RESTORE PEDDER FACT SHEET

Aquatic fauna and fauna habitat

TASMANIA
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Coordinated by
Lake Pedder Restoration Inc.
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The acidic, darkly coloured and humic waters of the Lake Pedder/Lake Maria wetland system were understood to support a distinctive suite of aquatic fauna communities including zooplankton, crustaceans, molluscs, insects, flat worms and segmented worms. Some of these species were believed to have disappeared due to changes in habitat and introduction of predators; some have subsequently been re-discovered. Subsequent searches have also uncovered newly discovered or previously undescribed species.

We know that changes in habitat and introduction of predator species after damming has impacted native fish species and resulted in the localised extinction of the Pedder Galaxias and the decline of populations of the Swamp Galaxias. Without specific measures to reduce brown trout numbers, these fish species are very unlikely to return to the previous population levels.

Evidence from international dam restoration projects show that de-watering the Huon-Serpentine Impoundment would result in significant changes to the types and amount of fauna habitat available. After an initial silt-dominated phase, the movement of water would increase the pools and riffles in new or old drainage lines and streams and wetlands would establish. The restoration would reinstate the diversity of still and flowing waters and associated habitats for fauna.

Following dewatering, the hydrology and physical habitats of Lake Pedder are likely to be similar, though not identical, to the pre-flooded state and the geomorphological and water runoff processes and rates will differ until vegetation cover establishes. In the longer term, ground and surface water patterns and the geomorphology may be different to what existed previously, but the dominant processes are expected to be similar.

Aquatic fauna

The surveys of aquatic fauna of the original Lake Pedder were limited before flooding, however, groups of scientists have made subsequent observations that indicate that flooding to create the Huon – Serpentine Impoundment significantly altered the type and amount of fauna habitat. For the native galaxiid fishes, these modifications included alterations to spawning and feeding habitat as well as changes to species interactions such as competition and predation. Brown Trout (*Salmo trutta*) invaded the new Lake Pedder impoundment from the Huon River catchment, while the Climbing Galaxias (*Galaxias brevipinnis*) invaded from the Serpentine River.

The ecosystem changes resulted in the near extinction of the Pedder Galaxias (*Galaxias pedderensis*) and a reduction in the numbers and distribution Swamp Galaxias (*Galaxias parvus*).

Image: J. Patil IFS

The Pedder Galaxias was originally only recorded in Lake Pedder and the inflowing streams and it is now considered extinct in the wild and endangered. The species survives in two translocated populations outside its original range, one at Lake Oberon and one at a modified water supply dam near Strathgordon; fish are breeding successfully at both locations. However, re-introduction of this species into a restored Lake Pedder would be unlikely to result in self-sustaining populations unless specific measures were taken to reduce predator and competitor species – particularly the exotic Brown Trout and the native Climbing Galaxias. Given this species' known preference for rock and boulder habitat, any re-introduction would need to ensure there was sufficient suitable spawning habitat present; this habitat may only develop after a few months to years following dewatering.

The Swamp Galaxias populations declined due to predation and competition from introduced fish species and direct physical loss of habitat by inundation of the swamps and lower reaches of streams preferred by this species. Fortunately, two self-maintaining populations have survived despite the presence of Trout and Climbing Galaxias since Lake Pedder was flooded but the risk of ongoing and increased threats are significant, and this species is listed as vulnerable (IUCN Red List).

The potential recovery of populations of the two endemic galaxiids into a restored Lake Pedder would be unlikely unless specific measures to address the key threats to galaxiids in Tasmania: namely, exotic species, hydrological manipulations, restricted distributions, general habitat degradation and exploitation of stocks. Specifically, measures to reduce the impacts of predator and competitor species – particularly the exotic Brown Trout and the native Climbing Galaxias require consideration.

The original lake and wetland systems also supported a diverse range of fauna including zooplankton, crustaceans, molluscs, insects, flat worms and segmented worms. Some of these species were believed to have disappeared due to changes in habitat and introduction of predators; some have subsequently been re-discovered.

