

The Monstering of Tamarisk: How Scientists made a Plant into a Problem

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Abstract. Dispersal of biota by humans is a hallmark of civilization, but the results are often unforeseen and sometimes costly. Like kudzu vine in the American South, some examples become the stuff of regional folklore. In recent decades, “invasion biology,” conservation-motivated scientists and their allies have focused largely on the most negative outcomes and often promoted the perception that introduced species are monsters. However, cases of monstering by scientists preceded the rise of popular environmentalism. The story of tamarisk (*Tamarix* spp.), flowering trees and shrubs imported to New England sometime before 1818, provides an example of scientific “monstering” and shows how slaying the monster, rather than allaying its impacts, became a goal in itself. Tamarisks’ drought and salt tolerance suggested usefulness for both coastal and inland erosion control, and politicians as well as academic and agency scientists promoted planting them in the southern Great Plains and Southwest. But when erosion control efforts in Arizona, New Mexico and Texas became entangled with water shortages, economic development during the Depression and copper mining for national defense during World War Two, federal hydrologists moved quickly to recast tamarisks as water-wasting foreign monsters. Demonstrating significant water salvage was difficult and became subsidiary to focusing on ways to eradicate the plants, and a federal interagency effort devoted specifically to the latter purpose was organized and continued until it, in turn, conflicted with regional environmental concerns in the late 1960s.

Keywords: introduced species, tamarisk, salt cedar, monsters, plant ecology, new deal, Reclamation Act, scientific practice, erosion control, hydrology, groundwater, phreato-phyte control, Southwestern United States

Prologue

Philip Pauly and I shared an interest in “thinking about the interactions between people and other organisms” in historical context.¹ We were both particularly intrigued by the darker, or at least more reflexive reactions of Americans to introduced species. Phil’s account of the late eighteenth century Hessian fly outbreak in American wheat fields is a classic treatment. His analysis of the intra-agency conflicts at the US Department of Agriculture over Japan’s gift of flowering cherries (the ill-fated forerunners of the photogenic trees still gracing the nation’s capital) is another.² As shown by the additional material regarding these cases appearing in his last book, *Fruits and Plains*, he did not consider either of them closed simply because he had written all he could at a given time. That is an approach I will emulate. “The Monsterring of Tamarisk” is part of a narrative that I anticipate both refining and expanding.

Phil and I converged on our common theme from elaborately different points of view: I as a government biologist and planner trying to stitch together policies and programs from the raggedly mismatched edges of conservation philosophy, ecological theory, political expediency and firsthand observations of Southwestern plants and animals; he as a historian’s historian, immersed in liberal arts and civilization, adept at teasing out and revealing the role of biological science in American culture. I’m afraid I can’t tell you what drew him to that study beyond what he revealed in his writings. We had few real opportunities for freewheeling discussion. Our conversations were shoptalk, dominated by problems of current research and writing. Only in the brief period after Phil had put the last touches on *Fruits and Plains*, and his health had yet again seemingly stabilized did we anticipate opening a broader conversation. Alas, it was not to be.

Introduction

Tamarisk

The cradles of Old World civilization were likewise the evolutionary wellspring of tamarisks (*Tamarix* spp.): brushy-looking, grayish-green

¹ Pauly, 2007, p. 263.

² See Pauly, 1996, 2002.

trees and shrubs common around the ephemeral waters of arid climates.³ Their tiny, scale-like leaves and occasional cone-like galls belie their angiosperm classification; unless covered in masses of tiny pink, white or beige blossoms they are easily mistaken for cedars or junipers. Often the only source of timber and firewood in chronically dry lands, tamarisks entered the myth, religion, material culture, and pharmacopoeia of many ancient traditions. The broad “native” range of *T. aphylla*, the largest species (a tree of many names known in America as the athel) may well be an artifact of an ancient horticultural trade.

Educated eyes recognize tamarisks in most media images of Middle Eastern villages. They are common and locally abundant from Cornwall to Mongolia, and Palestine to Korea, in a North African arc from Cape Verde to Kenya, and again in southwestern Africa. All species save the athel are difficult to distinguish, and their number remains uncertain.⁴ By the early nineteenth century, several species were cultivated in the Americas. They were promoted as hardy, flowering ornamentals, and recommended for controlling soil erosion in droughty regions. By 1880, uncultivated tamarisk stands appeared in parts of the American Southwest, and began to spread.⁵

Monsters

This is an account of scientists creating a monster: not by assembling and reanimating one as envisioned by Mary Shelley, but by declaring that an organism once presumed tractable was flouting human intentions, and recasting it as malevolent. The human principals, representing a particular institutional culture and a nascent scientific sub-discipline, were working at (and thus often beyond) the limits of their expertise. As in any unmapped space, the traditional caveat obtained: “Here there be monsters.”

Monsters “explode all of [our] standards for harmony, order and ethical conduct.”⁶ They are “mistakes of nature,” combining “characteristic components or properties of different kinds of living things or natural objects” and even (as here) artifacts and technologies.⁷ They “signal borderline experience of uncontainable excess.”⁸ Two centuries

³ Baum, 1978.

⁴ Baum, 1967.

⁵ Horton, 1964; Robinson, 1965.

⁶ Joseph Campbell, quoted in Gilmore, 2003, p. 7.

⁷ Gilmore, 2003, pp. 7–8.

⁸ Kearney, 2003, p. 3.

after the debut of *Frankenstein*, monsters still proliferate wherever science suffuses culture. “Each discipline...pushes back a whole teratology of knowledge beyond its margins...there are monsters on the prowl whose form changes with the history of knowledge.”⁹

Introduced Species Before Invasion Biology

Re-dispersal of biota is a hallmark of civilization. Agriculture, horticulture, animal husbandry, landscape gardening and pet keeping all entail relocating plants and animals, subsidizing some, suppressing others. The outcomes are delightful when they meet our expectations, making resources (food, medicine, materials, aesthetic experience, even affection) newly or more readily available.¹⁰ But delight is not inevitable. Costs may exceed benefits, or the two may seem asymmetrically or unfairly distributed.¹¹ Today when unhappy outcomes arise, we are used to specialists blaming the biota by labeling them “alien” and “invasive,” declaring that taxa refusing to defer to putative prior claims are unbelonging and even morally defective, reconfiguring both the discourse and objectives of science.¹² The popular press has cooperated with bleeding ledes. In summer 2001, an article about tamarisk in a major Colorado newspaper declared, “It’s a water-gulping, fire-feeding, habitat-ruining, salt-spreading monster.”¹³

The process described here occurred decades before the rise of popular environmentalism or the advent of organized invasion biology. It is remote and unfamiliar enough to avert a reading automatically tinged with environmentalist bias. Whether those who monstered tamarisk lived in a particularly dangerous and propaganda-saturated era is arguable, but Philip Pauly’s accounts of prior American reactions to Hessian flies and Japanese cherry trees suggest that all such actors are men of their time following cultural precedent, with objectives to accomplish and little patience or sympathy for conflicting or obstructing interests. To them, reporting the depredations of a monster was a way forward, rousing the rabble to gather with torches and pitchforks (or at least budget appropriations), calling would-be heroes to hone their

⁹ Foucault, 1970, p. 60.

¹⁰ For a discussion of American agriculture and horticulture as cultural pursuits, see Pauly, 2007.

¹¹ I am dealing specifically with *intentional* transport in this case, but *unintentional* transport also has delightful outcomes; they just cannot be anticipated.

¹² See Chew and Laubichler, 2003; Larson, 2007.

¹³ Hartmann, 2001.

weapons, gird for battle, and anticipate rewards from a grateful nation.

