RiversEdge West

RESTORE + CONNECT + INNOVATE

Riparian Restoration and Tamarisk Beetle Workshop
Tamarisk and Tamarisk Beetle History, Release, and Spread

Ben Bloodworth
Program Coordinator
Tamarisk is a non-native phreatophyte that can dominate riparian lands.
Getting to know tamarisk...

In the U.S., tamarisk is an invasive species
Invasive species = non-native to the ecosystem in which they are found and can cause environmental, economic, or human harm

Leaves are scale-like with salt-secreting glands

Produces 500,000 seeds/yr
Dispersed by wind, water, animals
How did it get here?
- > 5 *Tamarix* species; most are *T. ramosissima* X *chinensis* hybrids
- 3rd most common tree in western rivers, both regulated and free-flowing
- > 1 million ha. in No. America
- Deeper roots than most natives (mesquite has roots almost as deep)
- Does **NOT** use 200 gallons of water per day, but has water use roughly equal to native riparian species
- Can survive in dryer areas/upper benches and in times of drought where native trees cannot reach water table
- Grows more densely than other native plants
Simplified Conceptual Model of Tamarisk Dominated vs. Native Riparian Areas

From USU and Metro Water Cibola NWR study handout
More flood/drought resistant than other species

Roots can remain under water for up to 70 days and grow up to 25 feet deep
Flow alterations, both man-made and vegetation induced, have reduced habitat complexity (ditch-like river).

The bank stabilizing effects of the tamarisk prevent floodplain access and limit the creation of complex habitat (split channels, backwaters, pools, and riffles).

[Historic bridge supports circled in red]
Landscape-Level Control isn’t Practical

Humboldt River, NV
Tamarisk (*Diorhabda* spp.) leaf beetle

*Photo courtesy of Ed Kosmicki*

*Photo Sonoran Joint Venture*
Biological control results in an equilibrium between plant and herbivores.
Classical Biological Control

Ideal Candidate:

- No native Tamaricaceae
- Envir. impacts strong
- Low economic value
- Unusual chemistry, thus many specialist herbivores

Jack DeLoach (USDA) & I.D. Mityaev in Kazakhstan
Overseas Exploration: >300 specialist insects

- **Diorhabda carinulata** (tamarisk leaf beetle)
- **Coniatus tamarisci** (weevil)
- **Trabutina mannipara** (mealy bug)

1996 – 3 candidates approved by USDA
Tamarisk biological control timeline

- **1987:** Overseas exploration and research to find agent or agents
- **1989-1994:** Host specificity testing
- **1994:** TAG approval
- **1998-2000:** Field cage tests and monitoring plan put into place
- **2001:** Limited open releases
Humboldt River Basin in 2003 showing extensive tamarisk defoliation by *D. carinulata* (photo: A. Brinkerhoff)
With 40,000 acres defoliated, Lovelock became the prime collection site for *Diorhabda* in North America.
Diorhabda carinulata from Nevada, site of the first success

Collecting beetles near Lovelock, NV, 2005
Cages filled with beetles from Nevada
Trays of *Diorhabda* for distribution
August, 2005, first open field release in western Colorado, BLM site, Horsethief Bench
Larvae & Adults only eat Tamarisk (10+ years Testing)

Egg

Larva

Adults pupate & over-winter in litter
Other Similar leaf beetles
Tamarisk Beetle - *Diorhabda* spp.
Beetles and larvae defoliating tamarisk

Courtesy of Dr. Dan Bean, Palisade Insectary
Beetle/Tamarisk Interaction: Green to Brown 2009 - 2011

- Total Number by Period
- Periods by Year

Larvae
Adults
Ave. % Green

Percent Green

Periods by Year
2009
2010
2011

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Total Number by Period

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Periods by Year
2009
2010
2011

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Total Number by Period
Beetles drop from host plant and pupate in the leaf litter
Adults emerge from the leaf litter, climb up the defoliated plants and fly in search of food.
Average number of adult beetles counted per site across Grand Co. UT each survey period each year
Beetles will not eradicate *Tamarix*
An ecological relationship is established between the herbivore and the plant.
Beetles will shift ecological relationships

Biology of *Tamarix*

Biology of *Diorhabda*

biotic and abiotic ecosystem components
Beetles will defoliate *Tamarix* and the timing and frequency will be variable.

Beetles will move over large distances, periodically defoliating tamarisk stands, as illustrated by their movements on the Dolores River.
Tamarisk foliates in spring
Larvae hatch

OW/F

1

River km

1st Summer Generation (May and June 2011)

Marble Canyon

Avg. Larvae

Lee’s Ferry

Supai narrows begin

Redwall narrows begin

Little Colorado River
Larval feeding leads to defoliation!!

