Coarse woody debris

Coarse woody debris (CWD), synonymous with large woody debris, is a term used to describe wood from dead trees. Although an exact definition is not available, many researchers include all pieces of wood that are at least 10 cm in diameter and 1 m in length. CWD can consist of any coarse part of a dead tree, such as trunks or parts of trunks, branches, stumps, and root wads. A distinction is often made between standing dead trees, snags, and dead trees on the ground, logs. Dead roots in the soil are generally not considered as CWD although there is no principal reason why they should not be.

Researchers often distinguish between CWD and fine woody debris (FWD), where the latter consists of the parts of a dead tree smaller than CWD, exclusive of needles and leaves. The diameter threshold value distinguishing CWD from FWD varies between different studies.

Interest in CWD has increased dramatically during the recent decades, primarily because of increased understanding of the important role CWD plays in forest and **aquatic ecosystems.** CWD provides essential habitat for a wide range of terrestrial and aquatic species. Fallen trees provide habitat for a variety of small vertebrates including rodents, snakes and salamanders, and many species of mosses, lichens, fungi and insects depend on dead wood for their survival. Fallen trees in moist environments also serve as nurse logs for seedling establishment. In streams, CWD affects channel morphology by deflecting flow and encouraging patterns of scour and fill. Debris dams slow the flow of water, dissipate energy, trap sediment and organic matter, and create microhabitats for fish and benthic macroinvertebrates.

Both on land and in water, habitat simplification resulting from timber harvesting and the subsequent decreases in CWD input has been linked to long-term changes in species and community composition. It is widely acknowledged that **forestry** practices need to be modified to reestablish suitable habitat conditions for species depending on CWD.

For an individual species, the value of CWD depends on factors such as tree species, size, degree of decomposition, as well as site and local microclimatic conditions. Classification systems have been developed to categorize CWD by the degree of decomposition.

CWD is also important for carbon storage (see **Forest carbon cycling)** and as a major factor in the susceptibility of forests to fire **(see Forest fire models).** Carbon dioxide released from storage in CWD by decomposition or burning may be a substantial contributor to **global warming.** Tree death and subsequent decomposition also are important processes for the cycling of nutrients in forests **(see Ecosystem element cycling).**

Challenges to the measurement and quantification of CWD range from sampling issues to multivariate statistics for studying species occurrences and communities on dead wood. A brief overview of some specific environmetrical challenges follows.

Sampling Methods for CWD

CWD can be assessed using many different techniques. Remote sensing may be used, but will generally result in coarse estimates. With most kinds of satellite data the inferences will be indirect, linking identifiable features of a forest stand with the normal amounts of CWD present in such stands. With aerial photograph interpretation, direct measurements of the amount of standing and fallen dead trees (such as is used to assess fuel loading for forest fire risk) can often be made. However, to obtain accurate estimates of CWD, field assessment is generally required. Some important probability sampling methods for assessing CWD are plot based sampling, strip surveying, and line intercept sampling **(see Sampling, environmental).** The latter method is applicable only to downed logs. Data from ground-based surveys often is expressed as volume (e.g. cubic meters) or mass per unit area, typically kilograms per square meter ($kg\,m^{-2}$).

Studies of Decomposition Rates of CWD

The rate of decomposition varies with factors such as tree species, dimension, resin content, and macro- and microclimatic conditions. Two major approaches to modeling decomposition can be distinguished. Firstly, regression techniques are often used to determine and predict the decrease in dry weight over time. In this context, the exponential model is commonly used. Secondly, probabilities of transition of CWD units between different decomposition classes can be estimated. Thus, matrix models can be applied to study the amount of CWD present in different decay classes over time. Tree mortality functions, commonly derived using logistic regression, may be used to provide the input of new CWD to the models.

Species Occurrences and Communities on CWD

To quantify and predict CWD substrate quality for different species, methods such as logistic regression are commonly used. Thus, estimates of species preferences between different kinds of CWD can be obtained. With multivariate statistical methods (e.g. ordination) patterns of species communities can be mapped versus substrate quality and other relevant factors.

Further Reading

Bisson, P.A., Bilby, RE., Bryant, M.D., Dolloff, C.A., Grette, G.B., House, RA., Murphy, M.L., Koski, K.V. & Sedell, J.R. (1987). Large woody debris in forested streams in the pacific northwest: past, present, and future, in *Streamside Management: Forestry and Fishery Interactions*, E.O. Salo & T.W. Cundy, eds, University of Washington, Seattle, pp. 143-190.

Harmon, M.E., Franklin, J.F., Swanson, F.J., Sollins, P., Gregory, S.V., Lattin, J.D., Anderson, N.H., Cline, S.P., Aumen, N.G., Sedell, J.R., Lienkaemper, G.W., Cromack, K. & Cummins, K.W. (1986). Ecology of coarse woody debris in temperate ecosystems, *Advances in Ecological Research* **15**, 133-302.

Jonsson, B.G. & Kruys, N., eds (2001). Ecology of woody debris in boreal forests, *Ecological Bulletins 49*.

Maser, C. & Sedell, J. (1994). *From the Forest to the Sea: the Ecology of Wood in Streams, Rivers, Estuaries. and Oceans*, St Lucie Press, Delray Beach.

Maser, C. & Trappe, J.M., eds (1984). The Seen and Unseen World of the Fallen Tree. US Department of Agriculture, Forest Service General Technical Report PNW-164. Pacific Northwest Forest and Range Experiment Station, Portland.

Samuelsson, J., Gustafsson, L. & Ingelög, T. (1994). *Dying and Dead Tree. A Review of Their Importance for Biodiversity*, SLU, Uppsala.

(See *also* Forest inventory; Tree morphology)

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