2023/2024 Annual Report

Snowy 2.0 Threatened Fish Management Plan

NSW GOVERNMENT | snowyhydro | snowy 2.0

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Executive Summary

Snowy 2.0 is a pumped hydro expansion of the Snowy Mountains Scheme which will hydrologically link the existing reservoirs of Talbingo and Tantangara, via underground tunnels and an underground power station.

The transfer of water between these reservoirs and catchments brings with it the risk of transfer of pest fish and pathogens which are currently not present within the upper Murrumbidgee catchment, and which may impact the threatened fish species Macquarie Perch (*Macquaria australasica*) and Stocky Galaxias (*Galaxias tantangara*) if planned controls fail.

In accordance with the Infrastructure Approval for Snowy 2.0 Main Works, Snowy Hydro developed a Threatened Fish Management Plan (TFMP) for the Snowy 2.0 Main Works. The TFMP stipulates the development of an Annual Plan to be developed each year outlining what activities will occur as part of the TFMP along with an Annual Report to be produced detailing the results of the activities undertaken for the TFMP during the preceding 12 months ending in June 30 of each year.

The 2023/24 Annual Implementation Plan (AIP) for the Snowy 2.0 Threatened Fish Management Plan was developed by NSW DPIRD and endorsed by the TFMP Expert Advisory Committee. It outlined the activities that would be undertaken for the period 1 January 2024 through to 30 June 2024. This report documents the results and the details of activities undertaken for the 2023/24 AIP.

The 2023/24 AIP sets out the goal of the program, measures of success and the specific aims, objectives and targets of the five-year plan. Given that this is the inaugural year of implementation of the plan, not all of the aims, objectives and targets have been reached, nor can they be.

There has however been the establishment of basis of programs and activities that moving forward will be well placed to meet the aims, objectives and targets of the five-year plan and ultimately the overall goal of the program “to build resilience in Macquarie Perch and Stocky Galaxias within the upper Murrumbidgee Catchment, should a new incursion of pest fish occur due to Snowy 2.0 activities”.

The 2023/24 AIP was carried out in fullness, with the establishment of a fit for purpose monitoring program for both Stocky Galaxias and Macquarie Perch. The results of monitoring for both species found there were no threats or other triggers to require Trigger Action Response Plan (TARP) intervention. Macquarie Perch numbers at survey locations were at a record high with good recruitment and distribution detected. Stocky Galaxias abundance at both sites appeared lower than previously recorded, though direct comparisons were difficult given this was the first year of survey. These lower abundances may be a function of seasonal variability in population or sampling efficacy. Recommendations on investigating these potential issues have been provided.

Initial planning for the implementation of the catchment surveys involved a desktop study, which identified and prioritised locations to focus on for the 2024/25 catchment surveys with a total of 44 Stocky Galaxias and 14 Macquarie Perch priority sites identified to be assessed during 2024/25.

Captive breeding activities occurred for both Macquarie Perch and Stocky Galaxias, with 243 Stocky Galaxias being produced by Charles Sturt University and a captive population maintained. Captive breeding of Macquarie Perch continued at the Narrandera Fisheries Centre (NFC) in collaboration with the Sunshine Coast University, with the production of 4,526 juvenile Macquarie Perch. The captive population was maintained and added to with additional broodfish collected from other populations under the program to increase numbers and the genetic diversity of the captive population. Translocations occurred for both Stocky Galaxias and Macquarie Perch, with captive bred Stocky Galaxias being released into the Eucumbene Borrows and Macquarie Perch being translocated from Cataract Dam and Loddon Creek into the upper Murrumbidgee River for genetic enhancement of the population.

Temperature monitoring at the Eucumbene Borrows has identified maximum water temperatures much higher than recorded in Tantanagra Creek raising concerns regarding the suitability of the site as an ex-situ introduction site for Stocky Galaxias, recommendations on investigations into the temperature tolerance of Stocky Galaxias and further monitoring at Eucumbene Borrows have been provided.

Introduction

Snowy 2.0 is a pumped hydro expansion of the Snowy Mountains Scheme, which will hydrologically link the existing reservoirs of Talbingo and Tantangara, via underground tunnels and an underground power station, that will be owned and operated by Snowy Hydro Limited (Snowy Hydro).

The transfer of water between these reservoirs and catchments brings with it the risk of transfer of pest fish and pathogens which are currently not present within the upper Murrumbidgee catchment (Baumgartner et al 2018 and Ning et al 2019), and which may impact the threatened fish species Macquarie Perch (*Macquaria australasica*) and Stocky Galaxias (*Galaxias tantangara*) if planned controls fail, and pest species spread beyond Tantangara Reservoir.

Snowy Hydro comprehensively assessed the likelihood of these potential impacts and options to avoid transfer of pest fish through Snowy 2.0 as well as options to minimise potential impacts (EMM 2019, EMM 2020).

As a result, Snowy Hydro has committed to designing and constructing:

- A 'Galaxiid barrier' at the downstream extent of the Stocky Galaxias habitat (subsequently imposed as Condition 21(a) of the Infrastructure Approval);
- Fish screens at Tantangara Dam and the inlet to the Murrumbidgee to Eucumbene tunnel (M-E Tunnel) to prevent the transfer of all life stages of fish so far as is reasonably practicable from Tantangara Reservoir through the Dam to the mid-Murrumbidgee River and to Lake Eucumbene (subsequently imposed as Condition 21(a) of the Infrastructure Approval).

Details about these structures are provided in the Snowy 2.0 Biosecurity Risk Management Plan (BRMP).

In addition, the Snowy 2.0 Threatened Fish Management Plan (TFMP) was developed to minimise the impact of the development on threatened fish species and their habitat, particularly the Macquarie Perch, Stocky Galaxias and Murray Crayfish. A key part of this plan is a captive breeding program for the Macquarie Perch and Stocky Galaxias involving the spending of $5 million over 5 years from the commencement of the program that provides for:

- population monitoring, surveillance and research on the Macquarie Perch and Stocky Galaxias in the Mid to Upper Murrumbidgee catchment;
- habitat surveys to identify suitable receiving sites for stocking insurance populations of Stocky Galaxias and Macquarie Perch;
- captive breeding, stocking and monitoring of Macquarie Perch and Stocky Galaxias with the aim of achieving self-sustaining populations of these species;
- habitat enhancement for the Macquarie Perch in the mid-Murrumbidgee catchment in accordance with the National Recovery Plan.

The TFMP contains broad management objectives and is based on several underpinning plans and strategies developed for each species: Macquarie Perch (Lintermans et al. 2022a,b; Lyon et al. 2022; Tonkin et al. 2022); Stocky Galaxias (Raadik and Lintermans 2022a,b; Raadik et al. 2022; Stoessel and Raadik 2022). These detailed documents contain objectives, methods, and outputs for each species, and as such, along with the TFMP, provide the direction and detail for the implementation of the captive breeding program ('the program') under the TFMP.

The 2023/24 Annual Implementation Plan for the Snowy 2.0 TFMP was developed and approved by the Expert Advisory Committee (EAC) and is available on the Snowy Hydro website. This report summarises the activities and results of the actions that were undertaken in 2023/24 as outlined in the Annual Implementation Plan. Further detail on the EAC is provided in Appendix 1.

The Snowy 2.0 TFMP officially commenced on 1 January 2024, however there are activities occurring prior to this commencement date that will also be included in this report as they are directly relevant to the program, these include the captive breeding of Macquarie Perch, captive breeding of Stocky Galaxias and the Eucumbene Borrows works.

Summary of Planned Activities for 2023/24

- → Population monitoring of Macquarie Perch in the upper Murrumbidgee and Abercombie Rivers
- → Population Monitoring of Stocky Galaxias in Tantangara Creek and Sallys Flat Creek
- → Translocation of Macquarie Perch for genetic rescue in the upper Murrumbidgee
- → Translocation and monitoring of captive breed Stocky Galaxias into the Eucumbene Borrows
- → Captive breeding of Stocky Galaxias by Charles Sturt University
- → Captive breeding of Macquarie Perch at the Narrandera Fisheries Centre
- → Preliminary desk top analysis for catchment surveys for Macquarie Perch and Stocky Galaxias

Results

3.1 Population Monitoring

3.1.1 Stocky Galaxias

The overall aim of the Stocky Galaxias monitoring is to provide baseline, comparable data on the species, to inform decisions on management intervention for the long-term survival of the species.

Stocky Galaxias monitoring in Tantangara Creek and Sallys Flat Creek for the 2023/24 plan was undertaken by Mark Lintermans and Hugh Allan. A detailed report is provided as Appendix 2. A summary of the major findings of this monitoring and report are as follows.

Monitoring was undertaken at Tantangara Creek, as recommended by Raadik and Lintermans (2022), in early April 2024 at two sites (Top flat and Bottom flat) with backpack electrofishing. A similar method was applied at Sallys Flat Creek, with two sites sampled (Lower and Upper). Additional sampling effort was undertaken at Bottom Flat in Tantangara Creek to explore the low catch rates of Stocky Galaxias at this location.

A total of 218 fish (*Galaxias spp.*) were caught or observed with 183 confidently identified to species across all sites and reaches. Thirty-five Galaxids of uncertain species were caught or observed at Sallys Flat Creek (Table 1). A total of 99 Stocky Galaxias and 55 Mountain Galaxias (*Galaxias olidus*) were captured from Sallys Flat Creek, and 29 Stocky Galaxias captured from Tantangara Creek. Stocky Galaxias comprised 64 percent of the species-identified fish caught at Sallys Flat Creek.

Table 1. reproduced from Lintermans and Allan (2024) shows raw catch data for both Tantangara Creek and Sallys Flat Creek, total number (all shots combined) of Stocky Galaxias, Mountain Galaxias and unidentified galaxiids (*Galaxias spp.*) captured at each site and reach. * Indicates one fish observed but not measured.

Site	Reach	No. efish shots	Stocky Galaxias caught	Mountain Galaxias caught	Total no. of Galaxias spp. caught or observed	Total catch
Sallys Flat Creek	Lower reach	3	74	49	27	150
	Upper reach	3	25	6	8	39
Tantangara Creek	Bottom flat	5	2*	-	-	2
	Bottom flat – additional shot below Chinese cut	1	3	-	-	3
	Bottom flat – additional section	~200m	2	-	-	2
	Top flat	3	22	-	-	22
		Total fish	**128**	**55**	**35**	**218**

The results presented in Lintermans and Allan (2024) for Tantangara Creek show much lower catch rates than previous surveys, with the mean number of Stocky Galaxias per 30 m electrofishing shot captured in 2024 being 8.3 compared with 22 in February 2023 and approximately 35 for sampling conducted over 2016 to 2018. Whether these differences in abundance represent seasonal changes in abundance is unknown as there has been insufficient seasonal sampling to confidently assess seasonal abundance patterns (Lintermans and Allan 2024) or if they represent an actual decline in the population.

Specific monitoring objectives as outlined in the 2023/24 AIP and commentary regarding findings is provided below:

- **The persistence of Stocky Galaxias (presence and breeding):** The monitoring undertaken showed persistence of Stocky Galaxias at both Tantangara Creek and Sallys Flat Creek. Young-of-year fish were captured in all reaches of both creeks which provides clear evidence that successful spawning and recruitment occurred in 2023.

- **The population trajectory (is the population increasing, stable or decreasing) and variability (significant change from normal):** Given this is the first round of systematic monitoring through the TFMP that has occurred at these locations and with this specific method, the ability to evaluate the population trajectory is limited and it will take several years of monitoring to attain sufficient data and understanding to confidently determine the trajectories for each of these populations.

