2023/24 Annual Implementation Plan

Snowy 2.0 Threatened Fish Management Plan

NSW GOVERNMENT | snowyhydro | snowy 2.0

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1. 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 to increase the existing population's resilience to the potential biosecurity risks from the development.

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 program will be funded by Snowy Hydro and undertaken by NSW DPI with activities to be guided by an annual implementation plan (AIP) developed by NSW DPI to outline the activities and deliverables that will occur under the program. The AIP will be prepared by the 30th of June each year (or such date as otherwise agreed by Snowy Hydro Limited (SHL) and NSW DPI) and submitted to the Expert Advisory Committee (EAC) for review and endorsement or otherwise by the 31st of July of each year. NSW DPI will then provide deliverables to EAC as they occur throughout the year, including a draft annual report to the EAC by 31 August of each year detailing activities and results.

Once finalised, the annual report will be made public via the Snowy 2.0 website.

2. Program overview

Each year, the following sections are to be reviewed as part of the annual plan preparation to ensure they remain relevant as the Program progresses.

2.1 Goal

The overall goal of the program is 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.

2.2 Measures of success

Achievement of the goal of the program can be measured by progress against the following three key outcomes:

1. An established monitoring program that provides quantitative data about the spatial and temporal patterns of population size and structure (age, size, genetic) and distribution of Macquarie Perch and Stocky Galaxias in current known locations within the upper Murrumbidgee Catchment, to allow assessment of species status and inform success of re-stocking/re-introduction program.
2. An established basis for a successful re-stocking/ re-introduction program of genetically diverse individuals for Macquarie Perch and Stocky Galaxias supported by; scalable hatchery protocols for captive breeding; habitat rehabilitation; and for Stocky Galaxias an established captive reproductive insurance population in “The Eucumbene Borrows”.
3. Improved knowledge on the distribution (presence/ absence) and potentially suitable habitat of Macquarie Perch and Stocky Galaxias, to inform decisions on management intervention for the long-term survival of the species.

3. Specific aims, objectives, activities and targets of the five-year plan

The following details are taken from Lintermans et al. (2022a,b), Lyon et al. (2022),Raadik and Lintermans (2022a,b), Raadik et al. (2022), Stoessel and Raadik (2022) and Tonkin et al. (2022). These documents contain additional specific detail on methods and effort.

3.1 Goal

3.1.1 Stocky Galaxias

Aim: To provide baseline, comparable data on the species, to inform decisions on management intervention for the long-term survival of the species.

Objectives are to collect data on:

- → The persistence of Stocky Galaxias (presence and breeding).
- → The population trajectory (is the population increasing, stable or decreasing) and variability (significant change from normal).
- → The status of the Stocky Galaxias population (incorporating measures of abundance, distribution, reproduction, fish health and demographics).
- → 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).
- → The persistence and establishment of any new translocations of the species into the catchment.
- → 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.
- → Metrics informing triggers (as part of a Trigger Action Response Plan (TARP)) for identified management interventions to mitigate potential sudden declines because of identified threats (e.g. fish incursion, fire, drought).
- → 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).

Activities:

→ Undertake population monitoring at the 2 sites in Tantangara Creek and one site in Sallys Flat Creek as outlined in section 6.2.2 of this document.

Target:

→ Improved knowledge of baseline population, distribution, and fluctuations, and measuring the success or otherwise of restocking and translocation programs.

3.1.2 Macquarie Perch

Aim: provide baseline, comparable data on the Mid Murrumbidgee population, to inform decisions on management intervention for the long-term survival of the population.

Objectives are to collect data on:

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

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

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

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

→ Incursions of Redfin Perch into the Mid Murrumbidgee catchment.

→ 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).

Activities:

→ Undertake population monitoring at the 7 core sites and 2 fringe sites in the Murrumbidgee River and 2 reference sites in the Abercrombie River as outlined in section 6.1.4 of this document.

Target:

→ Improved knowledge of baseline populations, distribution and fluctuations, and measuring the success or otherwise of restocking and translocation programs.

3.2 Catchment Survey

3.2.1 Stocky Galaxias

Aim: improve knowledge on the distribution (presence/absence) and potentially suitable habitat of Stocky Galaxias, to inform decisions on management intervention for the long-term survival of the species.

Objectives:

→ Locate any additional Stocky Galaxias populations.

→ Identify potential future Stocky Galaxias translocation sites.

Activities:

→ Develop desktop prioritisation of sites and undertake prioritisation.

→ Undertake initial ‘rapid’ survey.

→ Second prioritisation.

→ Detailed survey of identified sites (habitat, barriers, predatory fish/barriers).

Output: Identify at least 3 priority reintroduction locations.

3.2.2 Macquarie Perch

Aim: Establish the geographic extent of the existing population/s of Macquarie Perch in both the Murrumbidgee River mainstem and major tributaries

Objectives:

→ Identify potential translocation sites.

→ Identify opportunities for habitat enhancement .

→ Verify the presence and distribution of target pest fish within the catchment (i.e. Redfin Perch, Perca fluviatilis).

Activities:

- → Determine current distribution and abundance.
- → Identify potential translocation/reintroduction sites.
- → Locate barriers to dispersal/colonisation and predator control barrier sites.

Target:

- → Identify at least 3 priority reintroduction locations.

3.3 Translocation

3.3.1 Stocky Galaxias

Aim: improve the conservation status of Stocky Galaxias in the wild to ensure enough viable populations with evolutionary potential exist to support long term persistence.

Objectives:

- → Increase the number of wild populations, and therefore decrease the risk of extinction of the species by establishing additional populations to the two presently known.

Activities:

- → Investigating and prioritising options to enhance the condition and resilience of the current population.
- → Establish a translocation procedure to enable the harvesting and translocation of Stocky Galaxias (wild-to-captivity, captivity-to-wild, and wild-to-wild) to act as brood stock for a captive breeding program, to establish additional wild populations, and where required, for emergency extraction.
- → Translocation site identification and suitability assessment.
- → Genetic modelling and assessment of the donor and recipient populations.
- → Collection of fish for wild-to-wild translocation.
- → Pre-release translocation site monitoring.
- → Translocate individuals to establish a captively maintained population in the short term, as insurance against the loss of the species in the wild.
- → Post-release monitoring to assess success of translocations (short- and long-term).

Target:

- → Have initiated stocking at, at least one of the priority locations, with the detection of survival of released fish.

3.3.2 Macquarie Perch

Aim: Improve the conservation status of Macquarie Perch in the upper Murrumbidgee catchment by enhancing condition and resilience of the current population/s.

Objectives:

- → extend the range and abundance of the current population or establish new populations. Improve the genetic fitness and ensure the persistence of the existing population/s in the catchment.

