RTI FACT SHEET **# 9**
Rural forest community issues *2001*

The Impact of Riparian Forest Management on Large Woody Debris (LWD) Recruitment Potential

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Large woody debris (LWD) recruitment plays an integral role in the production and maintenance of riparian and aquatic habitat (Beechie and Sibley 1997; Bisson et al. 1987; Bryant 1983; Harmon et al. 1988; Swanson et al. 1977; Swanson and Lienkaemper 1978; Triska and Cromack 1979). Recruitment processes can be classified in one of two categories: biological (e.g. natural mortality, insect/disease – induced mortality) and physical (e.g. windthrow, streambank failure) (Keller and Swanson, 1979). Although recruitment events are stochastic in time and space, the potential of a given riparian forest to recruit LWD can be measured at some snapshot in time. Thus, the impact of management changes on LWD recruitment potential can be modeled to support the development of better forest management plans.

Riparian vegetation is the primary source of large woody debris inputs into adjacent streams. Recruitment of large woody debris is a binomial event, there are only two possible outcomes: success and failure. When a biological or physical agent causes a tree to fall, either it will hit the stream (success) or it will not (failure).

Even the most conducive set of biological, physical, spatial, and temporal characteristics will recruit from only a subset of the total forest inventory. The probability of recruitment success is a function of a tree's height and distance from the stream (Robison and Beschta 1990). The probability space for a tree falling is a disk centered on the tree with radius equal to the tree's height.

Figure 1 illustrates how only those trees whose height is greater than the distance from the stream (such as tree N in the figure) will have a positive probability of recruitment success, which is the proportion of the total probability space that overlaps the stream. All other trees (such as tree M) will have zero probability of success. The set of all trees with positive recruitment probabilities (i.e. the set of all trees similar to N) is the set of LWD "candidates."

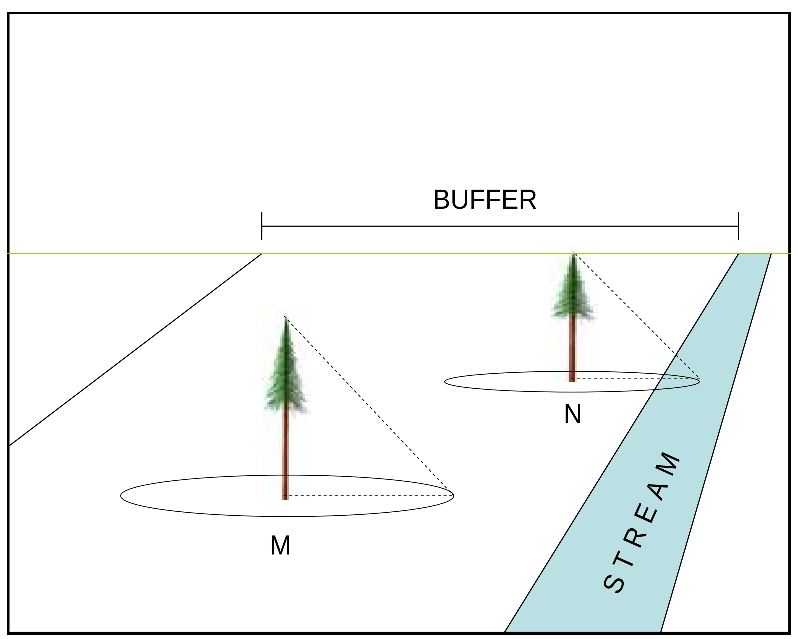
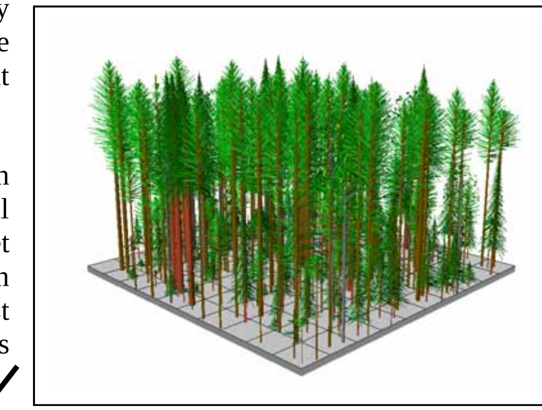


