

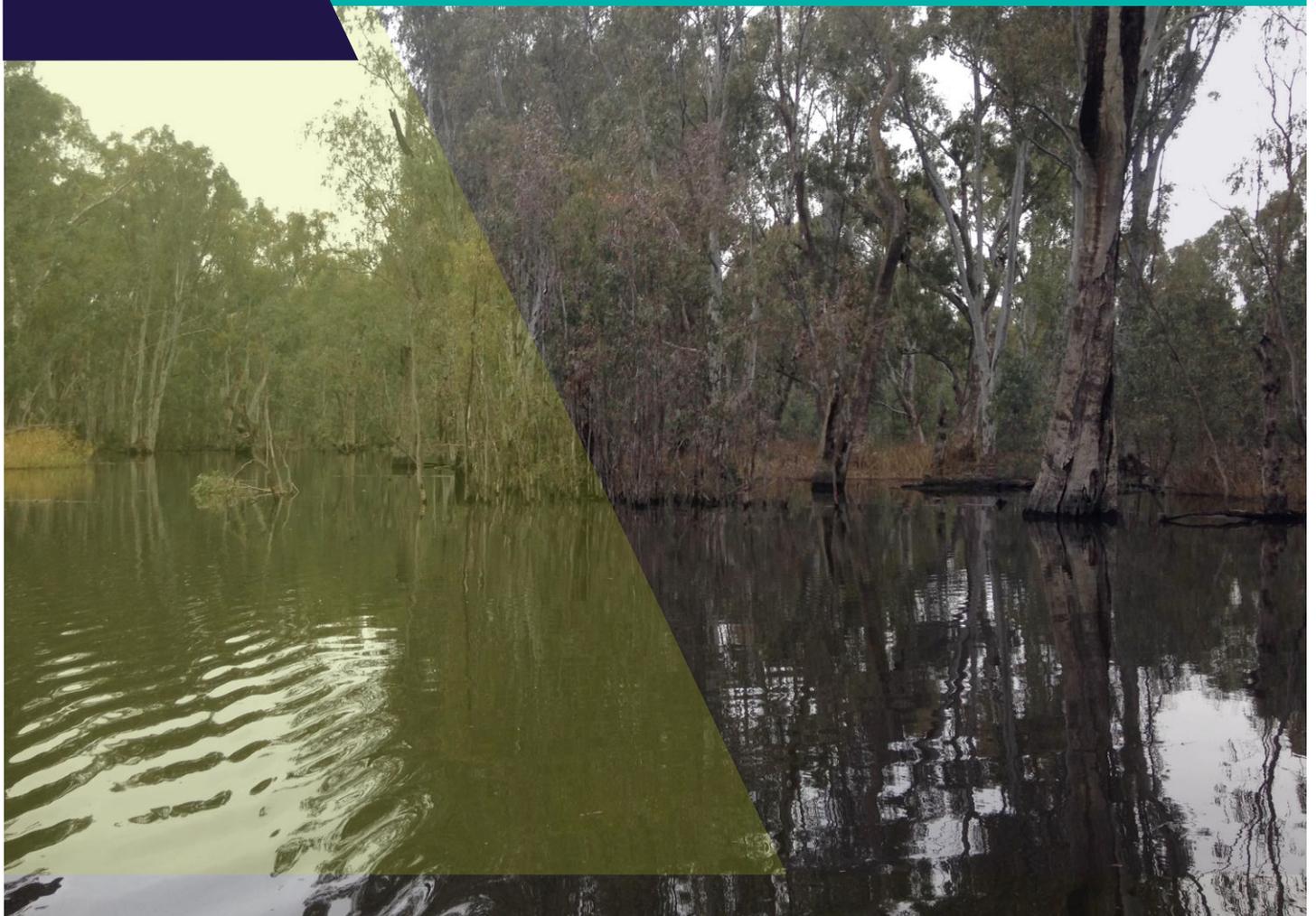


Carp movements during a managed inundation –

Little Gunbower Creek case study

J. Lieschke, B. Fanson and A. Pickworth

August 2020



Arthur Rylah Institute for Environmental Research
Client Report

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Carp movements during a managed inundation -

Little Gunbower Creek case study

Jason Lieschke, Ben Fanson and Andrew Pickworth

Arthur Rylah Institute for Environmental Research

Client Report for North Central Catchment Management Authority

Department of Environment, Land, Water and Planning

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1 Summary

Context

Gunbower Forest is an icon site within The Living Murray (TLM) program and has a watering strategy designed and implemented for multiple biodiversity benefits. The delivery of flows into Gunbower Forest must consider the potential for Carp recruitment, as Carp can affect water quality (turbidity) and aquatic vegetation (Bennetts and Sim 2016). The Gunbower Island Carp Management Strategy (NCCMA 2018) was prepared by North Central Catchment Management Authority (North Central CMA) to help minimise the impact of Carp on Gunbower Island, including Gunbower Creek and the broader River Murray system. Ongoing monitoring and research aim to address knowledge gaps outlined in the Carp management strategy, including tracking the movement of Carp in response to various watering scenarios. A three-year monitoring program in Gunbower Island, documented in Lieschke et al. (2019), identified broad movement patterns of Carp throughout Gunbower Forest and between the floodplain and Murray River, and recommended management options for further controlling Carp as well as areas where further research is required.

