Repairing biota: what to do at the site

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CRC for Water Sensitive Cities

Strategy 1. Create/protect refuges from high and low flows within the site

Suitability of strategy: most sites, particularly sites where high, scouring urban flows are thought to the major stressor to native fauna. Less suitable at sites where pollution is very high and considered to be the major stresso.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
1a. Create/protect slow-flow habitats in the main channel and on the floodplain See *Repairing lateral connectivity: what to do at the site and in the catchment* factsheet, Strategies 1 and 2, all actions	Slow flow or stillwater habitats provide a place for mobile aquatic animals (e.g. fish, turtles, amphibians) to retreat to during high velocity urban flows in the main channel. Slow-flow habitats in the main channel include bays, backwaters, in-channel wetlands or islands. Slow-flow habitat on the floodplain include natural or constructed wetlands (could be biofilters), ponds/depressions, or secondary channels (e.g. anabranch) that only connect during high flows.	In-channel slow-flow features are suitable for most sites, as long as scouring urban flows are unlikely to destroy them. Floodplain slow-flow habitats are most suitable in mid order streams and lowland rivers where the floodplain is well developed. Where floodplain wetlands do not support high loads of chemical pollutants and pose a threat to biota (e.g. ecological traps). See *Repairing lateral connectivity* factsheet for the suitability of specific actions.	[1, 2]	See associated factsheets
1b. Create/protect the hyporheic zone See *Repairing vertical connectivity* factsheet, all strategies	Spaces between coarse substrate particles can provide refuge for bacteria, algae and invertebrates during high flows, as well as very low flows.	Where the substrate is highly porous (e.g. gravel, cobbles). Where porous substrate is unlikely to be filled with sediment. See *Repairing vertical connectivity* factsheet for the suitability of specific actions.	[3-8]	See associated factsheet
1c. Improve instream habitat complexity See *Repairing riparian function: what to do at the site* factsheet, actions 5a–f	Large woody debris (logs), macrophytes and other complex habitat can provide some protection from scouring urban flows.	Where catchment scale repair of flow has occurred. Where there is little complex habitat instream. See *Repairing riparian function: what to do at the site* factsheet, actions 5a–f, for the suitability of specific actions.	[9, 10]	See associated factsheet
1d. Create deep pools	Deep pools provide an aquatic refuge for larger bodied fauna, such as fish, during low flow periods.	For reaches that cease to flow and where larger-bodied fish species are present.	[11, 12]	

Strategy 2. Improve the quality of instream habitat

Suitability of strategy: suitable for most sites, except those facing ongoing habitat modification/degradation. Most likely to succeed where flow has been repaired at the catchment scale.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
2a. Repair flow See *Repairing flow: what to do at the site* and *Repairing flow: what to do in the catchment* factsheets, all strategies	The flow regime has a strong overarching effect on the survival and persistence of instream biota. In an urban setting, high-velocity scouring flows create a physical disturbance that stresses instream animals (e.g. invertebrates and fish are dislodged from their homes). Scouring flows also indirectly stress biota by disrupting food production/retention, reducing instream habitat complexity and increasing sedimentation. Severe low flow periods also exacerbate water quality stress to instream animals, and magnify predation and competitive interactions.	Most likely to be successful if flow has already been repaired at the catchment scale or if the site is downstream of a flow-regulating structure. See actions in the associated factsheet for specific advice.	[5, 13, 14]	See associated factsheet
2b. Repair geomorphic complexity See *Repairing geomorphology: what to do at the site and in the catchment* factsheet, all strategies	Geomorphic complexity (e.g. bars, benches, pools, riffles) affects the abundance and complexity of instream habitat available for biota.	Where the channel form has been markedly altered by urbanisation. Where flow has or is being repaired (unless the channel is going to be allowed to naturally adjust). See actions in the associated factsheets for specific advice.	[15]	See associated factsheets
2c. Repair water quality See *Repairing water quality: what to do at the site* and *Repairing water quality: what to do in the catchment* factsheet, all strategies	Poor water quality (e.g. high temperatures, high levels of toxic pollutants, low levels of oxygen) is a significant cause of mortality to instream life in urban waterways. Improving water quality so that it doesn't cross thresholds is critical for the protection of instream biota.	Where water quality poses a serious threat to species persistence – i.e. oxygen falls below 4 mg/L, particularly if it falls below 2 mg/L. Or if temperature or pH exceeds the tolerance of species. See actions in the associated factsheet for specific advice.	[1, 15-22]	See associated factsheet