  Data from previous studies and sampling events with similar methods have been utilised to provide an indication of population trajectory. From this comparison it appears that either the population abundance at both locations has declined, or is influenced by seasonal factors that reduce sampling efficiency.

- **The status of the Stocky Galaxias populations (incorporating measures of abundance, distribution, reproduction, fish health and demographics).** The status of the Stocky Galaxias populations at both locations was assessed including abundance, distribution, reproduction, fish health and demographics. Similar to determining a population trajectory, given this is the initial round of monitoring, comparisons are not possible and this forms a baseline for which future monitoring results can be compared with. As discussed above, comparison with previous data and studies indicates a potential decline in the abundance at both locations, however distribution remains unchanged and reproduction has been detected at both locations. Fish health was assessed via condition and visual examination and whilst digenean trematode metacercaria were detected in Stocky Galaxias at Sally's Flat Creek, intensity of the infection was low and is not uncommon in Galaxias species andis not of concern.

- **The status of identifiable threats at Stocky Galaxias locations (e.g. riparian erosion, instream sedimentation, riparian vegetation condition with respect to ability to trap sediment).** A rapid, visual assessment of potential threats did not reveal any critical or new threats to the Stocky Galaxias populations at either location.

- **The persistence and establishment of any new translocations of the species into the catchment.** To date, no translocations have occurred into either Tantangara Creek or Sally's Flat Creek. Stocky Galaxias have only been translocated and stocked into the Eucumbene Borrows, a purposely constructed habitat below the Eucumbene Dam wall.

- **Incursions of exotic fish species (Brown Trout (*Salmo trutta*), Rainbow Trout (*Oncorhynchus mykiss*)), or invasive native species Climbing Galaxias (*Galaxias brevipinnis*) into known Stocky Galaxias populations.** No pest fish were detected by the monitoring undertaken in 2024.

- **Triggers for further investigations and/or identified management interventions to mitigate potential sudden declines because of identified threats (e.g., Redfin Perch fish invasion, drought, fire).** Given this is the first year of monitoring, several metrics identified for determining declines such as decline in relative population abundance, decline in fish condition and genetic decline cannot be assessed at this stage, however the monitoring that has been undertaken provides a baseline for comparison in future years. Of the metrics that could be determined, fire or drought, recruitment failure and predatory fish incursion, none of these have been triggered.

3.1.2 Macquarie Perch

The overall aim of the Macquarie Perch monitoring is to provide baseline, comparable data on the species, to inform decisions on management intervention for the long-term survival of the species.

Macquarie Perch monitoring of the upper Murrumbidgee River population was undertaken by Mark Lintermans. A detailed report of the results is provided as Appendix 3. Macquarie Perch monitoring of the two reference sites in the Abercrombie River was undertaken by NSW DPIRD. A summary of the major findings of the upper Murrumbidgee River and Abercrombie River results are as follows.

Upper Murrumbidgee River

Monitoring was undertaken in the upper Murrumbidgee consistent with the recommendations provided by Lintermans et al (2022), (see Appendix 3 for detailed method).

A total of nine sites (seven core sites and two secondary sites) were sampled, with sampling being conducted between late February and late April 2024.

A total of 269 individuals of seven fish species were sampled with the native Macquarie Perch the most abundant species followed by the alien Common Carp (*Cyprinus carpio*), then alien Goldfish (*Carassius auratus*) (Table 2). No other species recorded had an abundance >8 individuals. The only other native species captured were Mountain Galaxias and cod sp. *Maccullochella* spp. The cod could not be accurately identified to species as both Murray Cod and Trout Cod (*M. macquariensis*) have been stocked into the upper Murrumbidgee since the 1980s (Koehn et al. 2013; Lintermans 2023), with these species now hybridising (Couch et al. 2016).

A total of 196 Macquarie Perch were captured across eight of the nine sites sampled, including all of the core sites and one of the fringe sites.

Table 2. Reproduced from Lintermans (2024) showing raw catch data for the upper Murrumbidgee Macquarie Perch Monitoring, fish and non-target animals captured (or observed) in 2024.

Common Name	Macq Perch	Mountain Galaxias	Cod spp	Rainbow trout	Brown trout	Carp	Goldfish	Total fish	Long neck turtle	F/water prawn	Yabby	Platypus	Water rat
Sites													
1	-	-	-	-	1	-	-	**1**	-	-	-	1	-
2	51	-	-	1	-	-	-	**52**	-	-	-	6	-
3	4	2	-	-	3	-	-	**9**	-	-	7	9 (1)	obs
4	7	5	-	-	-	-	-	**12**	-	-	-	obs	-
5	36	1	-	2	-	-	-	**39**	-	1	-	2	obs
6	75	-	-	-	-	-	-	**77**	2	14	1	1	-
7	6	-	-	-	-	2	1	**13**	1	54	11	-	-
8	14	-	-	-	-	6	-	**16**	12 (1)	84	-	1	obs
9	3	-	1	-	-	2	18	**50**	3	62	4	-	obs
TOTAL	**196**	**8**	**1**	**3**	**4**	**28**	**19**	**269**	**18 (1)**	**215**	**23**	**20 (1)+**	**obs 4 sites**

Abercrombie River Reference Sites

Sampling was undertaken at two reference sites on the Abercrombie River in the Lachlan Catchment in early May 2024. A total of 32 individual fish were captured with Macquarie Perch the most abundant species accounting for 30 of the total fish caught at both sites (Table 3). The Macquarie Perch size range was from 81-353mm (Figure 1). Young-of-year 50-100mm were present at Smiths Crossing site comprising of 36 percent of total Macquarie Perch captures at this site. No Young-of-year were caught at Tween Cabin site, the smallest captured was recorded at 118mm. There were 11 Macquarie Perch caught at Tween Cabin in the +1 cohort 100-170mm. This accounted for 57 percent of the Macquarie Perch sampled during the event. Other native species caught were two Murray Cod at the Smiths Crossing site. No alien or introduced species were caught during this sampling event. Redfin and Carp are present in the upper reaches of the Abercrombie River but were not detected at either reference site.

Weight was unable to be recorded for these sites due to equipment malfunction in the field so a formal condition assessment is not possible, however the overall observed condition of the Macquarie Perch was good, no major fish deformities, injuries or external parasites were present on any of the Macquarie Perch or Murray Cod (Figure 25). Two individual Macquarie Perch had moderate caudal fin damage (Figure 26) and one fish was recorded as having a moderate lesion on the operculum and body. Lernaea cyprinacea was not present in any of the fish captured.

Two Platypus (*Ornithorhynchus anatinus*) and an Eastern Long-necked Turtle (*Chelopdina longicollis*) were captured during the sampling process. All were carefully released unharmed. One Platypus was captured in a Gill net during an evening set. This individual was placed in a specially designed Platypus holding container until the end of the gill net soak and released back into the water. Photos from the Abercrombie Monitoring trip are provided in Appendix 4.

Table 3. Fish and non-target animals captured at the Abercrombie River reference sites in 2024 monitoring.

Common Name	Macquarie Perch	Murray Cod	Total fish	Long neck turtle	Platypus
Site					
Smiths Crossing	11	2	13		1
Tween Cabin	19		19	1	1
TOTAL	**30**	**2**	**32**	**1**	**2**

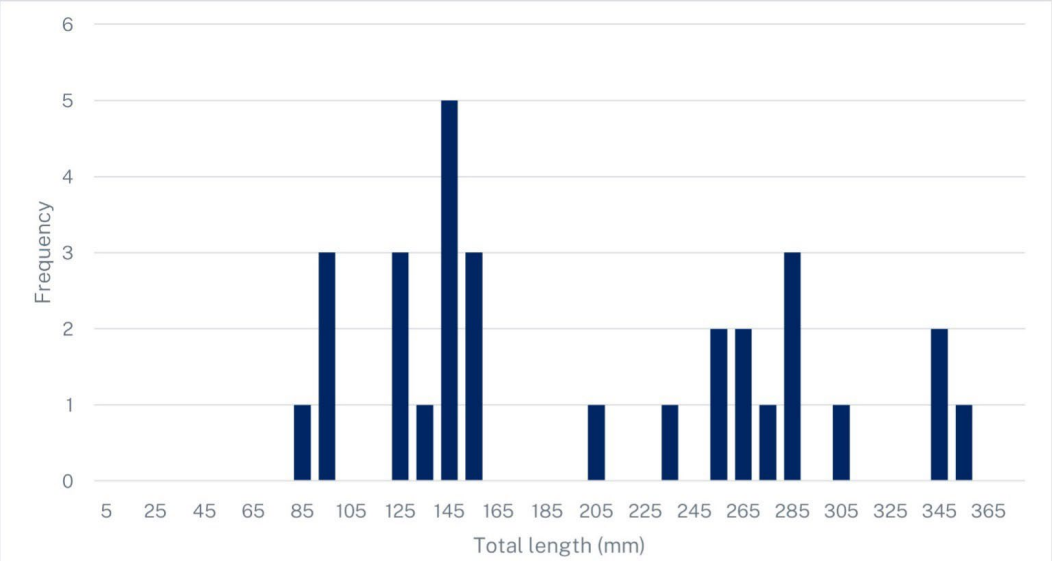

Figure 1. Length frequency of Macquarie Perch captured at the Abercrombie River reference sites.

Specific monitoring objectives as outlined in the 2023/24 AIP and commentary regarding findings is provided below:

→ **The persistence of Macquarie Perch (is the species still present and breeding at sites where recorded since 1998).**

Macquarie Perch were in high abundance with 196 individuals captured, and individuals recorded at eight of the nine sites on the Murrumbidgee River, including all of the core sites and one of the secondary sites. The only secondary site where the species was absent was at the most upstream site, upstream of Yaouk.

→ **The population trajectory (is the population increasing, stable or decreasing) and variability (significant change from normal).**

Given this is the first year of monitoring for the TFMP at several sites, a standard comparison of population trajectory is difficult until multiple years of results from the same sites are available. However, the combined abundance data of Macquarie Perch sampled in 2024 was the second highest on record for the upper Murrumbidgee when compared to previous data.

→ **The status of the Macquarie Perch population (incorporating measures of abundance, distribution, reproduction and demographics).**

The status of the Macquarie Perch population in the upper Murrumbidgee River for 2024 is secure, with the seconded highest recorded number of individuals captured. Good recruitment has occurred across the majority of sites and a good population structure is present with size classes ranging from adults, subadults and young-of-year.

→ **The persistence and establishment of any new translocations of the species into the catchment.**

There has not been any establishment of new populations at this stage in the project and this activity is dependent on the catchment surveys identifying suitable receival locations.

→ **Incursions of Redfin Perch into the upper Murrumbidgee Catchment.**

No Redfin Perch were detected in the upper Murrumbidgee Catchment as part of this survey. In addition, extensive eDNA surveys, undertaken by NSW DPIRD, were also conducted in 2023 that did not detect any Redfin Perch DNA within the upper Murrumbidgee catchment (Duncan et al 2023) see Appendix 5.

→ **Triggers for further investigations and/or identified management interventions to mitigate potential sudden declines because of identified threats (e.g., Redfin Perch fish invasion, drought, fire).**

The 2024 Macquarie Perch monitoring found that there were no triggers or additional threats that would trigger management intervention.

