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DEATH PENALTY FOR WATER THIEVES

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Phreatophytes¹ are plants with deep root systems that draw water directly from underlying aquifers.² A destructive invasive species of phreatophyte, called tamarisk or saltcedar, also spelled *tamarix*, has spread throughout the western United States, covering an estimated 1.5 million acres once dominated by native willows, or *salix*, and cottonwoods, *populus*.³ Tamarisk consumes more water per acre than na-

1. “Phreatophyte” (frē-ā-tō-fīt) derives from “phreat” which means “well” and “phyte” which means “plant;” it refers to plants that are directly linked to aquifers and depend on the water table and the capillary fringe for water uptake.

2. See David E. Busch et al., *Water Uptake in Woody Riparian Phreatophytes of the Southwestern United States: A Stable Isotope Study*, 2 *ECOLOGICAL APPLICATIONS* 450, 450 (1992).

3. C. Jack DeLoach et al., *Ecological Interactions in the Biological Control of Tamarisk (Tamarix spp.) in the United States: Toward a New Understanding*, in *PROCEEDINGS OF THE X INT’L SYMPOSIUM ON BIOLOGICAL CONTROL OF WEEDS - JULY 4-14, 1999*, at 819, 820, 824

tive vegetation; out-competes native vegetation; increases salinity in surrounding water sources; increases the frequency of fire; and has virtually no beneficial uses.⁴ A single mature plant can consume up to 200 gallons per day, “representing an unacceptable exotic overdraft on limited water resources.”⁵ Its roots, diving as deep as 160 feet below the surface, have dried up springs, wetlands, and riparian areas by lowering the water table.⁶ Without human intervention, experts expect tamarisk and other invasive species to replace nearly all native riparian plant communities in the west.⁷ Scientists with the United States Department of Agriculture have stated that tamarisk infestation has reached epidemic proportions and is “arguably one of the worst ecological disasters ever to befall western riparian ecosystems of the United States.”⁸

This article examines some of the legal issues and history, the hydrologic realities, and the legislative responses associated with the eradication of nonnative phreatophytes. The article begins with the

(Neal R. Spencer ed. 2000), available at

<http://www.invasive.org/publications/xsymposium/proceed/12apg819.pdf>.

4. David E. Busch & Stanley D. Smith, *Mechanisms Associated with Decline of Woody Species in Riparian Ecosystems of the Southwestern U.S.*, 65 ECOLOGICAL MONOGRAPHS 347, 347-48 (1995); ALAN T. CARPENTER, THE NATURE CONSERVANCY, ELEMENT STEWARDSHIP ABSTRACT FOR *TAMARIX RAMOSISSIMA* LEDEBOUR, *TAMARIX PENTANDRA* PALLAS, *TAMARIX CHINENSIS* LOUREIRO, *TAMARIX PARVIFLORA* DE CANDOLLE, SALT CEDAR, SALT CEDAR, TAMARISK 5-8 (Ramona A. Robison & John M. Randall eds., 1998), <http://tmcweeds.ucdavis.edu/esadocs/documnts/tamaram.rtf> (last visited Nov. 11, 2004); James R. Cleverly et al., *Invasive capacity of Tamarix ramosissima in a Mojave Desert floodplain: the role of drought*, 111 OECOLOGIA 12, 12 (1997); DeLoach et al., *supra* note 3, at 826, 828-29. See also Scott M. Stenquist, *Saltcedar Integrated Weed Management and the Endangered Species Act*, in PROCEEDINGS OF THE X INT’L SYMPOSIUM ON BIOLOGICAL CONTROL OF WEEDS PROCEEDINGS OF THE X INT’L SYMPOSIUM ON BIOLOGICAL CONTROL OF WEEDS - JULY 4-14, 1999, at 487, 488-89 (Neal R. Spencer ed. 2000) (estimating that tamarisk consumes between 1.4 and 10.5 acre feet of water per acre per year), available at <http://www.invasive.org/publications/xsymposium/proceed/06pg487.pdf>. But see Bertin Anderson, *The Case for Salt Cedar*, 16 RESTORATION & MGMT. NOTES 129-134 (1998) (presenting the view that a monoculture of tamarisk is preferable to bare ground, and that most western rivers are too degraded by salt and suppressed by flood control to support native vegetation in the event tamarisk is successfully eradicated), <http://ecologicalrestoration.info/162.asp>. See generally Sean M. Schaeffer et al., *Transpiration of cottonwood/willow forest estimated from sap flux*, 105 AGRIC. & FOREST METEOROLOGY 257 (2000) (discussing water consumption by willow and cottonwood), <http://www.ag.arizona.edu/snr/rfr/faculty/david/pdf%20reprints/Schaeffer%20%20Williams,%202000>.

5. S.J. Res. 8, 2003-04 Reg. Sess. (Cal. 2003).

6. PLANT ROOTS: THE HIDDEN HALF 829 (Yoav Waisel, et al. eds., 1996); Carpenter, *supra* note 4, at 5.

7. DeLoach et al., *supra* note 3, at 824.

8. *Id.* at 820. See also COLORADO DEP’T OF NATURAL RES., 10-YEAR STRATEGIC PLAN ON THE COMPREHENSIVE REMOVAL OF TAMARISK AND THE COORDINATED RESTORATION OF COLORADO’S NATIVE RIPARIAN ECOSYSTEMS 1 (Jan. 8, 2004) [hereinafter TEN-YEAR PLAN] (“Riparian lands in Colorado have been severely impacted by many activities and actions, but none so much as the invasive plant tamarisk...”), http://cwcb.state.co.us/Resource_Studies/Final_DNR_Tamarisk_10_Year_Plan.pdf.

first judicial treatment of the issue in the Colorado Supreme Court case of *Shelton Farms*.⁹ Next, the article considers the actual hydrologic effects of phreatophytes and the scientific methods used for measuring the quantity of water saved by control projects. Finally, the article outlines federal and state legislative responses to the problem, some of which the United States Congress is considering at the time of this writing.¹⁰

I. JUDICIAL TREATMENT OF PHREATOPHYTES IN COLORADO

The doctrine of prior appropriation, often summarized by the western maxim: “first in time, first in right,” governs water law in Colorado.¹¹ Prior appropriation guarantees that a senior water right holder receives his entire allocation of water before the next junior right holder receives a single drop. When a downstream senior right holder is not satisfied with the quantity of water he is receiving, he can place a “call” on the river. This means that upstream junior appropriators must cease diverting water. The law predates statehood as an “imperative necessity” of this semi-arid region¹², and today the state engineer and the water courts strictly administer the law.

A “developed” water right is an exceptional and superior kind of right recognized in Colorado that enables the right holder to divert water without being subject to a call.¹³ Developed water rights are associated with water removed from a river system since the time of the first appropriation on a particular river.¹⁴ Essentially, developed water is water either trapped or otherwise separated from the hydrologic cycle (e.g., contained in a mine shaft) or is the product of a transbasin diversion that brings water into a foreign and hydrologically unconnected basin. Since this sort of water was not part of the river system when

9. S.E. Colorado Water Conservancy Dist. v. Shelton Farms, Inc., 529 P.2d 1321 (Colo. 1974).

10. Texas and New Mexico have passed legislation and created funding mechanisms for tamarisk control projects. See discussion *infra* pp. 25-28. Colorado has developed a Ten Year Plan for the removal of tamarisk and the restoration of native ecosystems. See discussion *infra* pp. 28-30. Congress is currently considering two bills that would provide up to \$20 million per year for tamarisk control, revegetation, and research. See discussion *infra* pp. 30-34.

11. See *Coffin v. Left Hand Ditch Co.*, 6 Colo. 443, 446-48 (1882) (holding the doctrine of prior appropriation applies to Colorado).

12. *Id.* at 447. In 1882, the Supreme Court of Colorado held that prior appropriation was the practice since the earliest appropriations of water in the region (even before statehood) and must continue with the force of law to protect expectations in property rights and to permit the profitable cultivation of the land. *Id.* at 446-47. Harkening back to Justice Miller’s words on the same subject, it “was rather a voluntary recognition of a pre-existing right constituting a valid claim to its continued use, than the establishment of a new one.” *Id.* at 447 (internal citations and quotations omitted).

13. COLO. REV. STAT. § 37-82-106 (2002); *Shelton Farms*, 529 P.2d at 1325.

14. See *Shelton Farms*, 529 P.2d at 1325.

users established their priorities, Colorado law assumes that the use of developed water will not injure any senior rights holders and decrees for such water are awarded outside the priority system.