Botanical Monsters

The rise of (non-mythical) botanical monsters is an outcome of rapid, global bulk trade and mass travel. They appear unbidden and grow before our eyes, often going somehow unnoticed until they cannot be ignored. One of the first, best examples was a North American aquatic plant called common or Canada waterweed, *Elodea canadensis* Michx., (*Elodea*, following). *Elodea* arrived and proliferated in British canals, ponds and rivers during the third quarter of the nineteenth century. It seemed suddenly to be everywhere, “choking up” waterways, impeding human affairs and infringing freedom of navigation.¹⁴ Then, almost as abruptly as it arrived, *Elodea* encountered some still unidentified environmental resistance and slunk away. “At one time the ditches were full, but [in 1930] one has difficulty finding a specimen.”¹⁵

What can be made of such capriciousness? Fiction. *Elodea* doubtless inspired the “red weed” that accompanied H.G. Wells’ Martians to England in *The War of the Worlds*. Its decline against hope and expectation parallels the fate Wells assigned to his tentacled invaders.¹⁶ That so celebrated a botanical monster has retreated from memory suggests that such as these thrive longest when zealously propagated and liberally manured with media attention. Even kudzu, (*Pueraria lobata* [Willd.] Ohwi) “the vine that ate the South,” has largely faded from view beyond an immediately affected region, and requires periodic replanting in the larger public consciousness.¹⁷ Various management measures diminished kudzu from a monster to a nuisance, whence it was eventually co-opted as an icon of Southern indomitability, and celebrated at events like the annual “Blythewood (SC) Kudzu Festival.”¹⁸

Even though they are morphologically dissimilar, tamarisks, kudzu and *Elodea* share reputations for immodest fecundity and creeping formlessness. All three reproduce both sexually and asexually. Today we mostly encounter *Elodea* as fronds marooned in goldfish bowls or fragments under a Biology 101 microscope. In open water, delimiting an individual *Elodea* plant is a formidable task. Kudzu grows many

¹⁴ Lund, 1979; Simpson, 1984.

¹⁵ Ridley, 1930, pp. 180–181; 537–538.

¹⁶ Wells, 2005. See especially pp. 128; 142–146; 150; 160–161; 163; 166–168; 174–175.

¹⁷ Baskervill, 2002; Pauly, 2007, pp. 247–248.

¹⁸ See <http://www.kudzufest.com>. There are many such gatherings elsewhere in the southern states.

intertwining shoots from massive root crowns. Both species recall the hydra of Greek myth by producing new stems to replace those severed from the main body, and adventitious roots from stems contacting the substrate. Tamarisks grow from stem fragments or resprout from root crowns, but its amorphousness occurs at the stand level, where the branches of many plants may interdigitate to form a seemingly continuous mass.¹⁹

Elodea's arrival in Britain seems to have been an accident.²⁰ Kudzu and tamarisks were both premeditated imports to the United States, distributed commercially, endorsed and promoted by bureaucrats and academicians. Kudzu and *Elodea* both became vernacular monsters: affecting people where they lived, changing the way they did business, inspiring them to cry out for relief. Kudzu was further framed (like *Frankenstein*) as a fable of Promethean overreaching. By contrast, government scientists initiated the monsterring of tamarisk, with a definite and continuing purpose under a presumption of harm that still remains under-substantiated.²¹

Strategy and Objectives

Kudzu and *Elodea* have served to help introduce botanical monsters. The remainder of the account examines the monster-making aspects of the published discourse of tamarisk-related science in the United States. I begin by sketching the story of American tamarisk from the 1877 discovery of a “naturalized” population through a period of promotion and planting that intensified in the Depression years. Then I describe a brief period of equivocation followed by the assertive recasting of tamarisk during World War Two, and subsequent inception of a federal anti-tamarisk bureaucracy. The episode culminates in a 1952 trade journal article where one of the government’s leading anti-tamarisk scientists introduced it in monstrous terms to an “outside,” non-specialist audience.

My purpose is to illuminate episodes in the process by which a plant taxon once valued for particular inherent qualities was subsequently devalued and disparaged for very nearly the same reasons. The scientists who made this monster were assigned a variety of quantitative research tasks, none of which proved to be particularly straightforward. They became engrossed, perhaps enthralled by a single objective offering

¹⁹ Darwin readers will recall his account of an encounter with a stand of cardoon and thistles in La Plata from both *On the Origin of Species* and *The Voyage of the Beagle*.

²⁰ Simpson, 1984.

²¹ See Stromberg and Chew, 2002, 2003; Stromberg, et al., (in press).

some prospect of measurable success, developing a strident antipathy toward tamarisk that overwhelmed their original goal of water conservation.

Plantings and Promotions

A 1964 US Forest Service Research Note and a 1965 US Geological Survey (USGS) Professional Paper remain the major compendia regarding the American introduction and early spread of the genus. Taken together, these accounts have provided anecdotes suitable to the needs of most authors. Historian Tom Isern cautioned, “Scientific bulletins from our experiment stations are a great source of folklore. When scientists write the results of their own experiments, they are clinical. But when they compose the “historical” sections of their bulletins, they are gullible as all get-out.”²² Fortunately, the factual claims of these two papers appear to be well researched as far as they go. But they do not go far. The (likely) pre-nineteenth century arrivals and earliest dispersal of tamarisks in North America remain obscure. An 1818 inventory of the Harvard Botanic Garden is earliest mention I have found (so far) of any specimen growing in America.²³ Spotty documentation of subsequent commercial distribution survives in the form of plant nursery catalogs, from as early as 1823 on the Atlantic coast and perhaps 1854 on the Pacific.²⁴

By 1868, six species of tamarisk were growing at the US Department of Agriculture (USDA) Arboretum in Washington, DC.²⁵ The dense, shrubby growth habit and salt tolerance of some varieties suggested utility for controlling beach and sandbar erosion, and inspired a colloquial name: “salt cedar.”²⁶ Army engineers reported planting salt cedars in hopes of stabilizing a channel alongside St. Joseph (San Jose) Island, Texas in 1886.²⁷ An Arizona rancher recalled that around 1898 his father “brought home a switch of a new plant he had found growing in a sandbar along the Gila River [near Phoenix]...stuck in the moist

²² Isern, 1997.

²³ Peck, 1818, p. 3. Some readers will be interested to know that tamarisks are *not* listed among the plants growing in Thomas Jefferson’s Monticello gardens.

²⁴ Robinson, 1965.

²⁵ Ibid.

²⁶ Interchangeably also spelled salt-cedar or saltcedar.

²⁷ Mansfield, 1886, p. 1332.

soil of a ditch that ran by the house, it [became] a considerable clump of saltcedar.”²⁸ Meanwhile, enthusiasm for the plants persisted among urbane northeastern landscape gardeners. Rhode Island newspaper publisher Lucius Davis echoed a paean to one variety: “‘Nothing,’ says *Garden and Forest*, ‘can be more exquisitely graceful than the entire habit of this plant, and it is especially attractive in the early morning when its branches droop under the weight of silvery dew.’”²⁹

The USDA’s Section of Foreign Seed and Plant Introduction (SPI) was organized in 1897 under David Fairchild, making prospecting for new forms and varieties of economically valuable plants a federal government function.³⁰ Tamarisk was already well known to USDA by this time, but finding new uses for foreign plants was one of the SPI’s functions. Staffer Mark Carleton was credited with collecting rust-resistant durum wheat varieties from Russia and introducing them, with some difficulty (but eventual success) to farmers on the American plains.³¹ By the 1910s Carleton was increasingly concerned that dry farming of grains in shortgrass prairie regions was a reckless proposition. While encouraging farmers in the southern and western Great Plains to revert to raising livestock, he also promoted soil conservation techniques. His May 8, 1914 “special article” for *Science* was titled “Adaptation of the Tamarisk for Dry Lands.” Experimenting on his own Texas farmstead, Carleton found tamarisk “the most drought resistant and otherwise hardy of all the trees and shrubs planted on the same land...There appears to be no limit in dryness of the soil on any usual Great Plains farm beyond which this plant will not survive.” Furthermore, tamarisk was easily propagated from cuttings, so many plants could be realized from a small opening investment.³² Ornithologist W.L. McAtee, whose USDA office was in the same building as Carleton’s soon chimed in with a letter to *Science* noting that tamarisk flourished in wet soils as well as dry, and was the preferred firewood on Belle Isle, Louisiana, an “austral locality” where “little of that commodity is needed.” He also reported the variant colloquial name *salt-water cedar*, hardly ever mentioned elsewhere.³³

At about the same time, botanist J.J. Thornber penned the University of Arizona’s *Timely Hints for Farmers* number 121, regarding tests

²⁸ Robinson, 1965.

²⁹ Davis, 1899, p. 312. The *Garden and Forest* article was otherwise unidentified.

³⁰ Pauly, 2007, p. 127.

³¹ Pauly, 1996; 2007, pp. 127–128; Isern, 2000.

³² Carleton, 1914.

³³ McAtee, 1914.

of hardiness and other characteristics of several varieties of tamarisk in the Sonoran Desert. Recommending them for ornament and hedges, as windbreaks and shade for small livestock, he wrote, “doubtless these plants will be put to other uses as they come to be better known.”³⁴ Thornber would later be credited with the American introduction of the evergreen athel tamarisk after procuring cuttings directly from an Algerian correspondent.³⁵

Hydrologist Luna Leopold reminisced in 1960 that his father Aldo “planted a tamarisk [of an unspecified type] in front of their house in Albuquerque, New Mexico about 1920, and that the plant was rather uncommon.”³⁶ This was quite a recollection, since Luna was between 4 and 5 years old at the time of the planting. But the Leopolds lived “on a large lot with backyard access to the Rio Grande.”³⁷ Depending on the species, a tamarisk planted when Luna was a child could have grown into a substantial tree or shrub during the 4 years of the family’s residency there.

