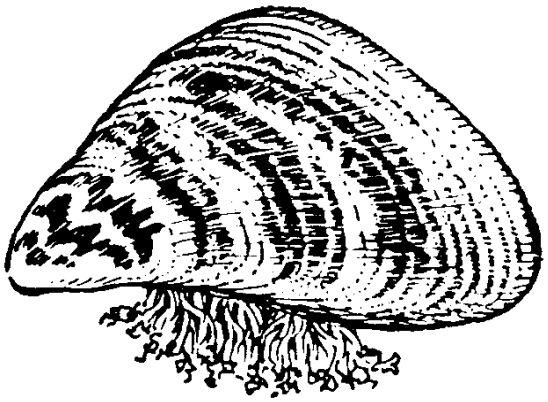
South/Central River Basins Team
USACE, Tulsa District Zebra Mussels



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SWD Invasive Species SME

Tulsa District, PE-E

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South/Central River Basins

US Army Corps of Engineers

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Tulsa District Infestation History

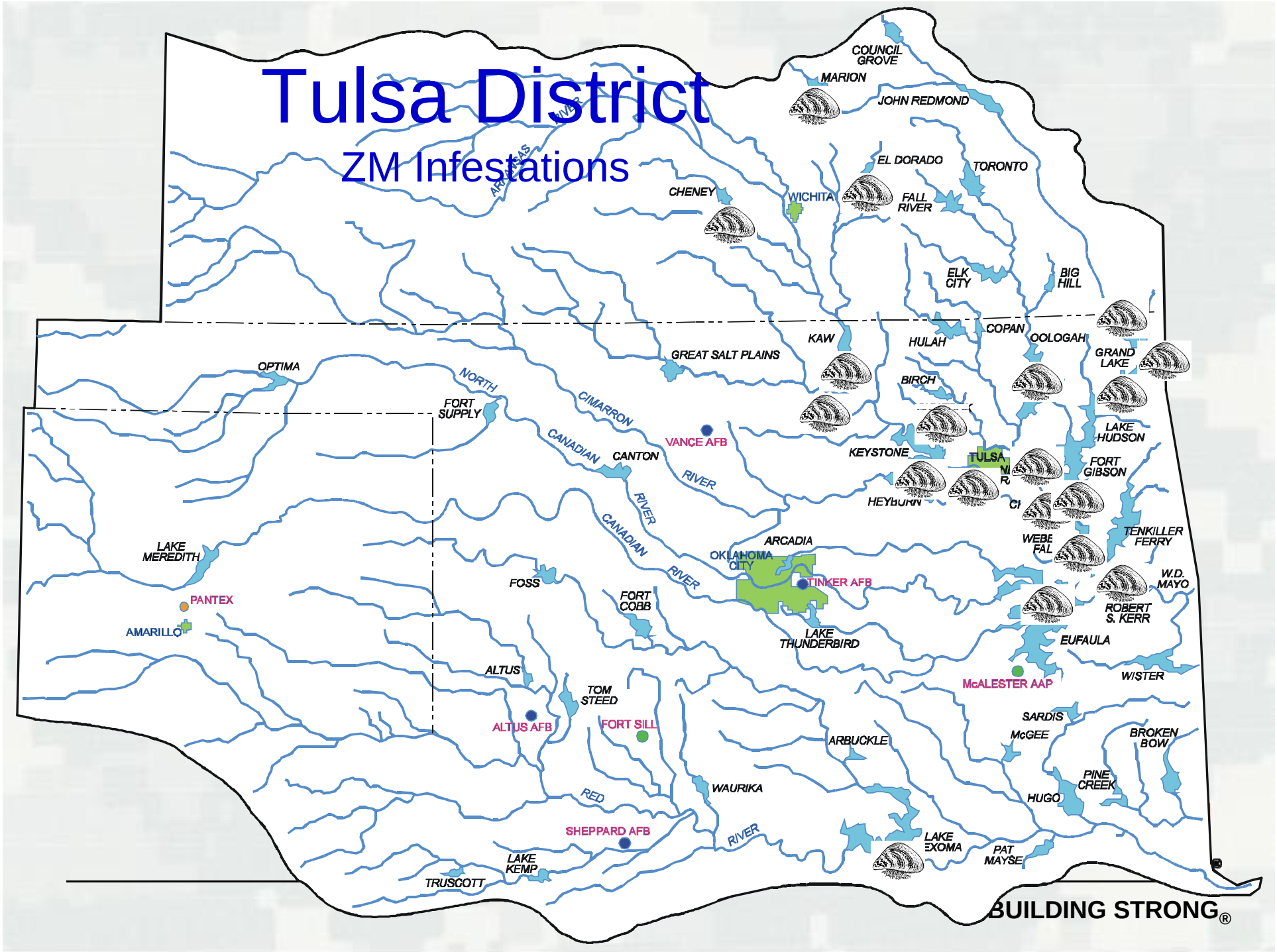
1. Jan 1993 ~ W.D. Mayo, R.S. Kerr, and Webbers Falls locks (Ark River)
2. June 1993 ~ Chouteau Lock (Verdigris River)
3. Jan 1994 ~ Newt Graham Lock (Verdigris River)
4. June 2003 ~ Oologah Lake (Verdigris River)
5. June 2003 ~ Lynn Lane Lake (Tulsa Water Supply)
6. & A.B. Jewell Lake (Tulsa Water Supply)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

