Developing a Recirculating Propagation System at the Species Recovery Centre

December 2025 - January 2026
The Freshwater Biological Association (FBA), based on the shores of Windermere.

Background

This case study will describe a recent development to freshwater pearl mussel propagation at the Species Recovery Centre (SRC). The method has been developed based upon our experience with the captive breeding program at the SRC, but there are a range of methods which facilities can employ based on their infrastructure and resources. The information here may be of use or interest to practitioners working on similar projects.

Currently, the process of collecting juvenile freshwater pearl mussels at the SRC is time consuming. The drop-off (excystment) period can span several months and involves a labour intensive, meticulous collection process. This excystment period is protracted for two reasons:
1) We have females which release at different times, sometimes differing by as much as 6 weeks (so glochidia mature at different times)
2) In some populations, juveniles begin drop-off during winter when growth and development/maturity slow. This means it takes longer for glochidia to reach the mature juvenile stage and start excysting, increasing the width of the peak drop-off period.

Propagation projects for *M. margaritifera* in Europe routinely keep mussels in close contact with host fish until the females release glochidia. In captivity, this does not appear to be a highly synchronous event as outlined by Young and Williams (1984); rather it can take up to several weeks for all the females in a population to release glochidia (FBA, unpublished data). This results in a large size range of glochidia on host fish, contributing to the problem of a protracted excystment period. It is however possible to manipulate when and how juveniles are collected through a method called ‘accelerated excystment’.

‘Accelerated excystment’ is an approach designed to maximise the number and quality of juveniles collected from infested host fish. Once all female mussels in a population have released glochidia, encysted fish should be kept at an elevated temperature compared to natural conditions; this will shorten the time glochidia spend on the gills of host fish and achieve a more synchronous drop-off event. In our systems, fish feeding ceases or reduces significantly immediately before excystment in order to avoid production and subsequent collection of fish faeces. Juveniles are collected from a clean system over a relatively short period of time (weeks rather than months). This strategy is commonly used in the USA (Patterson *et al.*, 2018) in species which have a short parasitic stage on host fish species. The method is used on Margaritiferids at the Alabama Aquatic Biodiversity Center with *Margaritifera marrianae* and *M. falcata*. A slightly modified method is also used by other *M. margaritifera* breeding programmes in the UK (J. Taylor, Wales & B. Strachan and R. Bond, England, pers. comm.), by waiting until spring to warm up encysted fish.

Whilst this method would likely benefit all populations held at the FBA Ark, it is of particular importance for populations that experience a steady decline in the number of encysted glochidia over time, so that low numbers continue to drop-off throughout late spring. This method facilitates cleaner, easier collection of juveniles over a shorter period.

Case study

What we did

The system was adapted from Barnhart (2003). The Recirculating Propagation System (RPS) was devised to hold fish in groups of several hundred and to recover juveniles continuously from a recirculating flow of water. Fish can be held in the RPS during the entire encystment period, or they can be moved to the RPS shortly before drop-off occurs. The juveniles can be recovered easily using a plankton net with attached collection bottle.

The basic RPS unit (Figure 1) consists of a conical-bottomed 950 litre tank to contain the fish, a sump containing a biological filter to maintain water quality, a plankton net to recover juveniles from the tank and a pump and associated plumbing to recirculate the water. One unit is currently in use at the FBA (Figure 2).

