Lake Burley Griffin Fisheries Survey 2017

Matt Beitzel, Lisa Evans & Mark Jekabsons

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Authors: Matt Beitzel, Lisa Evans & Mark Jekabsons.

Produced by: Conservation Research

Environment, Planning and Sustainable Development Directorate
ACT Government

Contact: Matt Beitzel

Telephone: (02) 6205 6755

Facsimile: (02) 6207 2122

Reviewed by: Lisa Evans

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1 EXECUTIVE SUMMARY

The National Capital Authority engaged the Conservation Research within the Environment, Planning and Sustainable Development Directorate of the ACT Government to undertake a fisheries survey of Lake Burley Griffin. Five sites were surveyed using boat based electrofishing in November and December 2017. This is the second survey of the lake using boat based electrofishing with the previous survey being undertaken in 2012. Electrofishing has been shown to be much faster and have much lower bycatch and mortality than the previous method of gill netting which was used prior to 2009. The ACT Government replaced gill netting with electrofishing for all urban lake surveys in 2009.

A total of 271 fish from six species were caught in the 2017 survey. The fish community was dominated by exotic pest species, Carp and Redfin, with 42% of the total number of fish caught being Carp. This is consistent with other large lakes in Canberra, however, in comparison to the previous survey of Lake Burley Griffin in 2012 it was shown that there was a significant reduction in Carp catch per unit effort. Recent work by the ACT Government on total Carp biomass in smaller urban ponds suggests that Lake Burley Griffin could contain over 350 tonnes of Carp. Although caution should be used in this comparison as it is likely that large lakes like Lake Burley Griffin and the smaller ponds operate differently in terms of fish populations and survey effectiveness. Additional research is underway as part of the National Carp Control Plan to address these issues.

In regards to native fish species, 33 Golden Perch were caught, resulting 22% of the biomass being Golden Perch. This is a significant increase over the 2012 survey where 5.6% of the biomass was Golden Perch. This results demonstrates the survival and growth of the stockings since 2011. However, the size range was limited, with all fish being over the recreational size limit of 300 mm, and a maximum length of 502 mm. No subadults were recorded which indicates that the most recent stocking of Golden Perch, of 48,000 fish in 2015, may not have been successful.

Only three Murray Cod were captured which was not an increase over the previous survey and only the largest cod was within the recreational size limit of 550-650 mm. The other two fish were subadult, probably from the more recent stocking in 2014 and 2017. Larger stockings of Murray Cod may prove to be more successful.

One other native fish was recorded, an Australian Bass. This species is native to the coastal catchments of eastern Australia and is not native to the Murray Darling Basin. Its presence is evidence of illegal stocking in the Molonglo catchment. Although this species will be

unable to breed in Lake Burley Griffin its presence indicates the risk that illegal stocking presents in terms of inducing exotic and pest species and disease.

Recommendations

- Continue the stocking on an annual basis alternating between Golden Perch and Murray Cod. Include a gap year only if it can increase funds for later fish stocking.
- Stock largest numbers possible and or 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.
- Education and enforcement of recreational anglers to increase the sustainability of fishery and reduce likelihood of pest introductions.
- Investigate improvement to the fish habitat within the lake and upstream.

2 INTRODUCTION AND BACKGROUND

The National Capital Authority (NCA) engaged the Conservation Research (CR) unit within the Environment, Planning and Sustainable Development Directorate (EPSDD) of the ACT Government to undertake a fisheries survey of Lake Burley Griffin (LBG) in Spring to Summer 2017/18.

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 surface area covered by the lake is 634 hectares and shoreline length is 33.3 kilometres (National Capital Planning Authority 1995). The Molonglo River and catchment historically held populations of a number of native fish species including Murray Cod *Maccullochella peelii peelii*, Macquarie Perch *Macquaria australasica*, Golden Perch *Macquaria ambigua* and Trout Cod *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 with Rainbow Trout *Oncorhynchusus mykiss* and Brown Trout *Salmo trutta* forming the majority of stockings up until the 1980's when supply of native Murray Cod and Golden Perch became more widely available. Other species in the lake today include pest species such a 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 LBG, is guided by the ACT and Regional Stocking Plan (ACT Government 2015). 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. Stocking history for LBG is shown in

Table 1.

Table 1. Stocking History in Lake Burley Griffin 1998 - 2018.

