The role of terrestrial plants in irrigation reservoir systems

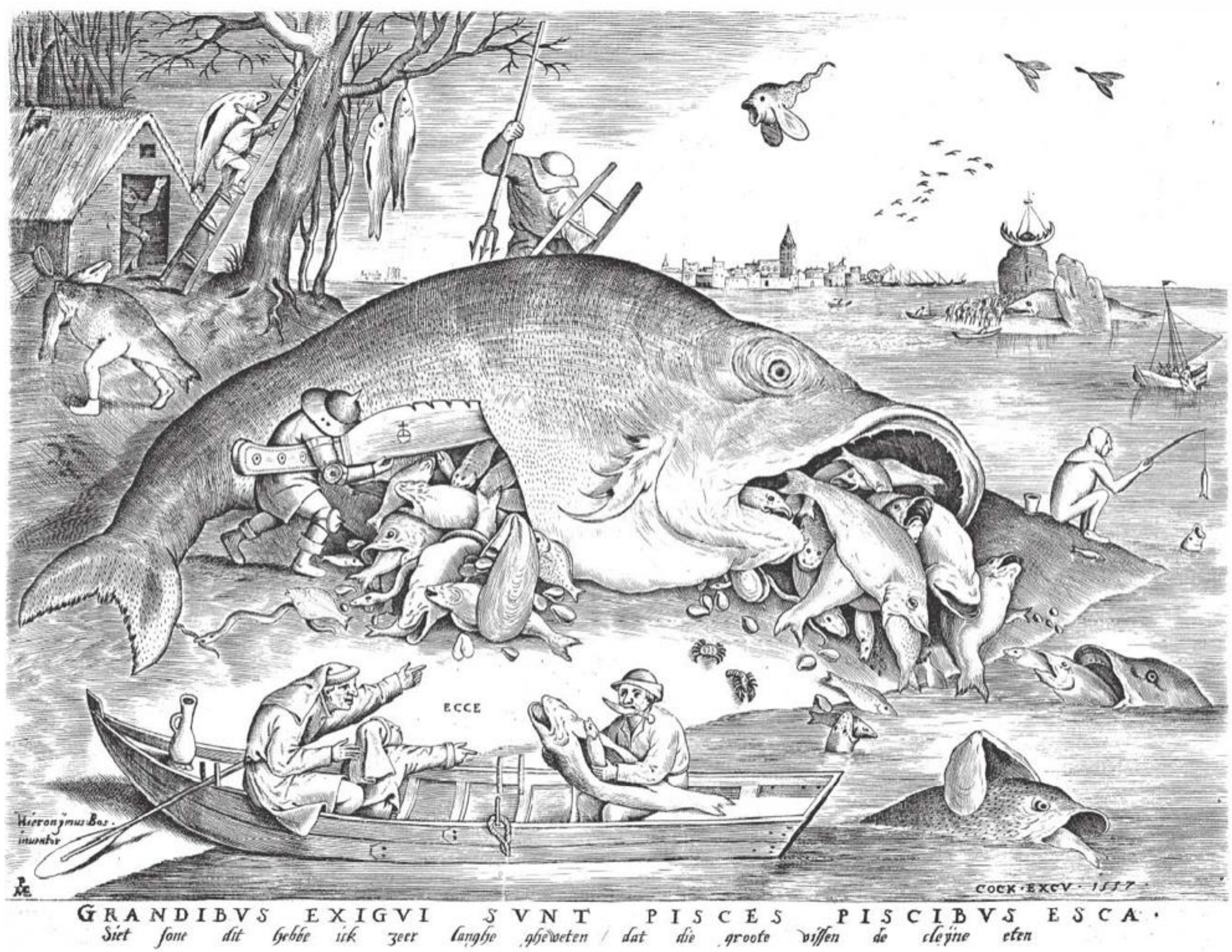
Friends of RESERVOIRS
WATER. HABITAT. LIFE.

Earl Conway
Conservation Director
New Mexico BASS Nation
October 6, 2018

ECO ISLANDS LLC

B.A.S.S. NEW MEXICO NATION

Welcome: I am not a biologist or fisheries manager……. I fish



🡐

Southwest Adapt-a-Cove

Adapt our thinking and actions to conserve fishery resources

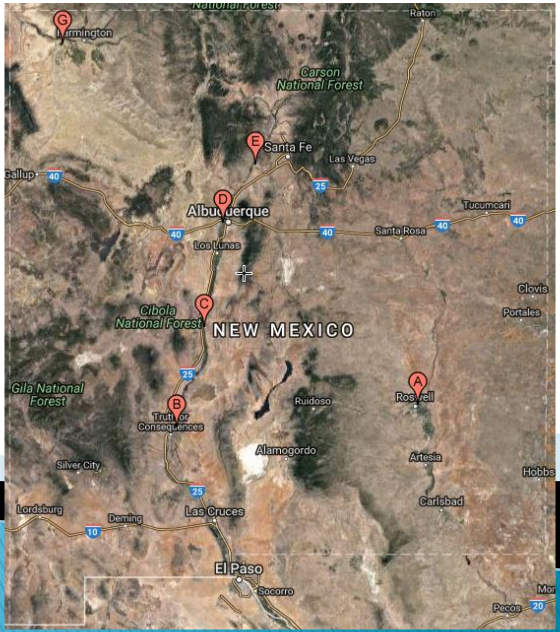
Prepare for possible future climates and water resource realities