In 1928 *The California Cultivator*, a weekly trade newspaper, reported, “Throughout Southern California there has been planted during the past few years a quite a good deal of evergreen tamarix [*sic*; i.e., athel] for windbreaks.” The author echoed Thornber’s propagation advice, adding “Its chief value lies in the fact that it is a most rapid grower and is quite effective in checking the sweep of winds within 3 years.”³⁸ Nearly a thousand miles east, USGS geologist (later Harvard geology professor) Kirk Bryan reported that “three plantations of the self-seeding saltcedar were set out [to slow gully formation] in October, 1926 on the Rio Puerco [NM] by the middle Rio Grande Conservancy District ...in July, 1927 the plants at mile 32 were growing vigorously.”³⁹ Root and bough, tamarisk was gaining a reputation for helpfully screening sunlight, wind and water flows under harsh environmental conditions.

Mrs. Joseph Measures of Colorado extolled the ornamental applications of tamarisks in a 1933 article for *Flower Grower* magazine. But she also reported “In America, [tamarisk] has taken foothold in many places. In Colorado it is found in the alkali washes with the Willows and the native Cottonwoods, in waste areas; and as specimen shrubs in

³⁴ Thornber, 1916.

³⁵ Swingle, 1924.

³⁶ Robinson, 1965 p. A5.

³⁷ Meine, 1988, pp. 146, 157.

³⁸ Miller, 1928.

³⁹ Bryan and Post, 1927, quoted in Everitt, 1980, p. 80.

yards. In New Mexico, Arizona and some parts of California it is used for windbreaks and division fences. Although it is a semi-tropical shrub, it is adapting itself to places where the temperatures often reach ten to twenty degrees below zero.”⁴⁰ Like everyone prior, Mrs. Measures had trouble accurately identifying species, but she had succinctly summarized the status of tamarisk in the southwest, and hinted at the adaptability, proneness to dispersal and riparian habit that would come to characterize the genus.

The Call of the Wild

The first known, naturalized American stand of tamarisks was found on Galveston Island in 1877, and identified as “*Tamarix gallica* – I think” by amateur botanist Joseph Joor, M.D.⁴¹ By 1900 tamarisk was growing unsown and untended at scattered locations in Texas, Arizona, Utah, and California. The following year, T.H. Kearney, later to co-author the standard *Arizona Flora*, collected tamarisk in Tempe, calling it “common in river bottoms.” Soon after, J.J. Thornber took a specimen in eastern Arizona’s Safford Valley, and naturalized populations were documented in New Mexico by the mid 1910s. Herbarium records accumulated, but these “escaped” plants otherwise attracted little interest in the United States.⁴² Ornithologist Harry C. Oberholser laconically included tamarisk as a component of the “Coast Prairie Thicket Association” of southeastern Texas in 1925, without commenting on its origins or recent advent.⁴³

McMillan Dam on the Pecos River in New Mexico was a rock- and earth-fill structure privately constructed during the winter of 1893–94, before the Reclamation Act era. Like any reservoir on a muddy waterway, Lake McMillan was a sediment trap. A 1904 USGS survey found that during 10 years of operation, its water storage capacity diminished by over 22% due to siltation, and a later recalculation suggested the reduction was as much as 34%. Much of this sediment was deposited as a delta at the reservoir inlet. By 1912 trees were noticed growing in the delta. By 1914 they were identified as tamarisks.⁴⁴

⁴⁰ Measures, 1933.

⁴¹ Joor, 1877.

⁴² Robinson, 1965.

⁴³ Oberholser, 1925, p. 576.

⁴⁴ Taylor, 1930, pp. 44–56.

University of Texas Professor and Dean of Engineering Thomas (T.U.) Taylor evaluated Lake McMillan among the cases in a 1930 monograph on reservoir silting. By the time he wrote, tamarisks were a significant feature, occupying over 12,000 acres, or roughly one-fourth of the lake's original surface area. Taylor quoted a 1928 letter about Lake McMillan's tamarisks from L.E. Foster, superintendent of the Bureau of Reclamation's Carlsbad Project (which consolidated several struggling private irrigation ventures along the Pecos under federal auspices). Foster described a ten-square-mile tamarisk woodland of roughly uniform aspect, occupying part of the delta and about two miles of riverside flood plain upstream: "In many places the growth is so dense as to be almost impenetrable. It ranges in height from twenty feet down to one foot or less. The diameter of the growth ranges from the size of a pencil to six or eight inches. Just how much effect this comparatively fine, dense growth has on the [water] velocities is not certain; but it is certain, however, that the heavier silt deposits are at the upper end of the area where such growth is more dense."⁴⁵

Foster saw Lake McMillan's tamarisk stand as a useful trap within a trap, concentrating sediments at the upstream end of the reservoir. Taylor carried this idea forward, titling his paper's next subsection "Tamarisk on Guard." There he wrote: "It now appears that the silt problems at McMillan Reservoir, which were at one time of a very serious nature, have been materially lessened by the accidental propagation of this foreign evergreen shrub. Possibly the shrub can be planted at the upper limits of other reservoirs, located in regions of similar climatic conditions, and there to be utilized to secure similar results." Taylor did not pretend to be a botanist, and his monograph included a number of erroneous statements about tamarisk biology. He was an engineer, searching for specific solutions to specific problems. He believed he had found a solution, rather than a problem, in tamarisk. But as a coda to his endorsement, Taylor closed by suggesting that tamarisk was not an unmitigated blessing. Citing A.H. Dunlap of the Texas Board of Engineers, Taylor mentioned that at some points along the Pecos River "the growth is dense...and lines the bank in many places. It has retarded the flow of the river to such an extent that at the present time a flow of 2,000 [cubic feet per second, or cfs] produces the same effect as to flood stages that 10,000 [cfs] did before tamarisk appeared in the river. In addition...the tamarisk has become so dense in the canals northwest to Barstow [NM] that it is often cheaper to construct a new

⁴⁵ Ibid., p. 53, quoting letter from L.E. Foster dated 20 July 1928.

canal than to clean the old one.”⁴⁶ In plainer terms, the capacity of the river’s floodplain to convey water was drastically reduced by the dense growth of tamarisk, locally transforming fast-moving shallow floods into slow-moving, deep ones.⁴⁷ Furthermore, once established, tamarisk stands necessitated a revised approach to canal maintenance.

A 1932 conference presentation generally echoing Taylor’s description of Lake McMillan added little new information to the story. But it brought American tamarisk to the attention of the Association of American Geographers, who had previously known the genus as set pieces of middle-eastern adventures. After summarizing the advantages and disadvantages of reservoir tamarisks, Kirk Bryan (of the 1927 “Rio Puerco” report) concluded, “On the whole...the effects [of spontaneous tamarisk growth] on the works of man may be beneficial, and the general effect on minor streams while not entirely predictable will probably compensate for any disadvantage to other waterways.”⁴⁸ A year later, Riverside (CA) City College zoologist Edmund Jaeger wrote that Thornber’s athel had “escaped from its original plantings on ranches and now occurs about many of the alkaline springs of Death Valley and the Salton Basin.”⁴⁹

At about the same time, graduate student William C. Van Deventer read a paper to the Illinois Academy of Sciences, outlining “Some Influences of Man on Biological Communities.” In his view, the advent of civilization encouraged the spread of “man tolerant” plants.⁵⁰ This was not a new idea, having been proposed by Swiss botanist Alphonse DeCandolle as early as 1855, and echoed by various others in the interim.⁵¹ Van Deventer’s work focused on invertebrates, not plants, and his analysis of plant communities was Clementsian, by the book. But it inspired another local entomologist, Harold M. Hefley, whose 1935 doctoral thesis and 1937 paper both cited Van Deventer. Hefley was concerned with the insects found among tamarisks and white sweet clover (*Melilotus alba* Desr.) growing along the Canadian River near the University of Oklahoma campus. He was, perhaps, the first to suggest that tamarisk had “invaded” a site in a Clementsian successional sense.

⁴⁶ *Ibid.*, p. 55.

⁴⁷ “Roughness” had long been known to affect water conveyance capacity; for example, it was represented by the coefficient *n* in Irish drainage engineer Robert Manning’s (1816–1891) formula for calculating open-channel flow. Roughness, not its particular cause or composition, was at issue here.

