

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

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This research was conducted on Walgalu country.

Cover photo: The lower sampling reach at Sallys Flat Creek. Photo Hugh Allan.

Introduction

The Stocky Galaxias *Galaxias tantangara* is a highly threatened freshwater fish, that was only described as a distinct species in 2014 (Raadik 2014). It is a small species with a maximum total length of 114 mm with most adults being 60-90 mm long (Allan et al. 2021). It is listed as critically endangered by the Australian Society for Fish Biology (Lintermans 2019); in New South Wales (NSW FSC 2016), the IUCN Red List (Lintermans & Allan 2019) and the Environment Protection and Biodiversity Conservation Act 1999 (TSSC 2021). The species is considered one of the top 22 most imperiled freshwater fish species in Australia (Lintermans et al. 2020) and is one of the most imperiled vertebrates in Australia (Garnett et al. 2022). The species was originally described from Tantangara Creek in the upper Murrumbidgee catchment upstream of Tantangara Reservoir (Raadik 2014) and for many years this stream was considered the only population of the species (NSW FSC 2016; Lintermans and Allan 2019). The species was listed as a priority species for recovery action following the 2019-20 bushfires (Legge et al. 2020, 2022), and has been subsequently listed as one of the 100 priority species under the National Threatened Species Strategy (Australian Government 2021) and subsequently the 110 priority species under the National Threatened Species Action Plan (DCCEEW 2022).

A second population was discovered serendipitously (via genetic analysis of finclips) in late 2020 whilst investigating bushfire impacts on spiny crayfish, with this second Stocky Galaxias population occurring in the upper Goodradigbee catchment at Sallys Flat Creek (Lintermans et al. 2021) (Figure 1). The population at Sallys Flat Creek is approximately 30 km as the crow flies but ~350 km by stream distance from the Tantangara Creek population (Lintermans et al. 2021). In January 2021 follow up sampling to collect additional voucher specimens confirmed that Stocky Galaxias were present and also confirmed that Mountain Galaxias *G. olidus* co-occurred with Stocky Galaxias. Both species were collected from a single location in Sallys Flat Creek, approximately 720 m upstream of a series of large waterfalls and cascades that plummet approximately 25 m in elevation down to its junction with the trout-infested Peppercorn Creek (Allan & Lintermans 2021; Lintermans et al. 2021). Sallys Flat Creek upstream of these waterfalls is trout-free. Sallys Flat Creek is considerably smaller than Tantangara Creek, and while both galaxiids are restricted to the stream above the waterfall, Stocky Galaxias is distributed along the

Snowy Hydro Limited received approval in 2020 to construct a new large-scale pumped hydro-electric storage and generation scheme (Snowy 2.0), to increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme. This will involve the connection of the existing Talbingo and Tantangara reservoirs via a series of underground pipes and an underground power generation station. Water will be transferred in both directions between the reservoirs, which are in separate river catchments. One of the threatened fish species potentially at risk from these water transfers (Cardno 2019) is Stocky Galaxias (NSW FSC 2016; Lintermans and Allan 2019; TSSC 2021). As part of the NSW and Commonwealth approvals for Snowy 2.0, the preparation of a Threatened Fish Management Plan including a series of monitoring requirements for threatened and alien fish were mandated (see Snowy Hydro 2023). As a component of this Threatened Fish Management Plan, a monitoring plan for Stocky Galaxias was developed in 2020–21 and finalised in 2022 (Raadik and Lintermans 2022). This report presents the implementation and results of the first year of the Stocky Galaxias Monitoring Plan (SGMP).

The Stocky Galaxias Monitoring Plan originally focused on the then-only known population of the species at Tantangara Creek. Although it is noted that “...the described methods may also be relevant to other populations which may be discovered or established by translocations” (Lintermans and Raadik 2022), the Sallys Flat Creek population is only partially included in the SGMP, as it was discovered after the SGMP was prepared; a “single population” is still (incorrectly) referred to in parts of the document (Snowy Hydro 2023). Consequently, the monitoring plan is lacking some precise details of the level of effort required at Sallys Flat Creek (or any future populations which may be discovered). Monitoring in 2024 adopted the overarching aim, philosophy and approach outlined for the Tantangara Creek site.

SGMP Objectives

The overall aim of the Stocky Galaxias Monitoring Plan is “To provide baseline, comparable data on the species, to inform decisions on management intervention for the long-term survival of the species” with specific Stocky Galaxias Monitoring Plan objectives to provide baseline, comparable data on:

1. The persistence of Stocky Galaxias (presence and breeding).

2. The population trajectory (is the population increasing, stable or decreasing) and variability (significant change from normal).
3. The status of the Stocky Galaxias population (incorporating measures of abundance, distribution, reproduction, fish health and demographics).
4. The status of identifiable threats at Stocky Galaxias locations (riparian erosion, instream sedimentation, riparian vegetation condition with respect to ability to trap sediment).
5. The persistence and establishment of any new translocations of the species into the catchment.
6. Incursions of exotic fish species (Brown Trout *Salmo trutta*, Rainbow Trout *Oncorhynchus mykiss*, or invasive native species such as Climbing Galaxias *G. brevipinnis*) into Stocky Galaxias populations.
7. Metrics informing triggers (as part of a TARP) for identified management interventions to mitigate potential sudden declines because of identified threats (e.g. fish incursion, fire, drought).

Trigger Action Response Plan (TARP)

Additional to the objectives outlined above, the Stocky Galaxias Monitoring Plan details a decision-making framework for additional sampling in response to deviations from a 'normal' condition in Stocky Galaxias population metrics (Raadik and Lintermans 2022) or other threats identified in the routine surveillance monitoring. This framework is known as the Trigger Action Response Plan (TARP) and identifies the following triggers which when observed, justify additional sampling:

1. Decline in relative population abundance.
2. Decline in fish condition.
3. Genetic decline.
4. Fire or drought.
5. Water quality decline.
6. Recruitment failure evident from population structure during routine monitoring.
7. Predatory fish incursion (detected by electrofishing during routine monitoring or by eDNA sampling).

