



ACT
Government

Lake Burley Griffin Fisheries Survey 2024



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Cover Photo: Large adult Murray Cod being revived next to the boat during the 2024 Lake Burley Griffin fisheries survey.

This project was undertaken by the Office of Nature Conservation, Environment Planning and Sustainable Development Directorate, ACT Government, for the National Capital Authority on Ngunnawal country.

EXECUTIVE SUMMARY

The National Capital Authority engaged the Office of Nature Conservation, within the Environment, Planning and Sustainable Development Directorate of the ACT Government, to undertake a fisheries survey of Lake Burley Griffin. Six sites were surveyed using boat-based electrofishing from November 2023 to January 2024. This survey follows on from surveys in 2017 and 2012.

A total of 204 fish from four species and one hybrid were caught in the 2023/24 survey. The fish community was dominated by exotic pest species, Carp and Redfin. This is consistent with other large lakes in Canberra. Regarding native fish species, there was an increase in the number of Murray Cod. Most were below the minimum size under the ACT Fisheries regulation of 55 cm. These fish are a result of recent stockings and are likely to enter the adult fishery over the next 1-3 years. Golden Perch had reduced in number as fish from the large stocking in 2012 age out of the population. Unfortunately, no sub adult Golden Perch from recent stockings were recorded. It should be noted that this survey occurred before the stocking of approximately 50,000 Golden Perch fingerlings into the lake in January 2024.

Recommendations

- Continue the stocking on an annual basis alternating between Golden Perch and Murray Cod.
- Stock largest numbers possible, aiming for 60,000 Golden Perch or 40,000 Murray Cod per year.
- Investigate pre-release predator training to improve survival.
- Undertake periodic boat electrofishing surveys every 5 years to determine effectiveness of stocking and changes in the fish community.
- Support EPSDD Fisheries Conservation Officer position to continue education and enforcement of recreational anglers. This will increase the sustainability of the fishery, reduce likelihood of pest introductions, and improve access to fisheries information.
- Investigate improvement to the fish habitat within the lake and upstream.

INTRODUCTION AND BACKGROUND

The National Capital Authority (NCA) engaged the Office of Nature Conservation (ONC) unit within the Environment, Planning and Sustainable Development Directorate (EPSDD) of the ACT Government to undertake a fisheries survey of Lake Burley Griffin in Spring to Summer 2023/24.

Lake Burley Griffin was formed by the damming of the Molonglo River in 1964. The lake has a mean depth of 4.0 m and a maximum depth of 17.6 m at Scrivener Dam. The lakes surface area of 634 hectares and shoreline length of 33.3 kilometres, makes it the largest urban lake in the ACT (National Capital Planning Authority 1995). The Molonglo River as part of the upper Murrumbidgee catchment historically held populations of a number of native fish species including Murray Cod (Mangi¹ in Ngunnawal) *Maccullochella pealii*, Macquarie Perch (Gubay) *Macquaria australasica*, Golden Perch *Macquaria ambigua* and Trout Cod (Gudu) *Maccullochella macquariensis* (Lintermans 2002, Trueman 2011). Trout were introduced to the catchment in the late 1800s. However, the collapse of mine tailings dams in Captains Flat in the 1930's, 1950's and 1960's resulted in the loss of fish from the Molonglo River (Lintermans 2002). Stocking of Lake Burley Griffin has been undertaken regularly since its construction in 1964. Rainbow Trout *Oncorhynchus mykiss* and Brown Trout *Salmo trutta* formed the majority of stockings up until the 1980's, when supply of native Murray Cod and Golden Perch became more available. Other species in the lake today include pest species such as Carp *Cyprinus carpio*, Redfin *Perca fluviatilis* and Gambusia *Gambusia holbrooki*, as well as smaller native fish, Western Carp Gudgeon *Hypseleotris klunzingeri* and Australian Smelt *Retropinna semoni* (Lintermans 2002).

Stocking in the ACT, including Lake Burley Griffin, is guided by the ACT and Regional Stocking Plan (ACT Government 2022). The plan details policies on stocking urban lakes for biodiversity and recreational benefits. Trout stocking has been discontinued in the ACT due to the very poor survival of stocked trout and the impact they can have on native fish communities. The last trout stocking into Lake Burley Griffin was 2003, though NSW Department of Primary Industries continue to stock trout in the Molonglo and Queanbeyan River in proximity to Lake Burley Griffin as well as in Googong Reservoir and the upper Molonglo and Queanbeyan Rivers. Despite these actions no trout have been detected in surveys and very few have been reported captured in or near the ACT urban lakes in the last 30 years. Stocking history for Lake Burley Griffin since 2004 is shown in Figure 1.

¹ Ngunnawal language provided by the Winanggaay Ngunnawal Language Group.

