A LOW COST BRUSH DEFLECTION SYSTEM FOR BANK STABILIZATION AND REVEGETATION[1]

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Abstract: A series of brush deflectors were installed along an eroding, undercut streambank on Lindo Channel in Chico, California. Pieces of brush were wired to sets of metal fenceposts driven into the bank perpendicular to stream flow and at strategic points upstream. Dormant cuttings of riparian plants were added for revegetation and long-term bank protection. To date (two years deployment), the system has stopped erosion.

Streaminders received funding from the California Department of Water Resources Urban Stream Restoration Program to develop a low cost brush deflection system to reduce bank erosion and restore riparian vegetation along a segment of Lindo Channel. Excessive costs associated with traditional bank protection such as rock rip rap, combined with undesirable environmental impacts has generated considerable interest in identifying other solutions to stabilize and slow bank erosion while preserving natural stream processes.

Bioengineering techniques which utilize biological materials such as brush, logs and living plants have been successful in achieving bank protection while maintaining environmental values (Schiechtl, 1980). A variety of bank stabilization techniques utilizing natural materials were explored along Prairie Creek with mixed results (Schwabe, 1986). Techniques which provided toe protection were the most successful in slowing erosion.

The Palmiter River Restoration Techniques, originated by George Palmiter of Ohio, involve a six step system which removes log jams, protects eroded banks with brush deflectors, removes sand and gravel bars and potential obstacles, and provides revegetation while requiring periodic maintenance (Institute of Environmental Sciences, 1982). Palmiter observed that obstacles such as log jams frequently forced currents against the bank causing erosion. By removing the log jam and placing brush deflectors at key points along an unstable bank, erosion was often controlled.

An experimental study is currently underway on the Sacramento River utilizing a palisade technique, consisting of placing nylon webbing between sets of pilings perpendicular to an eroding bank, in order to reduce water velocities and trap sediments (Michny, 1987). The palisade technique minimizes bank disturbance and has been utilized primarily on large river systems.

The bank protection technique explored here combines a palisade-type system with a brush deflection system originating from the base of the bank. Bank protection was simultaneously combined with revegetation to accelerate restoration of natural habitat values and further encourage sedimentation and bank stability. Locally available biological materials were used and labor was provided primarily by community volunteers.

Study Area

The study area is on Lindo Channel, a segment of Big Chico Creek located in Chico, Butte County, California, at an elevation of 69 meters. Lindo Channel carries high water overflow from Big Chico Creek but is dry for six months in summer. Peak flows experienced in recent winters can reach 90 cubic meters per second.

The upper five kilometers of Lindo Channel in the urban area has experienced increasing amounts of runoff and a long history of gravel mining, degrading the streambed and destroying riparian vegetation. Soil compaction on the surrounding terraces, combined with lack of summer flows, have created conditions difficult for the natural reestablishment of bank vegetation. Bridge crossings, bike paths, and a freeway overpass have caused localized erosion along banks by deflecting and altering currents.

The site selected for restoration consists of an eroding, undercut bank 69 meters long and 3 meters high, located along an outside curve just downstream of the Highway 99E freeway overpass. The freeway buttresses and apron are thought to have contributed to erosion along the bank by forcing flows against it, and by slowing velocity which causes an extensive point bar to form opposite the erosion site.

Methods

A system was designed using brush deflectors anchored in a continuous series along the eroding bank and at strategic points just upstream. Trenches 1 meter deep and 0.6 meters wide were used to facilitate placing cuttings into the gravelly substrate and to provide a

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trough in which to anchor deflectors. Figure 1 shows the location of deflectors. Deflectors A and B were installed just upstream to direct currents away from the bank. A continuous deflector C was placed parallel to the bank to stabilize the toe. Deflector C was extended 11 meters upstream of the erosion site and curved away the main channel to prevent flows from getting behind the deflectors. The downstream end was extended 12 meters beyond the end of the bank to accommodate downstream migration of the cut. Deflector D was placed downstream and across the channel to reduce any erosion induced by the project.

A rope "dead man" system was placed in the bottom of the trenches to help hold the brush deflectors in place, anchored with metal t-bar fence posts and weighted with short lengths of rebar. Pieces of freshly cut tree trimmings in 3 meter lengths were wired butt end down to the rope with 12 gauge wire. Tree trimmings with a lot of branching to dissipate energy were most desirable.