Despite the restoration of physical habitat following dam removal, due to the introduction of predator species and other species that compete for space and food, populations of the two native Galaxias fish are unlikely to recover to pre-damming levels.

The status of species believed to be endemic and occurring only in the original lake and wetland systems is detailed below.

Fauna species	Scientific name	Previous status	Current Status	Threatened?
Lake Pedder Planarian	*Romankenkius pedderensis*	Endemic to Lake Pedder area, considered extinct since 1986	Specimens collected in 2006 and ongoing existence confirmed in 2012	Listed as Critically Endangered (IUCN Red List)
Lake Pedder Caddisfly	*Taskiropsyche lacustris*	1965 survey - endemic to Lake Pedder area on sandy bottom of shallow waters of eastern shore	2000 survey collected a single Lake Pedder caddisfly from a small stream near Gordon Road	Endangered (*Tasmanian Threatened Species Protection Act 1995*)
McCubbins Caddisfly	*Taskiria mccubbini*	1965 survey - endemic to Lake Pedder area on sandy bottom of shallow waters of eastern shore	2000 survey collected two McCubbins caddisflies on the shore of the Huon-Serpentine Impoundment	Endangered (*Tasmanian Threatened Species Protection Act 1995*)

Whilst not occurring exclusively in Lake Pedder, the system was also considered important habitat for other aquatic fauna species. These include a tubifex worm (*Telmatodrilus pectinatus*); three crustaceans including the copepod (*Calamoecia australis*) and two mountain shrimps (*Alanaspides helonomus* and *Allanaspides hickmani*); three insects including the water bug (*Diaprepocoris pedderensis*) and caddisflies (*Archeophylax vernalis* and *Westriplectes pedderensis*) and a freshwater snail (*Glacidorbis pedderi*). These species are believed to still occur in the impoundment.

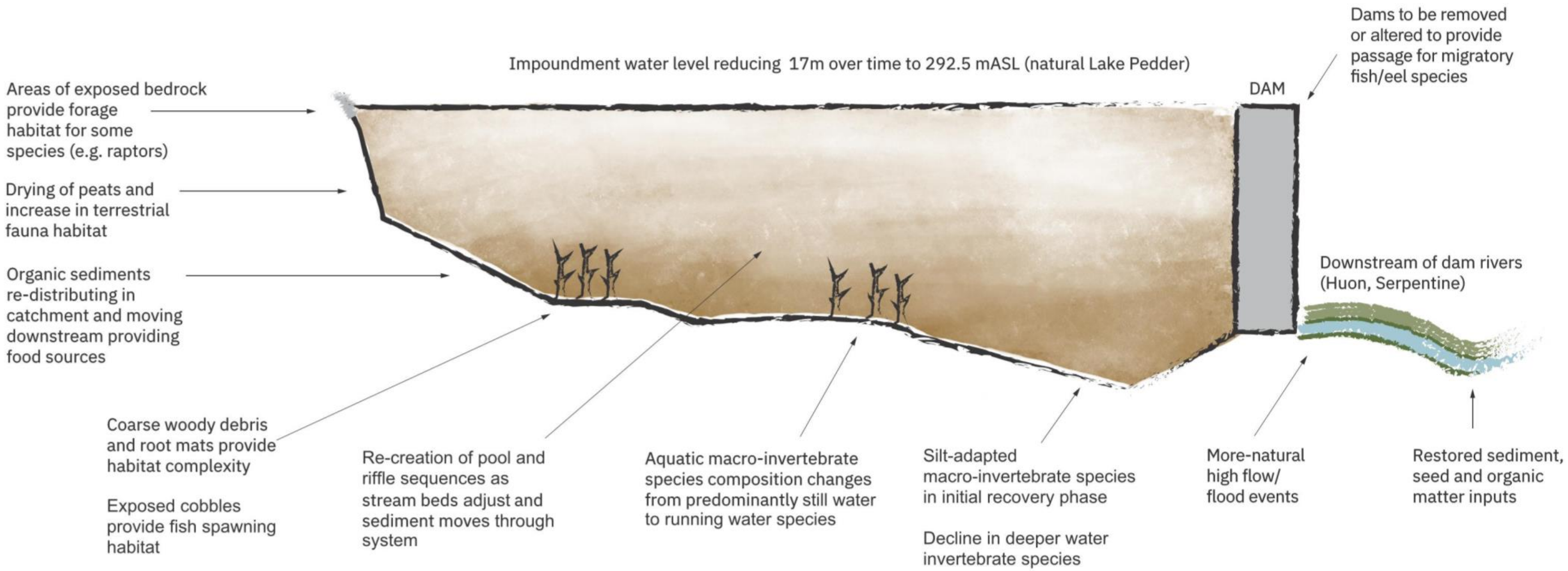
Surveys in the 70s and 80s also found that some of the animals of the distinctive sand-dwelling ‘psammon’ fauna community which lived in the shallow waters over the fine white quartzite sand of the original beach have survived; given the beach exists, this is likely to remain a suitable habitat for some of the original inhabitants.

