Inland Waters &
Catchment Ecology

Chowilla Icon Site Fish Intervention Monitoring 2023/24

J. F. Fredberg[1], C. M. Bice[1] and B. P. Zampatti[2]

[1]SARDI Aquatic and Livestock Sciences, [2]CSIRO Environment

SARDI Publication No. F2022/000394-4
SARDI Research Report Series No. 1243

SARDI Aquatic and Livestock Sciences
PO Box 120 Henley Beach SA 5022

February 2025

Report to the Department for Environment and Water

Government of South Australia
Department of Primary Industries and Regions

Government of South Australia
Department for Environment and Water

SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

Chowilla Icon Site Fish Intervention Monitoring 2023/24

Report to the Department for Environment and Water

J. F. Fredberg[1], C. M. Bice[1] and B. P. Zampatti[2]

[1]SARDI Aquatic and Livestock Sciences, [2]CSIRO Environment

SARDI Publication No. F2022/000394-4
SARDI Research Report Series No. 1243

February 2025

The South Australian Research and Development Institute respects Aboriginal people as the state's first people and nations. We recognise Aboriginal people as traditional owners and occupants of South Australian land and waters. We pay our respects to Aboriginal cultures and to Elders past, present, and emerging.

This publication may be cited as:
Fredberg, J.F.[1], Bice, C. M.[1] and Zampatti, B. P.[2] (2025). Chowilla Icon Site Fish Intervention Monitoring 2023/24. Report to the Department for Environment and Water. South Australian Research and Development Institute (Aquatic and Livestock Sciences), Adelaide. SARDI Publication No. F2022/000394-4. SARDI Research Report Series No. 1243. 17pp.

[1]South Australian Research and Development Institute.
[2]CSIRO, Environment.

DISCLAIMER

The contents of this publication do not purport to represent the position of the Commonwealth of Australia or the MDBA in any way and are presented for the purpose of informing and stimulating discussion for improved management of the Basin's natural resources. To the extent permitted by law, the copyright holders (including its employees and consultants) exclude all liability to any person for any consequences, including but not limited to all losses, damages, costs, expenses and any other compensation, arising directly or indirectly from using this report (in part or in whole) and any information or material contained in it. The authors warrant that they have taken all reasonable care in producing this report. The report has been through the SARDI internal review process, and has been formally approved for release by the Research Director, Aquatic and Livestock Sciences. Although all reasonable efforts have been made to ensure quality, SARDI does not warrant that the information in this report is free from errors or omissions. SARDI and its employees do not warrant or make any representation regarding the use, or results of the use, of the information contained herein as regards to its correctness, accuracy, reliability and currency or otherwise. SARDI and its employees expressly disclaim all liability or responsibility to any person using the information or advice. Use of the information and data contained in this report is at the user's sole risk. If users rely on the information they are responsible for ensuring by independent verification its accuracy, currency or completeness. The SARDI Report Series is an Administrative Report Series which has not been reviewed outside the department and is not considered peer-reviewed literature. Material presented in these Administrative Reports may later be published in formal peer-reviewed scientific literature.

Author(s): J. F. Fredberg, C. M. Bice and B. P. Zampatti

Reviewer(s): A. Newbery (SARDI) and Jan Whittle (DEW)

Approved by: Q. Ye
Program Leader – Inland Waters & Catchment Ecology

Signed: 

Date: 27 February 2025

Distribution: DEW, SARDI Aquatic and Livestock Sciences, Parliamentary Library, State Library and National Library

Circulation: OFFICIAL

ALL ENQUIRIES

South Australian Research and Development Institute – Aquatic and Livestock Sciences
2 Hamra Avenue West Beach SA 5024
PO Box 120 Henley Beach SA 5022
P: (08) 8207 5400 **F:** (08) 8207 5415
E: pirsa.sardiaquatics@sa.gov.au **W:** http://www.pir.sa.gov.au/research

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

This project was funded by the Murray-Darling Basin Authority's (MDBA) The Living Murray (TLM) Initiative through the South Australian Department for Environment and Water (DEW) and was managed by Jan Whittle (DEW). TLM is a joint initiative funded by the New South Wales, Victorian, South Australian and Commonwealth governments, coordinated by the Murray-Darling Basin Authority. Thanks to Mark Sutcliffe, Kate Frahn, Sandra Leigh, Travis Howson, Arron Strawbridge (SARDI) and Ruan Gannon (CSIRO), for assistance with field sampling for this project. Many thanks to Robbie Bonner, Tim Kruger, Warren Beer, Andy Watkins and Tony Waye (SA Water) for providing space for accommodation at Lock 6 and their generous hospitality. Thanks to Jan Whittle (DEW) and Anthony Newbery (SARDI) who constructively reviewed a draft of this report. The report was formally approved for release by A/Professor Qifeng Ye, Program Leader, Inland Waters & Catchment Ecology, SARDI Aquatic and Livestock Sciences.