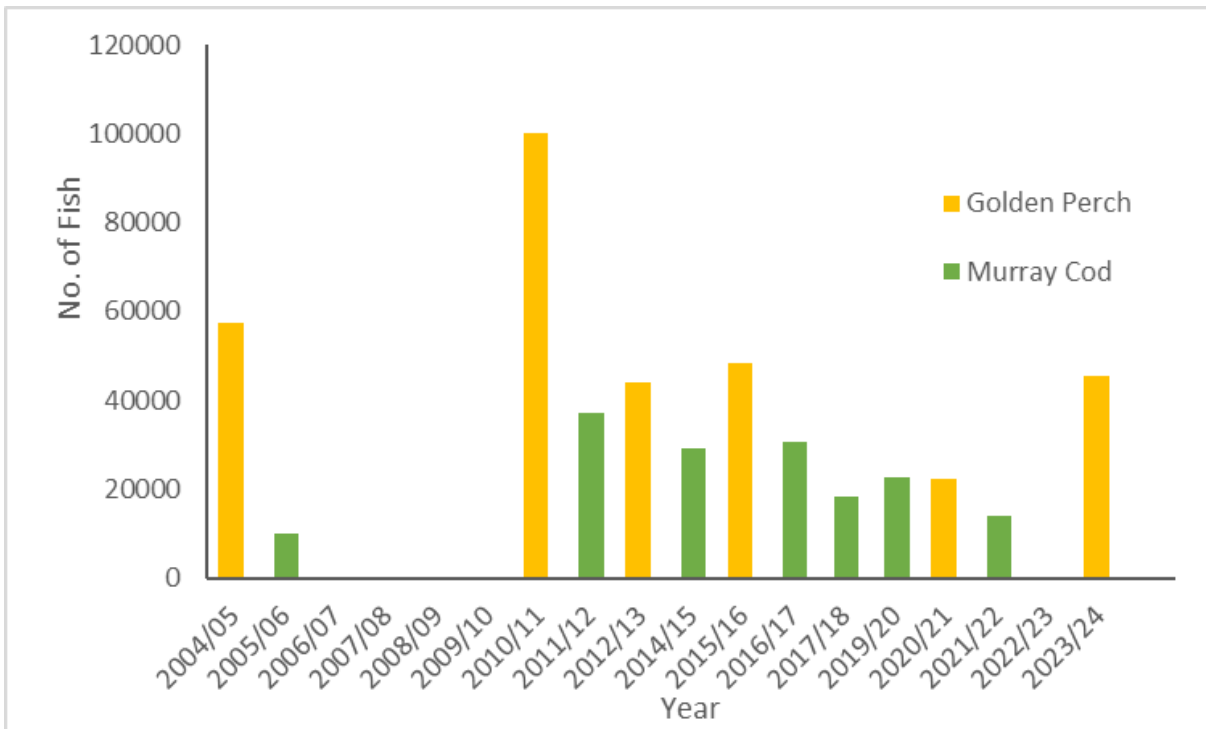


Figure 1. Stocking history in Lake Burley Griffin 2004-2024.

The previous surveys of the lake demonstrated that the large bodied native fish population of the lake is almost entirely dependent upon stocking (ACT Gov. 2012). In lakes habitats, despite native fish attempting to breed, the conditions for completing successful breeding are generally not available. This is consistent across all urban lakes in the ACT and more broadly across the Murray Darling Basin for Murray Cod and Golden Perch in reservoirs. Therefore, continued stocking of fish is required for there to be a native fish population in these lakes. A population of large native fish provides a top predator to the system, which assists biodiversity, places predation pressure on pest species, such as Carp and Redfin, and also creates a recreational resource for anglers.

Lake Burley Griffin is popular for recreational fishing and was the most popular fishery in the local region with 68% of anglers reporting fishing there in the 2015 social survey for the Healthy Waterways Program (Schirmer & Mylek 2016). Approximately 1 in 5 people fish in the ACT at least once a year. Murray Cod and Redfin were the most popular species to target, with the majority of anglers reported releasing native fish.

Since the 1990s the species within the lakes have been relatively stable with the population dominated by Carp and Redfin and stocked native species. In 2017 an Australian Bass, a fish native to the eastern coastal rivers of Australia, was recorded in both Lake Burley Griffin and Lake Ginninderra. This indicates that illegal stocking is still a risk to the ecology of the region's ecosystems, including lakes and additional education and enforcement of anglers would be beneficial.

METHODS

A total of six sites were surveyed in 2023/24. These sites are shown in Figure 2. Due to equipment and staffing issues the survey was conducted from late November 2023 to mid January 2024.

Boat-based electrofishing was used to survey each site. A 5 kw Smith Root electrofishing boat with twin booms and one or two netters was used. At each site, 12 two minute shots of active electrofishing was performed with affected fish being netted from the water and placed into an aerated holding tank for processing. Fish observed but not caught and identifiable to species level were recorded for each shot.

Fish caught during each shot were identified to species level, measured to the nearest mm from the nose to the centre of the tail (Caudal fork length or total length dependent upon species tail shape). One side of each fish was also assessed for external abnormalities such as parasites or lesions. Biomass was estimated using the Murray Darling Basin Authority Sustainable Rivers Audit Biomass Estimator Tool (MDBA 2008). The Carp/Goldfish hybrids was estimated using the Carp measures from the biomass tool.

