Platypus in the Yanco Creek System

UNDERSTANDING DISTRIBUTION AND POPULATION STATUS

Dale McNeil and Josh Griffiths

REPORT TO THE YANCO CREEK AND TRIBUTARIES ADVISORY COUNCIL

CITATION

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INTRODUCTION

Aquatic ecosystems of the NSW Riverina have been significantly modified as a result of altered flow regimes due to water extraction, construction of reservoirs and reduced run-off, widespread land clearing for agriculture, invasive species (e.g., willows, carp), and reduced water quality. All of these factors are expected to have significant impacts on aquatic dependent fauna although the extent of declines is often unknown due to a lack of contemporary data for many species. In addition, the recent drought in western NSW has reduced overall flows and caused extended cease to flow events in many waterways.

The iconic platypus (*Ornithorhynchus anatinus*) inhabits a variety of aquatic ecosystems throughout eastern Australia from Tasmania to Cooktown (Grant, 1992). Due to their reliance on aquatic habitats, platypuses are potentially vulnerable to a range of threatening processes affecting freshwater systems. These include drought, river regulation, water extraction, land clearing, habitat fragmentation and introduced predators (Grant and Temple-Smith, 2003). However, there is currently no robust method for estimating platypus abundance (Grant and Temple-Smith, 2003), which hampers assessments of their population status and the impact of threatening processes. Live-trapping and standardised observation surveys are time and labour intensive, difficult to implement over large spatial scales, and may have poor sensitivity to detect the species at low abundance. Due to these difficulties in studying platypuses and the lack of long-term data, there is a very poor understanding of population trajectories at both a local and catchment scale across their range.

The species' conservation status was changed from Least Concern to Near Threatened by the International Union for the Conservation of Nature (IUCN) in 2016 due to mounting evidence of population declines and localised extinctions, predominantly in urban and agricultural areas (Woinarski et al., 2014; Woinarski and Burbidge, 2016). Platypus populations in Victoria are considered under the greatest stress with significant declines revealed through long term studies in the greater Melbourne region (Griffiths and Weeks 2011; Griffiths et al. 2017; Griffiths, van Rooyen, et al. 2018) and Wimmera Catchment (Mitrovski, 2008; Griffiths and Weeks, 2018; Griffiths, Van Rooyen, et al., 2016). As a result, the platypus was just listed as Vulnerable in Victoria (January 2021). A recent comprehensive, large scale assessment has revealed significant past and predicted declines across their range (Bino et al., 2020). Compounding these problems, the devastating bushfires that ravaged southeastern Australia during the 2019/20 summer have resulted in a significant decline in some of the healthiest platypus populations throughout the area (Griffiths et al., 2020).

Platypus in the Yanco Creek System

The Yanco Creek System (YCS) in the NSW Riverina has two sources, the Yanco Creek, which runs out of the Murrumbidgee at Gillenbah near Narrandera, and the Billabong Creek which has a large unregulated catchment area in the south west slopes encompassing, Henty, Culcairn, Holbrook and Walbundrie, north of Albury. The waters of the Yanco and Billabong Creeks converge upstream of Conargo and flow together to the Edward River at Moulamein and into the Murray River. The Yanco Creek also splits near Morundah to form the Colombo Creek, which flows in a southerly direction to meet the Billabong Creek near Urana. The creek system is complex and has many anabranching creek systems, floodplains and peripheral wetland systems.

There are several historical records of platypus within the Billabong and Yanco Creek system (Atlas of Living Australia) however there is no further information about the extent or size of the population. No detailed assessment of the population has ever been conducted. The community and landholders of the Yanco Creek System value the resident platypus population and the iconic species has been used by the community to argue the need to maintain perennial flows (Figure 2). In 2017, an injured platypus was rescued from the Colombo Creek and sent to Taronga Zoo for veterinary care. This rescue re-iterated the vulnerability of platypus in the system and highlighted the lack of knowledge around where, and how many platypuses reside in the creek system. In 2020 the Yanco Creek and Tributaries Advisory Council (YACTAC) highlighted the need to better understand the ecology of platypus in the creek system, including this as a priority objective in the Yanco Creek System Strategic Plan (McNeil and Thompson, 2020).