The current project builds on the previous work and investigates Carp movements around the Little Gunbower Creek complex within the Gunbower Forest following a managed flow event in July 2019. The flow event filled wetlands within the complex, connecting creeks and floodrunners, and inundated areas of forest floodplain. Identifying Carp pathways and hotspots within this part of the forest help inform options to manage Carp during future managed flow events.

Aims

The project aims to investigate the movement patterns of Carp in the Little Gunbower Creek complex, specifically to:

- examine the movement of Carp within the Little Gunbower Creek complex, including timing and location of movement in response to a managed flow event.
- describe the habitat use and accumulations of Carp within the Little Gunbower Creek complex during and post a managed flow event.

Methods

Eleven acoustic receivers were placed at key areas within the Little Gunbower Creek complex where Carp are known to occupy on 26 June 2019, prior to inundation in early July 2019. Carp were captured by boat electrofishing within the Little Gunbower Creek Regulator refuge pool study site, and 10 fish were acoustically tagged and released back into the pool just prior to environmental watering.

Results

All 10 tagged Carp were detected during the study period. All Carp moved out of the refuge pool within five days of inflows commencing. Nine Carp returned to the initial tagging site as the floodplain dried out and were detected at the tagging site from mid-December to 26 March 2020. This site represented the only area where water was present when the receivers were downloaded on 26 March 2020. The tenth Carp was not detected after 19 July 2019 and potentially perished on the floodplain.

Carp were more likely to be detected in the larger pools and main channel, with fewer Carp detected in areas with smaller less defined channels (e.g. Little Gunbower Creek Channel receiver 2). The most frequently used pathways were from Little Gunbower Creek Regulator to Long Lagoon (via Little Gunbower Creek Channel 1), and from Little Gunbower Creek Regulator and Little Gunbower Creek Channel 1 to Little Gunbower Creek Channel 3, up to Black Swamp Deep Pool (via Black Swamp-Little Gunbower Creek Spur). The Little Gunbower Creek Channel 1, Little Gunbower Creek Channel 3 and Black Swamp – Little Gunbower Creek Spur acted as highways for Carp movement. Long Lagoon, Black Swamp Deep Pool and Little Gunbower Creek Regulator, the deeper sites, represented areas of more permanent residency.

Conclusions and implications

This study indicates that Carp will move across the floodplain as soon as floodplain connectivity is provided. It also highlights that Carp already present on the floodplain prior to managed flows have a strong homing behaviour – returning to the refuge pool. This homing behaviour can be exploited if the most important refuge habitat is known. Little Gunbower Creek Regulator refuge pool represents the most important refuge pool within the Little Gunbower Creek complex.

The following recommendations focus on options for Carp management within the Little Gunbower Creek complex, as well as how to build on existing Carp management actions. They include:

Little Gunbower Creek complex

The primary recommendation for carp management based on this study is:

- Investigate options for removal of adult Carp from the Little Gunbower Creek Regulator refuge pool during periods of low flows, such as:
 - Pumping the refuge pool down and then removing fish via electrofishing and netting.
 - Trial an intensive (electrofishing/netting) elimination study prior to pumping. The intensive study may find it is practical to remove all (enough) of the standing stock of Carp and may be cheaper than pumping. It may also be able to be used in areas where pumping cannot occur.
 - After a large natural flood event, netting and electrofishing should be used to determine whether carp need to be removed from the system again.

Additional recommendations:

- Investigate Carp trapping (and subsequent removal) in the channel between the refuge pool and the Little Gunbower Creek Channel 1 site during inundation events. Ideally this would be before the split which leads to Little Gunbower Creek Channel 3 site. This study showed that Carp constantly move to and from the refuge pool during a managed flow. This recommendation is only for when Carp cannot be removed from refuge pool prior to a managed watering event.
- Investigate construction of a removable fence barrier within the Little Gunbower Creek Channel between the refuge pool and Little Gunbower Creek site prior to the next managed watering event. This would restrict Carp from entering most of the Little Gunbower Creek complex as well as restrict potential spawning to the Little Gunbower Creek Regulator refuge pool. This recommendation is only for when Carp cannot be removed from refuge pool prior to a managed watering event.
- Determine the extent of Carp spawning on the floodplain during managed flow events and the level of recruitment that occurs.
- Investigate the conditions that lead to the proliferation of Carp in the Little Gunbower Creek complex between 2008 and 2012.

Build knowledge base to inform management options across the Gunbower Forest

- Further investigate water flow across the floodplain to enable better management of regulators and potentially identify additional management options. Determine the flow rates required (in the Murray River) to result in inflows through Barham Cut that connect with the Little Gunbower Creek complex and flows required to connect Little Gunbower Creek complex to Three Corner Hole.
- Continue current Carp management strategies including identification of other potential refuge habitats for potential Carp control. i.e. Spur Creek.
- Install additional receivers and tag more Carp in the forest to further clarify the location of Carp movement pathways and refuge habitats, particularly for upstream areas in the Gunbower Forest.
- Continue to improve and test exclusion fences around key wetlands i.e. Reedy Lagoon.
- Expand the Carp monitoring program to provide data on Carp population dynamics (Gunbower Forest and Murray River populations), and their responses to interventions such as managed flows. This program would involve surveys of the forest and surrounding waterbodies (i.e. Murray River and Gunbower Creek), tagging of juvenile Carp and analysis of otoliths. The data would inform management and support the validation, calibration and future refinement of the Carp population model.

