

# JUNIPER FOR STREAMBANK STABILIZATION IN EASTERN OREGON<sup>1</sup>

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*Abstract: Cut juniper trees (Juniperous osteosperma Hook.) anchored along eroded streambanks proved beneficial in stabilizing 96 percent of the erosion on eight streams evaluated in eastern Oregon over a 14-year-period. Juniper revetment was a successful substitute for costly rock structures on straight or slightly curved banks, but failed when placed on outside curves or when poorly anchored. Water velocities were reduced by 65 percent where juniper revetment was evaluated. Sediment buried tree tips the first and second year after treatment. Juniper revetment should last at least 20 years with proper grazing management and allow full recovery of riparian vegetation and bank stability.*

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Streambank stabilization may be required for the improvement of water quality, fish and wildlife habitat and the maintenance of productive riparian areas. Rock revetment, gabions and other structures are often used for bank stabilization.

This paper describes a technique used for streambank stabilization that has been in use for over 14 years in eastern Oregon.

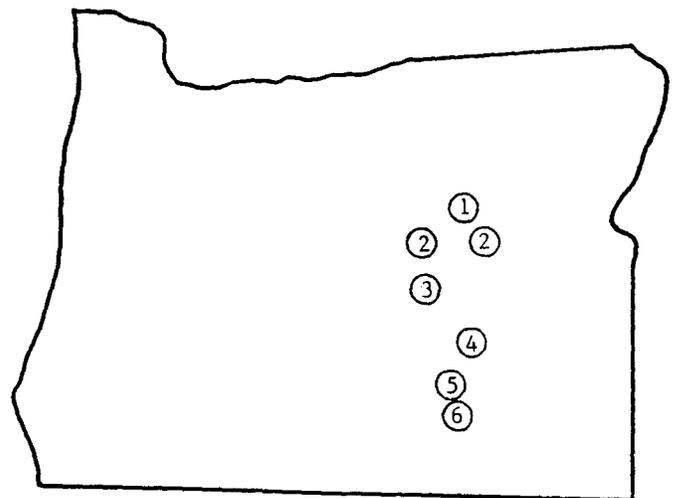
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## Range of Habitat Conditions of Treated Streams

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Six streams in eastern Oregon served as the study sites (fig. 1). Stream characteristics were gentle gradients (1 to 2 percent) with a substrate ranging from silt to cobbles. Streams varied from ephemeral drainages to perennial ones with a peak annual flow of .01 cubic meters/second (4 cubic feet/second) up to 169 m<sup>3</sup>/sec (6000 cfs), (table 1). Elevations in the study area ranged from 715 to over 2,700 m. These streams are typical of many streams found in the shrub-steppe and coniferous forest regions of the western United States (Bowers and others 1979, Thomas and others 1979). The vegetation is primarily basin big sagebrush (*Artemisia tridentata* subsp. *tridentata* Nutt.) and herbaceous species at lower elevations. Upper elevations have a predominant tree cover of ponderosa pine (*Pinus ponderosa* Dougl. ex. Laws.), Douglas-fir (*Pseudotsuga menziesii* Mirbel) and lodgepole pine (*Pinus contorta* Dougl.) in the Blue Mountains and mountain big sagebrush (*Artemisia tridentata* subsp. *vasyana* Rydb.) and aspen (*Populus*

*tremuloides* Michx.) in other drainages. Western juniper (*Juniperous osteosperma* Hook.) is found between the lower and upper elevations. Common riparian shrubs and trees include red-osier dogwood (*Cornus stolonifera* Michx.), thin-leaved alder (*Alnus incana* Moench), several species of willow (*Salix* spp.), black cottonwood (*Populus trichocarpa* T.& G.) and water birch (*Betula occidentalis* Hook.).



1. Fox Creek
2. John Day River
3. South Fork John Day River
4. Rattlesnake Creek
5. Krumbo Creek
6. Blitzen River

**Figure 1** - Map of Oregon showing juniper revetment sites evaluated.

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## Methods

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Methods used to stabilize eroding banks utilizing rock riprap are often costly and unsightly (Henderson and others 1984). Due to the high cost of treating extensive erosion problem areas, a technique was needed that would accomplish bank stabilization with minimal costs and equipment and would be more esthetically acceptable. Juniper tree revetment had been used on a limited scale by some private landowners in the John

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**Table 1**-Characteristics of six study streams, eastern Oregon

	Fox Creek	John Day River at John Day	John Day <sup>1</sup> River at Dayville	South Fork <sup>2</sup> John Day River	Rattlesnake Creek	Trib. to Krumbo Creek	Krumbo Creek	Blitzen Creek
Drainage area (kilometers <sup>2</sup> )	91	622	2,544	1,528	52	14	21	982
Peak flow since treatment (m <sup>3</sup> /sec)	2	21	169	28-85	.5	.1	.3	121
Years since treatment	2	1	14	9-11	2	2	2	10
Stream gradient at site(pct)	1.5	2.0	72.0	1.0-2.0	2.0	1.0	1.0	1.5
Length treated(m)	236	289	213	1,966	30	15	30	30
Height of eroded bank(m)	.6-3.0	1.3-1.7	1.0-4.0	1.0-3.0	1.0	3.3	1.5	3.3-4.0
Average channel width at site(m)	4	30	46	15-23	4	3	4	40

<sup>1</sup> Treated at two locations.

