Functions of Riparian Vegetation for Instream Ecology and Freshwater Fish Conservation

With the recent publication of The World's Forgotten Fishes[1], which highlighted that approximately 30% of freshwater fish are threatened with extinction and 80 known species have already been declared extinct, it is imperative that managers and custodians of freshwater resources consider actions that can improve the prognosis for freshwater fishes globally.

Restoring fish passage, natural flow regimes and riparian zones, controlling pest fish populations and point-source pollution, and improving regulation of inland fisheries are some of the approaches that can be used for improved sustainability of freshwater fishes. In this paper we consider the importance of riparian zones for freshwater fish and the functions riparian vegetation plays in regulating instream ecology.

Riparian vegetation can have a significant influence on aquatic ecosystem health via three main mechanisms or functions[2] :

- Mediating transfer of solar energy to aquatic ecosystems, which may in turn
    - minimise extreme seasonal and diel fluctuations in water temperature and associated water quality parameters (e.g. dissolved oxygen
    - create variability of thermal and light-based microhabitats, thereby enhancing biodiversity and promoting coexistence of closely related species
    - control basal metabolic rate of fishes and aquatic invertebrates (as they are cold blooded) and related physiological processes (e.g. immunity) and ontogenetic development (e.g. embryonic development, somatic and gametic growth, metamorphosis from larval to adult life stages)
    - intercept ultraviolet radiation that can otherwise be lethal to some fish larvae
    - promote growth of unicellular microalgae (high quality food resource for aquatic primary consumers) and limits growth of filamentous algae (which has low palatability to most aquatic fauna)
    - control the structure and extent of aquatic plant growth and associated positive habitat values or negative disturbance factors in cases where aquatic plants are invasive and / or prolific
- Baffling catchment runoff and mediating the transfer of inorganic material between terrestrial and aquatic ecosystems, such as:
    - protecting water quality by intercepting contaminants of terrestrial origin, including contaminants that are dissolved in overland flowing water or bound to sediments, with sediment also a contaminant in its own right (e.g. reduces water clarity, smothers benthic habitats)
    - providing bank protection from flood flows
    - increasing resilience and recovery from other disturbances, such as drought and fire

  - poviding bank stability (protection against slump erosion by deep rooted vegetation and protection against rill and gully erosion by shallow rooted vegetation)
- Mediating transfer of organic material between terrestrial and aquatic ecosystems, such:
  - as leaf litter (which is a significant source of organic carbon supporting aquatic food webs)
  - woody debris (which provides direct structural habitat and indirect habitat by influencing small-scale scour and deposition), and
  - trailing vegetation (such as insitu root masses, and herbaceous and graminoid roots and stems) that provides near-bank structural habitat and facilitates emergence by aquatic insects as they mature to adults (as well as providing access points for terrestrial predators of aquatic macroinvertebrates, such as spiders, that facilitates the transfer of energy from instream to riparian ecosystems).

These three broad functions of riparian vegetation directly, indirectly and cumulatively influence water quality, habitat quality and diversity, and trophic dynamics of aquatic ecosystems, which in turn influence the fitness of individuals, the diversity of species, and ultimately the composition of aquatic communities[3]. Together they determine the condition or health of an aquatic ecosystem, and the viability of local fish populations and communities.

Disturbances to aquatic ecosystems associated with degradation of riparian vegetation commence with relatively immediate pulse disturbances to water quality (e.g. disruption of thermal regime, increase inputs of terrestrial contaminants, disruption of light environment). They then continue over medium times scales as disturbances to natural trophic dynamics (e.g. reduced input of leaf litter, disrupted community metabolism) and finally over longer time scales with disturbances such as impacted habitat structure (e.g. proliferation of aquatic plants and / or weeds, bank failure and resultant sedimentation and loss of undercut banks, loss of large woody debris, and loss of individual fitness of aquatic organisms).

The scale over which riparian vegetation performs these functions is varied and many functions are also dependent on the landscape context. Consequently, there is no universal guideline accepted by the scientific community regarding the necessary width of a riparian zone for protecting instream aquatic ecological processes[4], although mediating the transfer of solar energy and organic material is likely a proximal function of the riparian zone (i.e. effected within tens of meters of the top bank), with proximal riparian vegetation also being typically denser than distal vegetation[5]. Minimizing the perimeter to area ratio of linear riparian areas is likely to have some ecological benefits for adjacent aquatic environments, providing that the width of the riparian zone is above a 'critical minimum'. This critical minimum riparian width is thought to be 30 – 200 m[6], with factors such as catchment size, channel width and stream order influencing the site-specific riparian width that should be adopted (i.e. larger catchment, channel width and / or stream order = wider riparian width)[7]. In some cases pragmatics factors may over-ride optimal riparian width for instream ecology, however restoring more length of riparian zone along a river frontage is likely to confer much greater ecological benefits for in-stream ecology than a wide but short riparian zone.

Existing riparian vegetation, when dominated by plant species that are native to the area, should be protected via appropriate environmental strategies and land use planning schemes (e.g. exclude development within a certain distance from waterways) and excluding stock access as much as practical. Restoration of riparian vegetation with plant species that are native to the area, using a range of shallow and deep rooted, ground stratum and canopy, species could be implemented in areas where riparian vegetation has been historically cleared. While a strategic approach towards riparian restoration would confer the greatest benefits (e.g. target erosion hotspots within the catchment), in many cases a pragmatic approach will be required, and this is a better management approach than to do nothing.

Protection and restoration of riparian vegetation is only one of a number of environmental management actions that need be taken to improve the prognosis for threatened freshwater fishes globally. Restoration of riparian vegetation is a relatively simple undertaking in most cases, and one where local communities can be actively involved in helping secure a future for freshwater fishes in their local waterways

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Brisbane Office and Laboratory:
PO Box 2363
Wellington Point Qld 4160

Sunshine Coast Office:
PO Box 392
Maroochydore Qld 4558