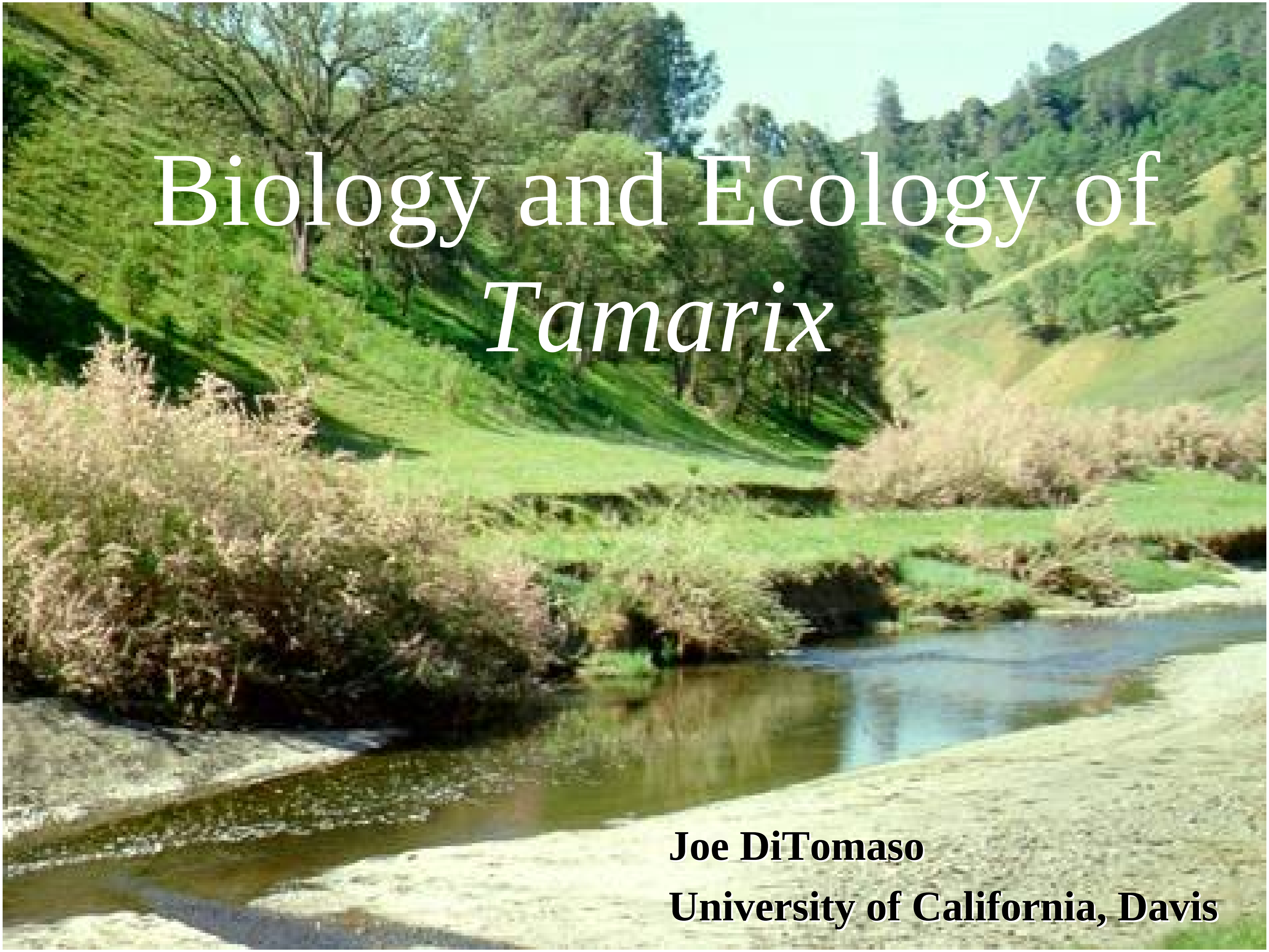

Biology and Ecology of *Tamarix*

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Riparian Areas of the West

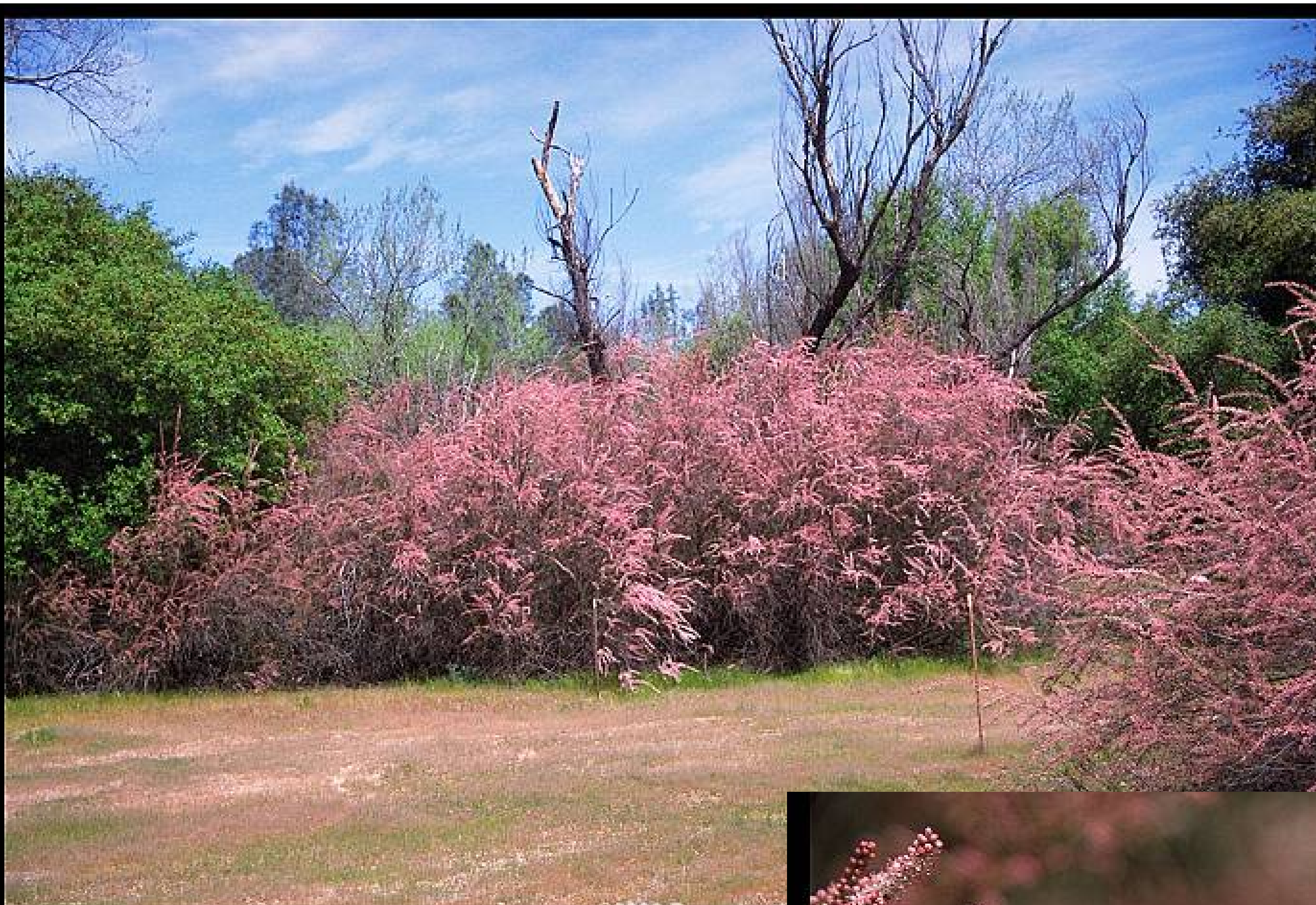
- <1% of all public lands in 11 Western States
- Among the most biologically diverse and important fish and wildlife habitats
- 80% of vertebrate wildlife use riparian habitat at some point in their lifetime


Distribution of *Tamarix* species

Species	**Range**
T. aphylla	Texas, Utah, Arizona, Nevada, and California, to 660 ft.
T. chinensis	Oregon, Montana, Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, and California, to 650 ft.
T. gallica	New Mexico and California, to 980 ft.
T. parviflora	All western states, except Wyoming, to 2625 ft. Many southern and eastern states.
T. ramosissima	Utah, Colorado, New Mexico, Arizona, Nevada, central Washington, and California, to 2625 ft. Central U.S., some southern states. Mexico (Baja California).