At this stage, no inferences can be drawn between the Upper Murrumbidgee and control location monitoring data. It is intended that this will become possible as longer term data sets are accumulated for both catchments.

3.2 Translocation

3.2.1 Stocky Galaxias

Translocations of Stocky Galaxias to achieve the objective identified in Raadik et al (2022) to *'Improve the conservation status of Stocky Galaxias in the wild to ensure enough viable populations with evolutionary potential exist to support long term persistence'*, rely on understanding critical aspects of the wild populations including population genetics, population size and structure along with identification of receival locations.

Until reintroduction sites have been identified via the catchment surveys, work has been undertaken to establish an ex-situ constructed habitat at the Eucumbene Borrows. The intention is to use this location to establish an ex-situ population to act as an insurance population, and potentially a source population, to be used for further translocations in the future if a population establishes and recruits in sufficient numbers.

The Eucumbene Borrows (Figure 2) is a disused quarry site below the Eucumbene Dam wall that was used during the construction of the Eucumbene Dam. The National Parks and Wildlife Service have been undertaking restoration of the site for several years to improve the stability and ecological values of the site. There are several dams and ponds of varying sizes present on the site that hold and maintain water. Rock lined streams that replicate the habitat of Stocky Galaxias have been constructed to connect three of these ponds (Figures 3, 4 and 5) and water is reticulated via submersible electric pumps powered by solar panels to replicate the flowing water habitats of Stocky Galaxias.

To date there have been three translocations/stockings of Stocky Galaxias into the Eucumbene Borrows, see Table 4 below.

Table 4. Number of Stocky Galaxias released at Eucumbene Borrows.

Release Date	Number	Source
27 April 2023	**78 juveniles**	**Captive breed at CSU**
	6 Adult males	Tantangara Creek 2020 fire rescue fish from CSU
	43 Young of Year	Translocated from Tantangara Creek
14 May 2024	**243 juveniles**	**Captive Breed at CSU**

Figure 2 (a). Overview of the Eucumbene Borrows site (image taken October 2023).

Figure 2 (b). Eucumbene Borrows upper constructed stream, connecting the mid and upper ponds (photo taken March 2023).

Figure 2 (c). Eucumbene Borrows lower constructed stream connecting the mid and lower ponds (photo taken March 2023).

Figure 2 (d). Example of the constructed stream habitat at the Eucumbene Borrows (photo taken March 2023).

Eucumbene Borrows Monitoring

There have been three formal monitoring events undertaken at the Eucumbene Borrows, with several informal visual surveys undertaken by both National Parks and Wildlife and DPIRD Staff. Monitoring methods include backpack electrofishing of the stream sections, fyke netting of the pond/dam (Table 5), spotlight surveys (Table 6), eDNA surveys (Table 7) and visual surveys of the streams.

Fyke Net Results

No Stocky Galaxias have been captured via fyke nets or observed from any of the ponds.

Table 5. Eucumbene Borrows Fyke net results.

Site	Date	Yabbies (*Cherax Destructor*)	Stocky Galaxias
Mid Pond	9 October 2023	34	0
	13 May 2024	42	0
Bottom Pond	9 October 2023	52	0
	13 May 2024	10	0

Spotlight Survey Results

Table 6. Eucumbene Borrows spotlight survey results.

Date	Stocky Galaxias observed
9 October 2023	20
13 May 2024	3

Electrofishing Results

Backpack electrofishing has been undertaken on one occasion. It was planned to be undertake as part of the October 2023 sampling event, however spotlight surveys undertaken the night prior showed that some of the
male Stocky Galaxias had a clearly defined white stripe along the ventral area suggesting that they were in or approaching spawning condition, so the decision was made not to undertake electrofishing which may potentially impact on spawning success.

Backpack electrofishing was undertaken along the entire length of both of the constructed streams on the 14 May 2024 with only one Stocky Galaxias being observed but not captured. This fish was observed in the
same pool as two of the three fish that were observed during the spotlight surveys the previous night.

Environmental DNA Results

Enironmental DNA monitoring was undertaken at the Eucumbene Borrows to monitor for the presence of alien trout (Rainbow Trout, Brown Trout and Brook Trout (*Salvelinus fontinalis*)) which have been previously detected at the site and Stocky Galaxias. Samples were collected from the three main dams at the site (Figure 6) on the 16 April 2024, by passing 5 L of water through 5-micron self-preserving Smith Root filter using an eDNA sampling systems (Smith-Root, USA; Thomas et al. 2018). The filters were analysed by EnviroDNA as part of the broader environmental DNA fish monitoring program, with species-specific markers and assays being used for the detection of trout DNA and a *Galaxias olidus* complex assay used for the detection of Stocky Galaxias (for details on the analysis methodology, see Griffiths et al. 2023).

Figure 6. Location of Eucumbene Borrows DNA sample collection.

No DNA was detected for any of target species at any of the three locations.

Table 7. Eucumbene Borrows eDNA results

Site	Date	Trout	*Galaxias olidus*
EB1	16-4-2024	Negative	Negative
EB2	16-4-2024	Negative	Negative
EB3	16-4-2024	Negative	Negative

Water Temperature Monitoring

Water temperature loggers were deployed in three locations within the constructed streams at the Eucumbene Borrows (Figures 7 and 8) on the 24 November 2023 to monitor water temperature over the 23/24 summer and assess the suitability of the Eucumbene Borrows as a continued location to maintain an ex-situ population of Stocky Galaxias (Figure 7).

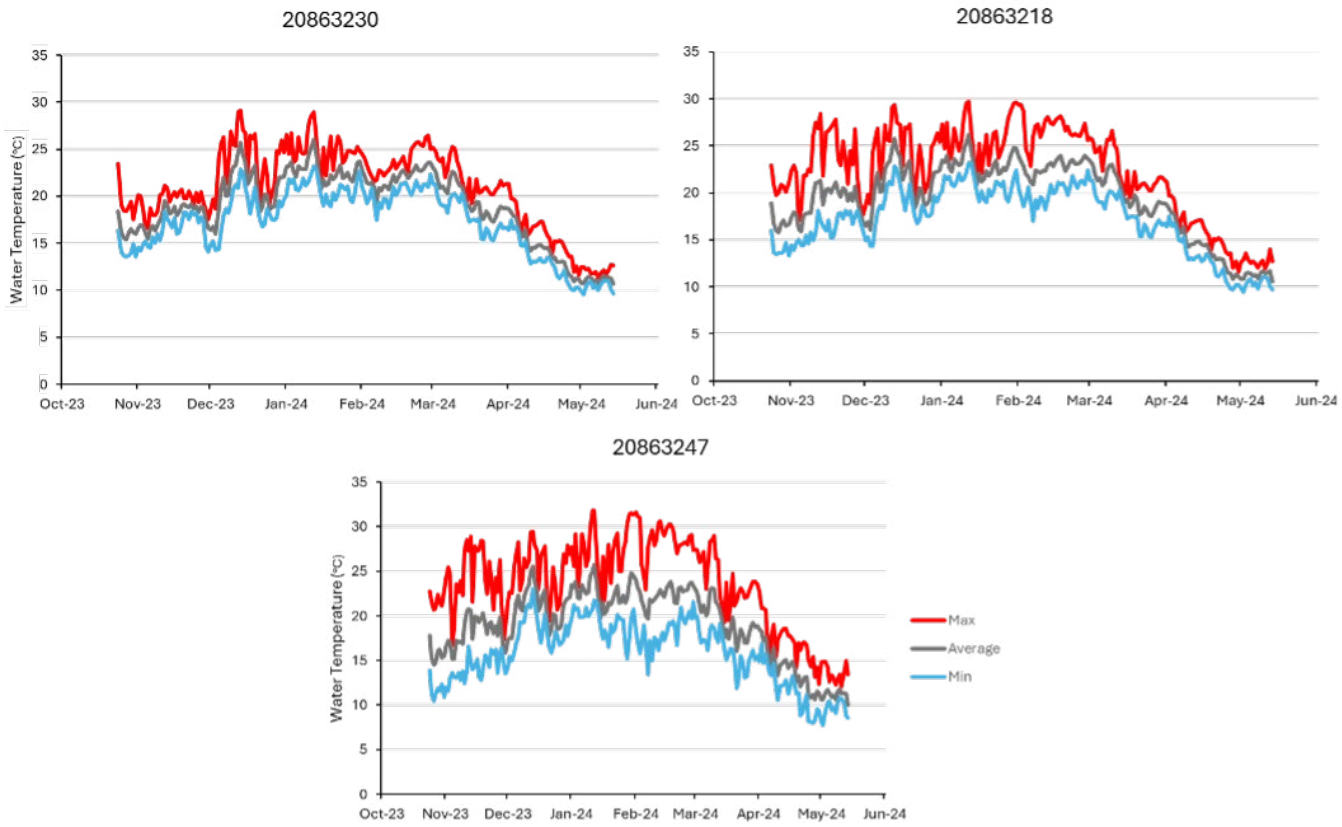

Figure 7. Water temperature for the three locations at Eucumbene Borrows between October 2023 and May 2024.

The 23/24 summer proved to be problematic for maintaining water flow within the constructed streams at the Eucumbene Borrows, with pump malfunctions, very low water levels at the upper supply dam and very hot and dry conditions. This is reflected in the water temperature monitoring results with very high temperatures recorded (Figure 7), much higher than those that have been recorded within Tantangara Creek.

Major structural works and upgrades are in the process of being implemented at the Eucumbene Borrows to improve the water storage, water security and flow on the site. These include the repair of a major breach in one of the upper dams, which will significantly increase storage capacity on the site and divert large flows into one of the other upper storages on site. These works are being funded from the Commonwealth Governments "Saving Native Species" Grant Program and will occur during the spring and summer of 2024/25.

Once the works have been completed and the system is operating in a more consistent manner with improved flow rates and water availability, temperatures within the constructed streams will be continually monitored. This will allow an evaluation of the suitability of the site and system as an ongoing ex-situ refuge location for the establishment of a Stocky Galaxias insurance population. Ongoing monitoring of the fish that have been released there to date will continue with spotlight surveys, backpack electrofishing of the streams and fyke netting of the ponds.

Future translocation activities with be guided by the development of a translocation plan as outlined in Raadik et al (2022). This plan will be informed by two current assessments of the genetic diversity of both the Tantangara Creek and Sallys Flat Creek populations. Both these assessments will provide further information on the genetic diversity and make up of these two populations and their suitability and capacity to sustain the collection of fish for translocation purposes.

The information will also inform how the genetic management of Tantangara Creek and Sallys Flat Creek populations is best managed through augmentation.

A study to complete a population estimate for the Stocky Galaxias population in Tantangara Creek is planned to be completed by early 2025, with funding from the Commonwealth Governments "Saving Native Species" Grant Program. This population estimate, along with the information on the genetic diversity and suitability of both populations, combined with the findings of the catchment survey will allow for the development of a well-informed translocation plan.

3.2.2 Macquarie Perch

The 2023/24 Annual Implementation Plan set the translocation target of 100 Macquarie Perch to be translocated from Cataract Dam into the upper Murrumbidgee to increase genetic diversity and build on past genetic rescue efforts that have previously occurred in 2020, 2022 and 2023. The 23/24 AIP proposed genetic rescue be undertaken at 3 sites: Killarney, Bolaro and Kissops Flat.