Squeeze every bit of recreation we can out of our ponds and reservoirs

Inspire communities *and agencies* to adopt and improve public resources

100% Volunteer Projects

A- Spring River Pond (City of Roswell)
B- Elephant Butte Reservoir (BoR)
C- Escondida Lake (Socorro County)
D- Tingley Beach (City of Albuquerque)
E- Cochiti Reservoir (CoE)
F- Morgan Lake (Navajo Nation)



http://www.nmbfn.com/home/conservation

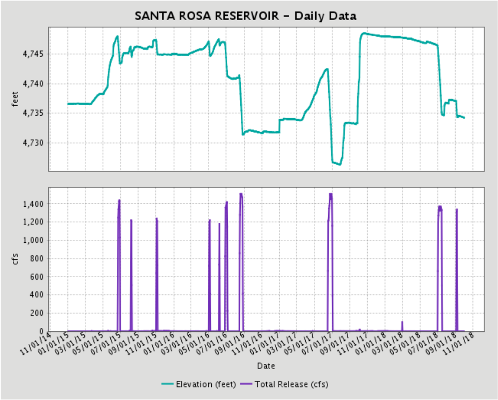
Experiment, Innovate and Adapt

- Seed balls and plants
- Floating plant nurseries
- “Silver Bullet” plants
- Portable fish habitats
- Floating fish habitats
- Hardwood brush piles



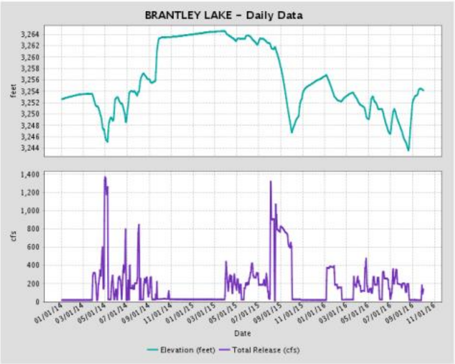


Pecos Irrigation Reservoir Experience



Santa Rosa

- Block Release Reservoir
- First Reservoir in Pecos Watershed
- Loaded with old juniper trees
- June block release provides new lake effect



Brantley

- 2014 New Lake Effect
- Flooded tamarisk flats
- Barren river bottom
- Stable spawning conditions
- DDT warning/catch & release order 2010-2017

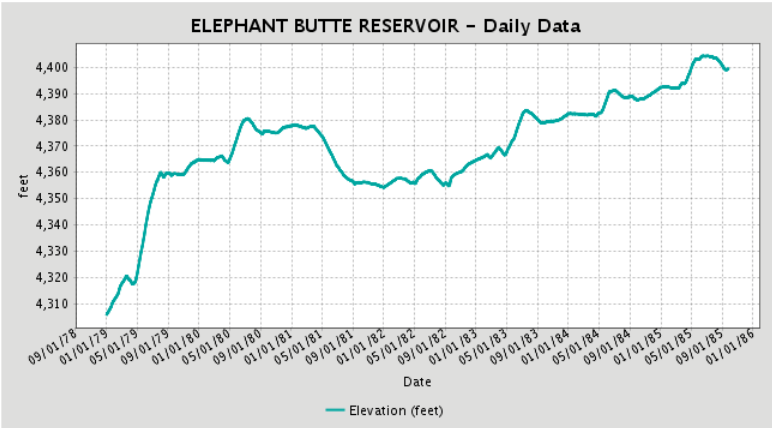
Weathering the "Rest of the time"   SWAC doesn't do "easy"

Section 8.9.7 "Thus, reservoirs with fluctuating water levels may have a riparian zone only part of the time; the ***rest of the time*** the riparian zone may be represented by a barren band or ring that follows the contour of the regulated zone. Providing diverse fish habitat within this contour is challenging"

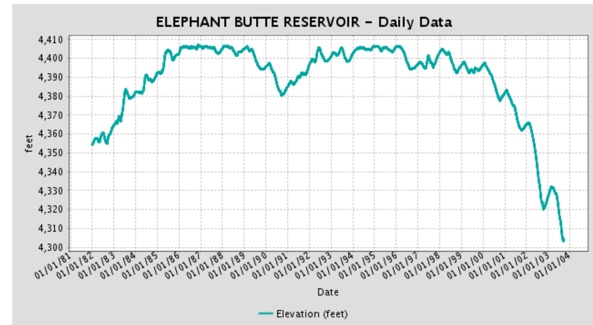
Effects of water fluctuations?

- Barren nearshore zones
- Reduced aquatic vegetation
- Interruption of natural propagation
- Increased erosion and sedimentation
- Increased turbidity during draw downs
- Increased temporal terrestrial vegetation
- Reduced spawning success
- Age class disparity
- Disruption of thermoclines and benthic processes
- Bigger predators (including LMB)

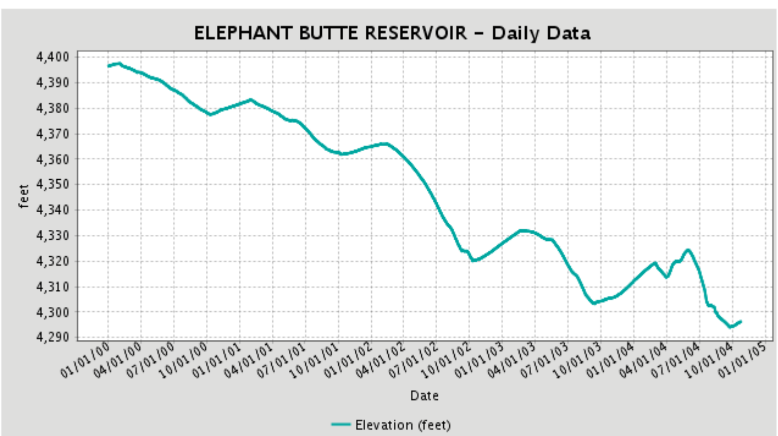
The Rise and Fall of Elephant Butte



Two sustained new lake periods



Observation window 1982-2004



Four-Year Crash

RAINFALL ACROSS A MILLENIUM

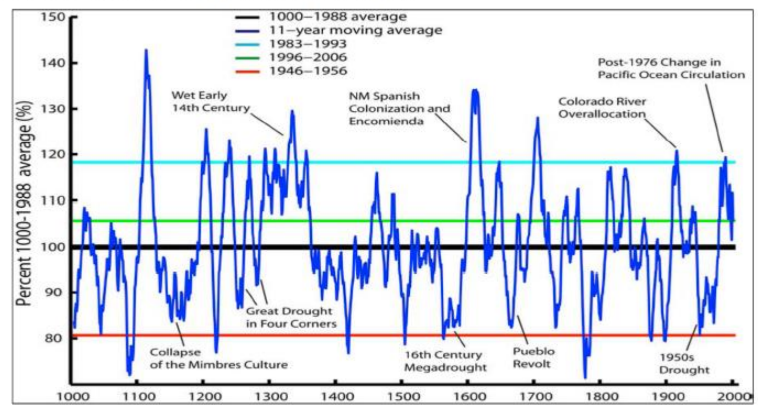


Figure 14: Precipitation Time Series for 1000 Years
(tree ring data; expressed as % departures from the 1,000 year average)[19]

It could have been worse!

