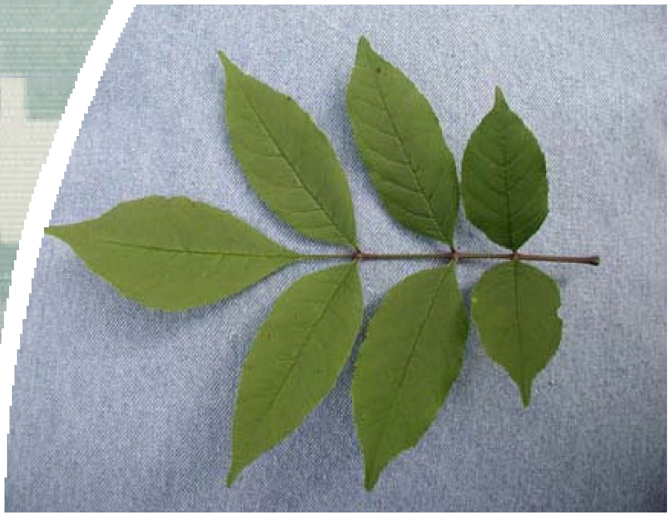
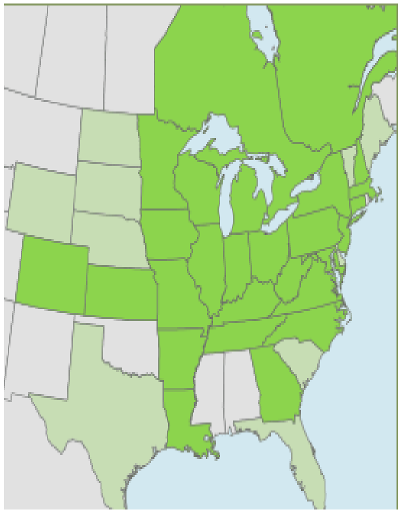
Invasive Species Management Community of Practice

Emerald Ash Borer (EAB)





FOR: Invasive Species CoP Webinar

May 6, 2015

Tim Toplisek
CECW-CO-N

What is EAB?

Why should I be concerned?

What indicators should I be looking for?

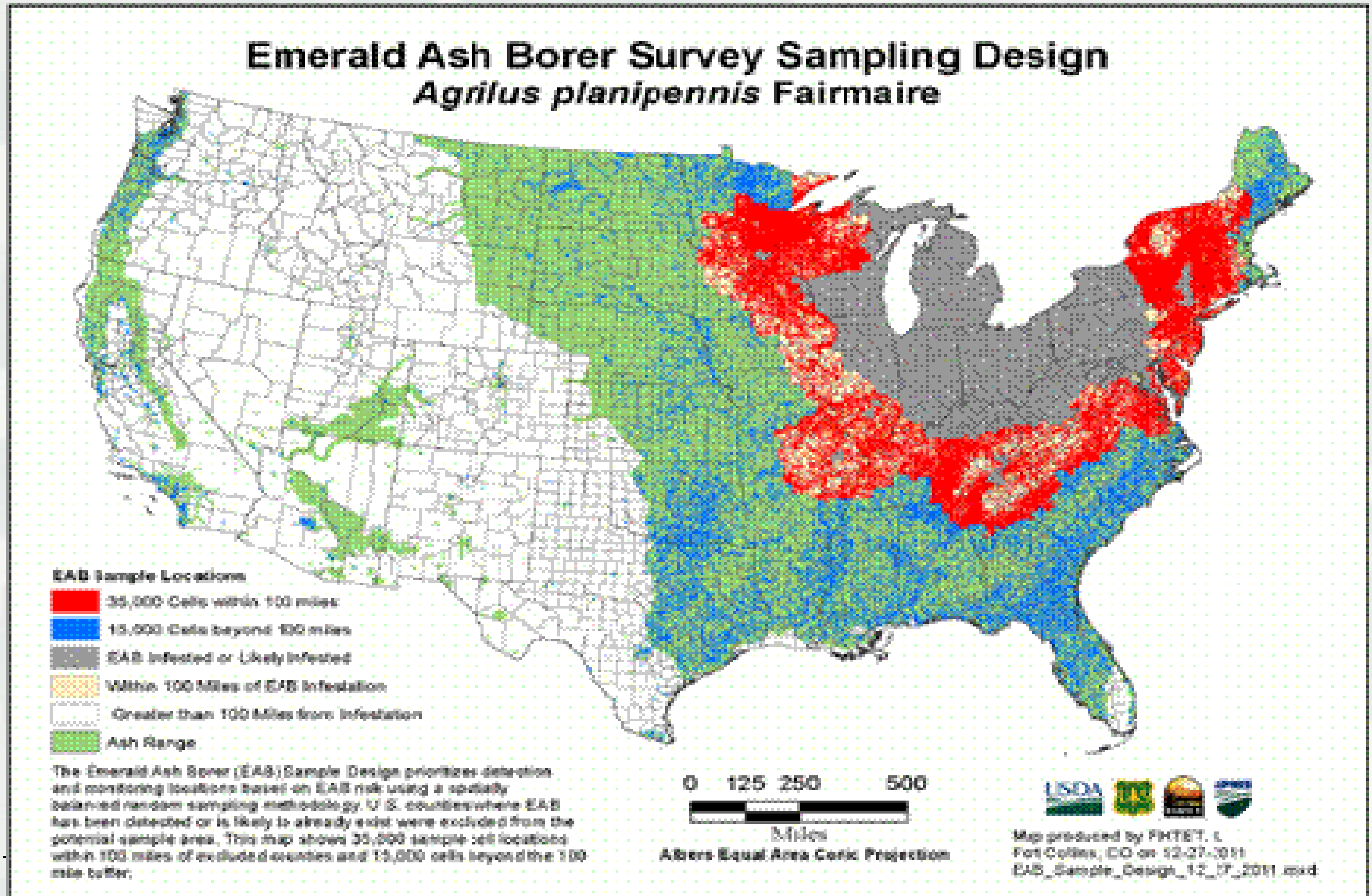
What types of control are available?