Collection of Macquarie Perch for the translocation from Cataract Dam to the upper Murrumbidgee occurred between the 11-14th March 2024. One of the main feeder creeks into Cataract Dam, Loddon Creek, was also targeted as part of this sampling to include Macquarie Perch from a lotic stream environment as previous studies have demonstrated using multiple sources for translocations, and including fish from lotic environments, leads to improved genetic and reproductive outcomes (Lutz et al. 2021).

A total of 76 Macquarie Perch were collected, 35 from Loddon Creek and 41 from Cataract Dam ranging in size from 48–280mm (Figure 8). Of these fish, six fish were retained at the NFC as broodstock, 67 were released into two sites in the upper Murrumbidgee, Site 3 (Bolaro) and Site 5 (Kissops Flat) (Figure 9) on 8 April 2024, after a three-week quarantine period at the NFC. A subset of fish was examined prior to their release for any external parasites and signs of disease. There were two mortalities during transportation and one fish was retained due to a scoliosis deformity. The proposed target of 100 Macquarie Perch was not achieved due to difficulties in sampling and equipment constraints. Due to the reduced number of fish collected, the decision was made to concentrate the releases at two sites rather than the three sites that had been identified in the AIP. This was to maximise the number of fish per site rather than try and spread them more thinly across three sites.

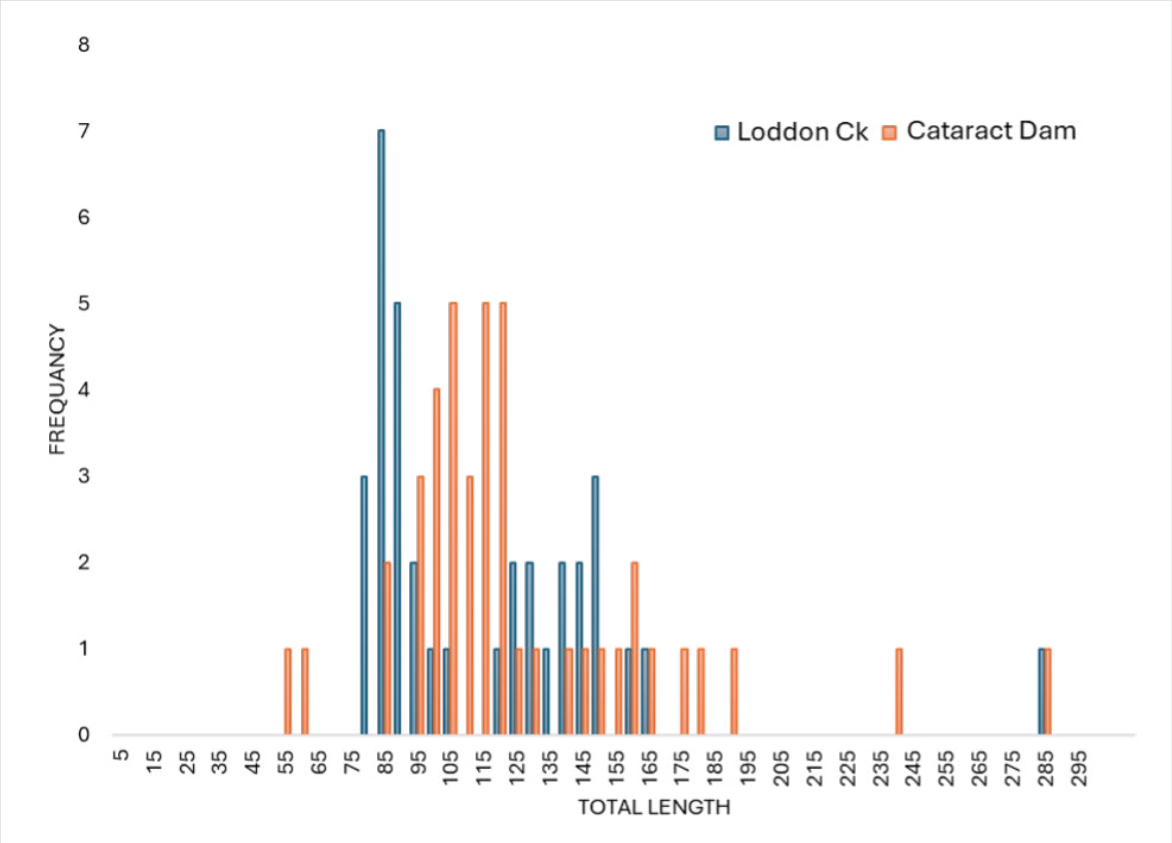

Figure 8. Length frequency of Macquarie Perch translocated from Cataract Dam and Loddon Creek into the upper Murrumbidgee River.

Figure 9. Translocated Macquarie Perch being released at Site 5 (Kissops Flat) in April 2024 for genetic enhancement.

3.3 Captive Breeding

3.3.1 Stocky Galaxias

Captive breeding of Stocky Galaxias and maintenance of the captive population was undertaken by Charles Sturt University (CSU) at the Thurgoona Campus in a purpose-built refrigerated shipping container. Charles Sturt University have been holding Stocky Galaxias since July 2020, when 16 Stocky Galaxias, rescued post-bushfire from Tantangara Creek and previously held at the Gaden Trout Hatchery at Jindabyne, were transferred to CSU. This original stock was added to in 2021, when a further 23 young-of-year Stocky Galaxias were collected from Tantangara Creek and added to the captive population. A further nine young-of-year fish, again from Tantangara Creek, were added to the captive population in 2023, see Table 8.

Table 8. Captive Stocky Galaxias population at Charles Sturt University.

	Current number	Original number	Fate
2020 Tantangara Creek Bushfire Rescue	6	16	6 males released at Eucumbene Borrows 2023. 4 mortalities.
2021 Tantangara Creek YOY	21	23	2 mortalities
2023 Tantangara Creek YOY	9	9	
CSU 2022/23 captive bred	4	n/a	78 juveniles released 2023
CSU 2023/24 captive bred	0	n/a	243 fish released 2024
Total	**40**	**48**	

2023 CSU Stocky Galaxias captive breeding update (Provided by Amina Price, Charles Sturt University)

Fish were observed to be ripe by mid November 2023. During the week of November 14th, eight female and 13 male fish were stripped. While additional ripe females were present, there was limited space available for egg incubation and the number of ripe males.

Viable eggs were obtained from six females, an improvement from 2022 year when only three out of seven females produced viable eggs. Females were stripped earlier this year to improve egg viability and this seems to have been successful. Further insights into how to determine when to strip the females (based on the extrusion of the papilla) were also gained.

However, given that it isn't possible to remove eggs to check development prior to stripping, there is still potential that female fish may be stripped either a little early or late resulting in fewer viable eggs.

Eggs incubated for between 34–44 days before hatching (in 2022, embryogenesis was more variable, ranging from 20–40 days). It's likely that the duration of embryogenesis was slightly longer as a result of cooler water temperatures due to stripping being undertaken a fortnight earlier than in 2022. Approximately 500 larvae hatched, the number of larvae per female was variable ranging from 6–217 individuals. Exogenous feeding commenced nine days after hatching and the larvae were fed live Artemia nauplii that were hatched daily. This was supplemented with live vinegar eels (*Turbatrix acti*) for the first three weeks.

Larvae were fed a minimum of 4–5 times per day at intervals of approximately 2.5 hours. At an average approximate age of 60 days white worms (*Enchytraeus albidus*) were introduced to each feed to supplement the fish diet and increase protein intake. Volume of feed was increased to match growth in juvenile fish.

Following hatching, approximately 115 dead larvae were removed from the incubation tanks. By February 17th approximately 300 larvae were remaining. There appeared to have been an additional ~140 larvae that did not survive but were not accounted for in the daily mortality. Investigations have indicated that these larvae may have been lost during daily tank cleaning procedures (incubation tanks are siphoned at the end of the day to remove uneaten food).

On May 14th, 243 fish were successfully released (Figure 10) with sizes ranging from approximately 40–50mm. There were two distinct size classes, 42–43mm and 46–51mm. This was attributable to differences in stocking density in the incubation tanks.

Figure 10. Charles Sturt University Research team releasing captive bred Stocky Galaxias into the Eucumbene Borrows May 2024.

3.3.2 Macquarie Perch

Captive breeding and maintenance of the captive population of Macquarie Perch was undertaken by DPIRD staff at the NFC in collaboration with the University of the Sunshine Coast as part of the "Cracking the Code" project. A detailed report of the outcomes of the captive breeding program for the 2023/24 season can be found in Appendix 6. Whilst the spawning activities undertaken in October 2023 were not funded through the Snowy TFMP, the ongoing maintenance of the captive population along with the collection of additional broodfish and upgrades to the hatchery in the first half of 2024.

The activities conducted during the October 2023 spawning season focused on spawning induction using GnRHa implants and determining whether the number of pairs of male and female broodstock in a tank influences the spawning response (Figure 13). Broodstock comprised of the captive held F1 and wild-caught Macquarie Perch at NFC. Slow-release GnRHa implants were effective, as observed in the preceding three spawning seasons, however only in tanks with more than two pairs of male and female broodstock: single pair, GnRHa-implanted fish did not spawn. When the single- and two-pair fish were combined, spawning occurred, confirming the need for a critical mass to achieve spawning activity. It was observed that some fish required a second GnRHa implantation to spawn.

A total of 62,300 eggs (fertilisation 70–98%) from at least six spawning events were collected and a total of 13,000 larvae hatched. These larvae were reared (Figure 14) for approximately two weeks in the hatchery before being stocked into a larval rearing pond for ongrowing. On 20 Dec 2023, a total of 4,626 juvenile Macquarie Perch were harvested from the larval rearing pond with an average length of 37.9 mm and weight of 0.7 grams. One hundred of these juveniles were retained and released back into the pond with the adult broodstock and the remaining 4,526 juveniles released into Winburndale Dam on the 21 Dec 2023 (Figure 15).

One of the major limitations to the current captive breeding program is the limited number of broodfish and access to ponds to house broodfish, on grow subadult broodfish and larval rearing. Under the 2023/24 AIP, an additional 28 Macquarie Perch broodfish were collected for incorporation into the program consisting of six from Winburndale Dam, seven from Cataract Dam, six from the upper Murrumbidgee and nine from the Retreat River (Table 9). Not all of these fish are sexually mature, and many will require on growing for a period before they will potentially contribute to the program.

Details of fish collected in 2023/24 are provided in Table 9 and fish held at NFC are provided in Table 10.

Table 9. Additional Macquarie Perch broodfish collected in 2023/24.

Origin	Length (mm)	Weight (g)
Winburndale	223	153
Winburndale	229	160
Winburndale	232	197
Winburndale	233	186
Winburndale	227	207
Winburndale	210	136
Cataract	232	148.2
Cataract	184	72.6
Cataract	166	47
Cataract	160	58.6
Cataract	173	55.1
Cataract	277	281.3
Cataract	154	48
Upper Bidgee	154	48
Upper Bidgee	244	189.4
Upper Bidgee	170	69.3
Upper Bidgee	285	291
Upper Bidgee	79	6
Upper Bidgee	66	3.2
Retreat	420	1400
Retreat	402	1150
Retreat	397	1050
Retreat	188	100.5
Retreat	154	50.5
Retreat	179	81.3
Retreat	173	79.1
Retreat	167	62.3
Retreat	170	77.5

Table 10. Inventory of current Macquarie Perch broodfish numbers held at NFC (excluding fish collected in 23/24) and their origins.