Activities:

- → Establish a catchment specific translocation procedure to enable the harvesting, transport and release/return of Macquarie Perch for translocation, stock for a captive breeding program, and for emergency extraction if needed.
- → Establish an ex-situ population maintained in captivity in the short term, as insurance against the loss of the population (and therefore unique genetic diversity for the species more broadly) in the wild.
- → Undertake captive breeding and/or wild to wild translocation of Macquarie Perch to establish an insurance population in a new area of the catchment if a suitable area is identified, and to provide offspring to bolster the upper Murrumbidgee population if needed.

Target:

- → Detection of admix genetics along current know Macquarie Perch distribution and have initiated stocking at, at least one of the priority locations, with the detection of survival of released fish.

3.4 Captive Breeding

3.4.1 Stocky Galaxias

Aim: Improve the resilience of the species by increasing the number of individuals and populations through the captive production of viable offspring with evolutionary potential.

Objectives: To identify:

- Existing knowledge and knowledge gaps in relation to the captive maintenance and breeding of Stocky Galaxias.
- The requirements for captive breeding and rearing of Stocky Galaxias.

Activities:

- **Quarantine**
  - Development of quarantine protocol specific to hatchery facility, including fish health protocol.
  - Isolation and observation of batches of fish entering the facility, and treatment for parasites or disease, to ensure no transferal of disease or parasites, and that only healthy fish are maintained.
- **Captive maintenance**
  - Development of a captive maintenance protocol to maximise fish health and vigour, to promote reproductive progression, and to minimise mortality.
  - Undertake captive maintenance of fish.
  - Genetic analysis of individuals to provide data to the breeding program (i.e. selection of brood stock or brood-pairs) to meet genetic targets of the captive breeding plan (see further down).
- **Captive breeding**
  - Development of a captive breeding protocol that is guided by genetics and that ensures reproductive success (egg fertilisation and development, hatching, and larval growth and survival) and genetic targets for offspring are met.
  - Development of post spawning recovery guidelines to maximise brood stock recovery, and, if necessary, the replacement of all or part of the brood stock if needed before captive management continues.
  - Undertake captive breeding (spawning, fertilisation, egg development and hatch, larval survival, and development).
- **On-growing offspring**
  - Develop larval rearing protocol.
  - On-grow offspring and maintain until release.
  - Assessment of offspring genetics to monitor compliance with the genetic target of captive breeding (if required).

Targets:

- Maintain a minimum of 100 Stocky Galaxias brood stock (genetic make up to be informed by current genetic analysis).
- The potential to initially produce 1500 Stocky Galaxias annually increasing to 2500 annually.
- Increase the abundance and distribution of Stocky Galaxias.

3.4.2 Macquarie Perch

Aim: Improve the resilience of the population by increasing the number of individuals through the captive production and stocking of viable offspring with evolutionary potential.

Objectives:

- Detail the current approach for captive breeding of Macquarie Perch.
- Outline existing knowledge gaps, known limitations of existing techniques and current research.
- Set out the steps to procure and stock Macquarie Perch in the mid-Murrumbidgee River.

Activities:

- Captive breeding.
- Genetic augmentation.

Targets:

- → 100 Macquarie Perch brood stock (genetic make up to be informed by genetic management plan currently under development).
- → The potential to produce of 25,000 Macquarie Perch annually by the end of the 5 year program.
- → Increase the abundance and distribution of Macquarie Perch within the Upper Murrumbidgee Catchment.

3.5 Implementation timeframes

The initial five-year implementation of the Snowy 2.0 Threatened Fish Management Plan commenced on 1 January 2024 and will conclude on 31 December 2028, however, the planning is on a financial year basis as outlined below (Figure 1).

Consideration for the continuation of the program beyond the initial five-year will occur as the program progresses and in accordance with the trigger, action, response plan outlined in the TFMP.

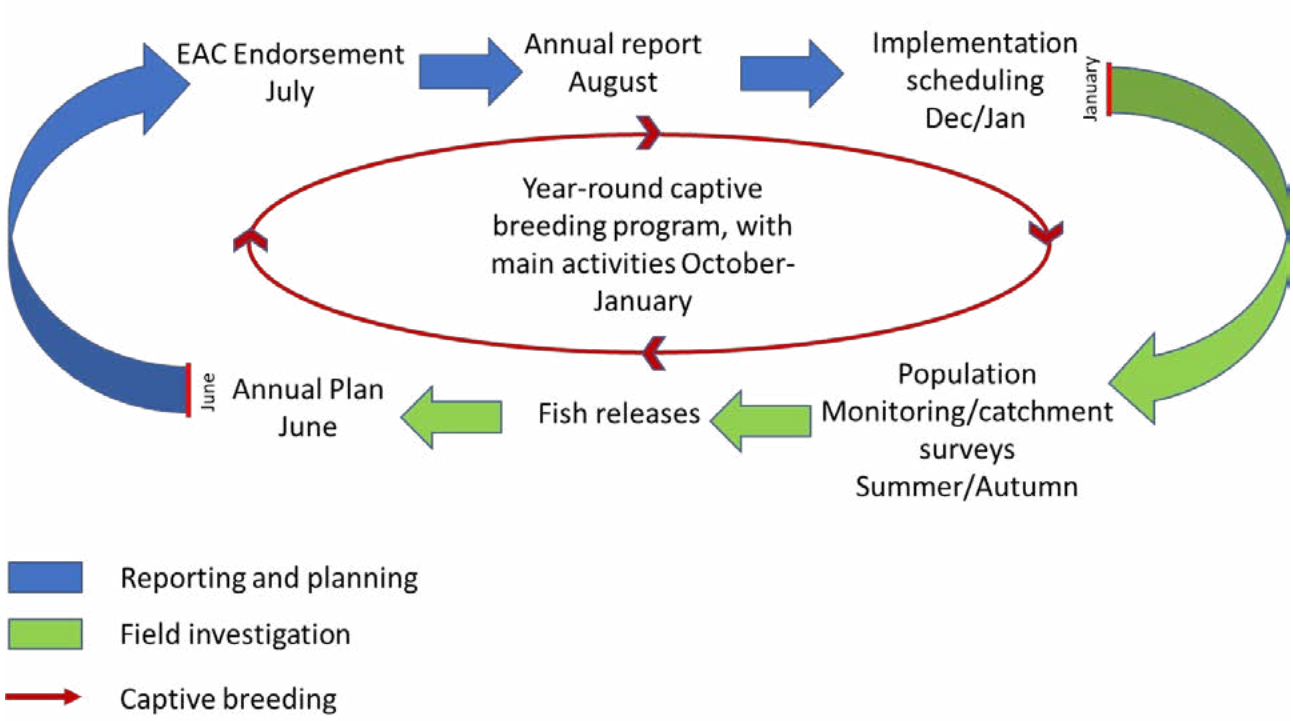


Figure 1. Indicative depiction of the implementation of the TFMP activities

4. Project management

Funding for the Program will be provided by Snowy Hydro to NSW DPI via a funding agreement.