In *Shelton Farms*, the Colorado Supreme Court considered whether a landowner who clears vegetation for the purpose of reducing the consumptive use of water on his property is entitled to a water right outside the priority system (i.e., a developed water right).¹⁵ This case, in 1974, was a matter of first impression for the entire United States judiciary.¹⁶ The controversy arose out of the creative activities of Dr. Harvey Phelps on a 700 acre farm on the Arkansas River (“Shelton Farms”).¹⁷ Dr. Phelps purchased the farm in 1967, at which time tamarisk and other phreatophytes covered roughly half of the acreage.¹⁸ Dr. Phelps read a report by Bittinger and Stringham, professors at Colorado State University, which concluded that along the Arkansas River, between Pueblo and the Colorado state line, 25,170 acres of tamarisk were consuming 65,900 acre feet of water per year (“afy”)¹⁹ depleting both instream flows and groundwater resources.²⁰ Dr. Phelps contacted the District 2 Water Referee about researching the potential benefits of clearing these phreatophytes.²¹ The Referee responded with a plan to obtain aerial photographs before and after clearing, in order to prove and quantify the water rights associated with the clearing project.²² On February 24, 1971, after the phreatophytes were cleared and replaced with less consumptive vegetation, such as brome and wheat grasses, Dr. Phelps applied to Division 2 for a conditional water right.²³ The Division 2 Referee found that:

applicants herein propose a new concept in the field of water development and water rights. Applicants, having cleared all phreatophyte growth from some 119 acres of river bottom land East of Pueblo, are claiming that they should be entitled to the usage of the water formerly consumed by the said phreatophytes. Applicants are, therefore, claiming in substance that they have developed a new supply of water

15. *Id.* at 1322.

16. *Id.*

17. HARVEY W. PHELPS, PHREATOPHYTES THAT INHABIT THE BANKS OF THE ARKANSAS RIVER (unpublished personal account), at <http://www.tamarask.com/id2.htm> (last visited Nov. 20, 2004).

18. *Id.* at 1-2.

19. One acre foot is equal to 326,000 gallons.

20. PHELPS, *supra* note 17, at 7 (citing MORTON BITTINGER & GLEN STRINGHAM, COLO. STATE UNIV. CIVIL ENG'G SECTION, COLO. AGRIC. EXPERIMENT STATION, A STUDY OF PHREATOPHYTE GROWTH IN THE ARKANSAS RIVER VALLEY (1963), available at <http://tamarask.com/id12.htm>).

21. *Id.* at 6.

22. *Id.*

23. *In re* the Matter of the Application of Water Rights of Phelps, No. W-140 (Colo. Water Court, Div. No. 2, May 25, 1971).

as if they had imported such water from the Western Slope, or from another source foreign to the Arkansas River Basin.²⁴

Awarding a conditional under-ground water right, the Division 2 Water Referee concluded:

[t]hat applicants have developed, according to a formula derived from a report entitled "A Study of Phreatophyte Growth in the Arkansas Valley" ... a new source of water totaling 181 acre feet annually.²⁵

The *Pueblo Star Journal* reported this outcome and Dr. Phelps initially received positive attention for his innovations.²⁶ The attention, however, turned negative when the Southeastern Water Conservancy District appealed the decree. The District argued that the court improperly considered this sort of water "developed" when it should instead legally classify the water as "salvaged" water.²⁷ The difference is that developed water is new water, never before part of the river system and not subject to the call of the river, and salvaged water is simply the elimination of wasteful water use that if recognized, is within the priority system.²⁸

The Supreme Court of Colorado agreed with the Conservancy District, finding that this type of water should be legally classified as "salvaged" because it is water "which ordinarily would go to waste, but somehow [is] made available for beneficial use."²⁹ The Court reasoned that since 1863, all surface flows of the Arkansas have been fully appropriated; there is not enough water to satisfy decreed water rights; and to grant a water right outside the priority system "would be wind-fall which can not be allowed, for thirsty men cannot step into the shoes of a 'water thief' (the phreatophytes)."³⁰

Although the court was reluctant to "stifle creativity in finding new water supplies" one of its chief concerns was that awarding a unique right for eradicating phreatophytes would lead to "a harvest of pandemonium" and "irreparable erosion."³¹ A second vexing issue was the inherent "technical difficulty of determining the amount of water salvaged" by clearing vegetation.³²

Justice Groves, a seminal figure in Colorado water law, grudgingly concurred in the decision but strongly recommended that the Colo-

24. *Id.* at 1-2 (emphasis added).

25. *Id.* at 2 (emphasis added). The Court affirmed and adopted this ruling June 21, 1971 when it issued a judgment and decree for Dr. Phelps.

26. PHELPS, *supra* note 17, at 16.

27. *Shelton Farms*, 529 P.2d at 1322-24.

28. *Id.* at 1325.

29. *Id.*

30. *Id.* at 1323, 1325-26.

31. *Id.* at 1326-27.

32. *Id.* at 1327 (internal citations omitted).

rado General Assembly provide an orderly solution to the “alarming” problem of increasing phreatophyte water use.³³ He threatened that if the legislature refused to act and a similar case came before the court again, in order to carry out the spirit of maximum utilization announced in *Fellhauer*, he intended to urge the court to reverse the decision and permit those in a similar position to Shelton Farms to take the water.³⁴ Bolstering his threat, the majority reminded the legislature that it had recently announced that “it shall be the policy of this state to integrate the appropriation, use and administration of underground water tributary to a stream with the use of surface water, in such a way as to maximize the beneficial use of all the waters of this state.”³⁵

Nonetheless, instead of following Justice Groves’ advice, the Colorado General Assembly did the exact opposite; codifying the holding in *Shelton Farms* in section 37-92-103(9), which expressly prohibits the award of water rights for the eradication of phreatophytes.³⁶ Since then, no substantial legislative action has been taken in Colorado and although the issue came before the Supreme Court again, it was obliged to follow section 37-92-103(9) and deny a developed water right for the claimant.³⁷

In the intervening decades, phreatophytes have expanded their domain exponentially with serious repercussions on Colorado’s water supplies. Recently, the Colorado State legislature passed a joint resolution supporting the efforts of Congress to eradicate tamarisk and the Governor of Colorado issued an executive order to the Department of Natural Resources to develop a statewide plan for the species’ eradica-

33. *Id.* at 1328.

34. *Id.* The twin mandates of *Fellhauer* were to protect vested rights and achieve maximum utilization of Colorado’s water resources. *Fellhauer v. People*, 447 P.2d 986, 994 (Colo. 1968). Following *Fellhauer*, the Colorado General Assembly codified the mandates by enacting amendments to the 1963 Water Rights Determination and Administration Act. COLO. REV. STAT. § 37-92-102(1)(a) (2000).

35. *Shelton*, 529 P.2d at 1326.

36. COLO. REV. STAT. § 37-92-103(9) (2003).

37. *Giffen v. City and County of Denver*, 690 P.2d 1244, 1248 (Colo. 1984). The Colorado Supreme Court decided *R.J.A. v. Water Users Assoc. of Dist. No. 6* on the very same day and the court denied a “developed” water right based on the removal of peat moss and the draining of a highly evaporative marsh. *R.J.A., Inc. v. Water Users Assoc. of Dist. No.6*, 690 P.2d 823, 824, 829 (Colo. 1984). In addition, in the *Pikes Peak Golf Club v. Kuiper* case the Supreme Court reversed the state engineer and granted a developed water right to Pikes Peak for water saved by draining a highly evaporative marsh that was not tributary to the stream. *Pikes Peak Golf Club, Inc. v. Kuiper*, 455 P.2d 882, 884-85 (Colo. 1969). To the extent *Pikes Peak* holds that water evaporated from soil or surface or transpired by plant life is inherently non-tributary because it does not find its way to the stream, the *R.J.A.* court believed it was wrongly decided. *R.J.A.*, 690 P.2d at 826. *But see* H.J.R. 03-1048 (Colo. 2003) (expressing the Colorado legislature’s support of federal legislation to control non-native phreatophytic weeds).

tion.³⁸ While this response may appear reasonable, it seems the least the State could do, considering its proposals to spend billions of dollars on water storage infrastructure, purportedly to solve the same underlying problem of water scarcity.³⁹

II. HYDROLOGICAL AND PHYSIOLOGICAL REALITIES OF PHREATOPHYE GROWTH IN THE UNITED STATES

A. TAMARISK PHYSIOLOGY

Tamarisk is native to the eastern Mediterranean region and western China.⁴⁰ Revealing its epic history, charcoal remains of tamarisk wood have been found in caves in Mount Carmel, Israel, dating back to the Natufian culture from 12300-10500 B.C.⁴¹ Tamarisk was introduced as an ornamental in the United States in the early 1800s and were later used to control erosion along riverbanks in the western United States.⁴² In 1920, tamarisk covered roughly 40-50 thousand acres of the southwestern United States.⁴³ In a shocking demonstration of species superiority, by 1965 this figure grew to over one million acres.⁴⁴ Today, tamarisk occupies roughly 1.5 million acres, distributed in elevations below 6,500 feet, from Mexico to Canada.⁴⁵ As a result of the invasion of the Colorado River and its tributaries, tamarisk has now replaced nearly 90% of riparian areas once covered by cottonwood and willow forests.⁴⁶ The tamarisk's domination of native cottonwoods and willows is a result of its competitive superiority in both drought and wet years.⁴⁷ Each mature tamarisk produces up to 600,000 windborne seeds each year, which are capable of migrating not just down, but upstream at

38. H.R.J. Res. 03-1048, 64th Gen. Assem., Reg. Sess. (Colo. 2003); Exec. Order No. D 002-03 (Jan. 8, 2003). Colorado's Ten Year Plan, which resulted from the Governor's order, is discussed in detail in the third section of this article.

39. See, e.g., REFERENDUM A: REVENUE BONDS FOR WATER PROJECTS (amending COLO. REV. STAT. § 37-60-201 (expired Oct. 16, 2003)).