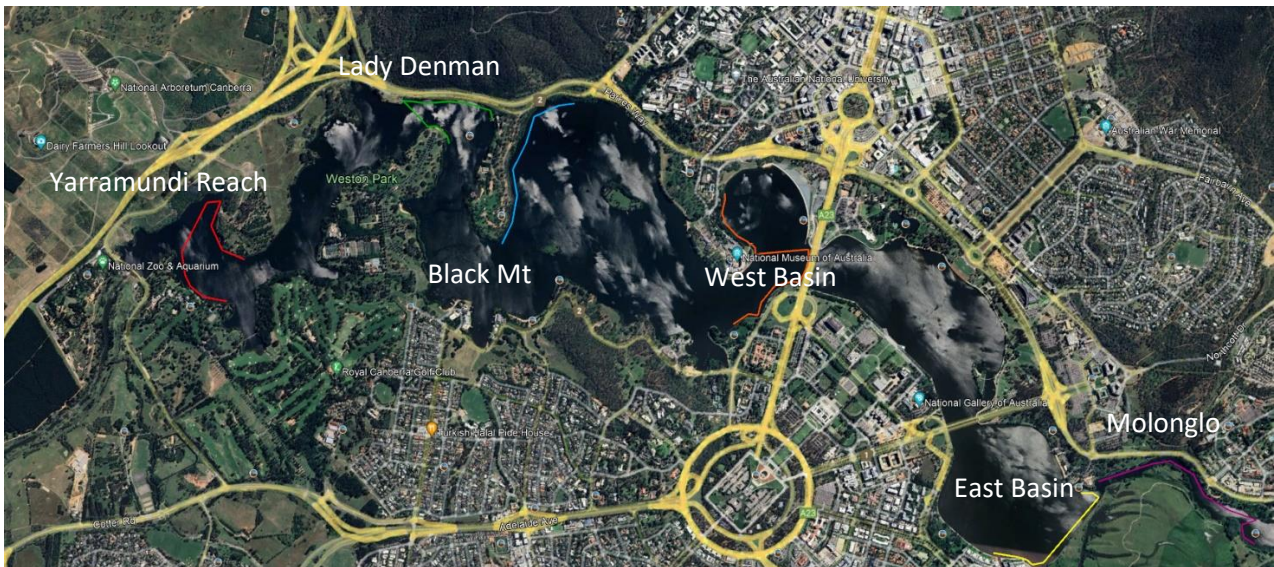


Figure 2. Map of sampling sites surveyed during the 2024 season.

RESULTS

Fish community

A total of 204 fish were caught over the six sites. The native species recorded were the stocked species, Murray Cod and Golden Perch. The two pest species, Carp and Redfin were the majority of individuals captured and the most widespread across sites. Two individuals were identified as Carp/Goldfish hybrids in the Molonglo Reach. The catch per site is listed in

Table 1.

Table 1. Summary of catch for the 2023/24 survey of Lake Burley Griffin.

Site	Date	Carp	Golden Perch	Murray Cod	Goldfish/ Carp Hybrid	Redfin
Yarramundi Reach	19/12/23	14	1			12
Lady Denman Drive	23/11/23	16	8	8		11
Black Mountain Peninsular	20/12/23	27				4
East Basin	21/12/23	41		2		4
West Basin	3/1/24	22				
Molonglo Reach	21/1/24	27		1	2	4

Carp were the most common species caught, totalling 72% of the overall catch, with Redfin the second most common species at 17% of the catch. Native species, Murray Cod and Golden Perch, totalled 9.8% of the catch.

In order to compare sites, the catch per unit effort (CPUE) as number of fish per electrofishing hour (Fish/EFhour) was calculated. The fish per hour is shown in Figure 3.

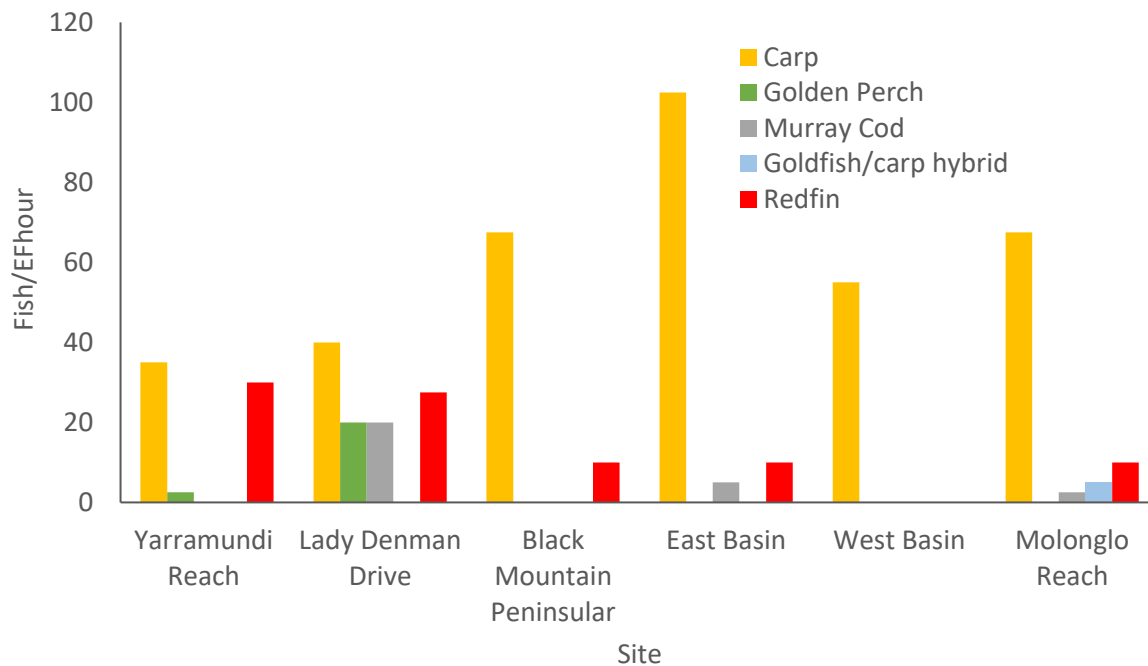


Figure 3. Comparison of CPUE of fish caught between sites for Lake Burley Griffin in 2023/24.

Lady Denman site had the highest catch of the native fish Golden Perch and Murray Cod. West Basin had the lowest diversity and number of fish with only Carp being recorded.

Two fish captured in the Molonglo Reach were identified as Carp/Goldfish hybrids. While not unknown, hybrids between Carp and Goldfish are rare. It is not known what influences the occurrence of these hybrids.