TD 2009-Current Infestation

17. 9 Mar 09 ~ Neosho River, OSU sample, NE of Miami, OK.
18. 3 Apr 09 ~ Lake Texoma, one on a private TX dock.
19. 11 Apr 09 ~ Grand Lake, Zebra Mussel infested boat stopped at a marina, from Lake Michigan, all were dead, cleaned before allowed to launch.
20. 12 Jun 09 ~ Lake Texoma, more specimens on two different marinas.
21. 12 Jul 09 ~ Lake Texoma, one on a fire extinguisher near a marina on the Washita River in Ok.
22. 30 Jul 09 ~ Lake Texoma, 28 on three samplers.
23. July 09 ~ W.R. Holway Reservoir and Lake Hudson , OK.
24. 3 Aug 09 ~ two on rocks in West Prong of Sister Grove Creek, 300 yds downstream of NTMWD outfall, and one near the Knob Hill Road bridge.
25. 7 Aug 09 ~ Lake Texoma ~ confirmations near the Denison water pump station, near the NTMWD pump station, the mouth of the main cove at Eisenhower SP, the upper end & mid-arm of Little Mineral Arm, and the ramps at Highport and Russwood.
26. Jan 10 ~ Eufaula Lake, several found on samplers in four parks on lake.
27. Jan 10 ~ Ft. Gibson Lake, several found in powerhouse during maintenance.
28. 15 Mar 10 ~ Ft. Gibson Lake, confirmed on samplers in two parks on lake.