Dormant cuttings of riparian plants 1.5 meters in length were placed between the anchored brush with two thirds of the cutting below the substrate and one third above. The trench was then backfilled.

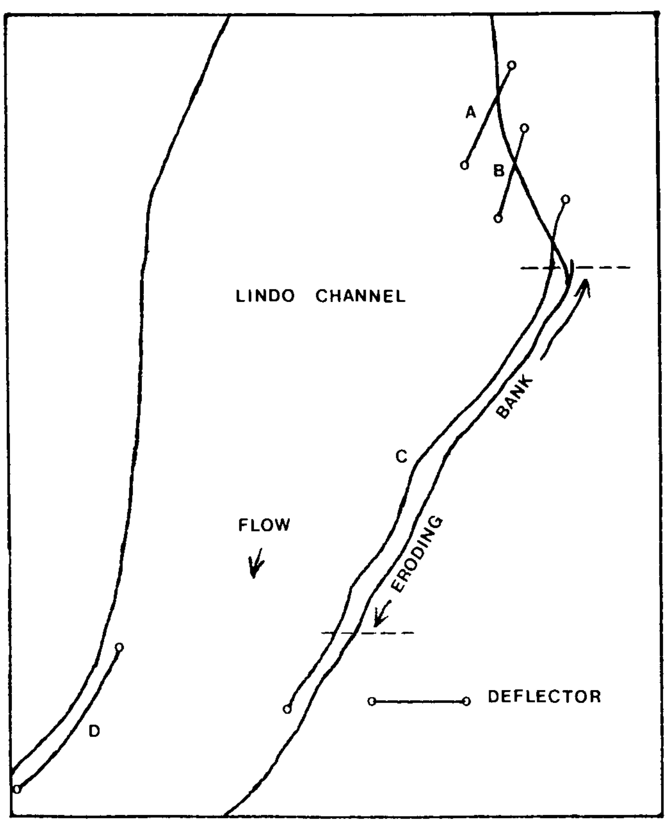

Figure 1 — Location of brush deflectors at Lindo Channel.

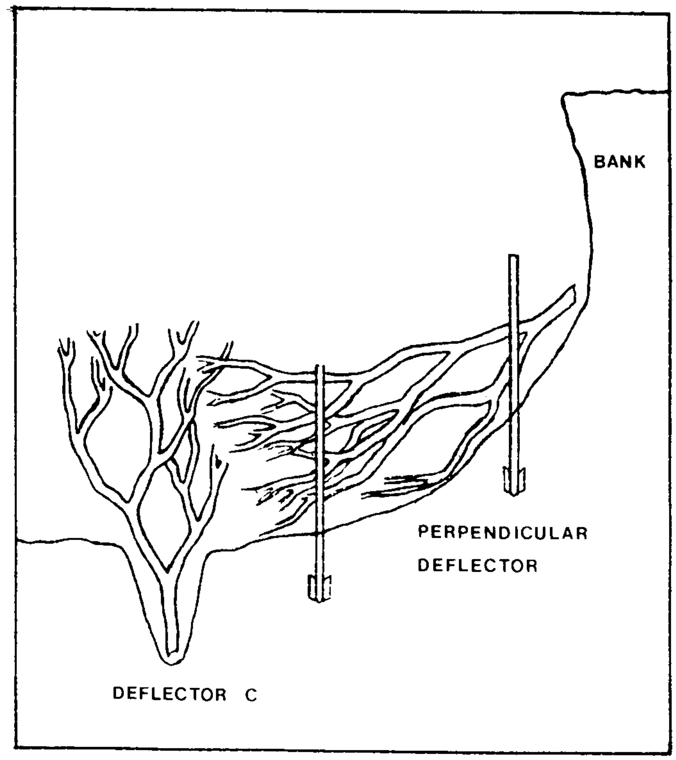

Figure 2 — Cross section of the eroding bank showing deflector C and a set of perpendicular deflectors.

Brush deflectors were also installed in a series perpendicular to the bank and deflector C. Figure 2 shows a cross section of the bank and deflector C with a set of perpendicular deflectors. Pairs of t-bar metal fenceposts 2 meters long were driven into the bank at 9 meter intervals. Tree trimmings were wired onto the upstream side of the fenceposts so that the branches extended out and down into the current. The finished height of the perpendicular deflectors was about 1.5 meters. Figure 2. Cross section of the eroding bank showing deflector C and a set of perpendicular deflectors.