Who can offer me help?

Emerald Ash Borer

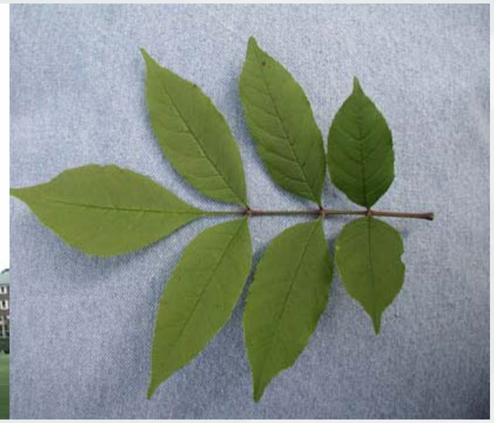
Agrilus planipennis Fairmaire

Range and Severity of EAB



Genus- Fraxinus

Species Black (nigra)



Species White (americana)

Species Green (pennsylvania)

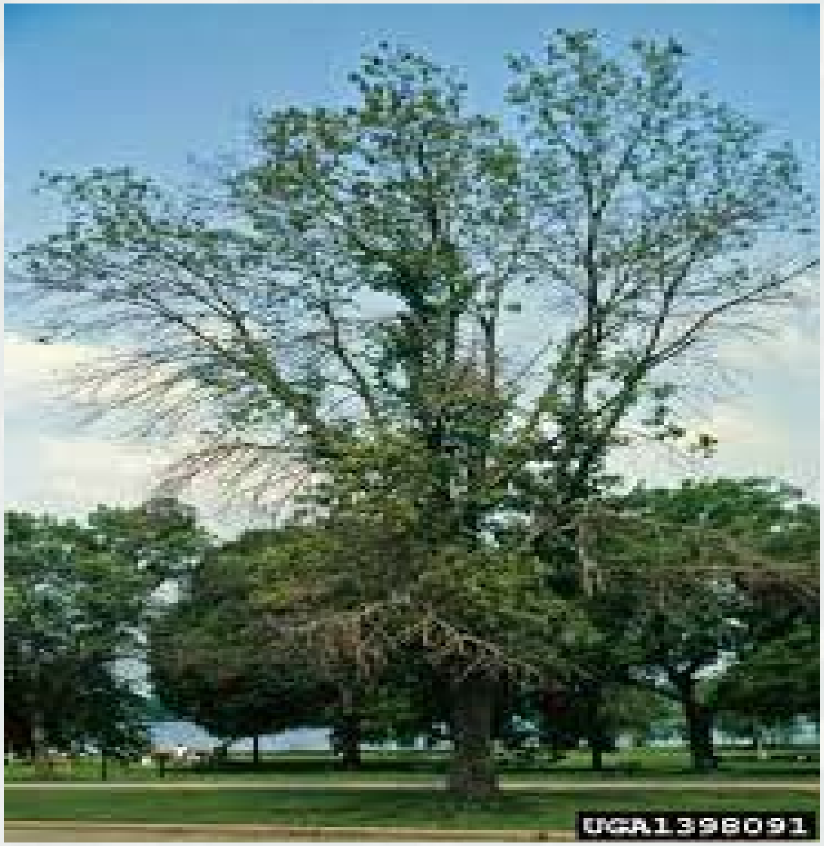
Genus- Sorbus

Species mountain (americana)