Tulsa District

ZM Infestations



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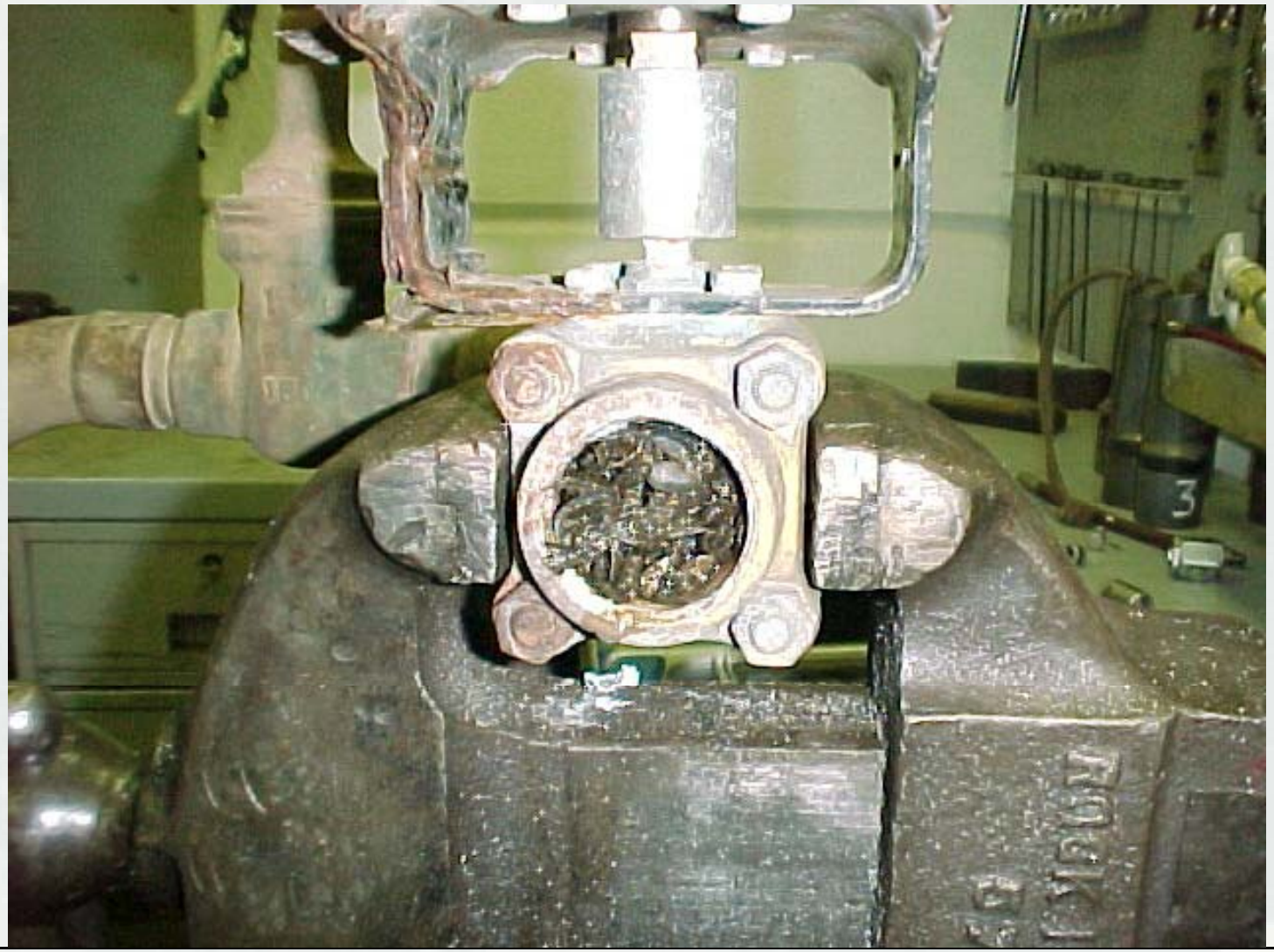
Webbers Falls #2 Strainer ~ 18 Aug 06



El Dorado Lake Trash Rack ~ Apr 06

Oologah Lake ~ Watergun

Oologah Lake ~ Shells on Shoreline

Beer Can

“However”

Navigation System crashed in 1997.

Oologah, Kaw, & El Dorado crashed in 2007.

~ High Spring Flows

~ Extreme & Abrupt Fluctuations

~ High Summer Water Temperatures

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			C.O'Neill, NY Sea Grant, Mar 96	

Historically

- Cold-water species.
- Spawn from 54º to 80º F.
- Become stressed at 86º F, die within a few weeks.
- Die within 5 hours at 90º F.
- Spawn 1 or 2 times per season.
- Grow @ 3mm/mo w/ @ 1 cm per year.
  - NE Lake Erie growth rate was 0.54mm/week (Dermott, et al., 1993)
- Filter 1 liter of water per day.