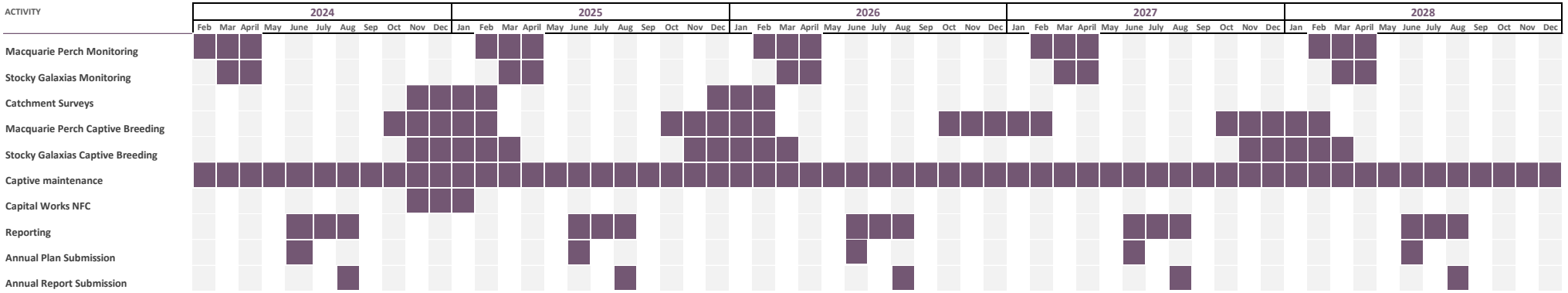
Implementation of the Program will be undertaken by the NSW DPI Fisheries, Habitat and Threatened Species team that sits within the Freshwater Environment Branch. Project lead will be the Senior Fisheries Manager Luke Pearce (Senior Fisheries Manager), who will be responsible for resource allocation and the development and delivery of the Annual Implementation Plan along with other staff within the team including Simone Mabon (Project Officer) and Tim McGarry (Fisheries Manager). Oversight of the development and implementation of the program will be provided by the Habitat and Threatened Species Program Leader Samantha Davis.

Myworkzone is the administration and finance system that DPI Fisheries uses for functions including finance, purchasing, procurement, staff time sheeting and cost centre management. All DPI projects are allocated a unique account identifier against which all related spending project spending (salaries, procurement etc.) are made. This allows expenditure to be planned, tracked and reported easily and allows for transparent audit processes to be undertaken. Daily time sheeting (with breaks) is also allocated to relevant project accounts to provide for accountable staff resourcing and tracking.

The NSW Government has set procurement guidelines and processes for the acquisition of goods and services, which is governed by the NSW Government Procurement Policy Framework. Procurement involves three broad stages: Plan, Source, and Manage. This provides for a structured approach to procurement, supported with a range of procurement tools to ensure business units achieve best practice procurement activity recommendations.

The Plan, Source, and Manage process provides for an accountable and transparent nine-step procedure to achieve successful procurement. The Department of Regional NSW maintains a Strategic Procurement Group that delivers procurement advisory and sourcing support services to optimise spend and deliver value for money for the department's sourcing activities, which will be used as needed during the project.

4.1 Schedule of implementation of the five-year program



5. Annual implementation plan 2023/2024

5.1 Schedule of the AIP for 23/24

Column1	FEB	MAR	APR	MAY	JUN
Mon			1 Easter Monday PH		
Tue			2 Genetic rescue upper Bidgee; Brood stock collection Bidgee		
Wed			3	1	
Thur	1		4	2	
Fri	2	1	5	3	
Sat	3	2	6	4	1
Sun	4	3	7	5	2
Mon	5	4 Macquarie Perch CTC and WOP Meeting; Stocky Gal TO engagement	8	6 Upper Bidgee Mac Perch Monitoring	3 Catchment survey desk top analysis
Tue	6	5	9	7	4
Wed	7	6	10 Stocky Gal Monitoring	8	5
Thur	8	7	11	9	6
Fri	9	8	12	10	7
Sat	10	9	13	11	8
Sun	11	10	14	12	9
Mon	12	11 Brood stock collection Cataract	15 Monitoring and brood stock collection Abercrombie; Upper Bidgee Mac Perch Monitoring	13 Stocky Gal release Eucumbene Borrows	10 Kings Birthday PH
Tue	13	12	16	14	11 Catchment survey desk top analysis
Wed	14	13	17	15	12
Thur	15	14	18	16	13
Fri	16	15	19	17	14
Sat	17	16	20	18	15
Sun	18	17	21	19	16
Mon	19	18	22	20 Eucumbene Borrows earth works	17 Snowy Reporting
Tue	20 EAC Meeting Cooma	19	23	21	18
Wed	21	20	24	22	19
Thur	22	21	25 Anzac Day PH	23	20
Fri	23	22	26	24	21
Sat	24	23	27	25	22
Sun	25	24	28	26	23
Mon	26	25 Native Fish Forum Canberra	29	27 Eucumbene Borrows earth works	24 Snowy Reporting
Tue	27 Brood stock collection Winburndale	26	30	28	25
Wed	28	27		29	26
Thu	29	28		30	27
Fri		29 Good Friday PH		31	28
Sat		30			29
Sun		31			30

6. Planned Activities

6.1 Macquarie Perch

6.1.1 Captive Breeding Current Program

Captive breeding will be ongoing at the Narrandera Fisheries Centre (NFC) as part of the "Cracking the Code" project which is focusing on utilising species-specific hormone technology to stimulate Macquarie perch to simultaneously spawn in captivity. This program is currently utilising F1 (Abercrombie origin) fish and Cataract Dam fish as the wild treatment. Previously held upper Murrumbidgee River brood fish that were collected in 2021 did not acclimate well to captivity at NFC and did not contribute to the captive program. These fish were all large adult fish when collected and it is likely that given their age (~20 years) and time spent in the wild they did not adjust well to captivity and lost condition whilst held. These fish were subsequently released back into the wild (Mongarlowe River) in March 2023.

The priority for captive breeding of Macquarie Perch as part of this plan is to establish capacity to house, maintain and grow additional Macquarie Perch from the Murrumbidgee and other populations in both outdoor earthen ponds and indoors in a controlled hatchery environment.

We plan to build the additional pond to hold increased numbers of brood fish and for larval rearing purposes to accommodate the required increased number of brood stock and production output. A minimum of 5 new ponds will be constructed to house and rotate broodfish, grow out subadults for future use in the program and larval rearing. We are currently investigating pond options and seeking quotes for pond construction that will occur in the 2024/25 financial year. We also plan to refit the existing hatchery building to allow for the housing and spawning of Macquarie Perch, this will involve the removal of some of the existing tanks which will be replaced with larger more appropriate tanks, the addition of improved filtration systems, recirculation systems and heater chiller units, components this will occur in the 2023/24 financial year.