Note that as this is the first sampling conducted under the SGMP plan, and not all sampling requirements of the SGMP or TARP are addressed or fulfilled in the current sampling (e.g. eDNA monitoring of predatory fish incursion; establishment of translocated populations), not all of the SGMP Objectives or TARP triggers can be evaluated during the current monitoring. Consequently, SGMP Objective 2 (population trajectory), 5 (establishment of translocated populations) and 6 (incursion of exotic fish species) are not addressed. This report details the 2024 monitoring program for both populations (Tantangara Creek and Sallys Flat Creek) in April 2024 and outlines the findings in line with their associated objectives and/or TARP triggers.

Methods

As recommended by Raadik and Lintermans (2022), sampling was carried out by conducting replicate 30 m electrofishing shots with a backpack electrofisher. Sampling was conducted in early April 2024 with the recommended sampling effort deployed at Top flat and Bottom flat in Tantangara Creek (Raadik and Lintermans 2022; Table 1; Figure 2).

Table 1: Recommended sampling effort for Tantangara Creek (from Raadik and Lintermans 2022). Note that Reach 1 in the table refers to Top flat and Reach 2 refers to Bottom flat.

Sampling type	Frequency	Location/Area	Method	Duration/Level of Effort	Parameters measured
Routine Surveillance Monitoring					
Population monitoring	Annually in autumn (March/April).	Tantangara Creek: 2 sites - Reach 1 (3 sections, 90 m) Reach 2 (5 sections, 150 m).	Backpack electrofishing	0.75 day per site (up to 2 days Tantangara Creek). Continuous electrofishing per section to cover all habitat, single electrofishing run per section, fish processed before commencing next section.	No. of fish; length and weight; visual assessment for parasites; WQ* and stream characteristics; visual threat assessment.
Population genetics	Collected and analysed every 3 years during population monitoring or as per TARP	As above	Caudal fin clipping	1.5–2.0 hrs per site. Fin clips to be collected from up to 90 individuals per site (Note: up to 45 individuals per reach at Tantangara Creek, 90 individuals total).	Using SNP data: Genetic diversity; effective population size; parentage analysis

As no sampling effort was specified by Raadik and Lintermans (2022) for Sallys Flat Creek, expert judgement was used and the site was sampled at two reaches (upper and lower) with 3 electrofishing shots per reach (Table 2). Both reaches at Sallys Flat Creek were upstream of the McLeods Trail Crossing (Figure 3).

Table 2: Sampling dates and number of electrofishing shots for each site and reach, and coordinates for the downstream start point of the first shot of each reach.

Site	Reach	No. efish shots	Date sampled	Latitude	Longitude
Sallys Flat Creek track crossing	Lower	3	02/04/2024	-35.57234	148.6528
	Upper	3	02/04/2024	-35.57612	148.6481
Tantangara Creek	Bottom Flat	5	03/04/2024	-35.84308	148.5667
	Additional shot (bottom flat, below Chinese cut)	1	03/04/2024	-35.83963	148.5684
	Additional transect shot (bottom flat)	~200 m	03/04/2024	-35.84132	148.5678
	Top Flat	3	05/04/2024	-35.84907	148.5692

Sampling was conducted by a two-person team using a Smith Root Model LR24 backpack electrofisher (typical electrofisher settings: 900 V, 80 Hz, 25% duty cycle) with each electrofishing shot consisting of a single electrofishing run of continuous fishing covering all habitats. Captured fish were processed before commencing the next shot. Three shots were sampled at each reach in Sallys Flat Creek and Top flat at Tantangara Creek, with Five shots conducted in the Bottom flat of Tantangara Creek. However, additional sampling was conducted at Bottom flat to explore the low catch rate of fish in this reach with an additional shot and ad hoc sampling completed (Table 2). The additional shot occurred downstream of the Chinese cut (approximately 150 m upstream of the waterfall that defines the

downstream limit of the Stocky Galaxias population), and ~200 m of intermittent sampling added downstream of shots 1-5 (Figure 2). The required three or five shots in each reach at each site were consecutive (i.e. shots were immediately adjacent to each other).

