

## **General Guidelines for the Collection, Propagation and Installation of Native Riparian Woody Plant Species**

### 1) PLANT SELECTION

#### Ecological Considerations

riparian plant community characteristics  
riverine hydrology & geomorphology  
general habitat characteristics and patterns of riparian plant growth

information sources: background data & literature search, aerial photos &  
site specific information (reference sites)

#### Biological Considerations

genetic integrity/ provenance, utilize local sources for seed & propagules

#### Practical Considerations

availability, cost and project timing requirements  
site restrictions  
installation and maintenance requirements

### 2) RIPARIAN PLANT SOURCES: COMMERCIAL NURSERIES

#### How to Locate

literature & professional referrals: Restoration and Management Notes,  
Society of Wetland Scientists; PlantSource, Hortus Northwest, etc.

#### How to Select

read the catalogs  
specialty nurseries (prairie, wetland, alpine, desert, etc.), natives only,  
custom/contract growers, growers only vs full-service design and build?

nursery inspection:  
observe propagation methods and general plant growth  
conditions...potential for weed and/or pathogen contamination?  
develop selection criteria: experience w/ species of interest?, capacity  
and skill to produce quantity & sizes needed?, proximity to site??

## Plant Condition

### Seed

cleaned or uncleaned, fresh or after storage, obtain test results for germination rate and % weed species and inert materials

few nurseries specialize in seed collection, so local seed sources for the species and/or quantities needed may be difficult

### Containerized

size, shape, and material varies

most woody and herbaceous species suitable for containers

*advantages:* available year-round, easy to transport, easy to maintain at site, plant an intact root system

*disadvantages:* high cost relative to other forms

### Ball and Burlap (B&B)

used primarily for shrubs and trees (conifers)

plants are field-grown, dug with rootball intact, wrapped in burlap

*advantages:* root system relatively intact, lower cost than containerized

*disadvantages:* availability generally limited to dormant season, specialized storage requirements, root damage during collection (cedars!)

### Bareroot

field-grown, dug and supplied during dormant season

includes rhizomes, pull-ups, sprigs, and plugs

nursery source does not necessarily mean nursery-grown...collection from wild populations maybe problematic

*advantages:* relatively inexpensive, handling ease

*disadvantages:* loss of roots, increased attention to maintenance, supply and planting limited to dormant season, length of storage is unknown

### Contract Grower Options

greatest assurance that the needed plants will be ready at the appropriate time, at a known cost

requires the greatest amount of lead time (generally at least one year)...develop design, seed or cutting collection, growing out to required sizes

conduce inspections during contract term

### 3) RIPARIAN PLANT SOURCES: SALVAGE AND PROPAGATION

SALVAGE...using resource that would otherwise be trashed; provides materials that are unavailable otherwise; enables use of either onsite materials or from similar habitat

Two Approaches:

- 1) plants alone
- 2) sod (soil and herbaceous plants together)  
(soil typically salvaged as part of landscaping, not as a source of plants but to provide growing medium)

*advantages:* plants adapted to physical & biological characteristics of site; maintaining genetic integrity/diversity of local populations; supplies surface soils, nutrients, and soil micro-organisms appropriate to the site

Plant Salvage: removal of plants from a donor site for storage or transplanting to a restoration site

*advantages:* source of native stock; soil mycorrhizae, seeds, rhizomes in rootballs;

when restoration performed to mitigate habitat destruction, consider plant salvage from impact site

alternatively, much opportunity in developing areas...many acres destroyed every day

requires planning and coordination

salvage and plant during dormant season (November through February, depends on species)

ideally, planting immediately following salvage maximizes survival and minimizes cost

holding before planting requires equipment, materials, and labor to build storage facility and maintain plants, drives up cost and lowers survival rate

additional benefits: potential for public participation & education

Soil Salvage: site cleared and grubbed, topsoil scraped and piled at beginning of project, respread before planting

rough handling, poor storage conditions results in soil homogenization and loss of viability of plant seeds, rhizomes, tubers, changes in soil microorganisms

minimize homogenization by limiting handling/rehandling & length of storage to avoid dry out and/or composting effects

PROPAGATION...undertaken to fulfill very specific requirements; requires special expertise & dedicated sites and/or facility for propagation activities.

two basic categories: seed propagation; vegetative (cutting) propagation

### Seed Propagation

allows maintenance of genetic integrity, **some species are more successful via seed than cuttings (well-developed root systems, branching patterns)**; requires specialized knowledge to collect, store, and grow native seeds

*collection:* need to know maturity dates & dispersal mechanisms; fleshy fruits disappear quickly due to birds; capsules may dry & split quickly

*storage:* requires proper preparation and conditions  
remove fleshy covering, dry to remove excess moisture  
keep seeds cool and dry...

store in low moisture, low temperature environment  
( < 50 F, < 50% relative humidity, avoid fluctuations)

*germination and growth:* some species germinate immediately, while others have dormancy requirements (i.e. cold stratification) thus ensuring germination within appropriate time intervals.