EXECUTIVE SUMMARY

The Chowilla Anabranch and Floodplain system (hereafter Chowilla) comprises the largest remaining area of undeveloped floodplain habitat in the lower River Murray, encompassing a series of anabranching creeks, backwaters, wetlands and terminal lakes that bypass Lock and Weir No. 6 (hereafter Lock 6) on the River Murray. Because of this, Chowilla provides unique structural and hydraulic habitats that maintain remnant populations of endangered riverine fauna, including Murray cod (*Maccullochella peelii*). Nonetheless, the ecological communities of both aquatic and floodplain environments are considered degraded due to the impacts of river regulation – primarily fragmentation by barriers to flow and fish passage, and decreased flooding frequency – as such, the site is now the focus of a range of interventions to promote ecological rehabilitation.

In 2014, the Chowilla Creek regulator and ancillary structures were constructed with the objective of using large-scale engineered floodplain inundation to maintain or improve 'ecological condition' of the floodplain. Operation of the regulator, however, poses several ecological risks, including: 1) fragmentation of habitats and obstruction of fish movement; and 2) alteration of stream hydraulics (e.g. reduced water velocities) that may influence the habitats of lotic fishes (e.g. Murray cod). These impacts may affect Murray cod movement and ultimately, population dynamics. Since 2007, under *The Living Murray* (TLM) Intervention Monitoring Program, the movement of Murray cod in the Chowilla system and adjacent River Murray has been studied using radio-telemetry. In recent years this research has aimed to better understand the behaviour of Murray cod in association with regulator operations and a range of other management interventions (e.g. weir pool manipulation), to inform adaptive management.

Intervention Monitoring in 2023/24 was comprised of two allied components: 1) maintenance of radio-tower infrastructure, and 2) commencing a transition from radio to acoustic-telemetry for longer term investigations of Murray cod movement. The primary objectives were to:

1) Undertake maintenance to radio-telemetry remote logging towers to ensure continued collection of data from existing tagged fish with remaining battery life;
2) Deploy an array of acoustic receivers in the Chowilla system to support future monitoring of movement at the same scale as the existing radio-telemetry network; and

3) Capture ~50 Murray cod and implant each with an acoustic tag to support continued investigations of movement.

Maintenance of radio-telemetry infrastructure and summary of existing radio-tagged Murray cod

Since 2007, research on Murray cod movement has primarily been supported by a series of nine radio-telemetry logging stations (ATS radio receiver/loggers) that have remotely monitored the movement of >100 individual Murray cod. To ensure system functionality and enable continued investigations of Murray cod movement and habitat use in the region, there is a need for periodic maintenance of radio-telemetry infrastructure and an understanding of the status of the radio-tagged Murray cod population. In 2023/24, upgrades and maintenance of radio-telemetry infrastructure included: the installation of a 160 W solar panel, a Victron solar regulator and a 105ah lithium battery at the Pipeclay logger; repairs to the ATS RDP 800 transmission unit on the Salt Creek logger; and the removal of faulty 3G modems on the River Murray/Chowilla Creek and River Murray/Swifty's Creek junction loggers. As of winter 2024 and based on estimated battery life, a total of 30 radio-tagged Murray cod may have active tags; 11 of these fish were detected within Chowilla or the adjacent River Murray within the past year.

Acoustic receiver deployment and implantation of acoustic transmitters for Murray cod within the Chowilla system

In 2023/24, an array of 24 acoustic receivers was deployed in Chowilla and the adjacent River Murray. The array was deployed in a manner that enables fine-scale tracking of fish movement within Slaney Creek, and assessment of broader-scale movements among major creeks within the Chowilla system and the River Murray. Additionally, a total of 17 Murray cod were captured within Chowilla and the adjacent River Murray and implanted with acoustic transmitters. The majority of these fish were tagged in Slaney Creek (n = 15) and were fitted with an acoustic tag that incorporated an accelerometer to capture additional information on locomotor activity (3D acceleration) of individual fish. The low numbers of fish tagged in 2023/24 (17 tags used out of 50 tags purchased), necessitates further tagging of Murray cod in future Intervention Monitoring investigations.

Keywords: Murray cod, acoustic-telemetry, radio-telemetry, movement.

1. INTRODUCTION

1.1. Background

The Chowilla Floodplain system is the largest remaining area of undeveloped floodplain habitat in the lower River Murray (i.e., downstream of the Darling River junction). Due to the construction of Lock 6, the Chowilla Anabranch system exhibits permanent lotic (flowing water) habitats in what previously would have been ephemeral streams. Lotic habitats are now uncommon in the South Australian section of the River Murray, as the construction of locks and weirs has generally created a series of lentic (still water) habitats (Walker 2006). The uniqueness of flowing habitats in the Chowilla region has been recognised by numerous studies and has been attributed to the maintenance of remnant populations of endangered flora and fauna that are uncommon elsewhere in the lower Murray, including Murray cod (*Maccullochella peeli*) (O'Malley and Sheldon 1990, Pierce 1990, Sharley and Huggan 1995). The ecological value of the Chowilla system resulted in its recognition as an *Icon Site* under the Murray-Darling Basin Authority's (MDBA) *The Living Murray Program* (TLM) (MDBA 2016).