There is an emerging appreciation of the role that citizen science – scientific data collected by the community – has to play in threatened species conservation in Australia, especially when a clear research objective is defined (Stevens et al., 2019). Community derived observational data has been successfully utilised to build knowledge of platypus populations in the Huon Valley in Tasmania (Otely, 2001) and Bellinger Catchment, NSW (Lunney et al., 2004). To better utilise the community knowledge held within the Yanco Creek System Community, engagement with landholders and the collection and collation of sightings may prove a very reliable source of data. Combined with systematic environmental DNA (eDNA) surveys, community data is likely to add significantly to our understanding of the platypus population.

AIMS

This study aims to establish the distribution of platypuses throughout the Yanco Creek System, including the Colombo and Billabong Creeks. Platypus occurrence will be determined through eDNA analysis of water samples taken at a large number of sites throughout the catchment. Environmental DNA (eDNA) is a relatively new, cheap, quick and non-invasive method for detecting species through genetic material that an organism leaves behind in its environment (Rees et al., 2014; McColl-Gausden et al., 2019; Thomsen and Willerslev, 2015). Quantitative comparisons with traditional sampling methods indicate that eDNA methods can be superior in terms of sensitivity and cost efficiency, particularly for scarce, elusive or cryptic species (Biggs et al., 2015; Smart et al., 2015; Thomsen et al., 2012; Valentini et al., 2016), such as platypus (Lugg et al., 2018).
Landholder and community information will also be accessed to determine where and when platypus have been sighted. The results of the survey will be used to identify priority actions and recommendations for platypus management in the Yanco Creek System.

METHODS

Water samples for analysis were collected at 104 sites throughout the Yanco Creek system (Figure 1). Sixty-three sites were sampled along the Yanco Creek, twenty-six in the Colombo Creek and fourteen in the Billabong Ck. A single dam was sampled close to the mid-Yanco Creek at Broome. Sites were selected to provide good spatial coverage throughout the area, incorporate a variety of habitat types, while being limited by access to private property in some areas. A higher density of sites was selected in the eastern end of Yanco Creek in accordance with historical platypus records from online databases (ALA, BioNet). Sites were >2km apart to ensure independence taking into account DNA dispersal with flow and animal movements.

Water samples were collected by YACTAC staff and YCS landholders following detailed instructions and demonstration of correct sampling techniques by EnviroDNA. At each site, duplicate water samples were collected by passing up to 500 ml water (average 92 ml) through a 0.22 µm filter (Sterivex). Filtration was conducted on-site to reduce DNA degradation during transport of water (Yamanaka et al., 2016). Clean sampling protocols were employed to minimise contamination including new sampling equipment at each site, not entering water, and taking care not to transfer soil, water or vegetation between sites. After filtering, samples were immediately stored at 4^{o}C to reduce degradation, then frozen at -20^{o}C. frozen samples were transported directly to the laboratory for processing as soon as collection was completed.

DNA was extracted from the filters using a commercially available DNA extraction kit (Qiagen DNeasy Blood and Tissue Kit). Real-time quantitative Polymerase Chain Reaction (qPCR) assays were used to amplify the target DNA, using species-specific markers targeting a small region of the mitochondrial DNA (cytochrome b), previously developed and assessed for specificity and sensitivity by EnviroDNA (Lugg et al. 2018; Griffiths, van Rooyen, et al. 2016; Weeks et al. 2015). Assays were performed in triplicate on each sample. Positive and negative controls were included for all assays as well as an Internal Positive Control (IPC) to detect inhibition (Goldberg et al., 2016).