Species Characteristics

Indicators

Indicators- Continued



Before and After Infestation

Monitoring

Purple Prism Traps

Control methods

Chemical

Fire

Biological

Insecticide Formulation	Active Ingredient	Application Method	Recommended Timing
Products Intended for Sale to Professional Applicators			
Merit® (75WP, 75WSP, 2F)	Imidacloprid	Soil injection or drench	Early to mid-spring or mid-fall
Safari TM (20 SG)	Dinotefuran	Soil injection or drench	Mid- to late spring
Transect TM (70WSP)	Dinotefuran	Soil injection or drench	Mid- to late spring
XytectTM (2F, 75WSP)	Imidacloprid	Soil injection or drench	Early to mid-spring or mid-fall
Zylam® Liquid Systemic Insecticide	Dinotefuran	Soil injection or drench	Mid- to late spring
AzasolTM	Azadirachtin	Trunk injection	Mid- to late spring after trees have leafed out
Imicide®	Imidacloprid	Trunk injection	Mid- to late spring after trees have leafed out
TREE-ägeTM	Emamectin benzoate	Trunk injection	Mid- to late spring after trees have leafed out
TreeAzin®	Azadirachtin	Trunk injection	Mid- to late spring after trees have leafed out
SafariTM (20 SG)	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Transect (70 WSP)	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Zylam® Liquid Systemic Insecticide	Dinotefuran	Systemic bark spray	Mid- to late spring after trees have leafed out
Astro® OnyxTM Tempo® Sevin® SL	Permethrin Bifenthrin Cyfluthrin Carbaryl	Preventive trunk, branch, and foliage cover sprays	Two applications at 4-week intervals; first spray should occur at 450-550 degree days (50ºF, Jan.1); coincides with black locust blooming

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OnyxTM	Bifenthrin		
Tempo®	Cyfluthrin		
Sevin® SL	Carbaryl		

Chemicals- Continued

Products Intended for Sale to Homeowner

Insecticide Formulation	Active ingredient	Application Method	Recommended Timing
Bayer Advanced Tree & Shrub Insect Control	Imidacloprid	Soil drench	Early to mid-spring
Optrol	Imidacloprid	Soil drench	Early to mid-spring
Ortho Tree and Shrub Insect Control Ready to Use Granules	Dinotefuran	Granules	Mid to late spring

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Zebra and Quagga Mussels: Invasion Timeline, Life History and Consequences

Brandon Mobley

Natural Resources Management Specialist

Fort Worth District

6 May 2015

US Army Corps of Engineers

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Zebra and Quagga Mussels

- Originally endemic to Europe
- Introduced to North America in ~ 1986
- Zebra mussels found in Lake St. Clair and western Lake Erie in 1989
- Quagga mussels also introduced in 1986 but not identified until 1991
- Rapidly spread throughout major US and Canadian drainage systems
- east of the Rocky mountains
- Zebra Mussels: Great Lakes drainage, Mississippi River and eastern tributaries, lower Missouri River, Arkansas River, isolated water bodies
- Quagga Mussels: Great Lakes drainage, upper Mississippi River, lower Ohio Rivers, lower Colorado River, water bodies in CO, AZ, southern CA
- Initial rapid dispersal in navigable waterways on commercial vessels
- Dispersed more slowly to isolated water bodies (i.e., overland transport)
- Quagga mussels found in Lake Mead (2007), soon after in the lower Colorado River, and reservoirs in southern California and Arizona
- Zebra Mussels in San Justo Reservoir Central CA (2008), Lake Texoma TX/OK (2009), Offutt Air Force Base Lake eastern NE (2006)
- Most costly macrofouling and ecological pests ever introduced to North American freshwaters

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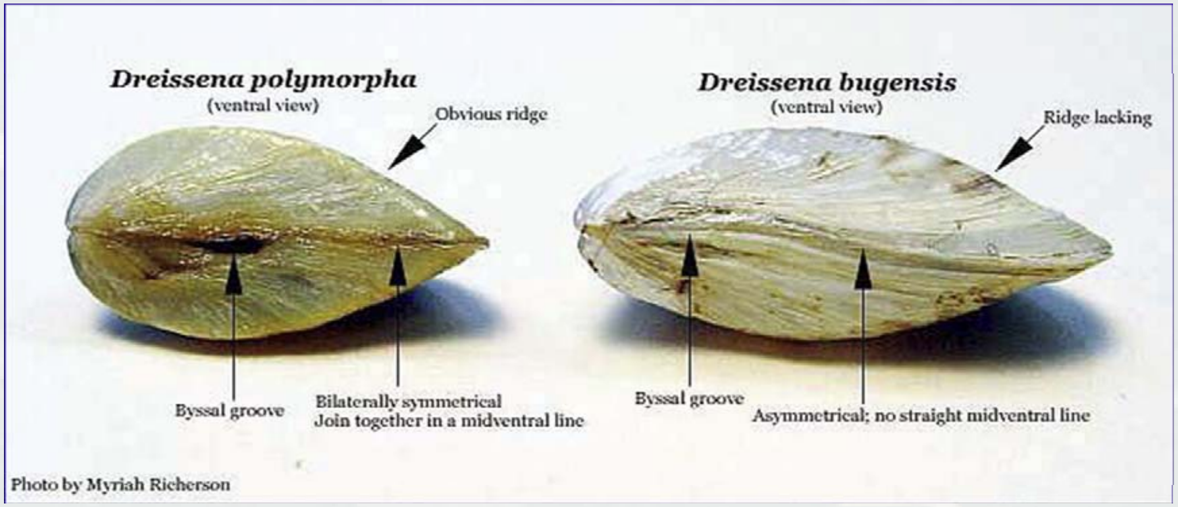
Dreissenid Shell Morphology