<sup>2</sup> Treated at 30 locations.

**Table 2** - Cost of juniper revetment contracted in eastern Oregon and southern Idaho.

Stream	Length treated (m)	Year	Placement method	Agency <sup>1</sup>	Cost/m (\$)
Juniper Creek	914	1983	Horses	BLM Boise, ID	5.48
Fox Creek	236	1986	Tractor	ODF&W John Day, OR	38.13
John Day River	290	1987	Tractor	ODF&W John Day, OR	24.13
Chewaucan River	1365	1982	Tractor	USFS Paisley, OR	4.36
Chewaucan River	1177	1983	Tractor	USFS Paisley, OR	4.36

<sup>1</sup>BLM = Bureau of Land Management

ODF&W = Oregon Department of Fish and Wildlife

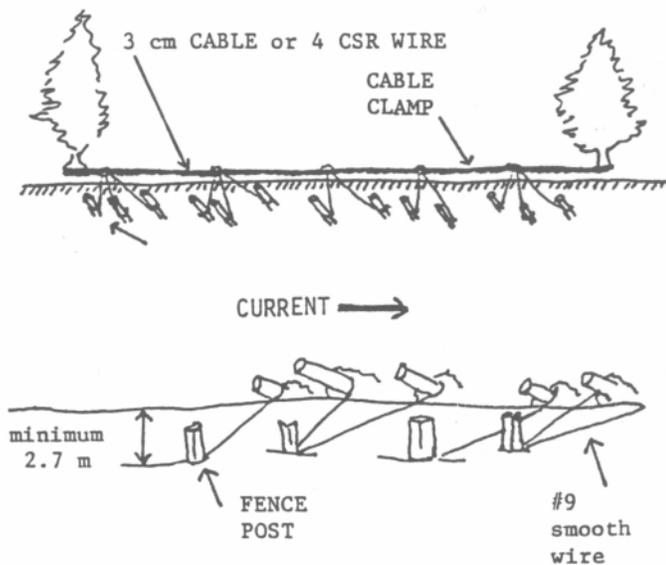
USFS = United States Forest Service

Day River Basin with variable success. Since juniper is abundant in much of eastern Oregon, it has now been used extensively on many problem areas. We evaluated 2,809 m of juniper revetment used on eight eastern Oregon streams treated from 1974 to 1987. During that period we found the following conditions to be important to the success of these projects:

3. Juniper trees should be green and full limbed with a heavy crown and in a "Christmas tree" or cone configuration.
4. The minimum tree butt diameter should be 15 to 30 cm d.b.h..
5. Trees should be placed in a shingled, overlapped pattern beginning downstream and working upstream (fig. 2).
6. Trees should be packed tightly and placed firmly against the bank.
7. Trees should form a downstream angle between the tree and the bank of about 45 degrees and be placed about 1 to 1.5 m apart.
8. The top of the tree should extend into the stream

channel 1 to 1.3 m.

7. Tree butts should rest on top of the streambank but should not extend above the top of the bank by more than 0.3 m.
  1. A 1814 to 2721 kg (2 to 3 tons) tilt-bed truck or flatbed trailer with solid sideboards was most practical for hauling trees.
  2. Anchoring
    - A. Steel fence posts should be driven back from the bank edge no less than 2.7 m from the top edge of the streambank in undisturbed soil.
    - B. Posts should be driven so the top of the post is 5 cm below the ground.
    - C. Post length should be 1 m. Full size posts were cut in half for use.
    - D. Final wire position should lie flat on the ground to reduce hazards to humans, livestock and wildlife. Scrap powerline wire (4 CSR) was used extensively in place of cable to reduce costs.



**Figure 2** — Methods for installing juniper revetment along a streambank.

On the South Fork of the John Day River, labor was provided by Youth Conservation Corps (YCC) crews who worked for 2 weeks each summer from 1976 to 1978. Four hundred and fifty work days were needed to treat 1,372 m of eroded bank. YCC travel and environmental education time, etc., reduced actual work time by at least 20 percent. The other areas treated were done by Oregon Department of Fish and Wildlife and Bureau of Land Management crews or by contract.