Biomass

In terms of biomass, Carp dominated with 86% of the overall biomass (Figure 4). Murray Cod and Golden Perch contributed 7% and 5% of the overall biomass respectively. Redfin do not provide a large proportion of the biomass as compared to the numbers because the majority of fish are small, young of year fish (fish spawned in Winter/Spring 2023) with an individual calculated average weight of 41 g. Murray Cod and Golden Perch comprised almost 50% of the biomass at the Lady Denman site but less than 20% at the other sites.

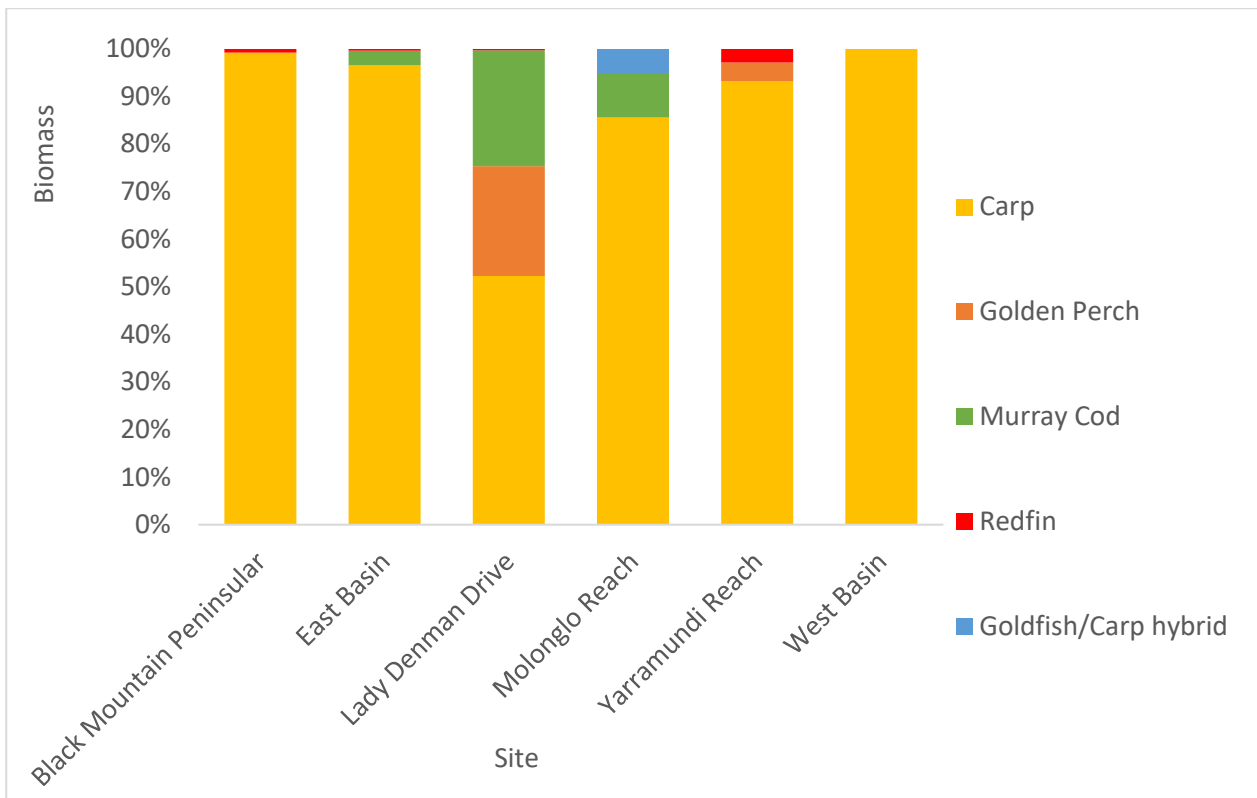


Figure 4. Comparison of the calculated fish biomass between sites for Lake Burley Griffin in 2023/24.

Length comparisons

The length frequency of the native species captured over all sites is shown in Figure 5. Murray Cod had two major of size cohorts, 250-300 mm and 450 mm in length. The largest Murray Cod recorded was 945 mm in length. Golden Perch only displayed one large age cohort with the majority being. 450-500 mm. The largest Golden Perch was 574 mm.