6.1.2 Brood Stock Collection

The captive population of Macquarie Perch held at the NFC consists largely of first generation (F1) captive breed fish from Abercrombie River genetics that were spawned on site at NFC in 2013 (N=37), captive bred second generation (F2) fish of Abercrombie genetics (N=120) some of these fish reached sexual maturity in 2023, Cataract Dam fish (N=32) these fish, whilst sexually mature are very small and have yet to contribute to the captive breeding program, Dartmouth fish (N=2) and one upper Murrumbidgee male.

One of the main priorities for 23/24 is to obtain additional brood stock to incorporate into the captive breeding program, particularly from the Murrumbidgee system as well as other populations to increase not only the number of fish in the program but also the genetic diversity. Previous attempts to include brood fish from both the upper Murrumbidgee River and Dartmouth Dam, proved to be unsuccessful. Past attempts to incorporate fish from these locations focused on the collection of large mature fish, these fish did not acclimate well to the hatchery environment at NFC, lost condition and did not contribute to the captive breeding program and where subsequently released back into the wild after 2 breeding seasons. The approach we are planning on taking is to collect younger animals (1+ and subadults) and on grow them at NFC to allow for a longer period of acclimation. This will hopefully increase the likelihood of these animals contributing to the program and will have less of an impact on the donor population as we are not removing large mature breeding fish. Whilst this approach will have the lowest possible impact on the donor population it will increase the timeframe at which the fish will be sexually mature

and contribute to the breeding program, depending on the age of the fish when collected they may take between 3-4 years before becoming sexually mature and hence then contributing to the breeding program.

Targets for collecting broodfish from each location is outlined below:

- → Upper Murrumbidgee – 50
- → Cataract Dam – 20 brood fish and 100 for translocation
- → Retreat River – 5 (potential to collect F1 fish from previous releases)
- → Winburndale Dam – 10 (collection of on grown and potentially sexually mature F2's)

6.1.3 Production Targets

The current Macquarie Perch 'Cracking the Code' project is aimed at refining and improving the use of a synthetic species-specific hormone to induce female Macquarie Perch to simultaneously spawn in captivity, results to date have been very promising, however the technique requires further refinement which the current project aims to do over the next 2 breeding seasons (Oct 2024 and Oct 2025). These 2 seasons will be used to increase the number and genetic diversity of the current brood stock held at NFC and grown them out to reach sexual maturity with increased production envisaged in the 2026 breeding season. Initial output targets will 5,000-10,000 fingerlings/year in the first 2 years of increased production, increasing to 25,000 fingerlings/year by the end of this program.

6.1.4 Population Monitoring

Monitoring aim and objectives

The overall aim of the monitoring for Macquarie Perch is:

- → To provide baseline, comparable data on the Mid Murrumbidgee population, to inform decisions on management intervention for the long-term survival of the population.

Specific monitoring objectives for Macquarie Perch in the Mid Murrumbidgee catchment to meet the overall aim are to provide baseline, comparable data on:

- → The persistence of Macquarie Perch (is the species still present and breeding at sites where recorded since 1998?).
- → The population trajectory (is the population increasing, stable or decreasing?) and variability (significant change from normal).
- → The status of the Macquarie Perch population (incorporating measures of abundance, distribution, reproduction and demographics).
- → The persistence and establishment of any new translocations of the species into the catchment.
- → 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).

Time of sampling

Annual population sampling of sites should be conducted in early to mid-autumn (March–April), as this is the time of lowest flows and Young-of-Year fish will be of an advanced size, both of which improve detection probability. Sampling earlier or later than this runs the risk of lower detection probability due to higher flows, with episodic high flow events during later sampling also introducing even greater variation in catch data. One monitoring event, repeated annually at the same time of year is considered adequate, based on other threatened species monitoring programs.

Monitoring sites

The known existing distribution of the Macquarie Perch recruiting population encompasses approximately 95 km of the upper Murrumbidgee River mainstem between approximately the Numeralla River junction (~25 km downstream of Cooma) and Yaouk (Figure 1) (M. Lintermans unpublished data; D. Gilligan unpublished data, Lintermans 2016, 2020). Subadult and adult Individuals are sporadically captured at sites downstream of the Numeralla junction to the ACT border, but these are largely considered likely to be dispersing or vagrant individuals (M. Lintermans unpublished data).

Monitoring sites/reaches, including two potential reference sites, are listed in Table 1 and Table 2 and Figure 2 and 3, and have been selected to give adequate spatial coverage of the core distribution and

allow for detection of spatial expansion (an upstream and a downstream fringe site are included).

Reference sites are a valuable inferential component of a robust monitoring programs (Reynoldson et al. 2001; Davies et al. 2010; Lintermans et al. 2013; Broadhurst et al. 2020) but can be problematic for rare or threatened species monitoring. Threatened species often occur as small, fragmented populations (often on different population trajectories) with few populations available to act as a reference. At least one reference population and two sites are required to allow inference of whether changes in a trend of the target population is a local response, or if it represents a broader response across the species range (e.g. to climate extremes such as drought). It was the reference site data from the mid Murrumbidgee that clearly identified that a multi-year recruitment failure of Macquarie Perch in Cotter Reservoir was a local rather than regional pattern (Broadhurst et al. 2020). No two sites or streams are directly comparable and ideally data from multiple reference populations would be used to better represent the species trajectory, however we do not have the luxury of multiple reference sites for Macquarie Perch available in NSW.

The two reference sites identified within the Abercrombie River Macquarie Perch population that have been included in this annual plan may require further review and refinement during the program and will continually be assessed for suitability as reference sites as well as other options for reference sites including populations from the ACT and Victoria.

