Translocating adult Murray Crayfish *Euastacus armatus* from an artificial canal to the Little Murray River

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Front cover photo: Murray Crayfish (*Euastacus armatus*) (Scott Raymond).

We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.

Translocating adult Murray Crayfish *Euastacus armatus* from an artificial canal to the Little Murray River

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Context:

Murray Crayfish (*Euastacus armatus*), the second largest freshwater crayfish in the world, is endemic to Australia's Murray River and its tributaries. Multiple threats have led to significant declines in their range and abundance since the 1950s, with recent blackwater events threatening the species' existence in the mid–Murray River system. In response to the species' high cultural and ecological significance, and reported low abundances, the North Central Catchment Management Authority (North Central CMA) commissioned the Arthur Rylah Institute for Environmental Research (ARI) to commence a Murray Crayfish translocation program to re-establish the species in the Little Murray River, an anabranch of the Murray River.

The Little Murray River Murray Crayfish translocation program consisted of four phases, with distinct outcomes and actions. This report documents the trilateral collaboration between Traditional Owners, the North Central CMA and ARI researchers (the Team), and the multi-phase translocation process.

Aims:

The aims of this project, were (1) to assess and select a suitable translocation reach of the Little Murray River for the re-introduction of adult Murray Crayfish, (2) to sample the selected reach for Murray Crayfish (i.e. a pre-translocation crayfish survey), (3) to capture, tag and transport 100 adult Murray Crayfish from the Stuart Murray Canal to the Little Murray River at Fish Point, (4) to undertake a post-translocation crayfish survey, (5) to ensure collaboration between North Central CMA managers, ARI research scientists, and Traditional Owners, and (6) to develop a translocation framework to guide the future re-establishment of crayfish into river reaches where they have previously occurred. A focus of the overarching project is enhancement of the current strong relationships between the project partners (the 'Murray Crayfish Team') by using a co-design, co-management and co-sampling (three C's) approach to the re-establishment of a threatened Murray Crayfish population in the Little Murray River.

Methods:

The Murray Crayfish Team ('the Team') selected six reaches for assessment as receiving locations, based on the Traditional Owner knowledge and cultural values associated with each location. Each reach was then assessed for water hydrometry (depth and flow), habitat characteristics (sinuosity and presence/absence of large woody debris) and proximity to a regulating structure. The Little Murray River at Fish Point (below the regulator) was chosen as the most suitable location for receiving and supporting crayfish (the 'translocation reach'). The Team then sampled the proposed translocation reach for Murray Crayfish at 12 sites, using a standardised crayfish sampling protocol (Raymond et al. 2017), which included setting baited Munyana nets overnight. The protocol consisted of deploying 10 baited Munyana nets at each of the 12 sites. The same protocol was employed to sample Murray Crayfish at 12 sites in a 4.6-km reach of the Stuart Murray Canal. The project partners (Traditional Owners, North Central CMA, and ARI) organised meeting times and dates for interested parties to collaborate in the collection, measuring, tagging, transport and release of Murray Crayfish into the Little Murray River at Fish Point and collation of the collected data. Four-month post-translocation surveys, employing replicate sampling protocols, were undertaken to assess the short-term success of the translocated Murray Crayfish population at Fish Point.

Results:

Murray Crayfish sampling was completed within the Little Murray River in July 2024, and no crayfish were found at the proposed translocation reach. Following this, the project partners successfully captured, tagged and translocated 100 adult Murray Crayfish (51 'berried' female crayfish and 49 male crayfish) from the Stuart Murray Canal to the Little Murray River in May 2025. The post-translocation survey captured 13 of the 100 translocated Murray Crayfish, with re-captures from the original release site (site 12, n = 7) and from the site immediately downstream (site 11, n = 6).

On Country 'riverside and campfire chats' were undertaken on the Stuart Murray Canal and on the Little Murray River, to facilitate a two-ways-of-knowing conversation between Traditional Owners, North Central CMA and ARI staff, with the aim of establishing a common dialogue of respect, interests, and goal setting. The relationships developed during the On Country conversations were strengthened through field meetings, field surveys, conferences, sharing of scientific and Traditional Knowledge, and through the planning and development of future collaborative projects.

Conclusions and implications:

This project successfully translocated 100 Murray Crayfish from the Stuart Murray Canal to a suitable reach of the Little Murray River, with post-translocation surveys confirming the survival of individuals 4 months post translocation. The collaboration between the Traditional Owners, the North Central CMA, and the ARI research staff demonstrated the potential for meaningful engagement to achieve positive outcomes for threatened freshwater crayfish species. Through the combined knowledge of the project partners, we developed a translocation framework for Murray Crayfish. This framework and the findings reported here are expected to improve the management and conservation of the species and enhance the existing relationships between the project partners. Finally, the project findings provide a baseline dataset that will be useful for assessing the trajectory, sustainability, and future requirements of the Little Murray River Murray Crayfish population, with outcomes expected to benefit similar taxa.

1 Introduction

Freshwater crayfish are imperilled globally, with almost one-third of species classified as threatened and at risk of extinction (Richman et al. 2015). Australia's largest freshwater crayfish, the Murray Crayfish (*Euastacus armatus,* von Martens 1866), is exposed to multiple threats, attributable to deteriorating habitat quality (Walker and Thoms 1993), historical and continuing harvest (Gilligan et al. 2007; McCarthy et al. 2014; Raymond et al. 2023a), modified river flows (Walker and Thoms 1993; Maheshwari et al. 1995) and the catastrophic effects of blackwater events (McCarthy et al. 2014). These threats are expected to be amplified under a changing climate (Balcome et al. 2011), with increasing frequency of blackwater (low-dissolved-oxygen) events likely to follow extended dry periods and subsequent flooding. One such example occurred on the Little Murray River in 2022, when crayfish were observed walking out of the water to escape the deteriorating conditions. In response, North Central Catchment Management Authority (North Central CMA) waterway managers, ARI researchers and Traditional Owners collaborated to restore the population through the capture and translocation of individuals from a canal system upstream of the blackwater event after the water quality had improved. This report documents the co-design, co-management and co-sampling (three C's) approach and collaboration used in re-establishing a threatened crayfish population and provides a template for undertaking similar projects across the Murray River and its tributaries.

1.1 Flooding and blackwater events

The 2010–2011 flooding event is considered to have triggered one of the worst blackwater events in the Murray River in the last century, with blackwaters extending from the Barmah–Millewa Forest downstream to the Murray mouth, some 2000 km (McCarthy et al. 2014). While the 2010–2011 flooding event was not larger than the largest recorded during the 1900s, floodwaters entered the Barmah–Millewa Forest following the 9 years of 'the Millennium Drought', which was a more severe drought than any in the last century (van Dijk et al. 2013). Furthermore, the 2010–2011 flooding and blackwater events occurred during summer, with temperatures exceeding 30℃, increasing the rate of the microbial decomposition of the terrestrial detritus in the water. Reports of surveys undertaken in the lower Barmah–Millewa Forest region in 2012–2013 indicated that no crayfish were captured (Raymond et al. 2013), whereas reports of previous surveys in the region indicated 'high' catch rates (e.g. 39 crayfish from 10 Munyana nets set during the day at Morning Glory). The Murray Crayfish population has shown minimal recovery in the 15 years since the flooding event (Raymond et al. 2025). Additional blackwater events were recorded in the Murray River and its tributaries in 2016 and again in 2022. The 2022 flooding/blackwater event instigated a fish and crayfish emergency rescue in late November; unfortunately, no crayfish rescues were undertaken in the Little Murray River, and the species is likely absent or in very low numbers throughout the upper reaches of this system.

The recognition of Murray Crayfish as 'ecosystem engineers' and 'keystone species', due to their key roles in maintaining the structure and function of ecosystems (Jones et al. 1994; Usio and Townsend 2004), highlights a fundamental need to restore the species in river reaches where they are absent or recorded in low numbers. Given the species' restricted movement (Ryan 2005; Raymond et al. 2023a), the presence of barriers (e.g. Torrumbarry Weir) and diversion channels (e.g. National Channel), the absence of Murray Crayfish in downstream environments (e.g. the Murray River below Swan Hill), and the distance to upstream populations, it is highly unlikely that populations in the Murray River can support natural recruitment of Murray Crayfish populations into the Little Murray River system. Consequently, it was concluded that the most feasible means of re-establishing a sustainable Murray Crayfish population in the Little Murray River was through conservation translocations.

1.2 Conservation translocations

The conservation goal of the current project was to translocate 100 adult Murray Crayfish from the Stuart Murray Canal (a canal connecting the Goulburn River with Waranga Basin) into a suitable reach of the Little Murray River, a waterway that has been adversely impacted by multiple blackwater events since 2010.

The Little Murray River Murray Crayfish translocation project was undertaken on Yorta Yota, Wamba Wemba and Barapa Barapa Country, in north-central Victoria. The Little Murray River Murray Crayfish Team (hereafter 'the Team') consisted of the Traditional Owners, the North Central Catchment Management Authority (North Central CMA) staff and research ecologists from the Arthur Rylah Institute for Environmental Research (ARI). The Team adopted a three C's approach to the project, to build and enhance existing relationships between the project partners. Planned 'riverside and campfire' chats were planned to highlight the interests, goals and priorities of the partners. Building respect and trust among participants is deemed to be an important feature of this threatened species recovery program.

The project consisted of four phases. The first phase (March 2024) involved the selection of six river reaches of the Little Murray River (each ~500 m in length), based on their cultural significance. Each of these river reaches was assessed for river depth and sinuosity, flow, and the presence and complexity of submerged structural habitat characteristics. The Little Murray River at Fish Point (below the Fish Point regulator) was selected as the most suitable reach to receive the translocated Murray Crayfish. The Little Murray River at Fish Point was then surveyed for crayfish (Phase 2, July 2024). In the third Phase (May 2025), 100 adult Murray Crayfish from the Stuart Murray Canal were captured, tagged and transported to the Little Murray River at Fish Point, and released immediately downstream of the Fish Point regulator. Ninety-six of the 100 transported crayfish were inserted with Passive Integrated Transponder (PIT) tags for individual identification. Lastly (Phase 4, September 2025), post-translocation sampling for Murray Crayfish was undertaken at the Little Murray River at Fish Point.

2 Methods

In order to achieve the objective of the program—establishing a new population of Murray Crayfish in the Little Murray River—a total of six sites was selected and assessed for habitat characteristics deemed to be supportive of Murray Crayfish populations (see Section 2.2). Following this, the most suitable site was surveyed for the presence of crayfish (see Section 2.3). The source population of Murray Crayfish (the Stuart Murray Canal population) was then sampled, and 100 adult crayfish were tagged and translocated into the Little Murray River (see Section 2.4). Details of the methods applied are outlined below.

2.1 Study species: Murray Crayfish

Murray Crayfish is the second-largest freshwater crayfish species in the world (Riek 1969). It holds high cultural, ecological, economic and social value (Noble et al. 2018) and supports a recreational fishery. The species is found in the Murray River and its tributaries, within Australia's Murray–Darling Basin (Furse and Coughran 2011; Noble et al. 2018; Todd et al. 2018). Murray Crayfish is listed as 'threatened' under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG) and as 'vulnerable' under the Australian *Environmental Protection Biodiversity Conservation Act* 1999 (EPBC) (DCCEEW 1999), due to widespread declines in its distribution and abundance since the 1950s (Geddes 1990; Horwitz 1995). Such declines facilitated the implementation of strict harvest regulations, including regional closures, a restricted harvest season (1 July to 31 August), a ban on the removal of egg-bearing ('berried') females, a bag limit (two/person/day, maximum of four in possession), and a Harvest Slot Legal Limit [HSLL: 100–120 mm occipital carapace length (OCL)] (VFA 2025).

Murray Crayfish is long-lived (25+ years, Todd et al. 2018), is extremely slow-growing (Furse and Coughran 2011), has limited mobility (Ryan 2005), has low fecundity (Holdich 2002), and is late-maturing (5–7 years, Todd et al. 2018). These *K*-selected life-history traits make it particularly vulnerable to harvest (Whiterod et al. 2018; Raymond and Todd 2020) and blackwater events (King et al. 2012), and it has been slow to recover from these events. Generally, Murray Crayfish breed in late April/early May, with females brooding externally fertilized eggs for approximately 140 days (Geddes 1990). Early instar Murray Crayfish remain attached to their mothers for a further 2–4 weeks, after which they 'fall off' the mother's tail and receive no further parental care.

The species show a preference for deep, fast-flowing and oxygenated waters with complex woody habitats and intact riparian zones (McCarthy 2005; McCarthy et al. 2014), and they may construct short (~1-m) burrows in the clay banks of rivers. The presence of slow-flowing water in Murray River weir-pools, high historical harvest (Gilligan et al. 2007), manipulation of water levels (potentially exposing burrows to the air), and extensive de-snagging of the Murray River in the 1900s, have likely contributed to the absence (or very low abundance) of the species from reaches downstream of the Barmah–Millewa Forest, in the mid-Murray River.

2.2 Little Murray River site selection and assessment (Phase 1)

Wamba Wemba Traditional Owners selected six reaches spread throughout the Little Murray River, based on their cultural significance, as potential Murray Crayfish translocation reaches (Figure 1). Each of the six river reaches (each ~500 m in length) was assessed and scored on reach-specific physical and hydrological characteristics, including (1) river sinuosity, (2) water depth, (3) complexity and size of structural woody habitat (woody debris) and (4) site proximity to existing water infrastructure (Table 1, Appendix 1). A visual example of the site-specific physical characteristics (water depth and habitat complexity) is provided in Figure 2. As Murray Crayfish show a preference for sites with deeper, fast-flowing water (McCarthy et al. 2014) on the outside of river bends, with complex structural woody habitat (Whiterod et al. 2018), these characteristics were used to compare and select the most suitable receiving reach for the translocation. The river reach with the highest cumulative score was selected as the receiving site for the translocation of Murray Crayfish. Riverine nomenclature was determined based on Frissell et al. (1986).

Table 1. River reach selection criteria and associated scores.