Year	Golden Perch	Murray Cod	Rainbow Trout
1998		30000	
1999	50000		
2000		25000	
2001			
2002			
2003			22250
2004			
2005	57575		
2006		10000	
2007			
2008			
2009			
2010			
2011	100000		
2012		37105	
2013	44067		
2014		29000	
2015	48210		
2016			
2017		30610	
2018		18413	

The previous survey of the lake in 2012 demonstrated that the large bodied native fish population of the lake is almost entirely dependent upon stocking (ACT Gov. 2012). It was also concluded that although numbers of native fish had fallen there were large Murray Cod and Golden Perch in the lake and that the recent stocking of 100,000 Golden Perch in 2011 had survived (ACT Gov. 2012). Prior to 2012, surveys of LBG have been conducted to determine success of stocking events, inform future stocking, monitor the pest fish populations, detect any contribution that natural recruitment has made to the fish community and assist in disease monitoring and detection. Since the 1990s the species within the lakes have been relatively stable with the population dominated by Carp and Redfin with numbers varying between years. Previous surveys have shown that Golden Perch from stocking were growing to approximately 400 mm in four years and generally living to 6-8 years of age but up to 13 years (Jekabsons and Lintermans 2006, ACT Gov 2012).

3 METHODS

A total of five sites were surveyed in 2017. These sites are shown in Figure 1.

Boat based electrofishing was used to survey each site. A 5 kw Smith Root electrofishing boat with twin booms and one netter was used. At each site 12 x 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) with the exception of Australian Bass *Macquaria novemaculeata* which was estimated following Harris (1987). Statistical comparisons with previous years data within species was undertaken through Wilcox Rank sum tests using Statistix 8.1 (2005)

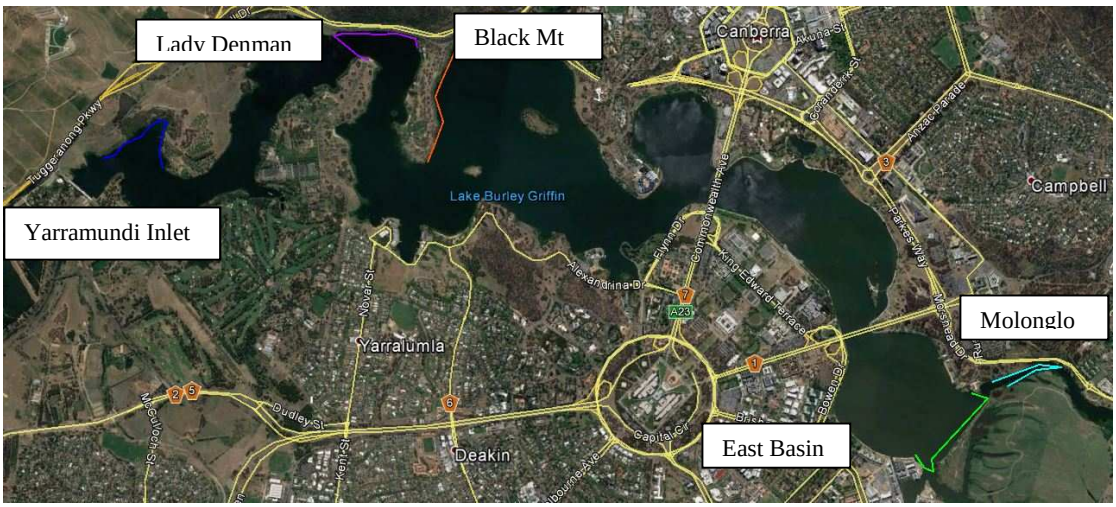

Figure 1. Map of sampling sites surveyed during the 2017 season.

4 RESULTS

4.1 Fish community

A total of 271 fish were caught over the five sites. Five species were caught comprising native species including Murray Cod and Golden Perch, and three pest species, Carp, Goldfish *Crassus auratus* and Redfin. The other species caught was an Australian Bass, which is not native to the Murray Darling Basin.

The catch per site is listed in Table 2. Summary of catch for the 2017 survey of Lake Burley Griffin.Table 2. It should be noted that large numbers of small Redfin were observed but not caught.

Table 2. Summary of catch for the 2017 survey of Lake Burley Griffin.

Site	Black Mountain		East Basin		Lady Denman Drive		Molonglo Reach		Yarramundi inlet		Total	
	Caught	Observed	Caught	Observed	Caught	Observed	Caught	Observed	Caught	Observed	Caught	Observed
Australian Bass	0	0	0	0	1	0	0	0	0	0	1	0
Carp	39	64	30	50	16	7	18	38	11	24	114	183
Golden Perch	7	5	5	1	13	3	5	3	3	2	33	14
Goldfish	0	0	0	0	0	0	0	0	1	0	1	0
Murray Cod	0	0	1	0	2	1	0	1	0	0	3	2
Redfin	25	292	25	95	25	113	18	74	26	712	119	1286
Total	**68**	**361**	**61**	**146**	**57**	**124**	**41**	**116**	**41**	**738**	**271**	**1485**

Redfin were the most common species caught totalling 43.9% of the overall catch with Carp the second most common species 42.1% of the catch. Native species totalled 13.3% of the catch, excluding the Australian Bass.