The flowing water habitats of Chowilla support one of the most significant populations of Murray cod in the lower River Murray. Water management, at the scale of the Chowilla system and more broadly in the lower River Murray, has the potential to influence the dynamics of this important population. Specifically, operation of the Chowilla Regulator and ancillary structures, and weirpool manipulation, particularly lowering of Lock 6, may fragment and alter the hydraulics of aquatic habitats to the detriment of Murray cod. Ultimately, changes to connectivity and hydrodynamics within the Chowilla system may impact the movement, spawning and recruitment of Murray cod.

The movement of Murray cod in the Chowilla system and adjacent River Murray has been a focus of research since 2007 (Leigh and Zampatti 2009) predominantly supported by the Icon Site Intervention Monitoring Program. Studies have primarily used radio-telemetry and involved tagging and tracking of movement manually and remotely, using telemetered logging stations (ATS radio receiver/loggers). This work has been critical in understanding the spatial ecology of Murray cod at Chowilla including identifying key habitats within the system, temporal and flow-related patterns of movement between the anabranch and the River Murray, and the influence of the Chowilla Regulator on these movements (Leigh and Zampatti 2013, Zampatti et al. 2016, Fredberg et al. 2019). As of 2024, up to 30 fish remain in the Chowilla region based on expected battery life (due to expire from 2025–2040), although status of these fish post flooding in 2022/23

is uncertain. To support continued investigation of Murray cod movement at Chowilla, there is a need to increase the tagged fish population. Furthermore, continued maintenance of infrastructure is required to ensure continued operation of the loggers.

An alternative approach to radio-telemetry is acoustic-telemetry, which has been used to track movements of Murray cod in Chowilla as part of specific short-term investigations (Bice et al. 2023). An advantage of acoustic-telemetry over radio-telemetry is the ability for individual fish to be detected on non-project receivers and hence, greater spatial coverage of movement monitoring, and the potential for greater resolution on direction of movement. At present, there is an extensive longitudinal array of acoustic receivers throughout the lower River Murray, including in the adjacent Lindsay Mullaroo system. Furthermore, long-term maintenance costs are lower when compared to radio-telemetry.

The movement and habitat use of Murray cod in association with water management at Chowilla and more broadly in the lower River Murray remain subjects of particular interest to natural resource managers and ecologists. As such, ongoing investigations of movement in relation to flow and other management interventions are reliant on maintaining tracking infrastructure and a population of tagged fish. In 2023/24, works to support future investigations of fish movement at Chowilla included: 1) maintenance of radio-tower infrastructure; and 2) commencing a transition to acoustic-telemetry for longer term investigations of fish movement.

1.2. Objectives

In 2023/24, the primary objectives of this project were to:

1) Undertake maintenance to radio-telemetry remote logging towers to ensure continued collection of data from existing tagged fish;
2. Deploy an array of acoustic receivers in the Chowilla system to support future monitoring of movement at the same scale as the existing radio-telemetry network; and
3. Capture ~50 Murray cod and implant each with an acoustic tag to support continued investigations of movement.

2. METHOD

2.1. Study Site

Chowilla comprises a series of anabranching creeks, backwaters, wetlands, and terminal lakes that bypass Lock 6 on the River Murray, South Australia (Figure 1). Chowilla is part of the Riverland Ramsar site, a Wetland of International Importance, and is an *Icon Site* under the TLM Program (MDBA 2016).