Additional dormant cuttings were placed in the eroding bank over the next winter. Crow bars were used to make holes for the cuttings. The bar was worked down into the gravelly substrate in a circular, rocking motion. Working in teams, one member gradually pulled the crow bar out while another held the cutting and forced it downward along the side of the crow bar. The bar was then used to work the substrate around the cutting to make sure there were no air pockets.

Cuttings were taken from plants native to Lindo Channel and collected on site or nearby and placed at a variety of locations up and down the bank. The following plant species were used for cuttings: cottonwood (*Poplins fremontii*); willow (*Salix goodingii*) and (*S. laevigata*); and mule fat (*Baccharis viminea*). A drip line placed along the base of the bank was irrigated for 12 to 18 hours every 7 days during the dry season.

Installation was achieved over a 2 day period in October of 1986. Trenches required 5 hours of backhoe work. Labor required 204 person hours, contributed by community volunteers and members of the California Conservation Corp. Four truckloads of tree trimmings and cuttings were brought in, approximating 120 cubic meters of material.

To accommodate more capacity in the channel and to reduce the amount of water forced against the eroding bank, the instream edge of the point bar opposite the bank was shaved off with a bulldozer and the gravel pushed across the main channel and against the base of the brush deflectors. Four hours of bulldozer work moved approximately 180 cubic meters of gravel.

In preparation for the second winter, deflectors A and B and perpendicular deflectors were supplemented to maintain their effectiveness. One additional fencepost was added to each perpendicular deflector abutting the bank. Deflectors A and B were extended an additional 3 meters into the main channel and several fenceposts were added to receive brush. Fresh tree trimmings were wired to fenceposts along each deflector and additional cuttings were placed up and down the bank and subsequently irrigated during the dry season.

Two truckloads of tree trimmings containing approximately 60 cubic meters of material was used to augment the deflectors. Seventy person hours of labor were contributed by volunteers.

Results and Discussion

Two months after the initial October installation, the rainy season began. While overall rainfall for the winter was less than normal, several storms resulted in high flows for periods of 1 to 4 days, inundating the deflector system. The peak flow for the year reached approximately 78 cubic meters per second in March.

The brush deflectors substantially reduced the effects of moderate and peak flows against the eroding bank. Debris accumulated in the deflectors and increased their effectiveness. Large chunks of overhanging bank material which fell in were held in place at the base of the bank. Fine sediments built up behind the initial deflectors A and B, and at the lower end of deflector C where flows were at their slowest. About 0.3 meters of downcutting was observed along the middle third of deflector C.

Much of the brush along the middle section of deflector C disappeared gradually over the winter. This section experienced the most intense flows. In contrast, the perpendicular deflectors between deflector C and the bank were full of debris and appeared to be the more effective at protecting the bank than deflector C.

Loss of brush along deflector C was probably due to the location of the trench itself. The backhoe could not trench close enough to the base of the bank and consequently, deflector C was 1 to 2 meters further into the main channel than desired. Trench location also resulted in poor sprouting for the cuttings placed there, since those in the middle section of deflector C were inundated even during low flow conditions. In contrast, cuttings placed higher up on the bank along the upstream and downstream end of deflector C, and in deflectors A, B, and D rooted well and grew over 1 meter the next summer.

Based upon this experience it is recommended that trenching not be used along steep banks because of the difficulty in working close enough to the toe without causing bank collapse. Trenching appears to be successful when applied to areas that have a gentle slope and when large amounts of cuttings are needed.

The second year, rainfall was about 40 per cent of normal. Two early storms in December inundated the deflectors. Occasional storms in spring maintained low flows in the channel, but no further high flows occurred.

Examination of the streambed the following spring revealed some downcutting and scour at the end of deflector B which had been extended too far into the channel. Deflector B's terminal fence post washed out and the second one was bent. Otherwise, deflectors A and B and the perpendicular deflectors performed well. Cuttings sprouted and are thriving.

Fresh tree trimmings will need to be added to the deflectors annually until the vegetation is large enough to provide both deflection and bank stability. Adjustments in the deflectors may be necessary to increase or decrease deflection at key points. Irrigation must be carefully planned and monitored in climates like that of California to assure that the revegetation effort is successful.

It is important to note that the system described here has not yet been exposed to heavy winter flows. The mild winters to date may well have enhanced revegetation by providing time for plants to root. It remains to be demonstrated whether the riparian vegetation establishing along the bank will be able to provide long term protection.

Acknowledgments

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