Cataract Dam	20
F1 (Abercrombie)	34
F2 (Abercrombie)	22
F2 (Unknown)	29
Dartmouth	3
Upper Murrumbidgee	1
Total	**109**

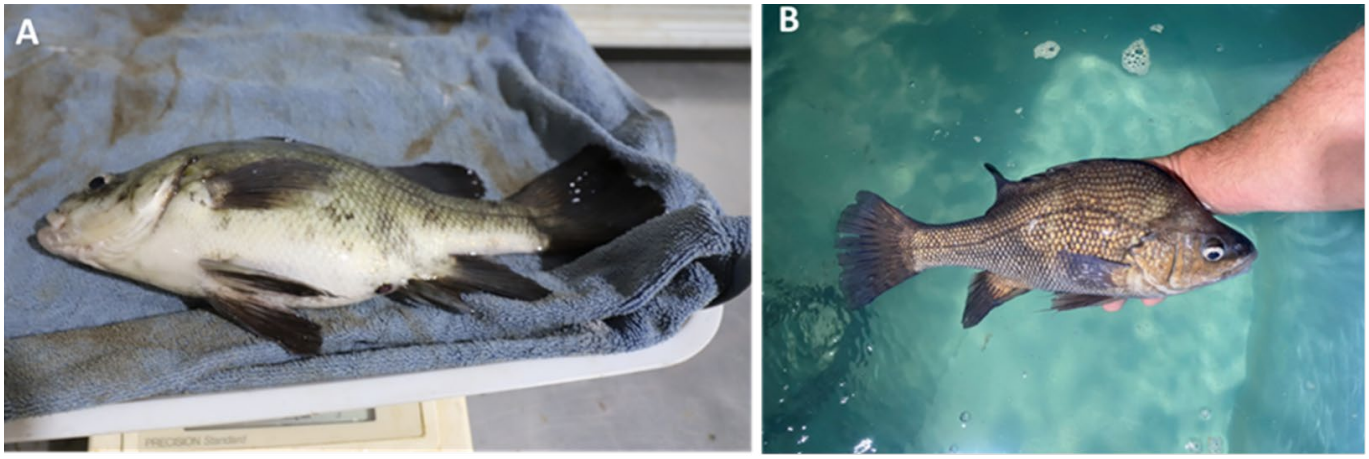

Figure 13. Mature female (A) and male (B) F1 Macquarie Perch broodfish in excellent condition prior to spawning October 2023.

Figure 14. Samples of juvenile Macquarie Perch from the October 2023 spawning season.

Figure 15. Release of Macquarie Perch juveniles into the Winburndale Dam in December 2023.

Pond infrastructure

The second major limitation on captive breeding capacity of Macquarie Perch at NFC is access to pond infrastructure to house, maintain and grow additional Macquarie Perch broodfish from the Murrumbidgee and other populations as well as larval rearing capability. Under the 2023/24 AIP, investigations were undertaken to identify options and opportunity to build additional pond infrastructure at the NFC to facilitate the forecast number of broodfish required and the production targets identified. These investigations identified suitable locations for the construction of an additional eight multipurpose Macquarie Perch ponds (Figure 16) to house and rotate increased broodfish numbers, grow out subadults for future use in the program and larval rearing. Preliminary designs have been developed and a tender process for the design and construction of the eight new ponds is planned for early 2024/25.

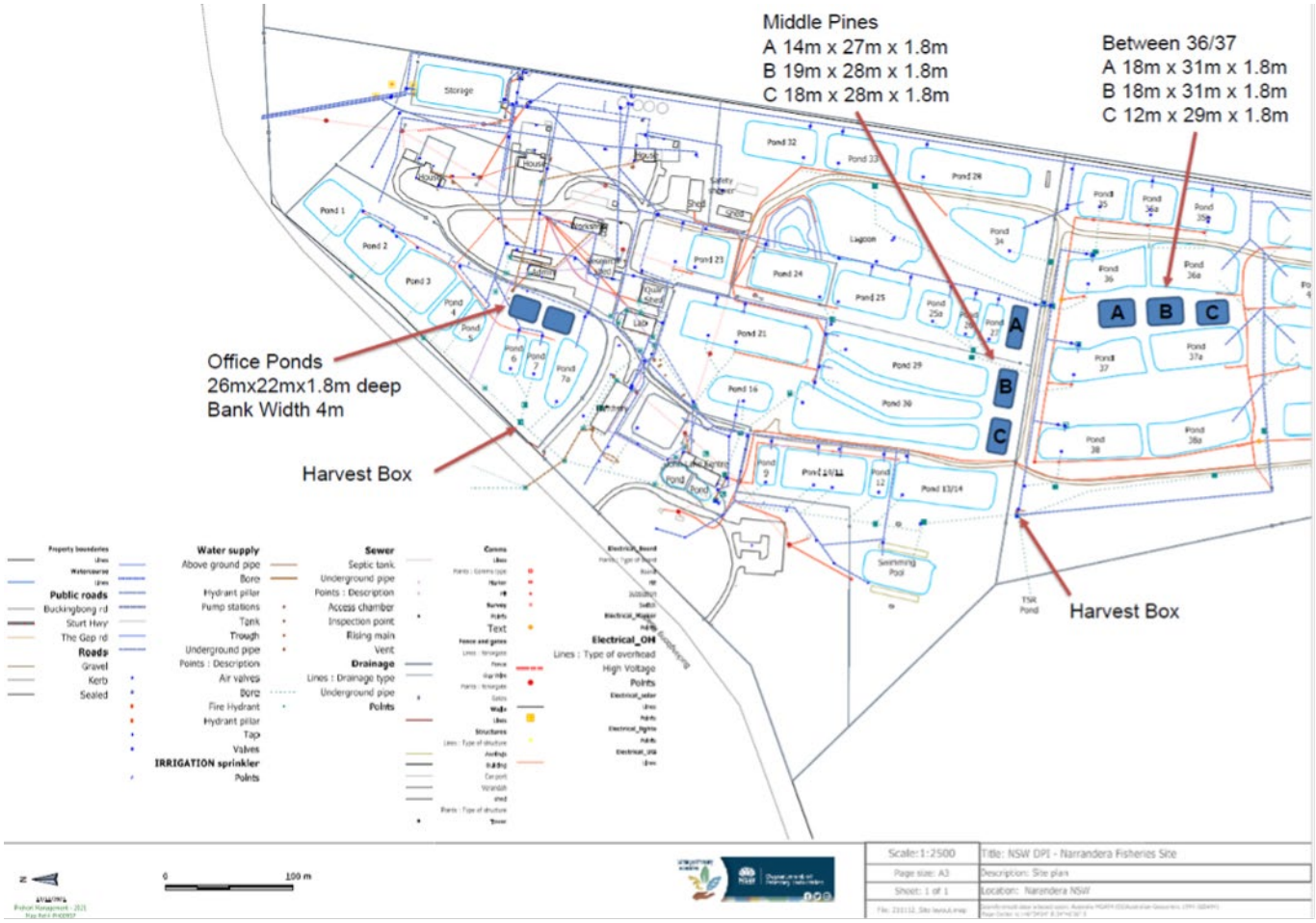

Figure 16. Location of the proposed Macquarie Perch ponds at the NFC.

Hatchery Upgrades

At the Narrandera Fisheries Centre a new hatchery building was constructed in 2022 to breed native fish species, mainly Murray Cod, Golden Perch, Silver Perch and Trout Cod. The old hatchery built in 1986 has been converted into a Macquarie Perch breeding hatchery. This conversion required a transformation and rebuild of existing hatchery infrastructure.

The main hatchery upgrades include:

- **Improved filtration of the river and bore water entering the hatchery.** A sand filter was installed out the front of the hatchery to filter the river line (Figure 17).

Figure 17. New sand filter installed on river line.

- **Incubation/larval rearing rooms.** Two recirculating filtered systems were installed in separate rooms that can use either river or bore water. These rooms are temperature controlled with a reverse cycle ambient temperature unit. A heater chiller water unit was incorporated into the recirculated system to further control the temperature during the egg incubation and larval rearing process. Each room contains a 10-tray bank of incubation/larval trays (Figure 18).

Figure 18. Incubation/larval rearing room at NFC including a heater/chiller unit that has been installed.

→ **Spawning tanks.** 16 spawning recirculated systems have been installed on the 2500 litre tanks. These systems use a submersible pump to recirculate water through an egg collection sump (Figure 19).

Figure 19. Spawning tanks at NFC with Egg collection sump bank (servicing 4 spawning tanks).

3.4 Catchment Survey

3.4.1 Stocky Galaxias

During delivery of the 2023/24 IP, a detailed dataset and desktop analysis undertaken by Raadik (unpubl. data) was provided to NSW DPIRD for review and further assessment. The dataset included 257 potential locations (Figure 20) with those where trout were known to exist excluded, bringing the total number of potential sites down to 171 (Figure 20). Sites were prioritised via a desktop analysis with 30 priority one sites, and 14 priority two sites determined, along with their access requirements, to survey during the 2024/25 season (Table 11).

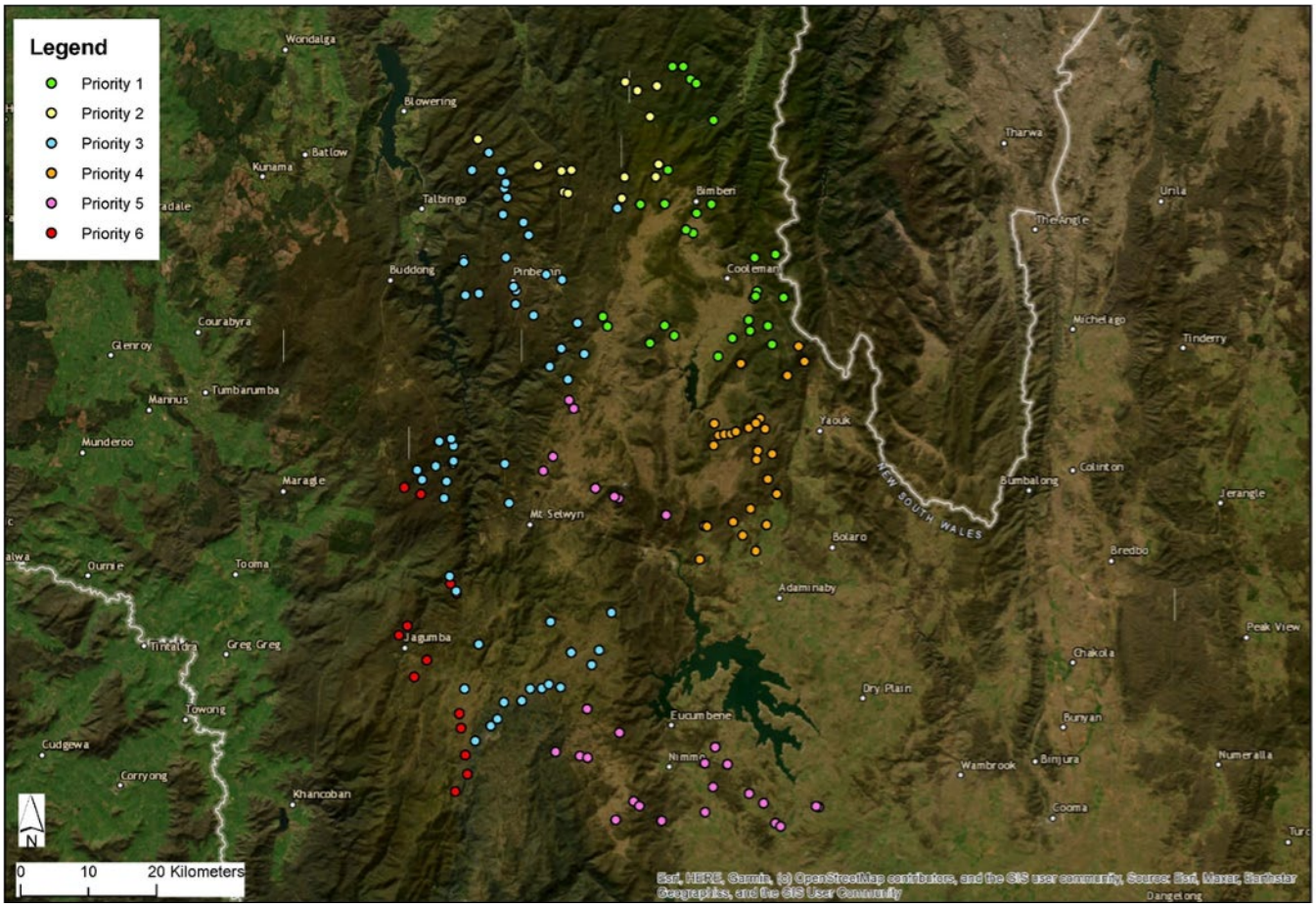

Figure 20. Map of potential sites for Stocky Galaxias catchment survey.