2 Introduction

Gunbower Forest, an icon site within The Living Murray program, has a watering strategy designed and implemented for multiple biodiversity benefits. Whilst delivering water for into the forest for terrestrial biodiversity, the potential for Carp recruitment must be considered as Carp can affect water quality (turbidity) and aquatic vegetation (Bennetts and Sim 2016). The North Central Catchment Management Authority (North Central CMA) developed a Carp Management Strategy developed the Gunbower Island Carp Management Strategy (NCCMA 2018) to help minimise the impact of Carp on Gunbower Island, including Gunbower Creek and the broader River Murray system. A recent study by Lieschke et al. (2019) identified broad movement patterns of Carp throughout Gunbower Forest. This project investigated Carp movements within and between wetlands of the Little Gunbower Creek complex within the Gunbower Forest following a managed flow event in July 2019. Identifying Carp pathways and hotspots within this part of the forest will help inform options to manage Carp during future managed flow events.

Aims

The project aimed to investigate the movement patterns of Carp in the Little Gunbower Creek complex, specifically to:

1. examine the movement of Carp within the Little Gunbower Creek complex, including timing and location in response to a managed flow event.
2. describe the habitat use and accumulations of Carp within the Little Gunbower Creek complex during and post a managed flow event.

Identifying Carp pathways and hotspots within this area of forest will help set management objectives and maximise opportunities to control Carp during future managed flow events.

3 Methods

3.1 Study area

The Gunbower Forest is situated in north central Victoria and is bounded by the Murray River and Gunbower Creek. It is a highly complex floodplain ecosystem with the periodic connection of the floodplain (floodplain forest, wetlands and creeks) to the Gunbower Creek and River Murray during natural flooding and environmental watering events. These events are critical to the ecological processes sustaining the Gunbower Forest ecosystem. The Gunbower Forest has both unregulated and regulated floodrunners. Regulated floodrunners are used to control flow entering and exiting the forest and within the current study area include the Little Gunbower Creek and Black Swamp regulators (Figure 1). Although not used in this study Barham regulator can also be used to water the Little Gunbower Creek complex.

Between 1 July and 12 July 2019, the Little Gunbower Creek regulator was used to provide floodplain inundation (a managed flow event) from Gunbower Creek to the Little Gunbower Creek complex, with no connectivity to the Murray River or Gunbower Creek (via the regulator or via Three Corner Hole). A total of 1,120 ML passed through the Little Gunbower Creek regulator onto the forest, which covered 149.5 ha of forest. Long Lagoon and the Black Swamp (Deep Pool) were the larger wetlands inundated, whilst Little Gunbower Creek Channel 1 was the main connecting channel between the Little Gunbower Creek Regulator refuge pool and Long Lagoon.

3.2 Acoustic receiver deployment

Eleven Vemco Model VR2W acoustic receivers were placed in-situ on 25 and 26 June 2019, prior to floodplain inundation. All receivers were placed within the Little Gunbower Creek complex, as well as at the regulator and Deep Pool in Black Swamp, as it was anticipated that some water may enter Black Swamp through the connecting flood runner (Table 1). The placement of the receivers within the forest enables identification of the movement pathways of Carp within the complex whilst inundated, but also potential accumulations and refuge habitat at the end of flooding. The 11 acoustic receivers used in this project were retrieved and downloaded on 26 March 2020.

Table 1. Receiver details and locations.

Receiver Number	Location	Latitude	Longitude	Condition [#]
124273	Little Gunbower Creek Regulator	-35.69679	144.17647	Wet
102718	Little Gunbower Creek Channel 1	-35.69655	144.18710	Dry
103579	Little Gunbower Creek Channel 2	-35.69940	144.19005	Dry
103577	Little Gunbower Creek Channel 3	-35.70195	144.18611	Dy
103588	Little Gunbower Creek Channel 4	-35.70422	144.19063	Dry
126428	Little Gunbower Creek Channel 5	-35.70001	144.19384	Dry
103578	Long Lagoon	-35.69579	144.20133	Dry
103596	Long Spur	-35.69397	144.20336	Dry
124269	Black Swamp – Little Gunbower Creek Spur	-35.70881	144.18757	Dry
125593	Black Swamp Regulator	-35.71021	144.17972	Dry
124271	Black Swamp Deep Pool	-35.71876	144.18931	Dry

[#] condition of water at receiver location when the receiver was retrieved.