Smallflower tamarisk

Tamarix parviflora



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Saltcedar
Tamarix ramosissima


French tamarisk
Tamarix gallica

Stems of athel tamarisk (left) and saltcedar (right)

Athel tamarisk
Tamarix aphylla

Impacts on plant diversity, flooding and erosion, and fire frequency

- Stands can reach 70-80% cover, reducing native vegetation
- Stabilize stream sides, restricts channel width by increasing sedimentation
  - Brazos River in Texas
    - Mean river width went from 155 m in 1941 (pre-invasion) to 66 m in 1979 (post-invasion)
    - Increased incidence of flooding
- Fire adapted
  - Reduces fire intervals
    - 35% of Colorado River infested with *Tamarix* burning from 1981-1992 compared to 2% in mesquite dominated area

Impacts of wildlife - Insects

- Two insects thrive in *Tamarix*, honey bees and cicadas
- Few insects use *Tamarix* as a cover or forage
- Decomposition of *Tamarix* litter caused a 2-fold decrease in aquatic insect richness and 4-fold reduction in overall abundance

Impacts on wildlife – Birds

- Sticky exudate can damage the plumage
- Birds that roost in *Tamarix* often forage elsewhere
- Many species with reduced use in *Tamarix* communities
  - Bell’s vireo, summer tanagers, yellow-billed cuckoos, various doves, Gambel’s quail
  - Granivores (seed feeders), frugivores (fruit feeders) and insectivores
- Some species utilize *Tamarix*
  - White-winged and mourning dove
  - Willow flycatcher

Impacts on wildlife – Birds

- Biodiversity highest in cottonwood-willow communities along Colorado River
  - Native riparian area – 154 birds/40 ha
  - *Tamarix* dominated area – 4 birds/40 ha
- Along Pecos River in New Mexico
  - More birds observed in 39 ha of cottonwood, willow and mesquite than 19,600 ha of *Tamarix*

Impacts on wildlife – Mammals

- No native mammals known to feed on mature *Tamarix*
- Porcupine and beaver have high affinity for willow/cottonwood communities, but do poorly in *Tamarix* dominated communities
- Diversity of native rodents increased significantly when *Tamarix* infested site were restored to native vegetation

Tamarix Biology

- Shoot growth
- Root growth
- Reproduction
- Germination
- Seedling establishment

Shoot growth

- Can grow 3 to 4 m per season
- Tolerant to a variety of stress conditions
  - heat
  - cold
  - drought
  - flooding
  - salt

Root growth

- Phreatophytes (deep-rooted to reach water table)
  - facultative rather than obligate
- Extensive root system
  - primary root >3 m deep
  - secondary roots develop later
- Adventitious roots develop from submerged or buried stems

Tamarix parviflora shoot from broken fragment of stem washed downstream

Reproduction

- Flowers
  - insect pollinated
  - produced after a single year of growth
- Fruit
  - produced over long time period to provide continuous supply
- Seeds
  - small and light (0.1 mg); 500,000 a year per plant
  - tuft of hairs at one end to aid in wind dispersal
  - also carried in water and deposited along sandbars and riverbanks


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Germination

- Occurs within 24 h on saturated soils or while afloat
- Short viability, probably <7 weeks
- Very susceptible to drought, scouring, or submergence

Seedling establishment

- Can occur in seasonally saturated soils
- Root growth slow in first 2-4 weeks
- Susceptible to drought

Tamarix Ecology

- Salinity
- Allelopathy
- Water acquisition

Salinity

- Typically occurs in areas with 6,000 ppm salts
- Can survive at levels as high as 15,000 ppm

Allelopathy

- Exudes salt from scale-like leaves (41,000 ppm from guttation sap)
- Can also secrete boron and other ions
- Deposited on soil surface
- Understory often dominated by salt tolerant species, such as saltgrass (*Distichlis spicata*) or perennial pepperweed (*Lepidium latifolium*)