In order to compare sites, the catch per unit effort (CPUE)(number of fish per electrofishing hour) was calculated. The fish per hour is shown in Figure 2.

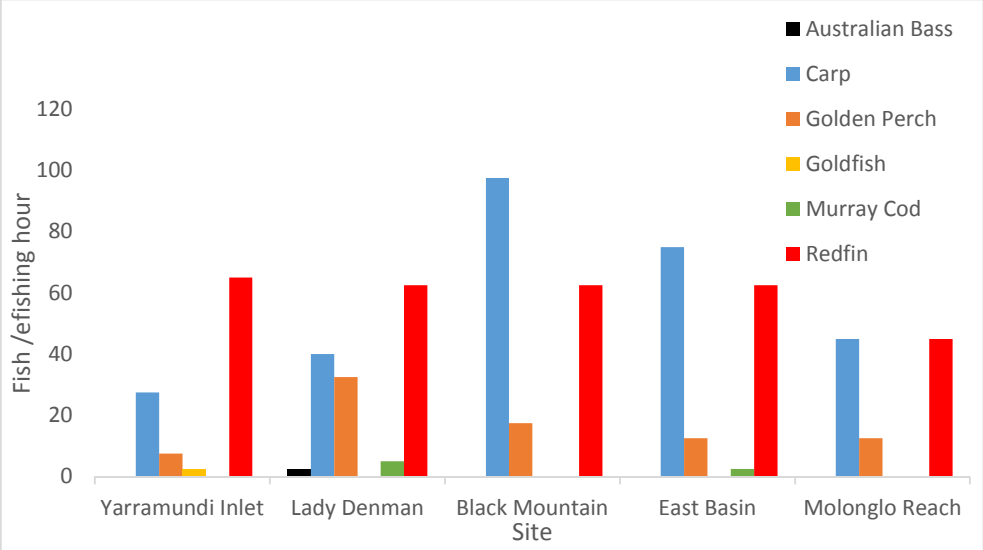

Figure 2. Comparison of number of fish caught between sites for Lake Burley Griffin in 2017.

Lady Denman site had by the highest catch of Golden Perch. Molonglo Reach and Yarramundi Inlet had the lowest number of fish overall. Note that the catch of Redfin is not representative of total numbers as a large proportion of small Redfin were observed but not captured. The ratio of caught to observed for the other species is less than 1:1.6 however the ratio of caught to observed for Redfin is greater than 1:10 (see Table 2).

4.2 Biomass

In terms of biomass, Carp dominated with 74.8% of the overall biomass (Figure 3). Golden Perch contributed 22% of the overall biomass with a calculated weight of 47 kg. Redfin do not provide a large proportion of the biomass as compared to the numbers because the majority of fish were small young of year fish (fish spawned in Winter/Spring 2017) with an individual calculated average weight of 15.15 g. However, as noted above this is an underestimate of biomass for Redfin because the number caught for measuring was a small proportion of the total number observed (see Table 2).