Selection criteria scores were assigned the following values: sinuosity (0–2 bends = 0, 3–5 bends = 1, >5 bends = 2), depth (>50% red and orange = 0, 25%–50% green = 1, >50% green = 2), habitat (>75% blue = 0, 1–2 red-spots = 1, >3 red-spots = 2), and proximity to water infrastructure (e.g. weir) (>1 km = 0, within 1 km = 3). Associated scores reflect the occurrence of multiple criteria (excluding proximity to water infrastructure) at the same location (no overlap = 0, 2 criteria overlap = 1, all 3 criteria = 3). Proximity to water infrastructure was assigned a comparatively high score due to the capacity of the structure (the weir) to regulate flows through the study reach.

Key selection criteria						
Reach number	River sinuosity	Water depth	Habitat kernel density	Proximity to existing infrastructure	Association between sinuosity, depth, and kernel density	Cumulative score
1	0	0	0	0	0	0
2	2	0	0	0	1	3
3	2	1	1	0	0	4
4	2	1	0	0	0	3
5	2	2	1	3	3	11
6	2	1	2	0	1	6

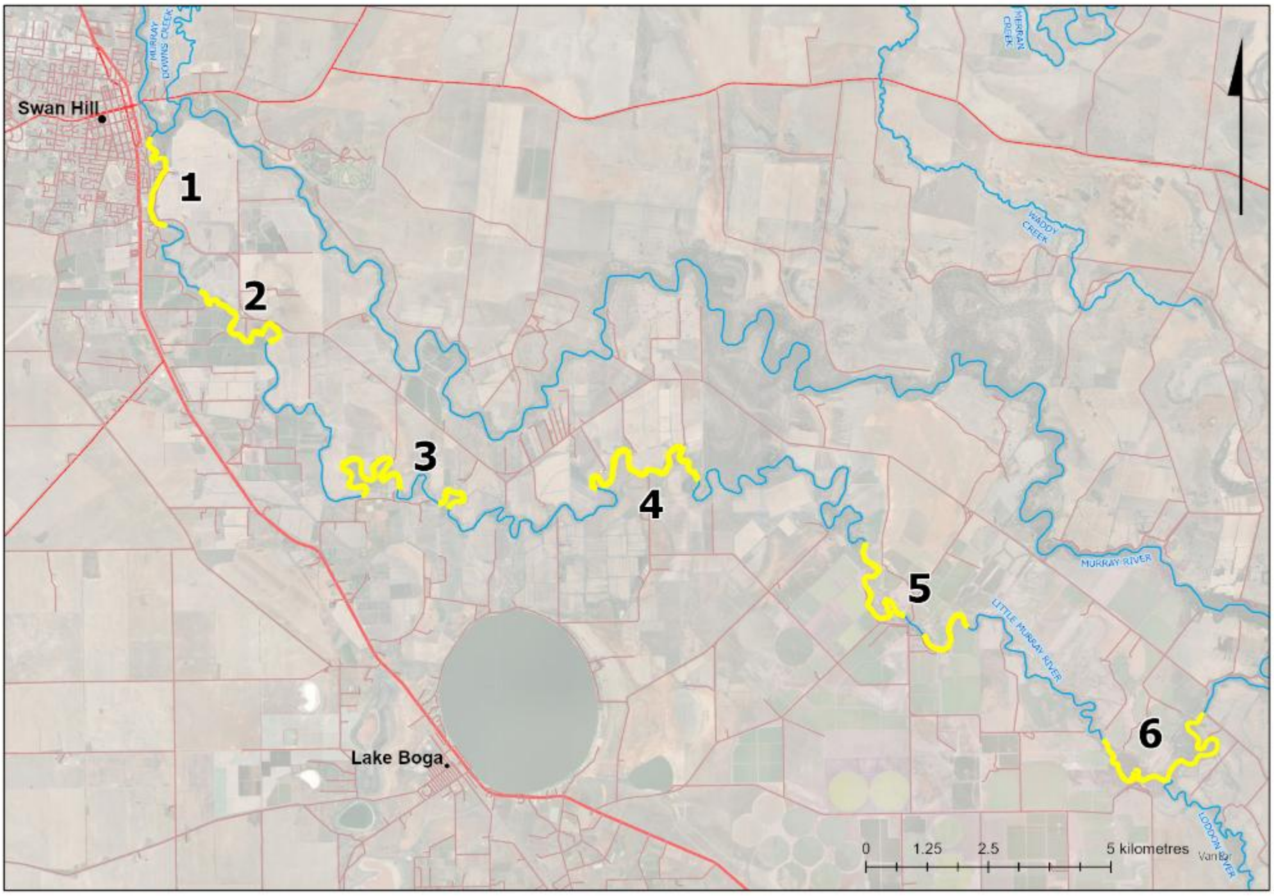

Figure 1. Murray Crayfish River reaches (numbered, highlighted yellow) selected for water and habitat characteristics in the Little Murray River.

Reach 5 is the Little Murray River at Fish Point. Water flows through the system from east to west.

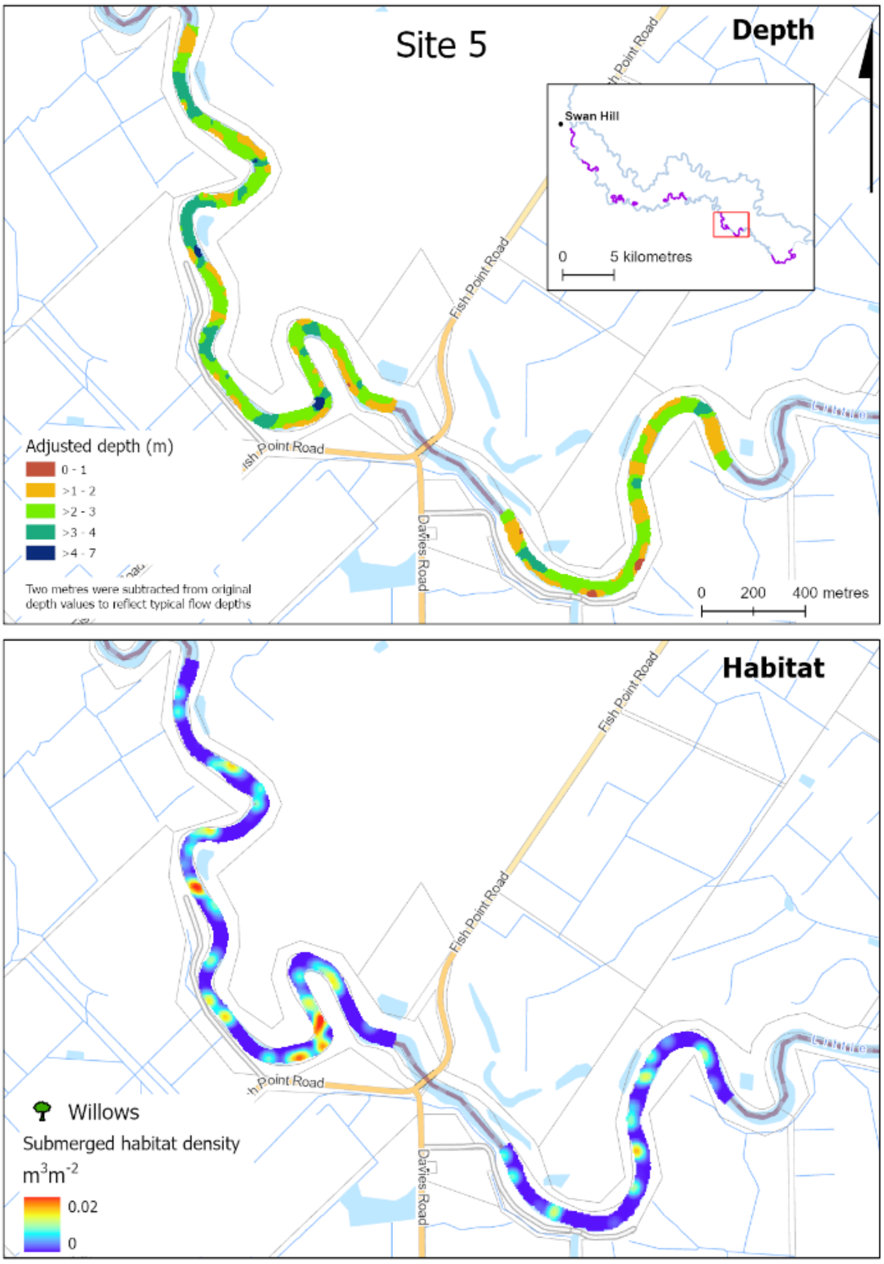

Figure 2. An example of the riverine habitat characteristics of the Little Murray River at Fish Point. Water depth (top pane) and habitat density (bottom pane) characteristics across the sample reach are colour-coded to highlight variability and relationships with one another and with river sinuosity.

2.3 Sampling the Little Murray River at Fish Point for Murray Crayfish (Phase 2)

In July 2024, the selected Little Murray River translocation reach (Figure 3) was surveyed for Murray Crayfish using an established sampling protocol (Raymond and Todd 2020), consisting of 12 sample sites. Each site was 200 m in length and separated from adjacent sites by 200 m. Ten Munyana nets (4.5-cm mesh size, 2 × 90-cm parallel collapsible hoops; Leland et al. 2013), each containing an ox liver bait (300 ± 50 g), were deployed at each site, separated by approximately 20 m from adjacent nets. Twenty metres was chosen to ensure that multiple nets were within an individual crayfish's estimated home range of 20–80 m (Ryan 2005; Raymond et al. 2023a). Nets were set in the afternoon (4–5 p.m.) and checked the following morning (7–9 a.m.). The survey period (7–11 July 2024) coincided with the austral winter and cooler water temperatures, consistent with the reported breeding season and higher levels of movement in the species (Coughran and Furse 2012).

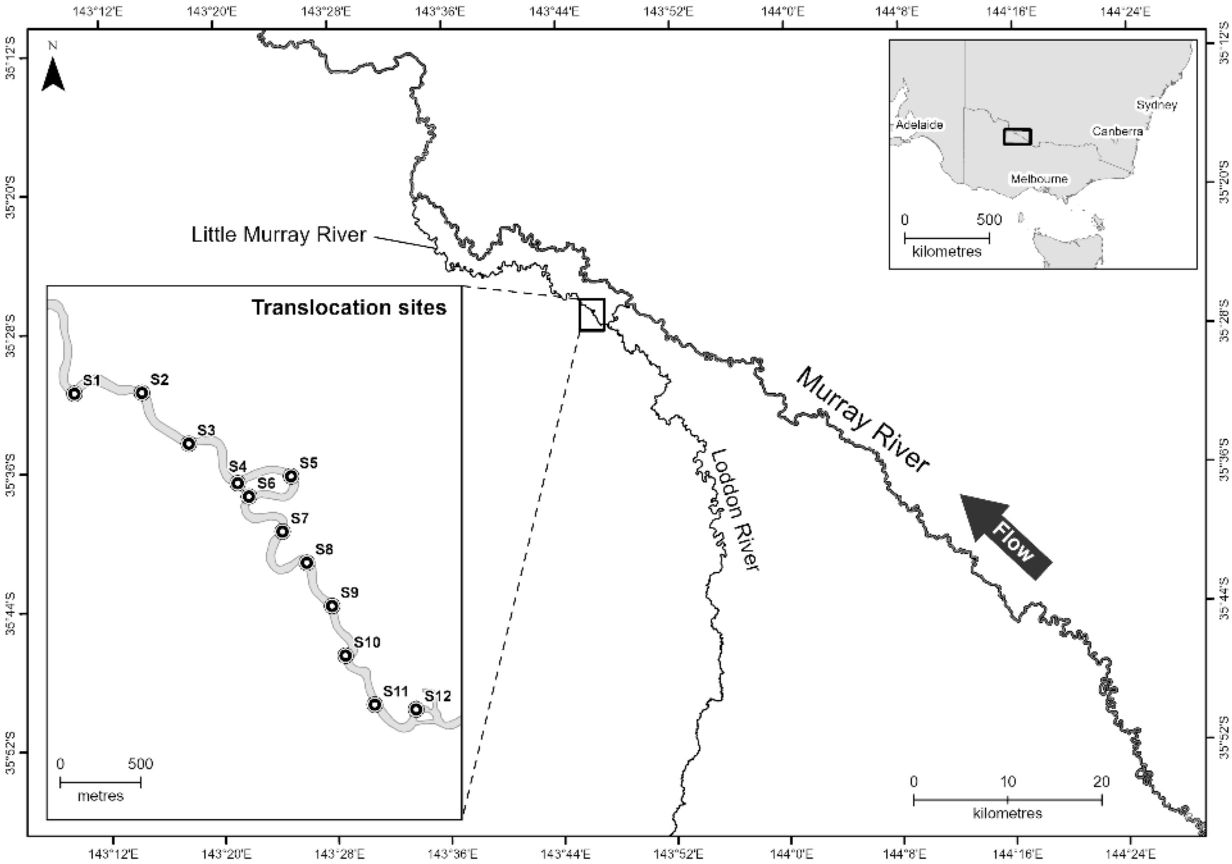

Figure 3. Map of the Murray Crayfish translocation reach and survey sites (s1–s12) at Fish Point on the Little Murray River.

2.4 Sampling, tagging and transporting Murray Crayfish from the Stuart Murray Canal to the Little Murray River (Phase 3)

The Team aimed to translocate 100 adult Murray Crayfish from the Stuart Murray Canal to the release site on the Little Murray River (Figure 4). Murray Crayfish were selected for translocation from the Stuart Murray Canal population based on their sex, size, absence of external damage, and, for females, their reproductive state (carrying eggs).

A total of 100 crayfish were chosen (1) to represent densities in upstream populations, (2) to account for the species' limited dispersal, and (3) in consideration of the size of the aerated transport trailer (1 m^3 of water). The goal of the translocation program was to capture 50 adult female Murray Crayfish with eggs and 50 adult male Murray Crayfish, and to transport and release them below the Fish Point Weir in the Little Murray River. Adult crayfish were selected for translocation to maximise survival rates (in view of the lower predicted survival rates of juvenile crayfish), and similar numbers of males and females were selected to ensure equal sex ratios, to maximise future breeding opportunities. Berried females were selected for translocation, over non-berried females, to promote early recruitment of young into the translocated population. Data for the individual tagged crayfish are provided in Appendix 2.