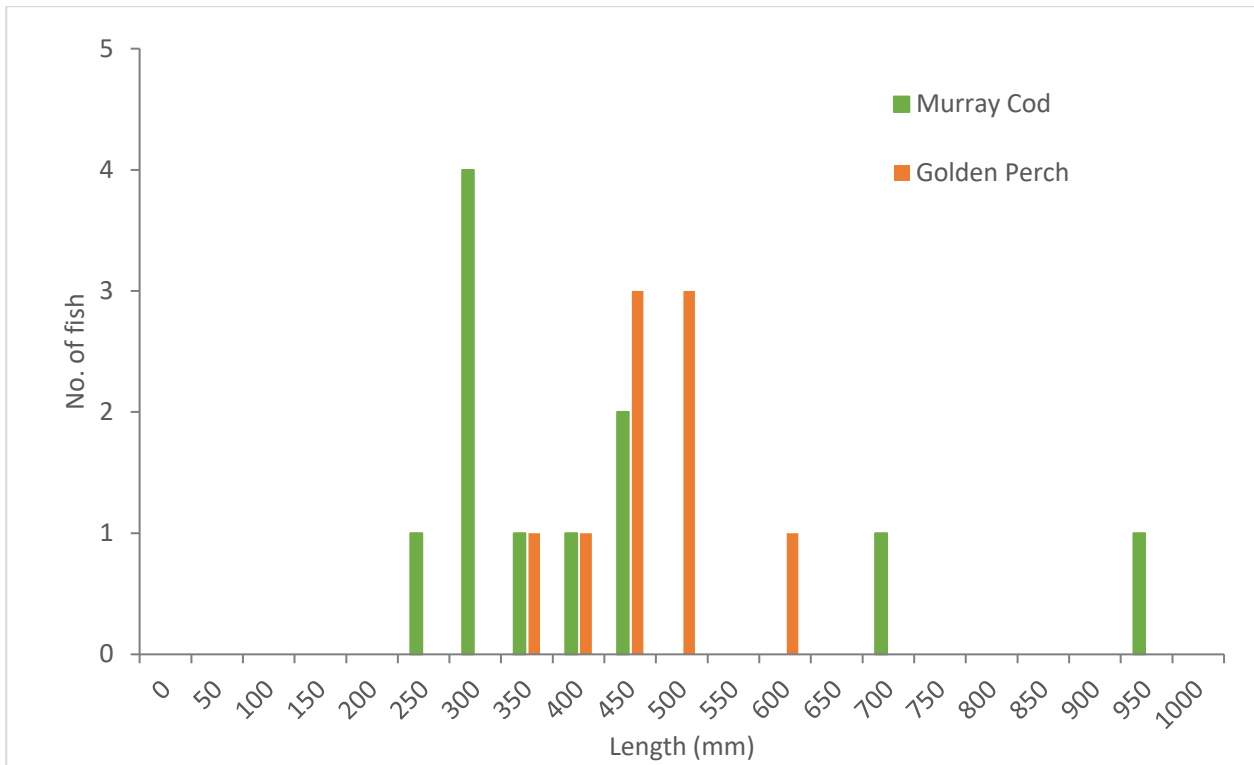


Figure 5. Length frequency for Murray Cod (Mangi) and Golden Perch from Lake Burley Griffin in 2023/34.

Carp showed one major cohort of adults 400- 700mm with a couple of young of year juveniles also recorded (Figure 6). The largest Carp caught was 665mm long.

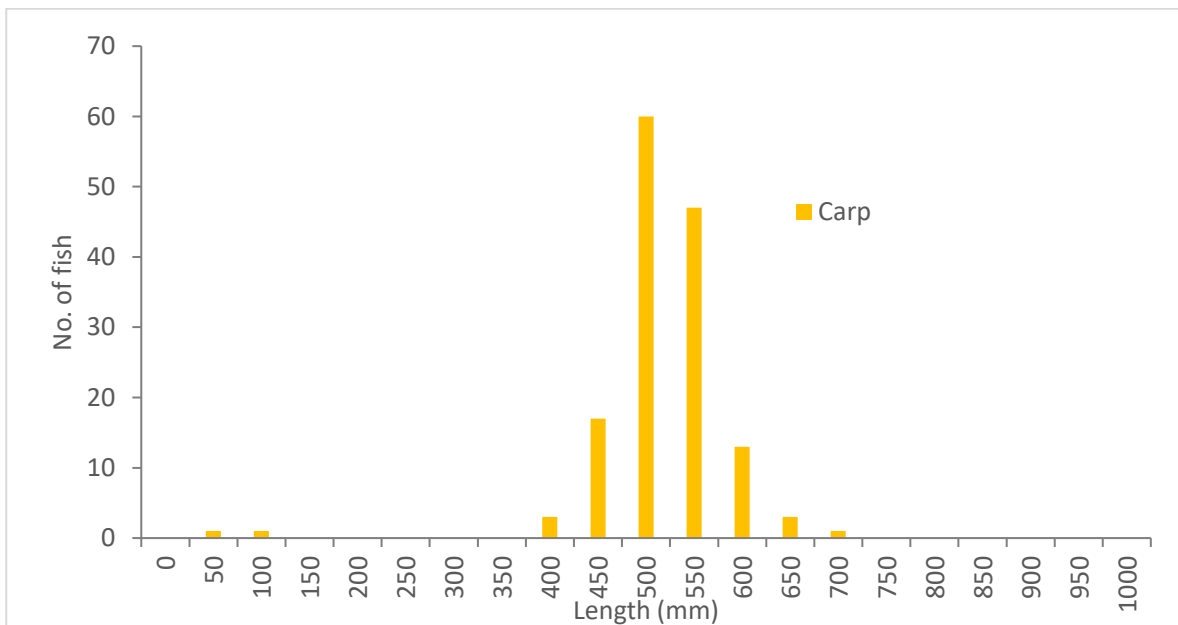


Figure 6. Length frequency of Carp from Lake Burley Griffin in 2023/24.

DISCUSSION

Fish caught

In 2023/4 the fish community of Lake Burley Griffin was dominated by the pest species Carp and Redfin. Most urban lakes in the ACT are dominated by one or both these two pest species of fish. It was encouraging to see good numbers of Murray Cod below 450mm indicating that there has been good recruitment from the stockings in 2021 and 2019 (Figure 7). However, the spatial distribution of Murray Cod was limited to 2 out of 6 sites.



Figure 7. Juvenile Murray Cod (Mangi) approximately 300 mm in length and likely to be 2 years old.

All Golden Perch were over the 300 mm recreational size limit, however, the size range was narrow, There were no sub adult or juvenile fish collected. Golden Perch can grow quickly and they can reach 300 mm in 2 to 3 years (ACT Gov. unpublished data, ACT Gov. 2012, Wright et. al. 2020, Mallen Cooper et. al. 2003). The cohort of 350-600 mm long most likely corresponds to fish greater than 4 years old (Figure 5 and Figure 8). This suggests that the stockings in the last few years have not been particularly successful. It should be noted that these surveys took place before the stocking of 45,000 Golden Perch in 2023/24. The 2023/24 stocking was much larger than those seen in recent years which averaged 20,000 fish and its success is not yet known. However, there is a lack of sub adult Golden Perch to replace the ageing cohort of large fish currently in the lake. It may mean that a gap in the Golden Perch population could occur before the current stocking, if successful, can grow to take its place.