⁴⁸ Bryan and Hosea, 1934.

⁴⁹ Jaeger, 1933, pp. 188–189.

⁵⁰ Van Deventer, 1934.

⁵¹ Chew, 2006, pp. 33–90.



Figure 1. A tamarisk sapling found growing beside the Colorado River in the Grand Canyon by Elzada Clover and Lois Jotter in 1938. The plant appears to be roughly 1.5–2.0 m tall. Used by Permission of Northern Arizona University, Cline Library, Special Collections and Archives, Lois Jotter Cutter Collection.

Hefley observed that tamarisk seeds “find their way to favorable places, especially along rivers,” and seedlings “appeared on the bare portions” of sediment banks near the water. His thesis mentioned that tamarisks were “grown locally for ornamental purposes in the upland section of the country surrounding the portion of the floodplain studied” but (oddly) he discounted the possibility that these could be the progenitors of the plants in his study area. Parentage notwithstanding, Hefley was convinced that tamarisks represented a permanent ecological addition and would eventually form a new type of riparian woodland in Oklahoma.⁵² He did not indicate whether he found that prospect alarming.

Into the 1930s, tamarisk seemingly remained just another riparian shrub, albeit a curiosity worth occasional mentions. University of Michigan Botany Professor Elzada Clover and her student Lois Jotter found spindly, isolated tamarisk saplings growing along the Colorado River (Fig. 1) during a 1938 expedition better remembered for making

⁵² Hefley, 1937a, b.

them the first women to traverse the Grand Canyon by boat.^{53, 54} Prior accounts of tamarisk growing anywhere along the mainstem Colorado River seem to be lacking. Unless the plants were truly rare, this is surprising. The Colorado was already a focus of regional commerce and controversy. Many eyes were cast upon it, and much ink was spilled describing, prescribing and criticizing river management schemes. Tamarisks were appearing along a major tributary, Arizona's Gila River, by the turn of the twentieth century. They were collected beside California's Salton Sea, formed by an accident of Colorado River management, as early as 1913.⁵⁵ The lack of documentation along the big river itself may be absence of evidence rather than evidence of absence.

In the 1940s and early 1950s, academic ecologists maintained a more or less clinically botanical view of tamarisk. A Kansas–Nebraska team summarizing the effects of pre-war prairie drought observed that as upland grasses declined, grasshoppers turned to defoliating trees and shrubs. They found that denuded tamarisks resprouted from the roots, thus surviving the intensive insect herbivory that killed some other trees.⁵⁶ Writing for *Texas Geographic Magazine* in 1948, Lloyd Shinnery of Southern Methodist University summed up the status of tamarisk there. “Salt cedar has evidently been cultivated in Texas for considerably more than half a century, and is probably to be found at the present time in every part of the state.”⁵⁷

In 1949, George Ware and William Penfound of the University of Oklahoma revisited Herbert Hefley's Canadian River sites. They were seemingly the first in the Americas to record the profoundly important observation that salt cedar blooms and disperses seed throughout its growing season, displaying a phenology different from that of spring-blooming cottonwoods and willows. They attributed tamarisk's tendency to form pure stands to its continuous breeding effort, but left no impression that they found this alarming.⁵⁸ John Brady Marks of the University of California seamlessly integrated tamarisk into his conceptual landscape, describing a *Pluchea* (= *Tessaria*, arrowweed)-*Tamarix* community “rich in species as well as in individuals.”⁵⁹ In 1953, Penfound (solo) called a

⁵³ Clover and Jotter, 1944.

⁵⁴ Cook, 1987.

⁵⁵ Robinson, 1965, p. A5.

⁵⁶ Albertson and Weaver, 1945, p. 415.

⁵⁷ Shinnery, 1948.

⁵⁸ Ware and Penfound, 1949, p. 483.

⁵⁹ Marks, 1950, pp. 180–181.

“*Salix*[willow]-*Tamarix* associates the most widespread of any of the plant communities found in Oklahoma lakes” without suggesting that this indicated anything amiss; tamarisk went unmentioned in his brief discussion of vegetation control methods.⁶⁰

New Science, New Monsters

Back about the time Aldo Leopold was planting his Albuquerque tamarisk, the Chief of the USGS Ground Water Division proposed a functional category of plants that “habitually utilize water from the zone of saturation” produced by capillary action in soils or sediments just above the water table.⁶¹ Oscar Edward Meinzer labeled such plants *phreatophytes*; that is, “well plants.” He developed the concept with four publications between 1920 and 1927. The first listed only a few plant species and genera as examples. In 1923 Meinzer established the term among many others in an “Outline of Ground-Water Hydrology.” There and in a 1926 sequel, *phreatophyte* was defined as “a species that habitually obtains its water supply” from groundwater rather than one that merely “utilizes” such water.⁶² In Meinzer’s view, *phreatophytes* were competing with farmers and others for shallow groundwater, an increasingly scarce resource.

Although Meinzer’s 1927 USGS pamphlet *Plants as Indicators of Ground Water* seems to have been written prior to his 1926 paper, it is more emphatic. Here Meinzer intensified his anthropomorphic imagery, subheading it “Plants that habitually feed on ground water.” His *phreatophytes* “habitually grow where they can send their roots down to the water table,” and (he claimed) “such a plant is literally a natural well with pumping equipment, lifting water from the zone of saturation.”⁶³ These plants were machines; furthermore, they acted as if they had intentions. Machines with intentions had barely entered fiction by 1927, but by Meinzer’s authority, they were at least metaphorically already a fact.⁶⁴

Luna Leopold’s assertion that tamarisk was still “rather uncommon” by the 1920s helps explain its nearly complete omission from Oscar

⁶⁰ Penfound, 1953, pp. 571, 580. *Associes* was another Clementsian coinage.

⁶¹ Meinzer, 1920.

⁶² Meinzer, 1923, 1926.

⁶³ Meinzer, 1927, p. 1.

⁶⁴ See, e.g., Ambrose Bierce’s “Moxon’s Master” (1909) and Karel Čapek’s *R.U.R.* (1921).

Meinzer's phreatophyte papers. Meinzer mentioned tamarisk only once, in his "history of the subject," quoting South African geologist P.A. Wagner's 1916 list of "other plants that betray the presence of ground water at shallow depths."⁶⁵ By 1927, most of the US-published discussion of tamarisk still associated it with drought tolerance and dry lands rather than stream banks and springs. Meinzer was based in Washington DC; he was not a botanist. Even though tamarisk was already present in the Southwest, Meinzer's information evidently came from published studies of sites where tamarisk hadn't yet gained a foothold.

The omission was not his alone. Meinzer acknowledged that he was "deeply indebted...for their critical examination of this paper and for many...valuable suggestions" to colleagues including J.J. Thornber.⁶⁶ Over 20 years after collecting tamarisk in the Safford Valley and 10 years after publishing his "timely hint," Thornber apparently did not suggest tamarisks to Meinzer as candidates for the phreatophyte list. Another near miss occurred when Meinzer cited three papers on rooting characteristics authored between 1911 and 1923 by W.A. Cannon of the Carnegie Institution's Desert Laboratory. Tamarisk appears in none of those three, but its deep taproots were noted (also in passing) in a fourth Cannon work from the same era.⁶⁷ Eventually many authors would tout tamarisks as *uber*-phreatophytes, even though they do not truly require near-surface groundwater to survive. The presence of shallow groundwater is a boon to tamarisk establishment, but its absence is merely inconvenient to mature plants. In later parlance, tamarisk is not an *obligate* phreatophyte.⁶⁸

During the 1920s groundwater hydrology was in its infancy; Oscar Meinzer has been acclaimed as its father.⁶⁹ But Meinzer had no compunction about dabbling in plant ecology, and botanist Thornber seemed willing to abet him.⁷⁰ Meinzer himself suggested that hard disciplinary boundaries had previously prevented either botanists or hydrologists from "preempting" studies of groundwater use by plants.⁷¹

⁶⁵ Ibid., p. 10n.

⁶⁶ Ibid., p. 15.

⁶⁷ Left uncited was Cannon, 1912, which twice (pp. 94–95) mentioned *Tamarix*.

⁶⁸ Turner, 1974.

⁶⁹ Deming, 2001, pp. 86–87.

⁷⁰ Thornber seems to have been a willing interdisciplinary collaborator. Meinzer (1927, p. 13) also credited him with helping irrigation engineer G.E.P. Smith on earlier, related studies of water use by desert plants.