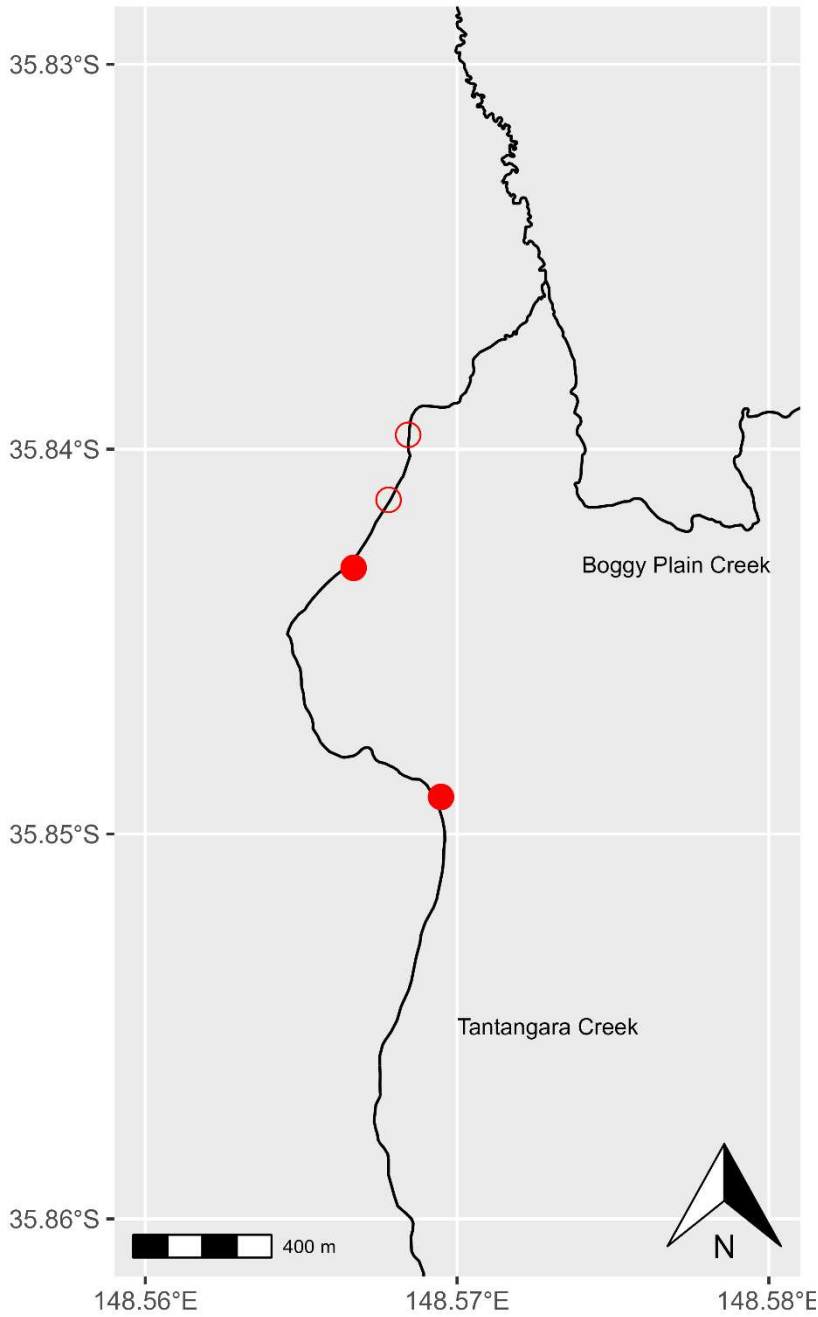


Figure 2: Location of sampling conducted at Tantangara Creek Bottom flat showing the start of electrofishing (5 shots, red filled circles), plus the additional shot downstream of the Chinese cut, and the additional ~200 m shot (red open circles).

Routine water quality measurements were taken at each site. pH was measured with Machery-Nagel test strips; conductivity and surface water temperature was measured with a Eutech Expert CTS meter;

dissolved oxygen was measured by titration with a Visicolor HE SA 10 kit; turbidity was measured with a turbidity tube.

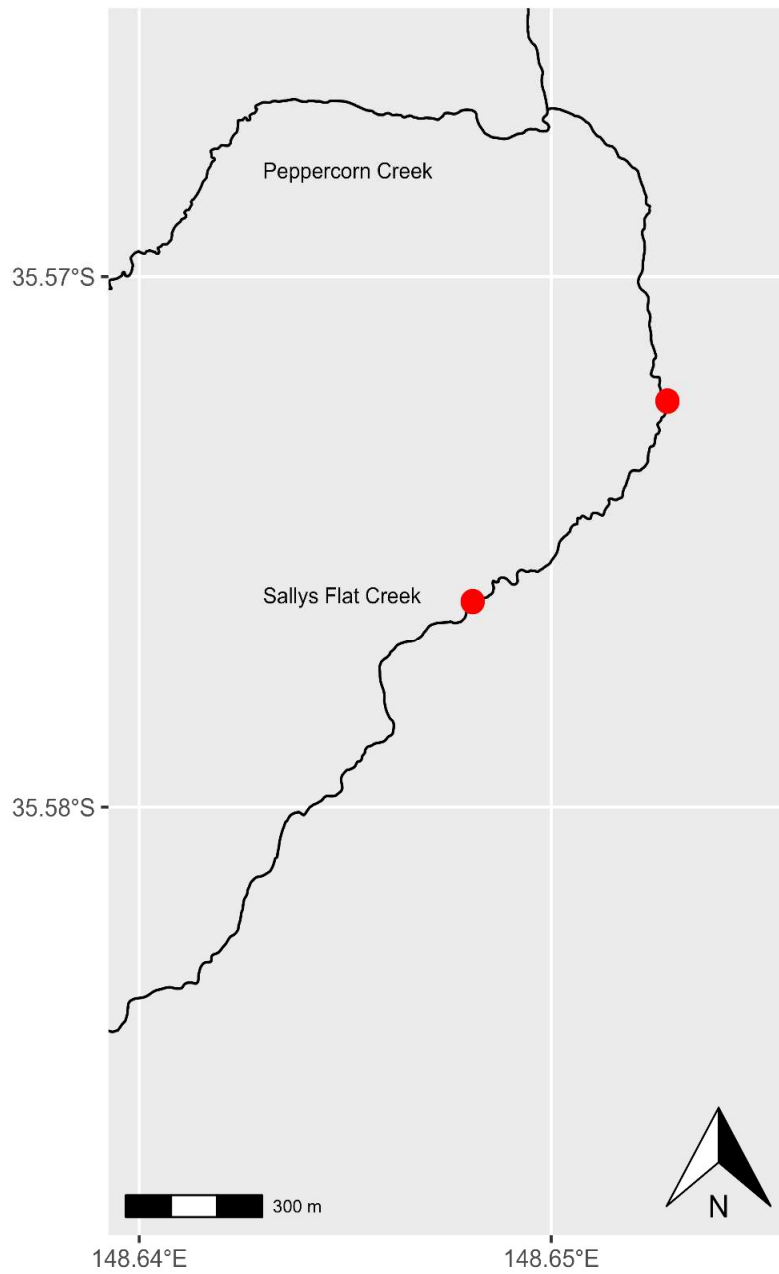


Figure 3: Location of sampling conducted at Sallys Flat Creek showing the start of electrofishing (3 shots) for both the lower and upper reaches.

