Colorado State Parks

COLORADO STATE PARKS STEWARDSHIP PRESCRIPTION

Date Created: April 10, 2002

Revised: April 1, 2005

Author: Mindy Wheeler

Parks Affected: Most

Cottonwood and Willow Management Stewardship Rx

Narrowleaf cottonwoods in autumn along the Yampa River

Significance of cottonwoods and willows in the riparian community

In the arid West, rivers and streams and associated riparian vegetation communities create extraordinarily diverse and lush ecosystems in an otherwise waterless landscape. Cottonwoods (*Populus* spp) and willows (*Salix* spp) are signature species of most healthy riparian ecosystems. Natural hydrology of streams and rivers has created ecosystems well adapted to periodic flooding and slow recession of floodwaters. Floodwaters carve out a plethora of habitats to be used by a variety of plant, bird, mammal and fish species. The combination of readily available water, rich soils and variety of habitats make riparian areas the lifeblood of the American West. These unique ecosystems support exceptionally high biodiversity, primary productivity and critical wildlife habitat. As an example, it has been reported that although riparian areas comprise only about 1% of the land area, they partially support up to 80% of the animals present in the area (Chaney et al 1990).

These numerous positive characteristics of riparian areas have also been the origin of the decline of cottonwoods and willows. Riparian areas and floodplains are very desirable areas for farming, grazing, and recreation and help provide precious water to a growing human population in the West. It has been estimated that greater than 80% of bottomland cottonwood forests have been lost as a result of changing land use practices and the altered hydrology that results from dams and water diversions (Smith et al., 1991). In riparian ecosystems, the loss of cottonwoods has catastrophic consequences. Wildlife habitat is lost, the forest canopy is lost, and the forest understory dies.

The primary goal of this prescription is to inform state park managers and staff how to best manage viable cottonwood and willow stands, how to encourage their natural recruitment (as conditions allow), and give information on the latest methods on planting and maintaining these species. Specifically, this prescription will address:

- Cottonwood and willow life history traits and ecology
- Reasons for the decline of bottomland forests
- Conservation, management and creation of cottonwood and willow stands
- Alternatives to cottonwoods for revegetation projects
- Common afflictions of cottonwoods and willows and how to address them

Once a full understanding of these processes is reached, creative methods may be used to mimic nature in order to experience better success with cottonwood and willow recruitment, establishment, development and maintenance.

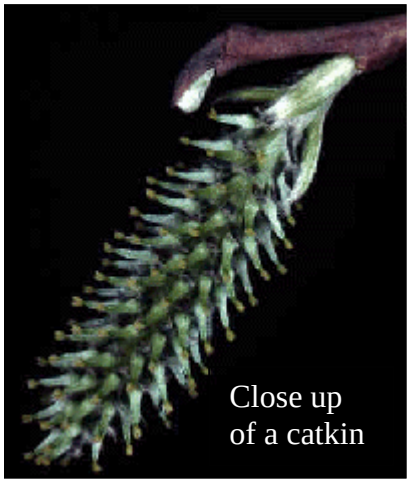
Distribution and life history traits of cottonwood and willow

DISTRIBUTION

The prairie cottonwood (*Populus deltoides*) generally occurs on the eastern plains of Colorado and on the river bottoms of the western slope, while narrowleaf cottonwood (*P. angustifolia*) occurs chiefly in the higher elevation riparian areas of the mountains. Each species also overlaps the other in their distribution.

Willow species are generally distributed along elevation and soil moisture gradients. Although over 35 species of willows occur in the state of Colorado, a handful of willows are recognized for their wide distribution. Peachleaf willow (*Salix amygdaloides*) chiefly inhabits water courses and ditches on the Front Range, but is also occasionally found on the West slope. ***Coyote willow (S. exigua***) is widespread in the lower elevations of the state, and decreases in abundance over 9,200 feet elevation. Coyote willow has the highest tolerance of alkaline and saline conditions, and also withstands periods of drought. Other species with wide distribution and commonly used in revegetation projects include mountain willow (*S. monticola*), and planeleaf willow (*S. planifolia*). Both cottonwoods and willows are known to cross-breed within their genera.

Since different species of cottonwoods and willows grow in various soil types, elevations and moisture gradients, it is almost certain that ecophysiological differences exist between the species inhabiting foothills, mountain valleys and prairie rivers. Mitigation or restoration projects must be adjusted to correspond with the specific type of river system involved.


Close up of a catkin

LIFE HISTORY TRAITS

Sexual reproduction

Sexual reproduction of cottonwoods and willows begins with the production of ‘flowers’ in the spring, usually before the leaves appear. The ‘flowers’ are called catkins (see photo), characterized by having no petals and only male or female parts. Each tree or shrub is also unisexual, possessing only male or female catkins. The pollen produced from the male catkins fertilizes the female flowers within 24 hours after pollination. The seed then matures over a period of 3 to 6 weeks. Both cottonwoods and willows are prolific seed producers. Some cottonwood seeds will remain viable for up to 5 weeks if it stays dry, however, as soon as the seed becomes moistened, the seed viability is shortened to 2-3 days. Willow seeds generally remain viable for up to 1 week

after dispersal. Although seeds are produced every year, successful establishment of cottonwoods may naturally occur once every 2 – 10 years. Cottonwoods reach sexual maturity between 5 and 10 years of age, whereas willows reach sexual maturity between 2 and 10 years.

Photo of the multitude of seeds produced by cottonwoods in the spring

Asexual reproduction

Cottonwoods and willows can also reproduce asexually as they will produce suckers from stumps,root crowns and from cuttings of stems. Sprouting is encouraged when an aboveground stem is broken or destroyed by cutting or flooding. This is done when branch and stem fragments regenerate by forming adventitious roots (if they remain moist), or when portions of stems root naturally if they are buried in moist soil. This clonal reproduction can sometimes be the dominant form of reproduction in a cottonwood or willow stand. Suckering occurs most commonly in middle-aged trees and declines in older trees (Read 1958). This clonal reproduction provides a gradation of tree sizes and increases forest structure, but also decreases the genetic diversity of the stand.