⁷¹ Meinzer, 1927, pp. 10–11.

In his last phreatophyte paper, Meinzer used the subheading “Relation of Phreatophytes to Other Ecologic Groups,” a specifically biological claim regarding his category’s theoretical identity and significance.⁷² Especially in arid settings where water availability acted as an obvious limiting factor to plant growth, the line between studies of groundwater hydrology and plant ecology would remain blurred. There, *ecohydrology* of both surface and ground waters persists as an interdisciplinary space occupied, sometimes uneasily, by both ecologists and hydrologists.

Reclamation: A Tamarisk Housing Project

Both sparse and highly variable precipitation makes the American Southwest ill suited to “dry” farming. By 1900, pre-Columbian stream water diversions and canals were being rehabilitated in Arizona desert valleys, and Mexican-era *acequias* continued to operate along the Rio Grande; but dependable, large-scale water storage and flood control were lacking.⁷³ President Theodore Roosevelt signed the Reclamation Act in 1902, initiating a massive public works project that would fundamentally alter the lowland hydrology of the western United States.⁷⁴ Nine years later, ex-President Roosevelt dedicated his namesake dam and reservoir on the Salt River upstream of Phoenix. Over the ensuing five decades, the Bureau of Reclamation and its regional partners built dams creating 75 of the country’s 100 largest reservoirs.⁷⁵

Building an understanding of tamarisk, and particularly its importance to irrigation projects and vice versa would take much longer. As federal dams rose, rivers that had previously flooded in early spring or briefly in midsummer were converted to *de facto* canals or to dry washes that ran only when the new storage infrastructure was overwhelmed. Riparian trees phenologically adapted to the effects of spring flooding were left without the annual renewal of bare sediments their seeds needed for germination, and then subjected to prolonged, drowning flows released from reservoirs during summer agricultural irrigation.

⁷² Meinzer, 1926.

⁷³ Pisani, 1992, pp. 38–46; Pisani, 2002, pp. 253–262. *Acequias* are local irrigation cooperatives.

⁷⁴ Pisani, 2002, p. 1.

⁷⁵ Mermel, 1958.

Blooming nearly year-round, tamarisks were fortuitously prepared to occupy the new niche created when the dam builders shifted the “bare sediment season” from late spring to early autumn. The “bathtub ring” of damp silt exposed annually at the margin of every depleted reservoir further enhanced this opportunity for late-season establishment.⁷⁶

Making Work; Saving Soil

During the Great Depression, make-work proposals grasped even at tamarisk. Louis E. Freudenthal included one in the lead article of *Science* magazine on November 17, 1933. Born in New Mexico, Freudenthal was a second-wave frontiersman, a Jewish insurance man active in the Farm Bureau and the Democratic Party.⁷⁷ His essay was titled “Flood and Erosion Control as Possible Unemployment Relief Measures,” an “Address to the Thirteenth Annual meeting of the American Association for the Advancement of Science” in Las Cruces. Freudenthal’s vision was replete with ideas for federal programs that could solve two or more problems simultaneously. Evidently familiar with T.U. Taylor’s silting monograph, he suggested “the possibility of utilizing labor in planting Tamarisk or similar plants at the inflow of large reservoirs, such as Elephant Butte or Roosevelt Lakes.”⁷⁸ Unbeknownst to Freudenthal, the necessary and sufficient means for pan-regional distribution and propagation of the plants was already operating.

With one significant exception, for the remainder of the decade tamarisk was mostly discussed and employed by managers as a panacea for erosion problems. Discussing the Navajo Indian Reservation, Arizona State University geographer J.W. Hoover mentioned “the tamarisk, introduced from Asiatic deserts, is transforming erosion and sedimentation processes along streams and lower deserts and is being planted in a few places in the lower parts of the reservation.”⁷⁹ The Bureau of Reclamation continued to erect dams, while regional and local irrigation cooperatives continued to divert, pump and redistribute water. Biotic responses to these abiotic revisions continued apace, but went mostly unrecognized, or at least unreported. No one could yet see that the reconstituted regional hydrology was tantamount to a massive ecological subsidy for tamarisk.

⁷⁶ Stromberg and Chew, 2002.

⁷⁷ Anonymous, 2000.

⁷⁸ Freudenthal, 1933.

⁷⁹ Hoover, 1937, p. 296.

The Monster Stirs

Where water is scarce, farmers must compete for it, and agriculture must vie with an array of other interests. Complicated water law is a signature theme of the American West. Three principles must be kept in mind for the present purpose. First, regardless of actual hydrological coupling, surface waters and closely associated shallow aquifers are not *legally* connected to deep groundwater. Second, there are statutorily defined “beneficial” uses for which surface water rights can be held, while other “non-beneficial” uses have no legal standing. Finally, rights to use surface water are governed via the legal doctrine of prior appropriation, i.e., “first in time, first in right,” where senior claims trump junior ones. When a new water use is proposed but all the surface water rights in a particular watershed have been claimed, and deep groundwater is inaccessible or nonexistent, something has to give. Under some circumstances, a holder of senior rights is allowed to transfer (i.e., sell) them to a new user for new purposes, while terminating the old use. Simple enough; but persuading someone to relinquish senior water rights is another matter. Since dry land is economically worthless land, water transfers are controversial, expensive and uncommon.

In such a situation, non-beneficial uses are like a businessman’s fixed costs. It stands to reason that if some non-beneficial use can be curtailed, water will be liberated, and new rights can be claimed for a beneficial use. If the effort is successful, it should be obvious to all that there is more water present than before, bearing in mind that the basic unit of precision is the acre-foot.⁸⁰ Estimating actual channel flow at any given point and moment is a tricky business. Estimating how flows might change under particular hypothetical conditions is (literally) exponentially more fraught. Perhaps wisely, Oscar Meinzer proposed using phreatophytes as a guide for locating shallow groundwater, and water use by the plants as a factor to bear in mind when calculating potential water yields. Nowhere in his phreatophyte papers did he speculate on, or recommend, removing the plants to *increase* yields. But Meinzer’s circumspection did not prevent his protégés from taking up that challenge.

⁸⁰ One acre-foot equals 325,851 gallons or 1,233,482 liters; i.e., a liquid cube about 35 feet on a side. The US Environmental Protection Agency roundly estimates that an average American family of four uses 400 gallons of water per day, so an acre-foot (appropriately treated) would supply their domestic needs for over 2 years.

The New Deal in New Mexico

The National Resources Committee (1935–1939) and its successor Planning Board (1939–1943) were creations and creatures wholly of the Franklin Roosevelt Presidency.⁸¹ After a preliminary national overview published in 1936, the Committee conducted a “joint investigation” of Upper Rio Grande water issues in 1936–1937, and the Planning Board another, of Pecos River issues in 1939–1940. Both projects were initiated in response to realized or feared water shortages and looming litigation over interstate water rights conflicts. Neither phreatophytes in general nor tamarisks in particular rose to mentionable importance in the preliminary document, but they featured in both Joint Investigations.⁸²

As the Chairman of an *ad hoc* “Consulting Board,” University of Chicago geographer Harlan H. Barrows supervised both projects, and reputedly “knocked bureaucratic heads together” to accomplish them.⁸³ Each joint investigation involved at least ten bureaus from four cabinet-level agencies, plus the State Engineers of Texas, New Mexico, and (for the Rio Grande) Colorado.⁸⁴ They ambitiously called for unprecedented coordination among disciplines, among agencies, and between scientist and bureaucrats.

Many individual scientists were involved in both projects. Notably, the USGS sent C.V. Theis, an agency junior geologist who had recently proposed a new mathematical model of aquifer dynamics, to open a New Mexico regional office. Meinzer had discouraged Theis from publishing his equation, thinking a practical geologist unlikely to succeed where real theoreticians were floundering.⁸⁵ This led to strained relations and a troubled working relationship, but Theis had few employment options, bit the bullet, and busied himself with Rio Grande research. Soon the “Theis equation,” which described groundwater movement by analogy with heat diffusion, “revolutionized the science of groundwater hydrology.”⁸⁶

Perhaps inevitably, all the results and recommendations of these projects could not be presented as seamless, internally consistent sets of recommendations. Some of the problems stemmed from the production of different chapters at different times, and the final preparation of

⁸¹ See Warken, 1979.

⁸² National Resources Committee (NRC), 1936.

⁸³ Colby and White, 1961.

⁸⁴ National Resources Planning Board (NRPB), 1942, p. viii.

⁸⁵ Bredehoft, 2008.

