Repairing longitudinal connectivity: what to do at the site and in the catchment

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Strategy 1. Assist the in-stream movement of water and biota

Suitability of strategy: most appropriate where aquatic biota require high rates of dispersal for ongoing persistence, and where there are important small, isolated populations of biota. Particularly recommended where a desired native aquatic animal is present downstream, but missing from the site due to barriers or poor functional connectivity between the restoration site and the site where the species is present.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
1a. Daylight or remove piped streams	Small streams in urban areas are typically piped or paved over, removing connectivity between the top of the stream network and lower reaches.	Where small headwater streams have been piped. Where daylighting is not prohibited by urban constraints.	[1]	[2-4]
1b. Remove or modify artificial instream barriers (e.g. rock dams, weirs)	Barriers prevent the passage of fish and other biota. The removal of barriers or the creation of fishways improves the passage of fish and biota along the length of the river.	Where the barrier is large (i.e. weir, dam) such that it prevents movement year round – even during high flows. Where migratory or diadromous species exist (i.e. fish need to move between fresh water and the estuary/ ocean to complete their life cycle). Where diadromous species are present, the removal of barriers downstream in the river network is particularly important. Caution: barriers should not be removed if their absence will increase the spread of non-native invasive species.	[5-7, but see 8 as a caution]	See fishway manuals
1c. Minimise or retrofit road crossings (i.e. use flyovers, minimise roads crossings, use fish-friendly culverts)	Road crossings can reduce the dispersal of aquatic (fish) and semi-aquatic biota (insects, turtles); hence reduce the potential for these species to recolonise restored sites. Where possible, road flyovers should be used in place of normal roads. Planning for new developments should prevent roads from bisecting riparian corridors as much as possible.	For fish – where the road crossing culvert is non-fish friendly. For semi-aquatic biota - where the road crossings are upstream in the catchment – i.e. they are blocking dispersal from a relatively healthy peri urban population of insects. Where the road crossing prevents connection of a riparian corridor to a wetland or a large remnant parcel of bushland.	[6, 9-11]	See fishway manuals

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Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
1d. Repair stream baseflow See *Repairing flow: what to do in the catchment* factsheet, Strategy 5, for specific actions	Unnatural reductions in baseflow associated with urbanisation (e.g. Melbourne, and water extraction, strand fish in pools during low flow periods, reducing their dispersal capacity and increasing their risk of mortality. Unnatural rises in baseflow associated with urbanisation (e.g. south-east Perth) can turn intermittent streams permanent and make them susceptible to invasion by non-native species.	Where the urban change to baseflow is marked. Stream baseflow is easier to repair when the catchment is small because there is not as much land to retrofit with water sensitive urban design (WSUD). Similarly, sites with a catchment that has a relatively low percentage of imperviousness will be easier than those with a catchment that has a high percentage. Increasing baseflow may be difficult to achieve in a drying climate.	[12-15]	See associated factsheet
1e. Improve instream cover Repairing riparian function: what to do at the site factsheet, actions 5a–5c and 5e	Instream cover (e.g. logs, pools, macrophytes, overhanging vegetation) supports particular life stages of, and provides shelter for, dispersing or migrating species.	Where little instream cover exists. Where scouring urban flows have been repaired by catchment-scale stormwater management or by flow regulation via an instream structure (e.g. weir).	[16]	See *Repairing riparian function: what to do at the site* factsheet, actions 5a–5c and 5e
1f. Repair streamside vegetation	Streamside vegetation provides shading and structural cover that protects instream biota, such as fish, from aerial predators (i.e. birds).	Where the natural vegetation is tall (i.e. trees are present) and the stream channel is relatively narrow (< 10 m wide). Where there are aerial predators.	[17]	
1g. Cold-water release from base of dam or other infrastructure	Water temperature can limit the movement of fish along the length of a river. Cold-water releases from dams may be used to facilitate fish migration by reconnecting thermal refuges.	Where valued fish species have thermal limitations and are restricted to deep, cool water refuges, or where life history migrations (e.g. spawning migrations) are cued by temperature changes (e.g. Australian grayling). This action should be monitored and used with caution as it could have unintended negative consequences for biota or life stages that require warm water.	[18]	Little information available, but see [18] for a discussion of the pros and cons
1h. Attenuate or remove urban point-source pollution	Point source pollution that is discharged into an urban stream can cause a chemical (toxic) barrier to movement.	Where point-source industry discharges into the waterway and causes unnatural conditions (e.g.toxic chemicals, low oxygen, altered pH or conductivity, macrophyte overgrowth) that deter or prevent the passage of animals.		See best practice documents on industrial release into waterways