40. DeLoach et al., *supra* note 3, at 823.

41. Curtis E. Swift, Colorado State University: Cooperative Extension, Power Point Presentation of Saltcedar (*Tamarix*) Physiology – a Primer (n.d.), at <http://www.coopext.colostate.edu/TRA/abstracts/CSAbstract.html> (last visited Nov. 20, 2004).

42. DeLoach et al., *supra* note 3, at 822.

43. Jay E. Anderson, *Factors Controlling Transpiration and Photosynthesis in Tamarix Chinensis Lour.*, 63 *ECOLOGY* 48, 48 (1982).

44. *Id.*

45. TAMARISK COALITION, *IMPACT OF TAMARISK INFESTATION ON THE WATER RESOURCES OF COLORADO* 3-4 (2003), http://cwcb.state.co.us/Resource_Studies/Tamarisk_Study_2003.pdf (last visited Nov. 20, 2004).

46. Anna Sala et al., *Water Use by Tamarix Ramosissima and Associated Phreatophytes in a Mojave Desert Floodplain*, 6 *ECOLOGICAL APPLICATIONS* 888, 888 (1996).

47. *Id.*

rates as high as 1,500 acres per year.⁴⁸ Table 1 compares relevant eco-physiological attributes of tamarisk to native vegetation.⁴⁹

Table 1

Attribute	Cottonwoods/Willows	Mesquite	Tamarisk
Stress Tolerance (water/salinity)	Low	Moderate	High
Peak Transpiration Rate (leaf area basis)	High	Moderate	Moderate
Peak Transpiration Rate (stand basis)	High	High	Very High
Water Use Efficiency*	Low	Moderate	High

*Water Use Efficiency is defined as the amount of organic matter produced by a plant per unit of water consumed.

Beyond its tremendous ability to thrive in riparian areas of the American West, the tamarisk has been aptly dubbed “saltcedar” because it increases the salinity of soils and surface waters. Dissolved salts within saline aquifers are drawn to the surface by the plants deep vascular system and deposited in its leaves and stems.⁵⁰ The salts are then spread into the environment as the leaves drop off of the plants and decay.⁵¹ Salinity can prevent the germination of native seeds;⁵² seriously impair crop production; and cause international strife. Tamarisk, thus, wields a two-edged sword, on one side consuming more water than native vegetation and on the other side polluting what water remains.

B. TAMARISK WATER USE

Tamarisk is an invasive species that is inhospitable to native wildlife; chokes native vegetation; increases wildfire frequency; alters stream channel morphology; and increases salinity of soils and surface

48. T.W. ROBINSON, U.S. GEOLOGICAL SURVEY, PHREATOPHYTES: WATER-SUPPLY PAPER 1423, at 74 (1958).

49. Table 1 is adapted from the findings of Stanley D. Smith et al., *Water Relations of Riparian Plants from Warm Desert Regions*, 18 WETLANDS 4, 687 (1998) (table created by Wendy Wempe).

50. CARPENTER, *supra* note 4, at 6 (citing J. D. HEM, U.S. GEOLOGICAL SURVEY, COMPOSITION OF SALINE RESIDUES ON LEAVES AND STEMS OF SALT CEDAR (TAMARISK PENTANDRA PALLAS): GEOLOGICAL SURVEY PROFESSIONAL PAPER 491-C (1967)).

51. DeLoach et al., *supra* note 3, at 826 (discussing the high flammability of fallen tamarisk foliage resulting in increased fire frequency; additionally, tamarisk tends to survive fires that kill willows and cottonwoods).

52. *Id.*

waters.⁵³ Evapotranspiration from phreatophytes in arid and semiarid regions is a major point of discharge for groundwater. Tamarisk is one of the most notorious phreatophytes, with roots known to extend as far as 160 feet below the surface, where they draw directly from aquifers.⁵⁴

Many studies have been conducted to determine the rates of water consumption by tamarisk in the west. These studies found a wide range of water use statistics, from 1.4 to 10.5 acre feet per acre per year.⁵⁵ These differences probably arise because the studies used different methods of measurement and variations in location, climate, sand density, and hydrogeology. While mostly anecdotal, the vast majority of studies found tamarisk a ravenous water user compared with endemic vegetation, consuming up to 50% more water than willows and cottonwoods, which dominated riparian zones prior to its introduction.⁵⁶ The Colorado Water Conservation Board estimated that infestations of tamarisk and Russian olive in Colorado occupy 55,000 acres and consume 170,000 afy *more* than the displaced native vegetation.⁵⁷ The big picture of tamarisk in the western United States reveals that the species consumes between 2,000,000 and 4,500,000 afy.⁵⁸

Typically, evapotranspiration is expressed per unit of transpiring leaf surface. This per unit expression results in quite a bit of uncer-

53. CARPENTER, *supra* note 4, at 5; CHARLES HART & ALYSON McDONALD, TEX. COOP. EXTENSION; TEX. WATER RES. INST. TEX. A&M UNIV., PECOS RIVER ECOSYSTEM MONITORING PROJECT 146 (2003), <http://twri.tamu.edu/reports/2004/tr273.pdf> (last visited Nov. 20, 2004). See Joseph K. Bailey et al., *Salt Cedar Negatively Affects Biodiversity of Aquatic Macroinvertebrates*, 21 WETLANDS 442, 442-44 (2001) (finding that tamarisk leaf litter is associated with a four-fold decrease in overall macroinvertebrate abundance relative to native Fremont cottonwood leaf litter); DeLoach et al., *supra* note 3, at 819 (observing that the spread of tamarisk has coincided with the decline of the endangered southwestern willow flycatcher and other riparian dependent bird species as well as a number of endangered fish); Stenquist, *supra* note 4, at 489 (explaining the negative impact of the saltcedar on native plant abundance, vegetative balance, and wildlife and plant diversity).

54. PLANT ROOTS: THE HIDDEN HALF, *supra* note 6, at 829.

55. Stenquist, *supra* note 4, at 489.

56. TAMARISK COALITION, *supra* note 45, at 16; CARPENTER, *supra* note 4, at 18. See also SANDRA OWEN-JOYCE, U.S. GEOLOGICAL SURVEY WATER RESOURCES OF ARIZONA, ACCOUNTING SYSTEM FOR WATER USE BY VEGETATION IN THE LOWER COLORADO RIVER VALLEY (during 1984, the United States Geological Survey estimated that on the lower Colorado alone, between the Hoover Dam and Mexico, phreatophytes consumed over 1 million afy), at <http://az.water.usgs.gov/factsheets/fact.lcras/fact.lcras.html#link4> (last modified July 30, 2001).

57. TEN-YEAR PLAN, *supra* note 8, at 8 (stating that tamarisk accounts for an estimated 40,000 acres of infestation, while Russian olive accounts for an estimated 15,000 acres).

58. Salt Cedar Control Demonstration Act, S. 1516, 108th Cong. §2(2)(B) (2003). To put this volume of water in perspective, the average annual flow of the Colorado, based on three centuries of data, is only about 13,500,000 afy and varies from 4,400,000 afy to over 22,000,000 afy. David H. Getches, *Competing Demands for the Colorado River*, 56 U. COLO. L. REV. 413, 419 (1985).

tainty, because measuring the leaf surface of the small stringy foliage of tamarisk is difficult and imprecise.⁵⁹ One researcher stated that it is difficult to extrapolate water use by a stand of tamarisk with measurements from a few leaves on a few trees.⁶⁰ This difficulty lead scientists to a combination of regional methods of measuring water use by tamarisk, such as Lower Colorado River Accounting System (“LCRAS”), and to local methods such as monitoring ground water wells, which reflect the cumulative impact of climate and plant populations.⁶¹

1. LCRAS: A Regional Method for Measuring Water Use by Tamarisk

As the *Shelton Farms* court recognized, the inability to accurately measure the quantity of salvaged water was one of the barriers to recognizing water rights based on the eradication of vegetation. This section explores some of the scientific methods used to determine the rates of water consumption by phreatophytes. The United States Bureau of Reclamation developed the LCRAS to estimate the consumptive use of water by vegetation.⁶² LCRAS relies on satellite images of vegetation types and distribution, along with the hydrologic water budget, to estimate consumptive use.⁶³ LCRAS measures all major consumptive uses of water, between gauging stations at Hoover Dam and Morelos Dam, except for phreatophyte water consumption.⁶⁴ The residual in the water budget is attributed to consumptive use by uncultivated vegetation and surface water evaporation.⁶⁵

59. Kenneth Brian Hays, *Water Use by Saltcedar (Tamarix sp.) and Associated Vegetation on the Canadian, Colorado and Pecos Rivers in Texas* 6 (May 2003) (unpublished M.S. thesis, Texas A&M University) (on file with author), available at http://farwest.tamu.edu/rangemgt/Saltcedar/Brian_Final_Thesis.pdf.

60. *Id.* at 6-7.

61. See, e.g., James R. Cleverly et al., *Seasonal Estimates of Actual Evapo-transpiration from Tamarix ramosissima Stands Using Three-Dimensional Eddy Covariance*, 52 JOURNAL OF ARID ENVIRONMENTS 181, 183 (2002) (studying water use by tamarisk in the Bosque del Apache using a combination of atmospheric data and well data).