Northeastern State University Study

McClellan/Kerr Navigation System ~ 1995

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

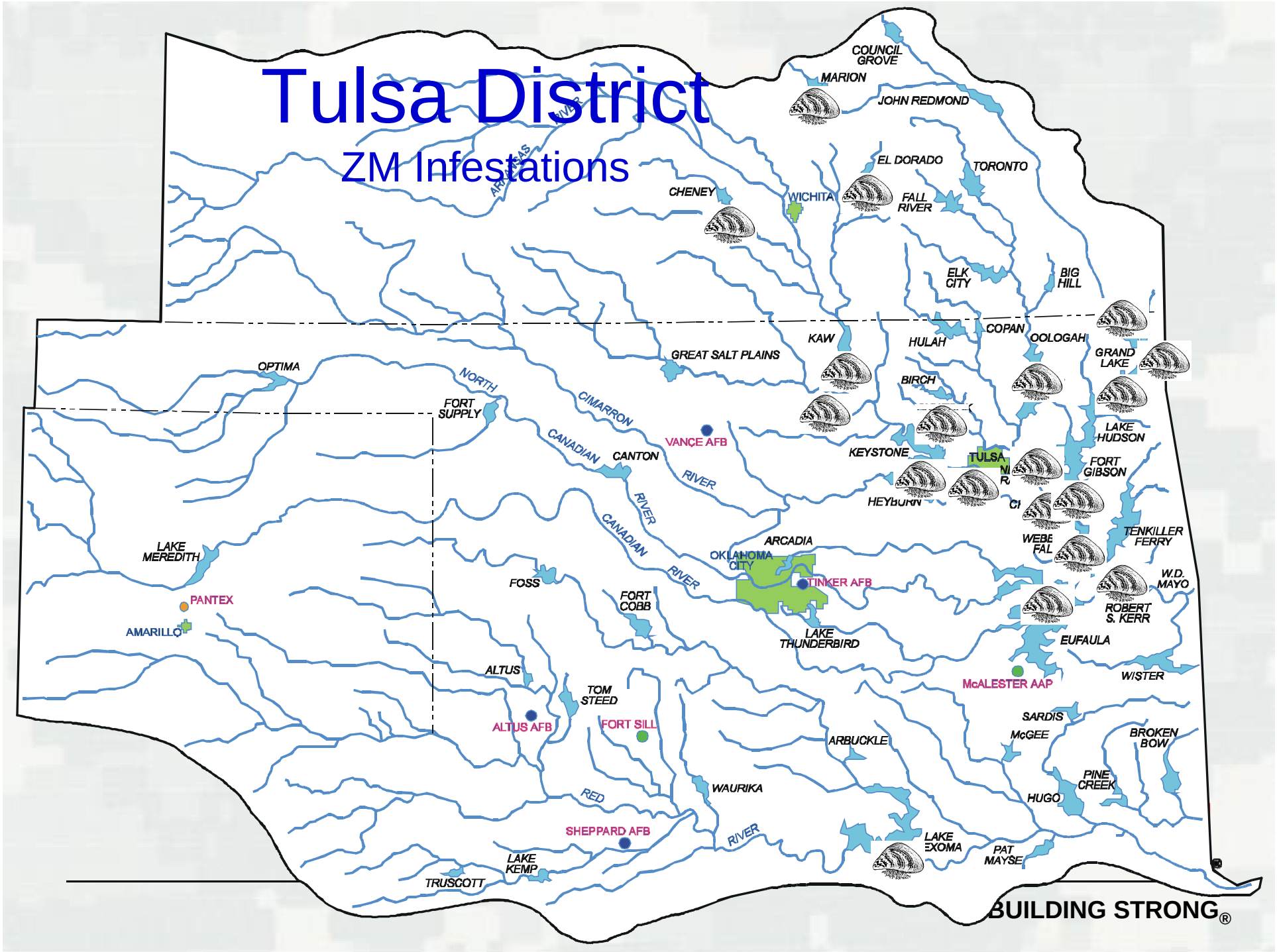
“OG&E Muskogee Power Plant”