1) mechanical...hard seed coat prevents seed from imbibing water, requires scarification (birds, knife, sandpaper, hot water soak, sulfuric acid)

2) chemical inhibitors within seed coat removed by leaching

3) internal...seeds contain dormant embryos and require moist-chilling before germination can occur (i.e., fall-winter).

Horticultural practice called "stratification or "cold strat".  
Requires moisture, cool temperature, and aeration (oxygen).

Simplest and easiest method to overcoming dormancy involves sowing seed in outdoor beds or flats in the fall and letting the change of the seasons do its work (i.e., imitate nature).

Important factors: protection from predation, proper moisture, proper seed density and planting depth, fertilization, disease, insect, and weed control.

flat or flats and containers, fill with 50/50 mix of peat and perlite or well-drained potting soil (not dirt...do not imitate nature), protect, water, set outside.

### Vegetative (cutting) Propagation

softwood/semi-hardwood/hardwood cuttings for shrubs and trees

division of multiple-stemmed hardwoods

obtain larger plants faster than from seed

*Softwood Cuttings*--taken when stems are elongating, during early part of the growing season ensures supple tissue and leaves; require special handling and environmental/pest control

*Semi-hardwood Cuttings*--taken during latter part of growing season provides firm wood and mature leaves; similar handling and environmental conditions to softwood

*Hardwood Cuttings*--taken during dormant season, thus firm wood, no leaves and dormant leaf buds. Relatively simple handling requirements, dormancy allows long-term storage (upto 6 months) under refrigerated conditions (<34 F, wrap in plastic to minimize dessication), rehydrate prior to planting and/or propagation.

*Division*--mutiple-stemmed hardwoods; whole plants divided to produce sprigs (stem & root intact); collection/planting during dormant season or early growing season

#### 4) SITE PREPARATION, PLANTING TECHNIQUES AND PRACTICES, PLANT MAINTENANCE, AND MONITORING

##### Site Preparation

- 1) soil amendment (broadcast recommended...amending individual planting holes provides only short-term benefits)

goal: create a soil with adequate drainage during wet season, moisture retention during dry season, and contains adequate nutrients for plant growth, *within limits of soil type that is appropriate for target ecosystem*

soil amendments should be based on reference site soil characteristics, and/or soil tests and plant requirements

If soils are compacted by heavy equipment, tilling, ripping, plowing may alleviate dense, tight soils

general guidelines: EPA Oregon study found soils in most created wetlands significantly lower amounts (about half) of organic matter than natural wetlands...recommend adding organic matter (compost, sterile straw, peat)...how much?...one reference says <25% by volume = no benefit...25-50% commonly used

- 2) weed control

mechanical (mowing, pulling up); chemical (herbicides);

habitat alteration (flooding, shading, soil solarization)

- 3) installation of fencing and/or use other herbivory control methods

- 4) install or create logs, snags

- 5) stake community boundaries or individual plant locations

- 6) plant delivery inspection

species, quantity, condition...opportunity to accept or reject plants

## Installation

planting time varies with region and plant material: ...

*moderate coastal environments* may be planted in late fall through early winter (warm, moist soils allow root growth until soil temps decline below 41F)...late winter/early spring is OK, but plants have less time to establish before low moisture, high light & temps impose stressful growth conditions.

*continental climatic regimes*-trees for reforestation planted in early spring to avoid frost damage to young (unestablished) trees.

In general, *hardwood cuttings* should be planted in late winter/early spring, firmly tamp dirt around cuttings to ensure soil/cutting contact to promote vigorous rooting.

### trees, shrubs, herbs

see attached schematic-details...dig hole larger than rootball, backfill with native (amended) soil, avoid air pockets, water in (no puddling), stake large trees and shrubs to prevent cracking

bareroot...soak in water (with transplant vitamin B1) for one hour first ball and burlap...slit burlap, unwrap (& remove from smaller root ball)

containerized...water before planting, **remove from container** (both plastic and fiber), tease apart roots

cuttings...recut both ends and rehydrate by soaking overnight (ca. 1/2 cutting below water); plant w/ buds pointing up; firmly tamp dirt around cutting; if unirrigated, place at least 2/3 cutting/whip/pole belowground

set all plants at same level they were growing at the nursery (allow for settling)

mulch & weed barrier cloth to retain moisture, moderate soil temperatures, discourage weeds

mulch materials: sterile straw, compost, bark and wood chips (avoid fir, cedar, spruce, larch, redwood, and other species reported to be toxic), synthetic weed barriers (woven/porous plastic)

*considerations*:availability, ease of application and maintenance  
appearance, stability under wet and windy conditions  
freedom from contamination, slow decomposition (large pieces, partly decomposed, high in lignin)

## Maintenance

irrigation (propagation beds & large scale projects)

weed & erosion control

control herbivory (temporary & permanent fencing options)

## Monitoring

sampling strategy (what, where, when)

generally involves permanent sampling plots, quantitative vegetation observations, and photodocumentation; may also include information on soils, hydrology, wildlife, habitat structure, water quality

Monitoring period determined by project success, budget, permit requirements...typically 5 years, but may be longer.