⁸⁶ White and Clebsch, 1994.

tables and figures by persons other than the credited authors. Nevertheless it is significant that comprehensive, integrated scientific analyses of southwestern water issues were being attempted.

Tamarisk Along the Rio Grande

USDA agricultural or botanical personnel analyzed vegetation for the Rio Grande Joint Investigation (Rio Grande JI, following). They never (in print) used the hydrologists' term "phreatophyte," nor, for that matter, did the USGS hydrologists, who made only an uncredited nod to their Chief by referring to "plants that habitually feed on groundwater."⁸⁷ Tamarisks were uniformly called "salt cedars," and then only in notations on vegetation maps. Some attempt was made to quantify native (i.e., uncultivated) vegetation by categories such as "trees" and "brush," but even on maps, salt cedar was not consistently assigned to either category.⁸⁸ By estimates published decades later there were 5,500 acres of tamarisk in the river's Middle Valley in 1936; but that number did not appear in the Rio Grande JI data summaries.⁸⁹

Hoping to quantify botanical water consumption, USDA personnel experimented with plantings made in metal stock tanks where they could control water input, but salt cedar was not among the species tested for the Rio Grande JI. The Investigation's final summary reported, "data are not available to permit even an approximate determination of the total amount of water which might be feasibly and economically recovered from the million acre-feet or more by which the stream flow is annually depleted in supporting the growth of native vegetation in the Upper Rio Grande Basin. It seems unquestionable, however, that some fraction of this loss should be susceptible of economic recovery by proper drainage construction."⁹⁰ Their proposed solution was, in effect, to salvage water by draining the swamp – lowering the riparian water table beyond root's reach of phreatophytes.

Tamarisk Along the Pecos

The Pecos River Joint Investigation (Pecos JI, following) emulated the Rio Grande JI's organizational model, but this time tamarisk took a

⁸⁷ National Resources Committee (NRC), 1938, p. 246. Perhaps Barrow intervened to excise obscure jargon.

⁸⁸ See, e.g., NRC, 1938, plates 14–17 (loose-leaf).

⁸⁹ Thomas and Gatewood, 1963, p. D20.

⁹⁰ NRC, 1938, p. 122.

star turn because the studies included Lake McMillan. Still, and commensurate with a patchwork genesis, different chapters of the Pecos JI's final report expressed differing opinions of the plants. A section detailing the history of irrigation development written by two "Assistant Agricultural Economists" from the USDA evidently relied on T.U. Taylor, claiming "the growth of tamarisk at the upper end of [McMillan] reservoir, starting about 1915, is credited with having appreciably arrested silting."⁹¹ Meanwhile USDA Irrigation Engineer Fred Scobey followed Meinzer's lead by classifying tamarisk and other "brush" as "non-beneficial but unavoidable users" of water, while estimating in very round numbers that "there are about 50,000 acres of salt cedar (tamarisk) in the Basin, and each acre... consume[s] 5 acre-feet of water per year."⁹² As he had done during the Rio Grande studies, Scobey lumped all uncultivated plants into the category "native vegetation" without distinguishing those of exotic origin. Where and when their ancestors originated was irrelevant to his water use estimates. Although Scobey cited Meinzer's 1927 paper in his Pecos JI report, he never used the term phreatophyte, substituting the less technical, less mellifluous "ground-water plants."⁹³

Scobey had to invent some of his methods. An aerial photograph of Lake McMillan (Fig. 2) was presented as an example of those he analyzed by cutting them up along supposed boundaries between vegetation types and weighing the pieces to determine their relative extents. Its caption identifies "13,000 acres" of tamarisk that "intercept silt and caused the delta formation in form and levels different from such a development without the growth. Also these cedars [*sic*] consume some 70,000 acre feet of water per annum. They constitute one of the major problems along the Pecos River."⁹⁴ Like T.U. Taylor, Scobey was not a botanist, and none intervened to correct his taxonomy.

Silting was difficult to quantify, but far easier so than transpiration losses. Lake McMillan had demonstrably lost about half its original water storage capacity to sedimentation during a half century of operation. "Consumptive" water use by "native" plants could only be estimated experimentally and in microcosm. For reasons unexplained, unidentified Pecos JI cooperators used different methods for evaluating different plants. They again tried to measure water use by uncultivated phreatophytes in microcosm, but used full-scale field data for irrigated

⁹¹ National Resources Planning Board (NRPB), 1942, Vol. 2, p. 142.

⁹² *Ibid.*, pp. 150–151.

⁹³ *Ibid.*, p. 195.

⁹⁴ *Ibid.*, p. 154.



Figure 2. Detail from an aerial photo of the Lake McMillan, New Mexico, sediment delta, annotated by USDA Irrigation Engineer Fred Scobey for the Pecos River Joint Investigation (National Resources Planning Board, 1942).

crops without mentioning any caveats.⁹⁵ It seems unlikely that any farmer would report using more water than he was entitled to, or that Pecos JI personnel would be constantly on hand to independently verify actual application rates. Nor would such verification be a simple matter.⁹⁶ The reported results suggested that native vegetation of all kinds routinely transpired more water per unit area than irrigated crops, but any conclusions drawn from comparing incommensurable data sets were necessarily suspect.

According to the Pecos JI summary, “the normal annual consumptive use of water in the Carlsbad area [including Lake McMillan] by irrigated crops, salt grass and sacaton, and salt cedar is 2.8, 3.4, and 6.0 acre-feet per acre, respectively.”⁹⁷ After factoring in local precipitation and the presumed replacement of floodplain grass by tamarisk, the Investigation concluded that floodplain tamarisks were using an additional 2.6 acre-feet of water per acre from each of 2,000 floodplain acres,

⁹⁵ *Ibid.*, p. 195.

⁹⁶ The author writes from experience as a current holder and user of Salt River Project (AZ) agricultural surface water and groundwater irrigation rights.

⁹⁷ “Sacaton” is *Sporobolus wrightii*, a very robust (1–2 m) valley bunchgrass.

and Lake McMillan tamarisks were uselessly appropriating 5.0 acre-feet of water from each of 11,000 delta acres. Cumulatively, this generated 60,200 acre-feet “as an estimate of the increased amount by which stream flow is depleted annually due to the salt cedars.” Having written that, they immediately cast doubt on their own findings, suggesting an editorial intervention: “Actually the conditions of stream flow and the distribution and varying density of the salt cedars are such that the full depletion given by this estimate probably does not occur.”⁹⁸ But the indictment was plain. The Pecos JI determined that “the reduction or complete elimination of the salt-cedar [related water] losses offers a major opportunity for water saving in the Pecos River basin.”⁹⁹

The Pecos JI summary findings regarding phreatophytes almost precisely parroted the Rio Grande JI’s in its initial details. But this time, their recommendation was more specific. “From the data which have been presented and the analysis in the single instance of the salt cedar area above McMillan Reservoir, it seems unquestionable that a substantial fraction of this loss should be susceptible of economic recovery.”¹⁰⁰ The death warrant had been drafted, if not yet signed. Thousands of acres of tamarisk *had* to be using lots of water, so eliminating them *had* to yield benefits, however hard to predict. Pecos JI personnel knew of some ways to kill tamarisk, and their knowledge was visible and measurable in acres of dead vegetation. A water-pumping, water-wasting monster was attacking the Pecos River. In some minds, confidence was high that it could literally be slain. However, confidence was lower that the water it was stealing could actually be recovered as a result.

Tamarisk Meets the Military-Industrial Complex

Another shortage of appropriable water, this time needed for a more urgent purpose, was developing in eastern Arizona. In 1939, prompted and financed by the War Department [Army] Engineer Office and the Bureau of Indian Affairs, Oscar Meinzer’s USGS staff began an inventory of water resources along the upper Gila River, where tamarisk had been present for at least a quarter-century. One objective of the program was to quantify water use by phreatophytes (*non-beneficial* by definition) in the hydrologically connected Safford and Duncan-Virden

⁹⁸ NRPB, 1942, Vol. 1, p. 56.

⁹⁹ *Ibid.*, p. 13.