Zebra Mussel
Dreissena polymorpha

Quagga Mussel
Dreissena rostriformis bugensis



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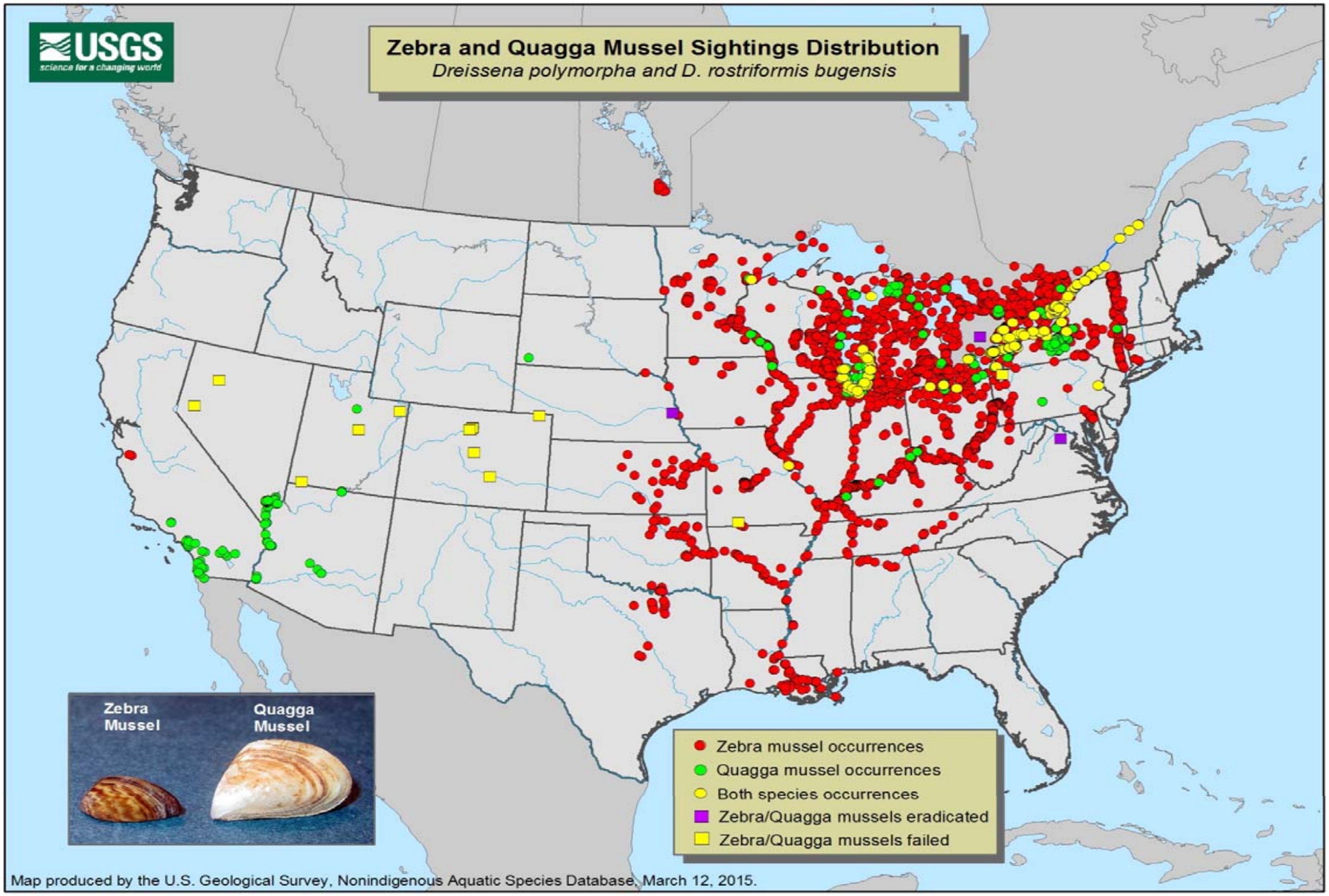
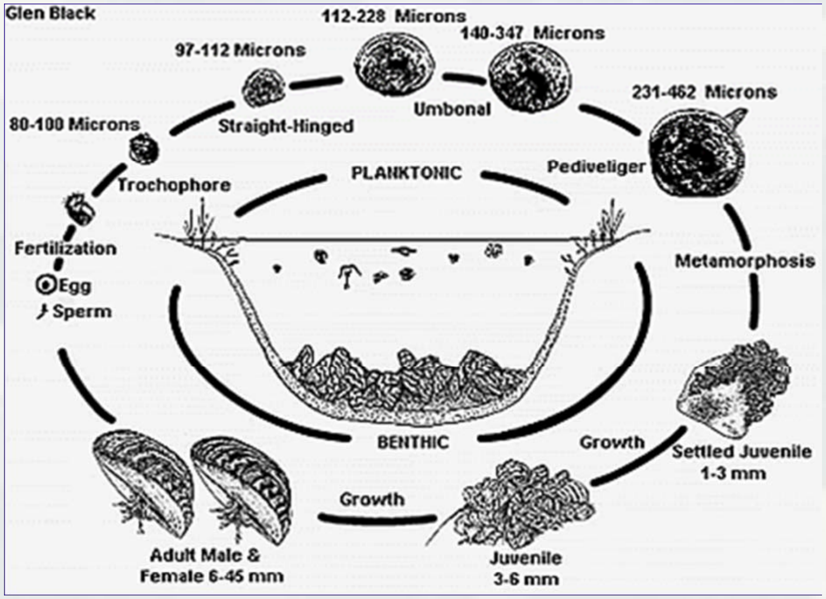