Figure 8. A large Golden Perch almost 600 mm in length captured at Lake Burley Griffin.

Eleven Murray Cod were captured in 2023/24, an increase from the 3 caught in 2017. This included a cohort of sub adults of 250-300 mm which are likely to be 2-3 years old (Figure 7). There was also a number of fish just below the angling take slot limit. These fish were 450-500 mm and the angling take slot limit is 550-750 mm. These fish are likely to be 4 years old from the stocking in 2019/20. There was one Murray Cod within the recreational slot limit and one very large fish (945 mm) which had exceeded the slot (see front cover).

In 2017 the ACT Government released a Native Species Conservation Plan for Murray Cod, to guide management and improve the sustainability of this iconic species (ACT Gov. 2017). The slot limit is one of the measures to make the Murray Cod fishery more sustainable included in the plan and in alignment with other Basin jurisdictions. Murray Cod will be likely to grow through the slot limit in 3-5 years (ACT Gov. unpublished data). As Murray Cod can live for more than 20 years it is hoped that the slot limit will increase the numbers of large cod persisting in the fishery.

Two native small-bodied fish, Australian Smelt and Western Carp Gudgeon are known to occur in the lake but were not recorded in this survey. Electrofishing is not a particularly efficient method of collecting these small native species and their absences from this survey is not concerning. It should be noted that both species are prey for both pest and native larger fish species such as Redfin and Golden Perch.

As in previous surveys the majority of native fish in 2023/24 were recorded in the Lady Denman site. This site has an abundance of rock habitat as part of a retaining wall and snag habitat from the exotic willow trees that occur on the bank. The native fish captured at this site demonstrate the importance of rock and structural habitat. Additional habitat structures such as rock reefs, snags or artificial concrete reefs added to the lake could be successful in attracting and maintaining native fish in Lake Burley Griffin. Artificial fish habitats are very common in saltwater environments and are becoming more popular to increase fish stocks and survival in freshwater. The planning of these structures is critical to ensure that they do not impact other Lake users or infrastructure. Rock reef and snag piles can be located in low sedimentation areas, either from barges or from shore by crane or long reach excavators. Snags and constructed habitats may be to be anchored. This has been done in a number of local areas including some urban ponds, Cotter Dam and the Murrumbidgee River. Another option is to use commercially produced concrete fish

habitat structures such as reef . These have the benefit in that they are easier to remove if required and can be made in a variety of shapes to suit species, life stages and environments (Recfish west 2017). Previously, Reef balls have been used by the ACT Government in Yerrabi Pond and in the Molonglo Ski Reach upstream of Lake Burley Griffin.

This is the first time that Goldfish/Carp hybrids have been recorded in the electrofishing surveys of ACT waterways with two collected in the Molonglo Reach sampling (Figure 9). While this is notable, it isn't a particular concern for the ecology of the lake as the hybrids would have similar effects to the parent species, particularly carp which are abundant in the reach. It's not known what conditions promote the production of Goldfish/Carp hybrids or if they are sterile.



Figure 9. One of two hybrid Carp/Goldfish collected in the 2024 Lake Burley Griffin survey.

Comparisons with previous surveys

In terms of native species in comparison to the previous survey conducted in 2017, there was a reduction in the number of native fish. This was driven by the reduction in Golden Perch but was offset by the increase in sub adult Murray Cod (Figure 10). The reduction in Golden Perch is likely due to the ageing out of the population of fish from the very large stocking of 2011/12(Figure 1). These fish would now be 12-14 years old, having supported the fishery in recent years and caused the increase in Golden Perch seen in the 2017 survey.

Regarding pest fish species, the number of Carp caught was similar to the 2017 survey and Redfin numbers were greatly reduced (Figure 10). Redfin populations regularly fluctuate in the urban lakes and the Murrumbidgee River (ACT Gov unpublished data). The cause for this may be undetected outbreaks of Epizootic Haematopoietic Necrosis Virus (EHNV), which is known to occur in the region and affect predominantly Redfin. However, during the survey, large flocks of Black Cormorants were observed, and it is likely they were feeding on schools of juvenile redfin in the open water, where electro-fishing is not particularly effective.

In work done in 2017 for the National Carp Control Program research was undertaken on Carp biomass in the ACT as well as more broadly across Australia (ACT Gov 2017, Stuart et. al. 2021). This research estimated that densities of Carp in Lake Burley Griffin could exceed 350 kg/ha resulting in a total mass of Carp in Lake Burley Griffin of 220 tonnes of fish. The Federal Department of Agriculture has recently commenced a program to further investigate biocontrol of Carp following the recommendations of the National Carp Control Plan 2022 (FRDC 2022). Details can be found on the department's website and developments in biocontrol may eventually enable landscape scale control of this pest species.

