New Distribution of the Tamarisk Beetle in the Lower Colorado River Basin and Implications for Future Riparian Restoration

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Society for Ecological Restoration - Southwest
Las Vegas, Nevada
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Tamarisk Beetle - *Diorhabda* spp.
Biological Control

Biological control results in an equilibrium between plant and herbivores
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 and larvae defoliating tamarisk

Courtesy of Dr. Dan Bean, Palisade Insectary
Stan Young ranch along East Salt Creek in Mesa County before and after beetles released.
Larvae hatch

1st Summer Generation
(May and June 2011)

Marble Canyon

Lee’s Ferry
Supai narrows begin
Redwall narrows begin
Little Colorado River
Larval feeding leads to defoliation!!

Marble Canyon

Defoliation (June 2011)

- Defoliation
- Refoliation

River km

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

% Defoliated

0 20 40 60 80 100

Lee’s Ferry

Supai narrows begin

Redwall narrows begin

Little Colorado River
Larvae hatch and begin to feed.
Larvae hatch

OW/F

1

Marble Canyon

1st Summer Generation (May and June 2011)

River km

Avg. Larvae

0 5 10 14 19 24 29 34 39 43 48 53 58 63 68 72 77 82 87 92 97 102 106 111 116 121

Lee’s Ferry
Supai narrows begin
Redwall narrows begin
Little Colorado River
Larval feeding leads to defoliation!!
Larvae defoliate new zone

Marble Canyon

Defoliation (July 2011)

% D Defoliated

0 10 20 30 40 50 60 70 80 90 100

River km

Lee’s Ferry
Supai narrows begin
Redwall narrows begin
Little Colorado River
Larvae defoliate new zone

Marble Canyon

Defoliation (July 2011)

% Defoliated

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

River km

0 20 40 60 80 100

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

F 2
Larvae hatch and begin to feed.

- Marble Canyon
- 2nd Summer Generation (July, 2011)

River km:
- Lee’s Ferry
- Supai narrows begin
- Redwall narrows begin
- Little Colorado River
Defoliation continues, refoliation is new refugia

Marble Canyon

Graph showing defoliation and refoliation percentages along the river km.

Lee’s Ferry: Defoliation begin
Supai narrows: Refoliation begin
Redwall narrows: Defoliation begin
Little Colorado River: Refoliation begin
Next generation of larvae are established
The distribution of beetles in the fall is predictive of where they’ll start the following year.
Colorado River near Moab, Utah
Plant’s carbon budget is a balance between sources and sinks

Carbon source: photosynthesis

Carbon sinks: growth, reproduction

Carbon sinks: metabolite storage, defense
Hultine hypothesizes that faster growing trees are killed more quickly by repeated defoliation.

Growth vs carbon storage
Impact Rapid & Dramatic

But: Re-growth fast, Dieback gradual & Mortality slow

First Defoliation

Survival
Change in Green Tamarisk Volume at Monitored Sites in Western Colorado, 2008 and 2013

Mean Volume in Cubic Meters

- Green canopy measured in 2008
- Green canopy measured in 2013
Tamarisk Mortality in Western Colorado
2010-2013

Percent Mortality

0 10 20 30 40 50 60 70 80 90 100

Salt Creek 1 Williams Gunnison Douglas Creek Gateway Horsethief SY Burned Salt Creek 2 Bedrock SY Unburned Knowles Flume

2010 2011 2012 2013
Decline in flowering/seed production

Stan Young Unburned Site

A marked tree representing the 40-60% flowering class
Mortality of tamarisk due to defoliation

- Drastic reduction to cessation of flowering
- Branch versus plant mortality
- Site conditions
  - Topography
  - Management techniques
  - Drought
  - Salinity
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
2007 Distribution of Tamarisk Leaf Beetle
(Diorhabda carinulata)

Funding Provided By:
Colorado Department of Agriculture
Tamarisk Coalition

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
2009 Distribution of Tamarisk Leaf Beetle (Diorhabda carinulata)

Funding Provided By:
The Walton Family Foundation
Kenny Brothers Foundation

Data Collected By:
Colorado Department of Agriculture:
Palisade Insectary
Dinosaur National Monument
Glen Canyon National Recreation Area
Grand Canyon National Park
New Mexico State University
Northern Arizona University
Tamarisk Coalition
University of California Santa Barbara