To minimize potential false positives, at least two positive PCR's (out of six assays undertaken for the site) were required to classify the site as positive for the presence of the target species. Sites were considered equivocal if only 1 assay returned a positive result, indicating very low levels of target DNA. While trace amounts of DNA may indicate that the target species is actually present in low abundance, it may also arise from sample contamination through the sampling or laboratory screening process (although minimised through clean sampling and laboratory protocols and negative controls), facilitated movement of DNA between waterbodies (i.e., water birds, recreational anglers, water transfers, predator scats), or dispersal from further upstream.

Landholder and Community information was collected during site visits. All landholders were contacted directly and asked to provide the location and timing of any platypus sightings over the past three years. In addition, calls for information were sent out in YACTAC and Murrumbidgee Shire Newsletters and emails to YACTAC members.

RESULTS

eDNA Survey

Results from the eDNA analysis are summarised below (Table 1). Platypus eDNA was detected at 19 of the 164 sites. Of the positive detections, 5 sites contained platypus DNA in 2 or more PCR assays (from a total of 6 assays at each site) with a further 14 sites detecting platypus DNA in only one assay and therefore considered equivocal. It is likely that many or all of these equivocal results are true positives but did not meet our defined threshold of at least 2 positive PCR's. Relatively low sample filtration volume due to turbidity may have contributed to the low DNA yields. When considering both positive and equivocal results, the site occupancy of platypuses in the system was 18%. No platypus eDNA was detected in the western reaches of Yanco and Billabong Creeks.

Recent platypus sightings, over the past 3 years, were recorded from 29 of the 104 sites. Of the 19 sites with positive eDNA results, all but one of these (6-mile lane-3 at Coolbaroo) coincided with landholder sightings over the past three years Figure 1. An additional ten sites recorded recent landholder sightings but did not record a positive result for DNA. Eight sites were linked to recent sightings but failed to detect any platypus DNA.

Most of the positive results for both eDNA and landholder sightings occurred in the upper reaches of Yanco and Columbo Creeks (Figure 1) indicating a permanent resident population in this area. Scattered equivocal results were recorded between Morundah and Bundure indicating a sparse or transient population in this area. Most of the community sightings not backed up by eDNA data occurred throughout the range set by the eDNA results and were predominantly in close proximity of positive and equivocal results, especially around Bundure in the Yanco and around Widgiewa in the Colombo Creek. This supports the acceptance of equivalent results in the current survey as positive identifications of platypus presence.

Table 1. Results for eDNA analysis of water samples for platypus (Ornithorhynchus anatinus) as well as records obtained from landowners (Recent <3yrs, Historical >3yrs ago)