Subsequent surveys of the Huon-Serpentine Impoundment have identified two new species of freshwater isopods (*Colubotelson pedderensis* and *Colubotelson edgarensis*), a freshwater sponge (*Radiospongilla pedderensis*) and a parasitic wasp (*Trichomalopsis sisyrae*) with a life history strongly associated with the freshwater sponge.

Potential habitat restoration from dam removal

One of the desired outcomes of dam decommissioning and removal is the recovery of aquatic and riparian ecosystems over time. Evidence from dam removal from rivers in the United States has shown many benefits to aquatic fauna by restoring fish passage, enabling access and connectivity to historical habitats. This in turn can provide a multitude of benefits to native fish communities including increases in species richness and life-history diversity. Documented long-term ecosystem benefits include restored access to historical habitat for aquatic organisms, more natural flow levels and rates and water temperature and a gradual return to more natural and nutrient cycling and restored sediment transport and debris loading. It should be noted that in the case of Lake Pedder, not all the sediment will flush through the system because the original Lake was lower than both of the dams; however, it is anticipated that much of the sediment will move downstream or be transferred into the Lake Gordon if an inter-basin transfer is undertaken for restoration.

The most significant benefits to aquatic fauna will be related to the restoration of a diversity of habitats from small channels to streams, rivers, wetlands and the peat moorlands. The rate of restoration of these habitats is not known and will vary between different areas and depend on the establishment of vegetation and the rainfall over the restoration period, however, experience elsewhere has shown that adjustments in macro-invertebrate fauna communities can be rapid, occurring within months.


Impoundment water level reducing 17m over time to 292.5 mASL (natural Lake Pedder)
Dams to be removed or altered to provide passage for migratory fish/eel species
DAM
Areas of exposed bedrock provide forage habitat for some species (e.g. raptors)
Drying of peats and increase in terrestrial fauna habitat
Organic sediments re-distributing in catchment and moving downstream providing food sources
Downstream of dam rivers (Huon, Serpentine)
Coarse woody debris and root mats provide habitat complexity
Exposed cobbles provide fish spawning habitat
Re-creation of pool and riffle sequences as stream beds adjust and sediment moves through system
Aquatic macro-invertebrate species composition changes from predominantly still water to running water species
Silt-adapted macro-invertebrate species in initial recovery phase
Decline in deeper water invertebrate species
More-natural high flow/ flood events
Restored sediment, seed and organic matter inputs

Evidence of changes and restoration of dominant processes

Studies of dam removals have shown that the sediment erosion and changes in channels and water flows alter the environment from one that favours pelagic fauna that live in the water column of still (lentic) waters to an environment that favours bottom dwelling, benthic fauna and running (lotic) water. The two following diagrams are adaptations from conceptual models developed by a group of aquatic scientists who have reviewed the information from dam removal case studies and ecological theory to better understand the processes following dam removal.

These diagrams show that the impacts of dam removal change over time from the initial state where sediments are moving throughout the system and many ecosystem adjustments are occurring to a more-stable transition and dominance of natural processes.

