SECTION 5.5.1.5 Distribution of Woody Debris and Its Role In Steelhead Ecology

Introduction

Large woody debris (LWD) can influence physical and biological functions of aquatic habitat throughout an entire watershed. Large wood manipulates surface flow and sediment transport. It also provides cover, substrate and food used by fish and aquatic invertebrates. The purpose of this section is to review the functions of LWD, the relationship between LWD and aquatic biota and the current information available on LWD in the Carmel River watershed.

Distribution of LWD within a Watershed

Distribution of LWD in a watershed is related to past and present recruitment rates, decay rates, rates of movement through the channel and land-use practices. LWD is recruited within a river channel by mortality from the adjacent riparian forest, windstorms, flooding, fire, bank erosion, and landslides (Keller and Swanson 1979; Benda et al. 2003.) Output processes of LWD are leaching, fragmentation, microbial decay, invertebrate consumption, and fluvial transport (Keller and Swanson 1979).

LWD abundance is correlated to stream size (Bilby and Ward 1989). Small channels tend to contain more pieces of LWD. As channel size increases the abundance of LWD decreases. This is because larger channels have the ability to transport larger pieces of wood. The average size of LWD is also related to stream size. The larger the stream size the larger the average piece of wood (Bilby and Ward 1989). Smaller pieces of wood are generally flushed from the larger channels during high flow events. Leaving only large pieces and causing a decrease in wood abundance, but an increase in average piece size.

Effects of LWD on Channel Geomorphology

LWD affects river geomorphology by manipulating and redirecting surface flows. This influences pool frequency, rates of bank erosion, and routing of sediment and organic matter (Montgomery et al. 2003; Cherry and Beschta 1989; Bilby and Ward 1989).

LWD creates pools by providing an obstruction within the channel, which concentrates flow and causes scouring of the bed. The type of pool created is dependent on its orientation and position above the bed (Montgomery et al. 2003). The size of the pool will depend on the size of the wood, angle of the orientation, flow velocity and amount of organic debris accumulated (Bilby and Ward 1989; Cherry and Beschta 1989).

Depending on the orientation of the wood, rates of bank erosion can be manipulated. LWD can accelerate the rate of erosion by redirecting flow into the channel bank and scouring the bank. In contrast, LWD can provide an armoring effect by deflecting the flow away from channel bank, sequentially stabilizing the bank.

Low flow velocities and bed scour created by LWD causes sediment deposition. Where flow deflected by LWD scours a pool, a depositional site will develop, partially defining the boundaries of the associated pool. The average size of depositional sites increases with channel size (Bilby and Ward 1989).

Substrate roughness is also affected by LWD. LWD encourages the transport of fine sediment, which exposes the gravel and cobble substrate. In general, streamflow determines the influence LWD has on routing and rates of scour and fill. At low flows, pools formed by wood tend to fill and riffles tend to scour, but when flow is high, pools scour and riffles are depositional.

Biological Influence of LWD

LWD has an important biological role by influencing flow, channel morphology, storage of organic material and providing cover and substrate. This influences the food supply of fish, the habitat available and the amount of energy they expend when swimming.

Invertebrates use wood in all stages of their life cycle. They use wood for resting and reproductive activities, refuge, substrate and as a source of food. In addition, the accumulation of organic matter and sediment LWD entraps, creates habitats favored by certain types of aquatic invertebrates (Dudley and Anderson 1982). Productivity, abundance and biomass of macro-invertebrates tend to be greatest in areas of high organic matter availability (Wallace et al. 1995).

Pools created by LWD provide low velocity habitats where fish can maintain their position and expend the least amount of energy, yet are in close proximity to swift currents to maximize access to invertebrate drift. Pools that are deep enough, can thermally stratify, providing coldwater refuge during increasing stream temperatures.

In addition to creating pool habitat and low velocity areas, LWD provides a source of cover and habitat complexity. During summer low flows, the pool depth is reduced and LWD cover is often the only protection from predators. Conversely, during high flows, LWD creates velocity breaks, which allow fish to maintain positions in favorable areas. Fish that take refuge in pools with complex cover have greater opportunities to be visually isolated. As complexity increases, there is an increase in available habitat, which tends to support more fish.