## **BACKGROUND REFERENCES FOR RIPARIAN WOODY PLANTS**

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Seed Collection and Storage Specifications for Selected Woody Riparian Plants

Species	DATES	Phenological Cues	Seed drying/processing	Seed testing	Seed Storage
<i>Alnus</i> spp.	Sept-Oct (Jan)	cone color/morphology*	bagged w/good air circulation tumbler w/screening	See Agar et al. 1994	(1-10yr) dry, sealed container w/refrigeration
<i>Populus</i> spp.	May-June	splitting capsules	air-dry thrash/screen w/shopvac	N/A limited viability (1-2wk)	(1yr) dry, sealed container w/refrigeration
<i>Salix</i> spp.	May-June	splitting capsules	air-dry thrash/screen w/shopvac	N/A limited viability (1-2wk)	(1yr) dry, sealed container w/refrigeration
* yellowish gray to gray/brown & cone bracts separate when twisted					
<i>Alnus</i> spp. (like many conifer species) require 2-4 weeks of cold stratification (15/5C) prior to germination					

Collection and Storage Specifications for Hardwood and Semi-Hardwood Cuttings/Whips/Poles

Species	DATES	LENGTH	DIA	Whip/Pole	Storage conditions	Pre-Planting
<b>Trees</b>						
<i>Alnus incana</i>	Jan-Feb	6 " to 24"	3/8" to 2"	6' to 8' (2" to 4"+)	10-28F, plastic wrap (8-16 wk)	24hr hydration, (0.8%IBA in talc)
<i>Populus trichocarpa</i>	Jan-Feb (Mar)	6 " to 24"	3/8" to 1.5"	6' to 10' (2" to 4"+)	10-28F, plastic wrap (8-16 wk)	24hr hydration
<i>Populus deltoides</i>	Feb (Mar)	6 " to 24"	3/8" to 1.5"	6' to 10' (2" to 4"+)	10-28F, plastic wrap (8-16 wk)	24hr hydration, (0.8%IBA in talc)
<i>Salix spp.</i>	Jan-Mar	6 " to 24"	1/2" to 2"	6' to 8' (2" to 3")	10-28F, plastic wrap (8-16 wk)	12 hr hydration
<b>Shrubs ( for container stock)</b>						
<i>Cornus stolonifera</i>	Feb-Mar	6 " to 24"	1/4" to 1/2"		32-34F (2 wk), plastic wrap	Precallus using boxes/flats of peat moss
<i>Physocarpus capitatus</i>	Feb-Mar	6 " to 24"	1/4" to 1/2"			
<i>Rubus spectabilis</i>	Feb-Mar	6 " to 24"	1/4" to 1/2"			
<i>Sambucus racemosa</i>	Feb-Mar	6 " to 24"	1/4" to 1/2"			
<i>Spirea douglasii</i>	Feb-Mar	6 " to 24"	1/4" to 1/2"			