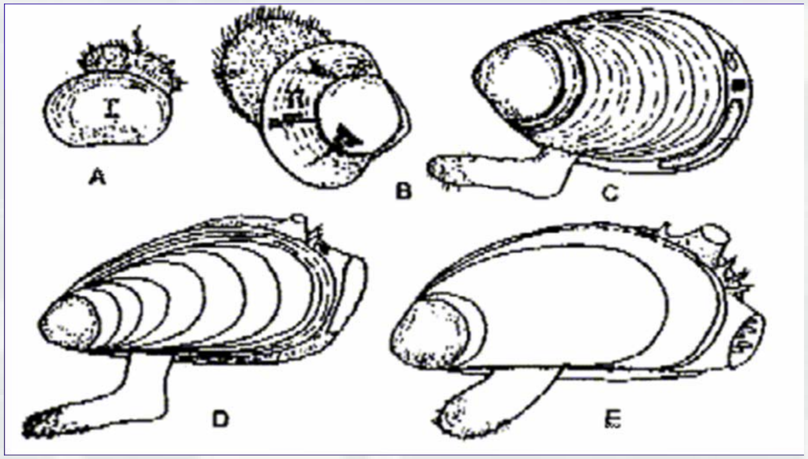
USGS
science for a changing world
Zebra and Quagga Mussel Sightings Distribution
Dreissena polymorpha and D. rostriformis bugensis
Zebra Mussel
Quagga Mussel
Zebra mussel occurrences
Quagga mussel occurrences
Both species occurrences
Zebra/Quagga mussels eradicated
Zebra/Quagga mussels failed
Map produced by the U.S. Geological Survey, Nonindigenous Aquatic Species Database, March 12, 2015.

Dreissenid Life Cycle

Separate sexes - external fertilization

- **Fecundity is typically 30,000-40,000 eggs per adult female per year**
- **Trochophore larva (6-20 Hours)**
  - **No shell (≥ 40 μm)**
- **Early Veliger larva (3-4 Days)**
  - **D-shaped shell (80-100 μm)**
- **Late veliger larva (1-2 weeks)**
  - **Umbonal shell (100-250 μm)**
- **Pediveliger larva (2-3 weeks)**
  - **Develops foot – settles, crawls to attachment site (200-400 μm)**
- **Plantigrade (3-4 weeks)**
  - **Byssal attachment – transforms to mussel shape (250-500 μm)**
- **Juvenile (3-5 Weeks)**
  - **Mussel-shaped shell (>400 μm)**
- **Spawning occurs at low levels > 10°C**
- **Spawning maximized at > 18-28°C**
- **Settle in three to five weeks**






Zebra mussel veliger larvae from
Lake Texoma, Texas/Oklahoma
Veligers

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Dreissenid Population Dynamics

- Maximum life span is typically 3-5 years depending on population
- Maximum adult size = 25 – 40 mm depending on population
- Growth rate typically declines with increasing adult size
- Survival rate is low across year classes
- Adult growth rates and population density dependent on temperature, water quality and food densities
- High fecundity leads to development of massive populations within 3-5 years after initial introduction