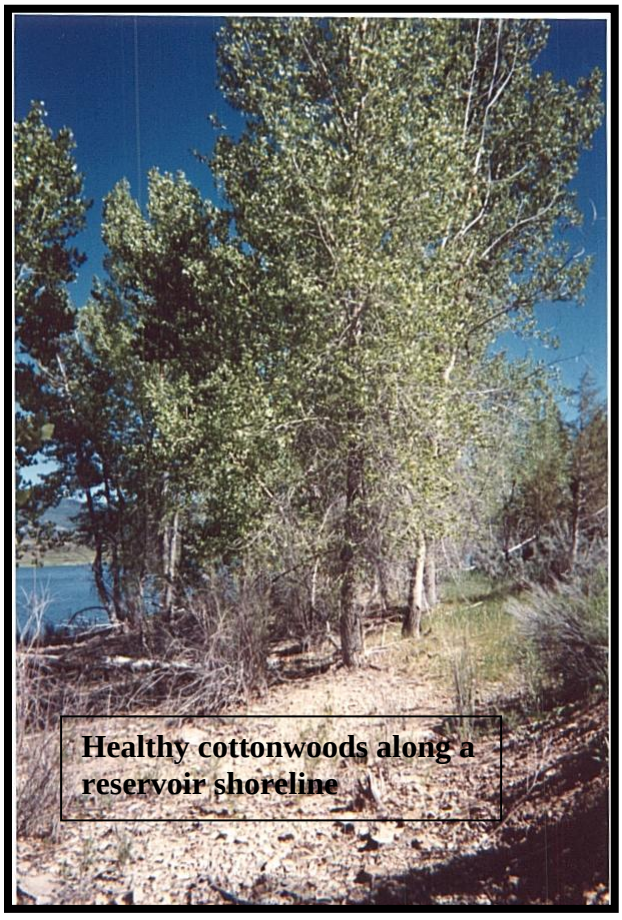
Suckering- A new shoot that is produced from the root or lower part of a stem

ECOLOGY

Cottonwoods and willows are highly dependent upon the hydrology with which they evolved. Streams and rivers flood freely across the floodplain each spring from heavy snowmelt. The large volume of fast moving water scours the streambeds and streambanks and deposits the sediment downstream to form banks of barren mineral soil. These deposits of moist, bare soil are ideal seedbeds for the millions of seeds being produced by cottonwoods and willows. Seed production is strategically timed to coincide with receding flood waters. As

flood waters slowly recede through the summer months, surface soil moisture becomes scarce. At this time, it is critical for the roots of the seedling to be able to follow the dropping water table down into the soil profile since seedlings are especially susceptible to drought. Essential conditions for cottonwood seedling establishment and survival occur at specific streambank elevations. The elevation must be high enough for protection from winter ice scouring and spring flooding, but not so high as to prevent root growth to the declining water table. This chain of events produces distinct bands of even-aged cottonwoods that mirror the historic stream channel along the river valley.

If the roots of the seedling reach a reliable source of water, escape ice scouring events or subsequent floods, a cottonwood can grow at a rate of up to 6-12 feet annually when it is young (FEIS).



Healthy cottonwoods along a reservoir shoreline

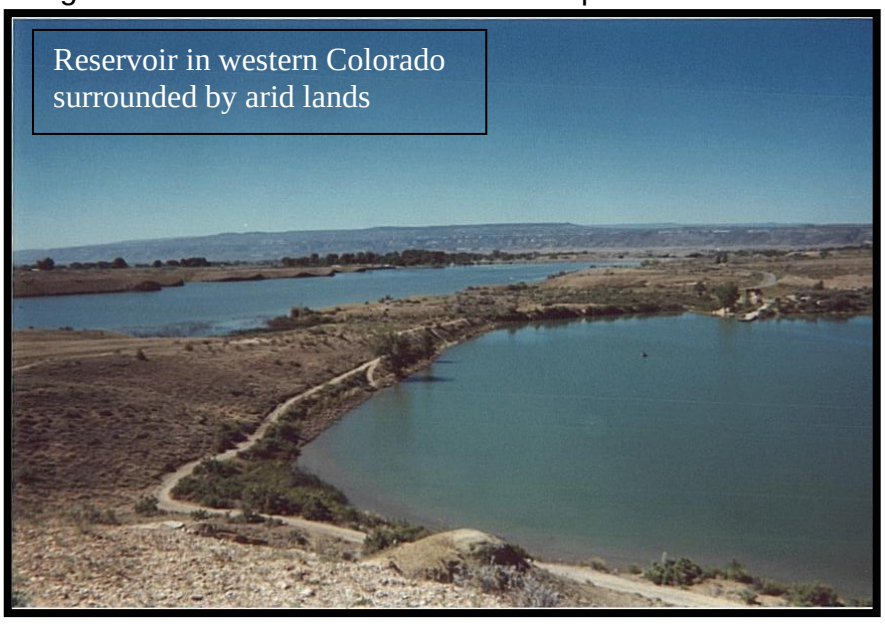
As colonizers of barren alluvial soil where abundant sunlight and moisture is readily available, cottonwoods and some willows are considered a fast growing pioneer species. However, certain species of willows are also considered a climax community. Planeleaf willow and Drummonds willow (*S. drummondiana*) are examples of willow stands considered as high seral (climax) communities.

Cottonwood and willow decline

WATER REGULATION

Increased human population in the arid West has put many strains on riparian ecosystems. Water has become a revered resource in the arid West as dams and water diversions are the rule within watersheds rather than the exception. Water management has seriously altered traditional hydrological processes by reducing peak flows, altering discharges, and decreasing suspended sediment loads. As a result, flood waters rarely possess the energy to transport and deposit sediment along the streambanks, and future seed beds (sediment) remain trapped under reservoir waters. More importantly, high downstream water demands in the summer coincides with a critical need for water for cottonwood and willow seedlings. Water is diverted to parched agricultural fields or thirsty human population centers instead of nurturing seedlings through the hot dry summer. Abrupt drops in the water table during the summer have been found to be extremely detrimental to cottonwood and willow saplings. (Kranjcec et al 1998, Rood et al 1995).

Water regulation has also caused channelization of water ways. Streams are no longer able to meander across the floodplain because the stream is so deeply incised. Water tables subsequently drop and riparian vegetation communities can no longer survive in the drier conditions.