At each reach categorical habitat descriptors were noted (Appendix 1). A rapid, visual assessment of potential threats was undertaken at each sampling site and reach.

Fish were identified to species where possible (see below) and all captured fish were measured (Length Caudal Fork, LCF in mm). Stocky Galaxias were weighed to the nearest 0.1 g, and Fulton's condition factor (K) was estimated for each fish where $K = 100 * W / L^3$, where W is the total weight of the fish in grams and L is its LCF in cm (Fulton, 1904; Nash et al. 2006). All Stocky Galaxias had a small section of the caudal fin removed as a genetic sample. Fish were examined for externally visible parasite loads, and all fish were released alive at the point of capture. While fish sexual maturity was not the focus of the current sampling, the presence of ripe males was noted by applying slight pressure on the fish's ventral surface when testes were visible through the abdominal wall (Allan et al. 2021).

Captured *Galaxias* at Sallys Flat Creek were identified based on two major characteristics (Figure 3):

- Stocky Galaxias have grey mottling pattern extending onto the top of head, cheeks and jaw, and no distinct barring on the body, and
- Mountain Galaxias have no mottling on top of head, cheeks and jaw, and mostly have conspicuous barring on the body, although some Mountain Galaxias have no body patterning or barring.

Small individuals (< 40 mm LCF) are difficult to confidently identify to species, and these individuals were recorded as *Galaxias* spp.; as a result, fish of this size class were not always captured and examined and if not captured was simply recorded as observed *Galaxias* spp.



Figure 4: The two species of Galaxias present at Sallys Flat Creek; Mountain galaxias (top) and Stocky Galaxias (bottom). From Lintermans et al. 2021; Photo: Tarmo A. Raadik.

Stocky Galaxias is the only fish species present at Tantangara Creek (Figure 5), and therefore did not need to be identified to discern it from Mountain Galaxias like in Sallys Flat Creek.



Figure 5: a large Stocky Galaxias from Top flat (Photo Hugh Allan).

Results and Discussion

As noted earlier, not all SGMP Objectives are evaluated as part of this monitoring report.

SGMP Objectives 1 & 3 - Population persistence and status

Abundance and distribution

A total of 218 fish were caught (or observed *Galaxias* spp.) with 183 confidently identified to species across all sites and reaches. Thirty-five *Galaxias* of uncertain species were caught or observed at Sallys Flat Creek (Table 3). A total of 99 Stocky Galaxias and 55 Mountain Galaxias 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.

Although no formal monitoring has been conducted at either site, it is apparent that abundance of Stocky Galaxias in surveys was very low at the Bottom flat of Tantangara Creek, with low abundance at Tantangara Creek also informally noted during sampling in early April 2023 when collecting individuals for translocation to the Eucumbene Borrows (Lintermans and Allan unpubl. data). Similarly, sampling in early April 2023 by NSW DPI (Fisheries) at Bottom Flat also recorded low abundance of Stocky Galaxias with a total of 13 individuals captured (plus 2 observed) across eight electrofishing shots (NSW DPI Fisheries unpubl. Data).

Table 3: Total number (all shots combined) of Stocky Galaxias, Mountain Galaxias and unidentified galaxiids (*Galaxias* spp.) captured at each site and reach. *includes one fish observed but not measured.

Site	Reach	No. efish shots	Stocky Galaxias caught	Mountain Galaxias caught	Total no. of <i>Galaxias</i> 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	~200 m	2	-	-	2
	Top flat	3	22	-	-	22
Total fish			128	55	35	218

In February 2023 an almost identical methodology was used in a mark recapture population estimate at Sallys Flat Creek. Single pass backpack electrofishing was used, with the start point for sampling being identical to that used in the current monitoring approach. Fish were identified to species and individuals < 40 mm TL were assigned to *Galaxias* spp. The only difference was that shot lengths in February 2023 were 33 m rather than 30 m length, with 3 sequential shots completed (Lintermans and Allan 2023). Fish were sampled on 8/02/2023, finclipped on the caudal fin, and then released at point of capture, before being resampled on 16/02/2024 (Table 4). To enable direct comparison with the current monitoring, raw abundance data as well as adjusted abundance data (number of fish per 30 m of sampling) is presented (Table 4). Mean number of Stocky Galaxias captured per 30 m of electrofishing in February 2023 (22.0) is higher than the mean number per shot in April 2024 (8.3).

Whether this is simply a seasonal difference in abundance (summer vs autumn) is unknown as there has been insufficient seasonal sampling to confidently assess seasonal abundance patterns.

Table 4: Comparison fish abundance data (raw and adjusted) from Sallys Flat Creek (upper reach) on 8th and 16th February 2023 (data from Lintermans & Allan 2023) and the current monitoring (in April 2024). Note raw numbers represent fish per shot length, and adjusted values are fish per 30 m.

Date	Shot No.	Shot length (m)	Stocky Galaxias raw	Stocky Galaxias adj.	Mountain Galaxias raw	Mountain Galaxias adj.	Galaxias spp. raw	Galaxias spp. adj.
8/02/2023	6a	33	23	20.9	1	0.9	12	10.9
	6b	33	24	21.8	3	2.7	5	4.5
	6c	33	29	26.4	1	0.9	6	5.5
16/02/2023	6a	33	17	15.5	3	2.7	7	6.4
	6b	33	24	21.8	1	0.9	5	4.5
	6c	33	28	25.5	1	0.9	7	6.4
2/04/2024	1	30	9	9.0	3	3	3	3
2/04/2024	2	30	6	6.0	1	1	1	1
2/04/2024	3	30	10	10.0	2	2	0	0

Single-pass electrofishing sampling conducted in 2016-2018 to collect samples for reproductive investigations reported mean Stocky Galaxias density of 1.18 fish/m, although large variation was observed over the course of this study (min 0.02, max 17.00 fish per metre (Allan & Lintermans 2018; Allan & Lintermans unpubl. data). The large variation was a product of sampling conducted across all seasons of the year, and at a range of varying habitat types in Tantangara Creek where backpack electrofishing efficacy can vary significantly. Nonetheless, adjusted for 30 m electrofishing shots as presented in Table 4, approximately 35 fish may be expected in a single 30 m electrofishing shot based on this mean density. Adjusted CPUE from only samples from late March, April and early May still yields approximately 30-35 fish per 30 m electrofishing shot.