1998, 1999, 2000, & 2005 Sampling

- Veligers present all summer w/ 3-6 peaks.
- Veligers in water over 80^{o}F.
  - 1998 mid June to late Sept
  - 1999 early July to early Sept
  - 2000 early July to mid Aug
  - 2005 late June to late Sept
- Veligers in water near 88^{o}F(31^{o}C) in 2005.
  - Aug 5 ~ 980/m^3
  - Aug 12 ~ 1636/m^3
  - Aug 22 ~ 1712/m^3

Tulsa District

ZM Infestations



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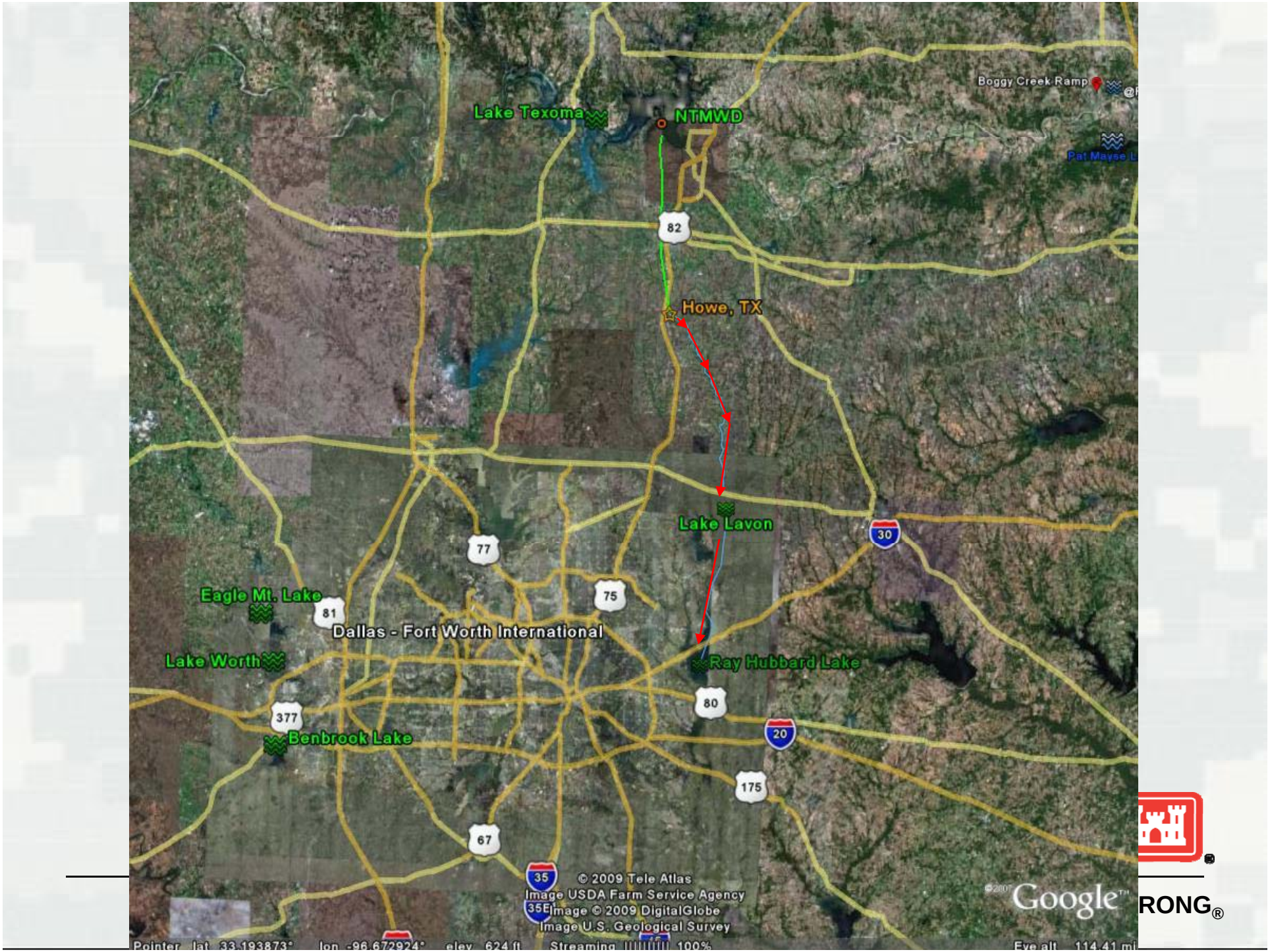
Boggy Creek Ramp
Lake Texoma
NTMWD
Pat Mayse L
82
Howe, TX
Lake Lavon
30
77
75
Eagle Mt. Lake
81
Dallas - Fort Worth International
Lake Worth
Ray Hubbard Lake
80
377
Benbrook Lake
20
175
67
35
35E
© 2009 Tele Atlas
Image USDA Farm Service Agency
Image © 2009 DigitalGlobe
Image U.S. Geological Survey
Google
Pointer lat 33.193873° lon -96.672924° elev 624 ft Streaming 100%
Eye alt 114.41 mi