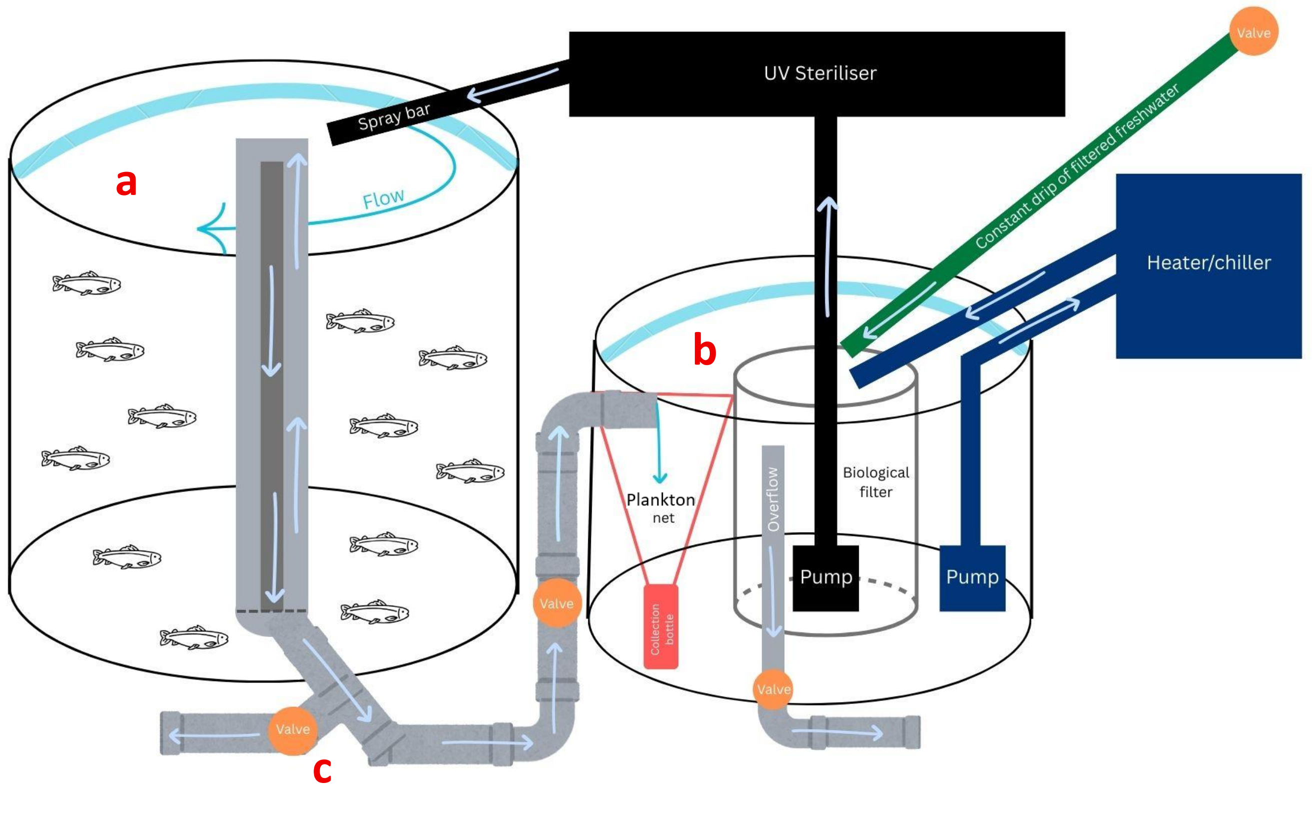

***Figure 1**. A diagram of the Recirculating Propagation System. Water flows from a tank containing encysted fish (a), into a sump tank (b) through a plankton net to recover juveniles. The fish tank has two central pipes, one inside the other. The larger outer pipe has slits at the bottom through which the water is suctioned, flows upwards, then down the smaller central pipe to the sump. This smaller central pipe controls the water level in the tank and can be lifted to flush the system. Water in the sump is pumped into a heater/chiller to control the temperature. Water then passes through a biological filter and is pumped into a UV steriliser, before returning to the fish tank through a spray bar. Blue arrows show direction of flow. Water can be emptied out the system through the valve at (c).*

Figure 2. *The recirculating propagation system in situ at the FBA's Species Recovery Centre.*

Farmed brown trout (*Salmo trutta*) parr (~ 8 g) were checked for encystment and 100 placed into the RPS, where the water temperature is matched to what the fish are currently experiencing in their normal holding tanks. Temperature was increased by 1 - 2°C daily until reaching 17°C. This gradual increase ensures minimal stress for the fish. This temperature is also close to the thermal tolerance of trout and matches temperatures for optimal growth of juvenile mussels in initial rearing systems (Lavictoire et al., 2016).