While the application of the monitoring approach reported herein will provide information on trajectory and changes in relative abundance for the Stocky Galaxias populations at both sites, a periodic estimate of the population size at each site will be helpful. Such estimates will allow more robust consideration of the scale of any impact from future translocations from the two wild populations. Such an estimate has been recently completed for the Sallys Flat Creek population, but there is no estimate currently available for the Tantangara Creek population. Conducting a population estimate is planned for early 2025, with funding from the Commonwealth Government's "Saving Native Priority Species" Grant Program. If this population estimate does not proceed for whatever reason, alternative funding for such an estimate is a priority.

Reproduction

Stocky Galaxias larvae are first observed in December (after November spawning) and are approximately 9.8-10.6 mm in length, and by February young-of-year fish are readily detectable by electrofishing (Allan et al. 2021). By April (the time of sampling in 2024), young-of-year can be expected to be between approximately 25 and 45 mm LCF (Allan et al. 2021).

Young-of-year Stocky Galaxias were captured in all reaches of both Tantangara Creek and Sallys Flat Creek and using a young-of-year length cutoff of 45 mm comprised 31/74 (42%) and 9/25 (36%) of the catch at Sallys Flat Creek lower and upper respectively, and 12/22 (55%) and 1/6 (17%) of the catch at Tantangara Ck Top flat and Bottom flat respectively (Figures 6 & 7). Size at age for young-of-year Stocky Galaxias has only been accurately determined (via monthly sampling) in a single study (Allan et al. 2021) with no otolith studies to verify age at length. Fish growth likely varies between years, and in small-bodied species the clear delineation of cohorts can be difficult with small length increments separating cohorts. As a consequence, the clear identification of the proportion of the Stocky Galaxias population that are young-of-year based solely on length is imprecise, but it is clear that recruitment has occurred after successful spawning in 2023. Given the very small home range of Stocky Galaxias and the lack of evidence to support large-scale spawning movements (Allan et al. 2021), the presence of young-of-year is believed to represent in-reach recruitment, although some downstream displacement of larvae is likely.

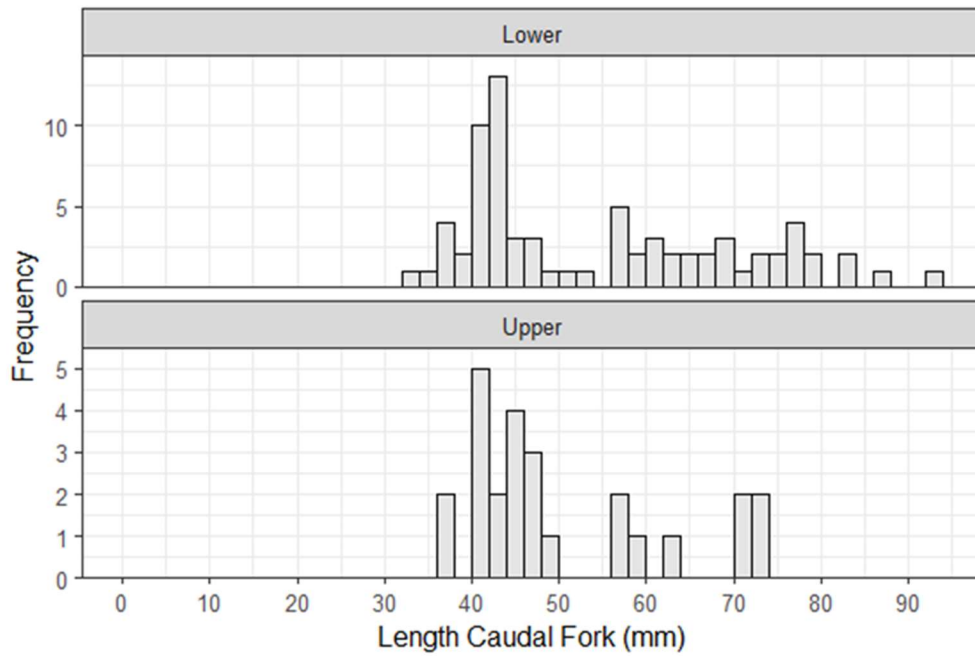


Figure 6: Length frequency of Stocky Galaxias captured from Sallys Flat Creek in April 2024.

