

South Esk – Great Lake Water Management Review

Scientific Report on the Trevallyn Elver Passage

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TREVALLYN ELVER PASSAGE

1. ASSESSMENT OF ISSUES AND STATUS

Assessment of fish passage at Trevallyn Dam was initiated following the Environmental Review and Community Consultation stages of the South Esk – Great Lake Water Management Review. There is an existing elver ladder on Trevallyn Dam, however the effectiveness of this ladder has been questioned.

Development History

The Trevallyn power scheme was commissioned in 1955 after a five-year construction period. It consists of a single 33 m high dam on the lower reaches of the South Esk River and an associated hydro-electric power station which takes water from this storage via a 3.2 km headrace tunnel and discharges directly to the Tamar Estuary (Figure 1). The river downstream of the dam flows through Cataract Gorge for a distance of 6.5 km before also discharging into the Tamar Estuary. Although most water is diverted from the dam through the power station, large flood-flows overtop the spillway and continue to flow down Cataract Gorge. In addition, a continuous riparian release of 0.43 m³/s is maintained in Cataract Gorge via a low-level release valve on the dam.

The Trevallyn power station has four Francis turbines giving maximum power generating capacity of 83.6 MW at a discharge of about 80 m³/s. This station is generally operated as a step-load station to take up fluctuations in Tasmanian electricity demand. This results in a variable water discharge regime at the tailrace, which results in variable flow velocities and water chemistry, but has minimal impact on water levels in the Tamar Estuary, where water levels are mainly determined by tidal conditions. During periods when inflow to the lake exceed the capacity of the power station, excess water flows through Cataract Gorge. At this time, the power station is generally operated at 'full gate' and serves to provide base-load electricity with minimal short-term variation in discharge.