The Stuart Murray Canal connects the Goulburn River with the Waranga Basin, within the Goulburn–Broken catchment in central Victoria (Figure 4), and the canal network is managed by Goulburn–Murray Water (GMW). A portion of Goulburn River water (volumes dependent on downstream demand) is diverted at the Goulburn Weir into the Stuart Murray Canal, where it flows northward through a series of small, gated weirs and artificial concrete structures to the Waranga Basin, some 50 km downstream of the Goulburn River. The canal water is predominantly used for the stock on the surrounding agricultural land and for irrigation of that land. During late Spring (October to November) and throughout the summer months (December to February), the canal is run at close to maximum capacity (~2.5-m deep), with volumes during the autumn and winter months being approximately half of the summer flows (GMW pers. comm.). The Stuart Murray Canal is U-shaped, has a clay bottom, its banks are lined with blue-metal rocks (of 10–60 cm circumference) to protect against flow scour, and it is 60-m wide at the study site. No structural woody habitat exists within the canal at the study site, and small isolated stretches (<20 m long) of *Phragmites*, River Redgum (*Eucalyptus camaldulensis*) and Willow (*Salix* spp.) line the canal banks (Figure 2).

In May 2025, Murray Crayfish were sampled from the Stuart Murray Canal (Figure 5 and 6), using the same sampling techniques employed on the Little Murray River. Occipital Carapace Length (mm), weight (g), sex (female/male), presence of eggs (yes/no) and female reproductive state were recorded for each of the sampled Murray Crayfish (Raymond et al. 2024). When captured, the chelipeds (claws) of all crayfish were fitted with 25 mm × 13 mm silicone bands, using a stainless-steel banding tool (Hilltop products, Pty Ltd.) to prevent damage to crayfish and to the people handling them.

Each of the crayfish selected for translocation was internally tagged with an HPT8-preloaded PIT tag (8 mm in length, KarlTek Pty Ltd), ensuring that each crayfish could be individually identified, to support future sampling of the translocated population in the Little Murray River. The translocation permit details are provided in Appendix 3.

Murray Crayfish were held overnight in Munyana nets in the Stuart Murray Canal and transported from the Stuart Murray Canal to the Little Murray River (~4 hours away) in an aerated purpose-built fish transporter (1000 L) provided by the Victorian Fisheries Authority. During transportation, dissolved oxygen levels and water temperature were checked hourly. Dissolved oxygen levels were replenished from approximately 60%–70% to 100% at each 1-hour check.

In late May 2025 (1 week post surveys), the Stuart Murray Canal crayfish survey reach was drained by GMW to undertake engineering works on a downstream bridge, providing the Murray Crayfish Team with the opportunity to assess the canal substrate, in-stream habitat, and shape.

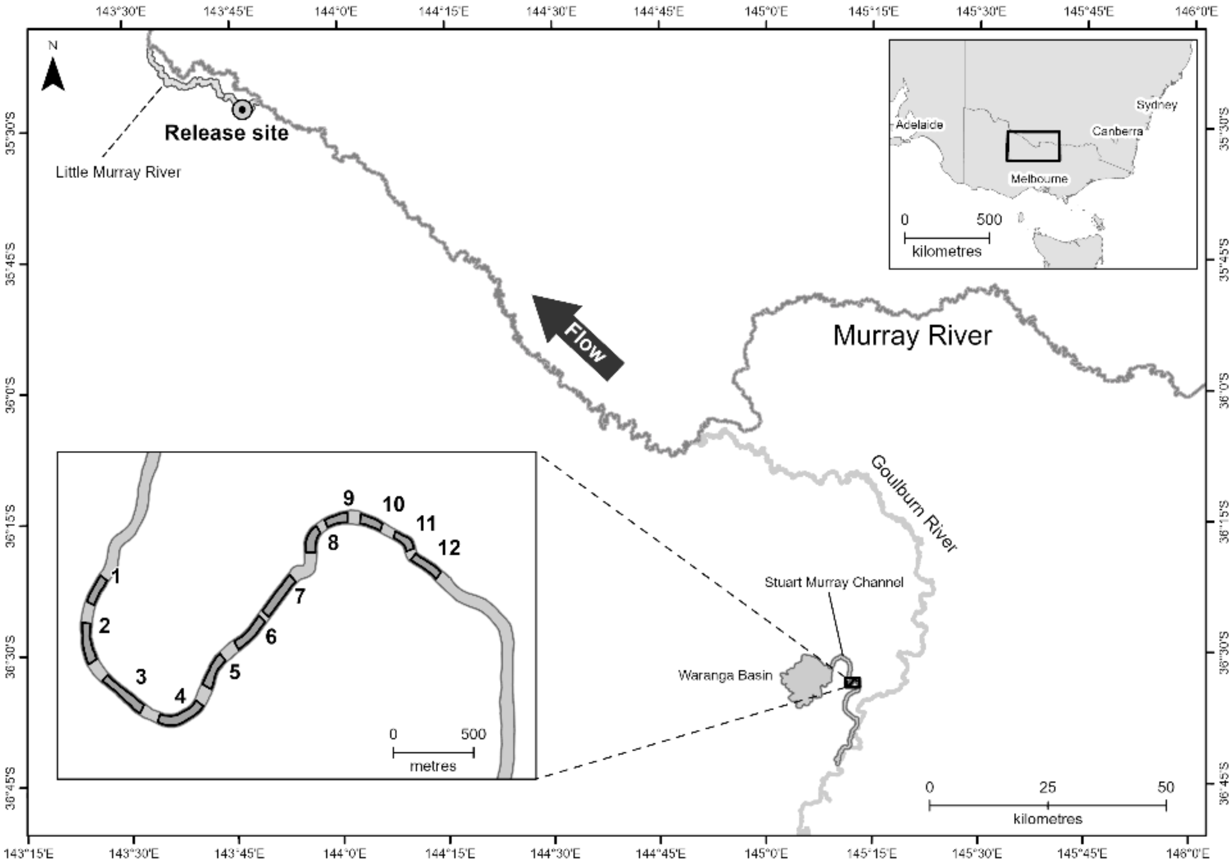

Figure 4. The 2025 Murray Crayfish translocation project collected crayfish from the Stuart Murray Canal (source population) and released them into the Little Murray River at Fish Point (encapsulated circle).

Numbered rectangles represent individual sampling sites on the Stuart Murray Canal.

2.5 Post-translocation sampling in the Little Murray River (Phase 4)

In September 2025, Murray Crayfish were sampled in the Little Murray River at Fish Point, replicating the sampling methodology employed in phases 2 and 3.

Figure 5. The Stuart Murray Canal (survey reach), Murchison. One hundred adult Murray Crayfish were captured in the canal and translocated to the Little Murray River (12–17 May 2025).

Figure 6. Yorta Yorta, Wamba Wemba, Barapa Barapa, North Central Catchment Authority, and Arthur Rylah Institute for Environmental Research staff collecting, tagging, and collating data for Murray Crayfish, Stuart Murray Canal 2025.

Fish/crayfish transporter supplied by the Victorian Fisheries Authority.

3 Results

3.1 Site selection and Little Murray River crayfish sampling (Phases 1 and 2)

The Little Murray River reach at Fish Point (reach 5, Figure 1) was selected as the translocation location for Murray Crayfish, because the reach provided the most suitable combination of habitat conditions (in terms of sinuosity, water depth, complexity and size of structural woody habitat, flows, and flow management infrastructure) to support crayfish. Further, the selected reach fell within a region of the river where previous restoration works had been undertaken by the North Central CMA (Appendix 4). At the completion of the Murray Crayfish sampling in the Little Murray River at Fish Point (reach 5) prior to the translocation, no crayfish were caught.

3.2 Stuart Murray Canal Murray Crayfish total catch summary (Phase 3)

A total of 191 Murray Crayfish were sampled from the Stuart Murray Canal in May 2025 (Figure 7, Table 2). Of these, 114 were female and 77 were male, representing an overall female:male sex ratio of 1.5:1. Sex ratios were equivalent (1:1) in those crayfish below the Harvest Slot Legal Limit (HSLL), but disparate in crayfish within (2:1) and above (2.5:1) the HSLL, respectively, consistent with a population subject to moderate to high harvest pressure (Raymond and Todd 2020; Raymond et al. 2023a). On average, females were larger (mean length 108 mm OCL) than males (mean length 97 mm OCL) (Table 2), consistent with the presumed proportionally higher removal rates of males than females, within the HSLL.

Of the 114 females captured from the Stuart Murray Canal, 89 females were carrying eggs (Table 3). Of the egg-bearing females, 86% were within or above the HSLL, and only a single female above the HSLL was not carrying eggs. The majority (97%) of females that had eggs present, had a full complement of eggs (an estimated egg load of 100%). One of the three females with <100% eggs, had an egg load of approximately 30%, with the attached eggs present presumed to be dead, based on their brown colouration and the presence of fungal spores. The remaining two females with less than their full egg complement were estimated to be carrying approximately 90% of their potential full load of eggs and were consequently excluded from the translocation program. While variable, fertilised Murray Crayfish eggs generally range in colouration from orange (1–2 weeks post fertilisation) to bright red (2–6 weeks post fertilisation) to deep red (6 weeks+ post fertilisation).

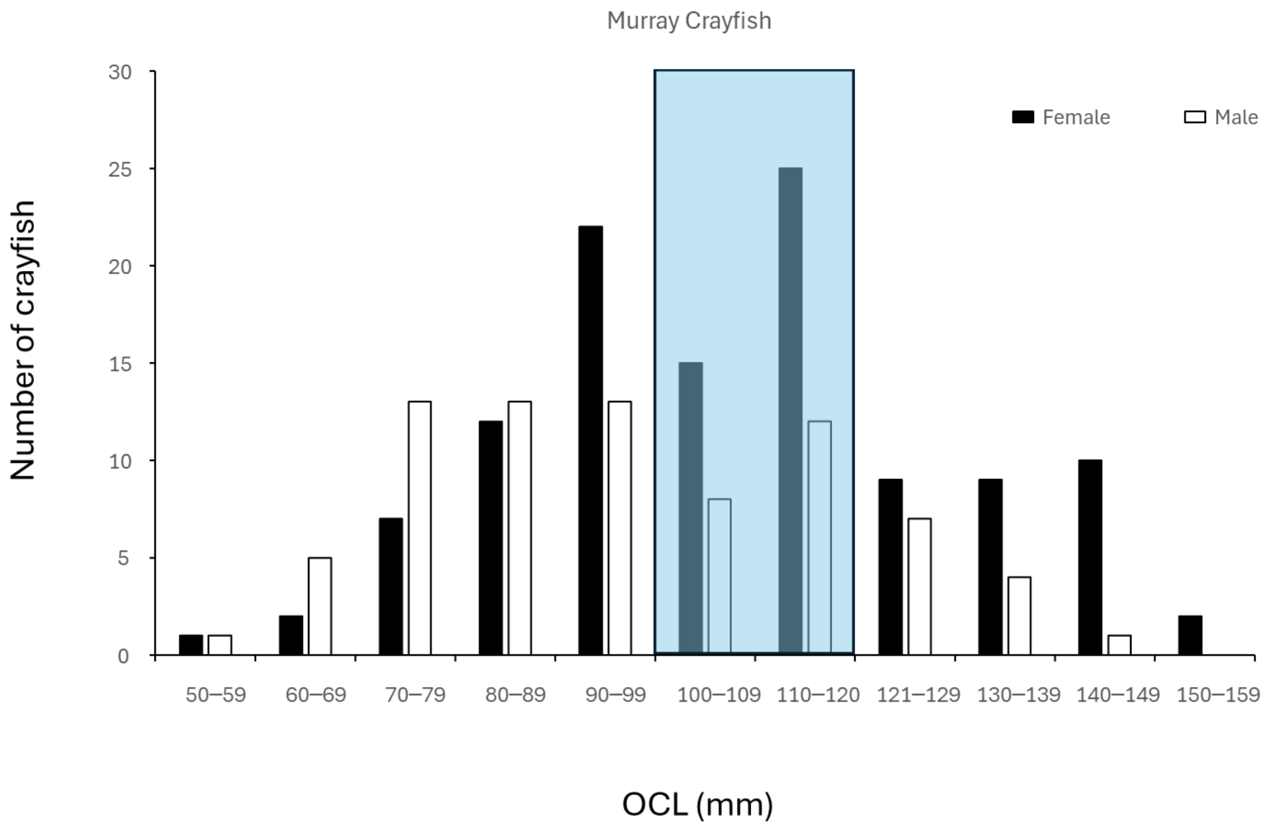

Figure 7. The occipital carapace length (OCL) (in 10-mm cohorts) of the sampled Murray Crayfish population from the Stuart Murray Canal, May 2025.
Bars represent female (black columns) and male (white columns) crayfish. The Harvestable Slot Legal Limit (100–120 mm OCL) crayfish columns are shaded in blue.

Table 2. Total mean (±S.E.) occipital carapace length (OCL) in millimetres, and number of Murray Crayfish [below, within and above the Harvestable Slot Legal Limit (HSLL)] sampled from the Stuart Murray Canal.

Crayfish	Number	OCL (mm)		Number of crayfish		
		Mean	S.E.	<HSLL	Within HSLL	>HSLL
Male	77	108	2.0	45	20	12
Female	114	97	2.4	44	40	30

Table 3. Reproductive state, mean (±S.E.) occipital carapace length (OCL) in millimetres, and number of female Murray Crayfish [below, within and above the Harvestable Slot Legal Limit (HSLL)] carrying eggs, sampled from the Stuart Murray Canal.