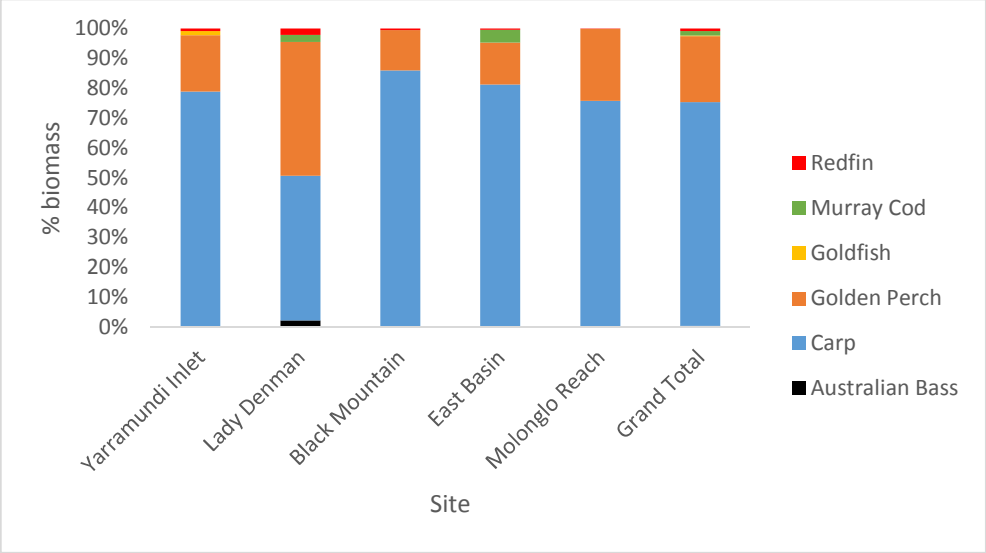

Figure 3. Comparison of the calculated fish biomass between sites for Lake Burley Griffin in 2017.

5 DISCUSSION

5.1 Fish Caught

In 2017 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. The number of native fish particularly Golden Perch contributing 22% of the biomass captured was encouraging. All Golden Perch were over the 300 mm recreational size limit, however, the size range was narrow, averaging 438 mm long with a maximum of 504 mm and a minimum of 391 mm (Figure 4). This corresponds to a calculated average weight of 1.4 kg and a maximum weight of 2.2 kg. There were no sub adult or juvenile fish collected. Golden Perch from 390-500 mm long may be from 4-10 years old (ACT Gov. unpublished data, ACT Gov. 2012, Mallen-Cooper 2003). This suggests that the most recent stocking in 2015/16, which could be expected to be 200-300 mm long, may not have survived.

Figure 4. Typical 400mm+ Golden Perch captured at Lake Burley Griffin 2017

Only three Murray Cod were captured. This included a juvenile fish of 160 mm, a sub adult of 430 mm and a small adult at 600 mm. The size of these fish correspond to fish of 1+, 3+ and 5+ years old and correspond well to the three most recent stockings of Murray Cod- 2016/2017; 2014/15 and 2011/12. Only the largest of these is within the current recreational slot limit of 550-650 mm. This shows the lag in time to allow fish to grow to recreational size. Murray Cod will be likely to grow through the slot limit in 3-5 years

(ACT Gov. unpublished data). 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). 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.

The Australian Bass which was recorded in the survey is not native to the Murrumbidgee Catchment (Figure 5). It is native to the eastern coastal catchments of NSW, southern QLD and Victoria. Its presence in Lake Burley Griffin is evidence of illegal stocking or release of aquarium fish. Australian Bass require access to estuaries to spawn and as such are not going to breed in the ACT. However, illegal stocking remains a threat through the introduction of pest species or disease that may impact on the native fish of the region.

Figure 5. Australian Bass (372mm CFL) captured in Lake Burley Griffin in 2017.

In 2015 ACT Government undertook a social survey of the ACT and surrounding councils as part of the Healthy Waterways Program which included a number of questions on fish and fishing (Schirmer & Mylek 2016). Approximately 1 in 5 people fish in the ACT at least once a year. Lake Burley Griffin is the most popular fishery in the local region with 68% of fishers report fishing in the lake. Other questions from the survey of relevance to the Lake Burley Griffin fishery include access to areas and fish stocks and bag limit changes. The majority of fishers 69% were satisfied with access to urban lakes. However, 32% were dissatisfied in the availability of fish stocks and 31% dissatisfied in the species available to target. High support was provided for the proposed size limit change for

Murray Cod to 550 mm – 650 mm slot limit and this was regulated under the ACT Fisheries Act in late 2016. Fishers were also asked if they caught the major recreational fish species and what they did with any fish caught. Seven percent of fishers reported catching and keeping Golden Perch and 24% reported catching and releasing this species. Interestingly very few recreational fishers, 2%, reported taking Murray Cod compared to 27% who report catching them and releasing them (Schirmer & Mylek 2016). Additional information on fisher's behaviour and goals is required on the reasons for release on each species and information at an individual waterway level.

The majority of native fish were recorded in the Lady Denman site. This site has an abundance of rock habitat as part of a retaining wall. This shows the importance of rock and structural habitat to native fish. The ACT Government has undertaken a project to add artificial habitat in the Molonglo River upstream of Lake Burley Griffin, in Yerrabi Pond and the Murrumbidgee River. These habitat structures have been successful in attracting large bodied native fish species and additional habitat structures such as rock reefs could be added to improve the habitat for native fish in Lake Burley Griffin.