Elephant Butte Reservoir
The New Normal? (20-40 ft Drops)

The Plan: NWP 27 Permit
Create an annual new lake affect by increasing vegetation and habitat

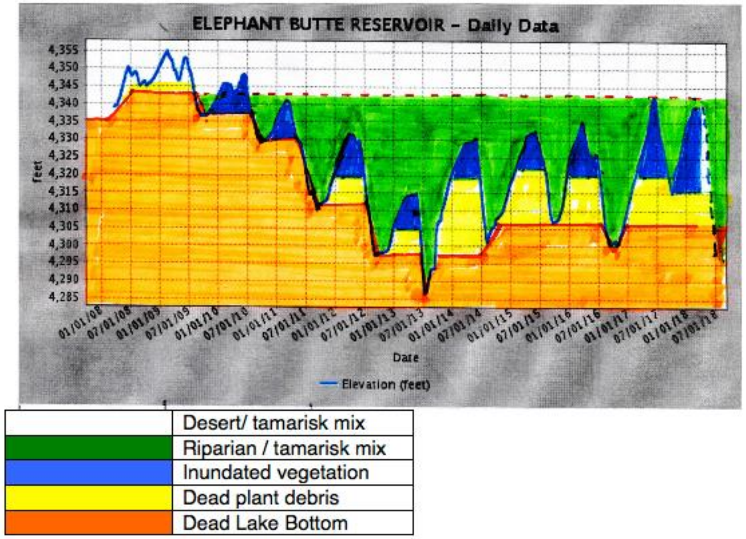
"Chase" the wet shore down in April-August with native seeds and plants. Propagate "silver bullet" plants

Fill in the vegetation gaps

Fill in the habitat gaps with artificial structures that also promote growth

Adapt! Every year presents new challenges and opportunities.

Do No Harm!



"Don't settle for 'easy'. Start something new! it's like jumping out of an airplane. You'll eventually hit the ground. The question is how hard!" Earl Conway

Nearshore littoral zone (AKA The Barren Zone)

- Destroyed during high water periods
- May not regenerate for decades*
- Macrophytes discouraged by water managers
- Soils are leached or non-existent
- No aquatic vegetation
- Recreation "Beaches"

** Disproportionate importance of nearshore habitat for the food web of a deep oligotrophic lake, Stephanie E. Hampton et al*

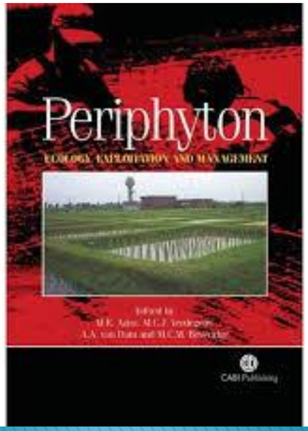
No textbook solutions

So what do you do if you are starting with a blank canvas?
Research = Steve Miranda, Raphaelle Thomas, Wentzl, …

Lots published on impacts but not on mitigation or restoration

Lots written on stream riparian restoration

Sweat the small stuff starting with the food web foundation;
Substrate surface area, substrate composition and roughness, carbon, nutrients, sunlight, periphyton, phytoplankton, seeds.



Real life solutions like brush parks

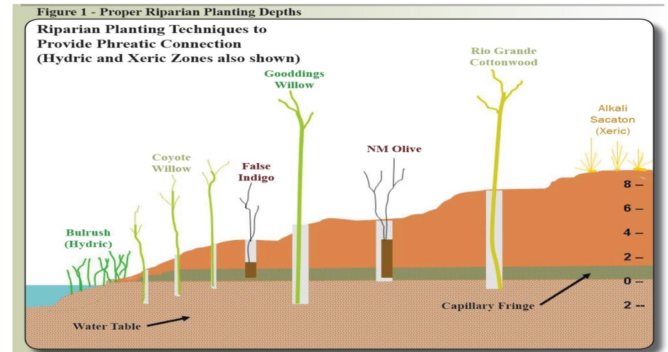
"Although periphytic algae live in close association with bacteria, protozoa, fungi and small meiofauna, these heterotrophic organisms are seldom included in reports concerning benthic food webs" Haglund