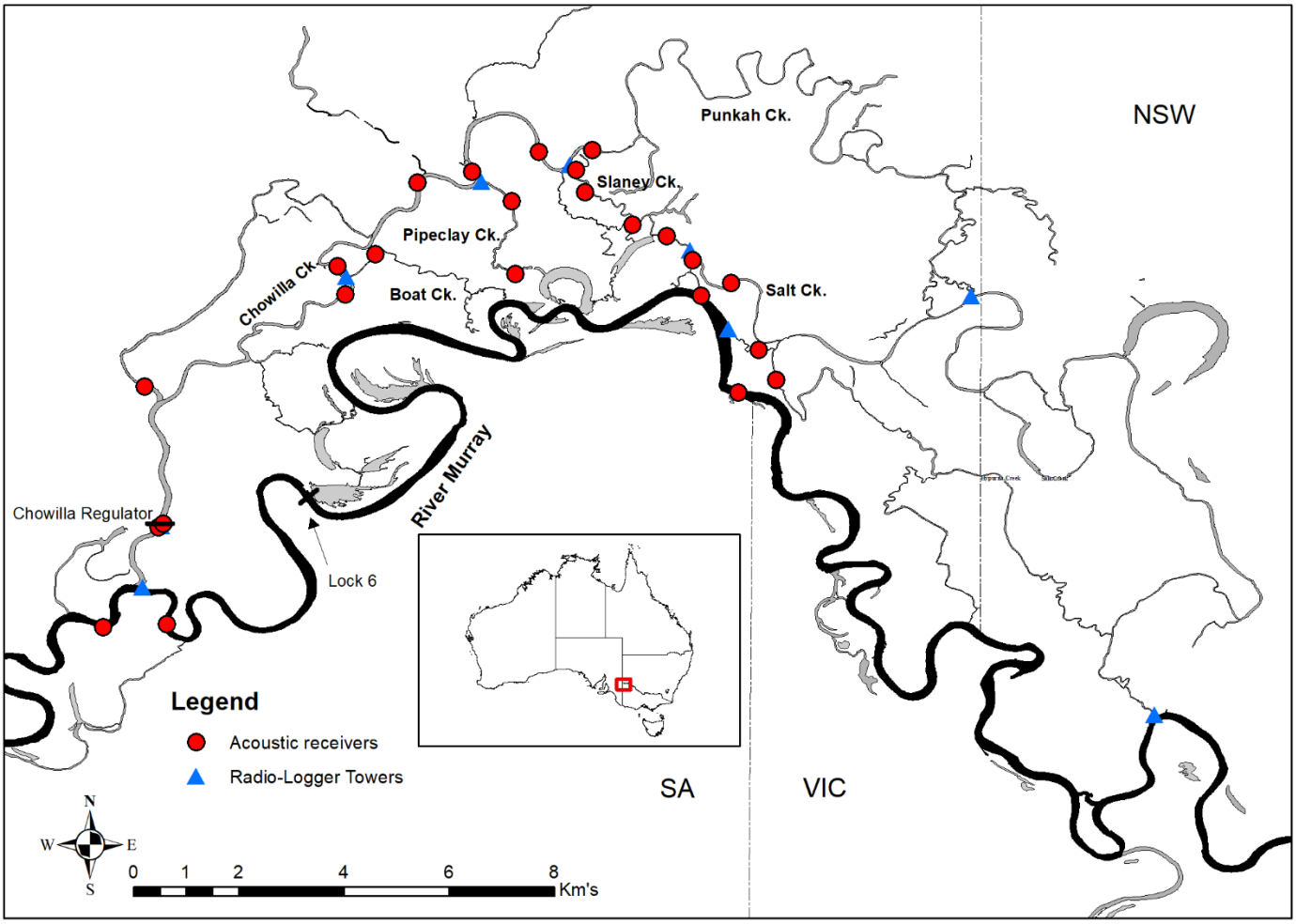

Figure 1. Map of the Chowilla Anabranch System on the River Murray, South Australia, depicting the location of: a) nine fixed radio-telemetry stations (logger towers) (closed blue triangles); and b) 24 acoustic receivers deployed to monitor the movement of acoustically tagged Murray cod (closed red circles).

2.2. Maintenance of radio-telemetry infrastructure and summary of existing radio-tagged Murray cod

Infrastructure maintenance

There are nine remote radio-telemetry logging stations (i.e. receivers and towers) located at major creek junctions within Chowilla, key upstream and downstream junctions with the River Murray, and on the Chowilla Regulator (Figure 1). Key internal components include: an ATS radio receiver (model R4520C); ATS RDP 800 (remote data platform); a KLK 300 industrial computer; a Maxon model MA 20-25 modem; Victron MPPT solar charge controller; and one lithium battery (105 A/h). Key external components include: three, directional yagi radio antenna; single 3G antenna; and 160w solar panel(s). As a fish passes within detection range (<600 m) of a logger tower its unique code is received by the ATS receiver via one of the three directional antennas. This data is stored on the ATS receiver and every hour a copy is stored on the ATS Remote Data Platform. Once a day, the KLK 3000 gathers a copy of the data and transmits it via email over the Telstra network to Karltek, which hosts an online database for fish movement data and tower diagnostics.

In 2023/24, four of the nine logging stations (Pipeclay, Salt, Murray and Swifty Creek) exhibited intermittent power supply and software/transmission issues. As such, from 18–22 December 2023, maintenance and upgrades were performed on these stations to enhance battery performance, remove faulty equipment and repair transmission faults.

Status of tagged fish population

To determine the status of active radio tagged Murray cod within Chowilla, a combination of remote and manual tracking was undertaken. Manual tracking occurred in June 2024, whereby core Murray cod habitat within Chowilla (Slaney Creek, Chowilla Creek, Pipeclay Creek, Salt Creek) and the adjacent Murray River main channel (Figure 1) were tracked using a portable ATS R4500C receiver and hand-held Yagi antenna. The position of each tracked fish was determined as the point of greatest signal strength and this location recorded with a GPS. Additionally, the remote logging station database was interrogated for the period September 2023–August 2024 to determine fish presence.

2.3. Acoustic receiver deployment and implantation of acoustic transmitters for Murray cod within the Chowilla system

Acoustic receiver deployment

In May/June 2024, an array of 24 Innovasea VR2W acoustic receivers was deployed at Chowilla (Figure 1). Receivers were deployed in an arrangement that enables: 1) fine-scale tracking of fish movement within Slaney Creek (receivers approximately every 800 m); and 2) assessment of broader-scale movements among major creeks within the Chowilla system and the River Murray as per the existing radio-telemetry logging tower network. In addition to project specific receivers, a further broader array of acoustic receivers exists across the lower Murray, mid Murray, and lower Darling rivers, which are maintained by South Australian Research and development Institute (SARDI), New South Wales Department of Primary Industries (NSW DPI, Fisheries) and Arthur Rylah Institute (ARI, Victorian Department of Energy, Environment and Climate Action). All receivers were deployed using stainless steel cable and attached to snags or manmade structures (e.g., water quality stations, buoy lines at flow regulating structures).