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

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2010 Distribution of Tamarisk Leaf Beetle (Diorhabda carinulata)

Funding Provided By:
The Walton Family Foundation
Colorado Water Conservation Board
Bureau of Indian Affairs
Telluride Foundation

Data Collected By:
Bureau of Indian Affairs:
- Western Navajo Agency
- Canyon de Chelly
- Colorado Department of Agriculture:
- Palisade Insectary
- Dinosaur National Monument
- Glen Canyon National Recreation Area
- Grand Canyon National Park
- Hualapai Tribe
- Lake Mead National Recreation Area
- New Mexico State University
- Tamarisk Coalition
- University of California Santa Barbara
- US Geological Survey

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

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2011 Distribution of Tamarisk Leaf Beetle (Diorhabda carinulata)

Funding Provided By:
The Walton Family Foundation
Colorado Water Conservation Board
Bureau of Indian Affairs

Data Collected By:
Bureau of Indian Affairs:
Western & Northern Navajo Agency
Canyon de Chelly
Colorado Department of Agriculture:
Palisade Insectary
Dinosaur National Monument
Glen Canyon National Recreation Area
Grand Canyon National Park
Grand Canyon Youth
Southern Nevada Water Authority
Tamarisk Coalition
University of Arizona
University of California Santa Barbara
US Geological Survey

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

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Yearly Distribution (2007 - 2011) of Tamarisk Leaf Beetle (Diorhabda carinulata)
Yearly Distribution (2007 - 2012) of Tamarisk Leaf Beetle (Diorhabda spp.)
Yearly Distribution (2007 - 2013)
of Tamarisk Leaf Beetle
(Diorhabda spp.)

Data Collected By:
- New Mexico State University
- Northern Arizona University
- Oklahoma State University
- Oquirrh National Wildlife Refuge
- Southern Nevada Water Authority
- Sul Ross State University
- Tamarisk Coalition
- Texas A&M University (TAMU)
- TAMU AgriLife Research
- Texas Parks and Wildlife Dept
- University of Arizona
- University of California Santa Barbara
- US Army Corps of Engineers
- US Geological Survey
- US Fish & Wildlife Service (USFWS)
- USFWS Partners for Fish & Wildlife
- USDA Forest Service
- Utah Dept of Natural Resources

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

Beetle Presence Data
- Year 2007
- Year 2008
- Year 2009
- Year 2010
- Year 2011
- Year 2012

Absent Beetle Points in 2013
(No data not collected in all regions)

Map Published By:
- Tamarisk Coalition
- 1/21/14
Yearly Distribution (2007 - 2014) of Tamarisk Beetle (Diorhabda spp.)

Map funded by: Walton Family Foundation
Map published by: Tamarisk Coalition on 12/8/14

Beetle presence/absence data provided by more than 50 partners across North America. For a list of data providers, or to become a partner, visit tamariskcoalition.org
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
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.
Four Old World *Diorhabda* spp. tamarisk beetles introduced into western North America from 2001–2009

- **Northern TB**
  - *D. carinulata*
  - E. (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
SW Willow Flycatcher & tamarisk beetle ranges - 2014

- Mediterranean
- Subtropical
- Larger
- Northern
- Mediterranean
- Subtropical
- Larger
- Northern
Tamarisk beetle (Diorhabda spp.) in the Colorado River basin: synthesis of an expert panel forum

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**Project decision tree**

Decision tree to guide restoration of a self-sustaining community of plant species that will support desirable wildlife in areas now dominated by tamarisk in the context of the biological control beetle. It assumes that this is the overarching goal (step 1) and should be used to assist in steps 2-4 in Shafran et al. (2008); questions can be answered for a reach/river/watershed of interest. For this approach to be self-sustaining, monitoring and adaptive management must be done, i.e., we may need to go through the process of the diagram more than once. This graph is adapted from one created by Gonzalez and Sher, pers. comm.

**GEOMORPHOLOGY**

Does physical space to establish and grow already exist (i.e., it is not a monoculture of tamarisk or is significantly defoliated) or is this a system that is already dynamic enough to create space for desirable replacement vegetation (riparian and/or xeric)?