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
2d. Repair leaf litter inputs See *Repairing riparian function: what to do at the site* factsheet, Strategy 4, all actions; and see *Repairing nutrients: what to do in the catchment* factsheet, all strategies	Leaf litter underpins the food web of many flowing waterways. Increasing the input and retention of leaf litter is therefore important to the return/ persistence of many animals, particularly shredder invertebrate species. It is important to recognise that high nutrient levels can undermine the food web of streams because they accelerate the breakdown of leaves - reducing the amount of food available for macroinvertebrates.	Where the food web is supported by terrestrial litter – typically streams that are narrow (< 10 m wide). Where the stream would naturally have been forested. Where riparian vegetation has been largely cleared. See actions in the associated factsheets for specific advice.	[23-26]	See associated factsheets
2e. Repair aquatic habitat See *Repairing riparian function: what to do at the site* factsheet, Strategy 5, all actions	Macrophytes and logs are important habitat for many animals, providing places to hide and a stable substrate on which to live for some invertebrates. Reinstating complex habitat is important for the recovery of biota.	Where instream habitat complexity has been severely simplified by urbanisation. This action is unlikely to succeed unless scouring urban flows have already been repaired. See actions in the associated factsheet for specific advice.	[2, 14, 15, 27]	See associated factsheet
2f. Ensure the habitat requirements for all life history stages of valued species are present at the site	Some urban restoration efforts have failed to recover biota because restored sites do not contain appropriate habitat to allow species to complete their life history. For example, sites may not recover certain insect species because they are missing suitable habitat for oviposition (e.g. boulders or logs that extend into and out of the water). Alternatively, intermittent waterways may not support certain species (e.g. frogs) if the hydroperiod is not sufficient to allow larval survival and metamorphosis.	Suitable where the biota of management interest can complete their life history within the site (e.g. semi-aquatic insects). Not appropriate for species of fish that need to migrate for breeding.	[28-31]	
2g. Ensure that the banks of the waterway have a gentle slope	Urban waterways should have gentle slopes, at least in some areas, so that semi-aquatic animals such as frogs and turtles can easily leave the waterway. Steeply sloped waterways may become ecological traps for some biota.	Where the waterway is channelized or canalised.	[32]	

Strategy 3. Reduce negative interactions with non-native species

Suitability of strategy: where non-native species are present and are invasive. Not appropriate for highly novel sites where native species are unlikely to survive.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
3a. Control non-native species by removal or exclusion	The removal or exclusion of non-native species that are highly aggressive or are habitat modifiers (e.g. common carp, mosquito fish, redfin perch, pearl cichlid, dogs, cats, foxes) can improve the survival of sensitive species. Removal can occur via physical or chemical means. Fences can be used to exclude non-native predators from riparian habitat.	Removal should be attempted where aggressive non-native species are present but have recently invaded (i.e. low abundance), or at relatively isolated sites (e.g. certain floodplain wetlands) where recolonisation of the non-native species is unlikely. Removal should not occur if it puts other valued biota at risk. Exclusion via instream barriers (e.g. weirs) should be used if the invasive species is not yet at the site. Fences are suitable for most sites but can compromise human amenity.	[27, 33, 34]	[34-36]
3b. Increase the complexity of instream habitat	Complex instream habitat creates places for vulnerable species and individuals to hide – reducing their interaction with aggressive non-native species and increasing their ability to persist in the long-term. See actions 2e and 2f this factsheet for specific actions.	Where instream habitat complexity has been severely simplified by urbanisation. This action is unlikely to succeed unless scouring urban flows have already been repaired.		
3c. Repair baseflow See *Repairing flow: what to do in the catchment* factsheet, Strategy 5, actions a–h where baseflow has fallen, actions i–p where it has risen	Falling baseflow will reduce water depth during low-flow periods and exacerbate negative interactions with non-native species. Rising baseflow will facilitate the invasion of non-native species into previously intermittent river reaches where they would normally not survive.	Falling baseflow – where pools undergo severe contraction during low flow periods. Rising baseflow – where the site naturally had an intermittent flow. See associated factsheet for suitability various actions to repair baseflow given conditions in the catchment.	[12, 37]	See associated factsheet

Strategy 4. Translocate fauna

Suitability of strategy: most suitable for sites in small streams, less suitable for lowland rivers. Only likely to succeed where flow, geomorphology, water quality and riparian ecosystem components have already been repaired to some extent, such that translocated animals are likely to survive. Unlikely to suceed if invasive competitors or predators are present.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
4a. Translocate fauna	In highly fragmented urban environments natural recolonisation may not be possible. In these instances, managers should consider translocating healthy individuals from nearby refuge sites. Urban wetlands – natural or newly created – can also be used as arks for native species of conservation risk, but should be treated with caution.	Where the species of management interest has very low recolonisation potential (e.g. mussels, crustaceans, gastropods as opposed to fish or semi-aquatic insects) or where the fragmented urban fabric makes colonisation very difficult (e.g. frogs, fish, turtles). Where translocation does not pose a disease risk or a threat to genetic diversity.	[38-41]	See state and federal translocation guidelines

Strategy 5. Protect from fire

Suitability of strategy: suitable for most sites.