Prior to juniper placement on the South Fork of the John Day River, flows were determined at one 30 m long site 0.3 m from the bank using a Gurley Current Meter. Following treatment, water velocities were reduced to such a low level that current meter cups would not turn. Since these low velocities could not be determined by that method an estimate was obtained by diluting red food coloring in 18.9 liters (5 gal) of water in a bucket and pouring the colored water into the river upstream and adjacent to the treatment area. As the labeled water moved downstream, it was timed, the distance measured, and a water velocity determined.

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## Results and Discussion

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Juniper revetment was successful on 2,697 m (96 percent) of eroded streambanks. The average water velocity at one site evaluated was 0.28 m/sec before treatment and decreased to 0.08 m/sec after treatment. Many sites had tree tips buried under 0.6 m of silt the first year after placement. A slope below the vertical bank was formed by siltation and inhabited by species indicative of early stages of plant succession (fig. 3).

These native plants occupied these sites during the first growing season.

A study completed on the Chewaucan River near Paisley, Oregon, found that 1.46 m<sup>3</sup> of sediment, or 1070 kg, was deposited per meter of bank 2 years following treatment with juniper revetment (Otani and Anderson 1988).

Among the juniper revetments we evaluated, 112 m (4 percent) failed. The failures were caused primarily by placement of trees on outside curves of the stream and/or by poor anchoring. Individual junipers placed on more severe turns with high water velocities were the most susceptible to failure. These failures were prevented on severe sites when junipers were used in combination with rock deflectors (fig. 4). Fence post anchors driven too close to streambanks caused banks to slough off and trees to detach. When trees were not tied tightly to cables, water circulated behind trees causing erosion and failure. This could also occur on streams having narrow channels with vertical banks and no area available for deflection of flows. Where junipers were placed adjacent to camping areas some trees were occasionally cut for firewood.

The use of structures, such as juniper, to restore streambanks should be used only as a tool to reach bank stability. Where bank stabilization can be accomplished by livestock management alone these structural techniques should not be used. Juniper revetment should always be combined with proper grazing management. Overgrazing by livestock is a major cause of streambank erosion and degraded riparian habitat in eastern Oregon (Thomas and others 1979, Elmore and Beschta 1987).



**Figure 3** — Juniper revetment 8 years after placement. Trees were sodded in and barely visible.



**Figure 4** - Juniper revetment used in combination with rock deflectors.

Although the mat of juniper limbs against a bank hampers livestock grazing, domestic animals will still attempt to graze the succulent forage under the limbs and cause a breakdown of the revetment. We found that continued uncontrolled livestock use in areas treated with juniper reduced the effectiveness of the project, causing additional bank sloughing. A change in the season of livestock use or other range management technique may be required (Platts and Nelson 1985).

Our data show that the cost of juniper revetment may be less than that of rock riprap. Our costs may not be the same as similar treatments on watersheds with different conditions. However, these values show relationships between costs of juniper revetment as compared to riprap. The cost of juniper revetment work contracted in eastern Oregon and southern Idaho ranged from \$4.36/m to \$38.13/m (table 2). Soil Conservation Service costs for rock jetties in the John Day, Oregon, area range from \$1,690 to \$2,210/30 m of bank treated (table 3). Juniper revetments costs are substantially lower than rock jetties where this treatment is appropriate. As eroded bank height increases, juniper revetment costs vary little; however, due to the marked increase in volume of rock needed, rock work costs increase proportionately. Another factor that may favor the use of juniper revetment is the avoidance of undesirable turbidity caused by heavy equipment excavation prior to rock placement. Juniper revetment work does not cause an increase in turbidity. If esthetics are a consideration, juniper revetment may be obscured by vegetation screening the trees from view. Eventually natural vegetation will obscure or replace the juniper as the rehabilitation of streambanks occur and trees deteriorate with time.

**Table 3** - Estimated installation costs of rock work and juniper revetment for 30 m of bank erosion control, John Day area, Oregon.

Erosion control	Bank height (m)	Quantity required	Cost (\$)
Rock jetties <sup>1</sup>	1.299.4 m <sup>3</sup>	1690	
Rock jetties <sup>1</sup>	1.8	154.7 m <sup>3</sup>	2210
Juniper revetment <sup>2</sup>	1.2	30 trees	728 to 1144
Juniper revetment <sup>2</sup>	1.8	30 trees	728 to 1144

<sup>1</sup> Assumes \$17/m<sup>3</sup> rock cost including delivery and excavation needed to construct three 50 m<sup>3</sup> jetties.

<sup>2</sup> Cost of \$24.28 to 38.13/m.

## Conclusions

Juniper revetment proved to be a successful substitute for costly rock structures on straight or slightly curved banks on those streams evaluated. With proper installation, juniper revetment can provide bank protection for at least 20 years. This project life can be extended for an indefinite period if management of the area allows for full recovery of riparian vegetation. Eventually, full riparian recovery will replace the juniper, thus providing long-term erosion control and bank stability.

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