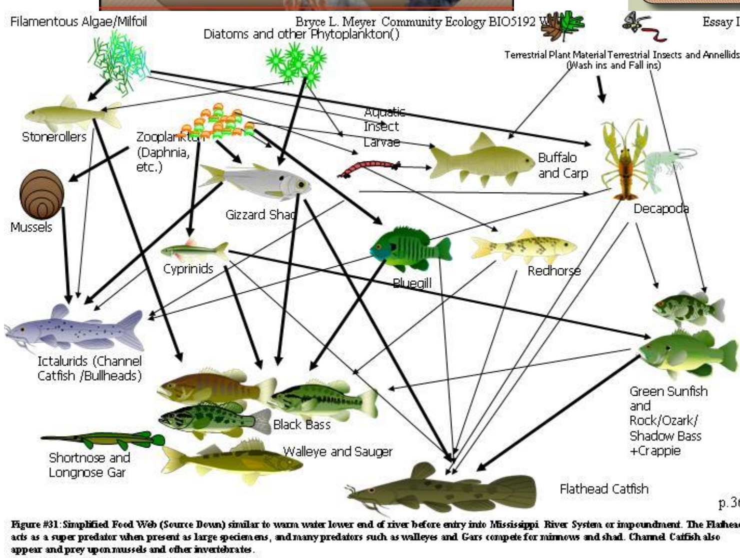
Patchwork Habitats

Suspended Structures

Floating Structures

Vegetation



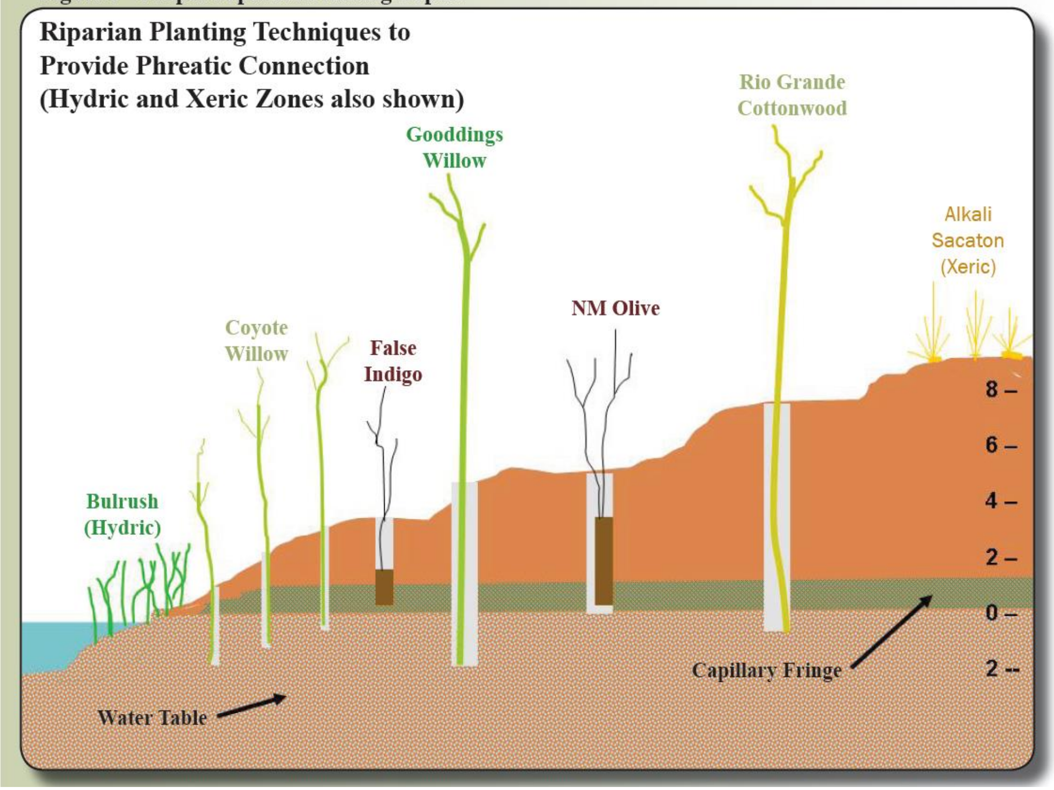


Brush Piles

Artificial Habitats

Know your plant community

Figure 1 - Proper Riparian Planting Depths



◇	A	C	D	E	F	G	H	I	J	K
1		Tier (1-5)	Priority	Sprin	Sumı	Fall	Availability	Reg	Season	Preferred Method
2	Common cocklebur	1	1		x	x	Self-propagating	Muc	Summer-fall	Self Proagating
3	Four-wing Saltbush	1	2	x	x		Com., Collect	Arrc	Spring-Fall	Pipes
4	Goodding Willow	1	3	x	x		Com., Collect	Muc	Spring-summer	Poles
5	Pennsylvania smartweed	1	4	x			Poor	Muc	Spring	Gourd
6	Desert Willow	1	5			x	Collect	Arrc	Spring-summer	Pipes
7	Rabbitbush/Chamisa	1	6	x	x	x	com	Arroyo		Seedling
8	Threeleaf sumac	1	7	x	x		Com	Arroyo		Seedling
9	Honey Mesquite	1	8		x		Collect	Arroyo		Seedling
10	Apache Plume	1	9		x		com	Hills		Seedling
11	Narrowleaf cattail	1	10	x	x	x	Collect	Islands		Gourd
12	Seepwillow	2	1		x	x	Com., Collect	Hills		Poles
13	False Indigo Bush	2	2		x	x	com	Arroyo		Seedling
14	Fremont cottonwood	2	3	x			Com., Collect	Transition		Poles
15	New Mexico pericet , stretchberry	2	4		x	x	Com	Hills		Seedling
16	Narrowleaf sumac	2	5		x	x	Com	Hills		Seedling
17	Netleaf Hackberry	2	6		x	x	Com., Collect	Hills		Gourd
18	One-seed juniper	2	7		x	x	Com., Collect	Hills		Gourd
19	Plains Sunflower	2	8	x	x		Com	Hills		Gourd
20	Mountain Mahogancy	2	9		x	x	Com., Collect	Hills		Seedling
21	Winterfat	2	10	x	x		Com., Collect	Mud flats		Gourd
22	Maximilian Sunflower	3	1	x	x		Com, Collect	Mud flats		Gourd
23	Prairie Sunflower	3	2	x	x		com	Sand		Gourd
24	Beebrush	3	3	x	x		com	Mud flats		Gourd
25	Broom dalea	3	4	x	x		Poor	Sand		Gourd
26	Spiny Hackberry, Granjeno	3	5	x	x		Collect	Hills		Seedling
27	Utah Serviceberry	3	6	x	x		Collect	Mud flats		Seedling
28	Buffalo Gourd	3	7	x	x		Collect	Sand		Gourd
29	Southwestern Rabbitbrush	3	8	x	x		com	Sand		Gourd
30	Western Soapberry, Jaboncillo	3	9	x	x		Com., Collect	Arroyo		Seedling