62. SANDRA J. OWEN-JOYCE & RICHARD P. WILSON, U.S. GEOLOGICAL SURVEY FACT SHEET 94-074, ACCOUNTING FOR CONSUMPTIVE USE OF LOWER COLORADO RIVER WATER IN ARIZONA, CALIFORNIA, NEVADA, AND UTAH (Dec. 1994), <http://az.water.usgs.gov/factsheets/fs94-74/FS94-074.html>.

63. *Id.*

64. OWEN-JOYCE, *supra* note 56.

65. See *id.* (detailing how the LCRAS accounts for certain types of water). There are eleven components of the water budget:

- (1) inflow at the upstream boundary, (2) outflow at the downstream boundary, (3) change in storage in reservoirs along the budget reach, (4) quantity of water exported out of the study area, (5) consumptive use by vegetation, (6) evaporation from open-water surfaces, (7) precipitation, (8) surface- and subsurface-tributary flow, (9) domestic, municipal and industrial consumptive use, (10) surface-water flow diverted above Morelos Dam that returns to the river below Morelos Dam, and (11) change in storage in the alluvial aquifer.

Id.

LCRAS revealed that in 1984, crops were grown on 70% of the vegetated area in the flood plain of the lower Colorado River and phreatophytes covered the remaining uncultivated vegetated areas.⁶⁶ From these satellite images and analysis of the water budget, the USGS concluded that within the study area, out of a total consumptive water use of 7,129,100 acre feet, phreatophytes consumed 1,051,300 acre feet, which includes losses from surface water evaporation.⁶⁷ Since LCRAS only encompasses the lower half of the Colorado River, this figure represents only a fraction of the actual consumptive use by phreatophytes in the west.⁶⁸

2. Well Monitoring of Diurnal Fluctuations

LCRAS is an indirect, regional method for measuring water use by phreatophytes. Tamarisk stands range drastically in terms of density and age, significant factors affecting their water consumption.⁶⁹ Therefore, it is important to develop direct methods for measuring water use by specific stands.⁷⁰ Scientists have employed an assortment of techniques to this end, which include: “evapotranspirometers, stem-heat-balance, Bowen ratio, lysimeter, drums, well monitoring, Blaney-Criddle and Eddy covariance.... The Bowen ratio, Eddy covariance and Blaney-Criddle methods use meteorological measurements (temperature, wind speed, solar energy, day length, CO₂ fluxes etc.) to estimate evapotranspiration.”⁷¹ “[E]vapotranspirometers, lysimeters, drums, and tanks utilize some type of container” for growing plants.⁷² These methods allow precise measurement of the added water and the water that remains, the difference being evapotranspiration.⁷³ Monitoring diurnal (daily) fluctuations in the groundwater table is a relatively new method of estimating water use by phreatophytes that reflects the cumulative impact of climate, geology, and vegetation (Figure 1).⁷⁴

66. OWEN-JOYCE & WILSON, *supra* note 62.

67. OWEN-JOYCE, *supra* note 56.

68. Interview with Tim Carlson, Executive Director, Tamarisk Coalition (Apr. 12, 2004). Mr. Carlson claims that tamarisk alone consumes nearly 3 million acre feet annually, “enough to support the needs of 20 million people.” *Id.* In the Salt Cedar Control Demonstration Act, which is currently pending, Congress found that tamarisk and Russian olive “(A) occupy between 1,000,000 and 1,500,000 acres of land; and (B) are non-beneficial users of 2,000,000 to 4,500,000 acre-feet of water per year.” S. 1516, 108th Cong. §2(2)(A)-(B) (2003).

69. See CARPENTER, *supra* note 4, at 8.

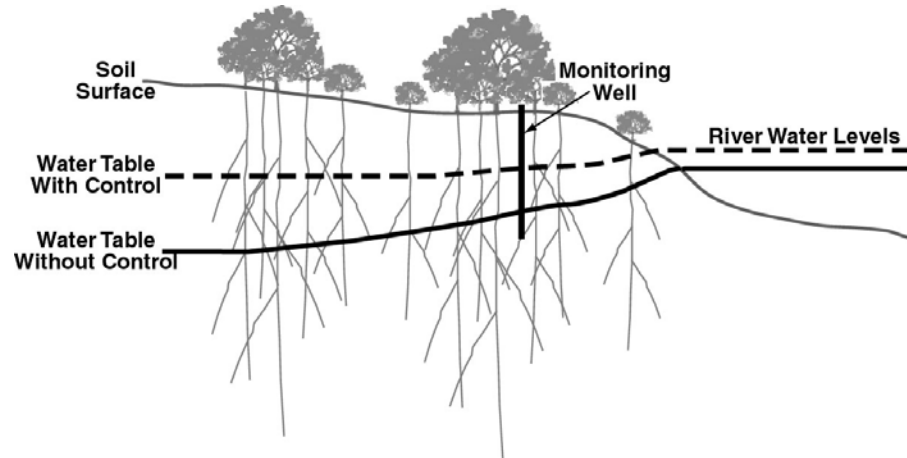
70. *Id.* at 22 (citing T.E.A. VAN HYLCKAMA, U.S. GEOLOGICAL SURVEY, WATER USE BY SALT CEDAR AS MEASURED BY THE WATER BUDGET METHOD: GEOLOGICAL SURVEY PROFESSIONAL PAPER 491-E (1974)).

71. Hays, *supra* note 59, at 4.

72. *Id.*

73. *Id.*

74. See *id.* at 2. Hays’ study was designed with the purpose of determining the best method for measuring water use by tamarisk using data from diurnal well fluctuations.

Figure 1⁷⁵

The hydrologic cycle is exceptionally dynamic and has structural components that affect the height of the potentiometric surface.⁷⁶ Piezometers are narrowly cased monitoring wells that are open to the atmosphere and allow careful measurement of the fluctuations in this surface. The *Handbook of Hydrology* states:

[w]ater levels in piezometers fluctuate on time scales ranging from a few minutes to hundreds of years, depending upon the nature of the processes that initiate the fluid pressure variations. Short-term fluctuations in confined aquifers can be caused by changes in barometric pressure of the atmosphere, earth tides, and seismic events. Earth tides can lead to water-level changes of 1 or 2 cm; atmospheric pressure changes may cause fluctuations of several tens of centimeters, depending upon the elastic properties of the aquifer and the magnitude of change in atmospheric pressure. These types of water-level changes are damped in unconfined aquifers. However, fluctuations

Id. at 3. The primary weakness Hays recognizes in estimating water use based on diurnal fluctuations is that measurements cannot be taken when recharge exceeds evapotranspiration, at which times no diurnal fluctuations exist. *Id.* at 7. These conditions can result from extremely high surface flows that correspond to sharp rises in groundwater levels. *Id.*

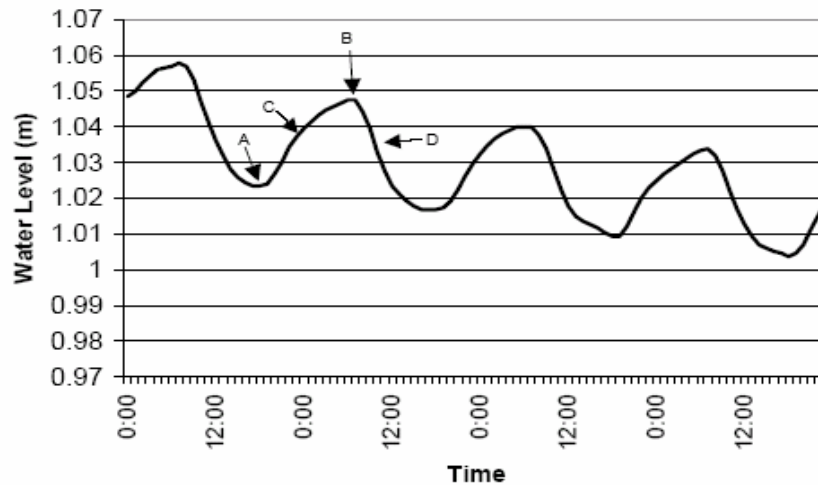
75. HART & McDONALD, *supra* note 53, at 148 (using “control” in the figure to reference tamarisk eradication) (figure created by Wendy Wempe).

76. The potentiometric surface is an imaginary surface that represents the total head in an aquifer; it is the height above a datum plane at which the water level stands inside tightly cased wells. U.S. GEOLOGICAL SURVEY, WATER RESOURCES OF NEW MEXICO, GLOSSARY, <http://nm.water.usgs.gov/glossary.htm> (last updated Oct. 5, 2004).

can occur in response to time-varying rates in consumptive use of water by plants whose roots penetrate to the water table.⁷⁷

An aquatard separates confined aquifers from the surface.⁷⁸ This is typically a confining layer of clay, rock, or another impermeable geologic formation that prevents (or significantly limits) the movement of water into the aquifer from surface infiltration. The aquatard makes the potentiometric surface of confined aquifers more susceptible to the effects of barometric pressure than that of unconfined aquifers. Therefore, only in unconfined aquifers can fluctuations in the potentiometric surface be directly attributed to evapotranspiration from vegetation. A study by Tromble explains diurnal groundwater fluctuations as reflections of varying rates of evapotranspiration by reference to Figure 2.⁷⁹

Figure 2⁸⁰



“[A]t the lowest point (A) on the curve, the inflow and outflow of water” are nearly equal, “at the highest point on the curve (B) recharge and transpiration are at a minimum.”⁸¹ “When outflow is greater than inflow (D) transpiration is high and when inflow is greater than out-

77. HANDBOOK OF HYDROLOGY 6.3.5 (David R. Maidment ed., 1993) (citations omitted).

78. Bruce Darling, Remarks at the Meeting of the Office of Conservation State of Louisiana In Re: Ground Water Management Commission 15 (May 29, 2002), (transcript available at <http://www.dnr.state.la.us/CONS/gwater/meetings/20020529/transcript.pdf>).