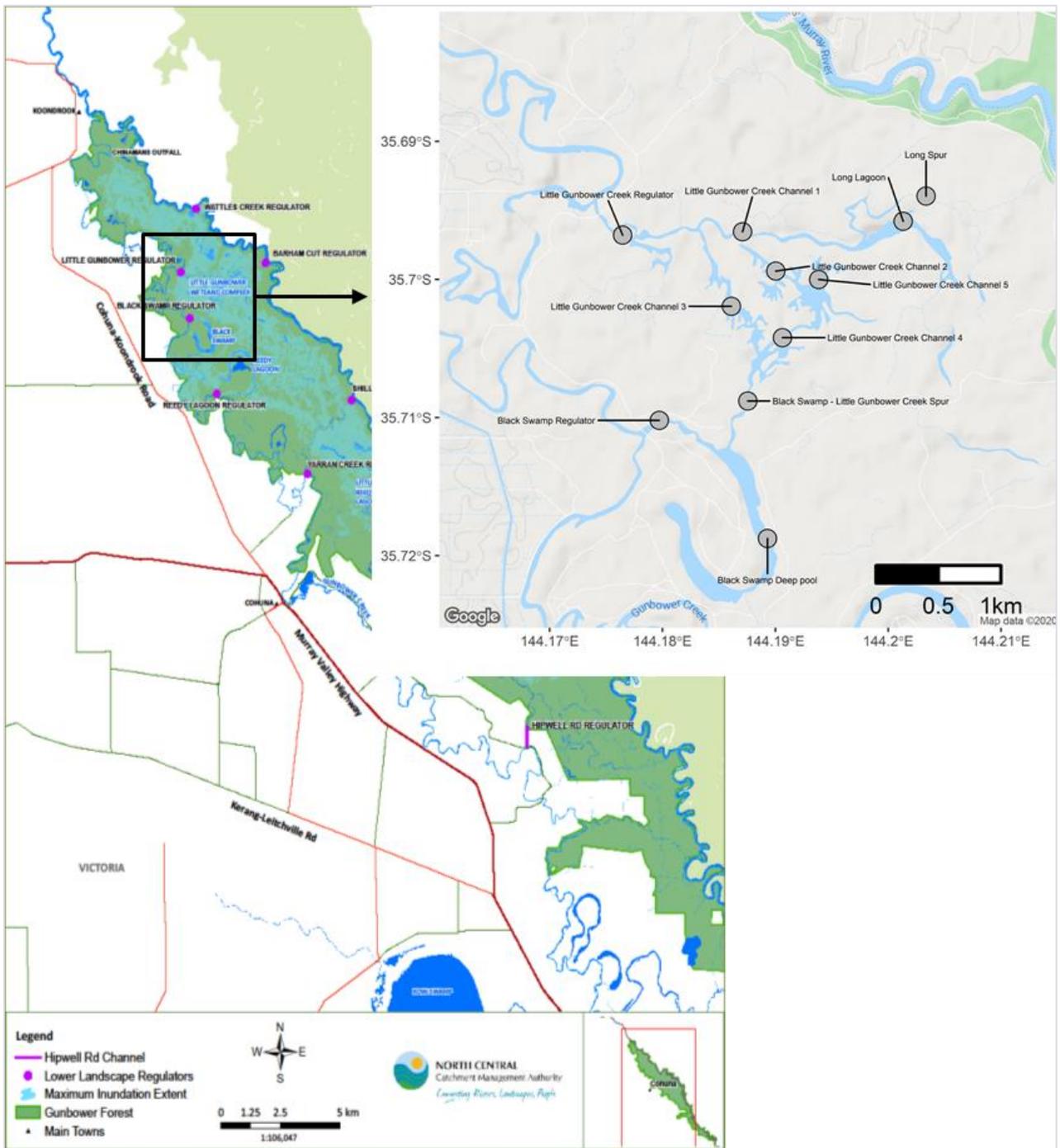


Figure 1. Location of Gunbower Forest study area showing Little Gunbower Creek complex.

3.3 Carp capture and tagging

Ten Carp were captured via boat electrofishing and acoustically tagged on 26 June 2019 (Table 2). All Carp were tagged in the refuge pool at the Little Gunbower Creek Regulator. Acoustic tagging of fish followed the methods of Koster et al. (2013). Anaesthetised fish were weighed (nearest g) and measured (total length, mm). Implantation of transmitters generally took 4-5 minutes and recovery to full consciousness was usually within 5-8 minutes. The individually coded transmitters were all Vemco (V9-2L-069k-1 VEMCO) and had a life span of 912 days (expected expiry 24 December 2021). All transmitters emitted a signal at a random pulse interval of 110 to 190 s. An external T-bar tag (Hallprint) was also inserted into the muscle surrounding the dorsal fin spine. Information on the T-bar tag offered a reward and provided a phone number for the tag's return. Passive Integrated Transponder (PIT) tags were also inserted into the peritoneal cavity, allowing the identification of fish using the fishway at Torrumbarry Weir.

Table 2. Carp captured, tagged and released at Little Gunbower Creek Regulator refuge pool (26/6/2019) and individual Carp details.