Fish were maintained on a minimal diet of commercial pellets, 1% of body weight per day. This minimises fish faeces collected in the juvenile recovery nets. Water quality parameters of ammonia, nitrites and nitrates were regularly monitored and partial water changes carried out when necessary. A continuous slow trickle of filtered lake water (15µm) was added to improve water quality, with an overflow installed in the sump to maintain water levels. The slow flow did not have any impact on water temperature of the RPS. The juvenile recovery net was checked daily and sprayed down to transfer juveniles into the collection bottle. Juveniles were processed, counted and added to heated aquarium systems (Lavictoire et al., 2016) for growing on.

Outcomes

- The RPS was completed in December 2025 and used through January 2026.
- More than 8,000 juveniles were collected from 100 relatively poorly encysted fish (approx. 10 - 100 glochidia on each host fish).
- Whilst not currently quantified, the percentage of glochidia/inviable/dead juveniles appeared lower than those observed in outdoor flow through collections.
- The condition of juveniles appeared greater than those in outdoor flow through collections, with individuals being more active and a better colour than when collected from colder temperatures (~6°C).
- The cleanliness of the collections was improved compared to outdoor flow-through collections, reducing the time taken to sort through collections.

Learning

- The RPS can produce large numbers of juvenile mussels from a relatively small number of fish.
- Essential design elements for juvenile mussel recovery include:
  - Temperature - elevated temperature will increase the rate of juvenile excystment.
  - Self-cleaning fish tank - flows at the base of the tank appear to efficiently entrain juvenile mussels which are subsequently recovered in the collection net.
  - Net cleaning - the collection net must be kept clean to avoid clogging and prevent juveniles (and debris) being lost into the sump. Using a pressurised sprayer regularly ensures juveniles are flushed into the collection net bottle for collection.
- Brown trout, as a pelagic species, are a suitable species to maintain in an RPS. At least 100 fish can be maintained in the FBA's system. However, filtration must be adequate to maintain water quality. Regular water testing for ammonia, nitrites and nitrates, must be conducted to monitor water quality, and water changes must be reactive to test results. A continuous slow turnover of water is an efficient way to maintain good water quality.
- Whilst species propagated in the USA can be efficiently collected within a relatively short time period (< 1 month), freshwater pearl mussels have an extended encystment period of > 1 month even within an RPS. Fish health and survival must be prioritised, including continuous feeding, during this time. This however will result in dirtier nets which should be collected daily to facilitate more efficient collection of newly excysted juvenile mussels.

References

Barnhart, M.C. (2003). *Culture and Restoration of Mussel Species of Concern*. Report to the Missouri Department of Conservation and US Fish and Wildlife Service, Columbia, MO, USA. 10.13140/2.1.4465.6967

Lavictoire, L., Moorkens, E., Ramsey, A.D., Sinclair, W. and Sweeting, R.A. (2016). Effects of substrate size and cleaning regime on growth and survival of captive-bred juvenile freshwater pearl mussels, *Margaritifera margaritifera* (Linnaeus, 1758). *Hydrobiologia*, **766**, pp.89-102.

Patterson, M.A., Mair, R.A., Eckert, N.L., Gatenby, C.M., Brady, T., Jones, J.W., Simmons, B.R., and Devers, J.L. (2018). *Freshwater Mussel Propagation for Restoration*. Cambridge University Press.

Young, M. and Williams, J. (1984). The reproductive biology of the freshwater pearl mussel *Margaritifera margaritifera* (Linn.) in Scotland I. Field studies. *Archiv für Hydrobiologie* **99**, 405-422.

Contact us

www.r4everkent.co.uk | hello@r4everkent.co.uk | Facebook LIFE R4everKent | Instagram @LIFE_R4everkent | X @LIFER4everKent