79. Hays, *supra* note 59, at 13 (citing J. M. Tromble, *Water Requirements for Mesquite* (*prosois juliflora*), 34 J. HYDROLOGY 175 (1977)).

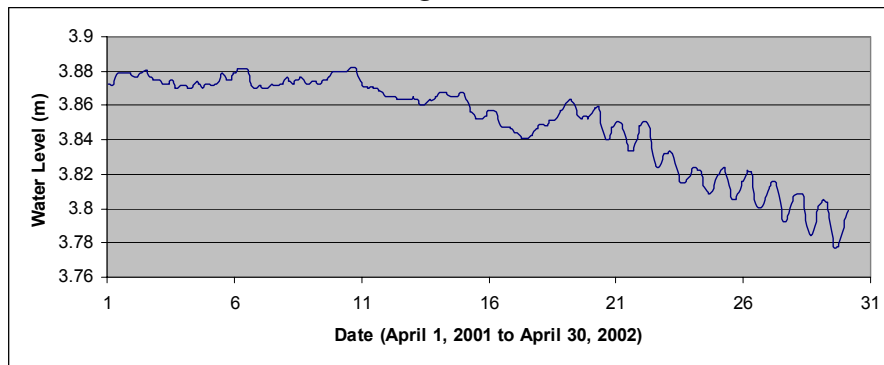
80. Hays, *supra* note 59, at 13-14 (figure created by Wendy Wempe).

81. *Id.* at 14.

flow (C) transpiration rates are lower.”⁸² “The recharge stopped at point (B) because the water level had reached the static head” and “[t]he nighttime peak (B) and the daytime low (A) decrease over time due to water loss from evapotranspiration from the shallow water table.”⁸³

More recent researchers, such as Hart and McDonald in 2004; Lacznai et al. in 1999, Rosenberry and Winter in 1997, and Hays in 2003, have affirmed Tromble’s basic findings that diurnal head fluctuations in groundwater monitoring wells are directly attributable to daily evapotranspiration.⁸⁴ These studies largely confirm the United States Geological Survey’s long held belief that daily fluctuations “vary directly with the temperature, wind movement, and intensity of sunlight and inversely with humidity, and they follow more or less closely the daily fluctuations in evapotranspiration from a free water source.”⁸⁵ The recent work by Hart and McDonald, and Hays demonstrates that regular diurnal fluctuations in unconfined aquifers only occur during the growing season, and cease after clearing vegetation (Figures 3 and 4).⁸⁶

Figure 3⁸⁷



Diurnal fluctuations coincide with the start of the growing season, around April 20th.

82. *Id.*

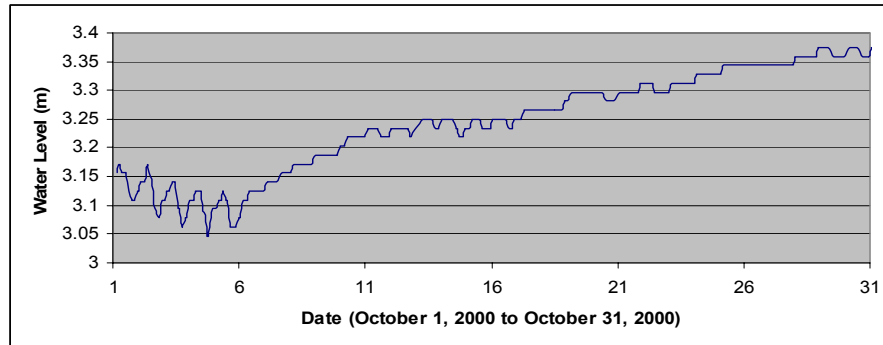
83. *Id.*

84. See HART & McDONALD, *supra* note 53, at 157; RANDALL LACZNAIK, ET AL., U.S. GEOLOGICAL SURVEY WATER RESOURCES INVESTIGATIONS REPORT 99-4079, ESTIMATES OF GROUND-WATER DISCHARGE AS DETERMINED FROM MEASUREMENTS OF EVAPOTRANSPIRATION, ASH MEADOWS AREA, NYE COUNTY, NEVADA 34 (1999); Donald Rosenberry & Thomas Winter, *Dynamics of Water Table Fluctuations in an Upland Between Two Prairie Pothole Wetlands in North Dakota*, 191 J. HYDROLOGY 266, 288 (1997); Hays, *supra* note 59, at 15.

85. Hays, *supra* note 59, at 15-16 (citing W.N. WHITE, U.S. GEOLOGICAL SURVEY, A METHOD OF ESTIMATING GROUND-WATER SUPPLIES BASED ON DISCHARGE BY PLANTS AND EVAPORATION FROM SOIL: WATER SUPPLY PAPER 659-A (1932)).

86. HART & McDONALD, *supra* note 53, at 157; Hays, *supra* note 59, at 42.

87. Hays, *supra* note 59, at 32 (figure created by Wendy Wempe).

Figure 4⁸⁸

Diurnal fluctuations stop at the end of the growing season, around October 6th.

White recognized that the amplitude of a diurnal fluctuation, not the frequency, varied between sites as a result of varying specific yields.⁸⁹ Specific yield is a property of the soil and refers to a “ratio of the volume of water that will drain under the influence of gravity to the volume of saturated rock.”⁹⁰ It is a measurement of the volume of pore space that is emptied and filled during the daily rise and fall of the water table and is represented as a percentage.⁹¹ Typically, specific yield increases with higher percentages of sand and decreases with higher percentages of clay in the aquifer.⁹² Estimates of the volume of water consumed by tamarisk derived from measurements of vertical draw-down must account for this factor.

Another hydrologic phenomenon that demands attention is that transpiration and recharge occur simultaneously and at varying rates.⁹³ Rivers that experience drastic and rapid changes in stream flow dimin-

88. *Id.* (figure created by Wendy Wempe).

89. *Id.* at 16 (citing W.N. WHITE, U.S.G.S. WATER SUPPLY PAPER 659-A, A METHOD OF ESTIMATING GROUND WATER SUPPLIES BASED ON DISCHARGE BY PLANTS AND EVAPORATION FROM SOIL (1932)).

90. U.S. GEOLOGICAL SURVEY, WATER BASICS GLOSSARY (2004), at http://capp.water.usgs.gov/GIP/h2o_gloss/ (last visited Nov. 6, 2004).

91. JAMES F. HOWLE ET AL., U.S. GEOLOGICAL SURVEY: WATER RESOURCES INVESTIGATIONS REPORT 03-4019, DETERMINATION OF SPECIFIC YIELD AND WATER-TABLE CHANGES USING TEMPORAL MICROGRAVITY SURVEYS COLLECTED DURING THE SECOND INJECTION, STORAGE, AND RECOVERY TEST AT LANCASTER, ANTELOPE VALLEY, CALIFORNIA, NOVEMBER 1996 THROUGH APRIL 1997, at 13 (2003), <http://water.usgs.gov/pubs/wri/wri034019/wri034019.book.pdf> (last visited Nov. 22, 2004).

92. See GEOTECHNICAL, ROCK AND WATER RESOURCES LIBRARY, WATER RESOURCES: SPECIFIC YIELD (n.d.), at <http://www.grow.arizona.edu/Grow-GrowResources.php?ResourceId=172> (last visited Nov. 20, 2004).

93. Hays, *supra* note 59, at 43.

ish the accuracy of drawdown calculations, because of drastic changes in their potentiometric surfaces.⁹⁴ Another complication is that the researcher must disregard transpiration that occurs during the winter and at night because that volume of water is not measurable. Hays states that this volume of water is minimal “compared to the volume transpired by a plant with full foliage during the growing season.”⁹⁵ By simply leaving these volumes out of the calculation, the end result is a conservative estimate of actual water use.

Water loggers record, “during the drawdown, the amount of evapotranspiration exceeding recharge.”⁹⁶ Since recharge occurs at the same time as evapotranspiration, actual evapotranspiration is much higher than just the depth of drawdown.⁹⁷ In order to take account of this recharge factor, Hays’ “Draw Down Recharge” method uses the high and low water level readings from the well hydrograph and “includes a recharge rate calculation.”⁹⁸

This formula [$Q = ((H_1 - L_1) + ((H_2 - L_1 / T_1) \times T_2)) (sy)$] works by taking the high for the night minus the low for the day.... However, a conservative estimate of recharge during this draw down period is estimated by subtracting the low from the next nights high divided by the number of hours during the recharge period to determine an estimated recharge rate. This is a conservative rate since some transpiration occurs at night. The amount of daytime draw down is added to the recharge rate times the number of hours during draw down to equal the estimate of water discharge for the well for the day.⁹⁹

Another tamarisk expert at Texas A & M University, Dr. Charles Hart, used diurnal fluctuations to estimate the effectiveness of the Pecos River Ecosystem Monitoring Project.¹⁰⁰ This two million dollar effort treated, killed, over ten thousand acres of tamarisk between 1999 and 2003.¹⁰¹ The well data revealed that, in 2001, a well that saw a 9.7

94. See *id.* at 43-44.

95. *Id.* at 42.