5.2 Comparisons with previous surveys

In terms of large bodied species in comparison to the previous survey, it was observed that two species have dramatically different Catch per Unit Effort (CPUE) (Figure 6). The reduction in Carp numbers was significant ($p=0.001$) using a Wilcox rank sum test. The increase in Golden Perch numbers was also significant ($p=0.01$) using a Wilcox rank sum test. The reasons for the increase in Golden Perch has been discussed above and is due to the success of stocking events in 2011 and 2013 (see **Error! Reference source not found.**) The reasons for the reduction in Carp is less obvious and may be due to the timing of recruitment events or other environmental or stochastic factors.

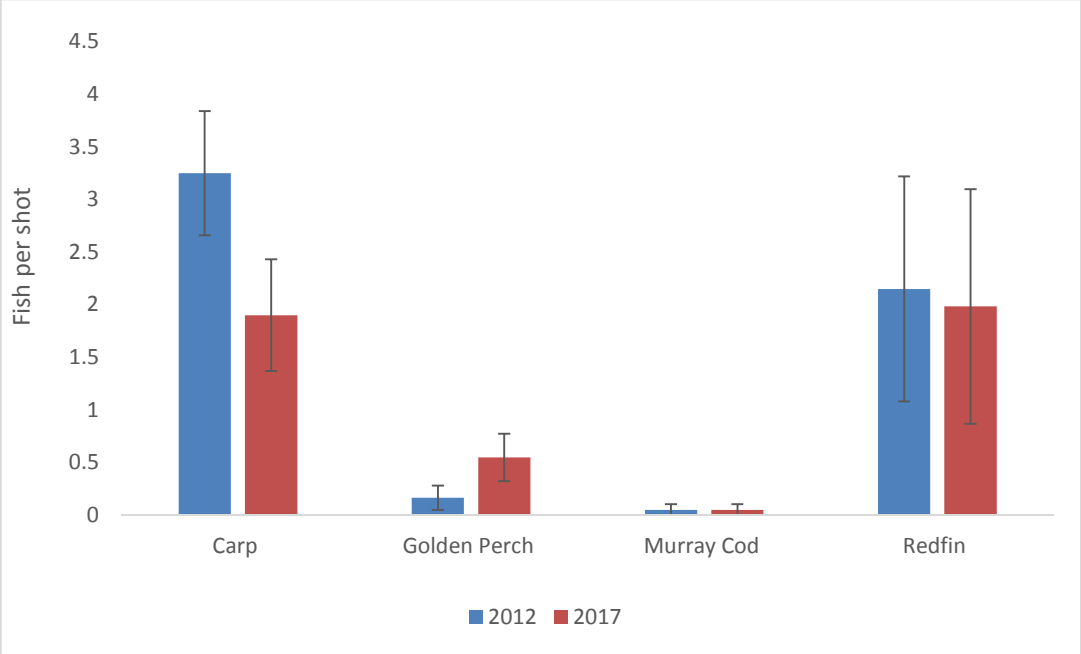

Figure 6 Comparison of overall fish per shot between 2012 and 2017 for the major large bodied fish species (95%CI)

The previous survey in 2012 recorded similar large bodied species to this survey, however the 2012 survey recorded two native small bodied fish that were not recorded in 2017, Australian Smelt and Western Carp Gudgeon. They formed a small proportion of the catch in 2012 and as electrofishing is not a particularly efficient method of collecting these small native species their absences from this survey is not concerning.

5.3 Carp densities

With the inception of the National Carp Control Plan (NCCP) in 2017, investigating the potential of the use of the Cyprinid Herpes Virus III as a tool for the biocontrol of Carp, the number and biomass of Carp in waterways has become of critical interest (NCCP 2017). In comparison to 2012 the relative catch of Carp was reduced in 2017 from 3.25 to 1.9 fish per shot (Figure 6).

Obtaining accurate total biomass or count data of fish for large waterbodies is difficult (Bajer & Sorensen 2012). The NCCP has commissioned work to develop a biomass estimate for Carp based on data from state fisheries jurisdictions including the ACT and this work should be completed towards the end of 2018. However in order to obtain a local estimate, in 2017 the ACT Government utilised the draining of two smaller urban ponds in southern Canberra to obtain estimates of biomass and relate that to pre draining electrofishing. Upper Stranger Pond and Isabella Pond had Carp densities of 380 and 588kg/ha respectively when drained in April 2017.