Figure 1: Identifying Set of LWD Candidates

If the riparian forest inventory information is spatially explicit then the set of candidates and their associated probabilities of success can be measured directly. However, by making an assumption regarding the distribution of tree heights across the forest, the set of candidates and their probabilities can be deduced even if the inventory data is not spatially explicit.

By measuring the recruitment capacity of riparian forests under various conditions, the effects of (active or passive) management can be analyzed and compared. By employing growth models, temporal comparisons can be made, and the enduring effects of different management scenarios can be analyzed.

Let the inventory visualized in Figure 2 represent an unmanaged scenario, the chart below illustrates the marginal and cumulative recruitment by distance class along 750 feet of an adjacent stream. The chart illustrates that more than 90% of all recruitment potential is achieved within the first 100 feet from the stream, and there is no effectiveness beyond 140 feet.



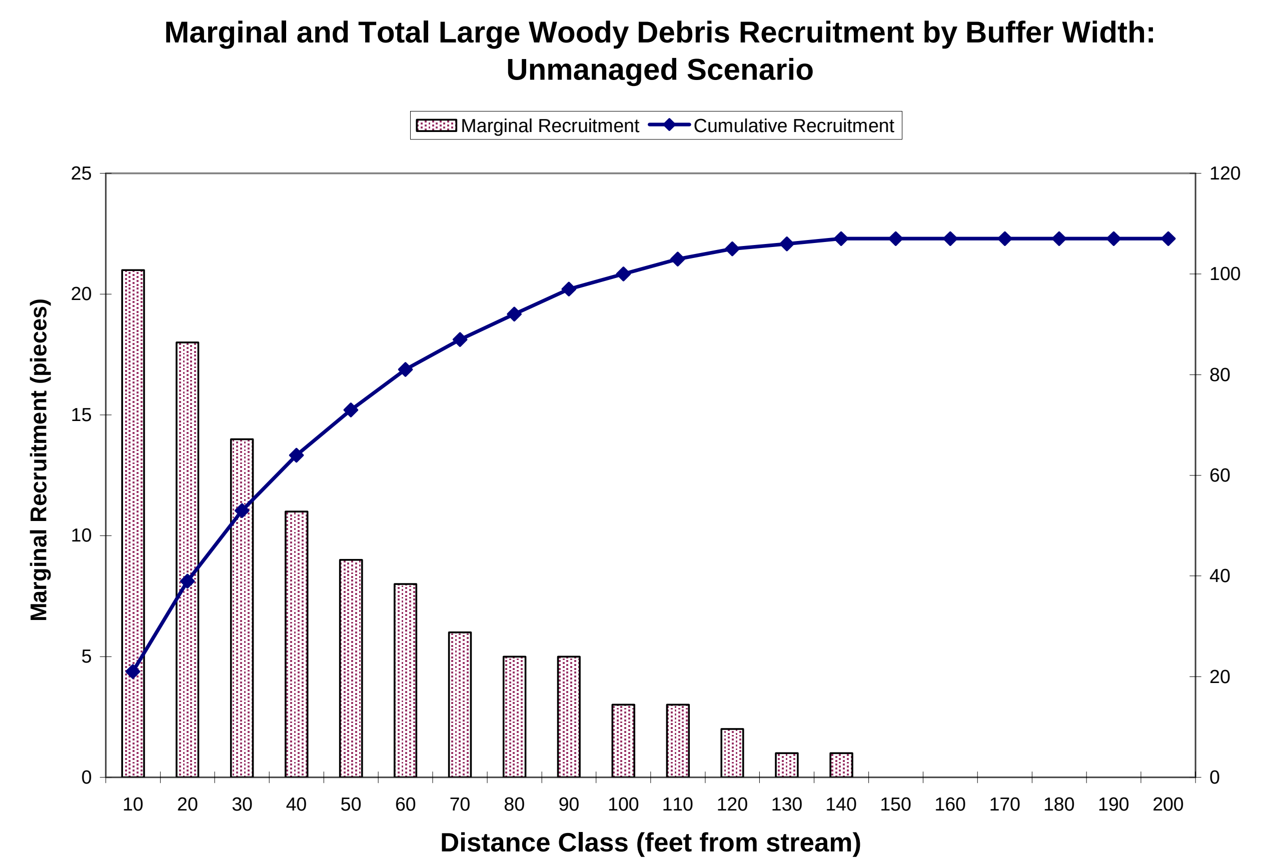
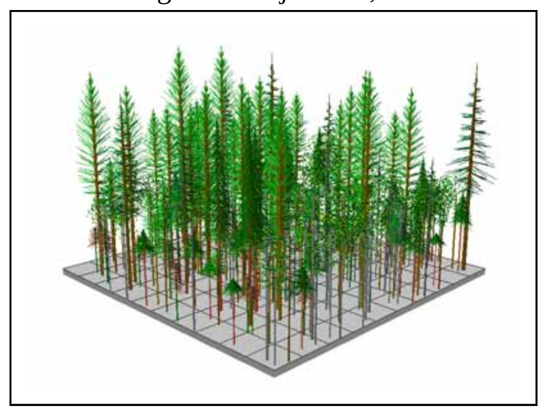