Status of LWD in the Carmel River

California State University at Monterey Bay's (CSUMB) Watershed Institute conducted a large woody debris inventory on the Carmel River during the summer of 2002 and 2003 (Smith and Huntington, 2004). This is the only LWD study to date that has been done on the Carmel River. The inventory sampled the lower river from Stonepine Resort down to the Highway 1 Bridge (**Figure 5.5.1.5-A**). The study included data on abundance, size, location, orientation and condition of large wood debris within the wetted channel. The inventory found that there were 471 occurrences of large wood or large wood accumulations within the surveyed reach. Average density per rivermile within the reach was 36.7 occurrences or 20.5 pieces/km, ranging from 10-40 pieces/km. Generally, the density of LWD decreased downstream of Stonepine Bridge, located approximately 2.5 km below San Clemente Dam (**Figure 5.5.1.5-B**). Garland Park was noted as having amongst the highest concentrations of LWD in the study, whereas the areas from Robinson Canyon Road to Schulte Road Bridge and downstream of Via Mallorca Road Bridge had the lowest concentrations.

Figure 5.5.1.5-A. Sample reaches and distribution of LWD in Carmel River (CSUMB Watershed Institute, 2004). White stars represent reaches where no data were collected.

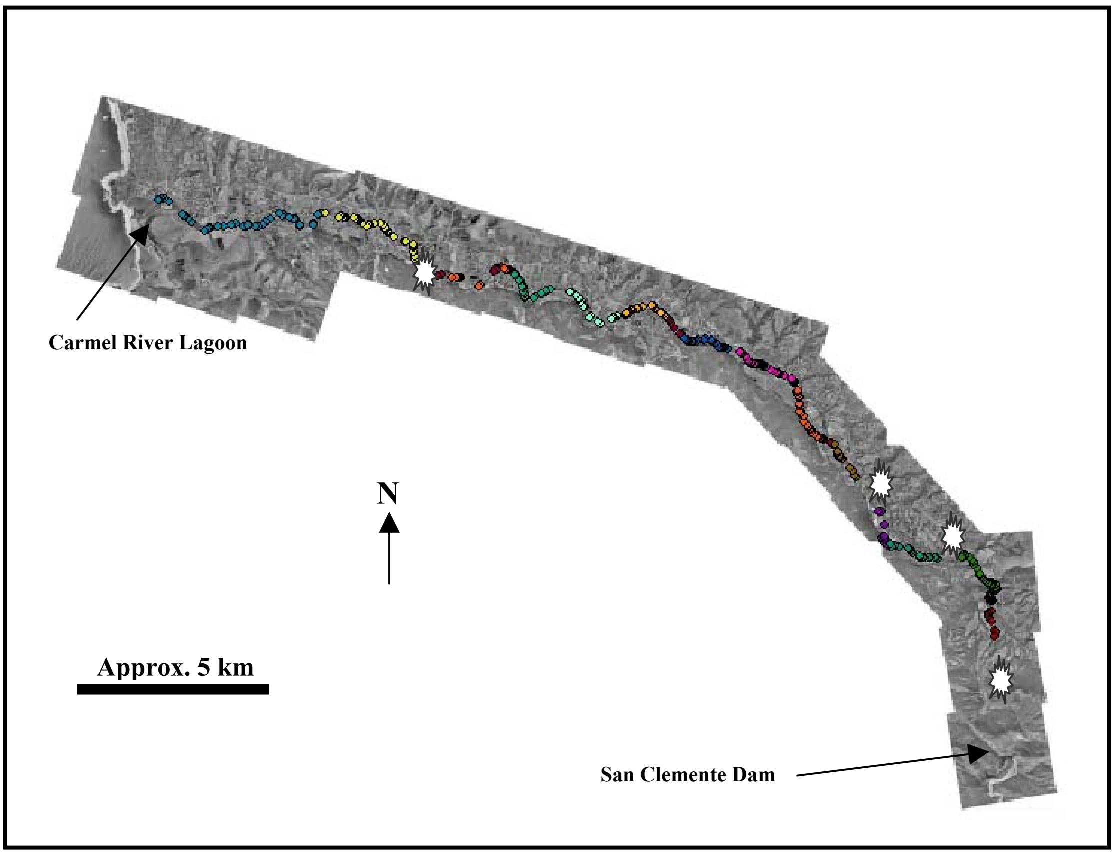
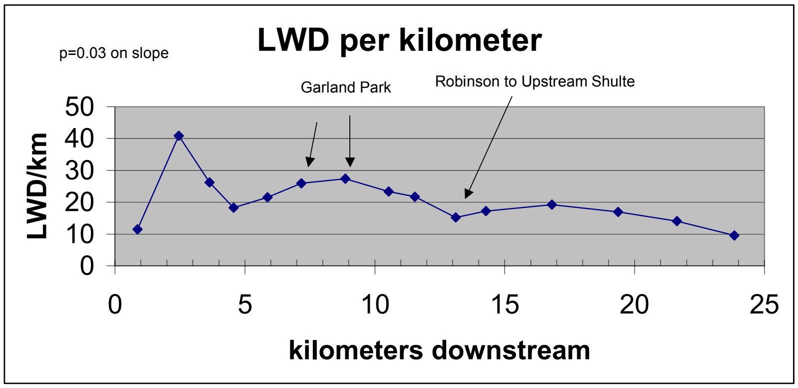


Figure 5.5.1.5-B. Density of LWD with distance downstream (CSUMB Watershed Institute, 2004).