Reservoir in western Colorado surrounded by arid lands

INCREASED SALINITY LEVELS AND PRESENCE OF NON-NATIVES

In addition to altered hydrology conditions, increased salinity levels in some riparian soils and increased presence of non-native species have also created a difficult challenge for cottonwood and willow establishment and survival.

Elevated salinity levels result in part from repeated irrigation and evaporation of agricultural fields. Salt-laden irrigation water evaporates and leaves the solutes behind on the soil surface. Unfortunately, increased salts favor invasive exotic species often found in riparian areas. Tamarisk (*Tamarix ramosissima*), or salt cedar, and Russian olive (*Eleagnus angustifolia*) are more tolerant of these increased saline conditions than cottonwoods and willows. Salt cedar exudes salt from their leaves as a mechanism to tolerate high salinity levels. This exacerbates the salt level in the soil and renders the soil inhospitable for native species.

Tamarisk along a river bank

Moreover, both Russian olives and tamarisk use more water than their native counterparts, which tends to dry up small streams and riparian areas by lowering water tables further. Oddly enough, these invasive species can withstand the dry conditions as well. Drier riparian areas are also more susceptible to fire. Unfortunately, tamarisk can withstand fire whereas cottonwoods are very intolerant of burning. Given the conditions under which cottonwoods, willows, tamarisk and Russian olives thrive and the conditions present in many riparian areas, the decline of cottonwoods and willows has been severe, yet inevitable.

LAND USE PRACTICES

Grazing and farming have also had a negative impact on riparian areas. Many areas have been cleared of woody vegetation to increase crop production. Streambanks become unstable when the strong woody roots of cottonwoods and willows are removed as they become more susceptible to premature sloughing and undercutting. In addition, livestock will browse cottonwood and willow seedlings heavily, and livestock trampling can cause undue soil compaction that can injure or prematurely kill seedlings.

Conservation, management and creation of cottonwood and willow stands

Ideally, the preservation and long-term management of cottonwoods and willows would revolve around the restoration of the natural regeneration processes of these species. Since bottomland forest decline can be primarily attributed to water management, it would be ideal to restore the natural hydrologic and geomorphic processes. However, the multiple uses of water in the west likely precludes the prospect that dams and water diversions shall be managed primarily for riparian ecology rather than agriculture and drinking water. Nevertheless, steps can be taken to restore some critical aspects of riparian ecology.

SITE AND PROJECT ASSESSMENT

Each potential riparian restoration project varies in site physical and ecological characteristics, scale, scope, and objectives. Careful analysis of the landscape (geomorphic valley from, stream type and vegetation community type) should take place before any restoration plans are drawn to verify the feasibility of the project as a whole. Details on these classifications can be found in Rosgen, D.L. 1985 and Carlson et al 1992. If these characteristics are found to be favorable, further investigation into the site should include:

- Depth to the water table throughout the year
- Hydrology data
    - Flood frequency data
    - Stream flow velocity estimates
    - Channel width, depth and shape at both high and low flow conditions
    - Sediment load
    - Water quality
- Soil texture
- Native vegetation community

These data will aid in setting realistic goals and objectives as well as assist with all aspects of the project, from drawing plans for channel recontouring to figuring irrigation requirements. If all options are realized and carefully studied, greater success of riparian restoration shall follow.

Measurement of channel incision
courtesy of Aquatic and Wetland Company

It is also important to assure that a cottonwood and willow management plan becomes a permanent feature of the overall park plan. The combination of the relatively short life expectancy of cottonwoods (under 100 years) and altered hydrology regimes points toward a perpetual maintenance program involving periodic plantings.

PROSPECTS FOR MANAGEMENT, RESTORATION AND MAINTENANCE

A brief description of each management option is given, followed by benefits and possible obstacles of each option. ***It is possible and most likely preferable to employ aspects of each option to create a site-specific riparian restoration plan.***

Before ground is broken for any restoration project, it is essential to remove invasive exotics.
If noxious weed control is not part of the restoration plan, the project is almost certain to fail as weeds tend to increase almost exponentially in disturbed areas. For further information on methods to remove Russian olive and salt cedar, please see the appendices of this prescription. Canada thistle (Breea arvense) and Russian knapweed (Acroptilon repens) are other noxious weeds common in disturbed riparian areas and also should be controlled before, during and after all riparian restoration projects.

OPTION: Restore the natural hydrology and regeneration processes within the riparian ecosystems.

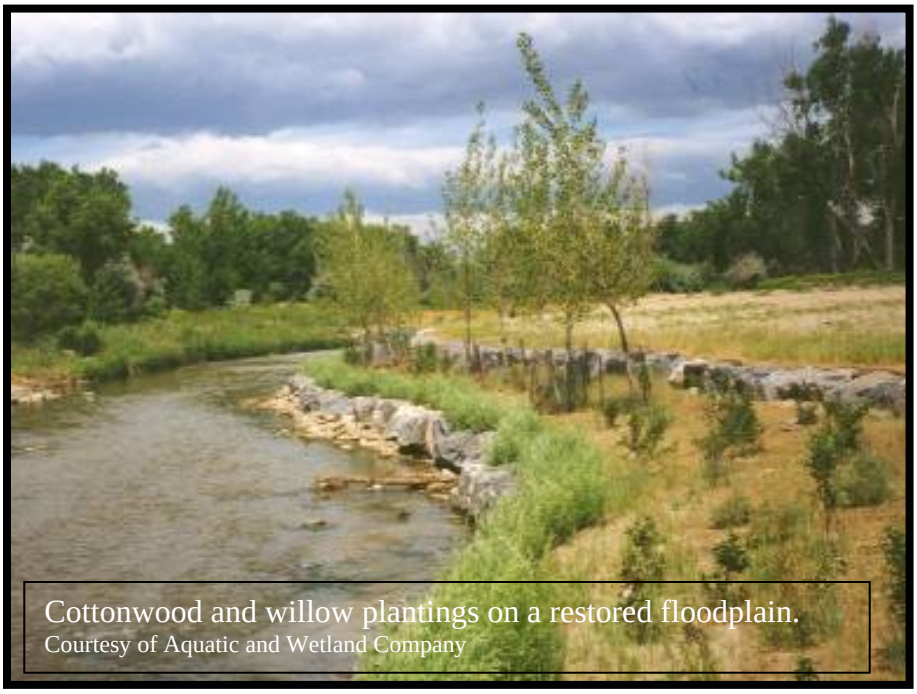
Description: Large scale riparian restoration projects have been known to purchase water rights or work with a local water authority to guarantee the hydrology needed to maintain a self sustaining cottonwood and willow ecosystem. Spring floods are allowed to carry and deposit sediment to its adjacent floodplain, and old oxbows are reconnected to the river to create backwater habitats. The restoration of these processes and habitats serves to release floodwaters slowly over the summer so cottonwoods and willows do not experience deadly dehydration.