Fish Capture and Surgery for implantation of acoustic transmitters

From 24 June–5 July 2024, Murray cod were captured from Chowilla and the adjacent River Murray using a vessel mounted 5 kW Smith Root Model GPP electrofishing system. Following capture, fish were anaesthetised using a 0.05 ml. L^{-1} solution of AQUI-S in a 200 L dosing tank. When fully anaesthetised — characterised by loss of equilibrium and unresponsiveness to stimulus — fish were weighed (g) and measured (mm fork or total length – FL/TL) and placed ventral side up into a V-shaped support. During surgery, a 0.02 ml. L^{-1} solution of AQUI-S solution was irrigated over the gills to maintain anesthesia. For all fish tagged, a small incision was made off-centre on the ventral surface, midway between the pelvic and anal fins, through which the acoustic tag was inserted into the peritoneal cavity. Incisions were then closed using a single cruciate suture. All fish were also implanted with a PIT (Passive Integrated Transponder) tag which was inserted in the dorsal musculature forward of the dorsal fin or, in large fish, in the cheek muscle, while an external dart tag was positioned between the dorsal pterygiophores. Following full recovery in an aerated tank (i.e. fish able to maintain equilibrium and swim freely), fish were released at their original capture location.

Three different Innovasea acoustic tags were used:

- V13-1x (dimensions 30 x 11 mm; weight 8 g in air; random delay of 70–130 seconds; and estimated battery life of 1360 days),
- V16-6x (dimensions 90 x 15 mm; weight 34 g in air; random delay of 70–130 seconds; and estimated battery life of 3650 days) and
- V16A-6x (accelerometer tags) (dimensions 92 x 15 mm; weight 34 g in air; random delay of 70–130 seconds; Acc On of 30 seconds; and estimated battery life of 3650 days).

The V16A-6x tags, in addition to providing information on movement as per standard tags, provide information on locomotor activity of individual fish by transmitting data on acceleration in three directions (i.e. x, y and z planes, equivalent to surge, heave and sway). These tags were only implanted in fish in Slaney Creek, as this area supports a high concentration of reproductively mature Murray cod and the finest-scale receiver array to capture continuous data. A combined tag weight (V13, V16 and V16A plus the PIT tag) aimed to maintain a transmitter to fish weight ratio of <2% (Jepsen et al. 2002).

3. RESULTS

3.1. Maintenance of radio-telemetry infrastructure

In 2023/24, maintenance was conducted on four logging stations: 1) Pipeclay Creek, 2) Salt Creek, 3) River Murray/Chowilla Creek junction and 4) River Murray/Swifty's Creek junction (Table 1). This included: 1) replacement of existing 80 W solar panels with 160 W panels, replacement of original solar regulator with Victron energy-smart bluetooth controlled regulator and the replacement of AGM batteries with a 105ah lithium battery at Pipeclay Creek; 2) repairs to ATS RDP 800 transmission unit on the Salt Creek logger; and 3) removal of faulty 3G modems on the River Murray/Chowilla Creek and River Murray/Swifty's Creek junction loggers (Table 1).

The upgrades performed at Pipeclay Creek increased power supply and reduced risk of 'down time', while the lithium batteries also have a greater estimated life span (>10 years) than the previous AGM batteries (3–4 years). At the Salt Creek logger, repairs were made to the ATS RDP 800 transmission unit to allow remotely collected movement data to be sent to the Karltek database successfully. Faulty 3G modems were removed from both the River Murray/Chowilla and River Murray/Swifty's junction loggers, which will result in these loggers requiring manual download in the future. Additionally, full upgrades to both the Boat Creek and Bank K logging stations will also need to be considered, but presently both stations are operational (Table 1).

Table 1. Status and details of completed and potential future upgrades at nine radio-telemetry logging stations in Chowilla as of December 2023.

Logging Station	Status	Recent upgrades	Potential future upgrades
River Murray/Chowilla Ck Jumction	Operational	Removal of 3G modem	Upgrade to 4G or 5G modem
Regulator	Operational	-	Upgrade to 4G or 5G modem
Boat Creek	Operational	-	160w solar panel 105ah lithium battery Solar regulator Upgrade to 4G or 5G modem
Pipeclay Creek	Operational	160w solar panel 105ah lithium battery Solar regulator	Upgrade to 4G or 5G modem
Slaney Creek	Operational	-	Upgrade to 4G or 5G modem
Salt Creek	Operational	Repairs to ATS RDP 800 transmission unit	Upgrade to 4G or 5G modem
River Murray/Swifty's Ck Junction	Operational	Removal of 3G modem	Upgrade to 4G or 5G modem
Punkah Creek	Operational	-	Upgrade to 4G or 5G modem
Bank K	Operational	-	160w solar panel 105ah lithium battery Solar regulator Upgrade to 4G or 5G modem

3.2. Summary of existing radio-tagged Murray cod

As of August 2024, based on estimated battery life, a total of 30 radio-tagged Murray cod may have active tags, while 11 individuals were detected within the Chowilla system in the past year (Figure 2). Of the potentially 30 fish with active tags, five have tags that are expected to expire in either 2025 or 2026, while the remainder have tags that are due to expire between 2028 and 2040 (Figure 2). Additionally, three fish with tags that were due to expire in early 2023 were still detected on logger towers over the last year (Figure 2).