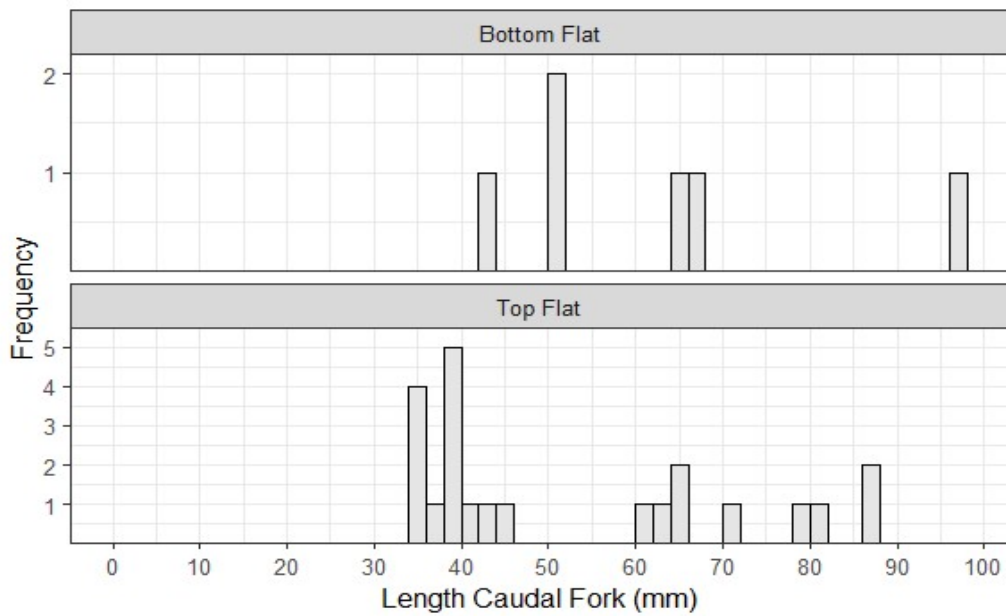


Figure 7: Length frequency of Stocky Galaxias captured from Tantangara Creek in April 2024.

Condition

Fulton's condition factor (K) for Stocky Galaxias was 0.197-1.06 (mean = 0.730, sd = 0.159, n = 96) for Sallys Flat Creek, and 0.540-1.26 (mean = 0.871, sd = 0.170, n = 28) for Tantangara Creek (Figure 8). Fish from Tantangara Creek had significantly higher values of K than those from Sallys Flat Creek (t -test, $t = -4.0782$, $df = 122$, $p < 0.001$) (Figure 8).

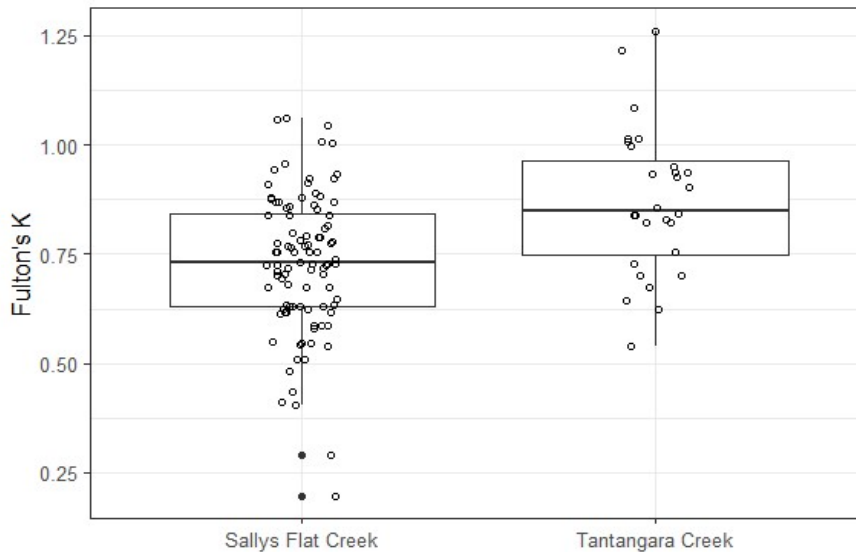


Figure 8. Range, median, and upper and lower quartiles for Fulton's condition factor (K) of Stocky Galaxias at Sallys Flat Creek and Tantangara Creek (both reaches combined).

Although a significant difference was observed between fish from different sites, Fulton's K is known to vary with fish length and relies on a cubic relationship of fish length to weight, with most species known to have the exponent of the weight-length relation deviating from 3 (Cone 1989; Froese 2006; Wuenschel et al. 2018). Fulton's K is not commonly used to evaluate body condition in *Galaxias* species in Australia and as with many fish species, would be expected to vary across the reproductive season (as gonads enlarge, and then empty with spawning) and vary between sexes (with females allocating higher investment to gonad weight than males at certain times of the year, see Allan et al. 2021). It might be expected that maturing individuals might differ in Fulton's K to immature individuals without developing gonads but there is no readily discernable relationship between Fulton's K and fish length (Figure 9).