Seed Challenges

- "Do they float?" Best question I asked!
- Availability Broom Dalia
- Viability 4-days for Goodding's willow
- Stratification Various seeds > 2 years
- Scarification Western soapberry
- Herbivory Honey Mesquite
- Soil Regime Sedges
- Moisture One-seed juniper

Plant Selection (300+ species)

- Native (go/no go)
- Habitat (Cover value)
- Surface area per plant
- Propagation potential
- Availability
- Growth rate
- Durability
- Planting/seeding difficulty
- Cost per unit ($/yr*SA)

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Cocklebursaved the Butte: Sedges helped too

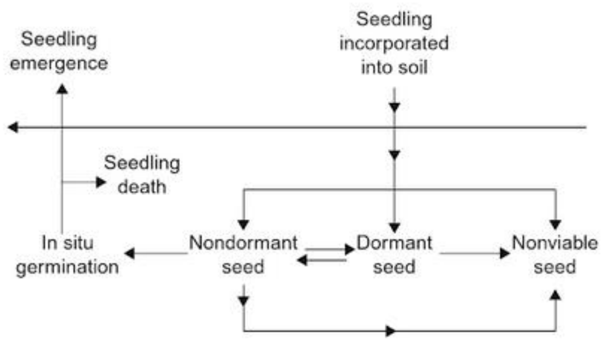
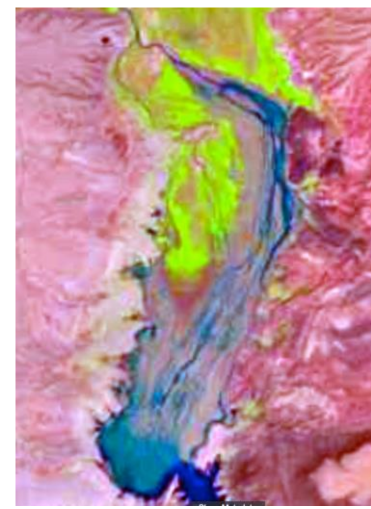


FIGURE 7.9 Diagram illustrating the changes seeds in a population undergo after they become buried in soil. *From Schafer and Chilcote (1970), with permission.*



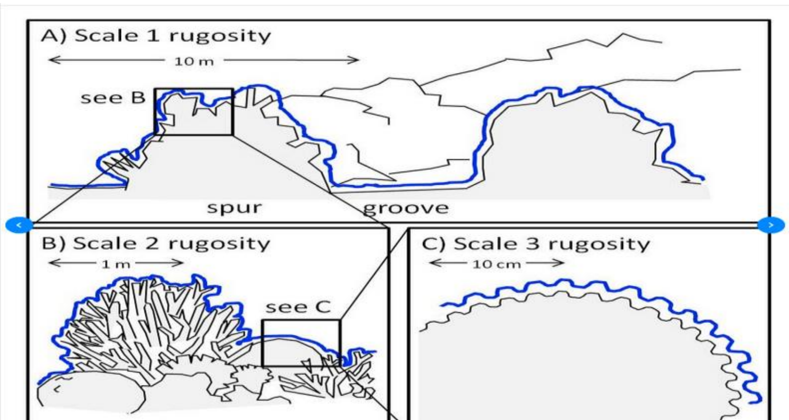


Figure S5. Three scales of coral reef rugosity (after Dahl 1973, diagram based on Stearn and Scoffin [28, 43]) A) Scale 1, or reef scale, rugosity-in the model parameter (5), RRug; B) Scale 2, or colony scale, rugosity (generated by function (D)) and C) Scale 3 (or 'microscale') rugosity, not included in the model.

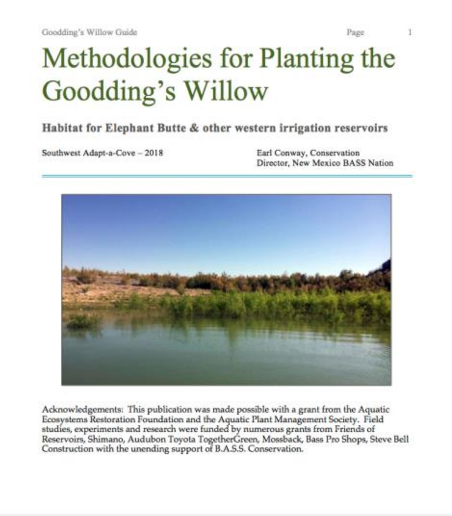
Gooding's Black Willow

(Salex Gooddingi, Salex nigra)

- Goodding's willow "discovered" and began propagating it in several ways

Willow stand

Gooding Willow Guide



Gooding's Willow Guide Page 1

Methodologies for Planting the Goodding's Willow

Habitat for Elephant Butte & other western irrigation reservoirs

Southwest Adapt-a-Cove – 2018

Earl Conway, Conservation Director, New Mexico BASS Nation

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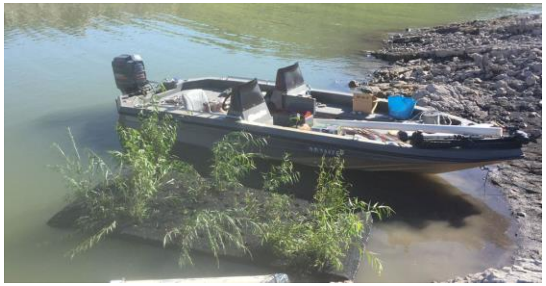
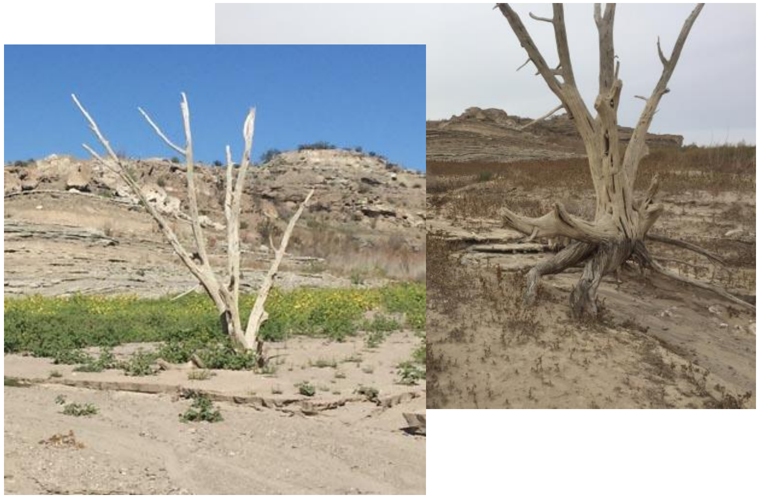
Beavers!