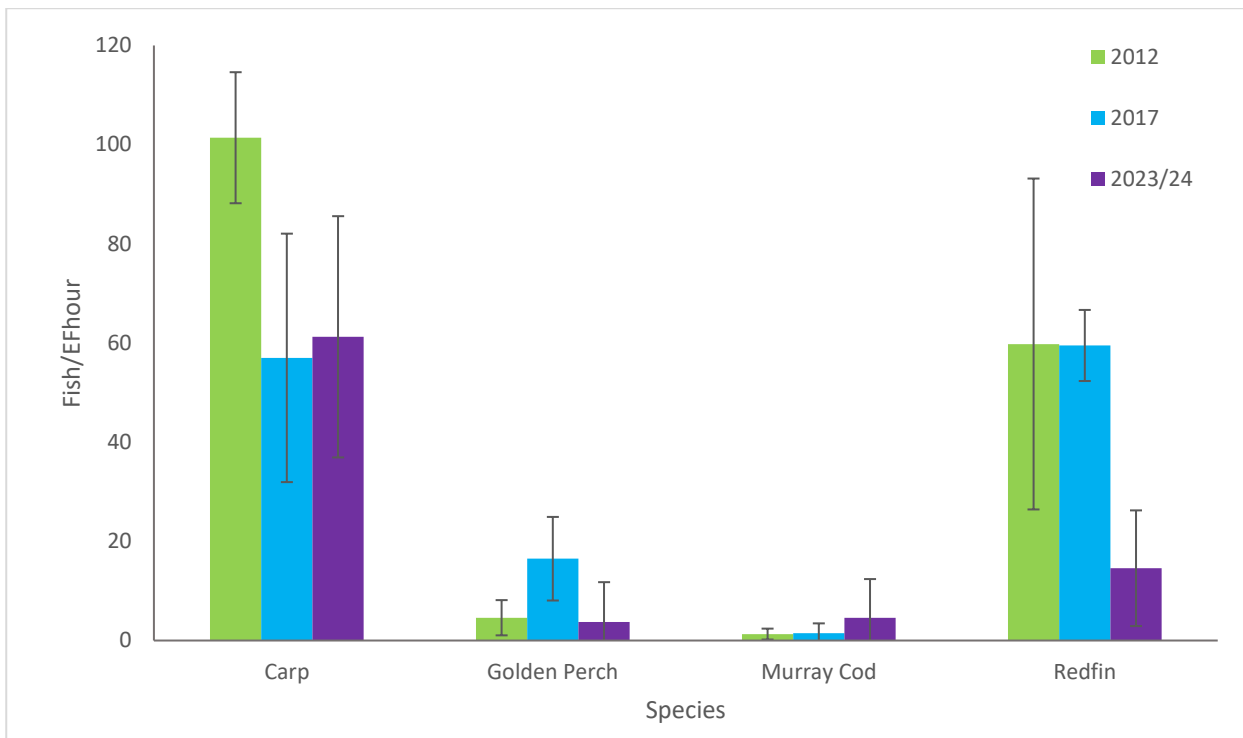


Figure 10. Comparison of average fish per shot between years 2012,2017 and 2023/24 for the major large bodied fish species. Error bars are Standard Deviation.

Stocking

The size structure of Golden Perch and Murray Cod indicates the need for ongoing follow up stocking to maintain a number of size classes within Lake Burley Griffin. Recently the ACT Government produced the 2022 ACT Regional Stocking Plan (Stocking Plan here after) to guide stocking in the four ACT Government managed lakes as well as Lake Burley Griffin and Googong in consultation with the NCA and NSW Department of Primary Industries. Responses on the draft Stocking Plan during public consultation included the desire to see more fish stocked into the urban lakes, as well as expanding the number of species stocked. The ACT Government plans to engage with recreational fishers to determine how these values can be incorporated into the urban fishery.

The Stocking Plan in general recommends stocking on a rotational basis with Murray Cod in one year followed by Golden Perch in the following year (ACT Government 2022). However, this strategy does have increased risk of gaps in the age and size structure of either species should a stocking event fail or not be undertaken. Stocking events can fail to recruit into the fish community of the lake for a number of reasons, including adverse environmental conditions, such as periods of cold weather or floods, as well as interactions with other species, such as, excessive predation or disease. It takes 3 years for Golden Perch and 5 years for Murray Cod to grow to adult size. This lag time means that large gaps or failures in stocking are not apparent to the recreational angler for a number of years. Due to the longevity of these species, 8-15 years for Golden Perch and more than 20 years for Murray Cod, any gaps can continue to impact the recreational fishery for many years.

In general, annual rotational stocking has taken place in Lake Burley Griffin (Figure 1) with only one year of no stocking (2022 where supplies were not available) and stocking of Murray Cod consecutively 2017 to 2019. This helped bolster the number of Murray Cod while the Golden Perch population was supported by

previous high stocking events. However, given the results of the current survey, particularly the absence of sub adult Golden Perch, it is recommended that gap years, where no stocking is undertaken, should be avoided and species be alternated.

Given the size of Lake Burley Griffin it is recommended that the target for stocking be at least 40,000 Murray Cod or 60,000 Golden Perch. Stocking numbers of less than 20,000 fish would be unlikely to achieve significant biodiversity or recreational benefits particularly in years where there are large numbers of predatory Redfin present. Repeated annual stockings of over 40,000 are likely to develop a fish population with a range of size classes. A spread of size classes is likely to provide a more robust fishery both recreationally and in biodiversity effects.

It may be unachievable to boost stocking numbers significantly, particularly with increasing costs of fingerlings. There are potential options to increase survival which could be investigated such as predator training or addition of habitat structures.

This survey indicated large numbers of Redfin, which are known to be particularly predatory on juvenile fish. Predator avoidance training of fingerlings has been shown to increase survival of stocked fish in heavily predated waterways (Hutchison et. al. 2022). This generally involves short periods (1-3 days) being exposed to small numbers of the main predator in a tank setting with available cover and/or separation. This exposure trains the hatchery bred fish to avoid predators and results in increases in survival for the stocked fish on release. At first, a trial would be recommended to undertaken on a smaller lake than Lake Burley Griffin. This would allow the process to be developed and use the existing ACT government infrastructure.