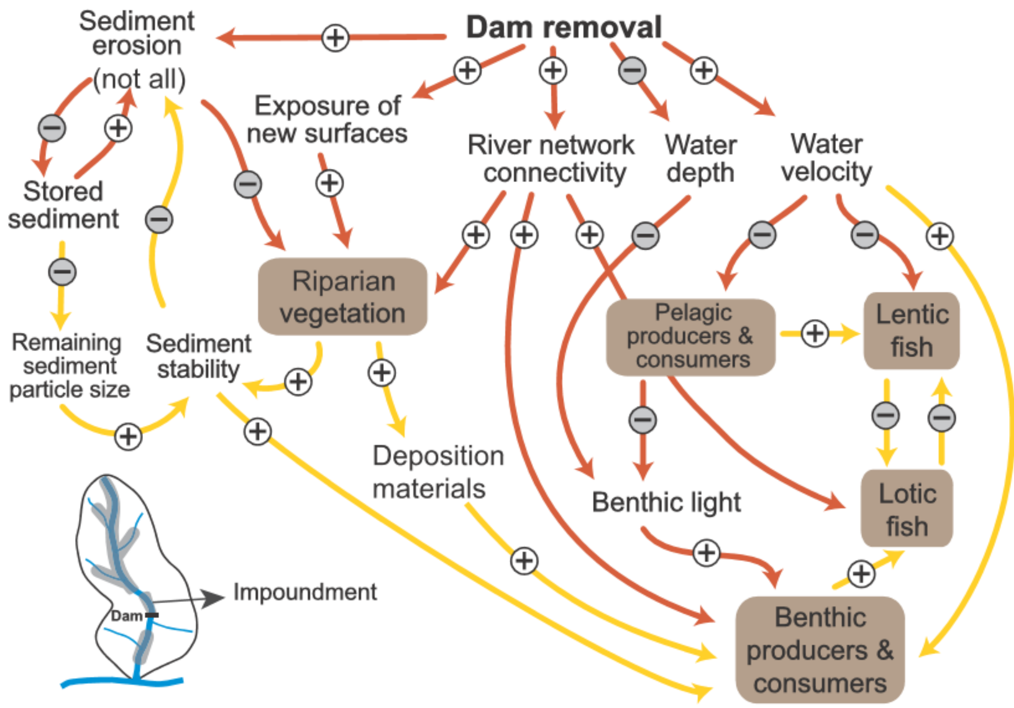
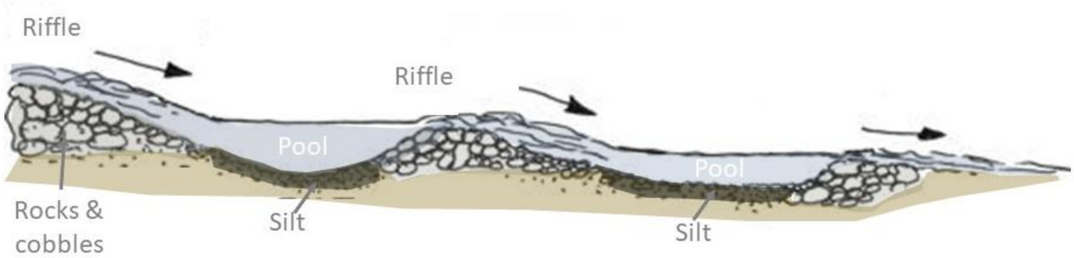


Diagram showing the cause-and-effect links and feedback loops associated with dam removal for former impoundment areas (adapted from Bellmore *et al.*).

The arrows indicate the direction of influence, and the plus and minus signs indicate whether the influence is positive or negative. The timescale of the causal links that control responses at short time scales (hours to years) are shown in orange and longer time scales (years to decades) are shown in yellow.

Re-establishment of pool and riffle sequences

It is well known that dams and weirs generally reduce riffles and gravel substrates in the still-water bodies they create. These features are important habitats for many fauna and aquatic flora species, creating a diversity of habitats and niches for different species and multiple studies of dam removal indicate that riffle habitat development can be an important mechanism to restore sensitive species and biological diversity following dam removal.