Reproductive state	Number	OCL (mm)		Number of crayfish		
		Mean	S.E.	<HSLL	Within HSLL	>HSLL
Females with eggs	89	116	1.8	20	40	29
Females without eggs	25	82	2.7	24	0	1

3.3 Murray Crayfish selected for translocation

The Murray Crayfish Team employed four criteria for selecting individual crayfish for translocation: (1) sex, (2) size, (3) observable damage (e.g. with lost or comparatively small limbs) and (4) (for females) egg-bearing. Ideally, 50 adult females and 50 adult males with no external damage and a full complement of eggs (for females). The limited availability of large (>HSLL) males in the Stuart Murray Canal crayfish population resulted in the selection of comparatively smaller males than females, including males from the 80–89 mm OCL cohort (Figure 8). Similarly, the limited number/absence of large males in the top two size cohorts (140–149 and 150+ mm OCL) resulted in the selection of a greater number of large females than large males. As a result of the limited abundance of adult (>80 mm OCL) males, 51 female and 49 adult males were translocated to the Little

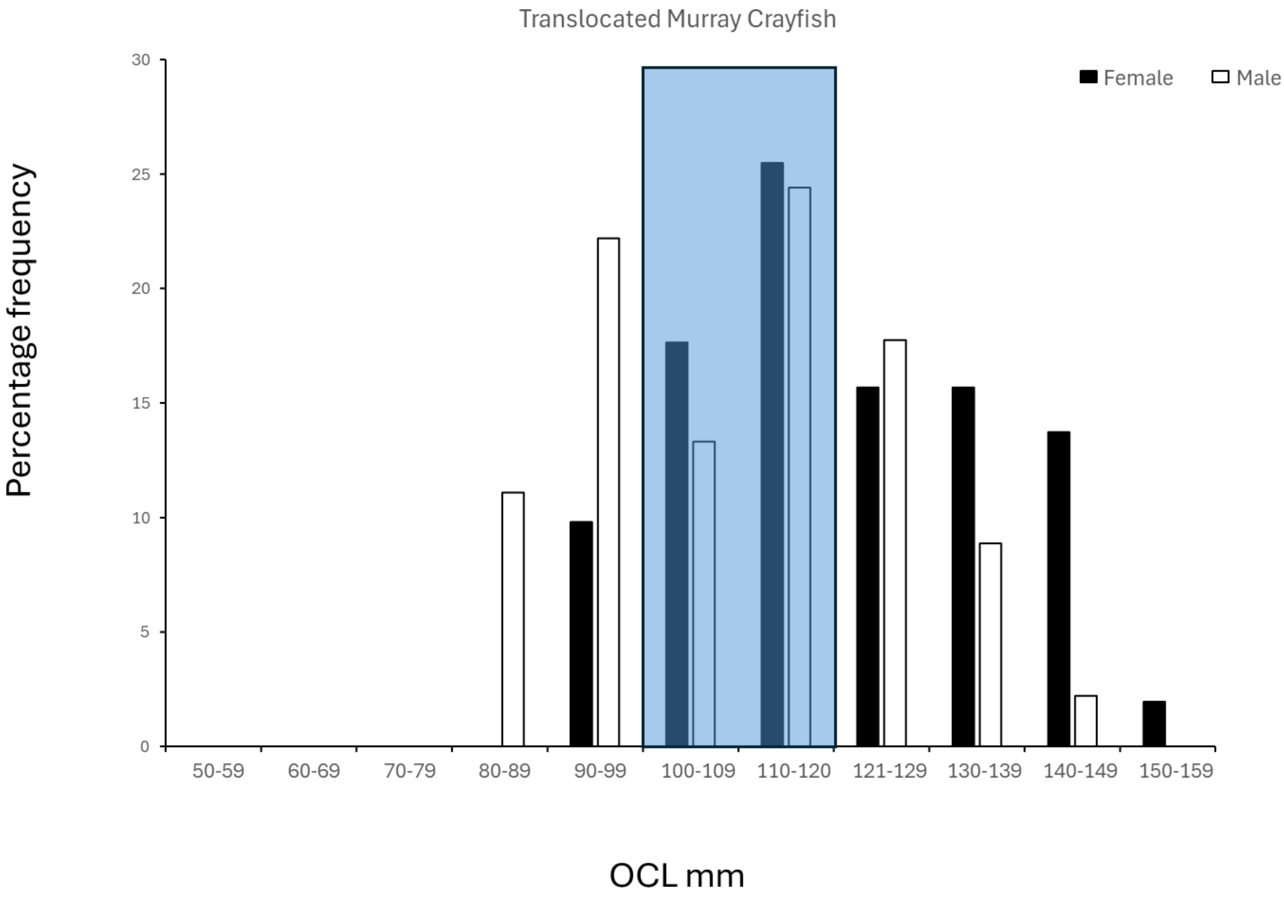

Figure 8. The occipital carapace length (OCL) (in 10-mm cohorts) and sex of the 100 Murray Crayfish selected for translocation from the Stuart Murray Canal to the Little Murray River.

Bars represent female (black columns) and male (white columns) crayfish. The Harvestable Slot Legal Limit (100–120 mm OCL) crayfish columns are shaded in blue.

3.3.1 Translocation procedure

Approximately 70 selected Murray Crayfish were held overnight in Munyana nets (net entrances closed to avoid escape) in the Stuart Murray Canal prior to transport, while the remaining 30 individuals were captured on the day of transportation. A 20-L oxygen tank, attached to an in-tank strip aerator, was adjusted to deliver constant aeration at 90–100% saturation (prior to placing crayfish in the transportation tank). All crayfish were removed from the Munyana nets, and each of them was fitted with a PIT tag, scanned for individual identification (PIT tag number), and placed within the 1000-L aerated transport tank (filled with canal water). Once crayfish were placed in the transporter, the dissolved oxygen was re-adjusted to 90–100% saturation. Dissolved oxygen levels were checked in situ every 1 hour throughout the 4-hour trip from the Stuart Murray Canal to the Little Murray River, using a YSI ProDSS (Xylem brand) portable water quality meter. Aeration (oxygen level) was re-adjusted to account for oxygen consumption by crayfish; the oxygen levels had declined to 60–70% saturation at each 1-hour check. Individual Murray Crayfish data and corresponding PIT details are provided in Appendix 2.

On arrival at the Little Murray River, one-quarter of the transporter water was drained and replaced with local river water, to allow crayfish to acclimate to the local water characteristics (e.g. temperature, salinity, hardness). This procedure was repeated 30 minutes after the initial water transfer. Following acclimation, North Central CMA, GMW, Wamba Wemba and ARI staff netted crayfish from the transport tank and positioned them at the water's edge, to support the movement of the crayfish into their new environment (Figure 9).

Figure 9. One of the 100 adult Murray Crayfish translocated into the Little Murray River (left), immediately below the Fish Point Weir (right).

3.3.2 Translocation summary

In total, 100 adult Murray Crayfish (51 females and 49 males) were translocated from the Stuart Murray Canal to the Little Murray River at Fish Point, May 2025. All 51 females were inserted with PIT tags. Four male crayfish were placed in the transporter without confirmed length, weight and PIT tag details.

3.4 Post translocation survey (Phase 4)

In September 2025, the Fish Point reach of the Little Murray River was surveyed for crayfish, 4 months following the initial Murray Crayfish translocation. Thirteen of the 100 translocated Murray Crayfish were re-captured. Eight females and five males were re-captured; however, the PIT scanner was unable to detect the tag of one female crayfish. As visible signs of tag insertion are difficult to detect (even immediately after tagging), (1) this female repelled the tag, (2) the tag was faulty, or (3) this female was a 'natural' resident. Although 2 females from the original translocation of 51 females had the same length and similar weight to those of the unidentified crayfish, we were unable to definitively assign a PIT-tag number to the re-captured crayfish.

All 13 re-captured crayfish were detected in site number 11 (seven crayfish) or site number 12 (six crayfish), with site number 12 corresponding to the original translocation release location and the most upstream survey site.

During the 4-month interval from the initial release (May 2025) of the Murray Crayfish to the post-translocation sampling (September 2025), the re-captured male crayfish had increased in weight from an average of 600 g to 660 g (~10%) (Table 4). In contrast, the average weight of the re-captured female crayfish (excluding the unidentified female) increased from 819 g to 828 g (~1% increase). All re-captured females (excluding the unidentified female) retained approximately 80% (ranging from 70%–90%) of their eggs/larvae during the post-sampling survey, a period covering the core brooding period of the species

(Table 5). Length measurements were not compared, as individuals only increase in length following moulting, which occurs annually in adults during March–April (prior to mating).

Table 4. Murray Crayfish mean weight pre- and post-translocation (4 months between sampling events).

Sex	Number	Weight (g)		% increase
		Pre-translocation	Post translocation	
Males	5	601	660	10
Females	8	819	828	1

Table 5. The average percentage of eggs retained by gravid females pre- and post-translocation (4 months between sampling events).

Reproductive state	Number	% of eggs retained (±S.E.)		% decrease
		Pre-translocation	Post translocation	
Gravid females	8	100 (0.0)	79.4 (3.4)	20

Figure 10. Members of the Murray Crayfish Team on the banks of the Stuart Murray Canal, June 2025.

Following the successful translocation of 100 adult Murray Crayfish to the Little Murray River, members from each of the partner groups sat together for a 'riverside chat' on the bank of the Stuart Murray Canal, with the aim of building respect, trust, and an understanding of one another's interests, goals and future collaboration opportunities. ARI researchers outlined their understanding of crayfish biology, ecology, and population dynamics and highlighted future research avenues. Wamba Wemba and Yorta Yorta members shared their knowledge of Country, Creation and the inextricable links between their peoples and the land. We shared stories of our upbringing, racism, separation and identity. We also discussed mob cultural hierachy, cooking, dreamtime, self-determination, reconciliation, hunting and art (Figure 10). The day concluded with a Smoking Ceremony to acknowledge, pay our respects to, and protect the group from ill-foreboding, due to the discovery of potential human remains found within our study site.

During the Murray Crayfish re-sampling (Phase 4, September 2025), the Team held multiple discussions on local ecology, scientific design, family relationships, field gear, traditional tool-making, life on the reserve, and future collaborative projects (Figure 11). The Murray Crayfish Team showed interest in (1) modelling a range of Murray Crayfish regulatory scenarios, (2) the impacts from variable seasonal egg attrition on Murray Crayfish population dynamics, and (3) the ongoing translocation of Murray Crayfish into the Little Murray River. All members of the Team were passionate and excited to pursue a Traditional Owner weaving/crayfish-trap building workshop in 2026.

Figure 11. The Murray Crayfish re-sampling Team on the banks of the Little Murray River, September 2025.

Arthur Rylah Institute and North Central Catchment Management Authority staff and members of the local community were treated to a day of traditional tool-making (note the spear leaning against the tree in the photo on the left and the walking stick in the photo on the right).

4 Discussion

Using a multiphase approach to species translocation, the Murray Crayfish Team successfully translocated 100 adult Murray Crayfish from the Stuart Murray Canal at Murchison to the Little Murray River at Fish Point in May 2025. The Team (Traditional Owners, North East CMA and ARI researchers) employed a co-design, co-management, and co-sampling approach to incorporate local knowledge and values within a robust project design to (1) build and maintain collaborative relationships and (2) collectively support the long-term aim of re-establishing Murray Crayfish within the Little Murray River system. While the project successfully translocated and then assessed the reach (post translocation) for crayfish (proof of concept), the Team recognises the need to continue translocating crayfish into the reach annually, over the next 10+ years, to help establish a self-sustaining Murray Crayfish population. River and campfire chats and collaboration were integral to building relationships and for developing a greater understanding of the interests and goals of the project partners. Here, we discuss the state of the Stuart Murray crayfish population, the successful reintroduction of a threatened crayfish species into a river reach where they once persisted, and the need for further monitoring and evaluation. This is the first reported project to have successfully translocated Murray Crayfish from an artificial canal to a waterway where the species has previously existed, providing a template for future conservation translocations for similar taxa.

4.1 The Stuart Murray Canal Murray Crayfish population

The Stuart Murray Canal Murray Crayfish population is unique in that the population has successfully established itself in an artificial canal linked with the Goulburn River and persisted, despite the seasonal nature of water delivery typical of irrigation systems. Pre-translocation, the population was healthy in terms of abundance (albeit lower abundance than that of local riverine populations), lack of external damage to individuals (no loss of limbs), 99% of females within and above the HSLL carried eggs, and all berried females carried their full complement of eggs (based on crayfish size and egg coverage on pleopods). This contrasts with local riverine populations (e.g. in the Ovens, Murray and Goulburn rivers), where the rate of external damage to the fish is comparatively higher—up to 50% of females within and above the HSLL are devoid of eggs, and berried females often carry <50% of their full egg complement (Raymond and Todd 2020; Raymond et al. 2023a, 2023b; Raymond et al. 2025a). These differences suggest that conditions within canal habitats differ from those of rivers, likely as a result of differences in in-stream physical structure, predation, harvest pressure, productivity, density dependence, and flow variability, all of which may be linked to variable abundance of taxa. While the lack of exoskeleton damage and the reproductive status of the canal population may be regarded as healthy, alternate indicators (e.g. sex ratio, size structure) reflect a population exposed to considerable harvest pressure.

In the absence of exceptional circumstances (e.g. parthenogenesis, temperature-driven sex determination), not observed in Murray Crayfish, the ratio of females to males in animal populations is expected to be 1:1 (Fisher 1930). Disparity in the sex ratio (Coltman et al. 2003; Ancona et al. 2017) and differences in size-based sex ratios (Festa-Bianchet 2003; Milner et al. 2007) are useful for determining continued exposure to harvest, or recovery from the impacts of harvest. The observed disparity in the Stuart Murray Canal Murray Crayfish sex ratio (1.5 F:1 M), and the larger average size of female crayfish compared with male crayfish within the canal population, reflect a population under moderate to high harvest pressure (Raymond and Todd 2020; Raymond et al. 2023a, 2024). Typically, fishers selectively remove more males than females within the HSLL, to conform with harvest regulations that ban the removal of 'berried females' within the HSLL (VFA 2025), inadvertently skewing the sex ratio and size structure of populations. The adverse consequences for over-harvested populations can be severe. In many taxa, including crayfish, these consequences include changes in mate selection, behaviour modification leading to increased aggressive encounters, impaired reproduction (e.g. sperm limitation and decreased fertilisation rates), recruitment failure, and increased risk of extinction (Solberg et al. 2002; Sato and Goshima 2007; Sato and Yoseda 2010). While harvest appears to be the most likely driver of the disparate sex ratio and truncated size-structure of the Stuart Murray Canal crayfish population, other factors [e.g. size- and sex-selective predation (by fish/birds/mammals), movement, and behaviour] require further investigation.