Table 11. Stocky Galaxias catchment survey monitoring sites planned for 24/25.

Priority	River Basin	System	Waterbody & Site	Elevation
1	MURRUM	Goodradigbee	Browns Creek - Cooleman Creek Trail	1165
1	MURRUM	Goodradigbee	Browns Creek - Off Cooleman Creek Trail	1125
1	MURRUM	Goodradigbee	Bull Flat Creek - Cooleman Creek Firetrail	1147
1	MURRUM	Goodradigbee	Cave Creek - Blue Water Hole Trail 02	1270
1	MURRUM	Goodradigbee	Cave Creek Tributary - Blue Water Hole Trail 02	1295
1	MURRUM	Goodradigbee	Cave Creek Tributary - Upper Reaches	1285
1	MURRUM	Goodradigbee	Dunns Flat Creek - Murray Gap Trail	1452
1	MURRUM	Goodradigbee	Goodradigbee River Tributary - Just off Leura Gap Trail 01	1216
1	MURRUM	Goodradigbee	Greenhide Creek - Cooleman Creek Firetrail	1083
1	MURRUM	Goodradigbee	Hall Creek - Off Long Plain Road	885
1	MURRUM	Goodradigbee	Peppercorn Creek Tributary - Long Plain Road	1390
1	MURRUM	Goodradigbee	Peppercorn Creek Tributary - Off Mcleods Spur Trail	1350
1	MURRUM	Goodradigbee	Pocket Creek - Upstream of Weir	1285
1	MURRUM	Goodradigbee	Pocket Creek Tributary - Upstream of Weir	1285
1	MURRUM	Goodradigbee	Pocket Creek Tributary - Upstream of Weir	1290
1	MURRUM	Goodradigbee	Pocket Creek Tributary - Upstream of Weir	1295
1	MURRUM	Goodradigbee	Rolling Grounds Creek Tributary - Off Leua Gap Trail	1430
1	MURRUM	Goodradigbee	Tin Pot Creek - Off Long Plain Road	1380
1	MURRUM	US Tantangara Res	Gurrangoramble Creek - At Tributary branches	1320
1	MURRUM	US Tantangara Res	Gurrangoramble Creek - Off Track	1284
1	MURRUM	US Tantangara Res	Gurrangoramble Creek Tributary - Headwaters	1430
1	MURRUM	US Tantangara Res	Mufflers Creek - Off Port Phillip Firetrail	1344
1	MURRUM	US Tantangara Res	Mufflers Creek - Port Phillip Firetrail	1281
1	MURRUM	US Tantangara Res	Mufflers Creek Tributary - Upper	1361
1	MURRUM	US Tantangara Res	Murrumbidgee River Tributary - Long Plain Road	1306

Priority	River Basin	System	Waterbody & Site	Elevation
1	MURRUM	US Tantangara Res	Murrumbidgee River - Peppercorn Firetrail	1457
1	MURRUM	US Tantangara Res	Paytens Creek - Headwaters	1450
1	MURRUM	US Tantangara Res	Tantangara Reservoir Tributary - At track	1294
1	MURRUM	US Tantangara Res	Tantangara Reservoir Tributary - At Tantangara E Trail	1305
1	MURRUM	US Tantangara Res	Yorkies Creek - Off Long Plain Hut Access	1363
2	MURRUM	Goobarragandra	Broken Cart Creek - Off Broken CartTrail	1241
2	MURRUM	Goobarragandra	Bulls Flat Creek - Off Goobarragandra Powerline Road (Above Falls?)	1095
2	MURRUM	Goobarragandra	Bulls Flat Creek - Off Goobargandra Powerline Road	1235
2	MURRUM	Goobarragandra	Bulls Flat Creek Tributary - Alpine Headwaters	1360
2	MURRUM	Goobarragandra	Dubbo Creek - Off Boundary Road	1250
2	MURRUM	Goobarragandra	Goobarragandra River - Off track	1315
2	MURRUM	Goobarragandra	Goobarragandra Creek Tributary - Off Broken Cart	1335
2	MURRUM	Goobarragandra	Goobarragandra River Tributary - Off Feints Range Trail	1160
2	MURRUM	Goobarragandra	Goobarragandra River Tributary - Off Feints Range Trail	1328
2	MURRUM	Goobarragandra	Peak River - Atkinson Creek Trail	1085
2	MURRUM	Goobarragandra	Peak River - off Goobarragandra Powerline Road	1285
2	MURRUM	Goobarragandra	Pheasant Creek - Off Boundary Road 03	1155
2	MURRUM	Goobarragandra	Pheasant Creek - Boundary Rad	1075
2	MURRUM	Goobarragandra	Wild Horse Creek Tributary - Downstream Warogong Trail	1140
3	MURRUM	Yarrangobilly	Yarrangobilly Creek - Off Peppercorn Firetrail	1310

3.4.2 Macquarie Perch

During the 2023/24 implementation, a detailed desktop analysis was undertaken to review the potential catchment surveys sites identified by Lintermans et al (2022b) that may contain previously unidentified populations of Macquarie Perch or be suitable translocation sites. These sites were assessed against the current NSW Fisheries database to determine any historical and recent data regarding fish populations, accessibility, ownership and potential suitability as reintroduction locations. From this assessment, 14 priority sites were identified for a rapid assessment including eDNA to be undertaken in 2024/25 (Table 12; Figures 21 and 22). The 14 priority sites are tributary sites and the mainstem sites upstream of the Yaouk Road and will not include the sites Goat Shooters, Downstream Bredbo, Baroona Rd, Lawler Road or Chakola as these sites are considered a lower priority and some have either recently been sampled under other programs or had surveys in close proximity. Surveys for 2024/25 will also not include the Queanbeyan River sites as these are located outside the catchment and therefore a lower priority.

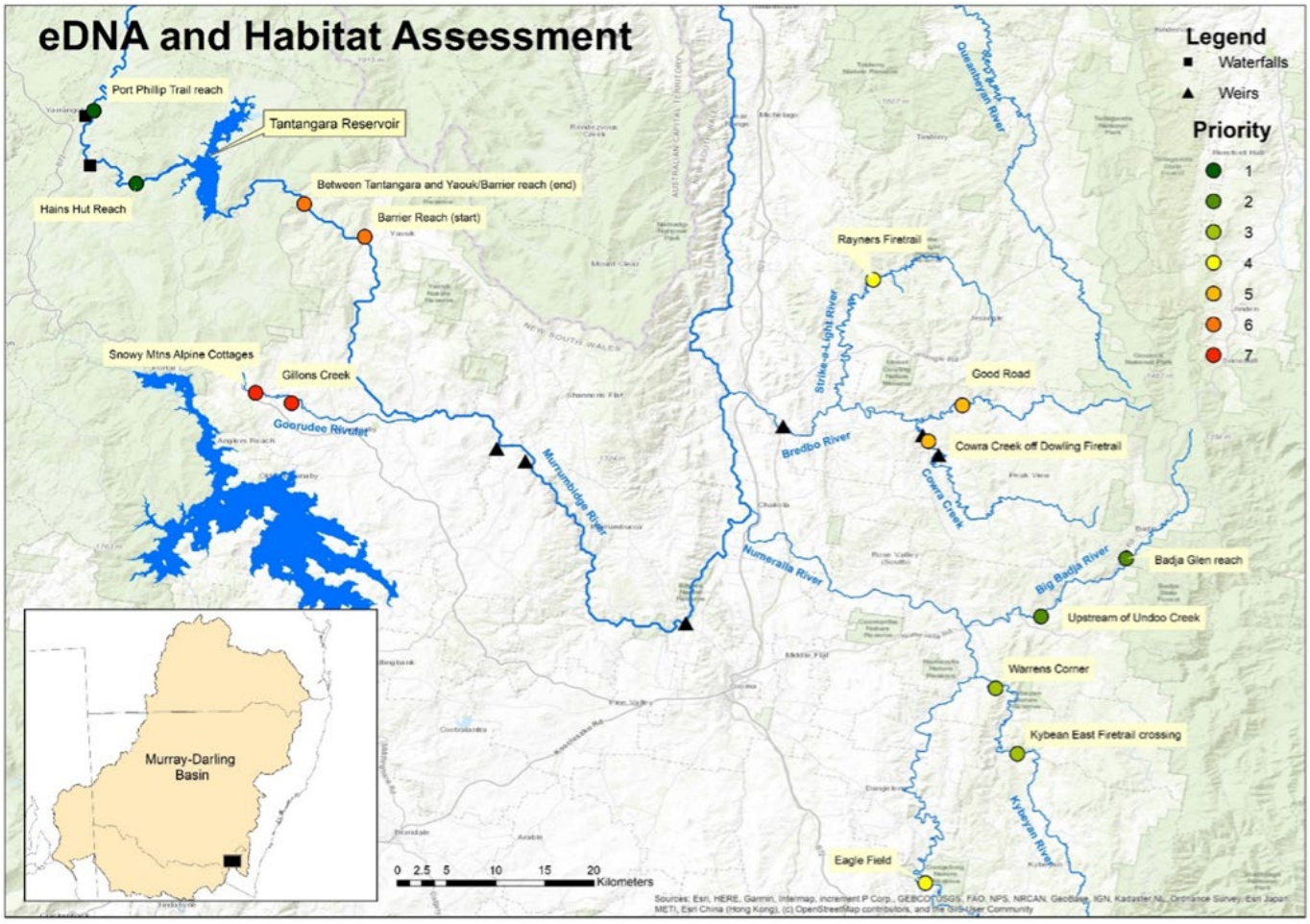

Figure 21. Map of sites to be assessed in the Macquarie Perch catchment surveys 24/25.

Table 12. Macquarie Perch catchment survey monitoring sites 24/25.