Woody Riparian Plant Growth Requirements and Nursery Specifications

SPECIES	COMMON NAME	USFWS	ECOZONES	SOIL	WATER	LIGHT	CONDITION	SIZE	SPACING
Trees									
<i>Abies grandis</i>	grand fir	FAC	1,2,3,6	m	SF, SS PS	full/partial sunlight	bareroot, container, b&b	1-3'	8'+
<i>Acer macrophyllum</i>	bigleaf maple	FACU	1,2,3	m	SF, SS	full/partial	bareroot, container	3-8'	8'+
<i>Alnus incana</i>	speckled alder	FACW	4,6,7	m	PS, SF	sunlight full/partial	bareroot, container	3-8'	6'+
<i>Alnus rubra</i>	red alder	FAC	1,2,3	m	SF,PS, SS	sunlight full/partial	bareroot, container	3-8'	8'+
<i>Betula occidentalis</i>	water birch	FACW	4,6,7	m	PS,SF	full/partial	bareroot, container	1-2'	6'+
<i>Fraxinus latifolia</i>	Oregon ash	FACW	1,2	m	SF,PS, SS	full/partial sunlight	bareroot, container	3-8'	8'+
<i>Picea sitchensis</i>	Sitka spruce	FAC	1,2,3	m/o	PF,SF, PS,SS	full/partial sunlight	bareroot, container	6-12"	8'+
<i>Populus tremuloides</i>	quaking aspen	FAC	1-7	m	SF,SS	full sunlight	bareroot, container,	3-8'	6'+
<i>Populus trichocarpa</i>	black cottonwood	FAC	1-7	m/g	SF,SS	full sunlight	root suckers bareroot, containers,	3-8'	8'+
<i>Salix lasiandra</i>	Pacific willow	FACW	1-7	m/g	SF,PS	full sunlight	whips/poles bareroot,	1-6'	6'+,
<i>Salix lasiolepis</i>	Arroyo willow		4,5,7		SS		container,	1-6'	2' for
<i>Salix scouleriana</i>	Scouler's willow		1,2,3,4,6				cuttings,	1-8'	cuttings
<i>Salix sitchensis</i>	Sitka willow	FAC	2,3				whips/poles	1-8'	
<i>Thuja plicata</i>	Western red cedar	FAC	1,2,3,6	m/o	SF,SS	partial sun to full shade	bareroot, container, b&b	1-6'	8'+
<i>Tsuga heterophylla</i>	Western hemlock	FACU	1,2,3,6	m	SS	full/partial sunlight	bareroot, container, b&b	1-6'	8'+

Woody Riparian Plant Growth Requirements and Nursery Specifications

SPECIES	COMMON NAME	USFWS	ECOZONES	SOIL	WATER	LIGHT	CONDITION	SIZE	SPACING
Shrubs									
<i>Acer circinatum</i>	vine maple	FACU	1-4, 6	m	SF, SS	full sunlight	bareroot, container	3-8'	6'+
<i>Alnus sinuata</i>	Sitka alder	FACW	3, 4, 6	m	SS	full sunlight	bareroot, container	1-6'	6'+
<i>Cornus stolonifera</i>	red-osier dogwood	FACW	1-7	m	SF, PS, SS	full/partial sunlight	bareroot, container, cuttings	1-4'	4'+, 2'+ for cuttings
<i>Lonicera involucrata</i>	black twinberry	FAC	1, 2, 3, 4, 6	m	SS	full sunlight	container	1-2'	4'+
<i>Physocarpus capitatus</i>	ninebark	FAC	1, 2, 3, 4, 6, 7	m	SS	full/partial sunlight	bareroot, container	1-3'	3'+
<i>Pyrus fusca</i>	western crabapple	FAC	1, 2, 3	m	PS, SS	full/partial sunlight	bareroot, container	1-6'	6'+
<i>Rubus spectabilis</i>	salmonberry	FAC	1, 2, 3	m	PS, SS	full/partial sunlight	bareroot	1-3'	4'+
<i>Salix amygdaloides</i>	peachleaf willow	FACW	5	m/g	PS, SF	full sunlight	container, cuttings/whips	1-4'	4'+, 2'+ for cuttings
<i>Salix exigua</i>	sandbar willow	OBL	4, 5, 6, 7		PS, SF				
<i>Salix hookeriana</i>	Hooker willow	FACW	1, 2		SF, PS				
<i>Sambucus cerulea</i>	blue elderberry	FAC	1-7	m	SS, PS	full/partial sunlight	bareroot, container	1-4'	21'+
<i>Sambucus racemosa</i>	red elderberry	FACU	1, 2, 3, 4, 6, 7		SS	sunlight	container		10'+
<i>Spirea douglasii</i>	Douglas' spirea	FACW	1, 2, 3	m/o	SF, PS, SS	full/partial sunlight	bareroot, container, cuttings	1-4'	3'+, 2'+ for cuttings
<i>Vaccinium spp.</i>	huckleberry			m/o	SS, PS	full/partial sunlight	bareroot, container	1-2'	4'+

WATER: (PF) Permanently flooded, (SF) Seasonally flooded, (PS) Permanently saturated, (SS) Seasonally saturated

Common problems of vegetation establishment, their diagnosis and remedies.  
(Adapted from Coppin and Richards 1990.)