The absence of female crayfish <90 mm OCL and male crayfish <80 mm OCL from the canal population deviated from expectations based on similar surveys of riverine populations, where crayfish of 60–90 mm OCL have frequently been sampled (Raymond et al. 2023b). While the mesh size of the survey gear (Munyana nets) specifically targets mature crayfish (>60 mm OCL), the comparative absence of maturing crayfish suggests that the canal population may be a population 'sink' rather than a self-sustaining population. This suggestion tallies with knowledge about Murray Crayfish growth (which take 5–7 years to reach maturity; Todd et al. 2018) and the time since the Stuart Murray Canal was last drained and refilled

(6 years ago, GMW pers. comm.), and highlights the critical relationship between the canal management and the Murray Crayfish population structure and health. Consequently, the Murray Crayfish Team engaged in discussions with GMW to better understand the drainage, filling and flow regimes of the canal system. Monitoring of the canal population, the species' recolonisation pathways (following refilling) and of its source population in the Goulburn River require further work, to better understand and manage this resource, which is critical for supporting future translocation programs.

4.2 Conservation translocation outcome

The Murray Crayfish translocation program undertaken by the Murray Crayfish Team was a success. The co-design, co-management and co-survey approach was adopted for locating a source population for translocation, for the collection and transportation of the crayfish, and for the recapture of translocated crayfish in the Little Murray River (which were heavier and retained comparatively more eggs than conspecifics in other riverine populations). Potentially, the most positive outcome was the development of trust and respect among the project partners, through a shared understanding of the value of Country, the recognised need for (and drivers of) Traditional Owner self-determination, and a shared desire to restore ecosystem health.

From an ecological and biological perspective, the return of Murray Crayfish to the Little Murray River is likely to improve the ecosystem health, through their polytrophic feeding and movement habits—which facilitate the transfer of energy among the trophic levels (Merrick 1993; McCarthy 2005)—and through their key role in the structural manipulation of physical habitats. Crayfish are considered a keystone species in riverine environments (Jones et al. 1994; Usio and Townsend 2004).

A further indicator of the success of the translocation was the calculated average weight gain of male and female crayfish of 10% and 1%, respectively, during the 4-month period following translocation, indicating that both sexes have continued to feed since the translocation. The sex-based disparity in the weight gain may reflect the loss of eggs by females, and/or the inferred greater energy requirements of berried females (Raymond et al. 2023a). Furthermore, the translocated females retained an average of 80% of their eggs 4 months post translocation, compared with approximately 50 to 60% in the nearby Murray and Goulburn rivers populations (Raymond, Barmah–Millewah Forest icon site unpublished data). This is remarkable, given that the translocated crayfish were exposed to multiple handling events, internally tagged, and transported to a waterway in which the habitat, potential predators, and flow characteristics differed from those of their source environment (a canal). The use of a suitable transporter and soft-handling techniques for Murray Crayfish, described in Raymond et al. (2024), may have contributed to a reduction in handling related stress often associated with declining condition (e.g. weight loss and egg loss in similar taxa (Gelling et al. 2009; Danylchuk et al. 2014; McLean et al. 2016). The comparably greater egg retainment of the Stuart Murray Canal crayfish likely represents the exceptional health of the translocated individuals (e.g. no damage and full egg allotment) and the suitability of the translocated waterway for supporting crayfish. The restricted dispersal of the sampled crayfish is consistent with the reported limited dispersal capabilities of the species (Ryan 2005; Raymond et al. 2023a). The Team will continue to work closely with GMW to improve the in-stream conditions for the Murray Crayfish population.

While the Team regard the translocation of Murray Crayfish from the Stuart Murray Canal to the Little Murray River as a success, we recognise that the program is in its infancy with regard to establishing a self-sustaining Murray Crayfish population. The Team also recognises the ongoing threats from blackwater events (King et al. 2012; McCarthy et al. 2014) and from other environmental drivers of change (e.g. climate change, drought, fires, etc.), and their potential adverse impacts on the flows and conditions that support aquatic taxa. For successful long-term population sustainability, we recommend that (1) the Murray Crayfish translocation program translocates 100+ adult crayfish annually into the Little Murray River, and (2) annual monitoring and evaluation of the population be undertaken to assess the ongoing program success. Translocated fish populations of Australian freshwater fish that have resulted in self-sustaining populations [e.g. Trout Cod (*Maccullochella macquariensis*) and Macquarie Perch (*Macquaria australasica*) populations] have relied upon multiple translocations of individuals over a period of 10+ years (Lyon et al. 2012; Koehn et al. 2013; Lutz et al. 2021; Pavlova et al. 2025), and this template should be replicated for Murray Crayfish until our monitoring results indicate success. A self-sustaining population of Murray Crayfish within the Little Murray River will likely be characterised by the presence of re-captures, berried females, and in the future (likely in around 5 years' time) the presence of recruits.

The Team acknowledges the limitations of the Little Murray River translocation program and the need for improvements. We advocate for the addition of four survey sites to extend monitoring of the most upstream portion of the study reach. Alternately, the bottom four sites could be exchanged for four new sites upstream of the top site. This would improve the detection of crayfish that may move through the Fish Point regulator, and account for crayfish that may move around the regulator when water heights are sufficient to operate the historical spillway around the regulating structure. Our final recommendation is to consider modifying the existing Murray Crayfish population model (Todd and Lovelace 2017) to assess a range of translocation outcomes based on variable translocation scenarios (e.g. the abundance of crayfish translocated per year, number of translocation years). The development of a comprehensive framework for prioritising site characteristics (e.g. linking habitat characteristics with species-specific ecological and biological requirements) and selecting translocation sites is required in order to justify future site selection.

4.3 Collaboration, communication and Country

Establishing a co-design, co-management and co-sampling (three C's) strategy to the Little Murray River Murray Crayfish translocation program set the foundation for success. Through a unified approach to threatened species recovery, the Team benefited from incorporating Traditional Owner knowledge gathered over millennia, the experience of river and land managers, and the capacity of ARI researchers to understand ecological and biological systems and processes through an evidence-based approach. The three C's approach considered the rights, interests and long-term benefits of all partners. Respect and trust were understood to be the drivers of responsible collaboration among the partners (AIATSIS 2020; DEECA 2025).

During the crayfish re-sampling field trip (September 2025), project partners discussed future collaborative crayfish projects, including extending the current project and a desire to hold a weaving workshop to highlight the skills required to construct traditional baskets and crayfish traps. During these discussions, the North Central CMA and ARI research staff were treated to a demonstration of the creation of traditional spears and hunting clubs, by members of the Wamba Wemba mob, including which materials to use, how to select and collect the materials, and how to treat the materials to achieve the desired shape, hardness, etc. This was viewed by staff as an honour and a reflection of the trust and respect between the project partners.

4.4 Conclusion

The Murray Crayfish is an iconic species within the Murray–Darling system but is on the brink of collapse in the Murray River mainstem due to overfishing, habitat loss, and blackwater events. This project has demonstrated successful engagement with a range of stakeholders, including Traditional Owners, and how we can work together to achieve a positive outcome for Murray Crayfish. It has also identified a largely unrecognised population of Murray Crayfish existing within an irrigation network, largely protected from the risk of blackwater events. We suggest that, with a little flow and fishing compliance support, the Stuart Murray Canal Murray Crayfish population could grow into a stable source population and one that can be used to re-establish natural riverine populations ravaged by blackwater events. While ongoing translocations, monitoring, and evaluation of research outcomes is required, this pioneering work highlights the benefits of collaboration, communication and respect in achieving positive outcomes for threatened species and for the project partners.