**HYDROLOGY**

Do both surface and subsurface flows occur at appropriate magnitude, timing, frequency, rate of decline in subsequent years to promote arrival of propagules of desired species (riparian and/or xeric) and their establishment?

**SOIL**

Are soil activities low enough to support xeric species?

**VEGETATION**

Is propagule dispersal of desired vegetation timing?

**ACTIVE WEED MANAGEMENT**

Seeding (preferred) or pole-whole root planting

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**Mechanical clearing method decision-tree**

Are prescribed fires feasible or recommended for a particular riparian/wetlands or other sustainable?

Clear with prescribed fire, timed to promote natives

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**Mechanical clearing of tamarisk site preparation**

Are there any overstory or active trees?

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**Hydrological Considerations**

- Keep operations or irrigation sufficient to provide water but not create sites for previous monoculture (firing may burn and not necessarily facilitate geomorphic dynamism; thus adaptive management may mean a second round of clearing and removal of invasive species and/or mechanically lowering the riparian where possible.
- Attempt to re-establish natural hydrograph. If not in magnitude, at least in phase or timing.
- Adequate sediment supply will be necessary to create new stems internally or externally and to facilitate this in some areas.
- Consider promoting/retarding flow.
- Consider use of agricultural treated effluent and/or storm water return flows where feasible to recharge system.

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**OTHER FACTORS**

Is there significant grazing that prevents establishment of seedlings?

Exclude or manage timing of grazing

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Does physical space to establish and grow already exist (i.e., it is not a monoculture of tamarisk or is significantly defoliated) or is it a system that is already dynamic enough to create space for desirable replacement vegetation (riparian and/or xeric)?

- NO
  - Is Salicaceae/riparian species recruitment desired/needed?
    - NO
      - Do Safe sites exist for xeric species recruitment?
        - NO
        - YES
          - Mechanical clearing of tamarisk/site preparation*
        - YES
          - Mechanical clearing of tamarisk to create safe sites and facilitate dynamism*
    - YES
      - Mechanical clearing of tamarisk/site preparation*
Project decision tree

HYDROLOGY

Do both surface and sub-surface flows occur at appropriate magnitude, timing, frequency, rate of decline in subsequent years to promote arrival of propagules of desired species (riparian and/or xeric) and their establishment? [YES/NO]

- NO: Can good water be directed to site? [YES/NO]
  - NO: Can water be directed to site? [YES/NO]
    - NO: Locally controlled flooding/irrigation and site preparation**
    - YES: POOR CANDIDATE FOR RESTORATION
  - YES: Locally controlled flooding/irrigation**
- YES: Are dam operations feasible in the socioeconomic context to create these conditions? [YES/NO]
  - NO: Can good water be directed to site? [YES/NO]
  - YES: Dam operations**

Facilitate synanthropism
**Project decision tree**

**SOIL**
- Are soil salinities low enough to support riparian species? (NO)
- Are soil salinities low enough to support desired vegetation? (NO)
  - POOR CANDIDATE FOR RESTORATION

**VEGETATION**
- May hydro-geomorphic and/or climatic regime favor establishment of undesired species as well? (YES)
  - **Active weed management**
  - Is propagule dispersal of desired vegetation limiting? (NO)
    - Seedling (preferred) or pole/whole root planting***
  - YES

**OTHER FACTORS**
- Is there significant grazing that prevents establishment of seedlings? (NO)

* Mechanical clearing method decision-tree

Are prescribed fires feasible/recommended from a political/practical/ecological standpoint?

YES → Is there an overstory of native trees?

YES → Clear with prescribed fire, timed to promote natives

NO → Clear patches with other mechanical means (limited scale)
** Hydrological Considerations

- If dam operations or irrigation are sufficient to provide water but not safe sites, previous mechanical clearing may (but will not necessarily) facilitate geomorphic dynamism, thus adaptive management may mean a second round of clearing and/or removal of levees and/or mechanically lowering the riverbank where possible.
- Attempt to re-create natural hydrograph, if not in magnitude, at least in shape/timing.
- An adequate sediment supply will be necessary for flows to create safe sites; mortality of tamarisk will facilitate this in some areas.
- Consider promoting/reintroducing beaver.
- Consider use of agricultural, treated effluent and/or storm water return flows where feasible to recharge system.
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http://www.coloradomesa.edu/water-center/
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