Water Acquisition

- Can extract soil moisture from less saturated soils in areas with deeper water tables
- Has a wider cavitation safety margin and less tight regulation of water loss
- More drought tolerant than most natives
- Infestations increase composition of xeric species
- Can be a low or high water user, depending on water availability
- Has higher water use efficiency at higher salinity levels

Saltcedar Transpiration Rates

- Water transpiration higher for willows on a per leaf basis, but *Tamarix* forms dense stands and has higher leaf area
- Midsummer rates comparable to irrigated alfalfa
- Max: 11 mm d^{-1} in mid June
- 0.4 – 4.0 m^3 / year (data from a range of study sites across the southwest)
- *Tamarix* water use across the southwest has been estimated to be 2x the major cities of Southern California!

- TNC Coachella Valley Preserve
  - Removal of 25 acres (80% saltcedar cover) over a five year period
- Rapid recovery of springs within cleared oases
- Vegetation restoration was rapid with increased water flow

Additional Examples

- Eagle Borax Spring in Death Valley National Monument
  - 1940's: *Tamarix* invasion
  - 1960's: surface water of marsh gone
  - 1972-82: *Tamarix* removal
  - 1983: rapid recovery with return of surface water
- Spring Lake, Artesia, New Mexico
  - Water table rose from 6 m to < 1 m following saltcedar control

The rebirth of Spring Lake

Removing saltcedar restored surface water to dried lake bed

BY DON DALE

Artesia, New Mexico

Spring Lake had been dry for over 20 years until NMSU tried Arsenal on the saltcedar choking it. Now the dead saltcedar have been cleared, and water has appeared again.

There have been three givens about saltcedar over the years: the imported trees grow prolifically, drink lots of water and have been very difficult to get rid of once established.

One of those items has changed. They are now pretty easy to kill, and that may also change the other two givens.

This is good news along the Pecos River in central and southern New Mexico, where saltcedar has taken over most native vegetation and consumed a lot of water since it was introduced to the state at the turn of the century. In fact, these dense forests of saltcedar are being blamed for enormous water losses, which are beginning to strain farms and municipalities. Yet, tests of new chemical controls hold some hope for reversing that.

"Nothing ever showed up as being helpful to us," Keith Duncan, the brush and weed specialist at New Mexico State's Agricultural Science Center in Artesia, says of controls other than expensive mechanical ones, "People had pretty well given up on chemical control of salt cedar." But in the late 1980s Duncan tried a couple of chemical trials of American Cyanimid's Arsenal on the trees. Other trials were included--most of the backpack sprayer scope--over the next two years.

"We ended up with over 30 plots, total," Duncan says, and apparent success with those plots led to a much larger trial in 1989. This was on Spring Lake south of Artesia. Spring Lake is actually two 13-acre lakes, one spring-fed and the other caused by runoff from the first. Privately owned, the lakes were active water recreation areas in the early '60s, with residents recalling water skiing there.

"By 1968-69 the saltcedar had taken it over," Duncan says. "It was dried up."

When Duncan first checked the lakes they were choked with the trees and dry as a bone. The trees' deep root systems had dropped the water table 20 feet below the surface. But aerial spraying of the lakes with Arsenal at a 1-lb. rate per acre (7 gallons in solution) reduced the saltcedar to skeletons. It took a while to get rid of all growth, but now the lakes are free of the "trash trees," more significantly, spring water is now seeping back into the upper lake.

"By 33 months after we sprayed it we had surface water in Spring Lake," Duncan boasts, and that was during a drought period. "The only difference was that the saltcedar was dead."

The test has drawn a lot of attention from all over the West, and although Duncan admits this is not a replicated trial, he calls it a demonstration that shows that the tough trees--which are native to Asia, Africa and Europe--can be killed economically. Furthermore, he thinks it shows that getting rid of saltcedar can increase water supplies.

The economic and political significance of this could be huge in states where saltcedar has taken over river basins. The Pecos River is a prime example of a watershed where the trees have not only taken over the riparian habitat, but also wasted millions of gallons of water annually. This is a complex issue between New Mexico and Texas, Duncan points out. He explains that New Mexico for over 50 years has been legally obligated, through the Pecos River Compact, to deliver a certain amount of water, determined each year by a complex formula, to Texas.