Benefit: Restoring a hydrological regime that recreates historical flows has potential to create a self-sustaining native bottomland forest. This in turn will create a plethora of habitats for wildlife, birds and fish.

Possible obstacle(s): This option is likely very expensive- if even possible- to gain water rights or sufficient water. Most riparian restoration, mitigation or management projects do not have the budget to carry out such large-scale operations.

OPTION: Reconnect the stream with its floodplain.

Description: Many stream channels have become excessively incised as a result of water management. Channelized streams are often accompanied by deeper riparian water tables that compound drought mortality. To hydrologically reconnect streams and adjacent floodplains, create gentle slopes alongside streams or reservoirs and plant willows and/or cottonwoods. (see 'Wattles' and 'Live staking' in the appendix)



Cottonwood and willow plantings on a restored floodplain.
Courtesy of Aquatic and Wetland Company

Benefit: The new growth will ultimately be able absorb and then slowly release the flood waters to mimic the hydrology of an intact riparian ecosystem. This will also serve to hold the soil in place

to slow any accelerated erosion.

Possible obstacle(s): Careful analysis of stream flows, channel shape and other characteristics is essential to ensure this option is feasible. High velocity streams may need extra erosion control measures to be installed or deeply incised streams may require an impractically lengthy slope to be created to reconnect the stream and the floodplain.

OPTION: Establish new stands of cottonwoods and willows.

Background: Stands can be established from either nursery grown seedlings 'live staking' (see appendix). It is preferable to plant nursery grown seedlings from seeds collected from the site, but may not always be possible. Nursery grown seedlings also have the potential to increase genetic diversity within the site and have generally shown to have a lower mortality rate than live staking, but are more expensive. Seedlings will also require longer periods of watering and care.

Benefits: Assuming a good supply of cottonwood and/or willow stakes can be found, this can be the most successful and the least expensive method available to grow cottonwoods and willows. It is imperative to plan for appropriate irrigation, and if needed, fencing around the trees for protection from beaver to ensure survival of the stakes.

Possible obstacle(s): Willow stakes need to be in direct contact with the water table or a high rate of mortality will ensue. Cottonwoods will need supplemental irrigation (up to 3 years) until the roots reach the ground water. Perpetuation of planted restored riparian forests may require a maintenance program involving periodic plantings.

OPTION: Encourage suckering from established cottonwoods and willows

Background: Both cottonwoods and willows can be encouraged to grow additional shoots by scarification (abrasion to the roots). Cottonwood and willow stands can be induced to enhance density and age-class distribution, thus improving forest structure. Middle-aged cottonwoods are most likely to sprout from roots. Because new shoots are very palatable to livestock, it is extremely important to keep livestock out of the project area for 2-3 years after the area is scarified.

Benefits: This method will promote a cottonwood or willow stand that has a greater age-class distribution and thus improved forest structure and function.

Possible obstacle(s): Genetic diversity will not be improved with this management method. The disturbance may encourage weed invasions

SIGNS OF STRESSED COTTONWOODS AND WILLOWS AND COMMON AFFLICTIONS

Although mature cottonwood trees have large taproots, water can still be elusive in drought years. Primary indications of drought stress include reduced leaf size, premature leaf loss, and crown dieback (Tyree et al 1994). Prolonged periods of environmental stress such as drought can weaken trees and increase their susceptibility to disease and insect pathogens. The key to disease and pest-fee trees is to maintain its vigor. Any signs of stress should be noted and addressed.

Although plant vigor will help prevent disease and insect pathogens, it is not a guarantee. The appendix contains a list of common afflictions of cottonwoods and willows, noticeable symptoms, and actions to take to maintain a healthy tree or shrub.

Alternative trees for floodplain areas if hydrology will not support cottonwoods

- **Box elder** (*Acer negundo*)- a medium sized, short lived (20-40 years) deciduous tree that grows to 45 feet tall in optimal conditions.

- **Peachleaf willow** (*Salix amygdaloides*) Large deciduous tree growing up to 45 feet in height. Most common along water courses and ditches on the Front Range and Plains, occasionally on the Western slope.

- **Single leaf ash** (*Fraxinus anomala*) A tall deciduous shrub to small tree up to 20 feet in height. Occur naturally in xeric canyons and slopes along water courses and ephemeral drainages. This plant will need to be pruned consistently if it is to take the shape of a tree.

- **Western water birch** (*Betula occidentalis*) This is a fast growing multi-stemmed tree that grows up to 30 feet in height. It occurs naturally near mountain streams and meadows.

- **Hackberry** (*Celtis reticulata*) This deciduous tree grows up to 30 feet high and has bright green saw tooth elm-like leaves. It grows naturally on dry, rocky hillsides and canyon bottoms and is excellent for wildlife and reclamation.

- **Buffaloberry** (*Sheperdia argentea*) Medium sized deciduous shrub to small tree up to 25 feet in height. Naturally occurs at 4500-7500 feet elevation. Good for somewhat saline sites. Only the female plant produces fruit, so a pollinating plant is necessary. This plant will need continuous pruning to encourage a tree shape.

REFERENCES

Bradley, C.E., and D.G. Smith. 1986. Plains cottonwood recruitment and survival on a prairie meandering river floodplain, Milk River, southern Alberta and northern Montana. Canadian J. of Botany 64: 1433-1442.

Busch, D.E., N.L. Ingraham and S.D. Smith. 1992. Water uptake in woody riparian phreatophytes of the southwestern United StTes: a stable isotope study. Ecological Applications 2(4): 450-459.

Busch, D.E. and S. Smith. 1995. Mechanisms associated with decline of woody species in riparian ecosystems of the southerwestern U.S. Ecological Monographs 65(3): 347-370.