Action	Explanation	Conditions where action is most likely to be suitable andeffective	Other references recommending action	Guidelines for implementation
5a. Protect from fire	Fire in the riparian zone of a restoration site will exacerbate the stresses to biota caused by urbanisation, and should therefore be prevented whenever possible.	All sites.	[42]	

Supporting documents

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Strategy 2. Improve the quality of instream habitat

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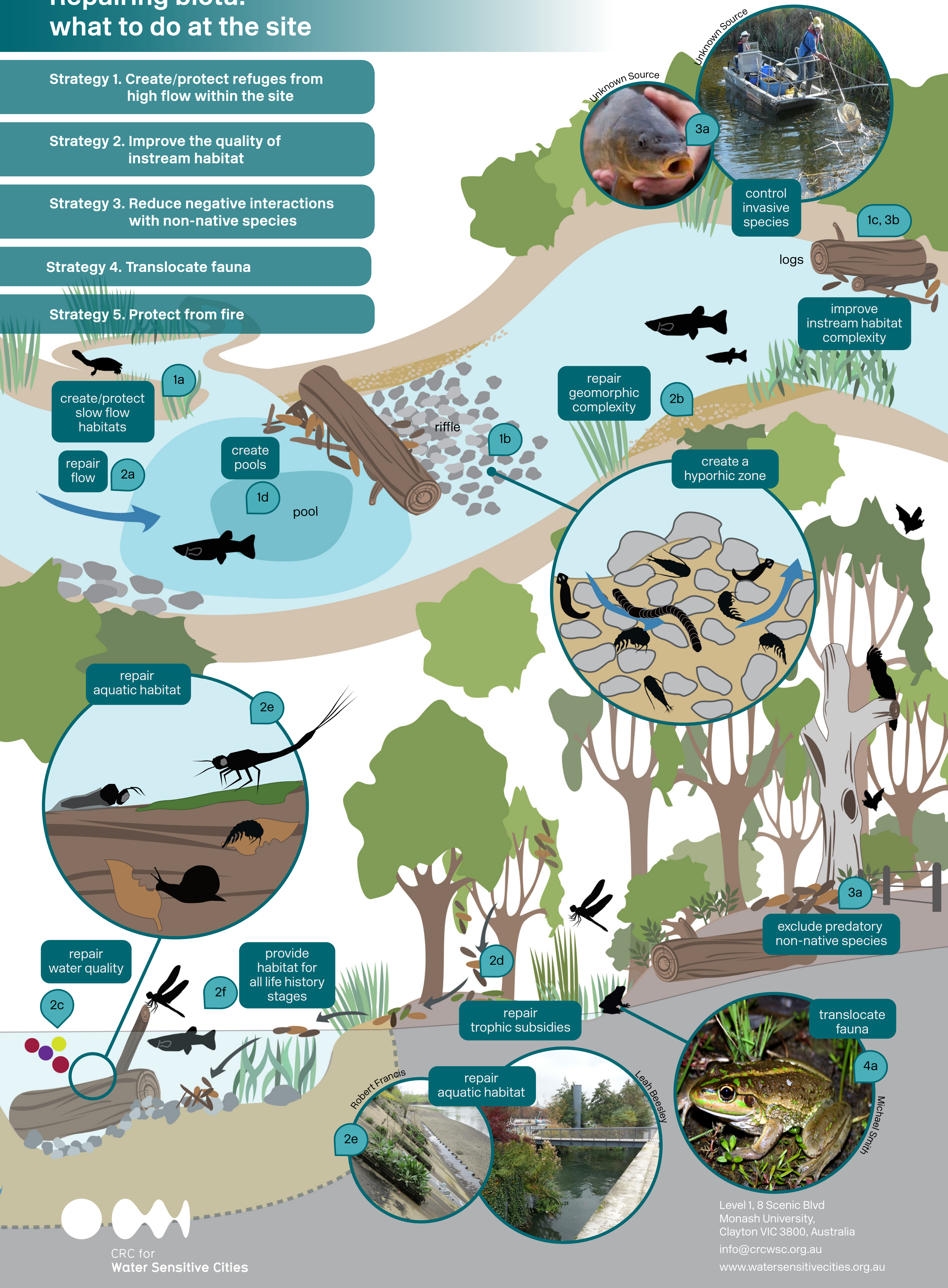
Strategy 4. Translocate fauna

Strategy 5. Protect from fire



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