Acoustic Tag Number	Length (mm)	Weight (g)	T-bar Tag Number	Last Date Detected	Sex
19277	570	3837	141701	26/03/2020	Female
19278	532	2872	141702	26/03/2020	Male
19279	592	4474	144008	12/07/2019	Female
19280	570	3988	141707	26/03/2020	Female
19281	525	2578	143628	26/03/2020	Male
19282	528	2816	141705	26/03/2020	Male
19283	615	4602	141704	26/03/2020	Female
19284	570	3486	141703	26/03/2020	Female
19285	520	2396	143609	26/03/2020	Male
19286	525	3006	141706	26/03/2020	Female

4 Results

4.1 Movement patterns of Carp

An environmental flow of 1,120 ML was used to inundate 149.5 ha of Little Gunbower Creek complex between 1 July and 12 July 2019. Carp moved quickly and widely throughout the newly flooded area, with one Carp moving out of the refuge pool tagging site (Little Gunbower Creek Regulator) on the day flows commenced and the regulator was opened. By day two, four Carp had moved out of the refuge pool tagging site, and by day five, all ten fish had moved away from this area. Seven or more Carp were detected at eight of the 11 receivers (Table 3). Aside from the tagging site:

- all ten Carp were detected at the Little Gunbower Creek Channel 1 site
- four Carp were detected at the Black Swamp Regulator and at Little Gunbower Creek Channel 2.
- no Carp were detected at Long Spur. The floodplain connectivity between Long Spur and Long Lagoon during the managed flow event was unknown.

One Carp was last detected on 19 July 2019 (25 days after tagging), but during that period had moved around much of the study area (detected on nine receivers). It is unknown whether this Carp perished on the floodplain or the acoustic receiver (19279) stopped working. Following the recession of the managed flow the remaining nine Carp returned to the tagging site and were detected in the refuge pool from mid-December 2019 to the time of the downloads on 26 March 2020. Eight Carp were detected at seven or more receivers. One Carp showed limited movement, only being detected at three receivers (Table 4) moving from the Little Gunbower Creek Regulator to Long Lagoon via Little Gunbower Creek Channel 1. This Carp spent large amounts of time at Long Lagoon, but periodically moved between Long Lagoon and the tagging site before remaining at the tagging site from 16 December 2019. All surviving Carp were predominantly back at the tagging site by mid-December, with the last detection outside of this being a single fish on the 4 January at Little Gunbower Creek Channel 1.

The most detections were recorded at the Little Gunbower Creek Regulator site (Table 5). This is not unexpected, as Carp were restricted to this refuge site from mid-December until March. The next highest were Long Lagoon, Black Swamp Deep Pool and Little Gunbower Creek Channel 1.

Table 3. Number of Carp detected at each receiver.

Location	Receiver id	Number Carp
Little Gunbower Creek Regulator	124273	10
Little Gunbower Creek Channel 1	102718	10
Little Gunbower Creek Channel 2	103579	4
Little Gunbower Creek Channel 3	103577	9
Little Gunbower Creek Channel 4	103588	9
Little Gunbower Creek Channel 5	126428	8
Long Lagoon	103578	8
Long Spur	103596	0
Black Swamp – Little Gunbower Creek Spur	124269	9
Black Swamp Regulator	125593	4
Black Swamp Deep Pool	124271	7

Table 4. Number of daily detections and number of receivers detected per Carp. Only a single detection per receiver in a day was recorded. Fish can have multiple daily detections if it visits multiple receivers.

Carp id	Number of daily detections	Number of Receivers
19277	344	8
19278	305	7
19279	20	9
19280	315	10
19281	317	7
19282	352	10
19283	319	8
19284	306	8
19285	208	8
19286	286	3

Table 5. Number daily detections for each fish and receiver (only receivers with at least one hit are shown). Only a single detection per receiver per day was recorded. Fish can have multiple detections if it visits multiple receivers on any given day.

Carp id	124273	102718	103579	103577	103588	126428	103578	124269	125593	124271
19277	141	55	0	25	14	2	16	32	0	59
19278	150	8	0	17	3	0	0	21	3	103
19279	1	1	2	4	2	2	0	1	1	6
19280	115	25	52	15	19	16	29	16	11	17
19281	233	16	0	22	17	12	10	7	0	0
19282	171	28	5	16	8	5	42	19	12	46
19283	219	33	14	9	8	2	32	2	0	0
19284	242	23	0	14	3	2	4	8	0	10
19285	93	35	0	11	9	5	44	6	0	5
19286	117	16	0	0	0	0	153	0	0	0
Total	1482	240	73	133	83	46	330	112	27	246

The most used pathways were from Little Gunbower Creek Regulator to Long Lagoon (via Little Gunbower Creek Channel 1), and from Little Gunbower Creek Regulator and Little Gunbower Creek Channel 1 to Little Gunbower Creek Channel 3, up to Black Swamp Deep Pool (via Black Swamp-Little Gunbower Creek Spur) (Figure 2). No fish moved between Little Gunbower Creek Channel 1 and Little Gunbower Creek Channel 2. The thin lines in Figure 2 represent where a Carp moved between receivers but was not detected at other receivers e.g. Between Long Lagoon and Black Swamp-Little Gunbower Creek Spur.