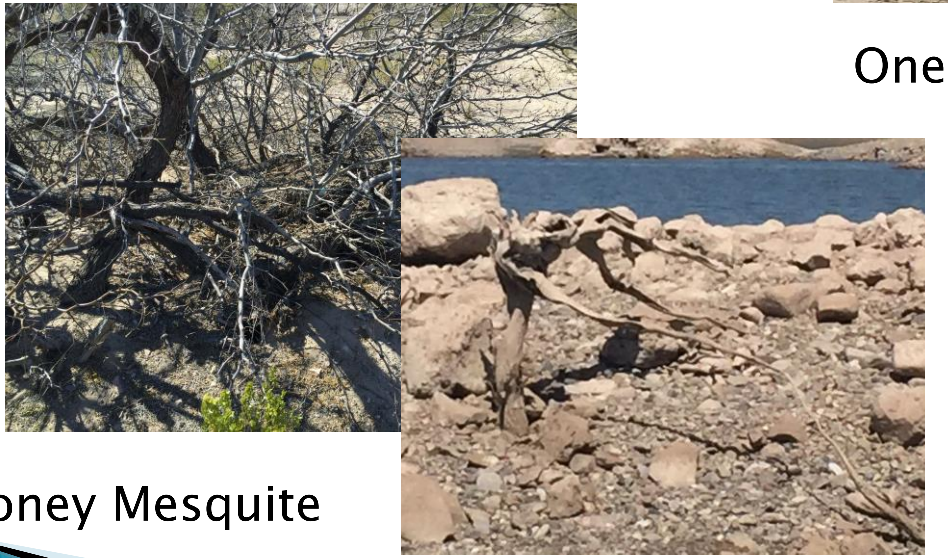
Goodding's Willow nursery mat

I'd be better if I were six feet under (water)

- One-seed juniper and honey mesquite stumps have endured 100+ years of submersion, droughts and erosion
- Slow and hard to grow but worth it? We'll see



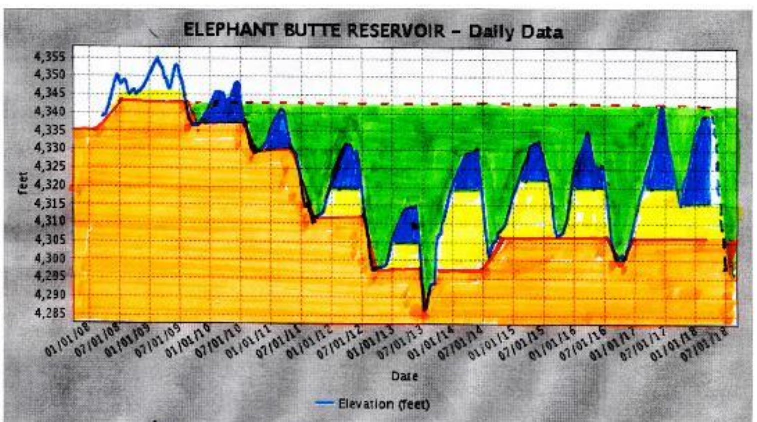
One-seed juniper



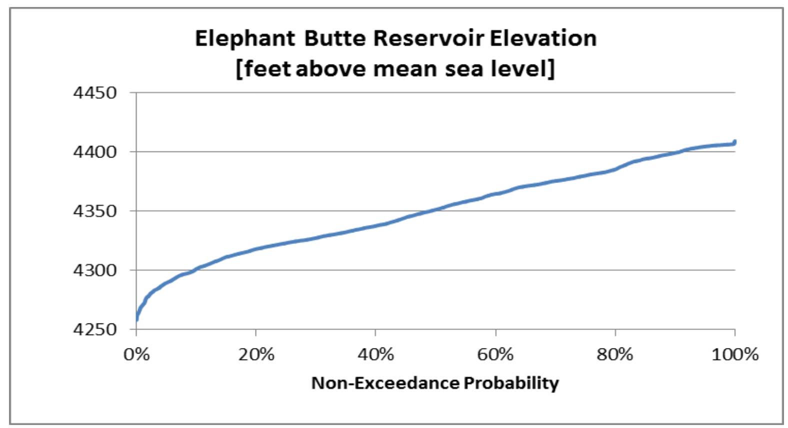
Honey Mesquite

Planting Strategies: What are the chances?