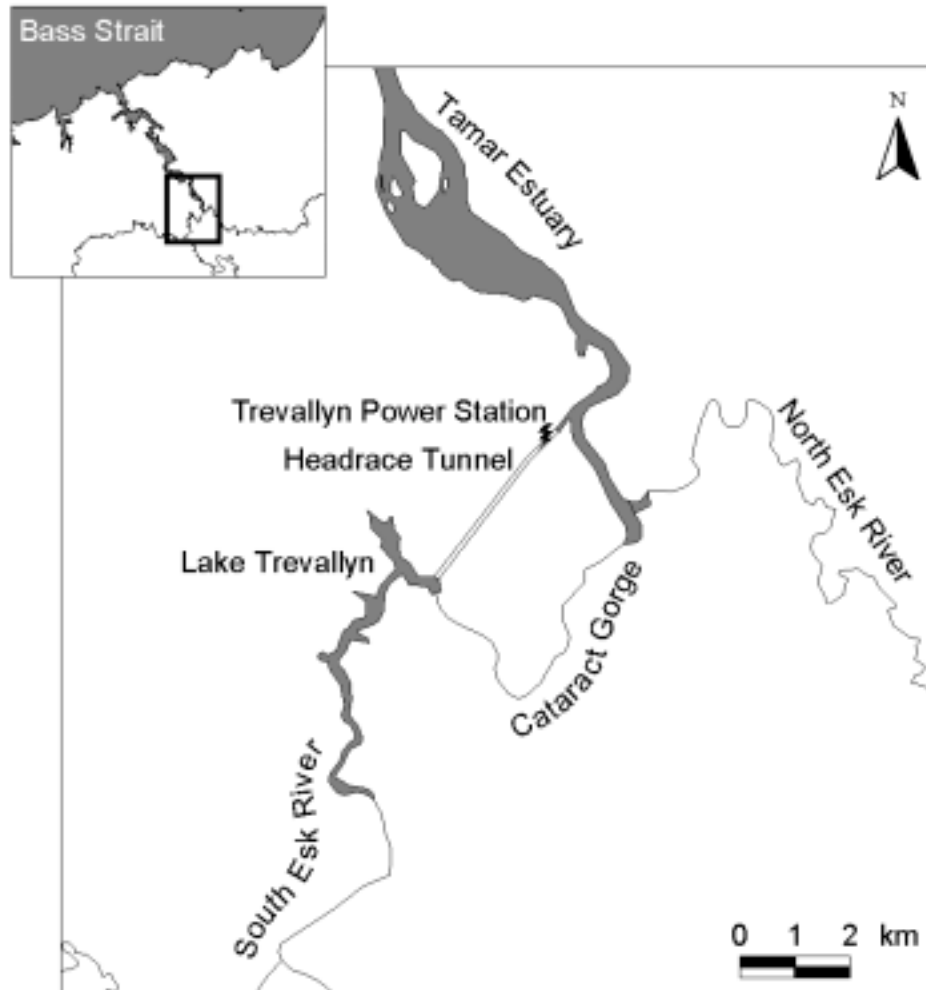


Figure 1: General layout of the Trevallyn power scheme

Biological Background

Two species of diadromous eels are found in Tasmania. The short-finned eel (*Anguilla australis*) is by far the most common and is found in all the major catchments in Tasmania, whilst the long-finned eel (*A. reinhardtii*) appears to be restricted to the north-east drainages including the Tamar estuary catchment, but typically makes up less than 1 % of the elver population at this location.

The life-cycle for both species is now reasonably well understood. In terms of upstream migrations, the leptocephalli larvae metamorphose into glass eels over the continental shelf, are carried southward by the East Australian Current where they move inshore and invade estuarine waters from the sea. These invasions are facilitated by tidal movement, using flood tides and mainly occur at night. The glass eels are generally sedentary during their first year in estuarine or fresh water during which time they develop into pigmented elvers. The elver migration into freshwater therefore comprises of individuals that have been resident in the estuary for up to a year.

The greatest concentrations of elvers are recorded in the lower reaches of waterways, and as elvers make their way steadily upstream, their numbers become reduced by mortality and by diversion into tributaries, or other suitable habitat.

The elver run in the Tamar River typically commences in early November and continues through to late March. The number of elvers undertaking annual migrations in Tasmanian rivers is very large. The largest harvest of elvers occurs at Trevallyn power station tailrace, where it is estimated that between 3 and 6 million elvers are caught each year (Inland Fisheries Service, 2002, pers. comm.).

It is difficult to isolate the specific environmental factors that trigger elver runs. Day length, water temperatures, river flow and social interaction between elvers may all be contributing factors. At the Trevallyn power scheme, periods of reduced water temperatures (less than 10 °C) appear to inhibit the elver migration.

Upstream Migration Issues

The influence of Altered Freshwater Flows

Glass eels are attracted to the Tamar Estuary by freshwater flows originating from the South and North Esk Rivers. In 1964 water that naturally flowed from Great Lake south to the Derwent River was re-directed northwards via the Poatina power station to the South Esk catchment eventually flowing into the Trevallyn Dam storage (Lake Trevallyn) to be utilised by the Trevallyn power station. The average monthly flow diverted from the Derwent to the South Esk catchment varies between 6 and 40 m³/s depending on season. It is assumed, although probably impossible to quantify, that this additional water would attract more glass eels and elvers to the Tamar Estuary than may previously have occurred. Consequently, the regional influence of the Trevallyn power scheme is likely to assume an even greater significance to Tasmanian eel stocks than before this diversion.

Once in the estuary, elvers are attracted to three major flow sources: the North Esk River, the South Esk River and the Trevallyn power station (Figure 1). The North Esk River is not developed for hydro-electric power but is subject to various other water uses such as irrigation and town water supply. The South Esk River is highly regulated by the Trevallyn Dam, which captures most river flows for power generation. The diversion of freshwater flows out of Cataract Gorge and into the Tamar Estuary results in an attractive flow at the power station tailrace that effectively truncates the upstream elver migration. It is not known what proportions of elvers entering the estuary are attracted to the tailrace; however, it is considered to be significant.