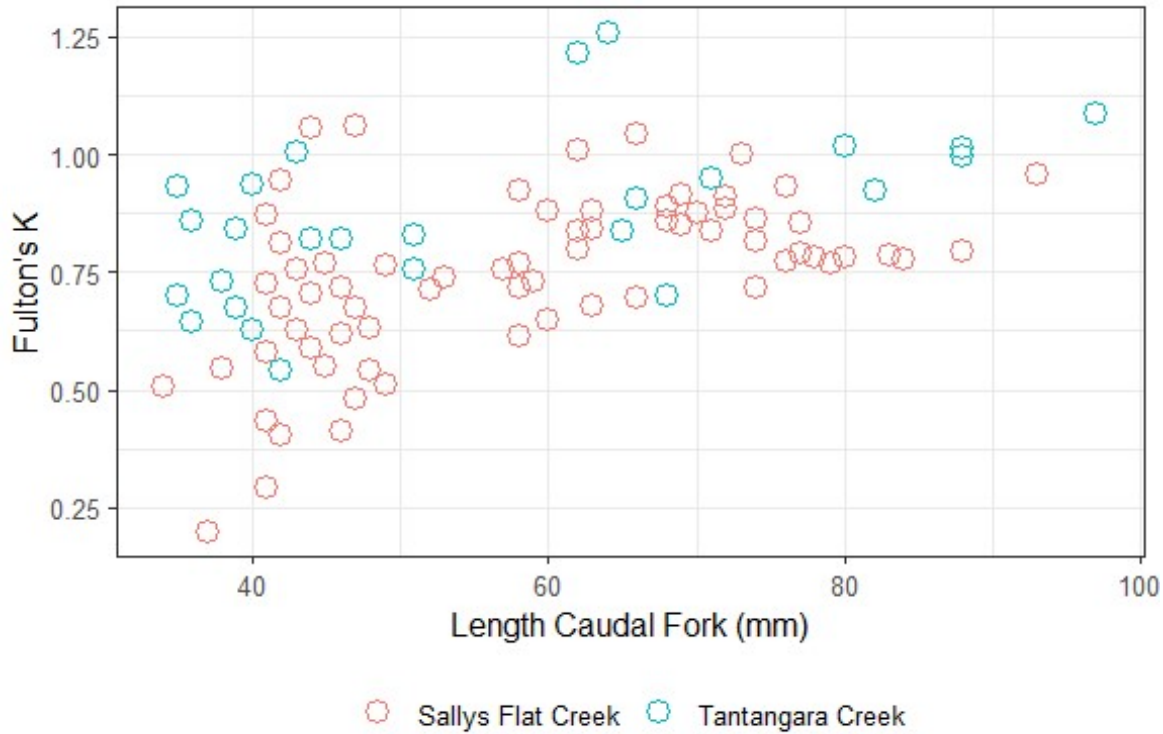


Figure 9: Relationship of Fulton's K with fish length (red circles Sallys Flat Creek, blue circles Tintangara Creek).

Fish health

Digenean trematode metacercariae were externally visible on both species at both reaches at Sallys Flat Ck, but none were observed at Tintangara Creek (Table 5). Intensity of metacercarial infection was low on both species at both reaches at Sallys Flat Creek with a maximum count of three on Stocky Galaxias and five on Mountain Galaxias (Table 6).

Metacercariae of digenean trematodes are commonly observed in many *Galaxias* species (Smith & Hickman 1983; Raadik 2014; Tritt 2018; Lintermans 2023) and the prevalence and intensity of infection was much lower than recorded in some other nearby locations (e.g. the Canberra region, see Lintermans 2018; unpubl. data) and was not of concern.

Table 5: Prevalence (% fish infected) of digenean trematode metacercaria in fish by site and reach.

Site	Reach	Stocky Galaxias	Mountain Galaxias
Sallys Flat Ck	Lower flat	5% (4/74)	4% (2/49)
	Upper flat	60% (15/25)	17% (1/6)
Tantangara Ck	Bottom flat	0	
	Top flat	0	

Table 6: Intensity (number of fish) of digenean trematode metacercaria in fish by site and reach (presented as counts of metacercaria per fish).

Site	Reach	Stocky Galaxias	Mountain Galaxias
Sallys Flat Ck	Lower flat	1,3,1,1	5,1
	Upper flat	2,1,2,1,1,2,2,1,1,3,	1
Tantangara Ck	Bottom flat	0	
	Top flat	0	

SGMP Objective 2 - Population trajectory & variability

As no intensive, systematic monitoring has been previously undertaken for Stocky Galaxias, the evaluation of population trajectory is constrained whilst data is accumulated over successive years (Raadik and Lintermans 2022). Consequently, the first 2-3 years of population monitoring is largely descriptive until trajectory can be ascertained.

A number of previous studies and isolated sampling events provide indication on the variability of Stocky Galaxias abundance in electrofishing surveys, although sampling did not necessarily follow the same methodology as outlined in the SGMP and the current monitoring. Nonetheless, these sources can provide indicative abundances and variability in Stocky Galaxias monitoring (see earlier discussion under *SGMP Objectives 1 & 3 - Population persistence and status*). It appears that either the population

abundance at both sites has declined, or is influenced by seasonal factors that reduce electrofishing efficiency. Further investigation is required to evaluate the effects of time of sampling (late summer vs mid-autumn).

SGMP Objective 4 - Threat status

The rapid, visual assessment of potential threats did not reveal any critical new threats to Stocky galaxias at either population. The impacts of feral horses at Tantangara Creek are being significantly ameliorated by the horse exclusion fencing (Lintermans 2023b; Lintermans and Allan unpubl. data). There has been no recent fire activity at any of the reaches, and no apparent loss of riparian vegetation or instances of new erosion activity.

SGMP Objective 6 - Pest fish incursion

No pest fish incursion was detected by the electrofishing sampling reported here. Additional pest fish incursion status information will be provided by the eDNA analysis of water samples, which is not part of this monitoring.

Trigger Action Response Plan (TARP) trigger evaluation

Of the seven identified TARP triggers, numbers 1-3 and 5 require baseline or trend data to determine if 'decline' has occurred. As this is the first monitoring year completed for Stocky Galaxias it is not possible to ascertain whether such declines have occurred, or triggers are met.

1. Decline in relative population abundance.
2. Decline in Fish Condition.
3. Genetic decline.
4. Fire or drought.
5. Water quality decline.
6. Recruitment failure evident from population structure during routine monitoring.
7. Predatory fish incursion (detected by electrofishing during routine monitoring or by eDNA sampling).

Trigger 4 (fire or drought) has not occurred in the last 3 years at either site, with the 2019-20 fires affecting Tantangara Creek but not Sallys Flat Creek. Fire severity at Tantangara Creek varied between the Top and Bottom flats with Top flat burnt more severely causing loss of significant amounts of riparian vegetation and loss and death of streamside *Sphagnum* deposits (Figure 10). Bottom flat had some patchy riparian burning but was much less affected (Figure 11). Riparian vegetation is recovering slowly at Top flat, and ground cover has recovered well at both reaches (Figures 10 and 11). Fencing to exclude feral horses from significant areas of both flats soon after the fire has been significant in protecting instream and riparian habitat (Lintermans and Allan 2022, unpubl. data).



Figure 10: severe fire damage to sphagnum and riparian vegetation at Top flat on 24/03/2020, 2 months after the fire. Photo Mark Lintermans.



Figure 11: patchy riparian burning at Bottom flat during the fire on 15/01/2020. Photo Mark Lintermans.

Recruitment failure can be assessed annually and therefore does not require baseline data, and length frequency distribution of Stocky Galaxias at both sites demonstrates that recruitment occurred in late 2023 with numerous young-of-year individuals detected at all sampled reaches (fish < 45 mm; Allan et al. 2021; Figures 6 and 7).