SYMPTOMS	CAUSE	DIAGNOSIS	REMEDIES
Ground covers			
Legumes disappear	Acidity	pH <5.5	Liming
	Low phosphorus	Extractable P test	P-fertilizer
	Grass competition	Grass height > 12 in.	Graze or cut
Poor growth, prone to drought in summer; shallow rooting; pale color	Soil compaction	Packing density <sup>1</sup> > 1.75 (mg/m <sup>3</sup> )	Cultivation
	Waterlogging	Water table <15 in. from surface	Drainage, use tolerant species
Poor growth, moribund	Nutrient deficiency	Extractable nutrient low	Add fertilizer, use legumes
		Low cation exchange	Add organic ameliorants
	Acidity	pH <5.5	Add lime, use tolerant species
	Drought	Low AWC <sup>2</sup> , coarse soil texture	Add organic ameliorant
Thick matted grass, moribund, no decomposition	Nutrient deficiency	as above	as above
	Acidity	as above	as above
	Low N in vegetation	C/N ratio >25	Add N-fertilizer, grazing
Growth too dense and vigorous	Soil too fertile	Presence of aggressive weed species	Cut regularly and remove herbage to reduce soil fertility.
Trees and Shrubs			
Failure to establish	Poor stock or bad handling and planting	All site factors are satisfactory	Replant
Dieback or death, poor root growth, foliage colored or sickly	Excessive soil compaction	Packing density >1.75 (mg/m <sup>3</sup> )	Cultivate
		Planting pit impermeable	Replant
	Waterlogging	High water table < 2 ft. deep	Drainage
Poor growth rates	Nutrient deficiency	Foliar and/or soil analysis	Fertilize
	Acidity	pH outside preferred range	Lime
	Drought	Low rainfall; low AWC, coarse soil texture	Mulches; watering
	Competition from ground cover	Dense vegetation around trees	Amelioration with organic matter Mulch or herbicide to suppress
Damaged, disfigured or discolored foliage, buds and stems	Disease	Symptoms of fungi or insect attack	Pest control; prune or fell affected trees, remove and burn

<sup>1</sup> Packing Density = Dry bulk density of soil in situ (mg/m<sup>3</sup>) + (0.009 x % clay)

<sup>2</sup> AWC = Available water capacity

# River in Nevada Helps Its Own Restoration

By JON CHRISTENSEN

WADSWORTH, Nev. The trembling leaves of a forest of knee-high cottonwood saplings flash a moving mosaic of light and dark green on the bank of the lower Truckee River. Just two years ago, the riverbank was a barren surface of dry, cracked mud and rocks baking in the hot Nevada sun. But an innovative restoration effort has taken advantage of two winters of abundant snowfall and spring floods to bring hundreds of thousands of trees back to this long-suffering river.

"Life is returning after the holocaust," said Paul Wagner, fisheries director for the Pyramid Lake Paiute Indian Tribe, whose reservation surrounds the lower Truckee River and the terminal desert lake toward which the water rushes. Pyramid Lake is home to two endangered fish, the Lahontan cutthroat trout and the cut-throat sucker ("knee sucker"), an ancient desert sucker found nowhere else. The cut-throat reproduction by spawning in the Truckee, but the trout

the river to do the job. These cottonwood saplings grew from seeds that floated down and carefully controlled floods in the last two summers. They are the first visible signs of success for a cooperative effort to make a tightly controlled river that furnishes much water for farms and cities and behave more like a free-running river.

"This is a totally new approach to restoration," said Graham Chisholm, special projects director for the Nature Conservancy in Nevada. "We're not planting trees. We're allowing the river to do what it wants to do. But we're not passive either." He said scientists were managing the river to mimic the natural flood cycles that were lost when water was diverted to farms and cities.

Natural cottonwood regeneration depends on just the right combination of spring floods and summer water levels; the levels must drop slowly enough that young tree roots beside the river can stay in contact with the declining water table. For the last two summers on the Truckee, those natural conditions have been artificially created with releases from reservoirs. The river level was slowly lowered throughout the summer. It dropped approximately an inch per day, the same rate at which cottonwood roots grow.

This year, the few old cottonwood trees that survive along the Truckee released their seeds in late May and early June. The fluffy white seeds drifted down like light snow, settled on the water and floated downstream to places where the river makes wide turns; on the inside edges of the turns, the water slowed, and some seeds settled in a sticky wet mat. Once-bare sand and gravel is now covered with tiny green seedlings along six miles of the river.

If this newborn cottonwood forest survives and expands, the endangered cut-throat and Lahontan cutthroat trout will benefit from a narrower, shadier, cooler river in which to spawn. Weeds that cover riverbanks will be crowded out by a healthy forest along the bank, the riparian zone. Songbirds that have avoided the hot riverbanks — 42 species once found here are now missing from the lower Truckee — are expected to return.

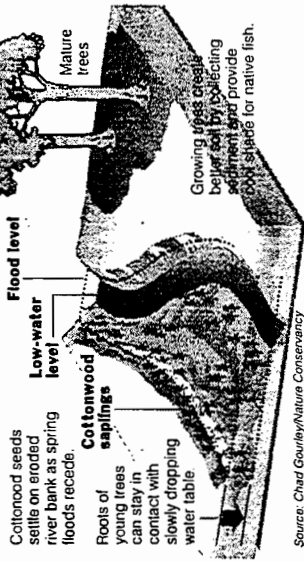
"The change is noticeable," said Norm Harry, chairman of the Pyramid Lake Paiute Indian Tribe. "The



Graham Chisholm of Nature Conservancy, left, and Paul Wagner of Pyramid Lake Paiutes check on young cottonwoods on Truckee River.