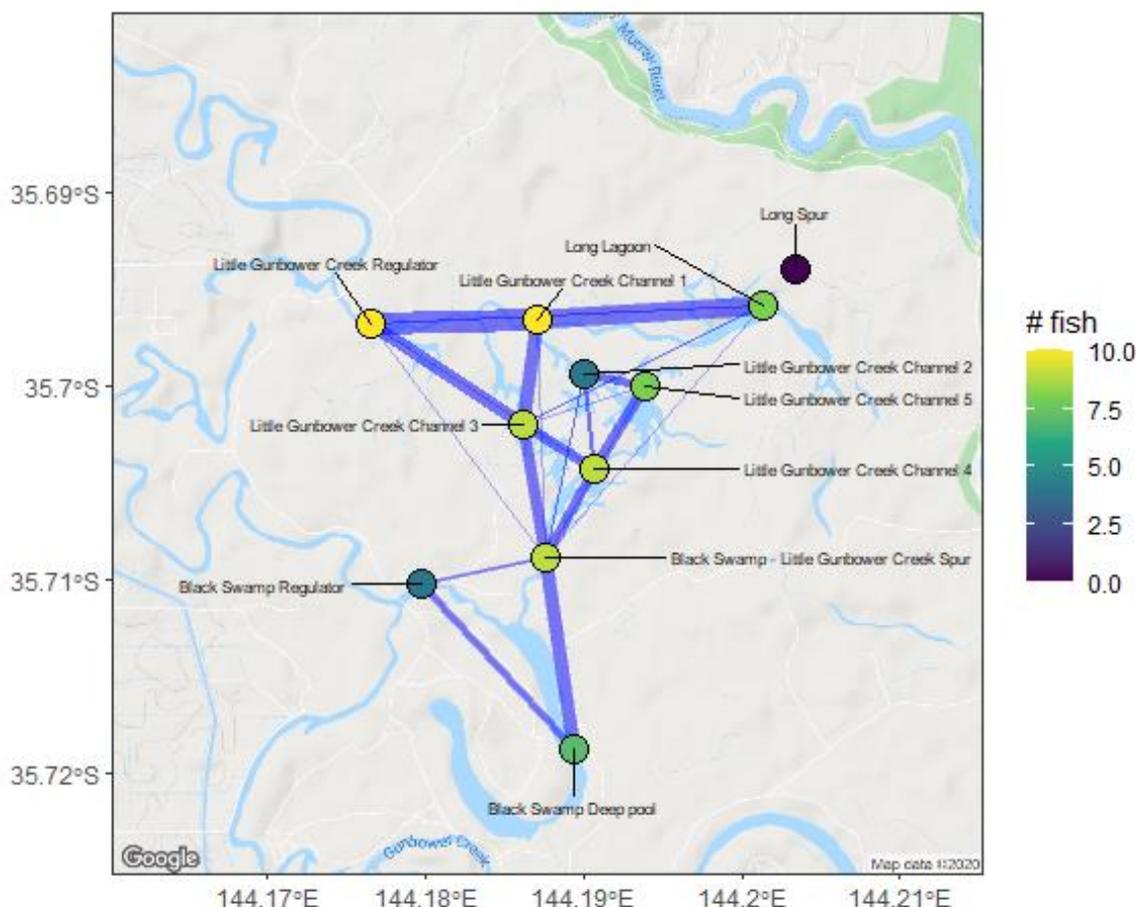


Figure 2. Map showing study site with receiver (coloured circles) and movements (blue lines). Colour in the circles indicate the number of unique individuals visiting that site. The thickness of the lines indicates the number of direct movements between those loggers (i.e. fish did not hit another receiver between the movement).

The Carp spread rapidly throughout the wetted area, with widespread detections in July when water entered the floodplain (Figure 3). Carp returned to the refuge pool periodically throughout the study but returned less during August and September when water was spread across the floodplain. Few Carp were detected away from the refuge pool in December and early January, as the water on the floodplain receded, with all Carp detected only at the refuge pool from mid-January onwards.

The timeline for total daily detections per month for each receiver cumulative for all Carp shows where Carp were distributed across the floodplain from July to October (Figure 4). The daily detections were highest and restricted to the Little Gunbower Creek Regulator from December/January onwards, evidence of restricted habitat outside of this refuge pool. The Black Swamp Deep Pool, Long Lagoon and Little Gunbower Creek Regulator sites had the highest number of daily detections from July to October (Figure 4), whereas Little Gunbower Creek Channel 1, Little Gunbower Creek Channel 3 and Black Swamp – Little Gunbower Creek Spur along with Long Lagoon (Figure 3) had more individual Carp detected during this time. This indicates that Little Gunbower Creek Channel 1, Little Gunbower Creek Channel 3 and Black Swamp – Little Gunbower Creek Spur acted as highways and the Long Lagoon, Black Swamp Deep Pool and Little Gunbower Creek Regulator sites were areas of more permanent residency.