Carlson, J.R., G.L. Conaway, J.L. Gibbs and J.C. Hoag. 1992. Design criteria for revegetation in riparian zones of the intermountain area. in Proceedings- Symposium on Ecology and Management of Riparian Shrub Communities. Gen. Tech Report, INT-289.

Cheney, E., W. Elmore, and W.S. Platts. 1990. Livestock grazing on western riparian areas. U.S. Gov. Print Off. 1990-775-443/21, 661 Region No. 8, Wash. D.C. 45pp.

Cooper, D.J., D.M. Merritt, D.C. Andersen and R.A. Chimmer. 1999. Factors controlling the establishment of Fremont cottonwood seedlings on the upper Green River, USA. Regulated Rivers: Research and Management 15:430-440.

Crenshaw, W., and D. Leatherman. 2000. Insects and diseases of woody plants in the central rockies. Colorado State University Cooperative Extenstion, Bulletin 506A.

FEIS Fire Effects Information System . 1996. Prescribed Fire and Fire Effects Research Work Unit, Rocky Mountain Research Station (producer), US Forest Service. http://www.fs.fed.us/database/feis/ [Version 12 Mar 98].

Johnson, W.T.,and H.H. Lyon. 1991. Insects that feed on trees and shrubs. Comstock Publication Associates, Ithaca.

Kranjcec, Julie; Mahoney, John M.; Rood, Stewart B. 1998. The responses of three riparian cottonwood species to water table decline. Forest Ecology and Management. 110: 77-87.

Read, R.A. 1958. Silvicultural characteristics of plains cottonwood. Rocky Mountain Forest and Range Experiment Station Paper 33.Fort Collins, Colorado.

Reily, T.W. and W.C. Johnson. 1981. The effects of altered hydrologic regime on tree growth along the Missouri River in North Dakota. Canadian J. of Botany 60: 2410-2423.

Rood, S. B. and S. Heinze-Milne. 1989. Abrupt downstream forest decline following river damming in Southern Alberta. Canadian J of Botany 67: 1744-1749.

Rood, S.B. and J.M. Mahoney. 1990. Collapse of riparian poplar forests downstream from dams in western prairies: probably causes and prospects for mitigation. Environmental Management 14(4): 451-464.

Rood, S.B., J.M. Mahoney, D.E. Reid, and L. Zilm. 1995. Instream flow and the decline of riparian cottonwoods along the St. Mary River, Alberta. Canadian J of Botany 73: 1250-1260.

Rosgen, D.L. 1985. A stream classification system. In: First North American riparian conferencve: proceedings; 1985 April 16-18; Tucson, AZ. Gen Tech Rep. RM-120. Fort Collins, CO; U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 91-95.

Sinclair, W.A., H.H. Lyon, and W.T. Johnson. 1987. Diseases of trees and shrubs. 1987. Comstock Publication Associates, Ithaca.

Smith, S.D., A.B. Wellington, J.L. Nachlinger and C.A Fox. 1991. Functional responses of riparian vegetation to streamflow diversion in the eastern Sierra Nevada. Ecological Applications 1(1): 89-97.

Tyree, M.T., K.J. Kolb, S.B. Rood and S. Patino. 1994. Vulnerability to drought-induced cavitation of riparian cottonwoods in Alberta: a possible factor in the decline of the ecosystem? Tree Physiology 14:455-466.

Other references for bioengineering reservoir edges, streamsides and riparian area restoration

USDA Natural Resources Conservation Service Chapter 16 of Engineering Field Handbook: Streambank and Shoreline Protection. 1996

Methods for planting and maintaining cottonwood and willow

LIVE STAKING

Definition: Live stake planting involves the insertion of live, cottonwood or willow cuttings into the ground in a manner that allows the cutting (stake) to take root and grow.

Purpose: Live stakes are the easiest and cheapest way to get new cottonwoods and willows into the riparian ecosystem. Live stakes will also create a root mat that stabilizes the soil by reinforcing and binding soil particles together.

Construction Specifications:

- Use on-site reconnaisance to identify plant species, growth form, soil and site conditions on the restoration/ construction site as well as on adjacent sites and compare their conditions. Greater success has been experienced with restoration projects that mimic characteristics of nearby sites. For project feasibility, examine the characteristics of the watershed in which the project is to be completed. This includes analyzing the geomorphic valley form, stream type and vegetation community type. Should these characteristics be favorable to a restoration project, further assessments should take place including the depth of the water table, soil texture, the typical hydrology of the site (peak flows, low flows, flood frequency, flow velocity estimates, water quality, channel shape), and identify and remove problematic non-native species such as tamarisk and Russian olive before beginning the restoration project. Details on removal of tamarisk and Russian olive are included in the appendix of this prescription.

Harvesting:

- Stakes shall be harvested and planted when the willows or cottonwoods are dormant. This period is generally from late fall to early spring, or before the buds start to break.
- When harvesting cuttings, select healthy, live wood that is reasonably straight.
- Use live wood at least 1 year old or older. Avoid suckers of current years growth as they lack sufficient stored energy reserves to sprout consistently. The best wood is 2-5 years old with smooth bark that is not deeply furrowed.
- Make clean cuts with unsplit ends. Trim branches from cutting as close as possible. It is best to cut the butt end so it is pointed or angled and the top end is cut square.
- Identification of the top and bottom of cutting is done by angle cutting the butt end. The top, square cut, can be painted and sealed by dipping the top 1-2 inches into a 50-50 mix of light colored latex paint and water. Sealing the top of stake will reduce the possibility of desiccation and disease caused mortality, assures the stakes are planted with the top up, and makes the stakes more visible for subsequent plantings.

Diameter:

- Cuttings should generally be 1/2 inch or larger depending on the species. Highest survival rates are obtained from using cuttings 2-3 inches in diameter.

Length:

- Cuttings of small diameter (up to 1 1/2 inches) should be 18 inches long minimum. Thicker cuttings should be longer.
- Cuttings should be long enough to reach into the mid-summer water table, if possible.
- No less than 1/2 total length must be into the ground.
- Stakes should be cut so that a terminal bud scar is within 1-4 inches (25-101 mm) of the top. At least 2 buds and/or bud scars shall be above the ground after planting.