Invasion of the Trevallyn power station and Trevallyn Dam structure

A proportion of elvers attracted to the tailrace make their way up the tailrace and into the power station itself. The elvers congregate in the stop-log pits and follow any seepage or other water sources within the power station. The elvers can pose a safety hazard for workers in the station due to the risk of slipping on invading elvers, however, the most pressing issue from a human perspective is the smell caused by dying elvers. While attempts to remove the elvers from inside the power station are undertaken, most perish in hard to access recesses or are spread such that removal exercises are inefficient.

At Trevallyn Dam, pipes directing seepage within the dam to the downstream face encourage migrating elvers into the dam galleries. The volume of water attracting these elvers is generally very low, however, the outlets are located near favoured elver congregation areas and the constant flow allows elvers to find the water source and enter the dam itself. Inside the dam there are various walkways with

gutters to direct drainage. These gutters are colonised by tens of kilograms of elvers at a time, which would eventually perish if not for the occasional efforts of Inland Fisheries Service and Hydro Tasmania staff.

Physical Barriers

There are no insurmountable barriers to elver migration through Cataract Gorge downstream of Trevallyn Dam. The dam itself, however, is impassable and acts as the prime hindrance in the upstream migration of elvers and other fish to the South Esk catchment. The release of a small riparian flow from the base of the dam, provides sufficient flow in Cataract Gorge to enable some wetted areas of the river channel to be maintained at all times, although it is not known to what degree if any, the elvers are susceptible to exaggerated predation by birds in shallow or constricted areas.

Stranding

Elvers that do find their way up Cataract Gorge eventually congregate in the plunge pool immediately downstream of the dam. During spill flows, a much larger proportion of the stream bed downstream is inundated including several large rock pools. As the dam comes off spill, these rock pools are isolated and in the absence of further flow, water quality deteriorates to the point that any elvers that have moved into these areas cannot survive. One rock pool at the base of the spillway, appears to attract large numbers of elvers, and is one such area that has been identified. It is not known to what extent this phenomenon occurs in other parts of the Gorge downstream, although it is assumed that the stranding issues near the spillway are larger than elsewhere.

Downstream Migration Issues

Comparatively little is known about the downstream migration of adult eels in Tasmania. Passage of eels downstream past Trevallyn Dam can only be achieved during spill conditions, or possibly through the riparian release valve, although this is considered unlikely. The only other pathway to the estuary is via the turbines of the Trevallyn power station. Table 1 shows that during the downstream migration months of December to June the dam was spilling on average 7 % of the time. It is not known what proportion of migrating eels utilise these spill events.

Historically, a commercial eel trap was operated in Cataract Gorge (at Deadmans Hollow) that targeted downstream migrations during dam spill events. It is not known whether records of these catches have been kept and no analysis of timing or relationship to environmental variables has been made. The trap is now abandoned, presumably due to low catch rates.

Month	% of days that dam was spilling	Mean discharge during spill events (m ³ /s)	Mean monthly discharge in Cataract Gorge (m ³ /s)
Jan	9.7	44.6	4.7
Feb	4.4	13.3	1.0
Mar	2.4	26.0	1.1
Apr	0.0	0.0	0.4
May	9.2	77.9	7.7
Jun	21.3	39.7	9.3
Jul	27.7	121.7	35.0
Aug	46.5	129.2	62.7
Sep	50.0	114.6	58.3
Oct	38.1	56.7	22.0
Nov	1.6	42.5	2.3
Dec	2.4	6.9	0.6

Table 1: Trevallyn Dam spill and Cataract Gorge flow statistics for 1996-2000

A series of fyke nets are presently utilised by a commercial fisher in Lake Trevallyn to capture adult eels. One of the nets is usually set in the lake near the power station intake and is known to have high catch rates. Although these catches are recorded, these data have not been analysed to date. Relatively common anecdotal reports of dead adult eels at the Trevallyn power station tailrace confirm that at least some eels do try to negotiate the turbines on their downstream migration. The death of these eels would either be caused by the rapid decompression as a result of the 112 m head difference, or by direct contact with the turbines.

Elver Ladder Issues

A study during 1999 - 2000 confirmed anecdotal reports that the elver ladder at Trevallyn Dam was not performing as expected. It was found that elvers were not attracted in any significant numbers into the elver ladder itself, nor were the elvers that did enter the ladder successful in negotiating it to its upstream end.