Site	Waterway	eDNA sampling priority	Historic presence	Previous survey data
Hains Hut Reach	Murrumbidgee River	1	Yes	
Port Phillip Trail reach	Murrumbidgee River	1	Unknown	
Badja Glen Reach	Big Badja River	2	Yes	Yes
Upstream of Undoo Creek	Big Badja River	2	Unknown	
Kybeyan East Firetrail Crossing	Kybean River	3	Unknown	
Warrens Corner	Kybean River	3	Unknown	Yes
Eagle Field	Numberalla River	4	Unknown	Yes
Rayners Firetrail	Strike-A-Light River	4	Unknown	
Good Road	Bredbo River	5	Unknown	
Cowra Creek off Dowling Firetrail	Cowra Creek	5	Unknown	
Barrier Reach (start)	Murrumbidgee River	6	Unknown	
Between Tantangara and Yaouk/ Barrier Reach (end)	Murrumbidgee River	6	Angler Report	
Gillons Creek	Goorudee Rivulet	7	Unknown	
Snowy Mountains Alpine Cottages	Goorudee Rivulet	7	Unknown	

Discussion

4.1 Stocky Galaxias

4.1.1 Population Monitoring

The 2024 monitoring found that there were no threats of other triggers that required TARP intervention. The abundance of Stocky Galaxias at both locations appeared lower than previously recorded, although it must be acknowledged that 2024 is the first dedicated sampling conducted under the Snowy 2.0 monitoring program. Whether this apparent low abundance compared to previous ad hoc sampling reflects a seasonal change in population abundance or sampling efficiency is unknown and will be investigated in the 2024/25 AIP (Lintermans and Allan 2024).

4.1.2 Captive Breeding

Given the uncertainty regarding the suitability of the Eucumbene Borrows as an ongoing ex-situ location to maintain an insurance population of Stocky Galaxias, due to high water temperatures during the 2023/24 summer, the current objectives of the captive breeding program were re-evaluated for the upcoming 2024 season, with the options listed and evaluated below.

Stocky Galaxias Captive Breeding Options 24/25 Season

1. Continue captive breeding program as planned with the collection of additional broodfish (10 females and 25 males). **Not Recommended**
2. Continue captive breeding program with the current broodfish, progeny released into Eucumbene Borrows or other sites identified during catchment surveys. **Not Recommended**
3. Continue captive breeding program with the current broodfish, progeny utilised for temperature tolerance experiments to gain a better understanding of the upper thermal tolerances of the species. **Recommended Option**
4. Continue captive breeding program with current broodfish, progeny to be held at CSU to be grown out for 12 months. **Not Recommended**
5. Hold current broodfish but don't undertake any breeding. **Not Recommended**
6. Pause the program and release current held broodfish. **Not Recommended**

Option 1. Further information is required regarding the capacity of the wild populations to sustain the required level of harvest before additional animals are collected from the wild. Population surveys and a population estimate of the Tantangara Creek population that are planned for this season will inform whether the Tantangara Creek population can maintain a level of removal. Further clarification is also required regarding the genetics of the populations and how this is best managed moving forward i.e. are the populations mixed via the captive program, and, do the wild populations require mixing or be maintained as separate genetic management units. **Not Recommended**

Option 2. Given the uncertainty regarding the high temperatures at Eucumbene Borrows it is not recommended that any further reintroductions occur there until such time as there is evidence of current released fish persisting over summer and further temperature data is collected. Release of captive bred fish into suitable sites identified via the catchment surveys may be an option but cannot be relied upon at this stage. **Not Recommended**

Option 3. This option will improve knowledge and understanding regarding the upper thermal tolerances of Stocky Galaxias, which along with additional data collected from Eucumbene Borrows, will inform whether to continue to use the site as a suitable release and refuge location. It will also provide insight into the lower elevationall limits of the species which will inform the geographic extent of where reintroduction may be successful. Following the experiments, juveniles will be either maintained in captivity or released at Eucumbene Borrows or at an alternative site. **Recommended Option**

Option 4. There would be additional costs associated with this option due to increased husbandry/feeding and monitoring of any on grown Stocky Galaxias. Depending on the number produced there may also be a requirement for additional facilities.
Not Recommended

Option 5. This option is not recommended as it will not further knowledge and understanding of the species.
Not Recommended

Option 6. This option is not recommended as there will potentially be additional impacts on the wild population due to increased broodfish collection in the future to restart the program, potential budget implications due to restarting the program, loss of continuity of staff and knowledge and missed opportunity to continue to learn and refine captive breeding and husbandry techniques.
Not Recommended

4.1.3 Translocation

Translocations of Stocky Galaxias to date have all been undertaken at the Eucumbene Borrows. At this stage no further translocations are to be undertaken at the Eucumbene Borrows until either:

- further temperature data is collected following intervention works that demonstrates improved maximum temperatures considered appropriate for the ongoing survival, spawning and recruitment of population
- there is evidence that the Stocky Galaxias that have been released into the site are surviving and reproducing or
- the temperature tolerance experiments demonstrate that the maximum temperatures recorded at the Eucumbene Borrows are within the thresholds suitable for Stocky Galaxias.

4.2 Macquarie Perch

4.2.1 Population Monitoring

The 2024 Snowy 2.0 Macquarie Perch monitoring found there were no threats or other triggers to require TARP intervention. The abundance of Macquarie Perch in the sampling program is at a record high, although it must be acknowledged that 2024 is the first dedicated monitoring conducted under the Snowy 2.0 monitoring program. The resumption of good recruitment of young-of-year fish at a number of sites in 2024 is encouraging, and it remains to be seen how this young-of-year abundance translates to age 1+ abundance in 2025 (Lintermans 2024).

4.2.2 Captive Breeding

The use of species specific GnRHa implants developed by the Sunshine Coast University continue to be successful in inducing captive held Macquarie Perch to spontaneously spawn in tanks within the hatchery environment. Whilst the process and techniques require further refinement, there is capacity to produce modest numbers of Macquarie Perch for potential reintroduction into the upper Murrumbidgee Catchment.

The Macquarie Perch spawning season for 2024 at the NFC is scheduled to commence on the 21 October 2024 and will involve several experiments to further refine and improve the spawning and egg and larval rearing process, a summary of the focus for the 2024 season:

Broodfish studies

1. Effect of temperature and water source on spontaneous spawning of Macquarie Perch in tanks

   2×2 factorial

   Temperature - ambient 18ºC (best practice) and 23ºC

   Water source - river and bore

   Replications - 3 tanks depending on number of mature female fish (12 tanks total)

2. Comparison of spawning of captive wild-collected and newly wild-collected Macquarie Perch in tanks

Comments: Fish which don't spawn within 48h after first GnRH dose will be cannulated and receive a second GnRH dose.

Hatchery studies

1. Effect of temperature and water source on incubation and hatching success of Macquarie Perch eggs - small-scale studies. Design to be developed.
2. Effect of boric acid and formalin on control of Saprelognia infestation of Macquarie Perch eggs – small-scale studies. Design to be developed. Pending APVMA approval.

Broodfish Management

A genetic management strategy for Macquarie Perch is currently being prepared by the team at Monash University. This plan will inform the current and future captive breeding program for Macquarie Perch and give clear guidance on which populations should be mixed, and to what extent, to achieve the greatest level of genetic diversity and adaptation potential. The advice and recommendations from this plan will guide the ongoing genetic management of the upper Murrumbidgee Macquarie Perch population and what admixing of genetics from other populations should be included in the program.

Long term brood stock targets will be informed by the genetic management strategy currently in preparation, however given the forecast production targets it is envisaged that at least 250 Macquarie Perch brood stock will be required.

Previous attempts to incorporate large mature broodfish into the program have proven unsuccessful. Large mature Macquarie Perch from the upper Murrumbidgee River, Mongarlowe River and Dartmouth Dam that were included in the program in the past all lost condition and did not contribute, particularly the females who either did not develop eggs or only developed eggs of very poor quality. Given this result, the focus will be on collecting younger subadult fish to acclimate over a longer period of time and in the interim, whilst we are waiting for these fish to mature, utilise mature running ripe Macquarie Perch from the upper Murrumbidgee to cross with some of the existing fish already in the program at NFC.

Collection of mature ripe broodfish from the upper Murrumbidgee River will occur the week prior to the commencement of the spawning season at NFC and will focus on one of the known spawning locations between site 7 and site 8 (van der Muelen et al. 2023), with a collection target of 10 adult Macquarie Perch.

4.2.3 Translocation

Translocations of 67 Macquarie Perch in 2024, whilst not meeting the target number of 100 animals identified in the 23/24 AIP, is still a valuable contribution to the genetic diversity of the upper Murrumbidgee River population, particularly at Site 3 (Bolaro) where genetic enhancement has not occurred previously, and recent analysis has shown low genetic diversity and strong inbreeding (Pavlova et al. in press). The success or otherwise of these translocations will not be known for a number of years until further genetic data is collected and analysed to determine if the translocated fish have survived and are contributing to the population and increasing the genetic diversity and fitness of the population.

Recommendations

5.1 Stocky Galaxias

5.1.1 Population Monitoring

→ Investigate the seasonal effect of timing of Stocky Galaxias sampling on fish abundance. The 2025 monitoring should be conducted twice at both locations (in early-February and late March/early April).

→ The monitoring approach developed and applied for the 2024 monitoring should be adopted as the protocol for future monitoring.

→ The requirement for a population estimate for Stocky Galaxias at Tantangara Creek is noted. Such an estimate is planned to be completed in early 2025 with funding from the Commonwealth Government's "Saving Native Species" Grant Program. If this population estimate does not proceed for whatever reason, it should be included as a priority for funding under this program in future years.

5.1.2 Captive Breeding

→ The current captive breeding program continues at CSU with the current broodfish and progeny to be utilised for temperature tolerance experiments to gain a better understanding of the upper thermal tolerances of the species.

→ Develop a broodfish management plan that is informed by the current genetic assessment currently being undertaken.

5.1.3 Translocation

→ Develop a translocation strategy in line with the recommendations of Raadik et al (2022) incorporating the information from the current genetic assessment and the results of the catchment surveys planned for 2024/25.

5.1.4 Catchment Surveys

→ Catchment surveys should be conducted in accordance with the recommendations provided by Raadik and Lintermans (2022b).

5.2 Macquarie Perch

5.2.1 Population Monitoring

→ Monitoring should be repeated in 2025 using the same sites and method. Further investigation of available access at Site 1 is required to enable better spacing of nets. If this enhanced access is not available, the site may have to be moved slightly downstream where better access is available.

→ To focus future TARP investigations into future potential recruitment failures, locating spawning locations across the recruitment reach is a priority if future TARP investigations are to be focused and deliver timely results.

→ Develop a proposal to identify key spawning locations.

5.2.2 Captive Breeding

- → Captive breeding of Macquarie Perch continues at the NFC as part of the “Cracking the Code” project.
- → The program attempts to include additional wild caught mature ripe Macquarie Perch into the captive program.
- → Additional broodfish are to be added to the program as informed by the genetic management strategy currently under development.
- → Develop a broodfish management plan informed by the current genetic management strategy being developed.
- → Additional Macquarie Perch pond infrastructure is to be developed at the NFC to enable the holding and on growing of larger number of broodfish and increased larval rearing capacity.

5.2.3 Translocation

- → Continue genetic rescue/enhancement of the upper Murrumbidgee River population with fish sourced from Cataract Dam and Loddon Creek.
- → Collect 102 Macquarie Perch from Cataract Dam and Loddon Creek for release at Site 2 (Killarney), Site 3 (Bolaro) and Site 4 (Koomulla).
- → Utilise suitable admixed Macquarie Perch from the captive breeding program at NFC if available to enhance the genetic diversity of the upper Murrumbidgee River Macquarie Perch population as recommended by the genetic management strategy currently in development.
- → Utilise suitable admixed Macquarie Perch from the captive breeding program at NFC to stock into appropriate reintroduction locations identified by the catchment surveys.