RONG®


Lake Lavon
77
69
121
75
Eagle Mt. Lake
81
114
Dallas - Fort Worth International
30
Lake Worth
482
Ray Hubbard Lake
80
377
557
Benbrook Lake
360
20
175
67
287
35W
35E
35
45
Richland Chambers Lake
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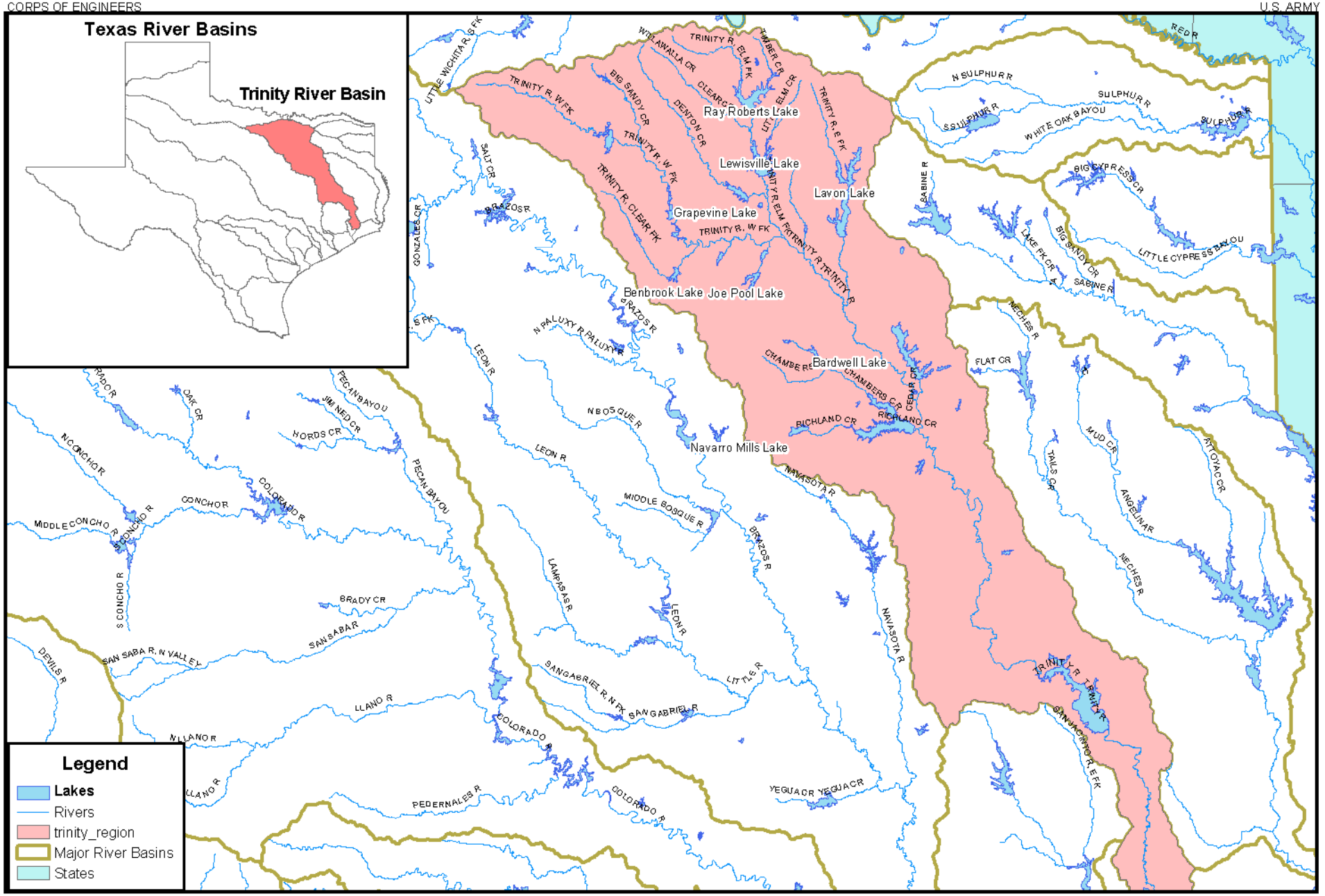
Image USDA Farm Service Agency
Image © 2009 DigitalGlobe
Image U.S. Geological Survey
©2007 Google™
Pointer lat 32.502401° lon -96.692014° elev 446 ft Streaming 100%
Eye alt 100.35 mi