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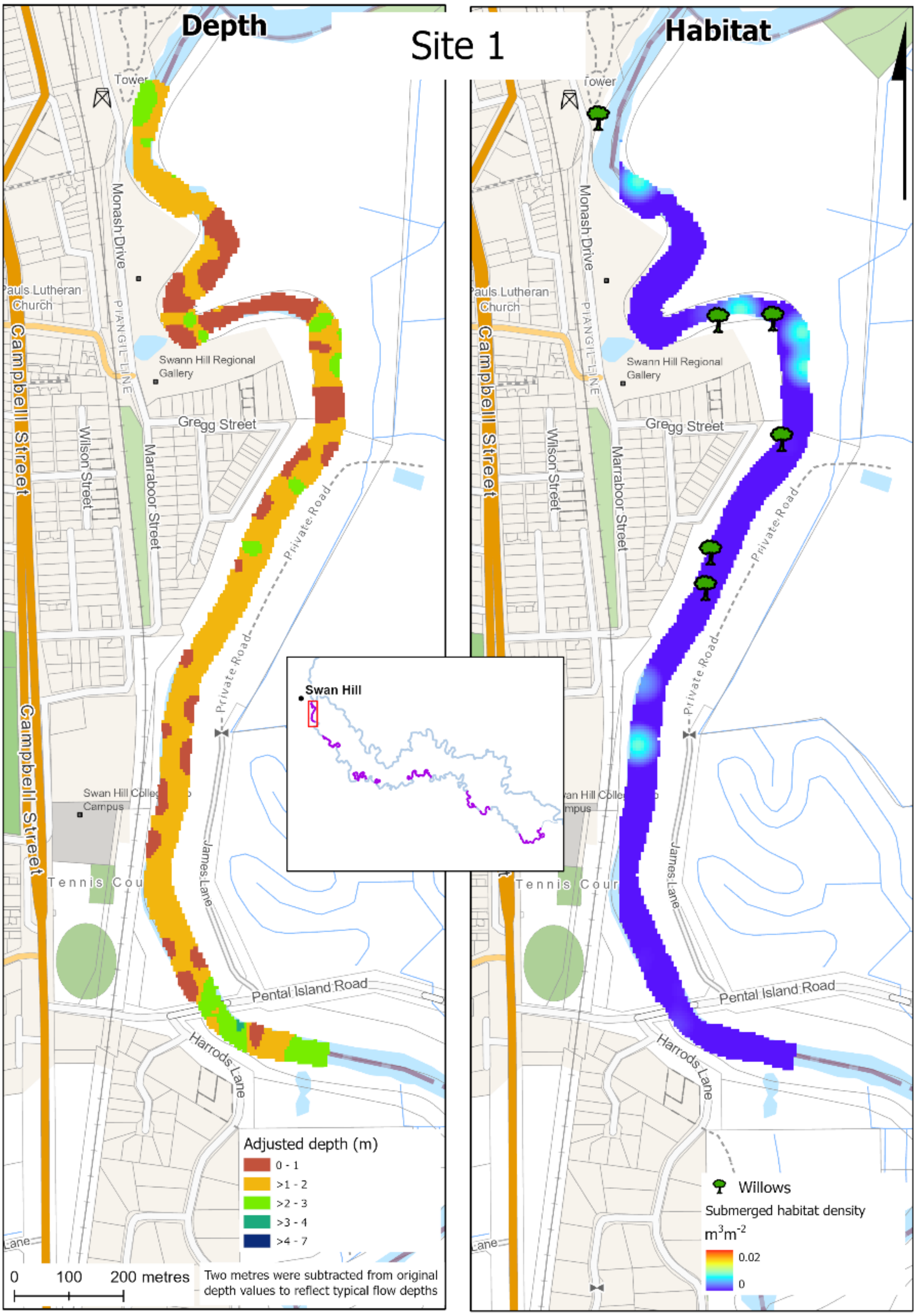
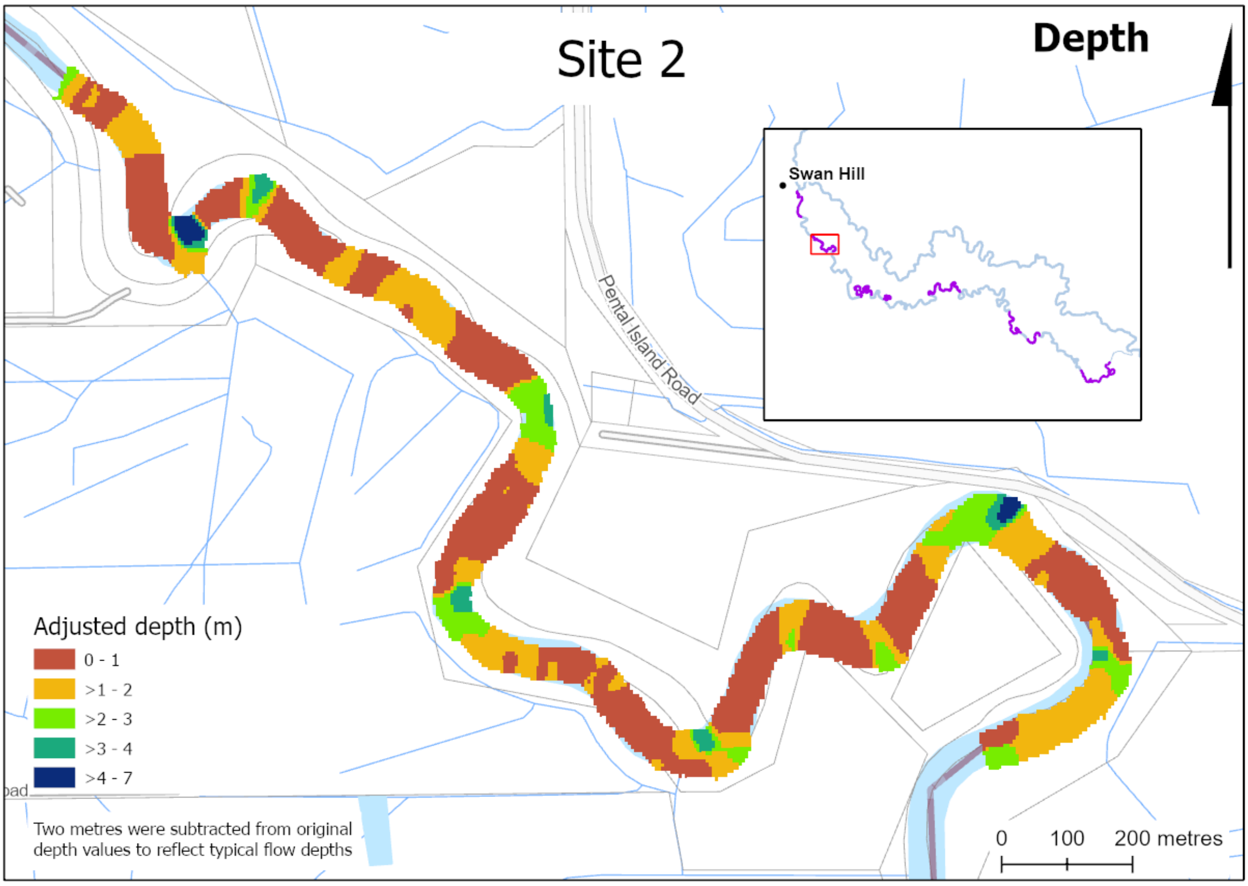
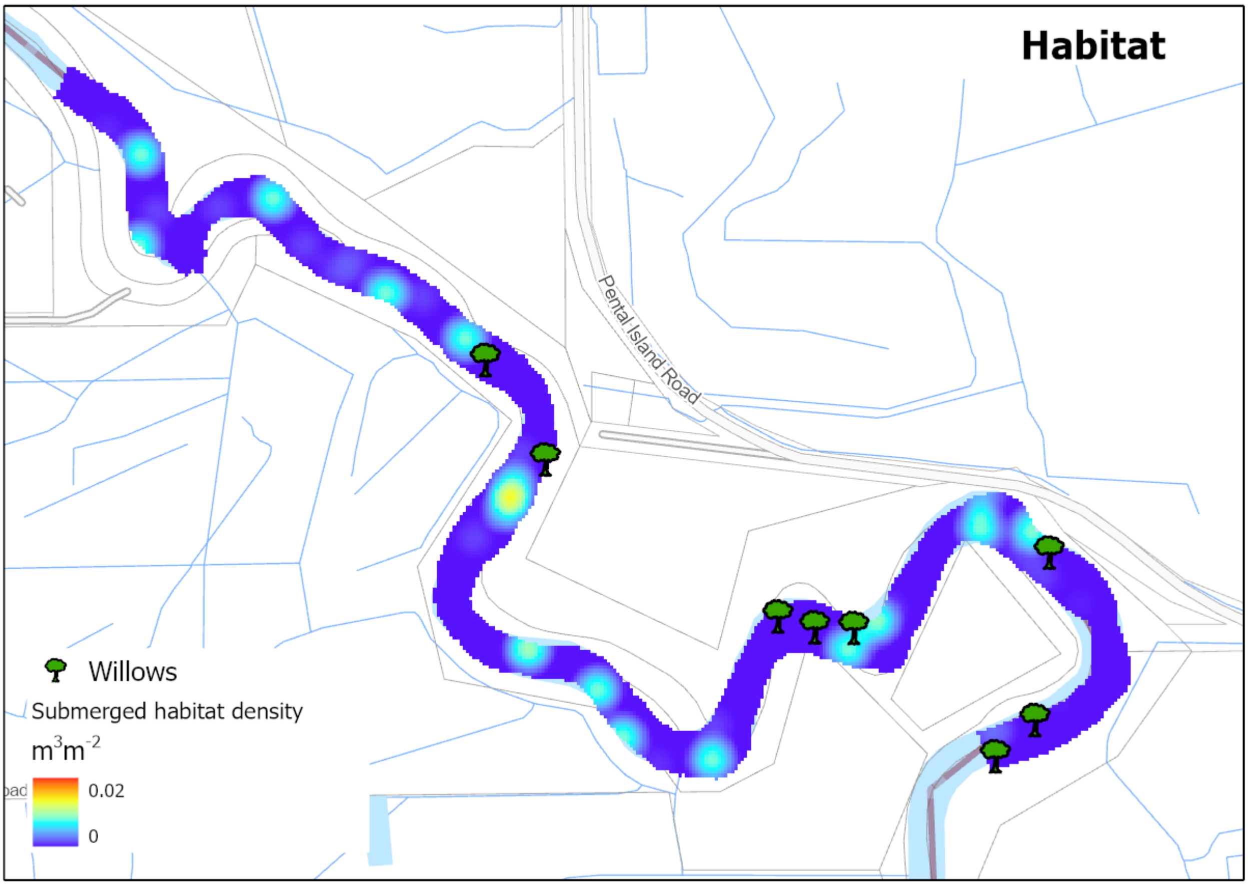
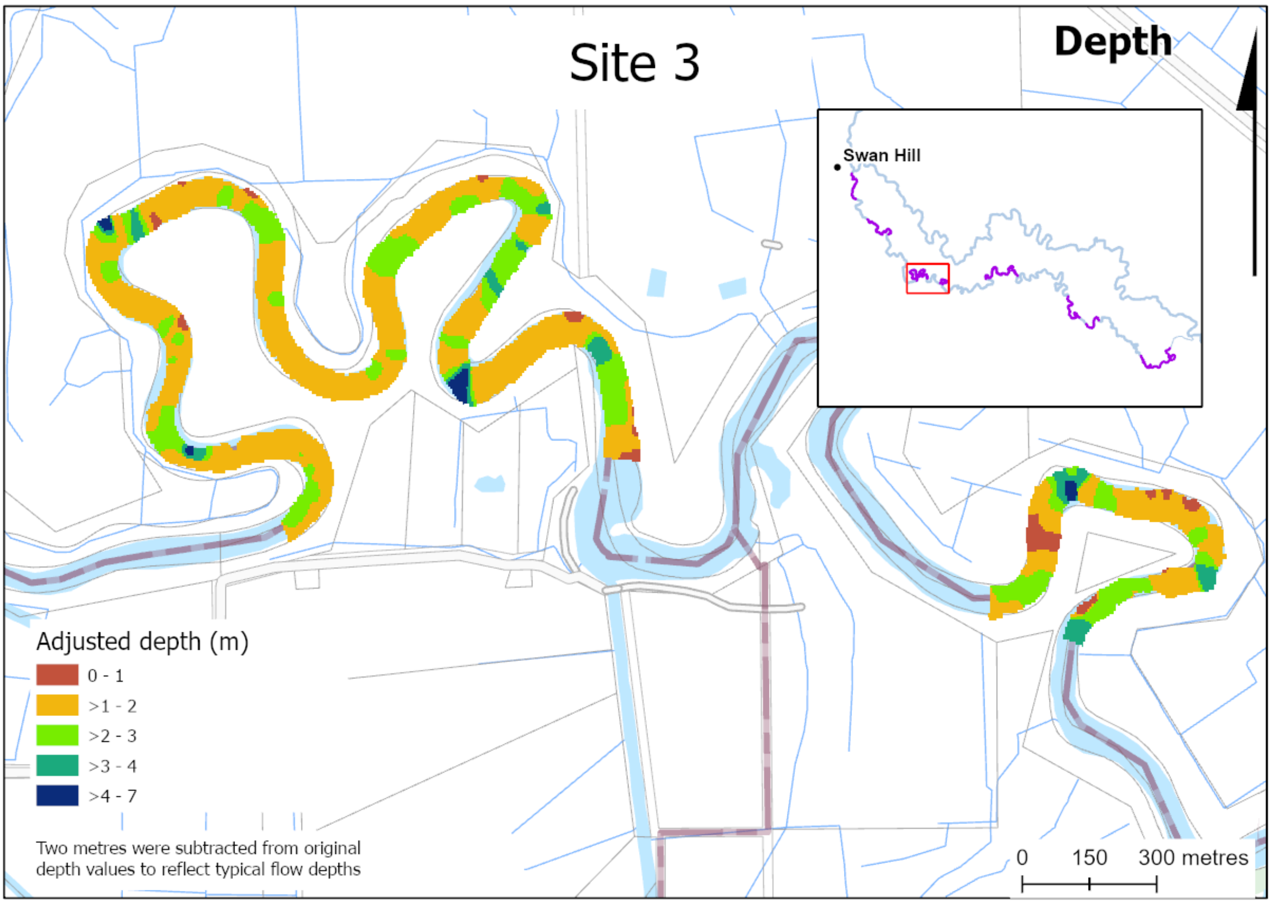
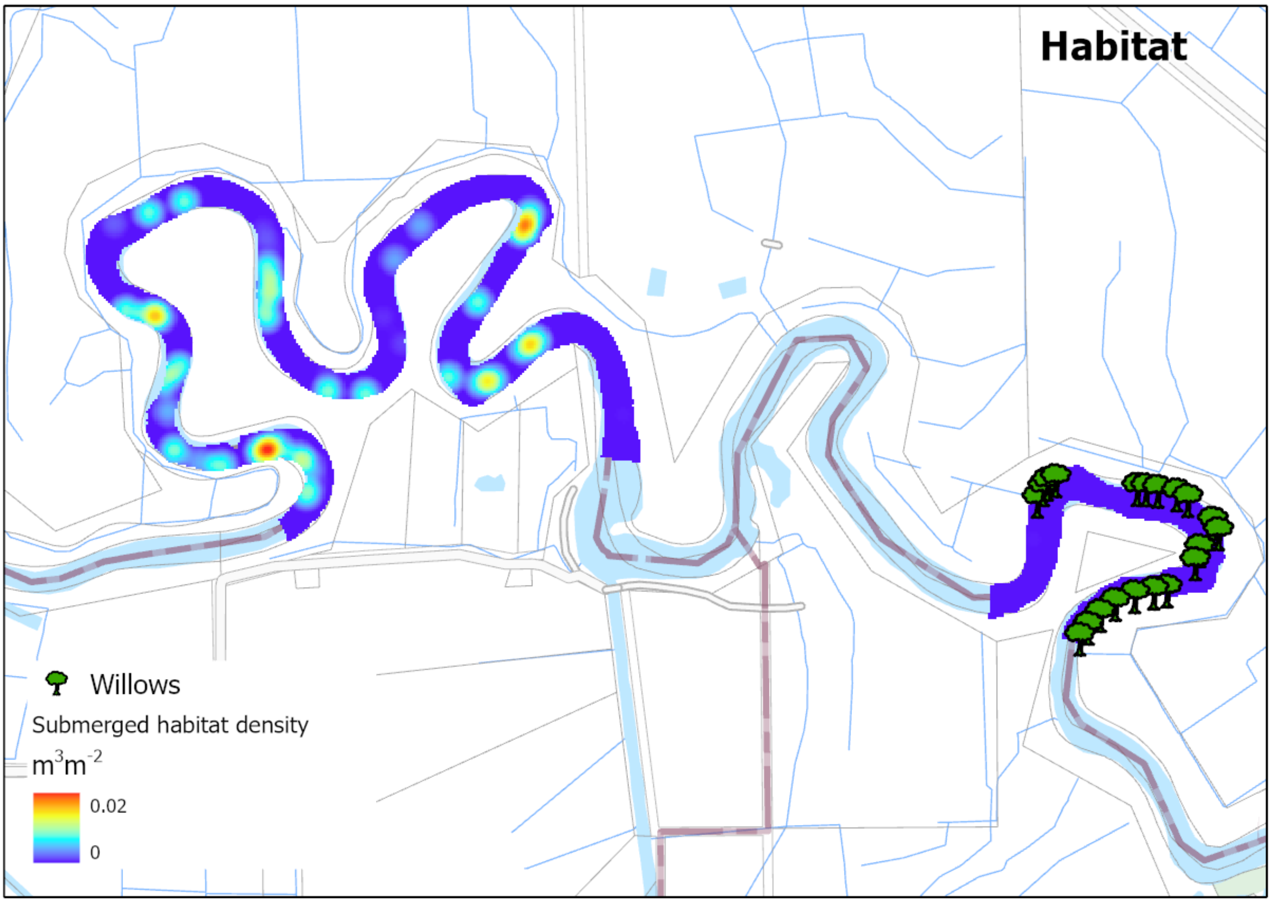
Appendix 1. Habitat characteristics of six reaches on the Little Murray River

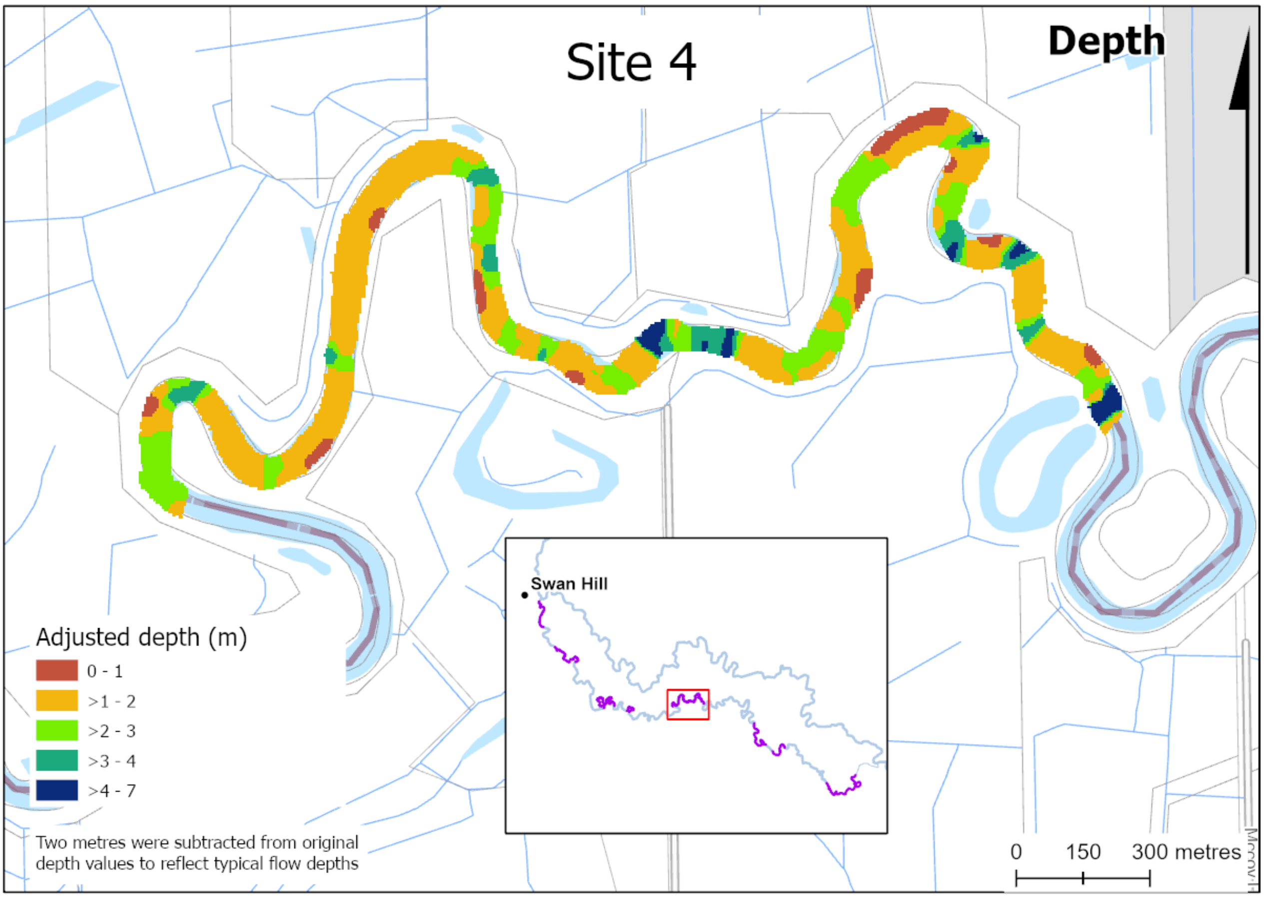



Site 2
Depth
Swan Hill
Pental Island Road
Adjusted depth (m)
0 - 1
>1 - 2
>2 - 3
>3 - 4
>4 - 7
Two metres were subtracted from original depth values to reflect typical flow depths
0 100 200 metres