During the review of its effectiveness, it was found that there were several improvements that could be made to facilitate more effective passage of elvers over the dam. The issues that were highlighted by this review are briefly presented below.

Entrance Location

The present location of the elver ladder entrance is on the right river bank (facing downstream) approximately 35 m downstream of the base of the dam wall. The ladder entrance is exposed to the 0.43 m³/s riparian release, which was initially thought to be a good elver attractant. The bed of the river is quite deep in this area and is scoured down to bedrock by spill flows. Consequently, the entrance to the ladder is located over deep water with moderate to high water velocities and there is little cover in the form of broken substrate. In addition, the volume of the riparian release overwhelms the small water jets that spray from the elver ladder as an attracting flow. It is concluded therefore, that the location of the entrance to the elver ladder is sub-optimal.

Slope of the Ladder

The slope of the elver ladder is not considered to be an impediment alone, however the gravel substrate glued to the inside of the pipe is thought to have washed off in places (particularly likely in the steeper sections of the pipe where the water velocity would be greatest). The smooth pipe would be difficult for elvers to negotiate.

Substrate Inside the Ladder

Through several years of operation, it appears that the gravel substrate that had been glued within the pipe-work is gradually washing away, such that sections of the inside of the pipe are not lined and only offer a bare metallic surface for the elvers to climb. This may not be an issue for the shallower sections of pipe, as water velocities are likely to be reasonably low. For the steeper sections of pipe (where the potential to wash away the substrate is greatest), this is likely to be a major issue as the water velocity would form a flow barrier and the smooth metallic surface would offer little grip. The loss of the substrate will also have exposed the bare metal, which is galvanised, and international studies have since shown that eels have an aversion to zinc.

Temperature

The present elver ladder is fully exposed to the sun during the warmer elver migration months. In some sections the pipe is mounted over large expanses of concrete with a high albedo. A series of water and air temperature probes logged variations in temperature over the length of the ladder. It was found that water temperatures up to 30 °C were consistently reached in the upper, most exposed, sections of the ladder. It was considered that although these temperatures would not be lethal, they may act as a deterrent to passage of elvers through the top sections of the ladder.

Water Flows Inside the Ladder

The water flows inside the ladder are controlled by a pump located within the dam and two small delivery pipes that run inside the elver ladder pipe-work. One of the pipes directs water from the top of the ladder towards the entrance and the other is used to flush elvers from the apex of the ladder down the vertical section that completes their journey to the upstream impoundment. There is a possibility that the portion of the ladder between the downstream facing and upstream facing jets is dry. This would compound the temperature problem discussed above, but could act as a barrier in its own right.

Elver Translocation

The Inland Fisheries Service has been conducting an extensive relocation program for elvers captured at the Trevallyn power station tailrace as well as Meadowbank Dam on the Derwent River. The elvers from the Trevallyn tailrace site are caught in fine-meshed fyke nets and transported via large tanks to upstream waters including Lake Trevallyn. This is a labour intensive program that involves night time trapping over most of the warmer months and significant cartage.

It is assumed that this has been effective in maintaining eel numbers in upstream waters although it is likely that recruitment is a fraction of natural rates. A Fisheries

Research and Development Corporation grant being jointly administered by the Inland Fisheries Service and Hydro Tasmania has been investigating the effectiveness of the elver-restocking program in Hydro Tasmania waterways. A report on the results of these studies is presently being finalised.

2. FORMULATION OF STUDY OBJECTIVES

- Assess fish utilisation of the South Esk River below Lake Trevallyn under current flow regimes.
- Assess the ecological and occupational health and safety implications of elver invasion of the Trevallyn power station
- Investigate methods to improve elver passage over Trevallyn Dam
- Finalisation of the joint Hydro Tasmania/Inland Fisheries Service Fisheries Research and Development Corporation study to investigate the impact of hydro dams on Tasmanian eels stocks.