Water quality

Water quality was unremarkable at both sites (Table 7).

Table 7: Water quality parameters (pH, conductivity, water temperature, turbidity and dissolved oxygen) at each site.

Site	Reach	Date	Time measured	pH	Cond. (uS/cm)	Water temp (°C)	Turbidity (NTU)	Dissolved Oxygen (mg/L)
Sallys Flat Creek	upper	3/04/2024	11:20	7.0	50	15.2	<9	8.3
Tantangara Creek	Bottom flat	3/04/2024	16:40	6.5	30	13.7	<9	9.2

Conclusion and recommendations

The 2024 monitoring found there were no threats or other triggers to require TARP intervention. The abundance of Stocky Galaxias at both sites 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 lower abundance reflects a seasonal change in population abundance or sampling efficiency is unknown. The effort and sampling approach at Sallys Flat Creek in 2024 is in accordance with the sampling approach and effort undertaken at Tantangara Creek but requires formal endorsement for continuation prior to the second year of monitoring.

Recommendations

- To investigate the seasonal effect of timing of Stocky Galaxias sampling, in 2025 sampling should be conducted twice at both sites (in early to mid-February and late March/early April).
- The monitoring approach developed and applied for the 2024 monitoring at Sallys Flat Creek should be adopted as the protocol for future monitoring years.
- That 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 Priority Species” Grant Program. If this population estimate does not proceed for whatever reason, alternative funding for such an estimate is a priority.

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Appendix 1(a). Habitat descriptors for Sallys Flat Creek (upper). Scores: a = abundant, f=frequent, o=occasional, r=rare, -=absent

Habitat sheet

Date 3/04/2024
 Reach name Upper
 Site name Sallys Flat Creek

Site habitat	Score	Site habitat	
ss	OPS 4-6		OPS 4-6
Substrate		Cover	
Bedrock	-	Rock	o
Boulder	-	Timber	-
Cobble	r	Undercuts	a
Pebble	f	Leaf litter	-
Gravel	f	Macrophytes	a
Sand	o		
Mud/silt	f		
Plants		Mesohabitat	
Native trees	-	Pool	r
Exotic trees	o	Run	a
Native shrubs	-	Riffle	o
Exotic shrubs	a	Rapid	-
Riparian grass	-	Backwater	-
Floating macrophytes	-	Velocity	mod
Emergent macrophytes	f	Avg depth (m)	0.1
Submerged macrophytes	f	Max depth (m)	0.2
Filamentous algae	a	Avg width (m)	0.6
Suspended algae	-		
Biofilms	a		

Appendix 1(b). Habitat descriptors for Sallys Flat Creek (lower).

Habitat sheet			
Date	3/04/2024		
Reach name	Lower		
Stream name	Sallys Flat Creek		
Site habitat	Score		Score
	OPS 1-3		OPS 1-3
Substrate		Cover	
Bedrock	-	Rock	o
Boulder	-	Timber	-
Cobble	o	Undercuts	a
Pebble	f	Leaf litter	-
Gravel	f	Macrophytes	a
Sand	o		
Mud/silt	a		
Plants		Mesohabitat	
Native trees	-	Pool	r
Exotic trees	-	Run	a
Native shrubs	o	Riffle	o
Exotic shrubs	-	Rapid	-
Riparian grass	a	Backwater	-
Floating macrophytes	F (buttercup)	Velocity	mod
Emergent macrophytes	F (milfoil, fluitans)	Avg depth (m)	0.12
Submerged macrophytes	f	Max depth (m)	0.3
Filamentous algae	f	Avg width (m)	0.8
Suspended algae	-		
Biofilms	f		

Appendix 1(c): Habitat descriptors for Tantangara Creek Bottom flat.

Habitat sheet			
Date	3/04/2024		
Reach name	Bottom flat		
Site name	Tantangara Creek		
Site habitat	Score		Score
Substrate		Cover	
Bedrock	-	Rock	f
Boulder	o	Timber	r
Cobble	f	Undercuts	f
Pebble	a	Leaf litter	r
Gravel	f	Macrophytes	-
Sand	-		
Mud/silt	f		
Plants		Mesohabitat	
Native trees	o	Pool	-
Exotic trees	-	Run	a
Native shrubs	f	Riffle	a
Exotic shrubs	-	Rapid	-
Riparian grass	a	Backwater	-
Floating macrophytes	-	Velocity	mod
Emergent macrophytes	-	Avg depth (m)	0.1
Submerged macrophytes	-	Max depth (m)	0.2
Filamentous algae	-	Avg width (m)	0.75
Suspended algae	-		
Biofilms	f		

Appendix 1(d): Habitat descriptors for Tantangara Creek Top flat.

Habitat sheet	
Date	5/04/2024
Reach name	Top flat (ops 1-3)
Site name	Tantangara Creek

Site habitat	Score
Substrate	
Bedrock	-
Boulder	f
Cobble	a
Pebble	a
Gravel	f
Sand	-
Mud/silt	f
Cover	
Rock	f
Timber	o
Undercuts	o
Leaf litter	r
Macrophytes	-
Plants	
Native trees	r
Exotic trees	-
Native shrubs	a
Exotic shrubs	-
Riparian grass	a
Floating macrophytes	-
Emergent macrophytes	-
Submerged macrophytes	-
Filamentous algae	-
Suspended algae	-
Biofilms	f
Mesohabitat	
Pool	r
Run	a
Riffle	a
Rapid	-
Backwater	-
Velocity	mod
Avg depth (m)	0.06
Max depth (m)	0.18
Avg width (m)	0.8

Appendix 2: site photos. Sallys Flat Creek (lower).



Appendix 2 (cont): site photos. Sallys Flat Creek (upper).



Appendix 2 (cont): site photos. Tantangara Creek Bottom flat.



Appendix 2 (cont): site photos. Tantangara Creek Top flat.