A comparison of the catch rate of Carp for selected waterbodies in the ACT in terms of cm of Carp per minute is shown below (Figure 7). It can be seen that in 2012 Lake Burley Griffin was at the highest catch per unit effort of all water bodies sampled at 78.5 cm of Carp/minute. However in 2017 the rate is much closer to other waterbodies in the ACT at 45 cm per minute. Using the drained lakes in green as a guide it could be estimated that Lake Burley Griffin as being close to Upper Stranger Pond which recorded a density of 588 kg/ha. Therefore Lake Burley Griffin could contain 372 tonnes of Carp. However, such results should be viewed with caution as the dynamics of the Carp population and the catch efficiency of the electrofishing may vary significantly between small and large lakes. The additional research from the NCCP should allow for more accurate prediction of Carp biomass in larger waterbodies (NCCP Biomass project).

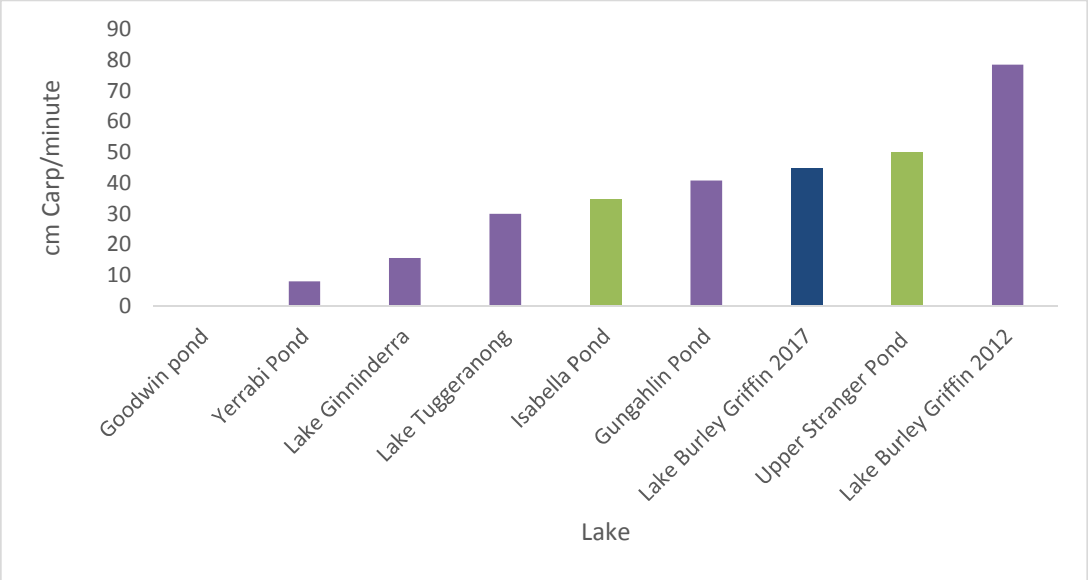

Figure 7. Relative Catch per unit effort (cm/minute) of Carp for sampled urban waterbodies in the ACT.

5.4 Stocking

The size structure of the Golden Perch and Murray Cod indicates the need for ongoing follow up stocking to maintain a number of size classes within LBG. The ACT Government developed a stocking policy to guide stocking in the four ACT Government managed lakes as well as LBG and Googong in consultation with the NCA and NSW fisheries. The plan in general recommends stocking on a rotational basis with Murray Cod in one year followed by Golden Perch in the following year and then a year of no stocking (ACT Government 2013). This maintains a stock composition that mimics natural systems where strong recruitment every year is not expected and maximises the number of fingerling of a species stocked in a year. However, this strategy does have increased risk of large 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, excessive predation or disease. It takes 3 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 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 will continue for several years after stocking is recommenced.

In 2012 it was proposed that the gap year not be included with stocking of Golden Perch and Murray Cod in successive years. In general this has taken place with only one year of no stocking and stocking of Murray Cod consecutively in 2017 and 2018. Given the results of the current survey, particularly the absence of sub adult Golden Perch, it is recommended that a gap year where no stocking is undertaken, not be continued into the future, unless the gap year can be used to increase stocking number in alternative years.

It may be unachievable to boost stocking numbers significantly, particularly with increasing costs of fingerlings. There are potential options to increase survival which may be investigated. 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.* 2012). 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 which increases in survival for the stocked fish. Alternatively additional structural habitat in the form of rock reefs may improve juvenile survival and holding capacity for adults.

Given the size of LBG it is recommended that targets for stockings of 40,000 Murray Cod and 60,000 Golden Perch be set. 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 Redfin present. This is likely to develop a fish population with a range of size classes in native fish. A spread of size classes is likely to provide a more robust fishery both recreationally and in biodiversity effects.

6 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 Golden Perch has increased significantly since the last survey in 2012 following the large stocking in 2011 and ongoing stocking. However, the most recent stocking may have failed.