Installation:

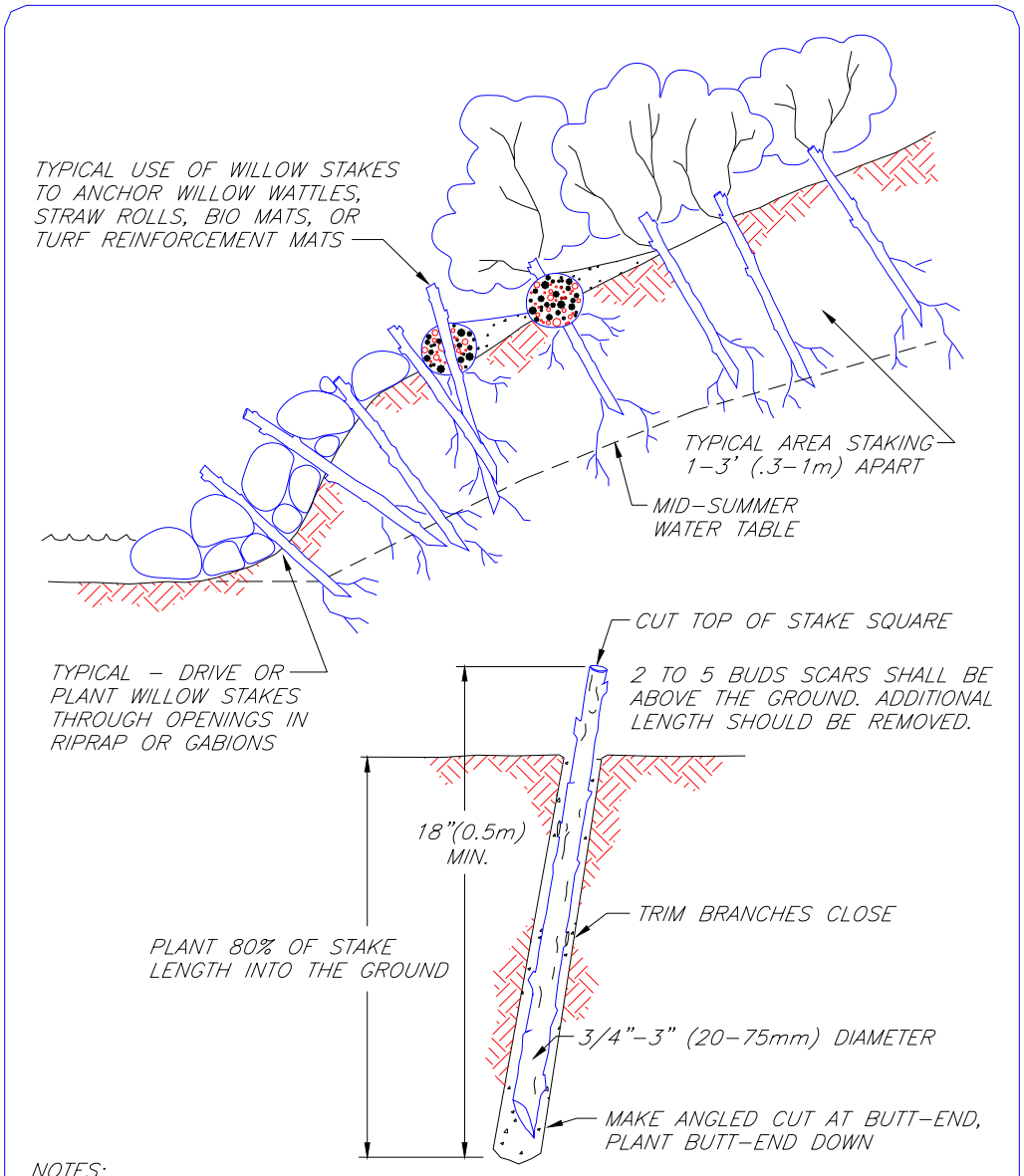
- Stakes must be planted with butt-ends into the ground. Leaf bud scars or emerging buds will point up.
- Soil must be moist to wet when planting stakes.
- Stakes must not be allowed to dry out. All cuttings should be soaked in water for a minimum of 24 hours. Soaking significantly increases the survival rate of the cuttings, however they may be planted the same day they are harvested.
- Plant stakes 1-3 feet apart and 3-4 stakes per hole to improve the survival rate.
- Set the stake as deep as possible into the soil, preferably with 80 percent of its length into the soil and in contact with mid-summer water table.
- It is essential to have good contact between the stake and soil for roots to sprout. Tamp the soil around the cutting.
- Use an iron stake or bar to make a pilot hole in firm soil. A 'stinger' (a bulldozer with a large rod attached to the front) is recommended to create deep, small diameter holes for difficult plantings.
- Do not damage the buds, strip the bark or split the stake during installation.
- Split or damaged stakes should not be used.
- Construct a 4 foot high chicken wire fence around the stakes or trunks of new plantings to prevent beaver herbivory or unwanted human intervention.

Aftercare:

- The amount and frequency of irrigation required will depend on the species planted, depth to the water table and soil texture. It is recommended that stakes be deeply watered at least once a week until the roots reach the groundwater. Cottonwood roots need sufficient water, but they also need sufficient oxygen to their roots. Total inundation for extended periods of time can be injurious to young cottonwoods. When cottonwoods reach the groundwater, a noticeable increase in leaf size occurs, and the rate of growth also increases noticeably. Coyote willow (*Salix exigua*) is surprisingly tolerant of changing water conditions.

- Consistent monitoring of the plantings for the first year is recommended to control invasive species to reduce competition, to ensure a higher rate of survival as fences may need fixing or stakes may need more water.

- As trees/ shrubs get older, watch for signs of drought stress such as crown dieback, reduced leaf size, and premature leaf loss. Prune injured or diseased limbs using sanitized equipment so as to not spread infection.



NOTES:
1. HARVEST AND PLANT STAKES DURING THE DORMANT SEASON.
2. USE HEALTHY, STRAIGHT AND LIVE WOOD AT LEAST 1 YEAR OLD.
3. MAKE CLEAN CUTS AND DO NOT DAMAGE STAKES OR SPLIT ENDS DURING INSTALLATION, USE A PILOT BAR IN FIRM SOILS.
4. SOAK CUTTINGS FOR 24 HOURS (MIN.) PRIOR TO INSTALLATION.
5. TAMP THE SOIL AROUND THE STAKE.