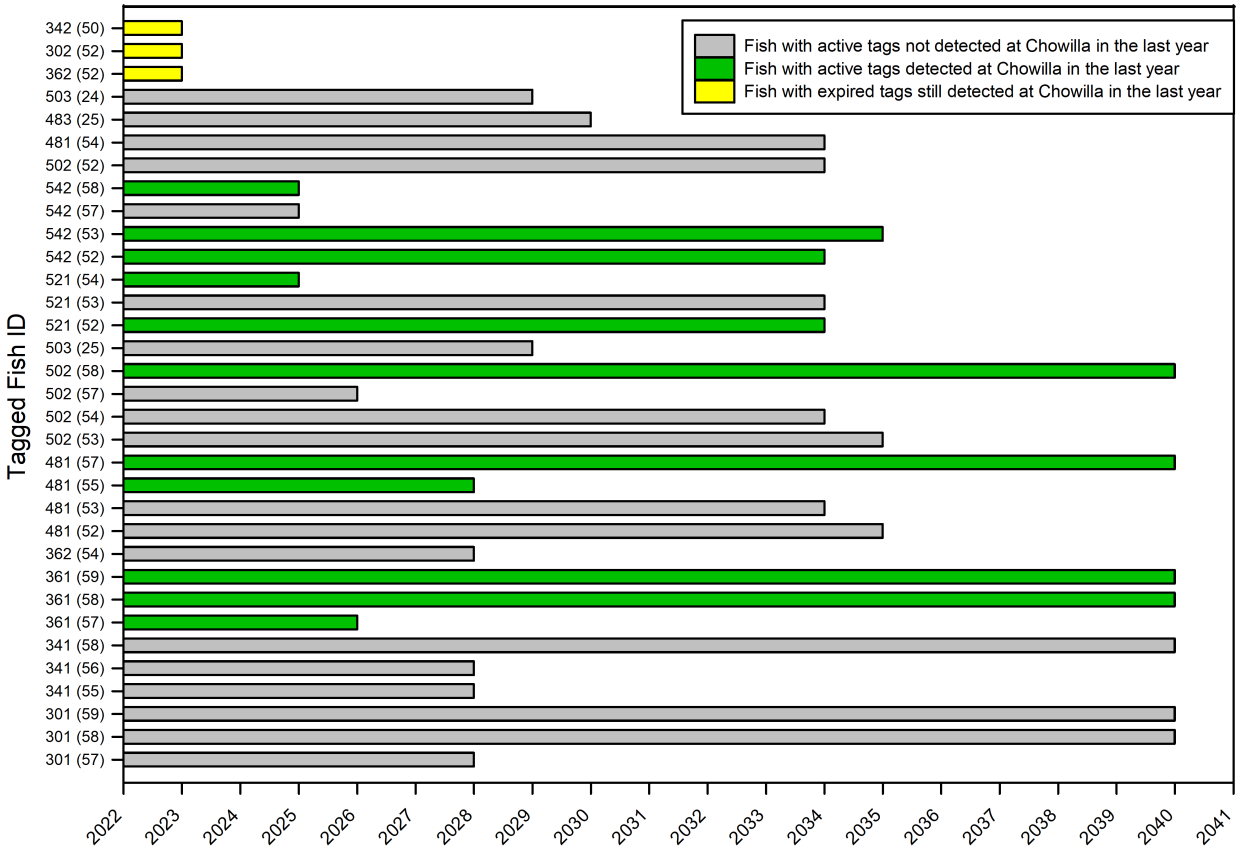

Figure 2. The expected battery-life of radio-tags fitted to 33 radio-tagged Murray cod within Chowilla.

3.3. Implantation of acoustic transmitters

From 24– June– to 5 July 2024, 17 Murray cod were captured from within the Chowilla Anabranch and adjacent River Murray and implanted with acoustic tags (Table 2). Fifteen Murray cod (670–1250 mm TL; 5.6–33.1 kg) were captured within Slaney Creek and fitted with V16A accelerometer tags (Table 2). Single Murray cod were captured in Chowilla Creek immediately upstream of Boat Creek (640 mm TL; 4.45 kg) and at the junction of Chowilla Creek and the River Murray (1120 mm TL; 27 kg), and fitted with standard V13 and V16 tags, respectively (Table 2).

Table 2. Capture location, acoustic ID and biological details of 17 Murray cod implanted with acoustic tags within Chowilla in 2024.