Additional structural habitat in the form of rock reefs or artificial structures may also improve juvenile survival and holding capacity for adults. These structures can be similar to the erosion protection rock at the Lady Denman site, which held the most native fish in this survey. Alternatively, a number of types of commercial concrete reef structures have been widely used in marine habitats and their utility for freshwater environments is growing. These have been successfully used in Yerrabi Pond and the Molonglo Ski reach. Their major advantage is that they are more easily removable should they cause conflict with other waterway users. Re snagging is also a common freshwater habitat rehabilitation technique. This technique can be seen as more difficult due to the potential for the snags to become mobile. With any of these techniques careful planning is essential to minimise the risk of problems and maximise the gains to the native fish community.

Fisheries Management

In 2023 the ONC was successful in obtaining a Conservation Fisheries Officer for 2 years as part of the Conserving Canberra Program funded by the ACT Government. This position is to undertake education and engagement with anglers and develop and undertake enforcement activities in the ACT.

It is hoped that this initiative will increase understanding and compliance with the fisheries rules and regulations, improving the conservation and sustainability of the aquatic ecosystems of the ACT. Unfortunately, at this stage, this is a temporary position and support will be required for these actions to continue into the longer term. Despite only starting in late 2023 there has been a significant number of engagement and enforcement activities already undertaken including weekend actions on Lake Burley Griffin and other waterways as well as presentations to major fishing clubs.



Figure 11. ACT Government Fisheries Conservation Officer undertaking a weekend engagement and enforcement activity with local anglers on Lake Burley Griffin.

CONCLUSIONS AND RECOMENDATIONS

The fish community of Lake Burley Griffin shows similar species composition and dominance as other large lakes in the ACT. The number and biomass of Murray Cod has increased, indicating successful stocking outcomes over the last 5 years. However, with the exception of January 2024 which cannot yet be assessed, the stockings of Golden Perch have been much less successful.

The CPUE of Carp has remained similar to 2017 and is also similar to other ACT Lakes. From work done in the National Carp Control Program and other waterways in the ACT, Lake Burley Griffin could contain over 220 tonnes of Carp. However, this number should be viewed with caution as only small areas of the lake were sampled compared to the overall surface and the estimates have wide margins of probability.

Recommendations to maintain the status and management of the fish community of Lake Burley Griffin collaboratively between the NCA and ONC include:

- Continue the stocking program on an annual basis alternating between Golden Perch and Murray Cod. Aim for at least 40000 fish each year;
- Undertake periodic boat electrofishing surveys (every 5 years) to determine effectiveness of stocking and changes in the fish community;
- Investigate improvement to the fish habitat within the lake and upstream Investigate pre-release predator training to enhance survival of stocked fish;
- Support the continuation of the Fisheries Conservation Officer in ONC through reporting and collaboration;
- Monitor the outcomes of education and enforcement activities to manage the sustainability of stocked fish and prevent illegal activities; and
- Engage in fisheries working group with ONC.

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GLOSSARY

Active survey method	Survey method which employs mobile survey method to collect fish.
Alien species	A non native species which has established a self sustaining population in the wild. Largely replaces the use of exotic species in freshwater aquatic ecosystems.
Base Flow	Nominal short term flow volume required to prevent permanent damage to the river. Generally represented by the flow during droughts and nominally the 80th%ile.
Benthic	Associated with the substrate.
Biomass	Total weight fish, species or community (eg native biomass) irrespective of number with an area or sampling unit eg shot, site, ha.
Calcein	Florescent chemical which can be safely used to mark batches of juvenile fish.
Cohort	Bounded age or size class that generally is representative of a single recruitment event or season.
CPUE	Catch Per Unit Effort. Number or kg of fish per sampling unit usually hour, minute or shot of electrofishing or Net/night
Crepuscular	Active at sunrise and sunset
Demersal	Sinking, bottom dwelling.
Diel	A period of 24 hours
Ecological Threshold	The point at which long term ecosystem or population change (usually negative) is unavoidable and recovery is difficult or unachievable.
EHN virus	Epizootic Hemipogic Necrosis Virus carried by Redfin and Trout and other fish and can cause mass mortality in native species such as Macquarie Perch.
Endangered	A species listed in the ACT or federally as Endangered under the NC Act or EPBC Act
Environmental flow	Flow provided or protected for an environmental purpose.
Genetic population size	Calculated number of effectively breeding individuals.
Larval Drift	Period of time in which newly hatch larval fish of some species move downstream with the river flow.
LBG	Lake Burley Griffin
Lentic	Refers to static water (Lakes).
Lernea	A copepod parasite which infect native and pest fish in the Canberra region
Lotic	Refers to flowing waters (Rivers).
Management Threshold or Trigger value	A limit on a measurable variable which if exceeded leads to other management actions.
NCA	National Capital Authority
Otolith	Ear bone of a fish which can be extracted and examined for age and other life history information.
ONC	Office of Nature Conservation, ACT Government
Passive survey method	Survey method which requires fish to move into stationary collection equipment.
Pelagic	Dwelling in open water.
Pest	Species listed under the Pest Plant and Animal Act
Pool Maintenance flow	Flow volume required to maintain the geomorphic stability of pools.
Population	Group of a species which interbreed and inhabit a defined area.
Refuge habitat	Habitat that provides shelter from threats or extreme events such as high flow or drought.
Special purpose flow	Flow release for a defined purpose such as to prepare riffles for spawning, prolong a natural high flow, facilitate access through riffle habitat or assist larval drift.
Threatened	Species listed in a state territory or federal jurisdiction for conservation protection
Young of year (YOY)	Fish spawned in the current years breeding season.
Vulnerable	A species listed in the ACT or federally as Vulnerable under the NC Act or EPBC Act