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Filter Feeding

- Zebra and quagga mussels both efficiently filter bacterioplankton (< 1 µm). Also phytoplankton, micro-detritus particles, and small zooplankton
- Average ≈ 1.5 L / day
- 150,000 L / day at a density of 100,000 mussels / m2
- Results in rapid water clarification
- Removes phytoplankton, bacteria and micro-detritus negatively impacting energy flow through food webs
- Promotes toxic blue-green algae blooms
- Quagga mussels are more efficient at filtering bacteria
- Can lead to eventual replacement of zebra mussels by quagga mussels

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1 2 3 4 5 6 7 8 9 10
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Key Water Quality Factors Affecting Dreissenid Mussel Distribution and Invasion

- pH: Inhabit waters of pH > 7.4

  Attain highest densities at pH > 8.0
- Calcium Ion Concentration: Not found in waters with calcium concentrations below 10-12 mg Ca/L

  > 24 mg Ca/L is optimal for growth and reproduction
- Oxygen Concentration: Not generally found below 30% of full air oxygen saturation

  Prevents mussels from establishing in the deeper portions of Texas water bodies which become oxygen depleted during summer months
- Temperature: Mussels cannot tolerate long-term exposures to temperatures greater than 32°C (90°F)

  Some Texas water bodies have surface water temperatures that average above 32°C during summer months making them resistant to zebra mussel infestation

Zebra mussel infestations can lead to extensive ecological and economic costs

Zebra mussels in KS, OK and TX have evolved increased thermal tolerances (30 vs. 32°C or 86° vs. 90°F)

Could eventually lead to mussel infestation of many Texas water bodies

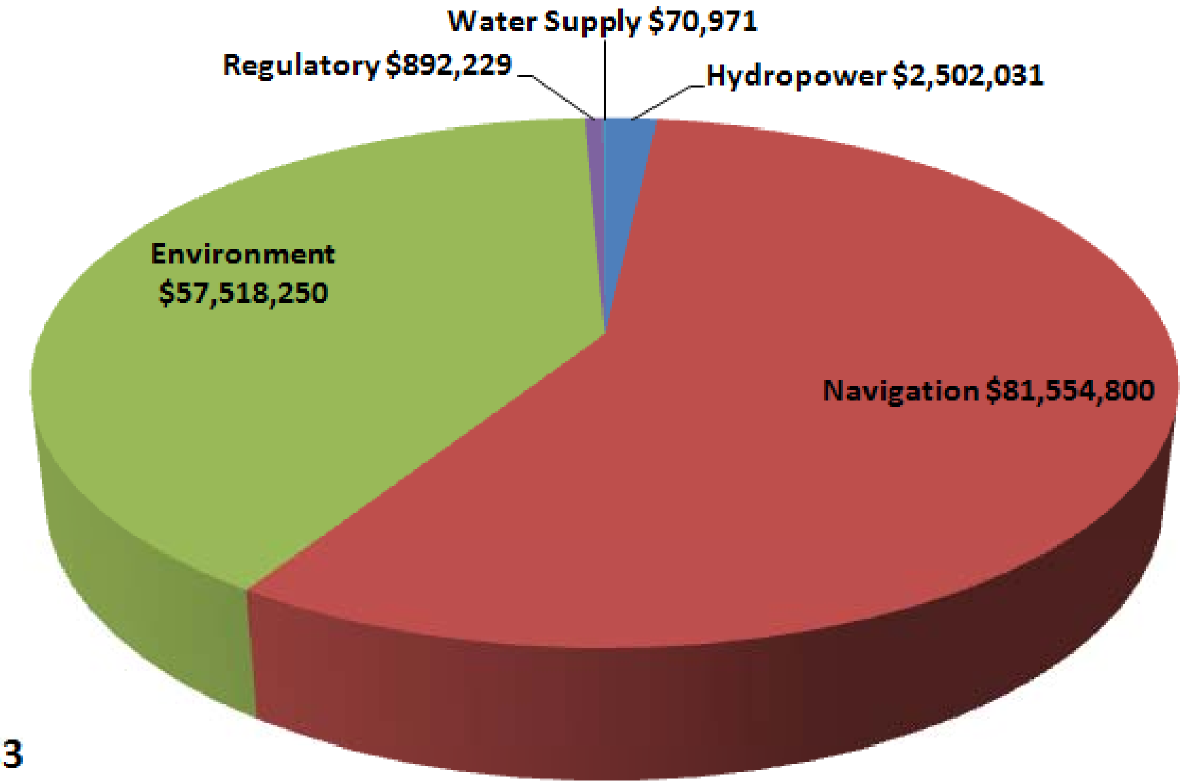
Invasion risk assessments are required to determine the most at risk water bodies

- Successful invasion may require introduction of a large number of mussels
- Analysis of boater movements/visitations
  - Collect data on boater movements (100th Meridian Boater Movement Database)
- Analysis of water body physical/chemical parameters
  - pH, Ca^{2+} concentration, O_2 concentration, summer surface water temperatures
- Concentrate prevention efforts on at-risk water bodies to reduce the rate of mussel introduction which could reduce the potential for mussel infestation