Species	Date Tagged	Tagging Location	Length (mm)	Weight (kg)	Acoustic Tag ID	Tag Type	PIT Tag ID
Murray cod	25/06/2024	Chowilla US of Boat Ck	640	4.45	60632	V13-1x	982091061590230
Murray cod	26/06/2024	Slaney Ck	1110	23	3450	V16A-6x	982091061590286
Murray cod	26/06/2024	Slaney Ck	1000	20.15	3448	V16A-6x	982000405336357
Murray cod	26/06/2024	Slaney Ck	1120	26.5	3446	V16A-6x	982000361607903
Murray cod	26/06/2024	Slaney Ck	1120	23.45	3444	V16A-6x	982126050147947
Murray cod	26/06/2024	Slaney Ck	750	6.3	3442	V16A-6x	982091061590521
Murray cod	26/06/2024	Slaney Ck	1140	29.9	3440	V16A-6x	982000196997192
Murray cod	26/06/2024	Slaney Ck	800	9.9	3449	V16A-6x	982091061590495
Murray cod	27/06/2024	Slaney Ck	990	20.8	3447	V16A-6x	982000361607530
Murray cod	27/06/2024	Slaney Ck	1010	16.6	3445	V16A-6x	982000361608548
Murray cod	27/06/2024	Slaney Ck	670	5.6	3443	V16A-6x	982091061590258
Murray cod	27/06/2024	Slaney Ck	1110	24.5	3441	V16A-6x	982091061590252
Murray cod	2/07/2024	Chowilla Ck/River Murray Junction	1120	27	46534	V16-6x	982091061590460
Murray cod	3/07/2024	Slaney Ck	1250	32.7	3439	V16A-6x	982091061540283
Murray cod	3/07/2024	Slaney Ck	1230	33.1	3451	V16A-6x	982091061590247
Murray cod	3/07/2024	Slaney Ck	1035	20.4	3453	V16A-6x	982126057457805
Murray cod	3/07/2024	Slaney Ck	1110	28	3455	V16A-6x	982091061590423

4. DISCUSSION

The Chowilla system supports a suite of large-bodied native fishes, including a regionally important population of Murray cod. Maintaining and improving this population is a key objective of management of the site. As such, an understanding of movement and population dynamics, particularly in relation to operation of the Chowilla Regulator and associated infrastructure, and weir pool manipulation, is required to inform adaptive management.

As an *Icon Site* under the TLM Program (MDBA 2016), since 2005, Chowilla has been the subject of a long-term fish condition monitoring program (e.g. Fredberg et al. 2024) and an associated intervention monitoring program that supports targeted investigations (e.g. Bice et al. 2023) to inform adaptive management. This report presents the fish intervention monitoring program for 2023/24, which comprised work to support ongoing investigations of Murray cod at the site, namely: 1) undertaking maintenance to radio-tower infrastructure to support continued base-level monitoring of existing radio-tagged fish; and 2) commencing a transition to acoustic-telemetry for longer term investigations of movement. Both components are discussed below, followed by recommendations for potential future investigations.

4.1. Maintenance of radio-telemetry infrastructure and summary of existing radio-tagged Murray cod

To ensure system functionality and enable continued monitoring of radio-tagged Murray cod in the region, there is a need to provide periodic maintenance of radio-telemetry infrastructure and understand the status of the radio-tagged population. As of 2024, all nine remote logging stations at Chowilla are operational, with all but two logging stations (Boat Creek and Bank K) having been fully refurbished within the past three years (involving replacement of solar panels, batteries, solar regulators and cabling). Commencing 28 October 2024, the existing 3G mobile network, which enabled remote transmission of telemetered radio tower data to the Karltek database, was switched off. This necessitates either: transition to the 4G/5G network and installation of new modems in each tower; or manual downloading of data from the logging stations. Each option will be associated with a cost, and the most appropriate choice of approach will be confirmed over the next 12 months.

In 2024, based on estimated battery life, potentially 30 Murray cod still have active radio tags, yet only 11 were detected in Chowilla from September 2023–August 2024. Of the 30 potentially active fish, five have tags that are expected to expire in either 2025 and 2026, while the remainder have

tags that are due to expire between 2028 and 2040. As such, these individuals may continue to contribute data on Murray cod movement at Chowilla along with new acoustically tagged fish. Additionally, a further three radio-tagged Murray cod that were expected to have ceased transmitting were detected in the Chowilla system over the same period, suggesting greater than expected battery life. Nonetheless, these tags will likely cease transmitting in the near future.

4.2. Acoustic receiver deployment and implantation of acoustic transmitters for Murray cod within the Chowilla system

In 2023/24, commencement of a transition toward acoustic telemetry for future investigations of Murray cod movement involved the deployment of an array of acoustic receivers and tagging of 17 out of a targeted 50 fish within the Chowilla system and adjacent River Murray. The current number of tagged fish is relatively low compared to similar studies of the species (e.g. Tonkin et al. 2022), and thus, deployment of remaining acoustic tags is required to support scientifically robust investigations into movement and habitat use relative to management. Additional tagging activities are proposed for 2025, which will most likely occur during targeted Murray cod surveys as part of annual Condition Monitoring. Further small-scale, ‘top-up’ tagging may be required post-2026 to maintain the tagged population but will be dependent on the fate (i.e. battery expiration, mortality, emigration) of existing tagged fish.