Figure 2: Visualization and Recruitment Potential: Unmanaged Scenario

We can compare this to the inventory visualized and charted in Figure 3, representing an alternative management scenario. While both marginal and cumulative recruitments are lower across the forest under this scenario, the effective width of the buffer is largely unchanged at 130 feet. Most importantly, 90% of the effectiveness is still achieved in the first 100 feet.

If minimum recruitment targets are set, then managers can create and analyze a matrix of silvicultural strategies that provide required levels of recruitment and achieve other management objectives, such as shade production. If analyses reveal that active management does not change the effective width of a buffer, then measures can be taken to recoup the loss in cumulative potential from a passive management scenario.



For stands that are significantly overstocked, active management may indeed increase the recruitment capacity of the stand over time. The silvicultural implication of managing for maximum recruitment potential is creating conditions with the maximum number of tall trees; in that tall trees increase the effective width of a buffer.

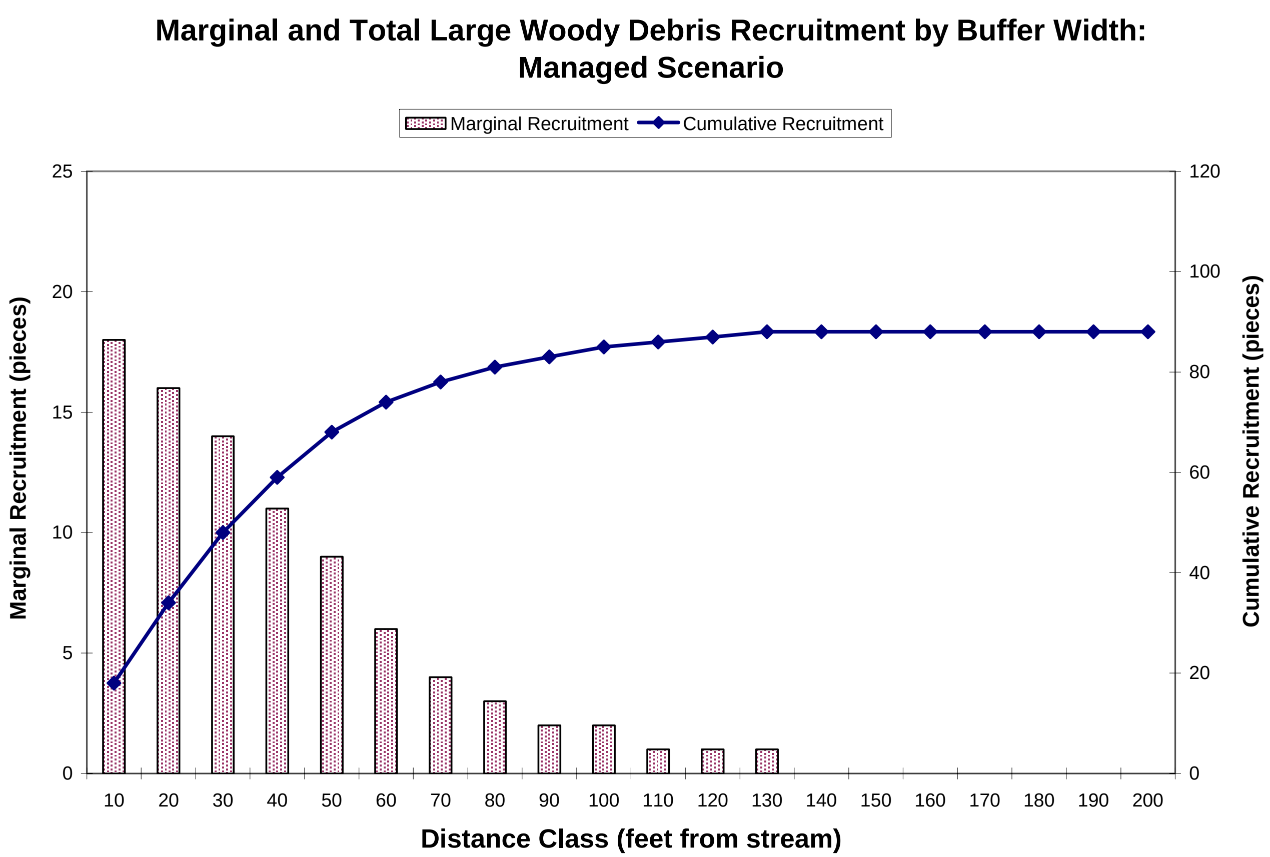


Figure 3: Visualization and Recruitment Potential: Managed Scenario

There are systematic temporal and physical influences that affect recruitment potential. Research indicates that recruitment potential varies between stand development stages (Triska and Cromack 1979; Spies *et al*. 1988; Van Sickle and Gregory 1990). Physical characteristics such as species composition, soil composition, soil stability, valley form, aspect, and management history also affect recruitment potential (Bisson *et al*. 1987).

