European Commission

NWRM

Natural Water Retention Measures

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Individual NWRM

Coarse woody debris

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REGIONAL ENVIRONMENTAL CENTER

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I. NWRM Description

Coarse woody debris in stream channels has multiple ecological and hydrologic benefits. Coarse woody debris consists of large sections of deadfall: tree stems or stumps that either fall into or are deliberately placed in streams. Coarse woody debris can be deployed with varying degrees of naturalness. At one extreme, coarse woody debris can be used to form coffer or placer dams which effectively limit water flow. At the other extreme, natural deadfall coarse woody debris is found when riparian trees are allowed to fall naturally into streams. Coarse woody debris will generally slow water flow velocity and can reduce the peak of flood hydrographs. In addition to its role in slowing streamflow and facilitating sediment accumulation, coarse woody debris can improve aquatic biodiversity by retaining food and providing additional habitat, such as refuges and spawning sites.

II. Illustration

Example of river with coarse woody debris
Source: http://www.sitatrust.org.uk/projects/can-we-save-the-native-crayfish

Example of river with coarse woody debris along Dordogne river, France
Source: Hélène Bressan, OIEau

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	Possible	While debris in streams is often considered undesirable in urban areas, coarse woody debris or a suitable surrogate could be used in some circumstances.
Agricultural Areas	Possible	While debris in streams is often considered undesirable in agricultural streams, coarse woody debris or a suitable surrogate could be used in some circumstances
Forests and Semi-Natural Areas	Yes	Coarse woody debris is associated primarily with streams in forest landscapes.
Wetlands	Possible	Coarse woody debris is associated primarily with streams in forest landscapes but may also be relevant for small watercourses in forest covered wetlands.

Region	Applicability	Evidence
Western Europe	Yes	This measure is applicable to forest streams throughout Europe. There are no geographic constraints on its use. It is more likely to be successful in permanent streams that are not subject to significant amounts of ice scour.
Mediterranean	Yes	
Baltic Sea	Yes	
Eastern Europe and Danube	Yes	

IV. Scale

	0-0.1km^2	0.1-1.0km^2	1-10km^2	10-100km^2	100-1000km^2	>1000km^2
Upstream Drainage Area/Catchment Area	Yes	Yes	Possible	Possible	No	No
Evidence	Coarse woody debris is most effective at moderating the flow regime of relatively small streams and rivers. Above a certain size, rivers will be too big for coarse woody debris to have measurable hydrological benefits.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	None	
	Slow Runoff	None	
	Store River Water	Low	Coarse woody debris (CWD) will slow the flow of small streams and rivers. When flow velocities are slowed, there will be a greater storage of water in stream channels. However, the storage benefits are limited compared to the benefits associated with slowing of river water.
	Slow River Water	High	
Reducing Runoff	Increase Evapotranspiration	None	
	Increase Infiltration and/or groundwater recharge	None	
	Increase soil water retention	None	
Reducing Pollution	Reduce pollutant sources	None	
	Intercept pollution pathways	None	
Soil Conservation	Reduce erosion and/or sediment delivery	Low	Coarse woody debris (CWD) may to some extent help accumulate sediment and thus reduce sediment transport downstream.
	Improve soils	None	
Creating Habitat	Create aquatic habitat	High	Coarse woody debris (CWD) increases the structural complexity of stream channels. This greater structural complexity creates additional aquatic habitat. The additional aquatic habitat associated with CWD in rivers and lakes can be important for both fish and aquatic invertebrates.
	Create riparian habitat	Medium	Coarse woody debris (CWD) that is both in the water and the near stream area can improve riparian habitat by providing dead wood and additional habitat structure.
	Create terrestrial habitat	None	
Climate Alteration	Enhance precipitation	None	
	Reduce peak temperature	None	

	Absorb and/or retain CO_2	None	

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	None	
	Fish stocks and recruiting	High	Coarse woody debris can contribute to fish stock and recruiting by providing additional aquatic habitat and habitat complexity. This habitat may be very important both for the survival of young fish and additional food sources for fish.
	Natural biomass production	None	
Regulatory and Maintenance	Biodiversity preservation	High	By providing additional habitat and increased habitat complexity, coarse woody debris can be an important contributor to biodiversity preservation in small streams.
	Climate change adaptation and mitigation	None	
	Groundwater / aquifer recharge	None	
	Flood risk reduction	Medium	There is a potential for flood risk reduction with coarse woody debris (CWD). As CWD reduces height of flood peak in smaller streams (see Wenzel et al. 2014), it can reduce flow velocity across larger landscapes, thereby contributing to a reduction in downstream flood risk.
	Erosion / sediment control	Low	Through increased sediment accumulation, there may be some potential for control of sediment transport with coarse woody debris (CWD).
	Filtration of pollutants	None	
Cultural	Recreational opportunities	Medium	The improved habitat and greater biodiversity may improve angling opportunities, thereby contributing to enhanced recreational opportunities.
	Aesthetic / cultural value	None	
Abiotic	Navigation	Negative	Coarse woody debris (CWD) may be a disservice to navigation under some circumstances. For instance, travel by boat on small waterways will be more difficult when there are large amounts of CWD in the stream.