5. CONCLUSIONS AND RECOMMENDATIONS

In 2023/24, we conducted works to support continued investigations of Murray cod movement and habitat use within the Chowilla system and adjacent River Murray. Further tasks will be required in 2024/25 to ensure overall system functionality, including:

- Conducting further tagging activities with remaining tags to increase the population of acoustically-tagged Murray cod (target of 50 fish in total) to further bolster investigations into movement patterns and habitat use within the Chowilla region;
- Undertaking periodic downloads of the newly deployed acoustic receiver array (ideally twice annually) to gather data on movement and locomotor activity; and
- Determining a future approach for radio-telemetry data collection either via remote transmission or manual download.

Ultimately, once the hybrid radio-/acoustic-telemetry system is fully functioning, specific investigations of data will continue and build upon previous research. Key investigations to better inform management of Chowilla and the broader lower River Murray may include:

- Investigation of creek-scale movement and habitat use of Murray cod in association with fine-scale management of system inflow (e.g. discharge via Swifty's, Slaney, Pipeclay and Boat creeks);
- Investigation of locomotor activity (accelerometer data) of Murray cod in association with environmental conditions (e.g. water quality, season, hydrology) and regulator operation; and
- Investigation of meso-scale movement and habitat use of Murray cod within the Chowilla system and adjacent River Murray associated with manipulation of Lock 6 water levels.

The above investigations are Chowilla-specific and related to Murray cod, but there are opportunities to use this receiver array to investigate questions regarding the movement of other large-bodied fishes (e.g. freshwater catfish, *Tandanus tandanus*), and to integrate the current project with a broader-scale project targeting Murray cod movement in the lower River Murray that is proposed to commence in 2025.

6. REFERENCES

Bice, C. M., D'Ombrain, T. H., Fredberg, J.F., Harrisson, K. A., Murphy, N. P., O'Dwyer, J. and Zampatti, B. P. (2023). Chowilla Icon Site Fish Intervention Monitoring 2021/22. Report to the Department for Environment and Water. South Australian Research and Development Institute (Aquatic and Livestock Sciences), Adelaide. SARDI Publication No. F2017/000331-7. SARDI Research Report Series No. 1197. 49pp.

Fredberg, F., B. P. Zampatti and C. M. Bice (2019). Murray cod (*Maccullochella peelii*) movement in the Chowilla region of the lower River Murray, South Australian Research and Development Institute (Aquatic Sciences), Adelaide. SARDI Publication F2019/000313-1. SARDI Research Report Series No. 1035. 27pp.

Fredberg, J., Bice, C.M. and Zampatti, B. P. (2024). Chowilla Icon Site Fish Assemblage Condition Monitoring 2023. South Australian Research and Development Institute (Aquatic and Livestock Sciences), Adelaide. SARDI Publication No. F2008/000907-14. SARDI Research Report Series No. 1228. 69pp.

Jepsen, N., A. Koed, T. E. B and E. Baras (2002). Surgical implantation of telemetry transmitters in fish: how much have we learned? *Hydrobiologia* **483**: 239-248.

Leigh, S. and B. Zampatti (2009). Movement of Murray cod within the Chowilla Anabranch system: progress report 2008/09. Report to the SA MDB NRMB, South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Leigh, S. J. and B. P. Zampatti (2013). Movement and mortality of Murray cod, *Maccullochella peelii*, during overbank flows in the lower River Murray, Australia. *Australian Journal of Zoology* **14**: 135-143.

MDBA (2016). The Living Murray Annual Environmental Watering Plan 2014-2015, MDBA publication no. 25/15. Murray-Darling Basin Authority, Canberra.

O'Malley, C. and Sheldon, F. (1990). Chowilla Floodplain Biological Study. pp 224. Nature Conservation Society of South Australia, Adelaide.

Pierce, B. E. (1990). Chowilla Fisheries Investigations. South Australian Department of Fisheries, Adelaide.

Sharley, T. and Huggan, C. (1995). Chowilla Resource Management Plan. Murray-Darling Basin Commission, Canberra.

Tonkin, Z., P. Moloney, J. Lyon, A. Kitchingham, J. O'Mahony, S. Raymond, G. Hackett, S. Saddlier, A. Greenfield, D. Wood and R. Hale (2022). Movement and behaviour of a threatened native fish informs flow management in a modified floodplain river system. *Ecosphere* **13**: e3916.

Walker, K.F. (2006). Serial weirs, cumulative effects: the Lower River Murray, Australia. In 'Ecology of Desert Rivers'. (Ed. R Kingsford) pp.248–279. (Cambridge University Press).

Zampatti, B. P., P. J. Wilson and C. M. Bice (2016). Science to inform artificial floodplain inundation: Movement and habitat use of Murray cod (*Maccullochella peelii*) during testing of the

Chowilla Creek Regulator, Goyder Institute for Water Research Technical Report Series No. xx/x, Adelaide, South Australia.