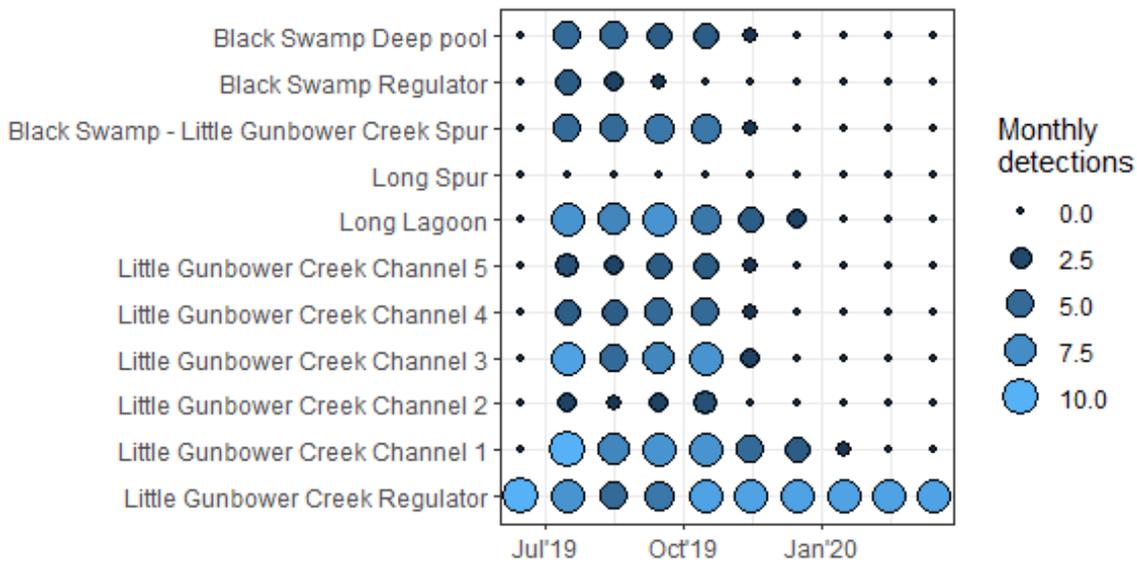


Figure 3. Timeline of unique Carp detected each month for each receiver. Only a single detection per receiver in a day was recorded. Fish can have multiple daily detections if it visits multiple receivers.

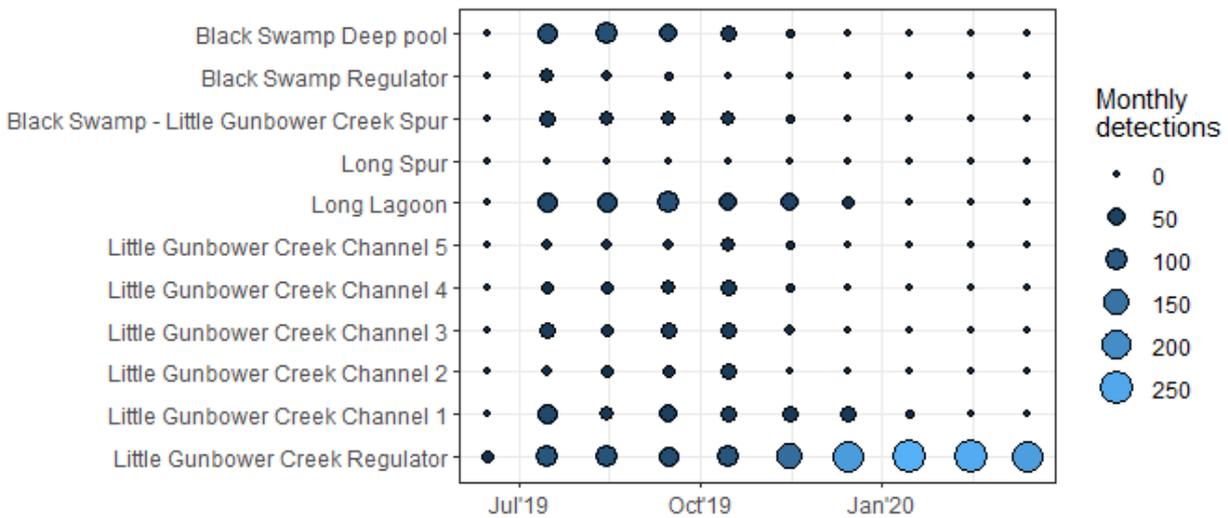


Figure 4. Timeline of total daily detections for each month for each receiver cumulative for all Carp. Only a single detection per receiver in a day was recorded for unique Carp. Fish can have multiple daily detections if it visits multiple receivers.

5 Discussion

Carp are known to move between a range of habitats during flooding and understanding these movements is important to help inform management options. The current study has identified the main connecting channels between Little Gunbower Creek and Long Lagoon and Little Gunbower Creek and Black Swamp as being the most utilized Carp movement pathways in the Little Gunbower Creek complex. This provides the North Central CMA with additional Carp management options within the complex (see recommendations). This study has built on knowledge gained in a previous study (Lieschke et al. 2019) which showed movements of Carp throughout the whole Gunbower Forest and between the forest and Murray River during a natural flood, however it did not focus on the local movements such as within Little Gunbower Creek complex. Carp movements are known to be associated with increasing water temperature for lateral (Jones and Stuart 2009) and longitudinal (Mallen-Cooper 1999) movements. Carp also have highly developed olfactory and gustatory senses used to find food, avoid predators, recognise habitats and locate conspecifics for spawning (Sorensen and Stacey 2004; Elkins et al. 2009), and have been shown to actively seek offshore habitats for spawning and feeding (Stuart and Jones 2006; Jones and Stuart 2009).

This study has confirmed the homing behaviour and importance of Carp hotspots within a defined area of the Gunbower Forest. The data collected from Lieschke et al. (2019), the Carp biomass study (Ivor Stuart, pers. comm.) and this current study all show that the Little Gunbower Creek Regulator pool is a refuge habitat hotspot for Carp within the Gunbower floodplain. This known aggregation site provides an opportunity to target Carp removal. It is recommended that the North Central CMA remove Carp from this area, particularly when they aggregate after large overbank flows occur.

