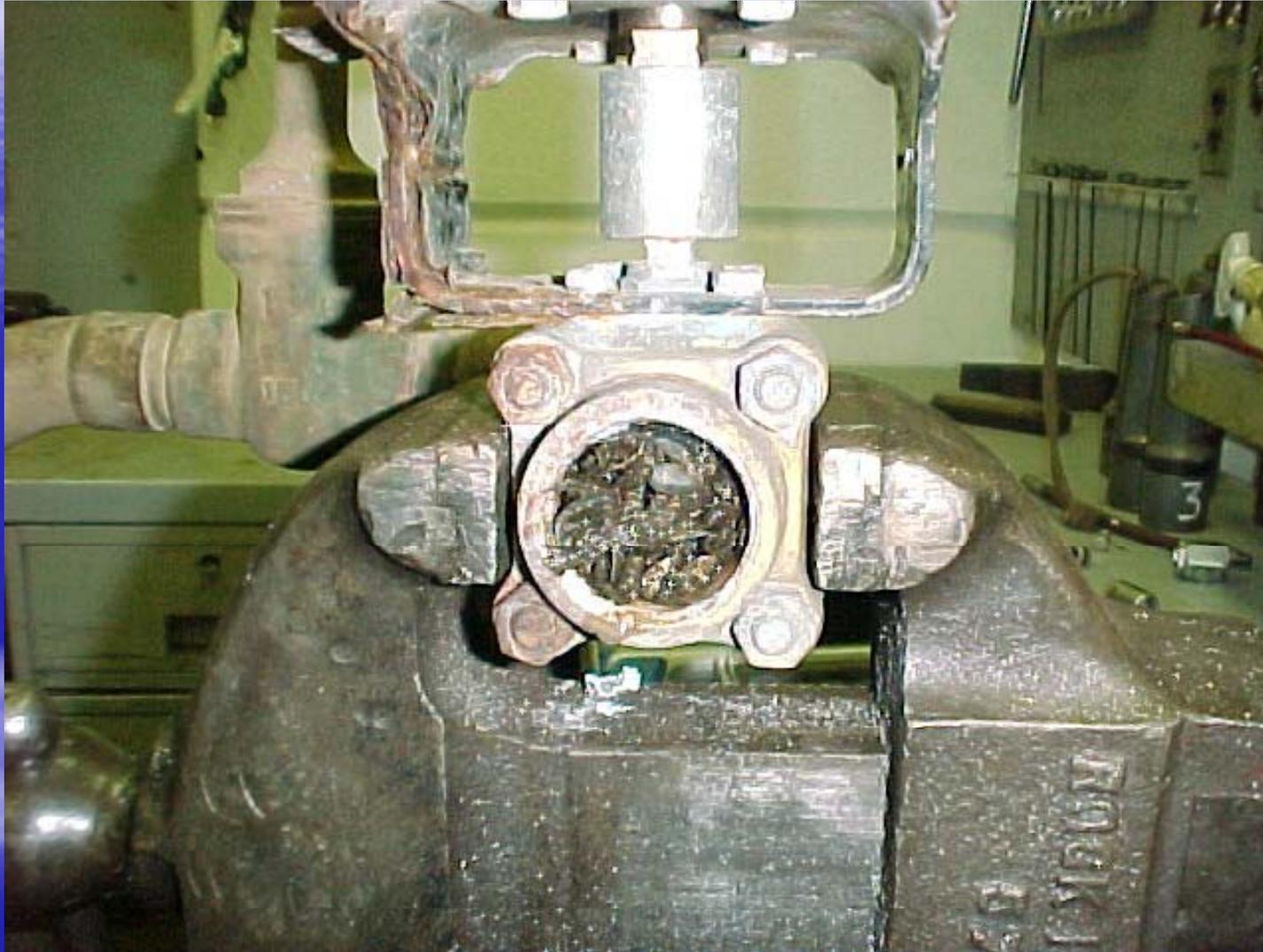
McClellan/Kerr Navigation System ~ 1995

- Late summer growth rates are slower than early summer at all sites.
- Water chemistry differences at sites may account for growth rate differences.
- The ranges for conductivity and calcium should support moderate to good growth at all sites.
- High temperature is probably limiting late summer growth at all sites.
- Early summer growth rates in Chouteau are slower, probably because of low pH.
- Early growth rates are much faster than cold waters.
 - Chouteau ~ 0.41mm/week
 - Webbers Falls ~ 1.19mm/week
 - R.S. Kerr ~ 1.03mm/week