Studies following dam removal have shown that water channels and associated pool and riffle sequences reform as the natural water flow and sediment transfer processes are reinstated. Riffles are shallow sections of streams or rivers with rapid currents and are important habitats for macroinvertebrate and fish and often support higher densities of macroinvertebrates than other habitats. Riffles increase water turbulence and oxygen concentration, providing important micro-habitat variability in the depth, flow velocity and substrates for aquatic macroinvertebrates. Thus, riffles also provide good feeding areas for insectivorous fish and platypuses. Gravel areas are also particularly important spawning areas for the native Galaxias.

Geomorphic and sediment processes – meanders and sinuous small streams

Restoration to the original Lake Pedder will also restore natural channel formation processes including channel bed scour and sediment transport, all of which are important to the re-establishment of physical fauna habitat and cycling of nutrients. Studies at nearby Gelignite Creek off Scotts Peak Road have shown that the fluvial geomorphology[1] processes in these landscapes sometimes show unusual features such as having many shallow, small streams that are very sinuous, hence the name of the Serpentine River and the organic soils can also act as barriers to water infiltration and movement in some circumstances.

Whilst these landscape processes may be unusual in some respects, the basic processes are likely to be similar to those documented in dam removal in the United States and conceptual models like that shown below indicate the stages of channel restoration.

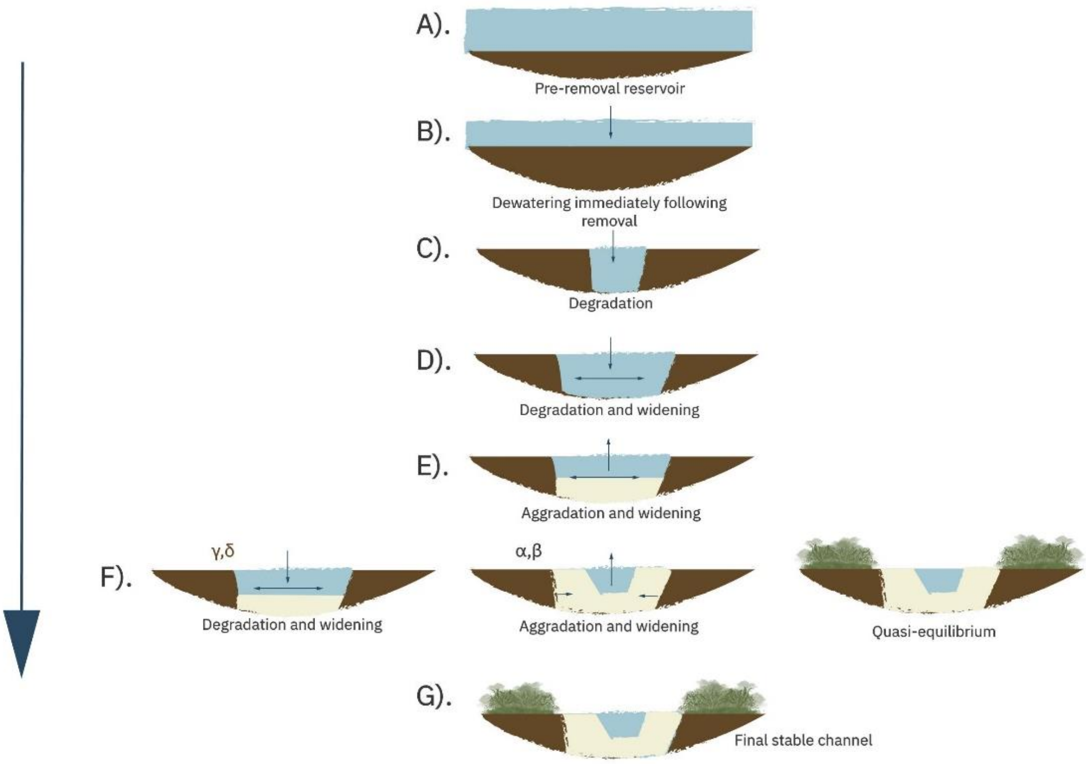


Image adapted from Cannatelli 2012

[1] Fluvial geomorphology is the study of the interactions between the physical shapes of rivers, their water and sediment transport processes, and the landforms.