Fiscal Year 2009 – Fiscal Year 2016 cost categories for Invasive Species

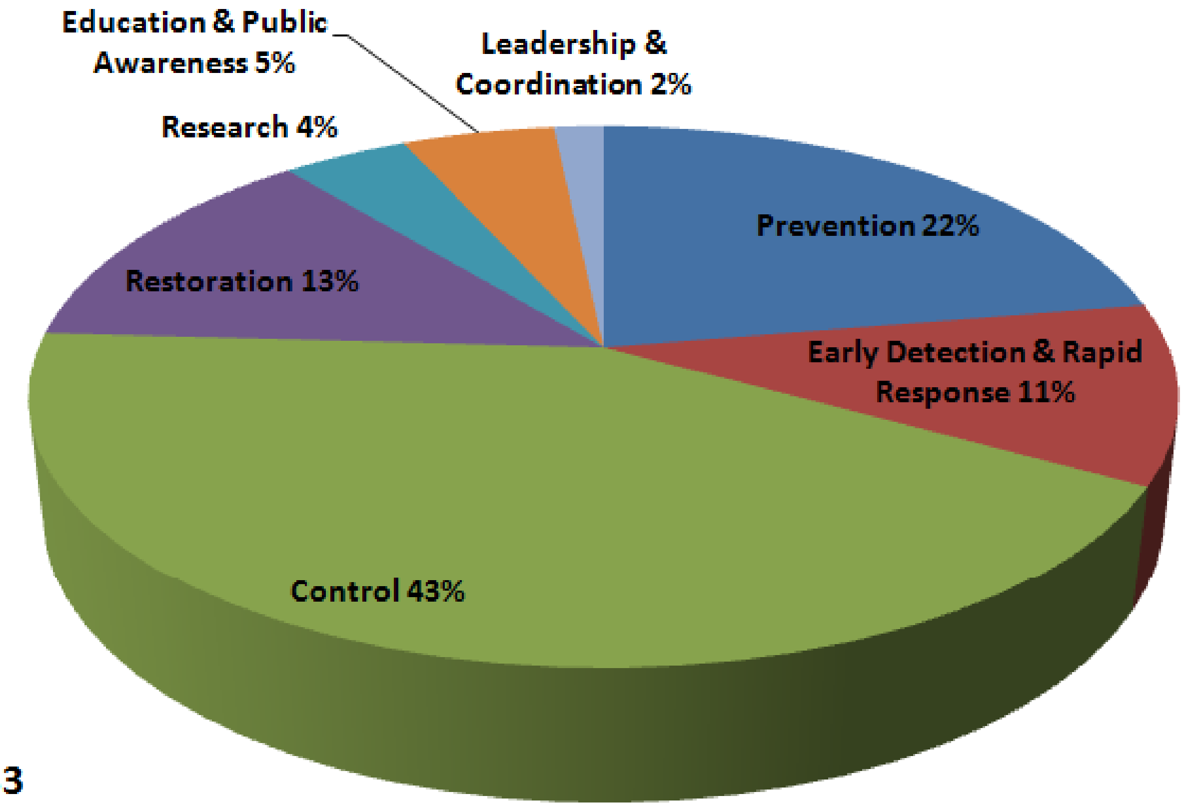
	FY09	FY10	FY11	FY12	FY14	FY15 (Enacted)	FY16 (Pres. Budget)
Prevention	$15,628,980	$14,186,768	$22,768,255	$23,538,108	$8,447,825	$30,326,990	$31,849,979
ED&RR	$8,529,248	$8,850,212	$11,870,812	$11,229,782	$9,225,489	$14,070,145	$15,254,231
Control	$83,629,351	$76,806,259	$83,219,082	$73,598,102	$109,705,363	$57,352,023	$61,065,729
Research	$4,490,000	$6,236,000	$6,541,232	$1,749,600	$4,647,647	$9,611,430	$6,028,709
Restoration	$10,550,200	$5,111,250	$29,826,460	$23,080,244	$12,243,975	$17,318,098	$18,637,728
Ed & Public Awareness	$2,577,068	$2,746,711	$3,508,579	$3,355,460	$2,796,070	$6,740,325	$7,334,356
Leadership/Int. Cooperation	$1,346,000	$1,445,000	$1,476,000	$1,485,300	$1,505,000	$2,074,816	$2,376,852
TOTALS	$126,750,847	$115,382,200	$159,210,421	$138,036,596	$148,571,369	$137,493,826	$142,547,583

USACE Invasive Species
FY16 Estimated Spending by Business Line



Total:
$142,547,583

USACE Invasive Species
FY16 Estimated Spending by Action



Total:
$142,547,583

Control Methodologies and Considerations for ZM's

- Chemical: (Chlorine, Chlorine Dioxide, Chloramines, Potassium Permanganate, Bromine, Hydrogen Peroxide, Ozone, Flocculation, pH Adjustment, Molluscicides, Potassium Chloride, Copper Sulfate, Copper Ion Generation