## Reforesting River Banks

By carefully controlling the rates at which water levels rise and fall, so that they mimic natural flood cycles, scientists made the Truckee River nurture cottonwood seedlings that the river planted itself.



Source: Chad Gourley/Nature Conservancy

river is on the mend. Areas that looked like a moonscape are covered with young forest now. It goes to show that nature has a way of healing itself."

Chad Gourley, who designed the restoration project for the Nature Conservancy, said that if the water flows were favorable, "once a patch of trees is established, it's self-perpetuating." He explained: "The trees collect sediment, creating better soil conditions and better shading. Then you get concentric rings of

leaty 20-foot-tall cottonwoods hard by the water's edge in some stretches. Between these young trees and the few old, decaying trees, however, the riparian forest is thin and ragged.

Dr. Scott said water levels on the Truckee were controlled until mid-August to make sure that the cottonwood forest established a beachhead. "Cottonwoods are so important in arid landscapes," he said. "The cottonwood is the dominant structural element of Western riparian ecosystems, and it's about the only tree you'll find at lower elevations."

The cottonwood restoration project on the Truckee River is "a precedent-setting case study for both the science and management of rivers internationally," said Dr. Stewart Rood, a professor of biological sciences at the University of Lethbridge in Lethbridge, Alberta. "If you can restore a desert stream in Nevada, you should be able to do it in most places." Dr. Rood has studied cottonwood forests across the western United States and Canada. He developed the model for dropping river levels an inch per day.

But the cottonwoods themselves gave the first sign that they might be able to make a comeback on the lower Truckee. Relatively few new cottonwoods had sprouted for 60 years. A few giant old trees stand to 100 yards from the riverbanks. But there is also a narrow belt of

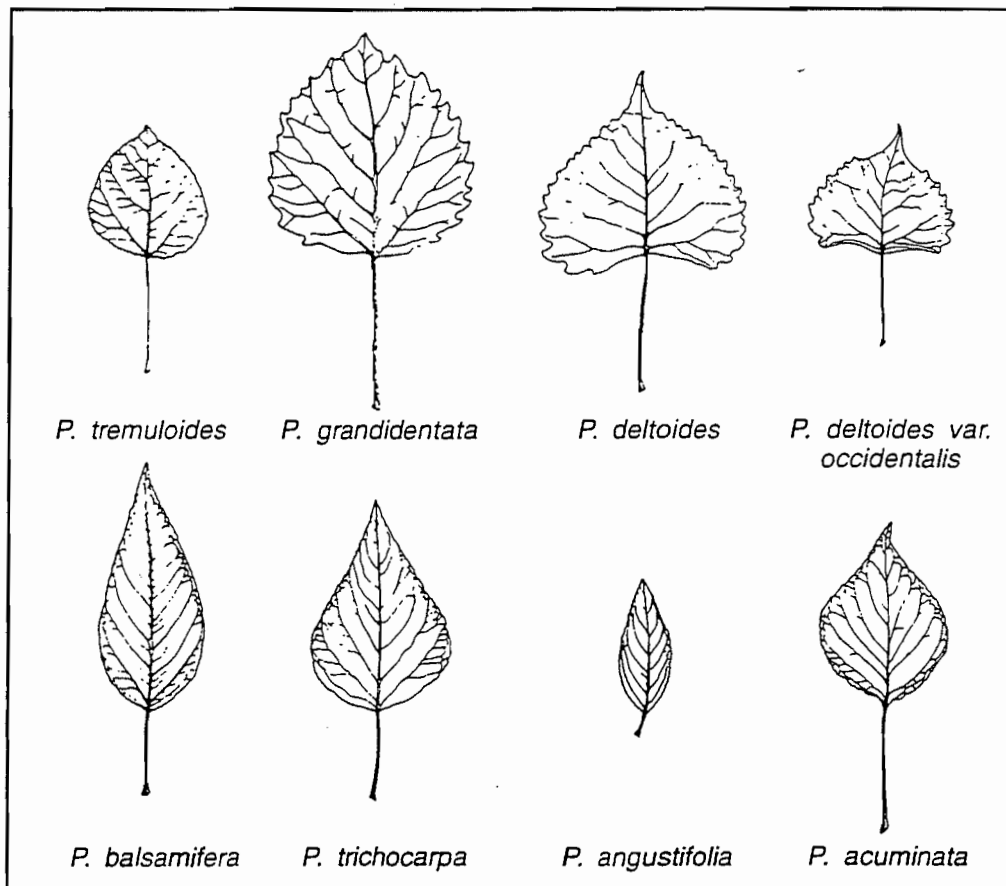
leaty 20-foot-tall cottonwoods hard by the water's edge in some stretches. Between these young trees and the few old, decaying trees, however, the riparian forest is thin and ragged.