3. DATA COLLECTION AND ANALYSIS

Fish Community in Cataract Gorge

A preliminary assessment of fish utilisation of the South Esk River below Trevallyn Dam was undertaken using electrofishing surveys conducted in June and November 2001. Six sites located between the Cataract Gorge and the dam were sampled during each site visit. The results of these surveys indicated that a diverse range of fish species utilise the river, particularly the downstream sites. Sandys (*Pseudaphritus urvillii*), Jollytails (*Galaxias maculatus*), Spotted galaxias (*Galaxias truttaceus*), shortfinned eels (*Anguilla australis*), a single long finned eel (*Anguilla reinhardtii*), blackfish (*Gadopsis marmoratus*), pouched lampreys (*Geotria australis*), redbfin perch (*Perca fluviatilis*), tench (*Tinca tinca*) and brown trout (*Salmo trutta*) were collected during the surveys. With the exception of the long finned eel, the native fish captured during the surveys are typically found in the downstream low altitude reaches of Tasmania's river systems. The surveys also indicated that the river supports a significant number of exotic fish species.

The elver incursion issue at Trevallyn power station was investigated during a site visit in February 2003. Although elvers were observed in the stop log pits, a team leader at the power station stated that elver incursions do not pose any significant problems to day-to-day operations at the site.

As was discussed earlier in this document, a study conducted during 1999 - 2000 by the Inland Fisheries Service confirmed that the elver ladder was largely ineffective in facilitating passage over Trevallyn dam. Factors such as elvers' aversion to zinc and therefore the galvanised piping used in the ladder, excessive heating of the ladder due to sun exposure and sub-optimal positioning of the ladders entrance have contributed to its ineffectiveness. Elvers currently enter the dam via the gallery drainage system, and have been observed significant distances up the drain adjacent to the gallery stairway. Following a reconnaissance of the dam gallery, a two-stage proposal is being considered which proposes to exploit this behaviour to facilitate passage over the dam. The first stage of the proposal aims to improve elver entry into the drainage system and encourage elvers to migrate to a trap at the top of the dam stairway. If Stage 1 is effective, Stage 2 will trial mechanisms to automatically pass or drain the contents of the trap into the lake.

The Fisheries Research and Development Corporation project entitled "Assessment of the impacts of hydro-electric dams on eels stocks in Tasmania and an evaluation and assessment of mitigation strategies" has been completed and is presently in the final stages of write-up. The project aimed to:

- assess the effect of hydro dams on the upstream and downstream migration of eels into lakes and rivers;
- assess the effect of hydro dams on downstream migration of sexually mature eels;
- determine the contribution of past elver translocation practices to lake populations of eels;
- evaluate the effectiveness of the elver ladder on the Trevallyn Dam;

- review overseas and interstate experience in mitigating against the effects of dams on eel populations, and prepare a report of this review; and
- prepare an eel fishery management plan based on the outcomes of the study.

In summary, the study has found that where upstream migration has been blocked by dams, eel populations would have been significantly reduced or in some cases died out without restocking via elver translocations. The study also provided a generalised assessment of the impact of major power schemes on downstream migrating eel populations, and recommends the management of lakes on an individual case-by-case basis rather than the adoption of broad-brush management prescriptions.

4. ENVIRONMENTAL MANAGEMENT OPTIONS FOR TREVALLYN ELVER PASSAGE

Upstream elver migration options will be assessed further as part of the dam gallery passage proposal and eel fishery management plan development, and the management plan will be directed by the recommendations of the soon to be completed Fisheries Research and Development Corporation eels and dams study.

Specific management options for downstream migration issues have not yet been developed but are still required for Trevallyn power scheme given its significance as a fish migration barrier and its potential impact on silver eel mortality rates. The final report of the Fisheries Research and Development Corporation eels and dams study includes discussion on potential mitigation measures for downstream passage, and this information will be used to develop options for management of silver eel migration issues at Trevallyn.

Elver incursion into the Trevallyn power station is not a significant issue and as such no management options are required. Options for non-anguillid migration issues may require further development, but was considered outside the context of this project.