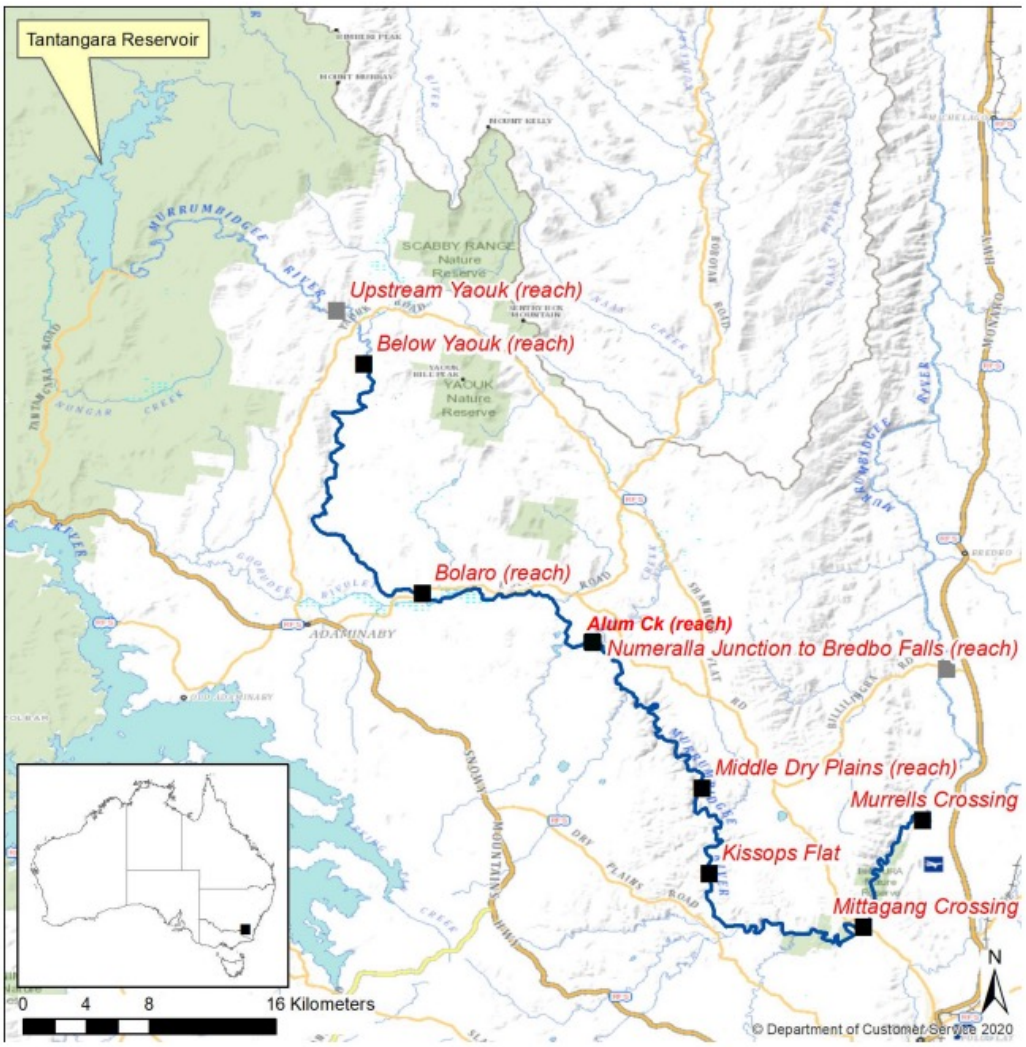


Figure 2. Map of project area and proposed monitoring sites on the Murrumbidgee River
Dark blue line – core reach for Macquarie Perch; Black squares – Core sites; Grey squares – Fringe sites.

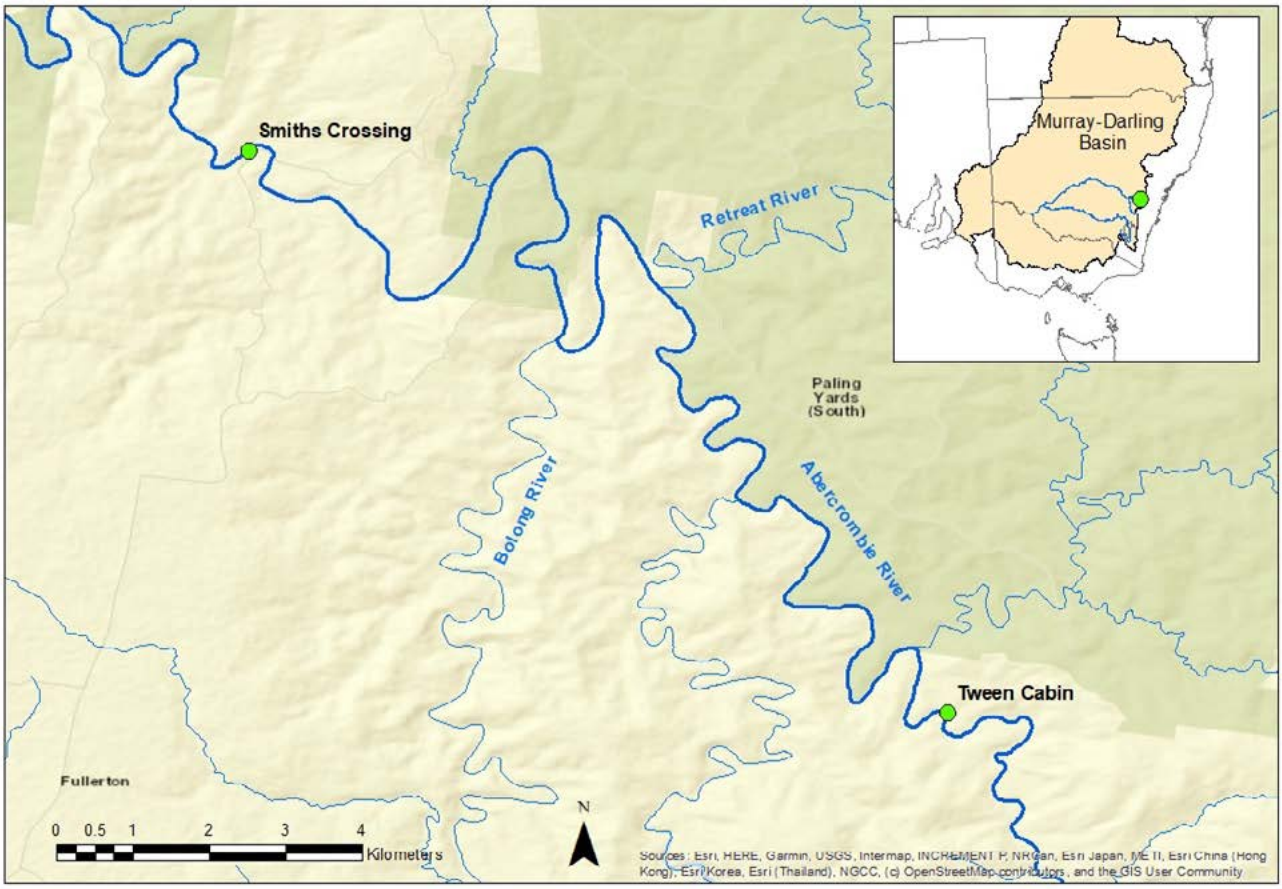


Figure 3. Map of reference sites in the Abercrombie River

Table 1. Monitoring sites/reaches in the Murrumbidgee catchment

[A] South East Local Land Services data; [B] data from Lintermans (2016); [C] data from Icon Water; [D] only fyke net data; [E] NSW DPI Boat electrofishing data, [F] ACT Government boat electrofishing data.