Site Code	Waterway	Latitude	Longitude	Date	+ve assays	Test Result	Reported Sighting
B01	Billabong Ck	-35.3536	145.76559	14/5/20	0	Negative	
B02	Billabong Ck	-35.3253	145.97288	14/5/20	0	Negative	
B03	Billabong Ck	-35.3545	145.72656	14/5/20	0	Negative	
B04	Billabong Ck	-35.3053	145.17450	15/5/20	0	Negative	
B05	Billabong Ck	-35.28714	145.18471	15/5/20	0	Negative	
B06	Billabong Ck	-35.27707	145.23661	15/5/20	0	Negative	
B07	Billabong Ck	-35.33818	145.41611	28/5/20	0	Negative	
B08	Billabong Ck	-35.34372	145.68875	28/5/20	0	Negative	
B09	Billabong Ck	-35.3438	145.59650	28/5/20	0	Negative	
B10	Billabong Ck	-35.3550	145.50616	28/5/20	0	Negative	
B11	Billabong Ck	-35.21411	144.82347	22/6/20	0	Negative	
B12	Billabong Ck	-35.11574	144.69275	22/6/20	0	Negative	
B13	Billabong Ck	-35.07619	144.27791	22/6/20	0	Negative	
B14	Billabong Ck	-35.0441	144.12788	22/6/20	0	Negative	
C01	Colombo Ck	-35.27979	145.95757	29/6/20	0	Negative	
C02	Colombo Ck	-35.15853	146.17612	29/6/20	0	Negative	
C03	Colombo Ck	-35.16057	146.15604	30/6/20	0	Negative	
C04	Colombo Ck	-35.16043	146.13640	30/6/20	0	Negative	
C05	Colombo Ck	-35.17416	146.10883	30/6/20	0	Negative	
C06	Colombo Ck	-35.18205	146.08915	30/6/20	0	Negative	
C07	Colombo Ck	-35.18347	146.06093	30/6/20	0	Negative	
C08	Colombo Ck	-35.19511	146.04231	30/6/20	0	Negative	
C09	Colombo Ck	-35.2094	145.99694	30/6/20	0	Negative	
C10	Colombo Ck	-35.25184	145.96368	30/6/20	0	Negative	
C11	Colombo Ck	-35.14233	146.18118	1/7/20	0	Negative	
C12	Colombo Ck	-35.11806	146.19755	1/7/20	0	Negative	
C13	Colombo Ck	-35.11855	146.24376	1/7/20	0	Negative	
C14	Colombo Ck	-35.0926	146.26803	1/7/20	0	Negative	
C15	Colombo Ck	-35.07162	146.27678	1/7/20	0	Negative	
C16	Colombo Ck	-35.0440	146.30568	1/7/20	0	Negative	
C17	Colombo Ck	-35.01407	146.31775	1/7/20	0	Negative	
C18	Colombo Ck	-34.97921	146.33162	1/7/20	1	Equivocal	Recent
C19	Colombo Ck	-34.97193	146.34034	1/7/20	0	Negative	
C20	Colombo Ck	-34.9671	146.34202	1/7/20	1	Equivocal	Recent
C21	Colombo Ck	-34.95681	146.33880	1/7/20	0	Negative	
C22	Colombo Ck	-34.9287	146.28721	3/7/20	1	Equivocal	

C23	Colombo Ck	-34.9201	146.28243	3/7/20	0	Negative	
C24	Colombo Ck	-34.9087	146.27849	3/7/20	0	Negative	
C25	Colombo Ck	-34.89231	146.28044	3/7/20	0	Negative	
C26	Colombo Ck	-34.94186	146.30286	9/7/20	1	Equivocal	Recent
D01	Dam	-35.12451	145.79423	29/5/20	0	Negative	
Y01	Yanco Ck	-34.71602	146.36589	24/5/20	0	Negative	
Y02	Yanco Ck	-34.71326	146.37858	24/5/20	2	Positive	Recent
Y03	Yanco Ck	-35.2893	145.36115	26/5/20	0	Negative	
Y04	Yanco Ck	-35.2964	145.49174	26/5/20	0	Negative	
Y05	Yanco Ck	-35.2920	145.51282	26/5/20	0	Negative	
Y06	Yanco Ck	-35.17766	145.63081	26/5/20	0	Negative	
Y07	Yanco Ck	-35.14640	145.77261	26/5/20	0	Negative	
Y08	Yanco Ck	-35.14678	145.77986	26/5/20	0	Negative	
Y09	Yanco Ck	-35.15352	145.81190	26/5/20	0	Negative	
Y10	Yanco Ck	-35.15285	145.80287	26/5/20	0	Negative	
Y11	Yanco Ck	-35.15497	145.83051	26/5/20	0	Negative	
Y12	Yanco Ck	-35.15752	145.84506	26/5/20	0	Negative	
Y13	Yanco Ck	-35.16092	145.76265	24/6/20	0	Negative	
Y14	Yanco Ck	-35.16351	145.74832	24/6/20	0	Negative	
Y15	Yanco Ck	-35.16137	145.72692	24/6/20	0	Negative	
Y16	Yanco Ck	-35.16966	145.71688	24/6/20	0	Negative	
Y17	Yanco Ck	-35.17260	145.69979	24/6/20	0	Negative	
Y18	Yanco Ck	-35.12966	146.01109	24/6/20	1	Equivocal	Recent
Y19	Yanco Ck	-35.12507	146.01400	24/6/20	0	Negative	Recent
Y20	Yanco Ck	-35.13654	146.00153	24/6/20	0	Negative	Recent
Y21	Yanco Ck	-35.14486	145.98027	24/6/20	1	Equivocal	Recent
Y22	Yanco Ck	-35.01112	146.21294	26/6/20	0	Negative	Recent
Y23	Yanco Ck	-35.00137	146.20937	26/6/20	0	Negative	
Y24	Yanco Ck	-35.01282	146.19090	26/6/20	0	Negative	
Y25	Yanco Ck	-35.0220	146.18035	26/6/20	0	Negative	
Y26	Yanco Ck	-35.12042	146.02440	26/6/20	0	Negative	Recent
Y27	Yanco Ck	-35.12473	146.01774	26/6/20	1	Equivocal	Recent
Y28	Yanco Ck	-35.12983	146.04056	26/6/20	0	Negative	
Y29	Yanco Ck	-35.12563	146.05719	26/6/20	0	Negative	
Y30	Yanco Ck	-35.14880	145.92913	3/7/20	0	Negative	
Y31	Yanco Ck	-35.09773	146.10503	3/7/20	0	Negative	
Y32	Yanco Ck	-34.9287	146.28721	3/7/20	0	Negative	
Y33	Yanco Ck	-34.88561	146.27799	3/7/20	0	Negative	
Y34	Yanco Ck	-34.89147	146.26892	3/7/20	0	Negative	