	Geological resources	None	
	Energy production	None	

VII. Policy Objectives

Policy Objective		Rating	Evidence
Water Framework Directive			
Achieve Good Surface Water Status	Improving status of biological quality elements	Medium	Coarse woody debris (CWD) in headwaters has the potential to improve Water Framework Directive biological quality elements in downstream waterbodies as it provides additional habitat and refuges in the small streams and water bodies used by juvenile fish.
	Improving status of physico-chemical quality elements	None	
	Improving status of hydromorphological quality elements	None	
	Improving chemical status and priority substances	None	
Achieve Good GW Status	Improved quantitative status	None	
	Improved chemical status	None	
Prevent Deterioration	Prevent surface water status deterioration	None	
	Prevent groundwater status deterioration	None	
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		Medium	Since coarse woody debris (CWD) can reduce peak flow velocity in small streams, it can be part of a package of measures to reduce flood risk. Reduced flow velocities also equate to greater water storage in the landscape. If there is enough CWD in streams across the landscape, the rate at which water is delivered to larger rivers will be slowed, potentially limiting downstream flood peaks.
Habitats and Birds Directives			
Protection of Important Habitats		Medium	Coarse woody debris (CWD) can contribute to maintenance of aquatic habitats, potentially supporting implementation of both the Birds and Habitats Directives.

2020 Biodiversity Strategy		
Better protection for ecosystems and more use of Green Infrastructure	Medium	Coarse woody debris (CWD) can be part of an areal green infrastructure for flood risk management as it can slow peak flow velocities in headwaters, thereby potentially reducing flood risk in downstream rivers. It may also be important for protection of aquatic and riparian ecosystems.
More sustainable agriculture and forestry	None	
Better management of fish stocks	Medium	The additional habitat provided by coarse woody debris (CWD) in streams can improve management of fish stocks and prevent aquatic biodiversity loss.
Prevention of biodiversity loss	Medium	

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	
Space required	There are no space requirements for this measure.
Location	Coarse woody debris (CWD) can be a feature in any watercourse but will probably have the highest water retention and biodiversity benefits in forest headwater streams.
Site and slope stability	There are no site or slope stability limitations associated with this measure
Soils and groundwater	
Pre-treatment requirements	
Synergies with Other Measures	Riparian forest buffers are a natural synergy for this measure as the trees when the trees in the riparian area fall into the stream, they will immediately become coarse woody debris.

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition		
Investigations & Studies		
Capital Costs		
Maintenance Costs		
Additional Costs		

X. Governance and Implementation

Requirement	Evidence

XI. Incentives supporting the financing of the NWRM

Type	Evidence

XII. References

Reference	Comments
Neary, Daniel G., George G. Ice, and C. Rhett Jackson. "Linkages between forest soils and water quality and quantity." *Forest Ecology and Management* 258.10 (2009): 2269-2281.	Good general reference on forest water issues
Kail, Jochem, et al. "The use of large wood in stream restoration: experiences from 50 projects in Germany and Austria." *Journal of Applied Ecology* 44.6 (2007): 1145-1155.	A meta analysis of experiences with hard and soft engineering using wood in German and Austrian streams
Wenzel, Robert, et al. "The potential of in-channel large woody debris in transforming discharge hydrographs in headwater areas (Ore Mountains, Southeastern Germany)." *Ecological Engineering* 71 (2014): 1-9.	Experimental study showing the slowdown in flood pulse associated with coarse woody debris
Robert E. Bilby and James W. Ward. 1991 . Characteristics and function of large woody debris in streams draining oldgrowth, clear-cut, and second-growth forests in southwestern Washington. Canadian Journal of Fisheries and Aquatic Sciences. 48: 2499-2508.	Reviews functions of CWD in different types of forests
Harmon M.E. et al. 1986. Ecology of coarse woody debris in temperate ecosystems. Advances in Ecological Research 15: 133-276	Comprehensive review on functions, formation and distribution of CWD in different ecosystems

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Robert E. Bilby and James 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(4): 368-378	Study on CWD characteristics and function in rivers of different size
Hirokazu Haga, Tomo'omi Kumagai, Kyoichi Otsuki, and Shigeru Ogawa. 2002. Transport and retention of coarse woody debris in mountain streams: An in situ field experiment of log transport and a field survey of coarse woody debris distribution. Water Resources Research 38 (8): 1-16	Study on transport patterns of CWD
J.B.Wallace, J.W. Grubaugh and M.R. Whiles. 1995. Influences of coarse woody debris on stream habitats and invertebrate biodiversity. In: D. A. Crossley, J. W. McMinn (Eds.) Biodiversity and Coarse Woody Debris in Southern Forests: Proceedings of the Workshop on Coarse Woody Debris in Southern Forests: Effects on Biodiversity, 119-129	Highlights importance of stream CWD for invertebrates