Robert S. Kerr ~ 1 May 02



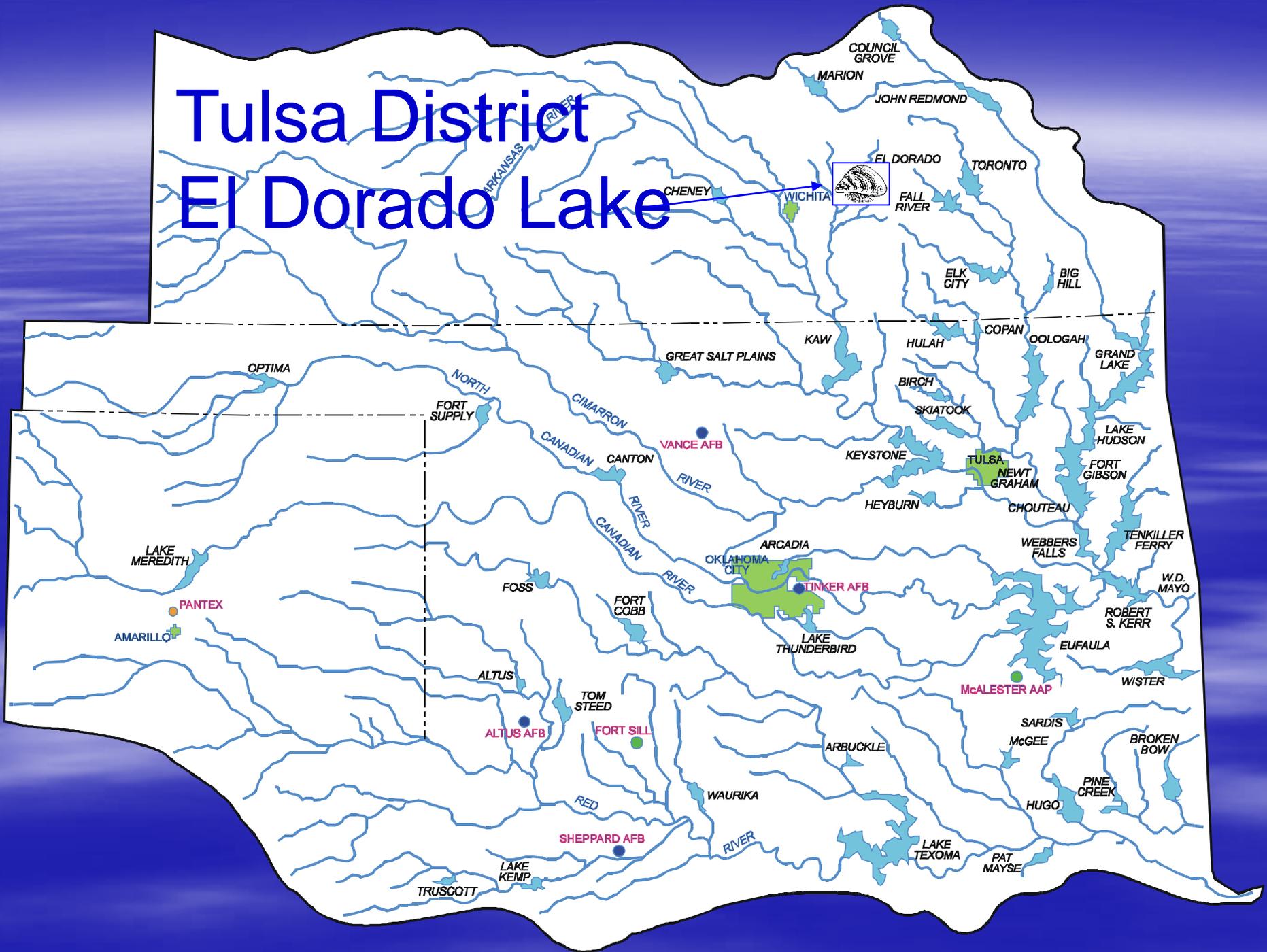
Webbers Falls #2 Strainer ~ 18 Aug 06



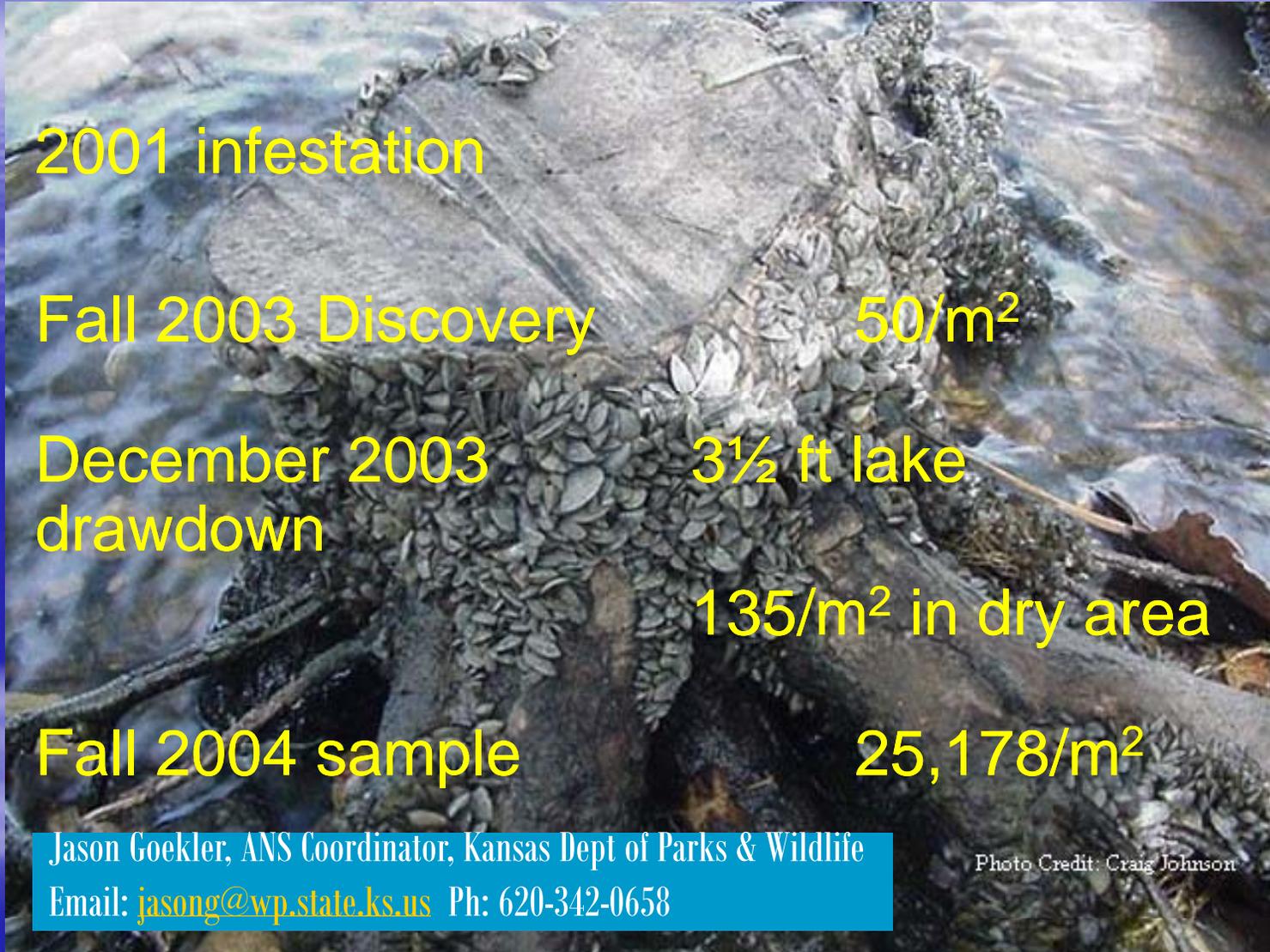
Webbers Falls #2 Strainer ~ 18 Aug 06



Tulsa District El Dorado Lake



El Dorado Timeline



2001 infestation

Fall 2003 Discovery $50/m^2$

December 2003 drawdown $3\frac{1}{2}$ ft lake

$135/m^2$ in dry area

Fall 2004 sample $25,178/m^2$

Jason Goekler, ANS Coordinator, Kansas Dept of Parks & Wildlife

Email: jasong@wp.state.ks.us Ph: 620-342-0658

Photo Credit: Craig Johnson

El Dorado Lake ~ 2003 Drawdown



Biological Reality

They like warm water!

- Continuously spawning all summer.
- Some spawning in water over 89° F for 2-3 months.
- Surviving in water over 90° F for several weeks.
- Can grow 1.19-1.25mm/week = 1cm in @ 2 months.
- Since Zebra Mussels are as genetically diverse as cockroaches, will they morph?

Therefore!

- They will likely continue to be a nuisance and O&M expense for all water users.
- They apparently are more tolerant to the warm water environments than thought.
- Survivors could produce more tolerant offspring.
- Populations could increase again with more tolerant individuals. Perhaps as a new and larger subspecies?