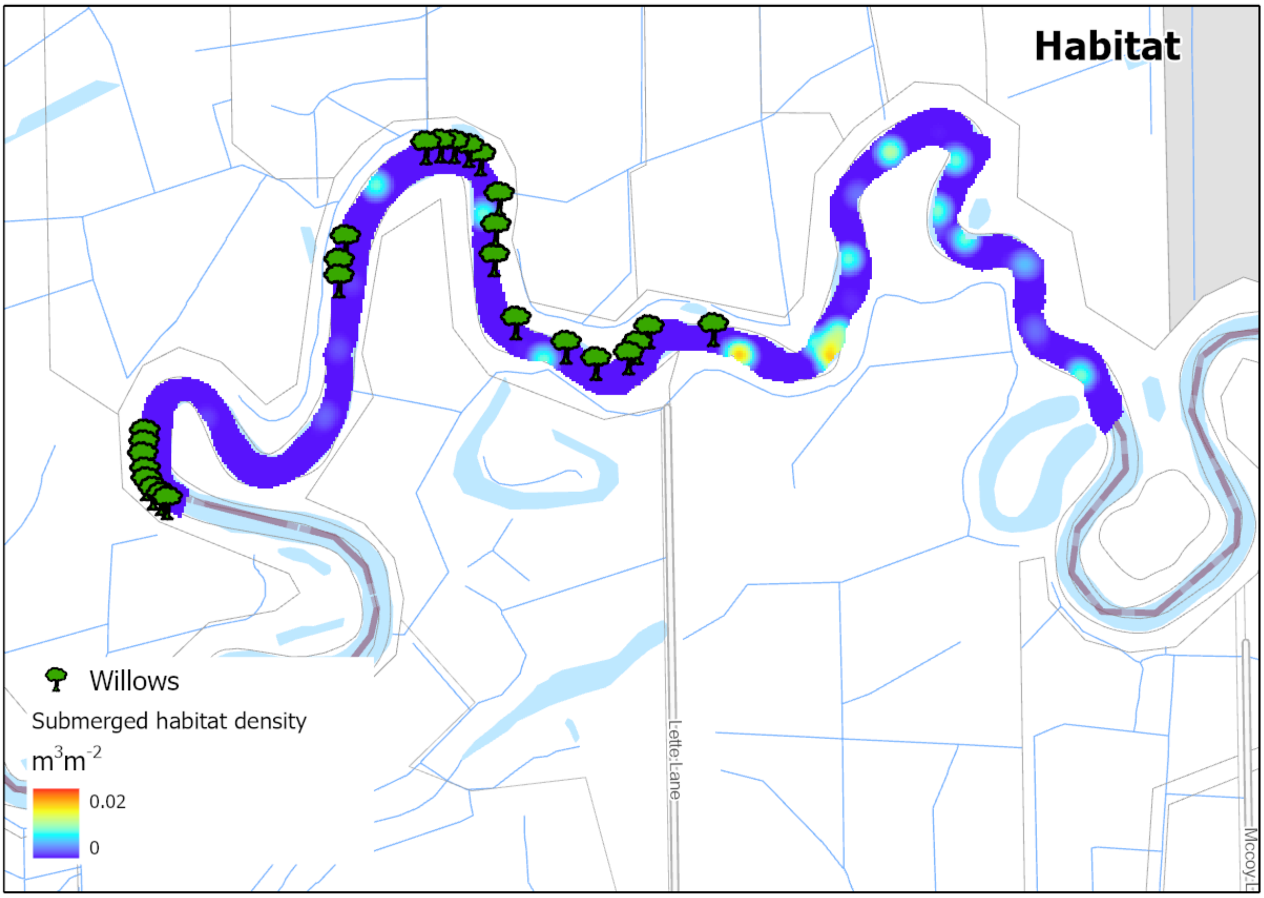

Habitat
Pental Island Road
Willows
Submerged habitat density
m3m-2
0.02
0


Site 3
Depth
Swan Hill
Adjusted depth (m)
0 - 1
>1 - 2
>2 - 3
>3 - 4
>4 - 7
Two metres were subtracted from original depth values to reflect typical flow depths
0 150 300 metres