Site/Reach name	Coordinates: Decimal Latitude, Longitude	Macquarie Perch previously recorded?	Core or fringe distribution	Public or private access	Previous comparable fyke and gill net data available? (years)	Boat electrofish data available[E]? (years)
Numeralla Junction to Bredbo Falls (reach)	-36.023571 149.138720	No	Fringe	Public and Private	No	No
Murrells Crossing	-36.109373 149.124937	Yes	Core	Public	Yes (1998[B], 1999[B], 2019-2021[A])	Yes[E] (2002-04, 2007, 2010, 2013-18, 2020)
Mittagang Crossing	-36.170377 149.091151	Yes	Core	Public	Yes (1998[B], 1999[B], 2020 [A])	Yes[EE] (2004, 2007)
Kissops Flat	-36.139947 149.003230	Yes	Core	Private		Yes[E] (2003, 2014)
Middle Dry Plains (reach)	-36.091389 148.999167	Yes	Core	Private	No	No
Alum Creek (reach)	-36.008944 148.940417	No	Core	Private	No	No
Bolaro (reach)	-35.980471 148.839602	Yes	Core	Private	Yes (2021[A])	Yes[E] (2004, 2007, 2018)
Below Yaouk (reach)	-35.849818 148.806370	Yes	Core	Private	Yes (1998[B], 1999[B], 2020[A], 2021[A])	Yes[E] (2003, 2007)
Upstream Yaouk (reach)	-35.819510 148.790909	No	Fringe	Private	Yes (1999[B])	No

Table 2. Reference sites.

Site/Reach name	Coordinates: Decimal Latitude, Longitude	Macquarie Perch previously recorded?	Public or private access	Previous comparable fyke and gill net data available? (years)	Backpack electrofish data available[E]? (years)
Abercrombie River, Smiths Crossing	-34.105570 149.586309	Yes	Private	No	Yes[E] 2006, 2008-14
Abercrombie River, Tween Cabin	-34.17190 149.66840	Yes	Private	No	Yes[E] 2006, 2008-10, 2013-14

Monitoring methods and level of effort

Population monitoring

Previous studies in the upper Murrumbidgee catchment have determined that fyke netting and gill netting were the most effective at detecting the presence of Macquarie Perch at a suite of survey sites, with fyke nets being particularly effective at detecting recruitment (i.e. Young of Year or age 1+ individuals) and gill nets effectively capturing subadults and adults (Lintermans 2013a, 2016). In a multi-method survey across multiple sites and years, fyke nets captured Macquarie Perch at 100% of sites where the species was detected, and gill nets captured the species at 86%. Boat electrofishing captured Macquarie Perch at 43% of sites where the species was detected but captured few Young of Year or juveniles (Lintermans 2015). It was recommended that future sampling for this species should employ fyke and gill nets to adequately characterise population structure (adults, juveniles, YOY), minimise false negatives and detect successful breeding from the previous year (Lintermans 2015).

While fyke and gill nets are most suited to sample pool, or slow-run habitats, sampling of faster flowing habitats using backpack electrofishing, which can cover larger spatial areas, increases the area that can be sampled (Lintermans et al. 2013, Tonkin et al. 2019, Broadhurst et al. 2020).

Methods

Macquarie Perch monitoring will be undertaken primarily by gill netting and fyke netting. Backpack electrofishing may be utilised where these methods are determined as not suitable.

Fyke nets. Twelve single-winged fyke nets (12 mm stretch-mesh) are to be set at each site. Nets are to be attached to the bank at the cod-end and then set at an angle to the bank facing downstream with a weight attached to the wing to hold the net securely. The single wing is attached to the centre of the front 'D' of the fyke net. Each fyke net is to have a 150 mm diameter polystyrene float inserted in the cod end to provide an airspace to prevent mortality of non-target animals such as Platypus (Ornithorhynchus anatinus). Nets are to be set between 15:30 and 16:30 hrs and left overnight until retrieved between 07:30 and 08:30 hrs the following morning, giving a ~16-hour soak time.

Gill nets. Two braided monofilament gillnets, 50 meshes deep, stretch mesh size of 75 and 100 mm, 33 m length when strung on a float line are to be set across the streams during the afternoon and early evening. Nets are set between 15:30 and 16:00 hrs and retrieved between 21:30 and 22:00 hrs, giving a 6-hour soak time (Lintermans 2013a, 2016, 2020, Lintermans et al. 2013b, Broadhurst et al. 2020). Gill nets must be floating, multifilament and essentially unweighted (light

weights may be used to ensure the net is not being streamed out by higher flows). Previous research has demonstrated that the 6-hr soak time captured 79% of the number of Macquarie Perch captured using a 16-hr soak time, and that mortality of both target and non-target species was reduced (Lintermans 2013a). One end of each gill net is to be attached to the bank and the other end is to be attached to an anchor mid-stream.

The limited soak time of gill nets also reduces stress or possible mortality of threatened fish species or non-target species such as Platypus and Eastern long-necked turtle (Chelodina longicollis). Gill nets will also be patrolled at approximately hourly intervals after dusk with any captured animals (fish or platypus) removed from the nets. Platypuses should be retained in plastic 60 liter bins (rubbish bins) overnight to prevent recapture, with the bins containing a quantity of leaf litter/grass 'nesting' material to allow animals to dry off and minimize stress. Platypuses should then be released at the point of capture after removing fyke nets the following morning.

Electrofishing. Electrofishing will only be used in situations or locations where both gill and fyke nets are not suitable or appropriate.

Water Quality Monitoring

Standard water quality parameters are water temperature (°C), electrical conductivity (µS/cm), dissolved oxygen levels (mg/L and % saturation), pH, and turbidity (NTU). Water quality should be taken at each sampling site on each sampling event.

In addition to standard water quality monitoring, water temperature and flow data will be sourced from existing programs and gauging stations within the catchment.

Fish processing

All fish species captured will be identified and measured for length (nearest mm; Caudal Fork Length or Total Length, as appropriate). Weight of each Macquarie Perch captured should also be recorded (nearest gram). All subadults and adult Macquarie Perch should be scanned for a PIT tag, and if a PIT tag is recorded, the code should be recorded in full. All fish should be visually inspected for deformities, injuries (e.g. cormorant strike) and external parasites (e.g. Lernaea cyprinacea). A small fin clip should be collected from selected Macquarie Perch and stored in 100% ethanol each year from up to 30 Young of Year and 30 age 1+ individuals from each site, including up to 30 adults > 300 mm TL.

Data collected in the field will be manually recorded then entered electronically and maintained (curated and backed up) during data analysis ensuring appropriate review and quality assurance procedures.

Genetic Sampling

Genetic samples will be collected at all monitoring sites with samples collected every year during population monitoring activities, with samples processed every third year. Collect a small sample of fin tissue from all fish ≥40 mm, clipping all fish up to a maximum of 90 individuals per site into 100% ethanol. If insufficient samples collected in routine monitoring, additional sampling may be required. Collected tissue will sent for population genetic analysis including effective population size, genetic diversity, parentage level analysis (using single nucleotide polymorphisms (SNPs) (as per Lutz et al. 2021).

6.1.5 Genetic Rescue

Recent genetic analysis of the upper Murrumbidgee Macquarie Perch population has shown that the population remains genetically depauperate and that the upstream reaches of the population are genetically isolated from the downstream reaches i.e. there is not upstream movement of genetic material from the lower sections.

There have been 3 separate genetic rescues undertaken in 2020, 2022 and 2023 with Macquarie Perch collected from Cataract Dam. The recent genetic analysis has demonstrated that there has been some admixture between the resident population and the newly introduced fish from Cataract Dam, with one recapture of a pure Cataract fish and 3 fish of mixed genetics from 2 cohorts captured in 2023 (Pavlova 2023 unpublished data).