Chad Gourley, a biologist with the Nature Conservancy, counted trees on a sampling of the young cottonwoods. He traced the trees in the summer of 1987, when water was released for the endangered cut-throat spawner upriver from Pyramid Lake. In most years, water for the spring cut-throat run has been abruptly cut off by early summer, when the river is sucked dry by upstream diversions for farms and towns. In 1987, the river was low, but it dropped slowly and steadily.

The fact that the trees sprouted in 1987 validated the research models, Dr. Rood said. "That gave us optimism about doing it deliberately," he said.

The Nature Conservancy then persuaded the United States Fish and Wildlife Service and the Federal Bureau of Reclamation to time the water releases from Federal reservoirs to produce the necessary flows in 1995 and 1996. The benefits of mimicking the river's natural flows were immediately apparent. "When we released water for the trees for the first time in 1995, it was also one of the best cuts ever," Mr. Gourley said.

**General Patterns of Leaf Morphology for North American *Populus* spp.**



General Patterns of Leaf Morphology for North American *Populus* spp. & Natural Hybrids

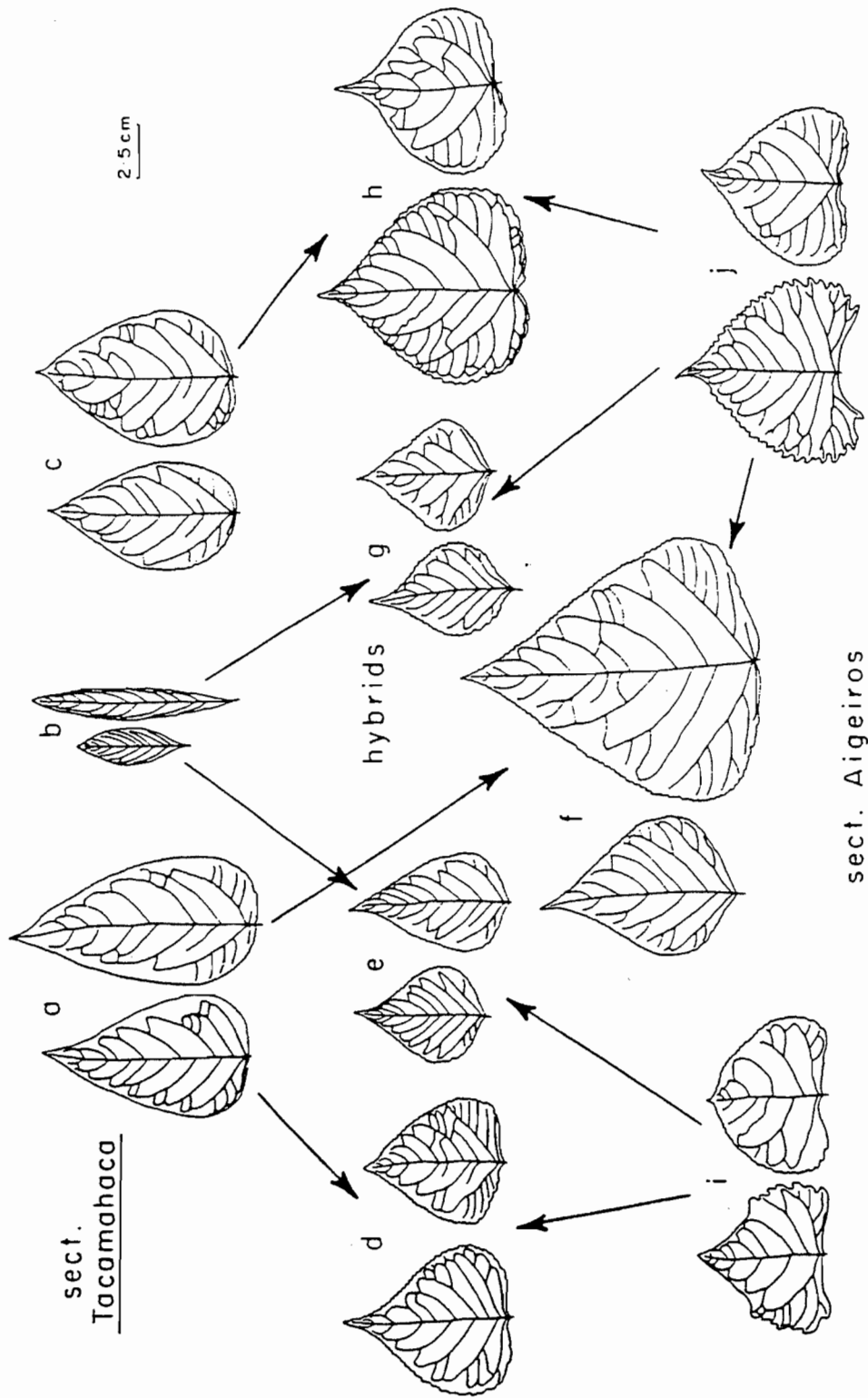
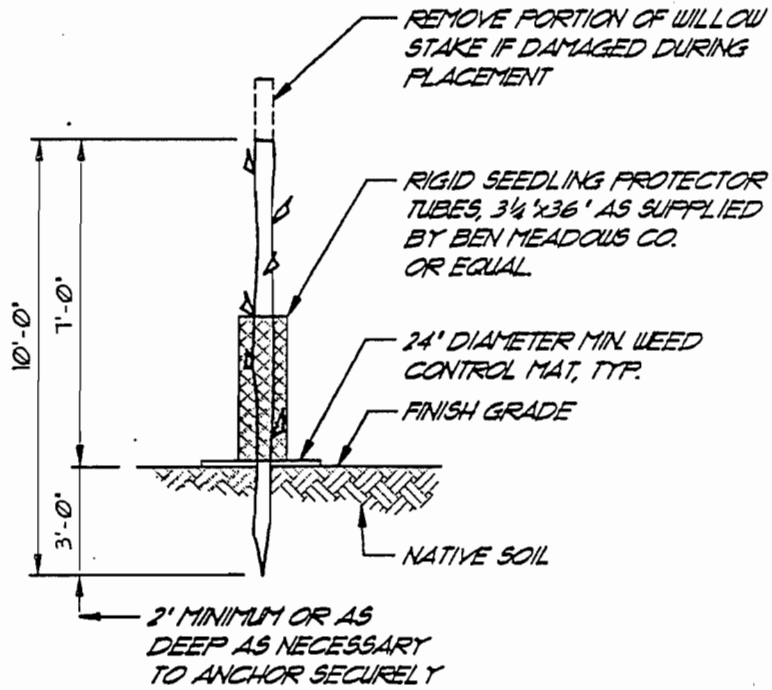
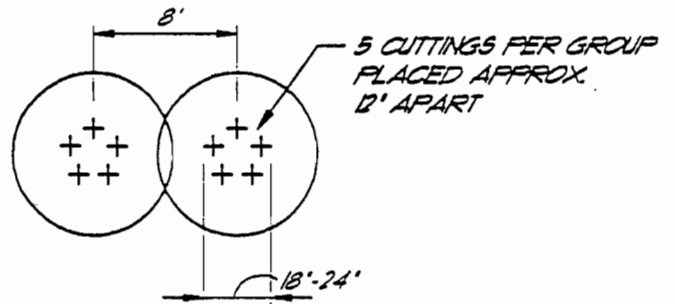
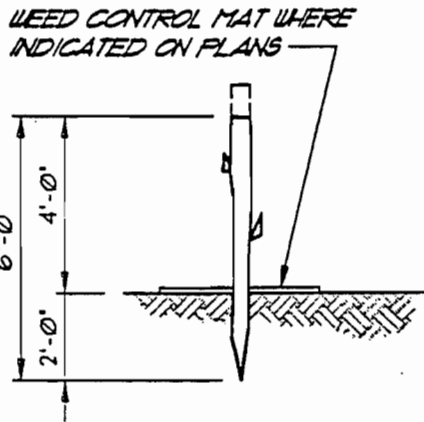