- Irrigation Board sets release schedule in January
- Pre-runoff peak reached in December
- Runoff may exceed discharge (or not)



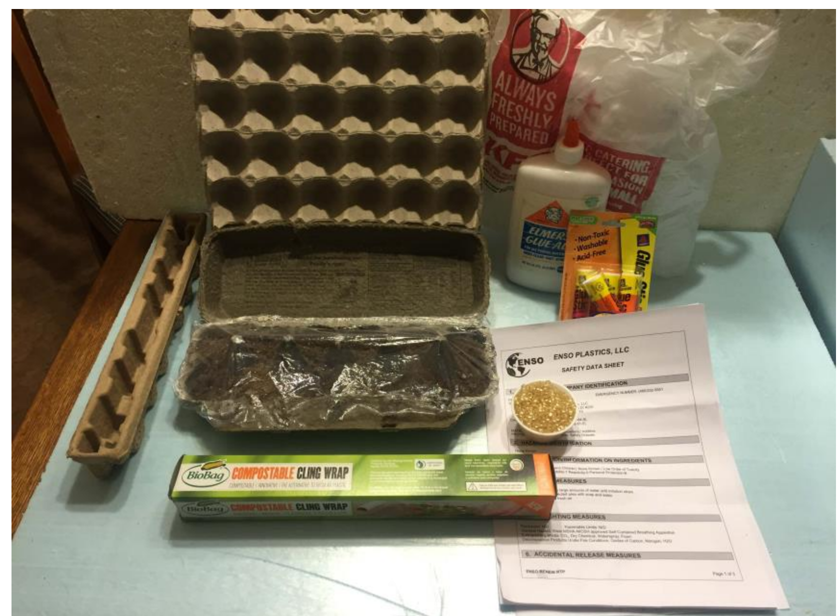
	Desert/ tamarisk mix
	Riparian / tamarisk mix
	Inundated vegetation
	Dead plant debris
	Dead Lake Bottom



The target elevations for fish habitat improvement are 4290 – 4350 Feet.

Innovative Approaches

- Seed balls, gourds, and pipes
- Floating seed colonies
- Walkabout Greenhouses
- Seedlings & Pole Plantings



Innovative Approaches

- Shallow berms
  - Water retention
  - Soil building

- Bird perches
  - Seed propagation
- Floating nurseries
- Built-in microenvironments
  - Water catchments
  - Rock cover
  - Disrupted soils

Summary

- Know your reservoirs
  - Flow regime (Block, flow through, irrigation)
  - Plant communities (“dead or alive”)
  - “Soils” (Landsat, field survey, micro-environments)
- Pick your battles
  - Is vegetation even possible?
  - Is more vegetation needed?
  - Will it matter?
  - Will plants propagate?
  - Which plants are best?
- Take a chance
  - Hedge for droughts
  - Plant for short and long term
  - Fill in the habitat mosaic
- Pray for rain (and snow)

Recommendations

- Expect the worse and hope for the best
- Plant as needed to backfill barren land
- Hedge your bet – maintain a good seed source
- Incorporate plant growth into artificial structures
  - Microenvironments
  - Sediment traps
  - Moisture retention
  - Erosion control
  - Seed bags
  - Critter comforts

Outreach and Education

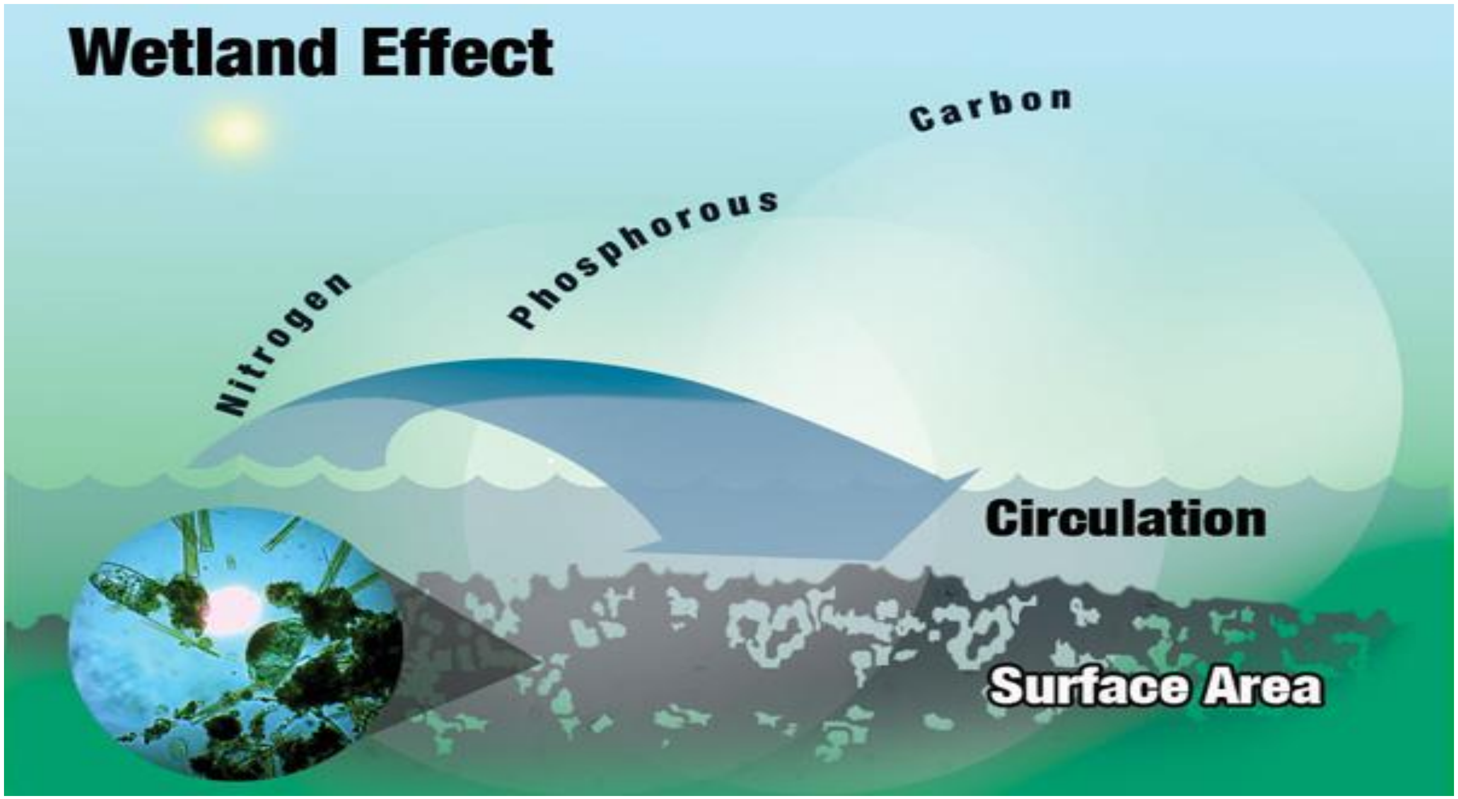
- Agencies are missing the boat
  - Bureau of Reclamation PR is MIA
  - New Mexico Game and Fish just starting to get it