¹⁰⁰ *Ibid.*, p. 123.

valleys. Despite its omission from Meinzer's seminal studies, nothing in this new report suggests that the investigators ever doubted whether tamarisk *was* a phreatophyte. But a separate, preliminary paper by two of its principals admitted "there are no data on water use by cottonwood, tamarisk and baccharis, and such are being obtained."¹⁰¹ Using several creative but primitive and incompletely described methods they estimated that "completely killing" "river bottom vegetation" in the Safford Valley would make available some 70,000 acre-feet of water annually; by odd coincidence, exactly the total predicted elsewhere by the Pecos JI.¹⁰²

Upstream of the Safford Valley, along the Gila River's tributary Eagle Creek, is the Morenci copper mine, and its eponymous company town. Phelps Dodge Corporation (PDC) acquired virtually exclusive rights to the ore body in 1921 but post World War One and Depression-era copper demand was weak. Not until 1930 did PDC decide to pursue open-pit mining at Morenci, and even then it took 7 years to accumulate project financing. The expansion effort was massive and fortuitously timed, placing PDC in prime position to supply the copper demands of the looming new war. But PDC's Eagle Creek water was insufficient to the requirements of the proposed operation, and water rights in the Safford Valley were already fully allocated. PDC either had to purchase existing rights or find "new" water, so they began to investigate the possibility of salvaging water by removing phreatophytes. As the US military geared up after the Pearl Harbor raid, the federal War Production Board directed PDC to "increase its overall copper production by 80%."¹⁰³ Supported by the Department of Commerce and the federal Defense Plant Corporation, PDC called for the USGS to take over and expand their project demonstration that removing Gila River phreatophytes would liberate Safford Valley water, creating appropriable water rights.¹⁰⁴

The wartime research program was belatedly written up for a 1950 USGS Water Supply Paper, *Use of Water by Bottom-Land Vegetation in Lower Safford Valley Arizona*. In his foreword, USGS Chief Hydraulic Engineer C.G. Paulsen stated, "This investigation, so far as is known, was the first attempt actually to measure the water consumed by a particular class of vegetation under natural conditions on a scale large

¹⁰¹ Turner and Halpenny, 1941, p. 741.

¹⁰² Turner and others [sic], 1941, pp. 47–50.

¹⁰³ Jackson, 1991, p. 24.

¹⁰⁴ Robinson et al., 1950, p. 3.

enough to be of economic significance.”¹⁰⁵ Its authors inserted tamarisk conspicuously at the top of their phreatophyte inventory, misattributing its classification as such to Oscar Meinzer (retired, 1946; died, 1948). Then they rationalized the battles to come with a series of statements about plants that we are inured to by modern hyperbole, but represented a significant shift in subtext.

Saltcedar “thrived and spread at the expense of nearly all the native plant life.”¹⁰⁶ In contrast with the categorical conceptions of earlier studies, this redeployed *native* to distinguish tamarisk from (not include it with) naturally occurring vegetation, and cast it assertively if vaguely as a hyper-fecund cheater/parasite/usurper. Ironically, PDC’s original plan (and its subsequent USGS iterations) had always included removing all nineteen phreatophyte species from the study reach; now they had disingenuously shifted eighteen of them to the list of victims.

Saltcedar formed “a dense jungle-like thicket that is difficult to penetrate.” This imagery plainly evoked memories of the recent war. One study participant later revealed that they had attacked Safford Valley tamarisks with flame-throwers, an iconic weapon of the “island hopping” Pacific campaign, and a treatment of last resort for America’s most intractable enemies.¹⁰⁷

Despite such drastic measures, “shoots from an area cut over [regrew] to a height of 6 to 8 feet in about 12 months.”¹⁰⁸ Like human aliens before and since, tamarisks were morally suspect due to high fecundity, aggressiveness and unfair competitiveness. In summary, tamarisks were foreign, insular, recalcitrant and unaccountably resilient. By standing in the way of mine expansion they were not merely impeding commerce and security, but flouting American values and even natural propriety. Scientists had unreservedly described something very un-plantlike. Tamarisk was a monster.

Meet “Mr. Phreatophyte”

The Lower Safford Valley study used six different methods to compute water use by phreatophytes and produced the highest ever transpiration rate claimed for tamarisk: assuming a maximum (100%) density of plants, the annual equivalent of 7.2 acre-feet of water per acre.¹⁰⁹

¹⁰⁵ Ibid., pp. xiii–xiv.

¹⁰⁶ Ibid., p. 11.

¹⁰⁷ Robinson, 1952b.

¹⁰⁸ Ibid., pp. 11–12.

¹⁰⁹ Gatewood et al., 1950, p. 195.

Adjusted for annual onsite precipitation, this translated to about 23,000 acre-feet of water, or a bit less than 8% of then legally claimed irrigation rights in the Safford Valley.¹¹⁰ Nevertheless, the 1950 report, like most of its predecessors, was conspicuously silent regarding just how much water could actually be salvaged and put to other uses by eliminating phreatophytes.

The project also reunited (or rematched) tamarisk and one of its greatest detractors. Groundwater hydrologist Thomas “T.W.” Robinson, “fondly known to many as ‘Mr. Phreatophyte,’” contributed to the Rio Grande JI and then built a career on tamarisk-bashing.¹¹¹ Robinson was second author of the 1950 Safford Valley report, and the fourth and last person to take charge of the groundwater study, including water-use experiments using the USDA stock tank methods inherited from the two Joint Investigations.¹¹² He followed the official report with a paper for the 1951 meeting of the American Geophysical Union (AGU). There, Robinson extrapolated from the Safford Valley findings (using “all available data”), claiming in a table that at least 10.7 million acres of phreatophytes were wasting at least 15.7 million acre-feet of water annually in 13 states, and suggesting that complete data for all 17 western states would raise those numbers by some 50%. After mentioning the failed flame-thrower treatment, he alluded to the hydra: after bulldozing, “soon new growth appeared from each severed [tamarisk] root, so that two plants grew where one had grown before.”¹¹³ However, he was still crying in the wilderness. Water salvage via phreatophyte removal remained hypothetical. It had never been attempted on a significant scale for an extended period, nor demonstrated at any scale, anywhere.

“Not for Publication”

Two new bureaucratic initiatives devoted to phreatophyte control and focusing on tamarisk emerged around 1950. One was the ephemeral “New Mexico Salt Cedar Interagency Council” (Council, following) of

¹¹⁰ *Ibid.*, p. xiii; p. 8. The report stated irrigation rights only in terms of “second-feet,” necessitating a conversion to acre-feet. PDC ultimately worked out a preliminary agreement providing \$2.5 million to fund construction of Horseshoe Dam on the distant Verde River in exchange for annual use of 250,000 acre-feet of nearby Black River water rights claimed by the Phoenix-area Salt River Valley Water Users Association. This was nearly nine times the potential water salvage hopefully attributed to phreatophyte removal along the Gila.

¹¹¹ Johnson, 1972.

¹¹² Gatewood et al., 1950, p. 6.

¹¹³ Robinson, 1952b.

which little evidence remains besides a single report prepared by its subsidiary “Salt Cedar Interagency Task Force.” The Task Force had four members: an assistant New Mexico State Engineer and representatives of the US Army Corps of Engineers, Bureau of Reclamation and USDA Soil Conservation Service.¹¹⁴ The body of the report reviewed some of the published work discussed above. Nevertheless, without stating specific reasons, Council Chairman C.L. Forsling classified the document “For Official Use Only – Not For Publication.” Only the appendices broke new ground, and a possible reason for official circumspection emerged in Appendix Four, crafted by two USGS groundwater hydrologists with impressive credentials: C.V. Theis, by then recognized as having revolutionized groundwater science; and C.S. Conover. Shortly after completing their appendix for the Council, Theis was promoted to coordinate all USGS activities carried out for the US Atomic Energy Commission, and Conover took his place supervising USGS New Mexico groundwater work.¹¹⁵

In Appendix Four, Theis and Conover comprehensively criticized the assumptions and outcomes of previous USGS and USDA work on phreatophyte water consumption. Most importantly for the present purpose, they disputed the premise of phreatophyte eradication efforts. Their language seems didactic to the point of exasperation: “The primary reason that phreatophytes use water is because the water is available. Thus investigations of the means of salvage of water should include studies of the source of the water. Conversely, it seems that the most successful manner of saving water would be to deprive the plants of water, either by drains, pumps, or channels, rather than by taking the plants away from the water by eradication.” Theis and Conover went on to point out, in a similarly instructive tone, that the very process of such draining would automatically collect the salvaged water and make it available for use, which would obviate uncertainties about the net benefits.¹¹⁶ Fifteen years after the Rio Grande studies, *their* solution was to drain the swamp. Instead of assuming that killing tamarisk would yield water, they told managers to go after the water directly. In their minority view, tamarisks were plants, not monsters. Dead tamarisks would be by-products of water salvage efforts, not the object of the exercise.

The second government phreatophyte initiative was more substantial and longer-lived, leaving a trail of detailed meeting minutes and other

¹¹⁴ Brown et al., 1951, p. 2.

¹¹⁵ White and Clebsch, 1994.