Marble Canyon

River km

0 5 10 14 19 24 29 34 39 43 48 53 58 63 68 72 77 82 87 92 97 101 106 111 116 121

% Defoliated

0 20 40 60 80 100

Defoliation (June 2011)

Lee’s Ferry

Supai narrows begin

Redwall narrows begin

Little Colorado River
Larvae pupate and new adults disperse in search of green tamarisk.
New generation established

F1/F2

Marble Canyon

Defoliation (June 2011)

% Defoliated

Lee’s Ferry  Supai narrows  Redwall narrows  Little Colorado River

begin  begin  begin  River
Larvae hatch and begin to feed.
Larval feeding leads to defoliation!!
Larvae defoliate new zone

Marble Canyon

Defoliation
(July 2011)

- Defoliation
- Refoliation

River km

0 5 10 14 19 24 29 34 39 43 48 53 58 63 68 72 77 82 87 92 97 102 107 112 117 122

Lee’s Ferry
Supai narrows begin
Redwall narrows begin
Little Colorado River
Larvae hatch and begin to feed.

River km

Marble Canyon

2nd Summer Generation (July, 2011)

Avg. Larvae

0 25 50 75 100 125

0 14 24 29 34 39 43 48 53 58 63 68 72 77 82 87 92 97 101 106 111 116 121

Lee’s Ferry

Supai narrows begin

Redwall narrows begin

Little Colorado River
Defoliation continues, refoliation is new refugia

Refoliation

Marble Canyon

Defoliation
(August 2011)

%D Defoliated

0 20 40 60 80 100

River km

Lee’s Ferry
Supai narrows
Redwall narrows
Little Colorado
begin
begin

begin

River
Defoliation continues, refoliation is new refugia
Next generation of larvae are established

Marble Canyon

3rd Summer Generation
(August, 2011)

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<td>19</td>
<td>24</td>
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Lee’s Ferry  Supai narrows begin  Redwall narrows begin  Little Colorado River
The distribution of beetles in the fall is predictive of where they’ll start the following year.
Beetle Browning 2005 at WB Site
Beetle Browning 2008 at WB Site
2006: 400 ha browned (add black flags)
2007: 4000 ha browned (add blue flags)
2008 – 2013: > 650,000 ha browned (add red flags)
Stan Young ranch along East Salt Creek in Mesa County before and after beetles released.

2007 pre-beetle

2010 post-beetle
Colorado River near Moab, Utah
Steady rise in populations across western CO with widespread defoliation across sites in 2017 and 2018.

Approximate Number of *D. carinulata* Collected and Released in CO, 2007-2018
Dinosaur National Monument Tamarisk Beetle Monitoring

2018 Monitoring Plot Counts
- No evidence
- Present
- 1 - 5 (Present)
- 6 - 30 (Established)
- 51 - 200 (High)
- 201 - 750 (Extreme)

Population counts were of all larval and adult *Diorhabda carinata* beetles collected in a standard protocol monitoring plot consisting of 25 sweeps of tamarisk foliage with an insect collection net.
Origins of the Biological Control Monitoring Program

- Colorado Department of Agriculture Palisade Insectary wanted to expand monitoring outside of CO
- 2007 TC worked with CDAPI and UC Santa Barbara to develop landscape scale monitoring program
- Focused on the Colorado River Basin
Monitoring the beetles

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<th>UTM Coordinates</th>
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<th>Sweep 2</th>
<th>Sweep 3</th>
<th>Sweep 4</th>
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<th>Early Larvae</th>
<th>Late Larvae</th>
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Note: Photos and diagrams of beetles and monitoring equipment are also included in the presentation.
2008 Distribution of Tamarisk Leaf Beetle
(Diorhabda carinulata)

Funding Provided By:
Colorado Department of Agriculture
Tamarisk Coalition
Williams

Data Collected By:
Colorado Department of Agriculture:
Palisade Insectary
Tamarisk Coalition
University of California Santa Barbara

Map Published by Tamarisk Coalition on: 11/4/11

Beetle Presence*
- Absent (0)
- Infrequent Individuals (1-4)
- Small Establishment (5-25)
- Large Establishment (26-500)

* Beetle Presence includes Adults, Larvae and Eggs
Yearly Distribution (2007 - 2011) of Tamarisk Leaf Beetle (Diorhabda carinulata)

Map Published by Tamarisk Coalition on: 11/4/11

Monitoring Years
- Red: Year 2007
- Orange: Year 2008
- Yellow: Year 2009
- Green: Year 2010
- Blue: Year 2011

Data Collected By:
- Bureau of Indian Affairs: Western & Northern Navajo Agency
- Canyon de Chelly
- Colorado Department of Agriculture: Pahsade Insectary
- Dinosaur National Monument
- Glen Canyon National Recreation Area
- Grand Canyon National Park
- Grand Canyon Youth
- Kaibab Paiute Tribe
- Lake Mead National Recreation Area
- New Mexico State University
- Northern Arizona University
- Southern Nevada Water Authority
- Tamarisk Coalition
- University of Arizona
- University of California Santa Barbara
- US Geological Survey
Yearly Distribution (2007 - 2012) of Tamarisk Leaf Beetle (Diorhabda spp.)