96. *Id.* at 44 (emphasis added).

97. *Id.*

98. *Id.* at 41. Hays provides an example of a formula evaluated for calculating water use: $Q = ((H_1 - L_1) + ((H_2 - L_1 / T_1) \times T_2)) (sy)$. *Id.* at 31. In the formula: Q is the rate of drawdown; H₁ is the high level for day 1; H₂ is the high level for day 2; L₁ is the low level for day 1; T₁ is the number of hours between H₁ and L₁; T₂ is the number of hours between H₂ and L₂; and sy is specific yield. *Id.*

99. *Id.* at 41.

100. See HART & McDONALD, *supra* note 53, at 157.

101. CHARLES HART, TEXAS WATER RES. INST., THE PECOS RIVER ECOSYSTEM PROJECT PROGRESS REPORT: SR-2004-01 6 (2003), <http://twri.tamu.edu/reports/2004/sr2004-001.pdf>.

foot decline in the water table, only saw a 0.57 and a 0.14 foot decline each season after the tamarisk was eradicated (Figure 5).¹⁰²

Figure 5¹⁰³

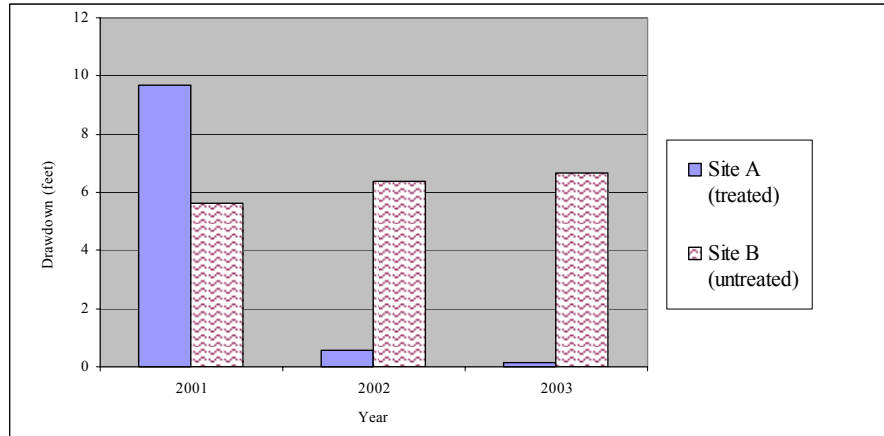
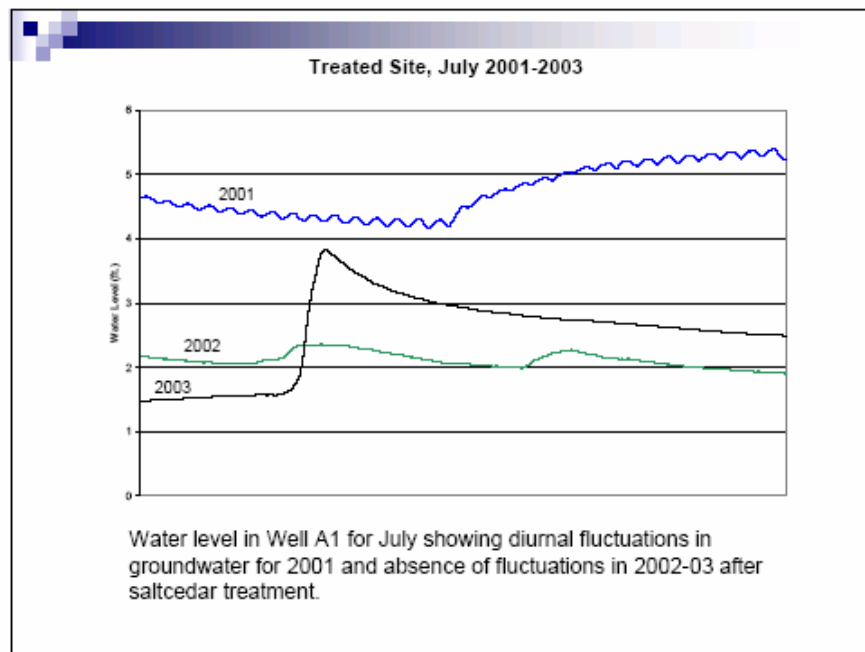


Figure 6¹⁰⁴



102. HART & McDONALD, *supra* note 53, at 160. These well sites were geographically close to each other, so it is unlikely that local recharge at individual sites skewed the data.

103. *Id.* at 160 fig.16 (figure created by Wendy Wempe).

104. *Id.* at 159 fig.15 (figure created by Wendy Wempe).

Dr. Hart also found that the water table rose and diurnal fluctuation stopped as a result of treatment (Figure 6).¹⁰⁵ Since native vegetation had not yet taken root in the treated area, these results do not represent long term water savings.

The method of estimating water consumption by using diurnal fluctuations in groundwater wells is not a direct measurement of the volume of water consumed, but rather is a measurement of the seasonal drawdown of the potentiometric surface. After designating a study area, drawdown can be converted into volume by multiplying the area of the study area times the depth of drawdown, and accounting for specific yield. In either case, decision makers left with a measurement of water table drawdown or a specific volume, can distinguish between successful and unsuccessful control techniques. As researchers carry out more experiments, the anecdotal evidence demonstrating the correlation between removing tamarisk with rising water tables will provide more scientific certainty. The case made by Dr. Hart, measuring the success of eradicating tamarisk on the Pecos River, is an impressive example, but passage of time is necessary to demonstrate long-term effectiveness. Regional methods such as those employed in LCRAS, combined with local methods such as drawdown data should lead to reasonably accurate measurements of water saved by tamarisk control projects and thus to better watershed management capabilities in the near future.

III. LEGISLATIVE RESPONSES TO INVASIVE PHREATOPHYTES

Phreatophyte growth has negatively impacted many states ecologically, including Arizona, New Mexico, Colorado, Nevada, Utah, California, Texas, Oklahoma, and Wyoming.¹⁰⁶ However, there are only two examples of state or local legislation that deal directly with the problem.¹⁰⁷ Some states, like California and Colorado, have simply pledged their support for federal legislation and rely primarily on federal agencies and federal funds to control phreatophytes.¹⁰⁸ States' reluctance to act may be attributed to the fact that the problem transcends state boundaries; or to the technical difficulty of measuring the quantity of water saved by control projects; or it may simply be a relic of the classic western approach to federal involvement in water supply

105. *Id.*

106. CARPENTER, *supra* note 4, at 5.

107. N. M. STAT. ANN. § 9-5A-10 (Michie 1978 & Supp. 2003); TEX. AGRIC. CODE ANN. §§ 203.001-.161 (Vernon 1982 & Supp. 2004-2005).

108. S.J. Res. 8, 2003-04 Reg. Sess. (Cal. 2003); H.R.J. Res. 03-1048, 64th Gen. Assem., Reg. Sess. (Colo. 2003). Reliance on the federal government has not, to date, moved the agenda very far along. However, a pending bill discussed below (S. 1516) may facilitate progress in controlling phreatophytes.

issues, to tell the Bureau of Reclamation, “[g]et out and give us more money.”¹⁰⁹

Regardless of the cause of state paralysis on the matter, federal agencies are making headway. Starting in 1998, “Interior Secretary Bruce Babbitt, Agriculture Secretary Dan Glickman, and Commerce Secretary Daley” joined forces to focus on eradicating invasive weeds.¹¹⁰ Also in 1998, scientists working on biological controls for tamarisk established The Saltcedar Consortium.¹¹¹ “The [C]onsortium functions as a leadership forum and working group” and “is open to all interested parties.”¹¹² The following year, President Clinton signed the Invasive Species Executive Order, which emphasized increased collaboration among local, state, federal, tribal, academic institutions, the scientific community as well as environmental, agricultural, and conservation organizations.¹¹³ These initiatives illustrate that a serious problem exists and that political support for a solution is available. However, to date the effort has not been proportional to the gravity of the circumstances.¹¹⁴ Two congressional bills discussed below contemplate, for the first time, allocating about one hundred million dollars to fight tamarisk infestation. This expenditure seems the least the federal government could contribute to combat a plant that critically impairs the twenty billion dollar federal water storage and delivery infrastructure.¹¹⁵

A. NEW MEXICO

New Mexico is seriously inundated with tamarisk.¹¹⁶ Because the plants pose such a threat to the state’s economic and ecological wellbeing, and impede the state’s ability to satisfy compact obligations, the

109. CHARLES F. WILKINSON, *CROSSING THE NEXT MERIDIAN LAND, WATER AND THE FUTURE OF THE WEST* 302 (1992).

110. STENQUIST, *supra* note 4, at 493.

111. *Id.* at 495. Biological control refers to insects that have potential to be introduced for the purpose of slowing or reversing the spread of tamarisk. *Id.*

112. *Id.*

113. Exec. Order No. 13,112, 64 Fed. Reg. 6183 (Feb. 3, 1999).

114. S. 2319, 58th Leg. Assem., Reg. Sess. (N.D. 2003) (appropriating \$250,000 from the Environment and Rangeland Protection Fund for the eradication of tamarisk).