5.2.4 Catchment Surveys

- → Catchment surveys should be conducted in accordance with the recommendations provided by Lintermans et al (2022b).

5.2.5 Habitat Enhancement Works

- → Undertake investigations to identify opportunities for investment in habitat enhancement works that will complement existing programs to achieve the greatest ecological benefit and value for money invested.

Expenditure

The forecast and actual expenditure on each of the planned activities for 2023/24 are detailed in Table 13 below. Total expenditure was less than forecast so these funds will be reallocated to activities in future years.

Table 13. Expenditure forecast 2023/24 and actual 2023/24

Activity	Forecast 23/24	Actual Expenditure 23/24
Macquarie Perch		
Population monitoring, surveillance and research	$54,195	$51,695
Habitat Surveys	$6,500	$2,286
Captive Breeding, stocking and monitoring	$253,795	$167,843
Habitat Enhancement	$0	$0
Stocky Galaxias		
Population monitoring, surveillance and research	$27,290	$27,290
Habitat Surveys	$6,500	$2,287
Captive Breeding, stocking and monitoring	$145,862	$145,862
Total	**$494,142**	**$397,263**

References

Baumgartner, L., C. Boys, D. Gilligan, L. G. Silva, B. Pflugrath, and N. Ning. 2018. Fish transfer risk associated with Snowy 2.0 pumped hydro scheme: A report prepared for Snowy Hydro Ltd. Institute for Land, Water and Society, Charles Sturt University. 28 pp.

Couch A.J., Unmack P.J., Dyer F.J., Lintermans M. (2016). Who's your mama? Riverine hybridisation of threatened freshwater Trout Cod and Murray Cod. PeerJ 4:e2593; DOI 10.7717/peerj.2593

Duncan, M. D., B. Sarwer, G. Morris, S. (2024). Detection of an invasive freshwater fish, redfin perch (*Perca fluviatilis*) using an environmental DNA (eDNA) approach. Department of Primary Industries and Regional Development.

EMM (2019). Snowy 2.0 Main Works Environmental Impact Statement. September 2019. Available at: https://pp.planningportal.nsw.gov.au/major-projects/projects/snowy-20-main-works

EMM (2020). Snowy 2.0 Main Works Environmental Impact Statement. Preferred Infrastructure Report and Response to Submissions. February 2020. Available at: https://pp.planningportal.nsw.gov.au/majorprojects/projects/snowy-20-main-works

Griffiths J, Licul S, Impey R, and Weeks, A. (2023). Monitoring for the presence of *Perca fluviatilis, Gambusia holbrooki,* and *Galaxias brevipinnis* within catchments connected to the Snowy Scheme using environmental DNA,2023. Report prepared by EnviroDNA for Snowy Hydro Limited.

Koehn, J.D., Lintermans, M., Lyon, J.P., Ingram, B.A., Gilligan, D.M., Todd, C.R. and Douglas, J.W. (2013). Recovery of the endangered trout cod *Maccullochella macquariensis*: What have we achieved in more than 25 years? Marine and Freshwater Research 64, 822–837

Lintermans, M. (2023). Macquarie perch recruitment monitoring in the upper Murrumbidgee and Mongarlowe rivers: March 2023 results, and five-year project review (2019–2023). Consultancy report to South East Local Land Services. Fish Fondler Pty Ltd.

Lintermans, M. (2024). Snowy 2.0 Macquarie perch monitoring in the upper Murrumbidgee catchment 2024. Consultancy report to NSW DPI (Fisheries). Fish Fondler Pty Ltd.

Lintermans, M. and Allan, H. (2024). Snowy 2.0 Stocky Galaxias monitoring at Tantangara Creek and Sallys Flat Creek 2024. Consultancy report to NSW DPI (Fisheries). Fish Fondler Pty Ltd.

Lintermans, M., Tonkin, Z., Lyon, J. and Gilligan, D. (2022a). Macquarie Perch – monitoring plan, Snowy 2.0. Published client report for Snowy Hydro Ltd, Cooma. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Lintermans, M., Lyon, J. and Tonkin, Z. (2022b). Macquarie Perch – catchment survey, Snowy 2.0. Published client report for Snowy Hydro Ltd, Cooma. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Lutz M.L., Tonkin Z., Yen J.D.L., Johnson G., Ingram B.A., Sharley J., Lyon J., Chapple D.G., Sunnucks P., and Pavlova A. (2021). Using multiple sources during reintroduction of a locally extinct population benefits survival and reproduction of an endangered freshwater fish. Evolutionary Applications 14(4), 950–964.

Lyon, J. Ho, H., Ingram. B, Gilligan, D., Pavlova, A., Moyles, A. and Tonkin, Z. (2022). Macquarie Perch – captive breeding strategy, Snowy 2.0. Published client report for Snowy Hydro Ltd, Cooma. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Ning N, Doyle K, Silva L.G, Boys C.A, McPherson J, Fowler A, McGregor C, Brambilla E, Thiebaud I, du Preez J, Robinson W, Deng Z.D, Fu T, Baumgartner L.J (2019). Predicting invasive fish survival through the Snowy 2.0 pumped hydro scheme. Report prepared for Snowy Hydro Limited. Institute for Land, Water and Society, Charles Sturt University. 93 pp.

Raadik, T.A. and Lintermans, M. (2022a). Stocky Galaxias - monitoring plan, Snowy 2.0. Published client report for Snowy Hydro Ltd, Cooma. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Raadik, T.A. and Lintermans, M. (2022b). Stocky Galaxias - catchment survey, Snowy 2.0. Published client report for Snowy Hydro Ltd, Cooma. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Raadik, T.A., Stoessel, D. and Lintermans, M. (2022). Stocky Galaxias - translocation strategy, Snowy 2.0. Published client report for Snowy Hydro Ltd, Cooma. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

Thomas A.C., Howard J., Nguyen P.L., Seimon T.A. and Goldberg C. S. (2018). ANDeTM: A fully integrated environmental DNA sampling system. Methods in Ecogical. Evolution. 9 1379–1385.

Stoessel, D.J. and Raadik, T.A. (2022). Stocky Galaxias – captive breeding strategy, Snowy 2.0. Published client report for Snowy Hydro Ltd, Cooma. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria, 33 pp.

Tims, A.R. and Saupe, E.E., 2023. Forecasting climate-driven habitat changes for Australian freshwater fishes. Diversity and Distributions 29(5), 641–653.

Tonkin, Z., Lintermans, M., Gilligan, D. and Lyon, J. (2022). Macquarie Perch - translocation strategy, Snowy 2.0. Published client report for Snowy Hydro Ltd, Cooma. Arthur Rylah Institute for Environmental Research, Department of Environment, Land, Water and Planning, Heidelberg, Victoria.

van der Meulen, D., Haantjens, P., Gilligan, D., Jess, L., and Stocks, J. (2023). Macquarie Perch Wild Egg Collection: An assessment of viability of wild eggs collection as a non-invasive method ro enhance Macquaire perch populations in the upper Murrumbidgee River. NSW Department of Primary Industries, Batemans Bay Fisheries Centre, Batemans Bay, NSW 2536.

Appendix

8.1.6 Appendix 1

Threatened Fish Management Plan Expert Advisory Committee

In accordance with Condition 24(b) of the NSW Infrastructure Approval an Expert Advisory Committee (EAC) was established in December of 2023 to oversee the development, implementation and reporting of the actives undertaken under the TFMP. The EAC is governed by agreed Terms of Reference (TOR) with membership consisting of various scientific and technical advisors relevant to the activities specified in the TFMP. The EAC will be comprised of a minimum of four and a maximum of six members comprising the following skills/membership;

1. Chair
2. NSW Fisheries Scientific Committee member
3. Freshwater fish specialist scientist
4. Other specialist

The current EAC membership along with the skills and experience they bring to the committee:

Barry Buffier – Chair

Barry is a former senior NSW public servant and headed up three NSW Government Departments with over 40 years' experience in a variety of departments. This included serving as the Director-General of the NSW Department of Primary Industries which included NSW Fisheries. Early in his career he was also the Executive Director with responsibility for Fisheries regulation.

He has extensive experience and expertise in the public and private sectors serving on many boards, committees and authorities.

Barry brings his critical thinking, pragmatic approach, eye for detail and his natural leadership skills to his role as Chair.

Dr Nick Whiterod – NSW Fisheries Scientific Committee member

Nick is an ecologist with more than two decades experience, working broadly conserving and researching freshwater species and ecosystems across South Australia and Australia. He has conducted several successful species reintroduction projects, contributed to the national conservation listing of more than 50 freshwater fish and crayfish, and actively worked to understand and conserve freshwater fish across Australia.

Nick is a current member of the NSW Fisheries Scientific Committee and brings and extensive knowledge and practical experience in the monitoring and recovery of threatened aquatic species.

Dr Tarmo A. Raadik – Freshwater fish specialist scientist

Tarmo is an aquatic taxonomist and research biologist with over 35 years of experience in the management, research and conservation of aquatic fauna. Tarmo has extensive knowledge on alien and native aquatic fauna distribution in eastern Australia and specialist skills in freshwater and estuarine aquatic fauna assessment, taxonomy/systematics, biology, conservation and monitoring, with emphasis on fish, decapod crustaceans and bivalve molluscs.

Tarmo discovered and described Stocky Galaxias along with 12 other new species of galaxiids in 2014 and is the pre-eminent expert on the family, including their conservation management.

Dr Natalie Moltschaniwskyj – Other Specialist NSW DPI Chief Scientist

Natalie is a pre-eminent marine biologist with a distinguished career in fisheries research and aquaculture spanning 30 years. Natalie is a highly regarded member of the scientific community, with over 100 publications to her name, she is renowned for her ability understand and communicate complex problems as well as facilitate and build collaborations across different fields and disciplines.

Natalie brings her wealth of knowledge and experience in the delivery of highly complex scientific projects to the committee.

Snowy Hydro provides administrative support to and manages the EAC and the membership with this role currently being fulfilled by Lizzie Pope.

NSW Department of Primary Industries and Regional Development is represented by Luke Pearce who provides reports and updates on activities undertaken or managed by NSW DPIRD.

8.1.1 Appendix 2

Snowy 2.0 Stocky Galaxias monitoring at Tantangara Creek and Sallys Flat Creek 2024.

8.1.2 Appendix 3

Snowy 2.0 Macquarie Perch monitoring in the upper Murrumbidgee catchment 2024.

8.1.3 Appendix 4

Photos from Abercrombie River Macquarie Perch Monitoring.

Figure 23. Various sizes classes of Macquarie Perch captured during sampling in the Abercrombie River.

Figure 24. NSW DPIRD staff with an adult Macquarie Perch, captured during sampling in the Abercrombie River.

Figure 25. Murray Cod captured during sampling in the Abercrombie River.

Figure 26. Macquarie Perch with damage to caudal fin captured during sampling in the Abercrombie River.

Figure 27. Smiths Crossing on Abercrombie River.

Figure 28. Tween Cabin on Abercrombie River.

8.1.5 Appendix 5

Detection of an invasive freshwater fish, Redfin Perch (*Perca fluviatilis*) using an environmental DNA (eDNA) approach.

8.1.4 Appendix 6

Macquarie Perch Captive Breeding Progress Report.


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