Data Collected By:
- Bent's Old Fort National Historic Site
- Big Bend National Park
- Bureau of Indian Affairs
- Bureau of Land Management
- Canyon de Chelly National Monument
- Colorado Department of Agriculture: Palisade Insectary
- Colorado State Forest Service
- Dinosaur National Monument
- Glen Canyon National Recreation Area
- Grand Canyon National Park
- Grand Canyon Youth
- Kaibab Paiute Tribe
- Lake Mead National Recreation Area
- Natural Resources Conservation Service
- New Mexico State University
- Northern Arizona University
- Oklahoma State University
- Ouray National Wildlife Refuge
- Southern Nevada Water Authority
- Suî Ross State University
- Tamarisk Coalition
- Texas A&M University
- Texas Parks and Wildlife Department
- University of Arizona
- University of California Santa Barbara
- US Army Corps of Engineers
- US Geological Survey
- US Fish & Wildlife Service
- Partners for Fish & Wildlife Program

Map Production Funded By:
The Walton Family Foundation
Colorado Water Conservation Board

Map Published By:
Tamarisk Coalition on: 11/08/12
Yearly Distribution (2007 - 2013) of Tamarisk Leaf Beetle (Diorhabda spp.)
2007-2015 Distribution of Tamarisk Beetle (Diorhabda spp.)

Data represent populations of tamarisk beetles as sampled at individual points in the years represented. Data are not comprehensive but are limited by the number of partners providing data to the Tamarisk Coalition for monitoring purposes. 2015 beetle presence/absence data are provided by more than 40 partners across the U.S. and Mexico. For a list of data providers, or to become a partner, visit www.tamariskcoalition.org.

Map funded by:
Walton Family Foundation
Map published by:
Tamarisk Coalition on 11/18/15
2007-2016 Distribution of Tamarisk Beetle (*Diorhabda* spp.)

Data represent populations of tamarisk beetles as sampled at individual points in the years represented. Data are not comprehensive but are limited by the number of partners providing data to the Tamarisk Coalition for monitoring purposes. 2016 beetle presence/absence data are provided by more than 40 partners across the U.S. and Mexico. For a list of data providers, or to become a partner, visit www.tamariskcoalition.org.
TC ArcGIS Online Map

Tamarisk Coalition's 2016 Tamarisk Beetle Distribution Map
Data represent populations of tamarisk beetles as sampled at individual points in the years represented. Data are not comprehensive but are limited by the number of partners providing data to the RiversEdge West for monitoring purposes. 2019 beetle presence/absence data are provided by more than 40 partners across the U.S. and Mexico. For a list of data providers, or to become a partner, visit www.riversedgewest.org.
Tamarisk beetle Old World distributions

Tracy and Robbins (2009)
Four Old World Diorhabda spp. tamarisk beetles introduced into western North America from 2001–2009

- **Northern TB**
  - *D. carinulata*
  - Ex: CN, KZ
  - 2001-NV, UT, WY, CO, AZ, NM, CA

- **Mediterranean TB**
  - *D. elongata*
  - Ex: GR
  - 2004-CA, TX

- **Larger TB**
  - *D. carinata*
  - Ex: UZ
  - 2007-TX

- **Subtropical TB**
  - *D. sublineata*
  - Ex: TN
  - 2009-TX
The genus *Diorhabda* comprises five tamarisk feeding species, four of which are now found in NA.
The genus *Diorhabda* comprises five tamarisk feeding species, four of which are now found in NA. Three of them can readily interbreed.
Hybrids possible, gene flow likely

Hybrids with reduced fecundity, gene flow rare

Diorhabda hybridization

- D. carinulata
- D. elongata
- D. carinata
- D. sublineata
Over-wintering induced by shortening daylengths – Go to sleep in middle of summer in southern areas

Lovell, WY – 44.5°N  
Xinjiang, China – 44.1°N  
Owens Valley, CA – 37.1°N  
Temple, TX – 31.1°N

New *Diorhabda*:
- *D. carinata* - 38.9° (Uzbek.)
- *D. elongata* – 35.1° (Greece)  
- *D. sublineata* - 34.7°(Tunisia)  
  All in Texas

Narrow reproductive window in Pueblo, CO and did not reproduce during the summer in Texas.
Evolution Happens…!
Diapause dates at 37°N

D. carinulata @ Pueblo CO 38°N

Bean et al. 2012
SW Willow Flycatcher & tamarisk beetle ranges - 2014
Subtropical tamarisk beetle dispersal projected from 2011-2022

• Final model incorporates functional connectivity and represents mean of 10 individual model runs using optimal dispersal kernel yielding maximum of ca. 210 km dispersal per year.
Coniatus splendidulus – Splendid tamarisk weevil
Coniatus splendidulus
Number of *Coniatus splendidulus* pupal cases and number of *Diorhabda carinulata* at each site during 2012 beetle monitoring season.
Coniatus begin feeding earlier in the spring and remain active later in the summer/fall than Diorhabda.

Tamarisk branch collected September 28. Diorhabda have been in diapause for about 30 days, Coniatus populations have exploded on the regrowth. Adults abundant, baskets abundant on branches with regrowth.
Coniatus splendidulus