FIG. 1. Outlines of representative early leaves (left) and late leaves (right) of North American species of sections *Tacamahaca* and *Aigeiros* and of intersectional hybrids among them. All leaves at TRI. Sect. *Tacamahaca*: (a) *P. trichocarpa* (Eckenwalder 352), (b) *P. angustifolia* (Carr 52), (c) *P. balsamifera* (Krotkov 103); intersectional hybrids: (d) *P. × parryi* (Eckenwalder 464), (e) *P. × hincleyana* (Eckenwalder 188), (f) *P. × generosa* (Eckenwalder 8015), (g) *P. × acuminata* (Nelson s.n.), (h) *P. × jackii* (Malte 727/22); sect. *Aigeiros*: (i) *P. fremontii* (Eckenwalder 465), (j) *P. deltoides* (Johnson s.n.).



SALIX LASIANDRA CUTTING



CUTTING

- SALIX HOOKERIANA
- SALIX SITCHENSIS
- SALIX SCOULERIANA
- CORNUS STOLONIFERA

SEE DETAIL AT RIGHT FOR CUTTING PLACEMENT

NOT TO SCALE

**MITIGATION PLAN: DETAIL 7  
CUTTING INSTALLATION**

PROPOSED: Place Fill  
IN: Portion of Wetlands on Site  
AT: Sections 1 and 12, Township 21N, Range 4E