NOT TO SCALE

LIVE STAKING

FILE: LIVESTK

WATTLES (LIVE FASCINES)

Defintion: A wattle is a long bundle of branch cuttings bound together in cylindrical structures. Wattles work best using willow cuttings.

Purpose: To reinforce streambanks or reservoir edges susceptible to erosion with native vegetation to increase bank stability and reduce erosion.

Construction Specifications:

- Use on-site reconnaisance to identify plant species, growth form, soil and site conditions on the restoration/ construction site as well as on adjacent sites and compare their conditions. Greater success has been experienced with restoration projects that mimic characteristics of nearby sites. For project feasibility, examine the characteristics of the watershed in which the project is to be completed. This includes analyzing the geomorphic valley form, stream type and vegetation community type. Should these characteristics be favorable to a restoration project, further assessments should take place including the depth of the water table, soil texture, the typical hydrology of the site (peak flows, low flows, flood frequency, flow velocity estimates, water quality, channel shape), and identify and remove problematic non-native species such as tamarisk and Russian olive before beginning the restoration project. Details on removal of tamarisk and Russian olive are included in the appendix of this prescription.

Wattle Preparation:

- Cuttings shall be harvested and planted when the willows are dormant. This period is generally from late fall to early spring.

- Choose plant materials that are adapted to the site conditions from species that root easily. A portion (up to 50%) of the bundle may be of material that does not root easily or dead material.

- The cuttings should be long (3 feet minimum), straight branches up to 1 1/2 inches in diameter. Trimmings of young suckers and some leafy branches may be included in the bundles to aid filtration. The number of stems varies with the size and kind of plant material.

- Cuttings should be tied together to form bundles, tapered at each end, 6-30 feet in length, depending on site conditions or limitations in handling.

- The completed bundles should be 6-12 inches in diameter, with the growing tips and butt ends oriented in alternating directions.

- Stagger the cuttings in the bundles so that the tips are evenly distributed throughout the length of the wattle bundle.

- Wattle bundles should be compressed and tightly tied with rope or twine of sufficient strength and durability. Polypropolyne 'tree rope' approximately a 3/16 inch diameter provides the necessary strength and durability.
- Wattle bundles should be tied 12-15 inches apart.
- For optimum success wattles should be pre-soaked for 24 hours or installed on the same day they are harvested and prepared. The wattles should be installed within 2 days after harvest unless pre-soaked. Wattles should be stored in the shade and under cover or under water.

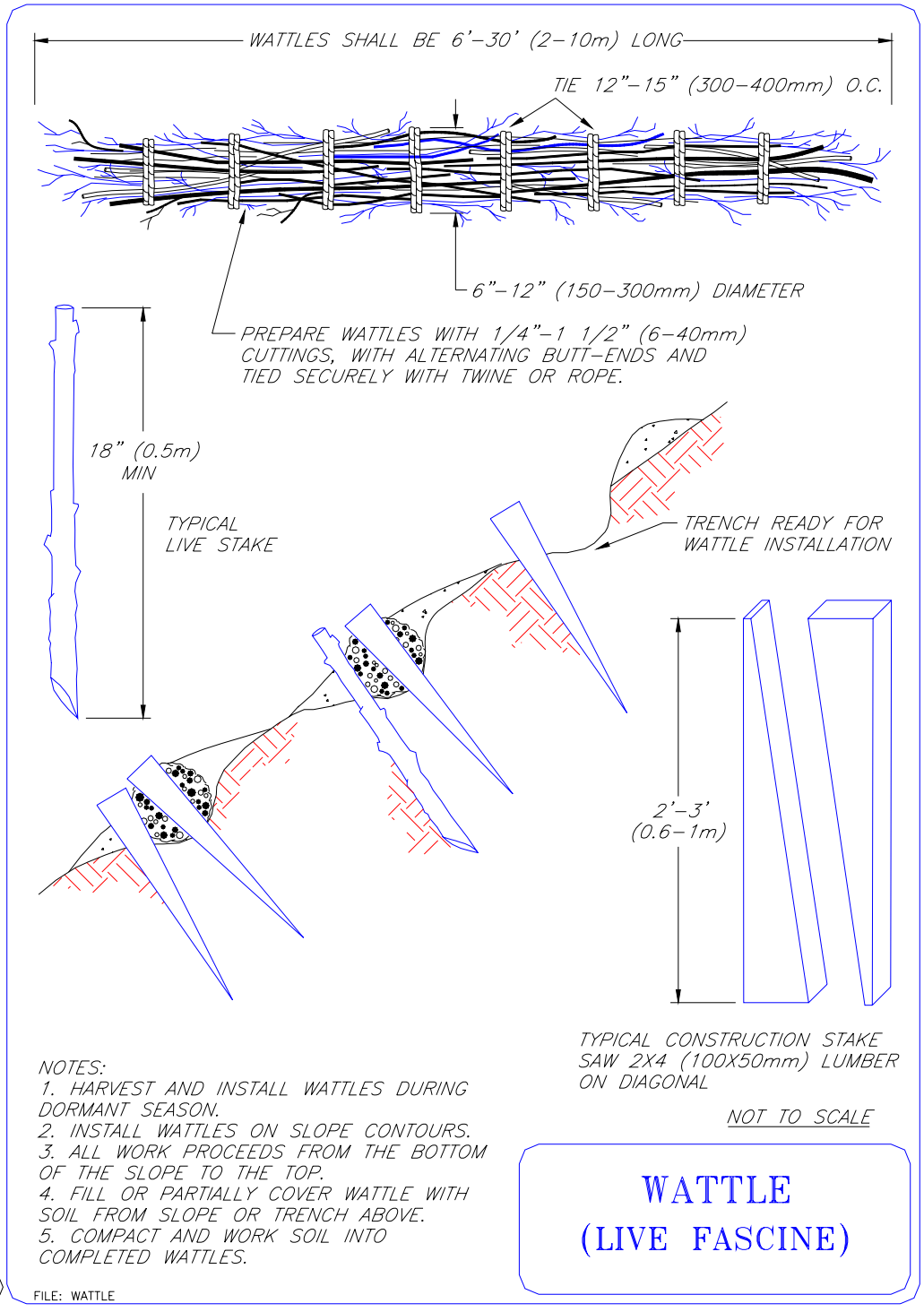
Installation:

- Work should progress from the bottom to the top of the slope.
- Install wattles into trenches dug into the slope on contour
- Spacing of contour trenches (wattles) should be about 5 feet apart or closer if the slope is steeper or soils are more erosive.
- Perform any slope repairs, such as gully repair, slope scaling, diversion dike, gabion, or toe wall construction, prior to wattle installation.
- Beginning at the base of the slope, dig a trench on contour. The trench shall be shallow, about 1/2 the diameter of the wattle. The trench width will vary from 12-18 inches depending on the slope angle.
- Place the wattles immediately after trenching to reduce desiccation of the soil.
- Wattles shall be staked firmly in place with one row of construction stakes on the downhill side of the wattling, not more than 3 feet apart. A second row of stakes shall be placed through the wattles, near the ties, not more than 5 feet apart.
- Overlap the tapered ends of adjacent wattles so the overall wattle thickness of the wattle is uniform. Two stakes shall be used at each bundle overlap such that a stake may be driven between the last two ties of each wattle.
- Live stakes, if specified, are generally installed on the downslope side of the bundle. Drive the live stakes below and against the bundle between the previously installed construction stakes.
- Proper backfilling is essential to the successful rooting of the wattles. Backfill wattles with soil from the slope or trench above. The backfill shall be worked into the wattle interstices and compacted behind and below the bundle by walking on and working from its wattling terrace.
- Repeat the proceeding steps to the top of the slope.
- Place moist soil along the sides of the live bundle. The top of the bundle should be slightly visible when the installation is completed.

- Seed and mulch slope. Shallow slopes, generally 3:1 or flatter may be seeded and mulched by hand. Steeper slopes should have seed applied hydraulically and the mulch should be anchored with tackifier or other approved methods.

Aftercare:

- Regular inspection and maintenance of wattle installations should be conducted, particularly during the first year.
- Repairs should be made promptly. Stakes that loosen because of saturation of the slope or frost action should be re-installed.
- Rills and gullies around or under wattles shall be repaired. Perform slope scaling and brushpacking as necessary.


WATTLES SHALL BE 6'–30' (2–10m) LONG
TIE 12"–15" (300–400mm) O.C.
6"–12" (150–300mm) DIAMETER
PREPARE WATTLES WITH 1/4"–1 1/2" (6–40mm) CUTTINGS, WITH ALTERNATING BUTT–ENDS AND TIED SECURELY WITH TWINE OR ROPE.
18" (0.5m) MIN
TYPICAL LIVE STAKE
TRENCH READY FOR WATTLE INSTALLATION
2'–3' (0.6–1m)
TYPICAL CONSTRUCTION STAKE SAW 2X4 (100X50mm) LUMBER ON DIAGONAL
NOTES:
1. HARVEST AND INSTALL WATTLES DURING DORMANT SEASON.
2. INSTALL WATTLES ON SLOPE CONTOURS.
3. ALL WORK PROCEEDS FROM THE BOTTOM OF THE SLOPE TO THE TOP.
4. FILL OR PARTIALLY COVER WATTLE WITH SOIL FROM SLOPE OR TRENCH ABOVE.
5. COMPACT AND WORK SOIL INTO COMPLETED WATTLES.
NOT TO SCALE
WATTLE
(LIVE FASCINE)
© 1996 JOHN McCULLAH
FILE: WATTLE

Common cottonwood and willow afflictions

Common cottonwood and willow afflictions

Cytospora canker – Caused by a fungus that attacks trees that are injured or in a weakened or stressed condition, such as drought or a wound caused by wind breakage. This fungus can be lethal. Cytospora also affects trees with root damage, often found in construction areas or newly planted trees.

Symptoms:
Yellow or orange-brown to black discolored areas on the bark of the truck and branches. Cankers, or sunken dead areas of bark with small black dots may be visible. Dead bark may remain attached to the tree for several year, then fall off in large pieces.

Control: Try to increase the vigor of the tree or shrub. Remove all infected limbs by making a smooth cut at the base of the limb without damaging the branch collar. Jagged and rough cut surfaces promote infection. Clean the wounds with ethyl alcohol or another disinfectant. Remove any dead bark, and clean tools after each cut.

Photo of cytospora canker

Tent catapillars- (*Malacosoma disstria and M. californicum*)-These insects appear in mid summer, flying at night, and deposit eggs in clusters of 150 to 250 in bands encircling twigs. The young catapillars are fully formed in 2-3 weeks, but will overwinter inside the eggs. They chew their way out of the eggs at about the same time as leaves appear in the spring. Outbreaks of these insects can cause reduced tree growth and kill a few branches, but generally will not kill the host.

Symptoms:
The catapillars create conspicuous white silken tents on tree or shrub limbs with clusters of hairy larvae found nearby or in the tents.

Control: Outbreaks of tent catapillars last generally 2-3 years, but can persist for up to 6 years. Tent catapillars are eventually controlled by a variety of factors. Eggs, larvae and pupae are killed by various insect parasites; beetles or bugs consume larvae, and birds eat all forms of this catapillar. Declines in outbreaks are often associated with cold weather at the time larvae are hatching. A crude, yet simple method can also be used to rid the tree or shrub of these catapillars. The tents can be knocked down with a pole, then the larvae can be exterminated with a step of the foot.

Marssonina leaf spot – Caused by the Marssonina fungus that can survive on fallen leaves over the winter that were infected the previous year. When the wet warm weather of the spring arrives, fungal spores are carried by the wind and infect emerging leaves. The disease can be particularly severe on young willow leaves and stems soon after bud break in the spring. Although unsightly, there is generally no significant damage to the growth of the tree or shrub. If the weather remains favorable(favors moist conditions), a secondary infection can cause premature leaf loss.

Symptoms: Leaf spots are dark brown to black irregularly shaped flecks often with yellow outline. These spots which can occur on either side of the leaf have a white center. On severely infected leaves, several spots may fuse to form large black dead patches.

Control: Pruning out dead and diseased branches and raking up fallen leaves can help control this disease to some extent.