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Vegetation development following stream/river restoration: more natural fluvial dynamics and morphology, return of aquatic and riparian plant species?

M.B. Soons
Ecology & Biodiversity Group, Institute of Environmental Biology, Utrecht University, The Netherlands (m.b.soons@uu.nl)

After centuries of human interventions in stream/river dynamics and morphology aimed at optimizing landscapes for agricultural and industrial purposes, new insights have inspired water managers to try and combine stream and river ecosystem functions with the conservation of biodiversity. Around the world, aquatic and riparian species have declined strongly due to pollution, destruction and fragmentation of their habitat, so that biodiversity conservation initiatives primarily focus on habitat restoration. In the past decades many stream and river restoration projects have been carried out and often hydrological dynamics and morphology have been restored to a more natural state. However, the successful restoration of aquatic and riparian habitats very often failed to result in restoration of their biodiversity. This lack of success from a biodiversity conservation perspective is usually attributed to 'dispersal limitation', meaning that the habitat may be restored, but species fail to reach the site and re-colonize it.

Especially re-colonization by aquatic and riparian plant species is important, as such species function as ecosystem engineers: their presence alters fluvial dynamics and morphology, generates additional habitat heterogeneity and provides habitat and food for animal species. Following minor disturbances, re-colonization is often possible through locally remaining populations, by seeds in the seed bank or by surviving plant fragments. However, following major disturbances, colonization and establishment from other source populations are necessary. This usually occurs through dispersal of seeds (and in more aquatic species also by dispersal of vegetative fragments) into the restored wetland area. As dispersal occurs predominantly over short distances and source populations of aquatic and riparian species may be lacking in the surroundings, dispersal may be a limiting factor in the development of aquatic and riparian vegetation at a restored site. But, even if seeds have successfully dispersed into an area, local germination and establishment may also be limiting for the development of local biodiversity and/or for restoration success. However, we know surprisingly little about the crucial process of colonization.

This presentation focusses on colonization by aquatic and riparian plant species. I combine the results of several studies investigating dispersal, germination and establishment. A study on restored riparian zones along mountain streams shows that several years after restoration, the species composition at the restored sites shows signs of dispersal limitation: species with nearby source populations re-colonized successfully, but species without source populations in the immediate surroundings often remained absent. A detailed study on the re-colonization of a restored riparian zone along a lowland stream reveals that many species enter the site as seeds, but relatively few of these seeds are able to germinate and establish successfully, indicating that both a strong dispersal filter and a strong environmental filter control local vegetation development and hence stream dynamics and morphological developments. While the intensity of the disturbance of local conditions has a great impact on the role of the environmental filter, dispersal clearly remains a limiting factor in many situations.