A new species, Australian Bass, was detected in this survey. This species is native to the eastern coastal drainages and is evidence of illegal stocking. It is impossible for this species to breed in the ACT, however they are relatively long lived and may survive in Lake Burley Griffin or surrounding waters for over a decade.

The CPUE of Carp has significantly decreased compared to the previous survey bringing Lake Burley Griffin into line with other ACT Lakes. From work done on smaller waterways in the ACT, LBG could contain over 350 tonnes of Carp. However, this number should be viewed with caution.

Recommendations to maintain the status and management of the fish community of Lake Burley Griffin include:

- Continue the stocking program on an annual basis alternating between 60,000 Golden Perch and 40,000 Murray Cod if possible;
- Institute a gap year only if additional funds are available to significantly exceed these target numbers in subsequent stocking years.
- Undertake periodic boat electrofishing surveys (every 5 years) to determine effectiveness of stocking and changes in the fish community;
- Education and enforcement of recreational anglers to manage the sustainability of stocked fish and prevent illegal stocking;
- Investigate improvement to the fish habitat within the lake and upstream.

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8 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 reprehensive 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 Hemipoagic 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 Vulnerable under the NC Act or EPBC Act
Environmental flow	Flow provided or protected for an environmental purpose.
Founder effect	Reduction of genetic diversity through the origination of a population from a small genetic subsample either through stocking or natural processes.
Genetic Drift	Random stochastic process of fixation of genetic structure which can dramatically effects small population.
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.
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.
Otolith	Ear bone of a fish which can be extracted and examined for age and other life history information.
Passive survey method	Survey method which requires fish to move into stationary collection equipment.
Pelagic	Dwelling in open water.

Percentile Flow (%ile)	A flow level that is exceeded by the nominated percentage of time. i.e. 80th% flow is a flow volume that is exceeded 80 % of the time
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.
Riffle Maintenance flow	Flow volume required to maintain the geomorphic stability of riffles.
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

APPENDICES

Appendix 1 -Methods

Below are details on the sampling techniques employed throughout the survey program.

Boat electrofishing

Boat electrofishing was carried out with a 5 kW Smith-Root generator powered by a 40 Hp petrol-powered motor at sites with access to navigable pools. The boat was slowly driven along the river with one operator controlling the boat and electrofisher settings whilst the other team member controlled the passage of electric current into the water and dip netted affected fish. At each site a series of two minutes of on time replicates or 'shots' were carried out. A pulsed DC electric field is produced in the water through two electrode on a booms at the front of the boat (Cowx & Lamarque 1990). The boat used was a 4.8 m aluminium punt, which has been modified specifically for electrofishing. The boat is crewed by two people, one directing the boat and the other dip netting stunned fish. The electric DC current has a variety of output settings included: voltage and pulse settings, with a duty cycle range from 10% to 100% (in practice 40-80%). Amperage ranged from 1 to 7 amps depending on water conductivity and output settings. Settings are selected to maximise catch efficiency and minimise potential injuries to fish. All electrofishing operations were in accordance with the Australian Code of Electrofishing Practice (Anon. 1997). Stunned fish were placed in an aerated tank of water to recover before caudal fork length (CFL) or total length was recorded.

Processing

All fish collected were identified to species, measured to the nearest millimetre from the snout to caudal fork (CFL) or total length dependent upon tail shape, assessed for external abnormalities and released. Weight estimates were calculated by using the Murray Darling Basin Authorities Sustainable Rivers Audit Biomass Estimation Models (MDBA 2008).

Appendix 2 –Length Frequency

Following are the length frequency graphs for Carp, Murray Cod, Golden Perch (Figure 8) and Redfin (Figure 9) from 2017. Graphs show the number of individuals collected within a size range (CFL Range (mm)).