Downstream effects

The initial peak in downstream transport of the sediment currently stored in reservoir deposits is anticipated to affect downstream habitats as suspended sediment, bedload and nutrients. Studies following dam removal in the United States have shown that these impacts will decrease over time as more-natural sediment cycling is reinstated and impacts are diluted.

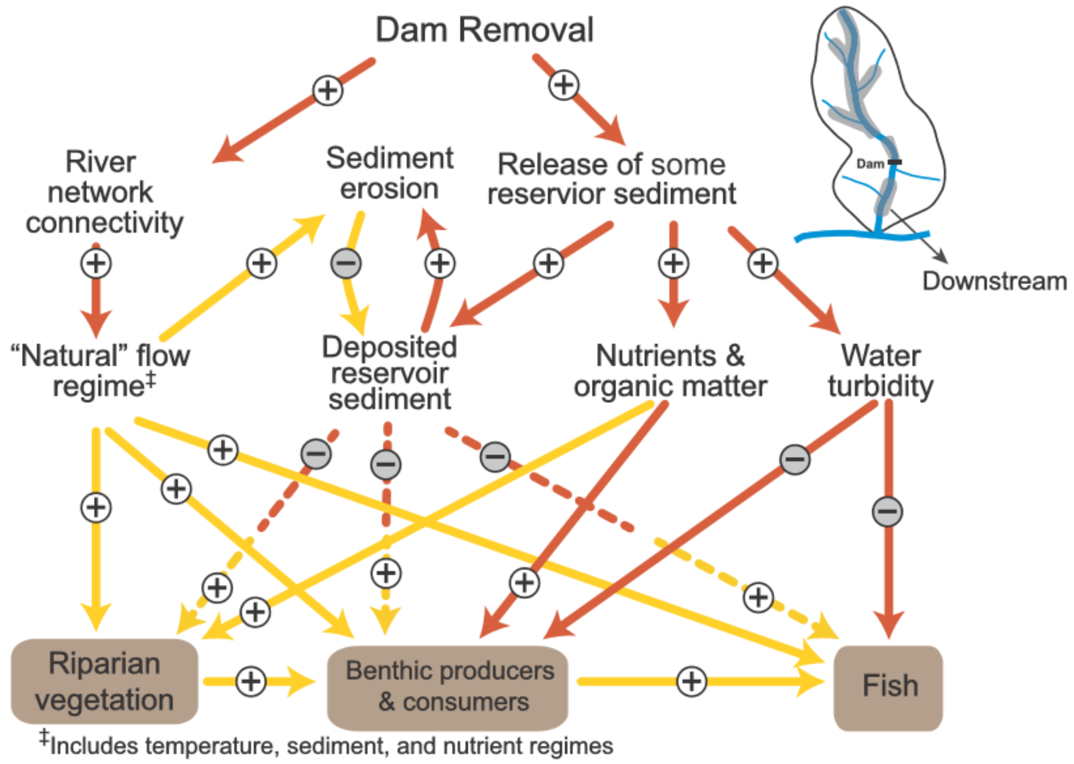


Diagram showing the cause-and-effect links and feedback loops associated with dam removal for downstream rivers (adapted from Bellmore *et al.*).

The arrows indicate the direction of influence, and the plus and minus signs indicate whether the influence is positive or negative. The timescale of the causal links that control responses at short time scales (hours to years) are shown in orange and longer time scales (years to decades) are shown in yellow.