115. Sandra K. Davis, *The Politics of Water Scarcity in the Western States*, 38 SOC. SCI. J. 527, 527 (2001) (stating that “Since 1902, the Bureau of Reclamation alone has spent \$21.8 billion to construct 133 water projects.”). The Bureau of Reclamation believes that 2.5 million acre-feet per year are wasted by tamarisk, which constitutes an annual loss of about \$288 million in irrigation water and \$43 million annual loss in power generation along the Colorado River. U.S. BUREAU OF RECLAMATION, *DECISIONMAKING MODEL HELPS CONTROL INVASIVE SPECIES WITHIN LIMITED BUDGETS*, at <http://www.usbr.gov/research/science-and-tech/news/02newsmodel.html> (last visited Nov. 20, 2004).

116. See Greg Hanscom, *Bringing Back the Bosque*, HIGH COUNTRY NEWS, Nov. 19, 2001 (detailing the effects of the inundation of tamarisk in the Middle Rio Grande), at http://www.hcn.org/servlets/hcn.Article?article_id=10856.

state legislature has taken affirmative steps to ameliorate the situation. First, the legislature directed the Secretary of Natural Resources to develop a comprehensive watershed restoration strategy focused on the removal of non-native phreatophytes.

§ 9-5A-10. Secretary of energy, minerals and natural resources; additional duties:

The secretary of energy, minerals and natural resources shall develop a comprehensive watershed restoration strategy that sets guidelines for coordination with state and federal land management agencies and political subdivisions, including the soil and water conservation districts and other stakeholders. The strategy shall focus on removing the overabundance of woody vegetation, particularly non-native species of phreatophytes that consume excessive amounts of water and on reestablishing the natural ecology of New Mexico. The strategy shall use:

A. incentives to encourage the formation of businesses to clear vegetation;

B. incentives to encourage biomass energy use; and

C. the use of inmates from the corrections department to assist with watershed cleanup.¹¹⁷

Second, the New Mexico legislature provided a financing mechanism for approved projects through the "Water Project Fund."¹¹⁸ Under section 72-4A-9, the New Mexico Finance Authority can issue revenue bonds, loans, or grants to soil and water conservation districts for projects that the New Mexico legislature approves.¹¹⁹ The legislature also pre-approved loans or grants to some water conservation districts for tamarisk, Russian olive, and mesquite eradication projects.¹²⁰ Since the Fund's inception, the State has spent six to eight million dollars on tamarisk control.¹²¹

117. N. M. STAT. ANN. § 9-5A-10 (Michie 1978 & Supp. 2003).

118. § 72-4A-9.

119. *Id.*

120. S. 843, 46th Leg., 1st Reg. Sess. (N.M. 2003) (granting funding "to the De Baca soil and water conservation district for a salt cedar, Russian olive and mesquite eradication project;" and "to the Tierra y Montes soil and water conservation district for a salt cedar eradication project..."). *See also* § 72-4A-9(C).

121. Interview with Tim Carlson, Executive Director, Tamarisk Coalition (April 12, 2004). Mr. Carlson also explained that New Mexico has primarily used aerial spraying of large swaths of infested land to control tamarisk, without attempting revegetation. The aerial spraying is partially due to the fact that the funds were available for aerial spraying before a statewide plan was in place. Environmental organizations and U.S.G.S. scientists criticized the spraying and the situation is in the process of being corrected.

B. TEXAS

The Texas “Brush Control” statute provides a mechanism to oversee and fund phreatophyte eradication projects.¹²² The Brush Control statute directs the State Soil and Water Conservation Board to rank areas where brush contributes to a substantial water quantity problem.¹²³ The Board must also prepare a statewide comprehensive plan for managing brush.¹²⁴ In ranking areas, the statute requires the Soil and Water Conservation Board to “give priority to areas with the most critical water conservation needs and in which brush control and revegetation projects will be most likely to produce substantial water conservation.”¹²⁵ Local water districts and private individuals carry out actual eradication projects, with the Board playing a supervisory and financing role.¹²⁶

The key to the Brush Control statute is the “Brush Control Fund.”¹²⁷ Since the Fund’s creation in the State Treasury, over twenty million dollars have been appropriated for brush control projects.¹²⁸ If a person applies for assistance from the Brush Control Fund, Texas may only supply a maximum of 70 percent of the total cost of a single project.¹²⁹ If a political subdivision of the State applies for these monies, such as a water conservation district, the State may not contribute more than 50 percent of the project’s total cost.¹³⁰ To compete for the money, individuals and political subdivisions of the state must apply to the State Soil and Water Conservation Board. The Board has authority to approve projects funded by the “Brush Control Fund” if the proposed method of brush control:

- (1) has proven to be effective and efficient method for controlling brush;
- (2) is cost efficient;
- (3) will have a beneficial impact on the development of water sources and wildlife habitat;

122. See TEX. AGRIC. CODE ANN. § 203.011 (Vernon 1982 & Supp. 2004-2005).

123. *Id.* § 203.051.

124. *Id.*

125. *Id.* § 203.053(b).

126. See *id.* §§ 203.104, 203.153.

127. *Id.* § 203.152(a).

128. LAURA BALL & MELINDA TAYLOR, ENVTL. DEF., BRUSH MANAGEMENT: MYTHS AND FACTS 4 (2003), http://www.texaswatermatters.org/pdfs/brush_management.pdf (last visited Nov. 22, 2004).

129. § 203.154(a).

130. *Id.* § 203.154(d).

(4) will maintain topsoil to prevent erosion or silting of any river or stream; and

(5) will allow the revegetation of the area after the brush is removed with plants that are beneficial to the stream flows, groundwater levels, and livestock and wildlife.¹³¹

Some further requirements for approving a project are that the landowner consents to the project; the Board approves the method of eradication; and “the project is a high priority within the context of the board’s [statewide] plan.”¹³² The Board’s priority system considers central factors, including stream flows; the quantity of underlying groundwater; and the amount of water that the project is expected to conserve.¹³³ The statute also requires the Soil and Water Conservation Board to regularly consult with appropriate state agencies to determine the effects of brush control projects on water quantity; agriculture; and fish and wildlife.¹³⁴ On top of the Brush Control statute, the Texas Water Resources Institute funds tamarisk control experiments through the Texas Agricultural Experiment Station.¹³⁵

C. COLORADO

There are a handful of tamarisk control projects already underway in Colorado, including work on the Animas River, Arkansas River, San Miguel River, Yampa River, Dinosaur National Monument, and Colorado National Monument.¹³⁶ The most impressive of these is the Nature Conservancy’s “Saving the Natives” campaign, which intends to eradicate tamarisk on the San Miguel River and its tributaries by 2006.¹³⁷ So far, about 30 miles, out of a total 100 miles of infested riverbanks, “have been cleared of tamarisk, Russian olive, or Siberian elm at an average cost of \$6,800 per mile.”¹³⁸ A wide array of federal, state, county, and private funds support the project; the project is expected to yield “a million acre, tamarisk free watershed.”¹³⁹

Pursuant to Governor Bill Owens’ executive order¹⁴⁰, the Colorado Department of Natural Resources has developed a comprehensive Ten

131. *Id.* § 203.055(b).

132. *Id.* § 203.158.

133. *Id.* § 203.159(c).

134. *Id.* § 203.016.

135. TEX. WATER RES. INST., 10 WATER RESOURCES RESEARCH GRANTS AWARDED (Mar. 25, 2004) (awarding a total of \$72,000, for ten research experiments, between March 2004 and August 2004), at http://twri.tamu.edu/news_2004-03-25.php (last visited Nov. 20, 2004).

136. TEN-YEAR PLAN, *supra* note 8, at 19-21.

137. *Id.* at 20.

138. *Id.*

139. *Id.*

140. Colo. Exec. Order No. D 002-03 (2003).

Year Plan to control invasive phreatophytes.¹⁴¹ Governor Owens recommended that the Department of Natural Resources carry out the plan as soon as funds can be appropriated. The following are some of the guiding principles of the Ten Year Plan:

- the objective of tamarisk control is the reestablishment of native vegetation that can be sustainable;
- control activities should occur on a watershed scale, should be partnerships with all affected interests, and have local control;
- success requires control, revegetation, monitoring, maintenance, and appropriate funding;
- *existing water rights, river management infrastructure, and property rights must be respected;*
- education is essential...;
- if no action is taken, the problem will continue to grow and degrade the state's river systems.¹⁴²

Almost all aspects of a successful tamarisk control plan are in place in Colorado except for appropriate funding. The Department of Natural Resources estimated the cost of the plan at \$5 million per year,¹⁴³ rising to \$13 million by the fifth year of implementation. During the state's current financial emergency, these costs are prohibitively expensive. Funding at the moment "is ... piece meal and inadequate to accomplish the objective of controlling tamarisk within 10 years."¹⁴⁴ Therefore, program must develop long-term funding "from combinations of state and local in-kind support, federal funding, and new sources."¹⁴⁵ Federal funds, potentially distributed pursuant to Senate Bill 1516, may be exactly what Colorado needs to begin implementation.