It is planned to continue the genetic rescue work in the Murrumbidgee with the focus on translocation of fish from Cataract Dam into sections of the Murrumbidgee that have not yet received translocated fish and are above barriers that preclude the current upstream movement of Cataract fish that have been released elsewhere in the system.

Proposed genetic rescue sites for 2023:

- → Killarney -35.891930 148.791900
- → Bolaro -35.973540 148.813510
- → Kissops Flat -36.138003 149.004026

We propose to collect 100 Macquarie Perch from Cataract Dam for release at the three sites above in the upper Murrumbidgee River. These fish will be quarantined at the Narrandera Fisheries Centre and given a health check prior to release.

6.2 Stocky Galaxias

6.2.1 Current Captive Breeding Program

The Stocky Galaxias captive breeding program will include a two staged approach, the first being intensive primary captive breeding in a controlled lab/hatchery environment and the second approach being that of an extensive semi natural, refugia based environment. This approach is being undertaken for several reasons, the first and foremost being that Stocky Galaxias are very difficult to maintain and breed in captivity. They require very low water temperatures which simulate those of the natural environment where they exist at high altitudes - this is very difficult to achieve and maintain during long hot summers at lower elevations. Secondly, Stocky Galaxias have relatively low fecundity (211-810 oocytes in fish 76 and 100mm in length, respectively). Therefore, to be able to produce large numbers of ecological significance that would facilitate a reintroduction program, very large numbers of brood fish would be required along with the facilities to house them and staff to maintain them. This presents both logistical and resourcing limitations. With this in mind, we are proposing that limited primary captive breeding be undertaken with the aim of producing fish to establish a secondary extensive production system in a purpose built refugia habitat at the Eucumbene Borrows. This is a purpose built Stocky Galaxias refugia habitat, with constructed streams and spawning habitats along with large pond/dam refugia habitats. The water is recirculated from the lower ponds to the upper ponds via solar pumps, from here it gravity feeds down the constructed streams providing flowing stream habitats.

It is anticipated that Stocky Galaxias will establish in both the streams and the ponds on site and reproduce naturally, which will provide a source population to allow for additional reintroductions elsewhere once suitable reintroduction locations have been identified through the catchment surveys.

Further infrastructure works are required at the Eucumbene Borrows to improve both water flow and water security, this includes earthworks to repair a breached dam wall, to increase onsite storage, and divert overland flows, increased battery capacity and replacement of pumps. These works are now going to be funded via a federal Threatened Species Grant.

Primary captive breeding of Stocky Galaxias will occur at Charles Sturt University (CSU) Albury. The team at CSU has a proven track record for not only maintaining a captive population, but also successfully breeding them in captivity. CSU has a purpose-built facility to house Stocky Galaxias, with a current captive population on site.

Approximately five hundred Stocky Galaxias have been produced by the team at CSU in the 23/24 captive breeding program, it is planned to release these fish at the Eucumbene Borrows in May 2024, this will coincide with monitoring at the site to determine is any of the fish that were released in 2023 remain and if any recruitment has occurred.

The interim production targets for Stocky Galaxias at CSU is 1500 annually over the next 2 seasons, with this production increasing to 2500 in the fourth and fifth years of the program.

6.2.2 Population Monitoring

Previous data

→ BPEOM site. Bottom Flat- sampled 05/04/2023.

→ Details: Electro fishing + Bait traps + eDNA

→ 1200 seconds. 22 fish size range 24-104mm

2024 Monitoring (3 sites)

Population Monitoring sites:

→ *Top Flat (3 sections, 90 m) 3×30m

→ *Bottom Flat (5 sections, 150 m) 5×30m

Reference Monitoring site

→ Sallys Creek (3 reaches, 90 m) 3×30m

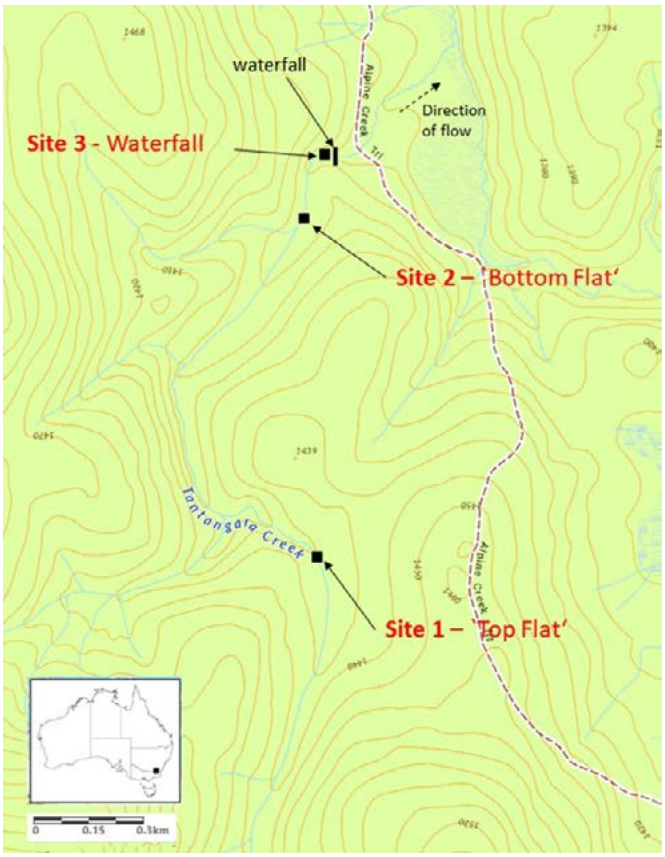


Figure 4. Map of monitoring sites on Tantangara Creek

Table 3. Proposed monitoring sites on Tantangara Creek.

Coordinates are given for approximate downstream extent of sites. Approximate average stream width and depths from Allan et al. (2021), M. Lintermans (unpublished data) and T. Raadik (unpublished data).