¹¹⁶ Brown et al., 1951, Appendix Four, p. 10.

documents. The impressively named “Pacific Southwest Federal Inter-Agency Technical Committee” (Later the “Pacific Southwest Inter-Agency Committee”) appointed a Subcommittee on Phreatophytes, initially chaired by S.F. Turner, a veteran of the Safford Valley studies, and including H.F. Blaney, who worked on the Rio Grande II. Before long, T.W. Robinson, although not an official member, was listed in the minutes as a regular attendee and occasional substitute Secretary. By September 1952, he was both member (representing the USGS) and official Secretary.¹¹⁷

The Subcommittee persisted until 1970, and only some of its earliest activities will be mentioned at here. The minutes of its first (January 1951) meeting in Phoenix, Arizona made it plain that the “unpublished” Salt Cedar Task Force report was already a topic of lively discussion. There was no specific mention of Appendix Four, but the Subcommittee was organized to promote phreatophyte suppression, not to salvage water by engineering means. Over the next few meetings they formally and dutifully accepted their charge from the full Committee, went through the motions of adopting Meinzer’s “phreatophyte” definition for their own purposes and doing other necessary housekeeping. Still (and always) stymied taxonomically, at their second meeting they estimated that forty species of tamarisk existed in the United States, but reduced their practical working inventory to two: athel, a “marvelous shade tree” and everything else, lumped together for convenience, and inadvertent commemoration of Joseph Joor, as *Tamarix gallica*.¹¹⁸

From the Government, Here to Help

At their seventh (June 1952) meeting in Boulder, Nevada, the Subcommittee considered a most salient information request from the Arizona Underground Water Commission (AUWC), who wrote:

“[We] would appreciate very much any help your committee could give in obtaining for [us] information on the following points relating to phreatophytes in Arizona:

1. Maps showing areas of phreatophytes and amounts of water estimated to be used by them in each area.
2. Quality of water in each major area of phreatophyte use.
3. Possibilities and methods of destroying phreatophytes in each area.
4. Effect of destroying phreatophytes in each area on water supply.

¹¹⁷ Phreatophyte Subcommittee, 1951–1959, p. 62.

¹¹⁸ *Ibid.*, p. 10.

Where would water go which now is being used by phreatophytes?

5. Estimate costs of various methods of destroying phreatophytes per acre foot of water saved for beneficial use.”¹¹⁹

The state of their art and science was evident from the Subcommittee’s reply. They simply and wholly ignored all but item three, assuring the AUWC that phreatophytes “use water in an uneconomical manner.” The Subcommittee added some terse tabular statistics about survival rates of salt cedar “in the Gila River adjacent to Phoenix” after spraying with the recently developed phenoxy herbicides 2,4-D and 2,4,5-T, a chemical cocktail that later became notorious as Agent Orange.¹²⁰ Their bailiwick was slaying monsters, not salvaging water.

A few months later, T.W. Robinson launched a more popular campaign against phreatophytes in an article titled “Water Thieves” for a trade magazine, the *Chemurgic Digest*.¹²¹ Again he summarized Meinzer’s 1920–1927 work and list of phreatophytic species, unapologetically adding and emphasizing salt cedar as always. He reiterated his own 1951 maximum estimate that 25 million acre-feet of water was lost to “consumptive waste” by phreatophytes in the 17 western states; “twice the average annual flow of the Colorado River at Lees Ferry [Arizona, just above the Grand Canyon].”¹²² The same year, respected American geographer Peveril Meigs cited Robinson’s symposium paper and the Safford Valley study for “Water Problems in the United States.” Meigs added the accusation that “at the delta heads of reservoirs...[tamarisk] has become a jungle, and not only consumes large quantities of water, but clogs the inlet to the reservoir.”¹²³ Thus the very quality extolled by Taylor in 1930 and proposed for exploitation by Freudenthal in 1933 was transformed into a new indictment. Meigs added a parting, xenophytophobic shot: “Native cottonwoods consume nearly as much water as salt cedar but are less aggressive in their spread.”¹²⁴

¹¹⁹ Ibid., pp. 56–57.

¹²⁰ Ibid., pp. 60–61.

¹²¹ Chemurgy was a movement that promoted agricultural production of industrial raw materials, which has experienced a revival of late, but not by that name.

¹²² Robinson, 1952a; 25 million acre-feet of water is about 8 billion US gallons or 31 billion liters.

¹²³ Meigs, 1952, p. 362.

¹²⁴ Ibid.

Summary and Conclusions

From 1877 to 1953 American academic botanists and ecologists displayed mostly mild interest and curiosity regarding *Tamarix* species, without really making them a focus of research.¹²⁵ During the same period, horticulturists uniformly recommended tamarisks as drought and salt-tolerant ornamentals. But in less than a decade, from the inception of the Pecos River Joint Investigation in 1938 to the completion of the Lower Safford Valley research project in 1944, the opinions of scientists and scientifically trained natural resource managers toward tamarisks changed drastically. Government experts (often from or affiliated with USDA units) had imported, recommended, distributed and planted tamarisks well into the Dust Bowl era. After seeing the naturalized stands at Lake McMillan, other government experts led by USGS hydrologists declared the plants to be worse than useless. Shrubs once extolled for erosion and sedimentation control became machine-like monsters pumping away scarce western water. Hard on the heels of that assessment came a further redefining moment, the wartime recasting of tamarisks in the Safford Valley as alien aggressors. By 1950 a permanent interagency bureaucracy had sprung up, focusing primarily on slaying the beast rather than demonstrating actual water salvage. It began to propagate the legend, as well as a few myths, that would keep its members busily cutting, bulldozing, spraying and reporting progress in terms of vegetation killed for another 20 years.

During the period described, naturalized tamarisk had little or no discernable public constituency, and little prospect of gaining one. Few who cultivated or advocated planting tamarisks would likewise have advocated the plants' unrestrained self-propagation. By the same token, there was little likelihood that a popular sentiment would develop *against* naturalized tamarisk. The rural West was more sparsely populated than the rural South. Relatively few private citizens encountered tamarisk on private lands the way Southerners faced kudzu. The monstering of tamarisk required the kinds of organization and impetus that only the federal government could provide in that era.

Lacking candid insider accounts, it is rarely obvious whether scientist-bureaucrats actually support the aims of the programs they are assigned to carry out, and thus whether their rhetoric represents principled endorsement, sincere conviction, careerist pragmatism or cynical

¹²⁵ The first full, botanical "life history" of tamarisk was published in 1957.

manipulation. Tamarisk was a denizen of major, mostly federal (or federalized) water projects. The physiology and ecology of the plants was examined almost entirely through the lenses of hydrogeology and water politics. Tamarisk was a convenient scapegoat for the complex problems encountered by government water managers, be they true believers in the monster or otherwise. Even so, it does not seem to have mattered strongly to the principals whether suppressing tamarisk ever made more actual “wet water” available. They could demonstrate productivity in acres of vegetation laid waste, again and again, while suppressing or simply ignoring the substantial doubts lingering over their theories, methods, and mandate. Monstering tamarisk was far from a superstitious exercise. It was an effective way to perpetuate a program.

Epilogue

Tamarisks proved to be resilient, outliving the Phreatophyte Subcommittee. Subsequent events include plot twists unimaginable in 1952, and too tortuous to outline here in much detail. By 1970, early environmentalist sentiment favoring conservation of native (non-alien) Southwestern riparian vegetation had rendered blanket condemnation of phreatophytes politically untenable. Tamarisks were categorically isolated and targeted mainly as noxious weeds (and when they continued to spread, as “invasive exotics”). This inspired a USDA search for “biological control” methods, organisms that could be introduced as counter-pests. In the 1990s an equivocal interlude followed the discovery that a songbird species proposed for “endangered” status evidently preferred nesting in tamarisks at some locations.¹²⁶ An explanation appeared for the taxonomic recalcitrance of the genus when molecular analysis revealed that (at least in the US) several *Tamarix* species were freely hybridizing.¹²⁷ The USDA identified, evaluated and released a tamarisk-eating beetle. A new period of regional drought inspired new hopes of water salvage. On 11 October 2006, President George W. Bush signed HR 2720, the “Salt Cedar and Russian Olive Control Demonstration Act.” Would-be heroes continue to step up for a crack at the monster, now legislatively lumped with another, more ominously named “alien invasive plant” into an axis of excess.

¹²⁶ See Stromberg and Chew, 2002; Shafroth et al., 2005; Stromberg et al., 2009.

¹²⁷ Gaskin and Shafroth, 2005.

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