The biological effects of mobile suspended sediments can initially be detrimental and may impact fish and eels in many ways including gill abrasion and clogging, decreased foraging efficiency. The subsequent deposition of suspended sediments has been documented to potentially impact spawning grounds by smothering eggs or impeding inter-gravel flow that may affect egg and fry development and emergence due to gravel clogging. Fine sediment deposition in slower off-channel habitats may also block connectivity between some off-channel habitats such as mainstem side channels which can be important habitats for juvenile fish rearing and spawning.

The initial release of reservoir sediments has also been shown in some United States dam removals to temporarily result in depressed dissolved oxygen concentrations in the water; this can impact the biological community in the affected reach. Depressed levels of dissolved oxygen are caused by high organic concentration of the reservoir sediments getting broken down by microbial communities. Whilst the cool waters of the Huon-Serpentine Impoundment have relatively high levels of dissolved oxygen and this scenario is unlikely, it should be noted and subject to further investigation.

Dam removal elsewhere has been found to improve water temperature conditions and creating patches of cooler water that could be used as temperature refugia by fish during summer and autumn. However, these changes in temperature also need to be weighed and considered with the impacts of too much cool water creating a thermal shock in downstream rivers and 'shandying' the water to moderate the temperature differences are a useful technique to achieve this.

Longer term, restoration is likely to improve downstream habitats to more-natural flow patterns and restore the sediment and nutrient inputs

How quickly should the impoundment be de-watered to minimise potential risks to aquatic fauna?

The optimum rate of dewatering varies greatly between the various environmental factors and what may be best for one factor, may not be the best for others. The rate could also be varied at different stages in the process to manage specific risks based on the shape and bank slopes of the impoundment.

Assuming a constant rate of dewatering, the following diagram shows the optimum rate of dewatering from the minimum practical time of 100 days to a nominal 24 months with shading to show the impact on various components. Green represents the optimal or preferred rate with the highest chance of meeting aim, orange represents sub-optimal rate with less certainty of meeting the aim and red represents the highest risk rate with the lowest likelihood of meeting the aim.

Whilst fauna species are mobile and often capable of moving to adapt to different habitat types, strandings of fish and other species have occurred in cases of rapid de-watering and hydrological studies would need to determine the balance between more-rapid dewatering to protect peat surfaces and slower dewatering to reduce risks to fauna.

A relatively rapid rate of vegetation recovery, especially around the small streams, would also be critical for aquatic fauna species to reduce the risk of thermal stress, provide shade cover and help in the restoration of foraging and spawning habitats. Active revegetation of riparian areas may be considered as a priority to speed up habitat stabilisation and shading for platypuses in the new environment created by the dewatering.

Component	Risk mitigation aim	100 days	6 mths	12 mths	24 mths
Aquatic fauna	Allowing retreat/movement of aquatic fauna				
Natural channel formation processes	Allow natural fluvial geomorphology processes to occur and shape channels (have a slower drawn down to reduce flow velocity)				
Provide favourable substrate conditions	Maximise safe sites for seedling establishment				
Shading of channels and stabilisation of banks	Maximise natural vegetation regeneration and expansion				
Provide favourable substrate conditions	Minimise desiccation and subsequent oxidation of peat				

There is much we don't know, and further studies could reduce these uncertainties to better plan restoration

The following additional studies are recommended to increase the reliability of conclusions about the effects of restoration on the aquatic fauna in the Huon-Serpentine Impoundment:

- undertake comprehensive sampling of the current fauna of the Lake to better understand the fauna distributions and population numbers
- assess the availability (extent and distribution) of various required habitat types likely over different time frames for fish.
- determine the structure of the food web and the likely response of changes in density and abundance of macro-invertebrate species and potential responses as predator numbers concentrate during dewatering (stable Isotope analysis)
- develop models of sediment dynamics and spatial patterns of deposition and understand potential sediment deposit areas
- investigate the level and duration of flushing flows required to carry sediments and result in channel formation in the most optimal way for diverse fauna habitats
- determine the maximum rate and duration of flow release to mitigate potential impacts of depressed dissolved oxygen and cool water release to minimise potential impacts on downstream fauna ('shandying' water).

Further Reading – fauna habitat processes

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Further Reading – fauna species

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