Site/Reach name	Coordinates: Decimal Latitude, Longitude	Public or private access	Land Tenure	Previous, comparable monitoring data available	Average Width (m)	Average depth (m)
Tantangara Creek Site 1 – Top Flat	-35.849597 148.56954	Public	National Park	No	0.7	0.06
Tantangara Creek Site 2 – Bottom Flat	-35.840144 148.56836	Public	National Park	No	0.9	0.15
Tantangara Creek Site 3 – Falls	-35.838890 148.569120	Public	National Park	No	1.1	0.25
Sallys Flat Creek Site 4 (Reference site)	-35.572104 148.652735	Public	National Park	No		

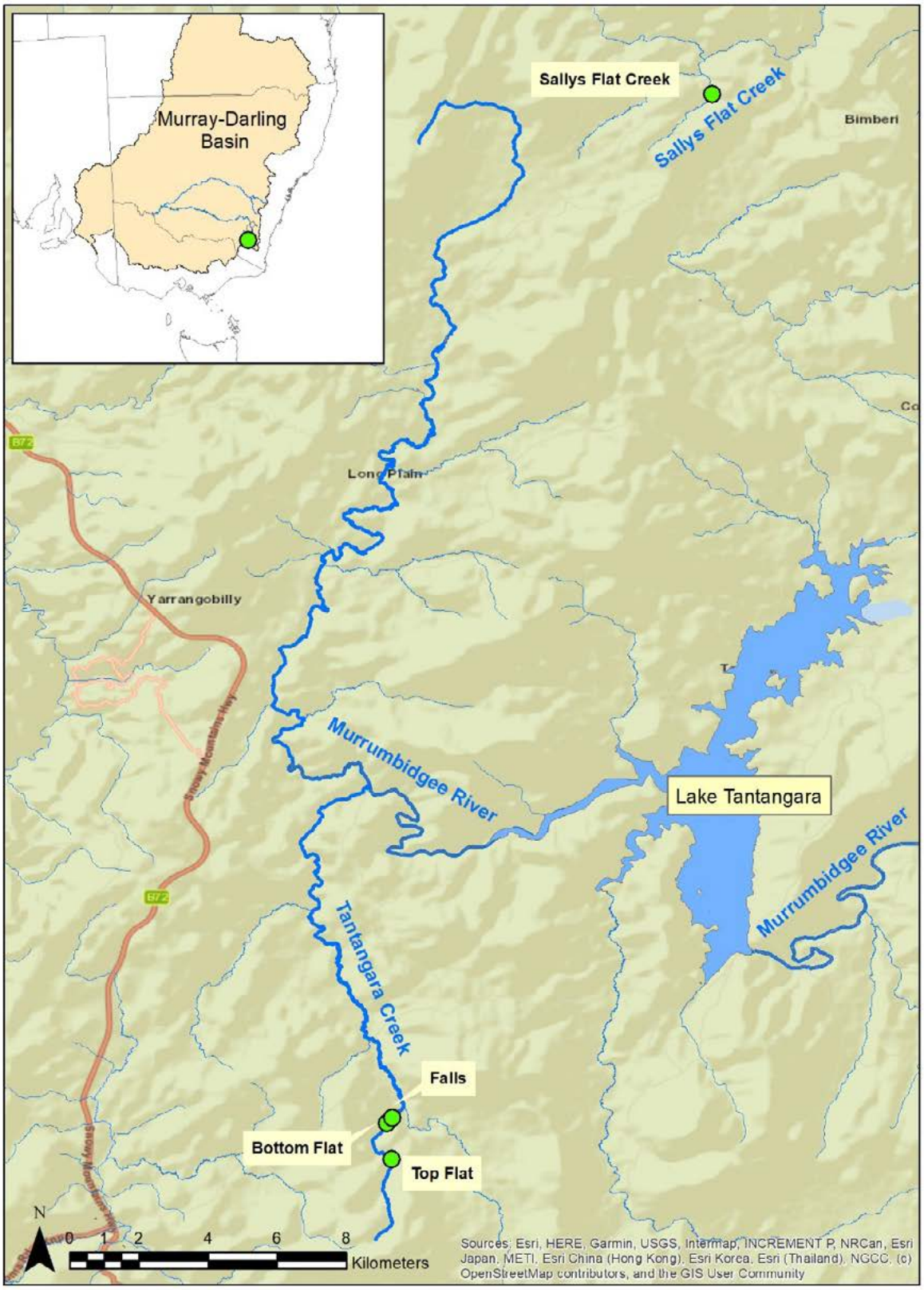


Figure 5. Location of monitoring and reference sites

Monitoring methods and level of effort

Electrofishing backpack setting

Backpack electrofishing of 30 m long sampling sections, five sections (150 m of stream length) to be sampled be at 'Bottom Flat- Reach 2', and 3 sections (90 m stream length) at 'Top Flat – Reach 1' and 5 sections (150 m of stream length) to be sampled at Sallys Flat Creek. One section should be sampled at a time with all fish collected processed and released before moving to the next section upstream. A stop net should be positioned at the upstream and downstream ends of each section before sampling, to maintain independence of sampling sections, electrofishing seconds per each 30m section are to be recorded.

Genetics

In order to monitor the level of population genetic variation and effective population size genetic material will be collected are part of the population monitoring. A small sample of caudal fin tissue will be collected from all fish > 50 mm in length, clipping all fish up to a maximum of 45 individuals per reach (up to 90 individuals total) into 100% ethanol. Collected tissue will be sent for population genetic analysis using single nucleotide polymorphisms (SNPs) (effective population size, genetic diversity, parentage level analysis) to an appropriate facility.
The number of tissue clips required each successive event may be able to be reduced following analysis of previously collected tissue.

Fish processing and data management

When captured, fish will be placed into bucket of water carried by the dip netter. At the end of sampling, all fish captured will be placed into a larger, aerated, container whilst being processed. Fish are to be picked up using a soft, fine-mesh aquarium dip net for transfer to a wetted measuring board and then a wetted weighing dish, followed by release to the site of collection, or to another water-filled, aerated container before final release. Handling of fish must be done with wet hands. All fish species captured will be identified and measured for length (nearest mm; Caudal Fork Length or Total Length, as appropriate). Weight of each Stocky Galaxias captured will be recorded (0.1 g), and fish will be visually examined for deformities, injuries (e.g. cormorant strike) and external parasites (e.g. Lernaea cyprinacea).

Record parasites on one side of fish (left side) and any abnormalities (wounds, lesions etc). Take photo of the whole fish and zoomed in section of abnormality.

Data collected in the field will be manually recorded then entered electronically and maintained (curated and backed up) during data analysis ensuring appropriate review and quality assurance procedures.

Water Temperature Monitoring

Install water temperature monitors at Bottom Flat, Sallys Flat Creek and at the Eucumbene Borrows.

Habitat Monitoring

Take a photo upstream and downstream at the beginning of each sampled section or reach (see figure 3).

6.2.3 Catchment Surveys

The catchment survey component for the 23/24 AIP will build on the work already undertaken (Lintermans et al. (2022, Raadik and Lintermans 2022b) and will consist of a desk top analysis and compilation of existing data from all available sources. This will be used to develop a spatial layer of known existing barriers to fish passage and available habitat that will be used to guide targeted further field investigation and initial prioritisation of areas as outlined in Lintermans et al (2022) and Raadik and Lintermans (2022b).

6.3 Budget Breakdown

Activity	Funding Allocated 23/24
Macquarie Perch	
Population monitoring, surveillance and research	$54,195
Habitat Surveys	$6,500
Captive Breeding, stocking and monitoring	$253,795
Habitat enhancement	$0
Stocky Galaxias	
Population monitoring surveillance and research	$27,290
Habitat surveys	$6,500
Captive breeding, stocking and monitoring	$145,862
Total	**$494,142**

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