Strategy 2. Support the terrestrial movement of semi-aquatic biota

Suitability of strategy: most appropriate where the urban catchment is fragmented by roads and when semi-aquatic biota have large home ranges, use riparian vegetation as movement corridors and are not adapted to edge environments.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
2a. Connect riparian corridors	Fragmentation, or breaks, in riparian corridors associated with the loss of riparian vegetation prevent the longitudinal movement of semi-aquatic and terrestrial biota.	Where relatively few road crossings exist, such that reconnection of a corridor puts large unfragmented pieces of riparian land together (i.e. peri urban areas).	[6, 9-11]	
2b. Minimise or retrofit road crossings (i.e. use flyovers, minimise roads crossings)	As per action 1c this factsheet	As per action 1c this factsheet	As per action 1c this factsheet	As per action 1c this factsheet
2c. Increase buffer width	Increasing the width and density of riparian vegetation will create a better movement corridor for wildlife.	Where pre-existing space is available for buffer expansion (e.g. greenfield development).	[19]	[20]
2d. Increase the structural complexity of riparian vegetation	For riparian land to function as an effective wildlife corridor, it should contain vegetation that has enough structural complexity so that animals feel protected as they move through it.	Where the current vegetation is very sparse.		Little known, but see [20]

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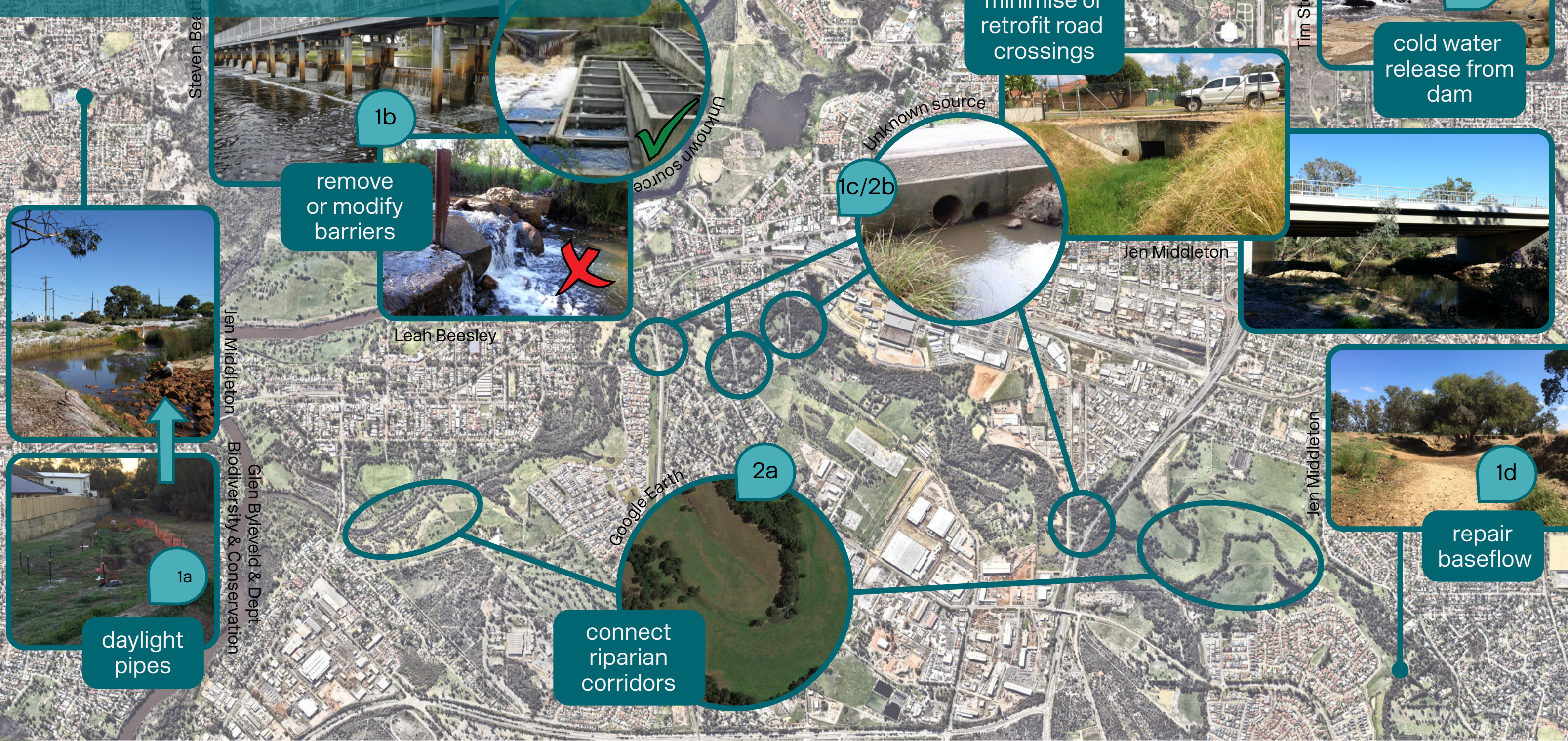
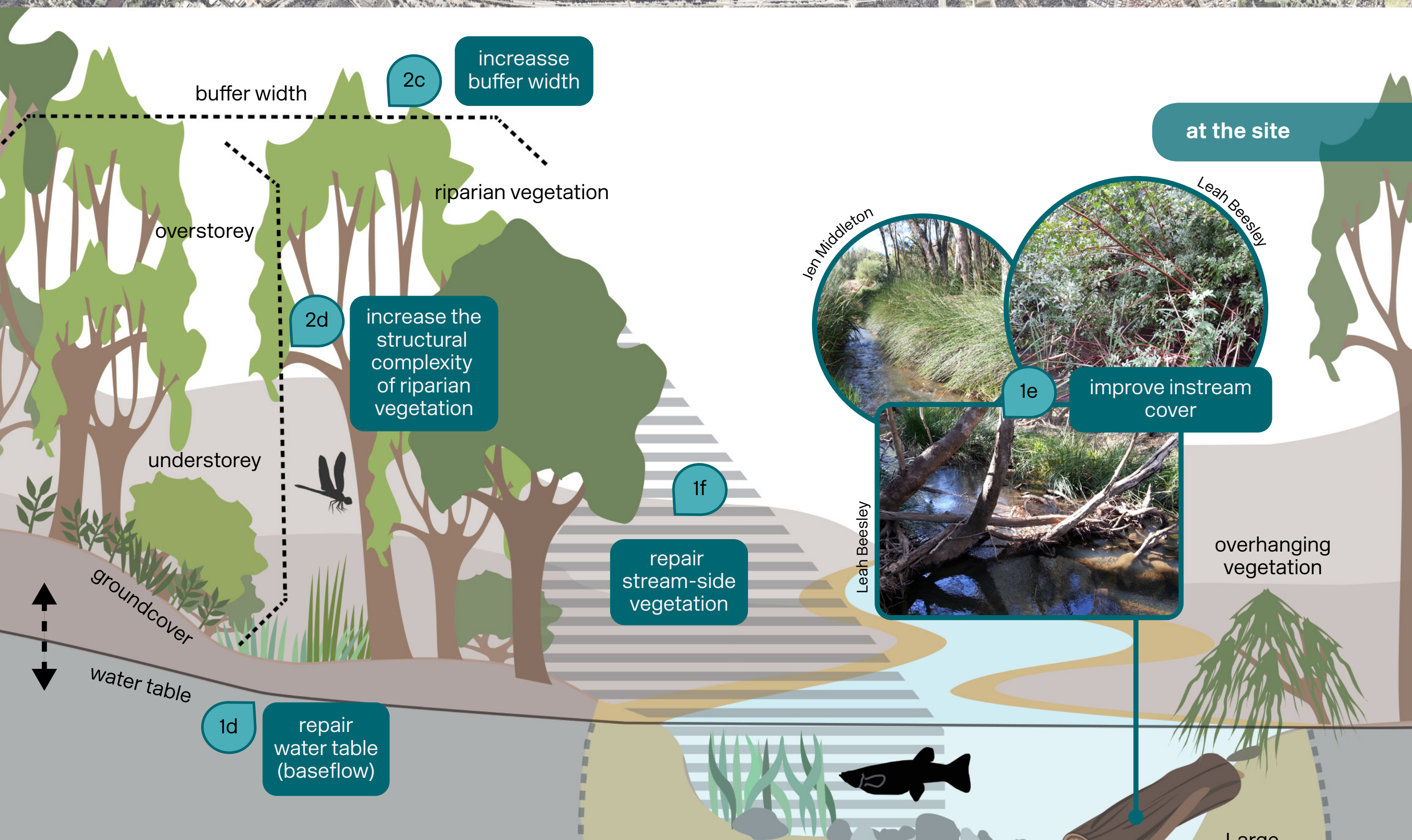
Strategy 1. Assist the instream movement of water and biota

Strategy 2. Assist the terrestrial movement of semi-aquatic biota





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