

Technical Tip

A Large Woody Debris Anchoring System for Sites With Limited Access

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This Technical Tip describes an anchoring system for Large Woody Debris (LWD) that is useful for sites where access is limited. This system has been successful at such a site on the banks of the Little Slokan River in the West Kootenays, where the lack of site access for materials and equipment meant that conventional LWD anchoring with boulders and cables was not feasible without helicopter support. Instead, Manta Ray™ soil anchors that are usually used for retaining walls, power line guy wires and marine anchorage, were used to anchor the LWD against flotation and horizontal sliding caused by flowing river water (Figure 1).

First, hydrological and hydraulic studies determined flows, water depths and water velocities to be used for design of the anchoring system. For the 178 km² catchment area of the Little Slokan River at the site, the estimated instantaneous discharges were 160 m³/s, for an average annual flood, and 218 m³/s, for a 10-year return period flood. Using these design floods and river cross-sections, provided by the Ministry of Environment, Lands and Parks, it was estimated that the Little Slokan River water levels would rise at least 1.5 to 2.5 m in the reach where the site is located, thus fully submerging the LWD. The corresponding water velocities on the outside of the bend, where the LWD were to be anchored, were estimated to be approximately 2 to 3 m/s.



Figure 1. Manta Ray™ soil anchor with the cable attached.

Guidelines in the Watershed Restoration Management Report No. 8, “Large Woody Debris Fish Habitat Structure Performance and Ballasting Requirements”, by S. D’Aoust and R. Millar, indicated that 6,000 to 11,000 kilograms of ballast was required to anchor each piece of LWD (with root wads attached). Such ballasting has traditionally been provided by cabling of boulders to the LWD. In this case, two to three boulders, each 1.3 m in diameter, would be required to anchor each of the 30 to 40 pieces of LWD. However, no boulders were available at site, and limited access made it impossible to import the approximately 100 boulders needed.

The successful alternative was the use of Manta Ray™ soil anchors and cable to anchor the LWD over more than 100 m of bank (Figures 2 and 3). These anchors are available in different sizes and can develop much higher anchoring capacities than the smaller Duck Bill™ anchors. Using a portable hydraulic jack, the Manta Ray™ anchors were driven approximately 4 m into the ground to place them below the estimated river scour depth. After the anchors were load tested, the pieces of LWD were attached to them with cables. Dywidag Systems, the supplier, provided an experienced technician to work with the field crew throughout the installation process. The 30 anchored logs remained in place through the 1999 and 2000

freshets. Because of the large snowpack the 1999 freshet potentially could have been a very extreme event, but due to a long cool spring, the resulting peak flows occurred late in the season and were in the order of 10-year return period flows or less.

An inspection of the site during the fall of 2000 revealed that one of the cables had broken at the upstream end of a piece of LWD. The cable failed immediately below the clamp and the anchor remained intact in the river bottom. However, the LWD remained in place, held by another anchor at the downstream end of the log and by an adjacent anchored LWD on the river side. A 2 to 3 m deep scour hole had developed over a length of 20 m where the broken cable was located.

Scour depth varied from 1 to 2 m over the rest of the site.

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Figure 2. Installing the soil anchor with hydraulic jack in the Little Slokan River, Slokan Valley.

Exact cause of the cable failure is not certain, but was most likely a combination of clamping methodology, fatigue, and loading. Most of the deep scour hole was formed during the 1999 freshet, when a large tree with a rootwad became grounded in mid-channel and directed flow against the site. This may have caused floating debris to wedge against the anchored LWD, increasing the load enough to cause the cable to fail. However, such additional debris was not present in the fall of 1999 nor in the fall of 2000. Another possibility is that the deep scour hole could have allowed movement of the LWD. Since this particular cable had been wrapped

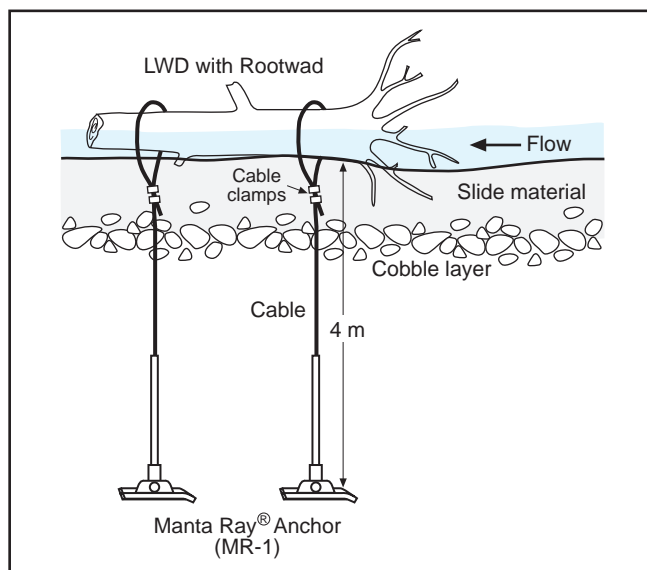


Figure 3. This diagram demonstrates the snug installation of the cables and clamping to avoid sharp bends. The Manta Ray™ Anchor was used to anchor the LWD against floatation and horizontal sliding caused by flowing river water.

around the LWD twice and then clamped to itself, tensioning of the cable would have resulted in a bend in the cable at the clamp. As this connection most likely contributed to the cable failure, it is important to note that future cable installations should avoid sharp bends (Figure 3).

In summary, when designing LWD anchoring systems that may include Manta Ray™ anchors, it is important to be aware of the following issues:

- At sites where boulders are not available or are too costly to import, soil anchors such as the Manta Ray™ are a good and reasonably-priced alternative to boulder ballast.
- The equipment used for driving the anchors into the ground can be moved by hand or an ATV; this allows access to very confined areas as it eliminates the need for large equipment.
- The anchors must be driven below the expected scour level of rivers, or in the case of landslides, below the area of soil movement.
- Cables should be clamped as shown in Figure 3, avoiding sharp bends.
- Cables should always be installed as snug as possible.
- Cable diameter should be oversized to allow for unexpected loading.
- Post-flood monitoring should be carried out to determine if maintenance is required.

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