Bilby and Ward (1989), found that the abundance of LWD increases with decreasing channel size. Their study showed that a stream with a channel width of 18 meters, the approximate channel width of the lower Carmel River, contains about 150 pieces/km. In contrast, the Carmel River averaged 20.5 pieces/km, only one-seventh of the density measured by Bilby and Ward (1989). It is important to note that the Bilby and Ward (1989) study was conducted in an old-growth conifer forest in southwestern Washington, and may not be directly comparable to the conditions present in the Central California region. While not directly comparable, the generally low density of LWD in the lower Carmel River probably reflects the decades old effort to remove wood following flood events and the overall reduction in riparian forest cover along the floodplain.

Management of LWD on the Carmel River

During the period from 1990-1998, MPWMD conducted an annual channel- clearing program that included the removal of vegetation by hand with chainsaws and loppers and the modification of large wood. Modifications to large wood included bucking up logs into 2- to 3-foot sections and sometimes moving them onto higher terraces out of the low flow channel. The recent listing of the California red-legged frog (*Rana aurora draytonii*) and the steelhead (*Oncorhynchus mykiss*) as threatened under the Federal Endangered Species Act (ESA) has drawn attention to the value that riparian vegetation and large woody debris has to these species. In 2003, MPWMD adopted guidelines for vegetation management that emphasize the protection of wood within the channel to the maximum extent practicable (MPWMD, 2003).

The transport of floating woody debris past Los Padres and San Clemente Dams is facilitated by California American Water Company (Cal-Am). The Los Padres Dam has a log boom which regularly traps large wood in the reservoir (**Figure 5.5.1.5-C**).

Figure 5.5.1.5-C. Picture of Los Padres Dam log boom taken on 11/15/2002.

This wood usually becomes waterlogged and sinks to the bottom of the reservoir. The wood remains until decomposition occurs and breaks it down. Depending on flows and the water level in the reservoir, large wood will sometimes pass onto the spillway and make its way back into the Carmel River unassisted. Large wood that migrates through the San Clemente Reservoir to the dam spillway is manually passed through the spill gates if the orientation and size of the wood does not allow natural passage.

References

Benda, L., D. Miller, J. Sias, D. Martin, R. Bilby, C. Veldhuisen, and T. Dunne. 2003.Wood recruitment processes and wood budgeting. Pages 49-74 in S.V. Gregory, K.L. Boyer, and A.M. Gurnell, editors. The ecology and management of wood in world rivers. American Fisheries Society, Symposium 37, Bethesda, Maryland.

Bilby, R. and J.W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in western Washington. Transactions of the American Fisheries Society 118:368-378.

Cherry, J., and R.L. Beschta. 1989. Coarse woody debris and channel morphology: A flume study. Water Resources Bulletin 25:1031-1036.

Dudley, T.L., and N.H. Anderson. 1982. A survey of invertebrates associated with wood debris in aquatic habitats. Melanderia 39.1-21.

Keller, E.A., and F.J. Swanson. 1979. Effects of large organic material on channel form and fluvial processes. Earth Surface Processes 4:361-380.

Montgomery, D.R., B.D. Collins, J.M. Buffington, and T.B. Abbe. 2003.Geomorphic effects of wood in rivers. Pages 21-47 in S.V. Gregory, K.L. Boyer, and A.M. Gurnell, editors. The ecology and management of wood in world rivers. American Fisheries Society, Symposium 37, Bethesda, Maryland.

Monterey Peninsula Water Management District. 2003. Final Guidelines for Vegetation management and Removal of Deleterious Materials for the Carmel River Riparian Corridor. 30 pp.

Smith, D.P., and Huntington, P., 2004. Carmel River large woody debris inventory from Stonepine to Carmel Lagoon, Fall, 2003: Watershed Institute, California State University Monterey Bay, Publication No. WI-2004-01, 72 pp.

Wallace, J.B., J.R. Webster, and J.L. Meyer. 1995. Influence of log additions on physical and biotic characteristics of a mountain stream. Canadian Journal of Fisheries and Aquatic Science 52:2120-2137.