D. UNITED STATES

As the West continues to experience the worst drought conditions in modern history, Congress has finally recognized the seriousness of the tamarisk infestation and its effect on water quantity. Five different bills aimed directly at tamarisk were introduced in Congress during the

141. TEN-YEAR PLAN, *supra* note 8.

142. *Id.* at 1 (emphasis added).

143. *Id.* at 2.

144. *Id.*

145. *Id.*

last year.¹⁴⁶ Pending legislation would provide an unprecedented twenty million dollars during its initial year and fifteen million dollars per year thereafter for tamarisk control, revegetation, and research.¹⁴⁷ Representatives from New Mexico and Colorado introduced the two pending bills.¹⁴⁸ Colorado's congressional delegation has been instrumental in gathering support for these bills; with Senator Campbell and Congressmen McNinnis, Udall, and Beauprez co-sponsoring the bills, a true bi-partisan effort exists.

Senate Bill 1516, the "Salt Cedar and Russian Olive Control Demonstration Act," is the version most likely to become law, having passed in the Senate on May 19, 2004.¹⁴⁹ Senate Bill 1516 would authorize the appropriation of twenty million dollars for 2005, and fifteen million dollars each subsequent fiscal year, to address the infestation of tamarisk and Russian olive trees in the west.¹⁵⁰ The bill calls on the federal government to bear the full cost of an infestation assessment; identification of long-term management strategies; and analysis of "economic means to dispose of the biomass created as a result of removal of salt cedar and Russian olive trees."¹⁵¹ Federal funding for demonstration projects carried out on non-federal land must not exceed seventy-five percent and the remainder state agencies may provide in the form of in-kind contributions and services by state agencies.¹⁵²

The first action item in Senate Bill 1516 requires "[t]he Secretary of Interior... acting through the Commissioner of Reclamation and in cooperation with the Secretary of Agriculture and the Secretary of Defense, ... to assess the extent of the infestation by tamarisk and Russian

146. Salt Cedar and Russian Olive Control Demonstration Act, H.R. 2707, 108th Cong. (2003); Tamarisk Control and Riparian Restoration Act, S. 1236, 108th Cong. (2003); Salt Cedar and Russian Olive Control Demonstration Act, S. 1516, 108th Cong. (2003); Salt Cedar Council Demonstration Act, S. 1051, 108th Cong. (2003); Tamarisk Research and Control Act of 2003, H.R. 695, 108th Cong. (2003).

147. Salt Cedar and Russian Olive Control Demonstration Act, S. 1516, 108th Cong. § 2(j)(1)-(2) (2003)

148. Senators Domenici and Campbell introduced S. 1516 on July 31, 2003. Representative Pearce introduced H.R. 2707 on July 10, 2003.

149. S. 1516. *See also* Interview with Tim Carlson, Executive Director, Tamarisk Coalition (April 12, 2004).

150. S. 1516 § 2(j)(1)-(2). The Senate Energy and Natural Resources Committee amended the original bill, reducing the total appropriation "from \$50 [million] for fiscal year 2004 and such sums as are necessary for each fiscal year thereafter to \$20 [million] for fiscal year 2005 and \$15 [million] each subsequent fiscal year." S. REP. NO. 108-235, at 6 (2004). "Subsection (f) establishes cost limitations for carrying out the legislation. The infestation assessment is limited to \$4,000,000; the identification and documentation of long-term management strategies is limited to \$2,000,000; the demonstration projects are limited to \$7,000,000 per project; and the biomass analysis is limited to \$3,000,000." *Id.* "The CBO [Congressional Budget Office] estimates that implementing S. 1516 would cost \$39 million over the 2005-2009 period." *Id.* at 7.

151. S. 1516 § 2(a)(1)-(3).

152. *Id.* § 2(f)(2)(B).

olive trees.”¹⁵³ Senate Bill 1516 then charges the Secretary of Interior with demonstrating strategic solutions for: (1) the long-term management of tamarisk; (2) the reestablishment of native vegetation; and (3) disposing of the biomass.¹⁵⁴

The Secretary of the Interior must carry out not less than five demonstration projects to evaluate the most effective control techniques.¹⁵⁵ Each project is limited to a maximum of \$7 million and is to be “implemented in collaboration with Federal agencies, units of State and local government, national laboratories, Indian tribes, institutions of higher education, individuals, organizations, or soil and water conservation districts.”¹⁵⁶ To compare and contrast the costs and benefits of different control techniques, the Secretary must assess the effectiveness of (1) airborne herbicide application; (2) mechanical phreatophyte removal; and (3) biocontrol, including goats and/or insects.¹⁵⁷ The bill further requires the Secretary of Interior to analyze the economic means, such as manufacturing wood products, to dispose of the biomass generated by phreatophyte removal in order to defray the costs of control.¹⁵⁸

IV. DISCUSSION AND POTENTIAL LEGAL ISSUES ASSOCIATED WITH PHREATOPHYTE ERADICATION

The tamarisk problem is drawn along natural instead of political boundaries. Not surprisingly, this has complicated the decision making and funding processes. It also poses a potential legal hurdle in terms of allocating the “salvaged” water. Some states may fear that without a framework for accurately measuring and distributing the salvaged waters, an upstream state’s investment of time and money eradicating phreatophytes will physically accrue to downstream states. In other words, the Colorado River compact entitles New Mexico to 11% of the upper basin’s share, so if New Mexico successfully increases the flow of the River, benefits may accrue to Colorado, Utah, and Wyoming.¹⁵⁹ Another legal possibility is that if the federal government becomes the primary funding source for eradicating tamarisk, it may claim a right to the salvaged water superior to both states and individual appropriators. The federal government could claim rights to the salvaged water based upon the unmet need for federal reserved rights to satisfy Indian tribes, endangered species, and national parks. This is

153. *Id.* § 2(a)(1).

154. *Id.* § 2(a)(2)-(3).

155. *Id.* § 2(d)(1).

156. *Id.* § 2(d)(1), (f)(1)(C).

157. *Id.* § 2(d)(2)(B)(i)-(iii).

158. *Id.* § 2(e)(1)-(2).

159. COLO. REV. STAT. § 37-62-101 art. III(a)(2) (2003).

a fear of some water conservation districts in Colorado, and the federal legislation contains no safeguards respecting the issue.¹⁶⁰

V. CONCLUSION

The Bureau of Reclamation has spent over twenty billion dollars constructing water supply infrastructure.¹⁶¹ Tamarisk inhibits the efficient operation of these facilities. The affected states, with the exception of Texas and New Mexico, have been unable or unwilling to put the necessary time and money into abating the “alarming situation” of phreatophyte infestation.¹⁶² Colorado has arguably even gone so far as to destroy any existing incentives for private landowners to control phreatophytes. As the body of scientific knowledge grows around tamarisk, and the gap between available water supplies and demands shrinks, the federal government is poised to apply itself to the problem of phreatophytes. The passage of the “Tamarisk Control Demonstration Act” would constitute the most significant allocation of resources to the eradication of phreatophytes in the nation’s history. Nonetheless, the bill is only a “Control and Demonstration Act,” and provides annual funding only in the tens of millions of dollars.¹⁶³ To successfully eradicate tamarisk throughout its current range of 1.5 million acres, and to provide for the restoration of native species, would probably require an effort on a different scale altogether.¹⁶⁴ All levels of government should rise to this challenge, not only to serve social and economic ends, but because “[a] thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community.”¹⁶⁵

160. Interview with Tim Carlson, Executive Director, Tamarisk Coalition (April 12, 2004) (the Southeastern Water Conservancy District, in particular, harbors this fear).

161. Davis, *supra* note 115, at 527.

162. See S.E. Colorado Water Conservancy Dist. v. Shelton Farms, Inc., 529 P.2d 1321, 1328 (Colo. 1974) (Groves J., specially concurring).

163. Compared to the 2.5 million acre feet per year wasted by tamarisk, which constitutes an annual loss of about \$288 million in irrigation water and \$43.5 million in power generation, the proposed funding seems inadequate. See U.S. BUREAU OF RECLAMATION, DECISIONMAKING MODEL HELPS CONTROL INVASIVE SPECIES WITHIN LIMITED BUDGETS, *supra* note 115. Tim Carlson, Executive Director of the Tamarisk Coalition, in cooperation with an array of state and federal agencies, are in the process of a thorough economic impact analysis of tamarisk, which should help drive informed resource allocation in the future.

164. See generally Juliet C. Stromberg, *Restoration of Riparian Vegetation in the South-Western United States: Importance of Flow Regimes and Fluvial Dynamism*, 49 J. ARID ENV'TS 17 (2001) (presenting the view that altered flow regimes, caused primarily by dams, are a central contributor to the spread of tamarix and the decline of natives, and that restoring natural hydrologic regimes is an important component of a successful eradication and restoration plan).

165. ALDO LEOPOLD, A SAND COUNTY ALMANAC 224-25 (2d prtg.1970).