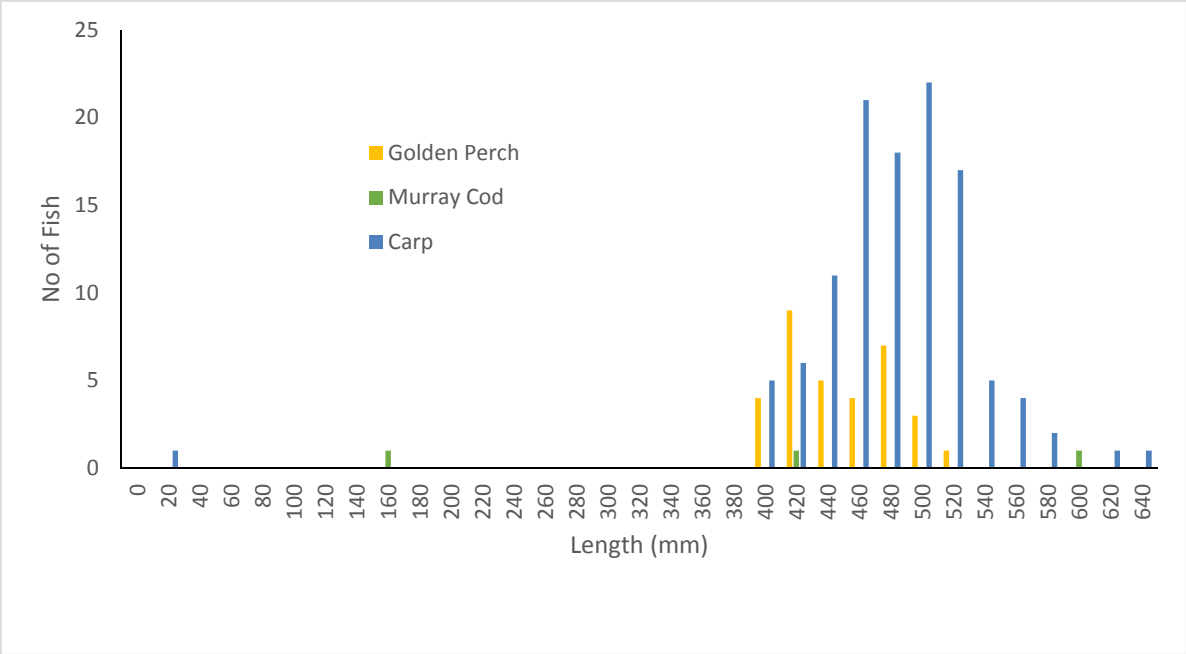

Figure 8 Length frequency for Carp, Golden Perch and Murray Cod from all site in the 2017 survey of Lake Burley Griffin.

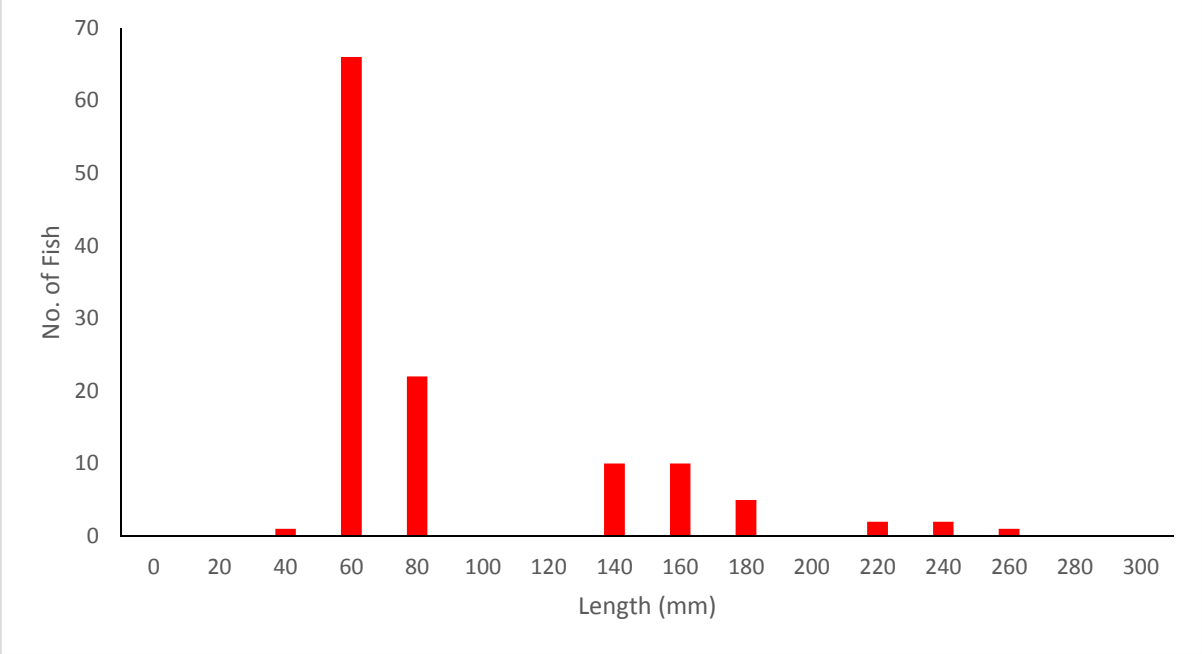

Figure 9 Length frequency for Redfin from all sites in the 2017 survey of Lake Burley Griffin.