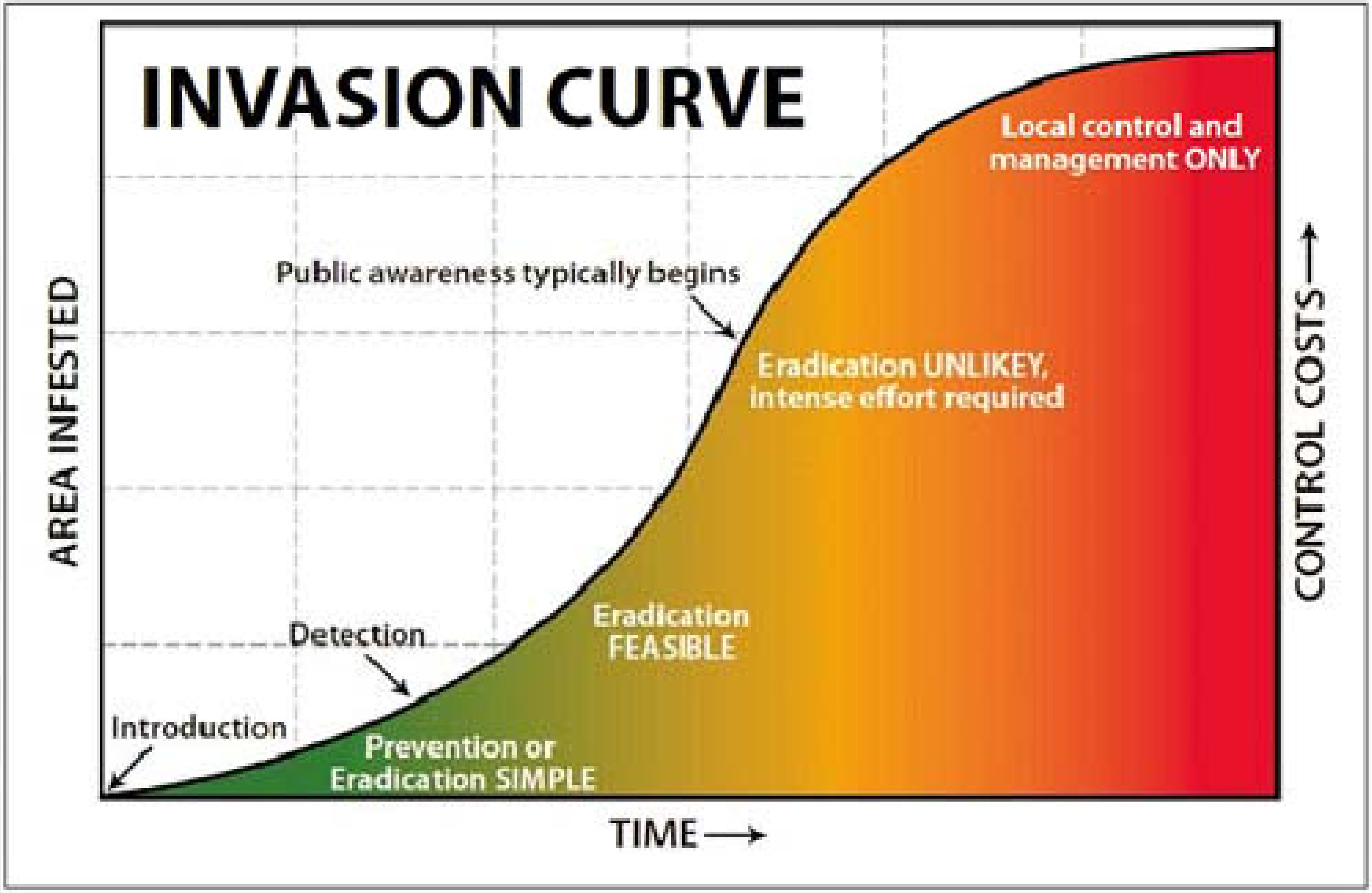
Control cont.

- Non-Chemical: Manual Cleaning (scraping, power washing, pigging), Velocity Control, Filtration, Thermal Treatment, Antifoul and Foul Release Coatings, Desiccation, Ultraviolet Light, Acoustics, Electric Current

Control Methodology Considerations

- Site specific conditions are critical when evaluating control methodologies and strategies (water chemistry, open water or isolated cove, critical infrastructure to include water conveyance facilities and treatment plants)
- Also important to consider regulatory and the legal aspects of certain control methodologies being considered

INVASION CURVE



Strategies

- Utilize resources available for prevention or try and control spread
- Work with stakeholders, resource agencies and public on control efforts
- Information and Education for both USACE staff and the public
- Access restrictions and citation authority

Questions?