Managed flows provide opportunities for Carp to colonise wetlands. This study showed that Carp preferred staying in deeper wetlands such as Little Gunbower Creek Regulator refuge pool, Long Lagoon and Black Swamp-Deep Pool, but they moved out of the newly inundated wetlands (Long Lagoon and Black Swamp) and returned to the refuge pool as the floodplain dried out. The previous study by Lieschke et al. (2019) indicated that if the Little Gunbower Creek refuge pool became connected to the river system, over half the Carp would exit the floodplain. The managed flow event in the current study, did not allow connectivity with the river system. It is recommended that any managed flows in this area aim to ensure that the Little Gunbower Creek complex remains disconnected from the river system to avoid exporting both adult and juvenile Carp to the river. If connectivity occurs the debris screen on Barham Cut regulator should be operated to limit the movement of adult Carp.

Managed flows have the potential to enhance Carp populations since they create large areas of newly inundated floodplain habitats. These inundations provide spawning opportunities during times of increased floodplain productivity, enhancing larval/young recruitment. This study did not involve aspects of Carp spawning during the managed flow event, but the annual fish condition monitoring program (TLM unpublished data 2020) found evidence of limited Carp recruitment at the Little Gunbower Creek Regulator site in May 2020. Additionally, the Gunbower Wetland Productivity study in December 2019, also found evidence of Carp spawning in Long Lagoon. Carp spawning within the Little Gunbower Creek complex in 2019 is likely due to the managed watering event. Given this, there may be varied levels of recruitment during managed flows that requires further investigation.

The movement of Carp throughout Little Gunbower Creek Complex as soon as water was available is consistent with findings of Lieschke et al. (2019). This highlights the importance of timing the managed flows outside the Carp spawning window (if feasible). Even with the winter managed flows within this study, water remained on the floodplain for long enough for conditions to be suitable for Carp to spawn and to survive as juveniles. The risk associated with a managed flow event, is that if Carp spawn during the event and water remains on the floodplain (not drying out) before a natural inflow occurs, it will allow export of Carp into the surrounding river system. Carp management is a priority when delivering water to Gunbower Forest wetlands, however decisions on the timing and volume of wetland deliveries can sometimes result in trade-off between competing objectives (e.g. managing Carp while achieving vegetation and waterbird outcomes). Each watering event needs to consider these competing objectives within ecological and operational constraints.

5.1 Recommendations for future monitoring and options to mitigate Carp

The following recommendations focus on options for Carp management within the Little Gunbower Creek complex, as well as how to build on existing Carp management actions. They include:

Little Gunbower Creek complex

The primary recommendation for Carp management based on this study is:

- Investigate options for removal of adult Carp from the Little Gunbower Creek Regulator pool during periods of low flows, such as:
 - Pumping the refuge pool down and then removing Carp via electrofishing and netting.
 - Trial an intensive (electrofishing/netting) elimination study prior to pumping. The intensive study may find it is practical to remove all (enough) of the standing stock of Carp and may be cheaper than pumping. It may also be able to be used in areas where pumping cannot occur.
 - After a large natural flood event, netting and electrofishing should be used to determine whether carp need to be removed from the system again.

Additional recommendations:

- Investigate Carp trapping (and subsequent removal) in the channel between the refuge pool and the Little Gunbower Creek Channel 1 site during inundation events. Ideally this would be before the split which leads to Little Gunbower Creek Channel 3 site. This study showed that Carp constantly move to and from the refuge pool during a managed flow. This recommendation is only for when Carp cannot be removed from refuge pool prior to a managed watering event.
- Investigate construction of a removable fence barrier within the Little Gunbower Creek Channel between the refuge pool and Little Gunbower Creek site prior to the next managed watering event. This would restrict Carp from entering most of the Little Gunbower Creek complex as well as restrict potential spawning to the Little Gunbower Creek Regulator refuge pool. This recommendation is only for when Carp cannot be removed from refuge pool prior to a managed watering event.
- Determine the extent of Carp spawning on the floodplain during managed flow events and the level of recruitment that occurs.
- Investigate the conditions that lead to the proliferation of Carp in the Little Gunbower Creek complex between 2008 and 2012.

Build knowledge base to inform management options across the Gunbower Forest

- Further investigate water flow across the floodplain to enable better management of regulators and potentially identify additional management options. Determine the flow rates required from Barham Cut to connect with the Little Gunbower Creek complex and flows required to connect Little Gunbower Creek complex to Three Corner Hole.
- Continue current Carp management strategies including identification of other potential refuge habitats for potential Carp control. i.e. Spur Creek.
- Install additional receivers and tag more Carp in the forest to further clarify the location of Carp movement pathways and refuge habitats, particularly for upstream areas in the Gunbower Forest.
- Continue to improve exclusion fences around key wetlands i.e. Reedy Lagoon.
- Expand the Carp monitoring program to provide data on Carp population dynamics (Gunbower Forest and Murray River populations), and their responses to interventions such as managed flows. This program would involve surveys of the forest and surrounding waterbodies (i.e. Murray River and Gunbower Creek), tagging of juvenile Carp and analysis of otoliths. The data would inform management and support the validation, calibration and future refinement of the Carp population model.

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