Texas River Basins
Trinity River Basin
Ray Roberts Lake
Lewisville Lake
Lavon Lake
Grapevine Lake
Benbrook Lake
Joe Pool Lake
Bardwell Lake
Navarro Mills Lake
TRINITY R. W FK
TRINITY R. CLEAR FK
TRINITY R. E FK
TRINITY R. ELM FK
TRINITY R.
BIG SANDY CR
DENTON CR
CLEAR CR
TIMBER CR
WILLAWALLA CR
LITTLE WICHITA R. SFK
SALT CR
BRAZOS R
GONZALES CR
N PALUXY R
PALUXY R
LEON R
NBOSQUE R
NAVASOTA R
CHAMBERS CR
RICHLAND CR
CEDAR CR
FLAT CR
MUD CR
TAILS CR
ANGELINA R
ATTOYAC CR
NECHES R
SABINE R
LAKE FK CR
BIG CYPRESS CR
LITTLE CYPRESS BAYOU
WHITE OAK BAYOU
N SULPHUR R
S SULPHUR R
SULPHUR R
RED R
TRINITY R. TRINITY R
SANJACINTO R. E FK
YEGUA CR
YEGUA CR
COLORADO R
PEDERNALES R
LLANO R
N LLANO R
SAN GABRIEL R. N FK
SAN GABRIEL R
LITTLE R
LAMPASAS R
MIDDLE BOSQUE R
BRADY CR
SAN SABA R. N VALLEY
SAN SABA R
DEVILS R
S CONCHO R
MIDDLE CONCHO R
CONCHO R
N CONCHO R
COLORADO R
OAK CR
RADR
JIM NED CR
NORDS CR
PECAN BAYOU
Legend
Lakes
Rivers
trinity_region
Major River Basins
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.)
- Work with other Federal, state, and local interests.
- 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
- Desiccation
- Filters
- Electrical Barriers
- Cathodic Barriers
- Ozone
- UV Light
- Acoustics

Questions?


THIS SAYS YOU SERVE FRESH OKLA CLAM CHOWDER!
I DIDN'T THINK THERE WERE ANY CLAMS IN OKLA!
THERE AREN'T... WE USE ZEBRA MUSSELS!
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