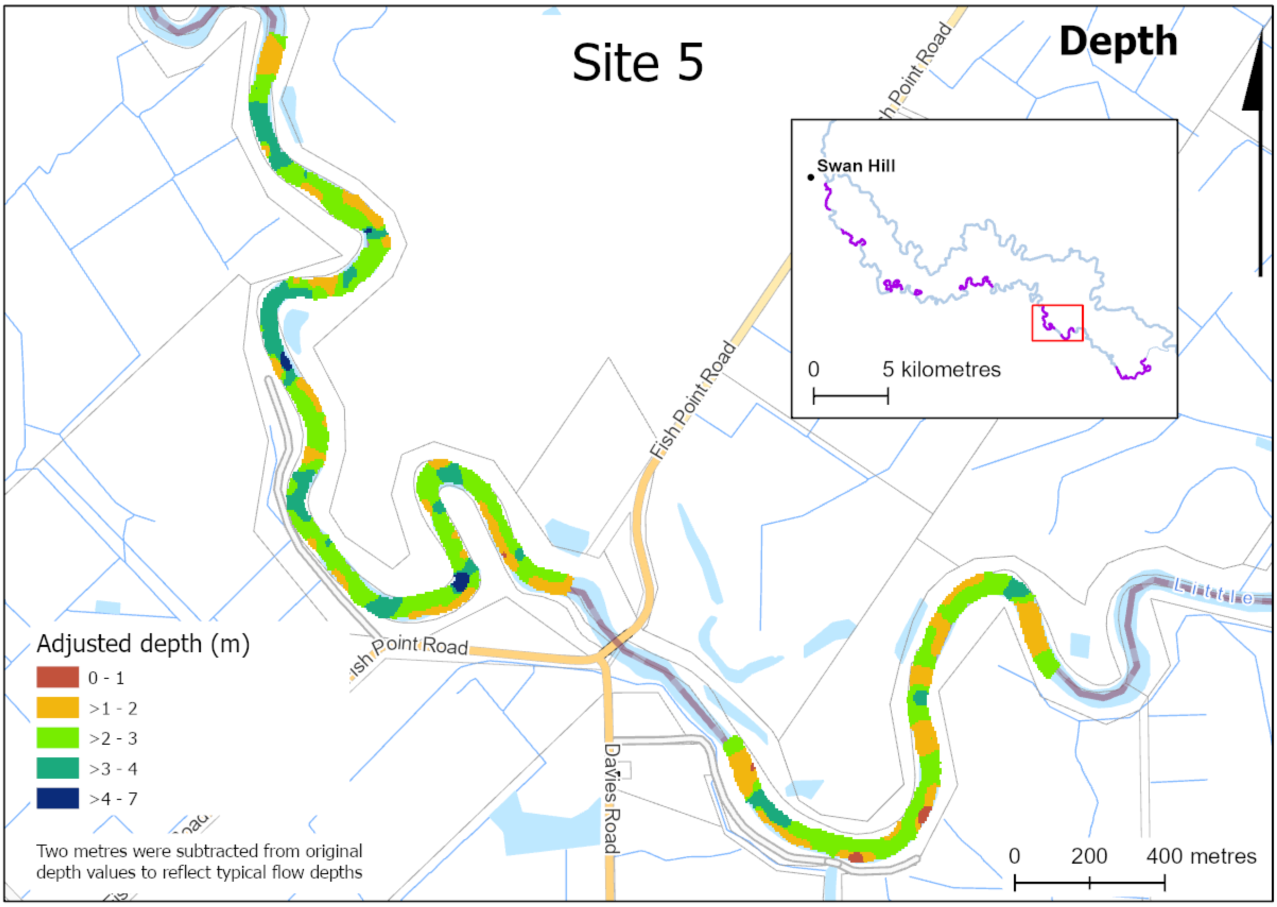

Habitat
Willows
Submerged habitat density
m³m⁻²
0.02
0

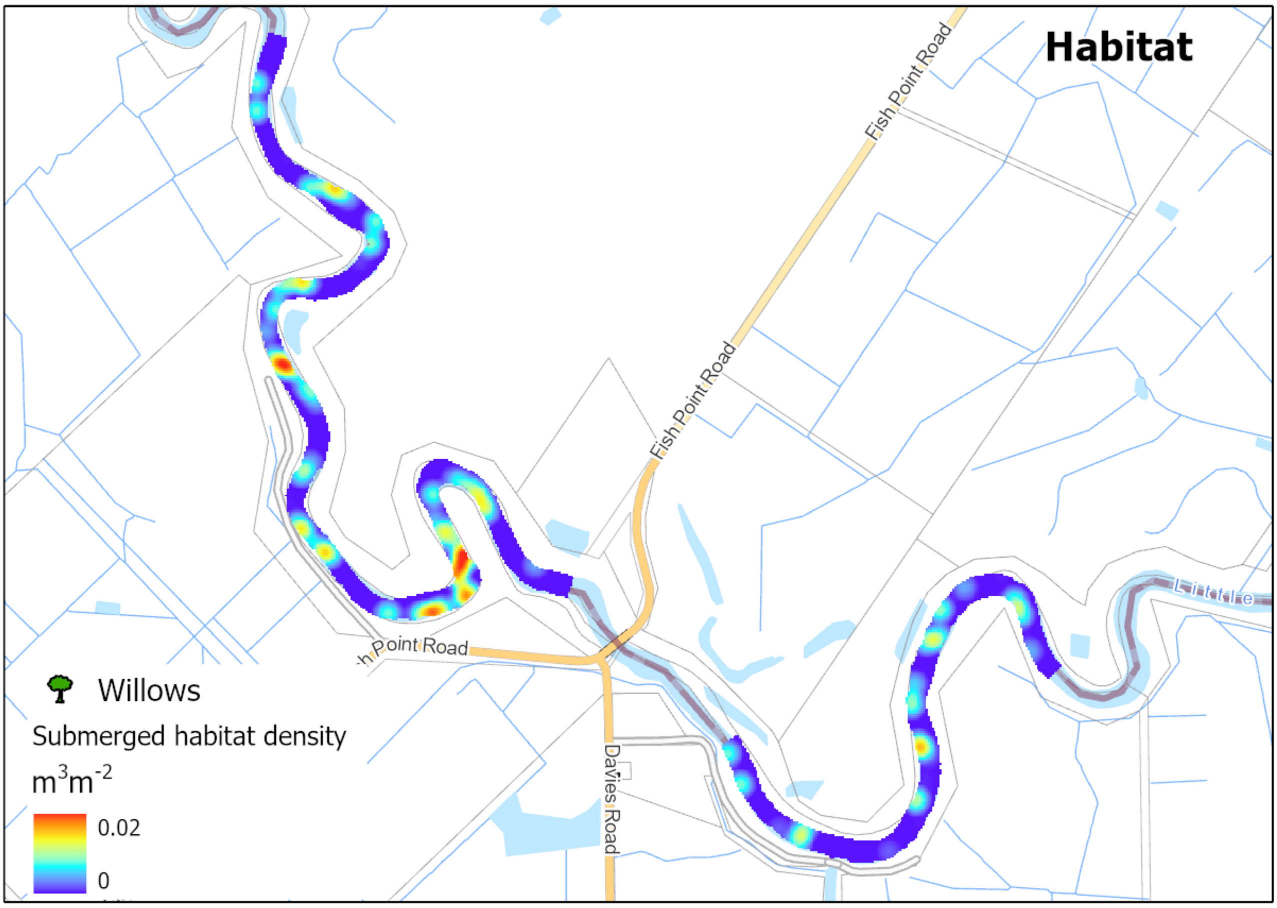


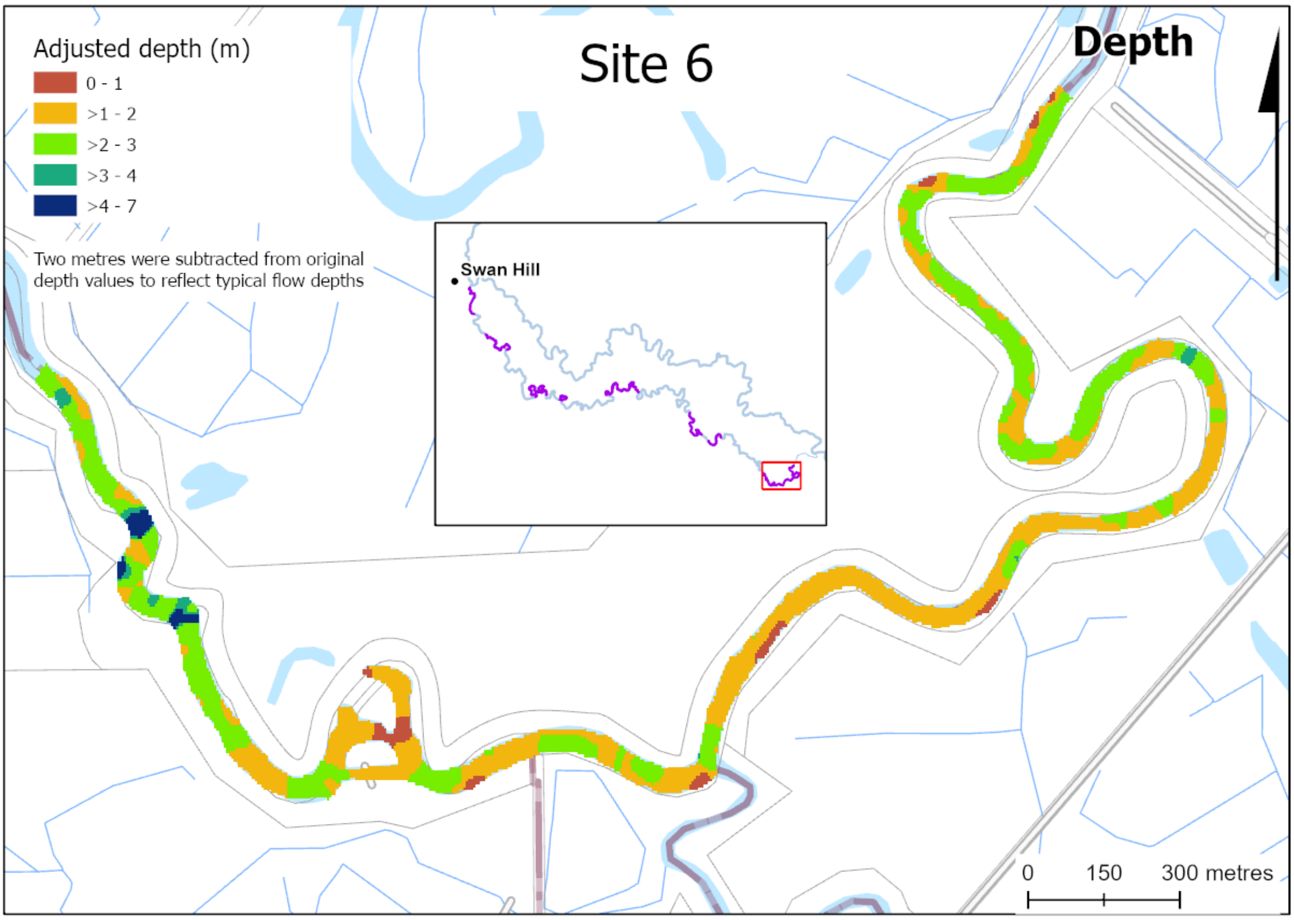
Site 4
Depth
Swan Hill
Adjusted depth (m)
0 - 1
>1 - 2
>2 - 3
>3 - 4
>4 - 7
Two metres were subtracted from original
depth values to reflect typical flow depths
0 150 300 metres

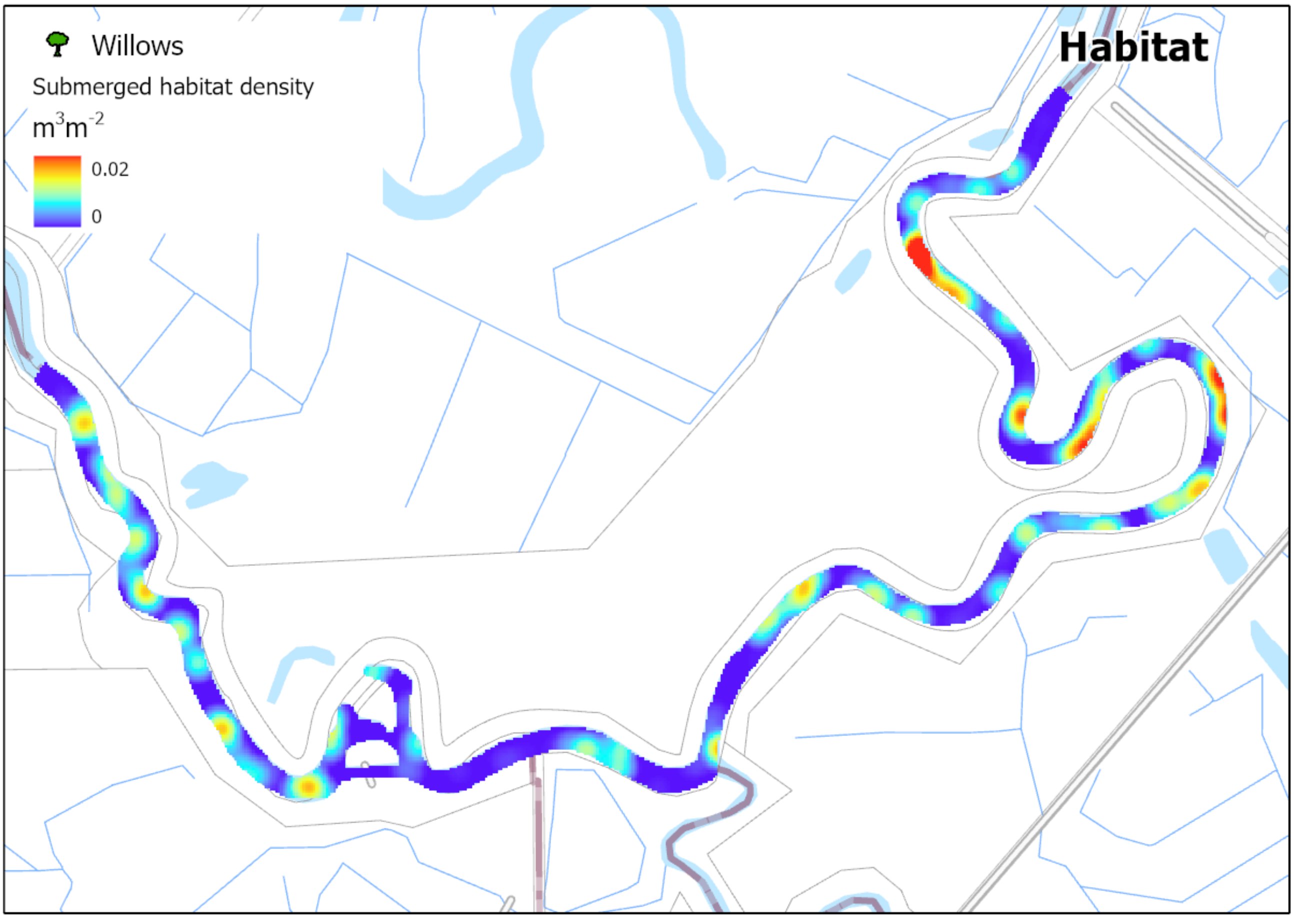


Habitat
Willows
Submerged habitat density
m^3m^{-2}
0.02
0
Lette Lane
Mccoy L


Site 5
Depth
Swan Hill
0
5 kilometres
Fish Point Road
Davies Road
Adjusted depth (m)
0 - 1
>1 - 2
>2 - 3
>3 - 4
>4 - 7
Two metres were subtracted from original depth values to reflect typical flow depths
0
200
400 metres


Habitat
Fish Point Road
Davies Road
Willows
Submerged habitat density
m^3m^{-2}
0.02
0


Adjusted depth (m)
0 - 1
>1 - 2
>2 - 3
>3 - 4
>4 - 7
Two metres were subtracted from original depth values to reflect typical flow depths
Site 6
Swan Hill
Depth
0
150
300 metres


Willows
Submerged habitat density
m^3m^{-2}
0.02
0
Habitat

Appendix 2. Summary data for each of the translocated Murray Crayfish

PIT-tag number	OCL (mm)	Weight (g)	Sex (M/F)
982091077867527	114	795	M
982091077867519	121	888	F
982091077867472	99	505	M
982091077867493	113	669	F
982091077867511	91	389	M
982091077867559	101	508	M
982091077867515	115	736	M
982091077867496	103	560	M
982091077867540	97	510	M
982091077867535	123	865	F
982091077867495	88	335	M
982091077867544	112	758	M
982091077867480	99	460	M
982091077867552	113	701	F
982091077867548	125	956	M
982091077867507	116	856	M
982091077867482	113	745	M
982091077867477	97	402	M
982091077867475	120	835	M
982091077867501	96	452	M
982091077867526	139	1278	M
982091077867474	91	378	M
982091077867479	98	489	M
982091077867555	131	1081	F
982091077867560	129	1103	M
982091077867476	108	626	F
982091077867503	129	1054	F
982091077867491	120	926	F
982091077867563	99	514	F
982091077867492	132	1036	F
982091077867549	135	1245	F
982091077867533	103	526	M
982091077867506	111	667	F
982091077867470	128	1156	M

PIT-tag number	OCL (mm)	Weight (g)	Sex (M/F)
982091077867564	116	792	F
982091077867520	97	480	F
982091077867485	122	969	F
982091077867499	120	873	F
982091077867488	100	495	F
982091077867489	134	1033	F
982091077867561	144	1120	F
982091077867516	124	956	F
982091077867545	126	938	F
982091077867505	100	593	F
982091077867551	134	1164	F
982091077867513	119	880	M
982091077867509	107	665	F
982091077867483	121	889	F
982091077867525	113	716	F
982091077867471	136	1173	F
982091077867517	90	378	M
982091077867487	141	1286	F
982091077867556	111	707	F
982091077867541	102	571	F
982091077867553	99	485	F
982091077867547	110	716	F
982091077867532	116	779	F
982091077867546	121	891	M
982091077867531	140	1155	F
982091077867522	114	816	M
982091077867543	117	792	F
982091077867484	149	1460	F
982091077867469	122.5	909	M
982091077867481	112.5	577	F
982091077867473	157	1839	F
982091077867497	147.5	1355	F
982091077867550	134	1285	M
982091077867518	117	865	M
982091077867512	147	1471	F
982091077867557	91	383	F
982091077867539	87	321	M
982091077867490	112	632	M
982091077867558	105	567	F
982091077867494	106	575	F

PIT-tag number	OCL (mm)	Weight (g)	Sex (M/F)
982091077867498	101	508	M
982091077867523	116	854	M
982091077867542	126	1013	F
982091077867465	82	283	M
982091077867521	130	1134	M
982091077867468	108	585	M
982091077867467	109	641	M
982091077867500	134	1267	M
982091077867508	120.5	923	M
982091077867530	148	1536	F
982091077867536	81	274	M
982091077867529	80	260	M
982091077867538	102	546	F
982091077867528	107	565	F
982091077867562	112	699	M
982091077867537	92	367	F
982091077867478	123	963	M
982091077867534	96.5	458	M
982091077867466	136	1320	F
982091077867554	143	1437	M
982091077867524	115	777	F
982091077867510	138	1254	F
982091077867486			M
982091077867565			M

M/F = male/female; OCL = occipital carapace length.

Appendix 3. Permit requirements for sampling and translocating Murray Crayfish

An exemption from the Victorian Fisheries Authority (VFA) General Permit regulations was granted to the Arthur Rylah Institute for Environmental Research (ARI) by the VFA in 2024, to allow for the capture of Murray Crayfish from the Ovens and Goulburn Rivers, and their translocation into the Little Murray River. Concerns regarding the potential adverse impacts from the removal of 'wild' individuals, on source populations, led to discussions between the project partners [ARI, North Central Catchment Management Authority (North Central CMA) and Traditional Owners], the VFA and local fishers. It was concluded that the Project Team would investigate an alternate source of Murray Crayfish for the translocation project. The North Central CMA reached out to their local community for assistance, resulting in a local fisher (Andrew Saunders) reporting the presence of crayfish within the Waranga Canal system. Preliminary sampling of the canal system confirmed the discovery of a previously unknown population of Murray Crayfish within the Stuart Murray Canal. The existing positive relationship between the permit regulators (VFA) and members of the Project Team facilitated a waiver of the current fishing guidelines to allow the translocation to be undertaken. The collaboration and communication between government agencies and the public resulted in the more desirable outcome of removing crayfish from an artificial waterway, mitigating any potential adverse consequences to natural riverine crayfish populations and their ecosystems.

Appendix 4. Summary of restoration works undertaken on the Little Murray River by the North Central CMA

The Little Murray River is part of a large and complex network of wetlands, creeks and rivers, surrounded by an extensive floodplain in north-central Victoria. The system was modified in the mid-1900s to facilitate the transfer of water through weirs and canals for the environment and to support water users within and downstream of the Little Murray River system. Restoring the aquatic and terrestrial ecosystem has recently become the focus of water managers, with the goal of supporting ecosystem functioning (e.g. enhanced flow dynamics, enhanced productivity, removal of barriers to aquatic species movement) and key ecological processes fundamental to aquatic biota (both physical and chemical). Specific restoration measures undertaken by the North Central Catchment Management Authority (North Central CMA) included:

1. lowering of the sill height of the Little Murray Weir to promote improved flow dynamics and movement of aquatic organisms
2. installation of fishways on the Fish Point and Little Murray weirs to increase connectivity and the volume of flowing-water habitat (including during attractant and spawning flows)
3. riparian planting and bank protection works to promote shading, bank stability, and the 'natural' input of woody debris
4. extensive habitat supplementation, including the addition of 300+ complex woody structures (snags)
5. improved management of water flowing through the system.

Further, the North Central CMA have undertaken extensive replanting of terrestrial and wetland habitats that reduce erosion and the sediment entering waterways. In combination, these restoration actions provide conditions that support the ecological needs of aquatic species and their life-history requirements. Specifically, these restorative actions enhance cues for movement and breeding, improve water quality for survival, provide shelter, and promote a greater diversity of habitats and food sources for terrestrial and aquatic taxa, including fish and crayfish. These ecological outcomes support the goal of improving river health across broad (e.g. Murray–Darling Basin) and localised (river reach) scales and are consistent with the recovery strategies outlined in the Native Fish Recovery Plan – Gunbower and Lower Loddon (Cornell et al. 2023). Annual surveys undertaken through the Murray–Darling Basin Fish Surveys provide an avenue for assessing trends in fish population abundances, recruitment, and community structure. Further, the North Central CMA has installed project signage and continues to effectively communicate the benefits and outcomes of projects to the local and scientific community.

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