Recruitment potential does not address the issue of recruitment effectiveness. More pieces may not be as desirable as larger pieces. If fewer but larger pieces are more effective, then this creates even more flexibility in creating silvicultural pathways that produce and maintain aquatic habitat.

Managers incorporating mechanical recruitment processes in their riparian strategies may increase both the effectiveness and flexibility of their management plans. First, mechanical recruitment is an event with a probability = 1; therefore, the stochastic nature of recruitment is eliminated. Second, mechanical recruitment allows managers to control the temporal and spatial aspects of recruitment; that is, they can control when and where LWD is recruited. Third, if size (or volume) of recruitment is proportional to effectiveness, managers can recruit as close to the stream as necessary to achieve a desired level of effectiveness.

Consider the two scenarios presented here, an unmanaged and a managed riparian forest. Based on the inventories and 750 feet of stream frontage, we would expect 107 recruitments in the unmanaged scenario, with 88 from the managed scenario. By mechanically adding 20 pieces from within the first 50 feet of the stream (~23 trees per acre) under the managed scenario, a manager can capture 100 percent of the expected number of recruitments from within 50 of the stream. Adding an additional 19 pieces from within the first 50 feet (~22 trees per acre) recovers the expected number of recruitments from the unmanaged scenario, all within 50 feet of the stream. Employing such a strategy would allow the rest of the buffer to be managed for other management objective, whatever they may be.

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