- The warm water subspecies could infest and survive better in the inland southwestern lakes.
- Our Zebra Mussels could be the seed stock for infesting other western states.

Tulsa District Program

- Continue to provide I&E and PR about Zebra Mussels, and other invasive species.
- Continue to monitor densities & reproduction.
- Continue to monitor lakes for new infestations.
- Continue to support studies (biology, adaptation, water quality, monitoring, controls, etc.)
- Continue to keep current with technology for controls.
- **Be prepared for adverse impacts to facilities.**

Some Controls

- Prevention in #1 Priority
- Chemicals
- Biocides
- Heat
- Toxic Metals (copper, bronze, zinc, gold, etc)
- Surface Coatings
- Physical Removal
- Water Speed (over 6.6cfs)
- Freezing
- Filters
- Electrical Barriers
- Cathodic Barriers
- Ozone
- UV Light
- Acoustics

Boating Recommendations for Infested Waters

- **Run your boat at high speed for 10-15 minutes just prior to leaving the lake.** Zebra Mussels may be washed off at speeds exceeding 5 mph and larval Zebra Mussels will be flushed from the cooling system.
- **Remove any visible vegetation** from boat, motor, trailer, and any equipment in contact with the water.
- **Inspect equipment for presence of Zebra Mussels immediately upon leaving the lake.** If you find Zebra Mussels attached, wash with hot water (140°) or air dry for at least 5 days before returning to the water. If equipment feels gritty to the touch, young microscopic Zebra Mussels may be attached. Power sprayers will detach Zebra Mussels.
- **Drain all bilge water, live wells, engine water, and bait buckets before leaving the lake.** Empty bait buckets on land. Never release live bait in the water.
- **Flush engine cooling system, live wells, and bilge with hot water.** Water hotter than 110° will kill larvae and hotter than 140° will kill adults.
- **Air dry your boat and other equipment for 5 days before using in uninfested waters.**

Suggested Web Sites

- <http://www.aquaticinvaders.org>
- <http://100thmeridian.org>
- <http://answest.fws.gov>
- <http://nas.er.usge.gov/zebramusssel>
- <http://www.seagrant.noaa.gov>
- <http://www.wes.army.mil>
- <http://www.protectyourwaters.net>
- “Or just search for **zebra mussel** or **invasive species**”

Other Invasives

Check Federal and State Invasive Species Lists for additional non-native species.

<http://www.aphis.usda.gov/ppq/weeds/weedlist2006.pdf>

<http://www.invasivespeciesinfo.gov/laws/statelaws.shtml>