Facebook and Instagram are the current "thing"

Elephant Butte Adapt-a-Cove

https://www.facebook.com/groups/191165874565994/

Wetland Effect is Essential



Not stated: Sunlight, temperature, pH, water, turbidity, clarity, salinity, ….Don't underestimate the importance of carbon

Notes on NWP 27 Ecological Reference Requirement

- An ecological reference can be conceptual
  - There is no existing ecological reference for irrigation reservoirs other than “as is”
  - A conceptual end state should be described
  - Before and after monitoring is required
  - Write measures around the habitat, not the fish

Seed Pipes

J. Range Manage.
57:399-401 July 2004

Gully seeder for reseeding rangeland and riparian areas

L.R. GUTIERREZ, J.E. HERRICK, AND G.B. DONART

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Abstract

Traditional methods of reseeding degraded arid and semi-arid rangeland are expensive and frequently unsuccessful due to high rates of seed predation and seedling mortality. A runoff-based method is described that protects seeds from predation and degradation until soil moisture is available, then deposits them in favorable microsites for germination and establishment. Seeds are placed in three, 2 cm-diameter x 8 cm PVC tubes. The small tubes are capped with crepe paper and glued inside of a 7.5 cm-diameter x 15 cm-long tube which is capped with hardware cloth. The tubes are placed in small rills, gullies, arroyos or riparian areas and the seeds are released sequentially from the 3 tubes as flow depth increases. Seeds are deposited beneath piles of litter where soil moisture and temperature are more favorable for seedling establishment.

Resumen

Métodos tradicionales de resiembra de áreas de pastizal árido y semiárido degradadas son costosos y frecuentemente no exitosos debido a altas tasas de depredación de semillas y muerte de plántulas. Un método basado en el escurrimiento superficial del agua de lluvia es descrito para proteger las semillas de la depredación y degradación hasta en tanto la humedad del suelo requerida este disponible, depositándose por consiguiente las semillas en micrositios favorables para su germinación y establecimiento. Las semillas son colocadas en tres tubos de PVC de 2 cm de diámetro y 8 cm de longitud. Los tubos pequeños son sellados con papel crepe y adheridos a la superficie interna de un tubo de PVC de 7.5 cm de diámetro y 15 cm de longitud, los cuales son protegidos en los extremos con una malla. Los tubos son colocados en pequeños canales, cárcavas o arroyos. Entonces las semillas son liberadas secuencialmente en los tres tubos conforme el nivel del escurrimiento aumente. Las semillas son depositadas bajo acumulaciones de mantillo lo cual coincide cuando la humedad y temperatura son más favorables para el establecimiento de plántulas.

Key Words: revegetation, land degradation, remediation, restoration, seeding methods

Many of the techniques developed for rangeland revegetation result in soil erosion due to short-term loss of surface cover and disturbance of the soil surface. In addition many of these strategies are expensive and often yield low seedling establishment (Ethridge et al. 1997). Mechanical seedbed preparation is an effective option but erosion risk is significantly increased particularly in areas with steep slopes and high rainfall intensities (Evans and Young 1987), and weed establishment is facilitated. Consequently, these modified environments frequently need additional investment in maintenance and weed control (Wiedemann 1987). The combination of high land preparation, seeding and maintenance costs together with low seedling establishment rates often make rangeland reseeding uneconomic (Ethridge et al. 1997).

Factors that commonly limit seedling establishment in rangelands include extreme temperatures, and low and erratic soil moisture availability during the growing season (O'Connor 1996, Ethridge et al. 1997, Peters 2000). Seedling establishment can be increased by modifying the microclimate around the germinating seed, limiting temperature extremes and increasing the quantity of water in soil surface horizons and the length of time it is available. Soil pitting, brush dams, and contour dikes and terraces have all been used to ameliorate soil surface temperatures and reduce evaporation by increasing infiltration and litter cover (Abernathy and Herbel 1973, Roundy and Biedenbender 1996, Whisenant 1999). The success of these labor-, energy- and machinery-intensive treatments is highly variable (Roundy and Biedenbender 1996, Rango et al. 2002) costs are high, and soil surface disturbance can be a problem (Herrick et al. 1997). One of the most significant problems is that rainfall is extremely difficult to predict. Seeds dispersed at the beginning of a relatively dry period are often lost to predation by ants or small mammals (Whitford 2002), or they germinate following small rainfall events when soil moisture is insufficient for establishment.

Simple, low-cost seeding techniques are required that increase the probability that seeds will germinate in locations favorable for seedling establishment at times when near-surface soil moisture is more likely to be available for extended periods. In much of the southwestern US and northern Mexico, these conditions are most likely to be met during the summer monsoons (Branson et al. 1981, Bailey 1998). This period is characterized by relatively high-intensity storms that generate overland flow in many parts of the landscape, feeding rills, gullies and arroyos, and causing streams to overflow their banks.

Based on this observation Barrow (1992) proposed a method of natural rangeland reseeding that takes advantage of these over-

Jerry Barrow, Dick Dunlop and other members of the Jornada Range assisted with the development of earlier designs. Jeff Parham prepared the figure. The senior author was supported by a grant from the Mexican government.
Manuscript accepted 6 Dec. 03.

Artificial matrix habitats

Surface area and topology is very important in the effort to grow food on substrates. Plastic fiber matrix is expensive but effective.

Lesson: Sweat the “small stuff” in the food web. Plants are pretty but matrix habitats are scud factories!