Y35	Yanco Ck	-34.8809	146.25845	3/7/20	0	Negative	
Y36	Yanco Ck	-34.8624	146.26238	3/7/20	1	Equivocal	Recent
Y37	Yanco Ck	-34.8526	146.26571	3/7/20	0	Negative	Recent
Y38	Yanco Ck	-34.90301	146.26824	3/7/20	0	Negative	Recent
Y39	Yanco Ck	-34.91882	146.26614	3/7/20	0	Negative	
Y40	Yanco Ck	-34.92931	146.27813	3/7/20	1	Equivocal	Recent
Y41	Yanco Ck	-35.16812	145.85690	6/7/20	0	Negative	
Y42	Yanco Ck	-35.16078	145.84544	6/7/20	0	Negative	
Y43	Yanco Ck	-35.15449	145.81807	6/7/20	1	Equivocal	
Y44	Yanco Ck	-35.16773	145.89469	6/7/20	0	Negative	
Y45	Yanco Ck	-35.0733	146.13407	6/7/20	0	Negative	
Y46	Yanco Ck	-35.0096	146.23605	6/7/20	0	Negative	
Y47	Yanco Ck	-34.9639	146.26731	6/7/20	0	Negative	
Y48	Yanco Ck	-34.9479	146.26812	6/7/20	1	Equivocal	Recent
Y49	Yanco Ck	-34.8824	146.29405	6/7/20	1	Equivocal	Recent
Y50	Yanco Ck	-34.97142	146.30286	9/7/20	2	Positive	Recent
Y51	Yanco Ck	-34.8571	146.30755	9/7/20	0	Negative	
Y52	Yanco Ck	-34.81740	146.29064	9/7/20	0	Negative	
Y53	Yanco Ck	-34.8383	146.32917	9/7/20	0	Negative	
Y54	Yanco Ck	-34.81223	146.34850	9/7/20	3	Positive	Recent
Y55	Yanco Ck	-35.0467	146.15711	20/7/20	0	Negative	
Y56	Yanco Ck	-35.0502	146.14285	20/7/20	1	Equivocal	Recent
Y57	Yanco Ck	-35.0306	146.17204	20/7/20	0	Negative	
Y58	Yanco Ck	-34.7599	146.35399	20/7/20	0	Negative	
Y59	Yanco Ck	-34.75261	146.36191	20/7/20	0	Negative	Recent
Y60	Yanco Ck	-34.7059	146.40003	21/7/20	0	Negative	
Y61	Yanco Ck	-34.7965	146.33116	21/7/20	2	Positive	Recent
Y62	Yanco Ck	-34.78181	146.33655	21/7/20	3	Positive	Recent
Y63	Yanco Ck	-34.7947	146.31355	21/7/20	1	Equivocal	Recent

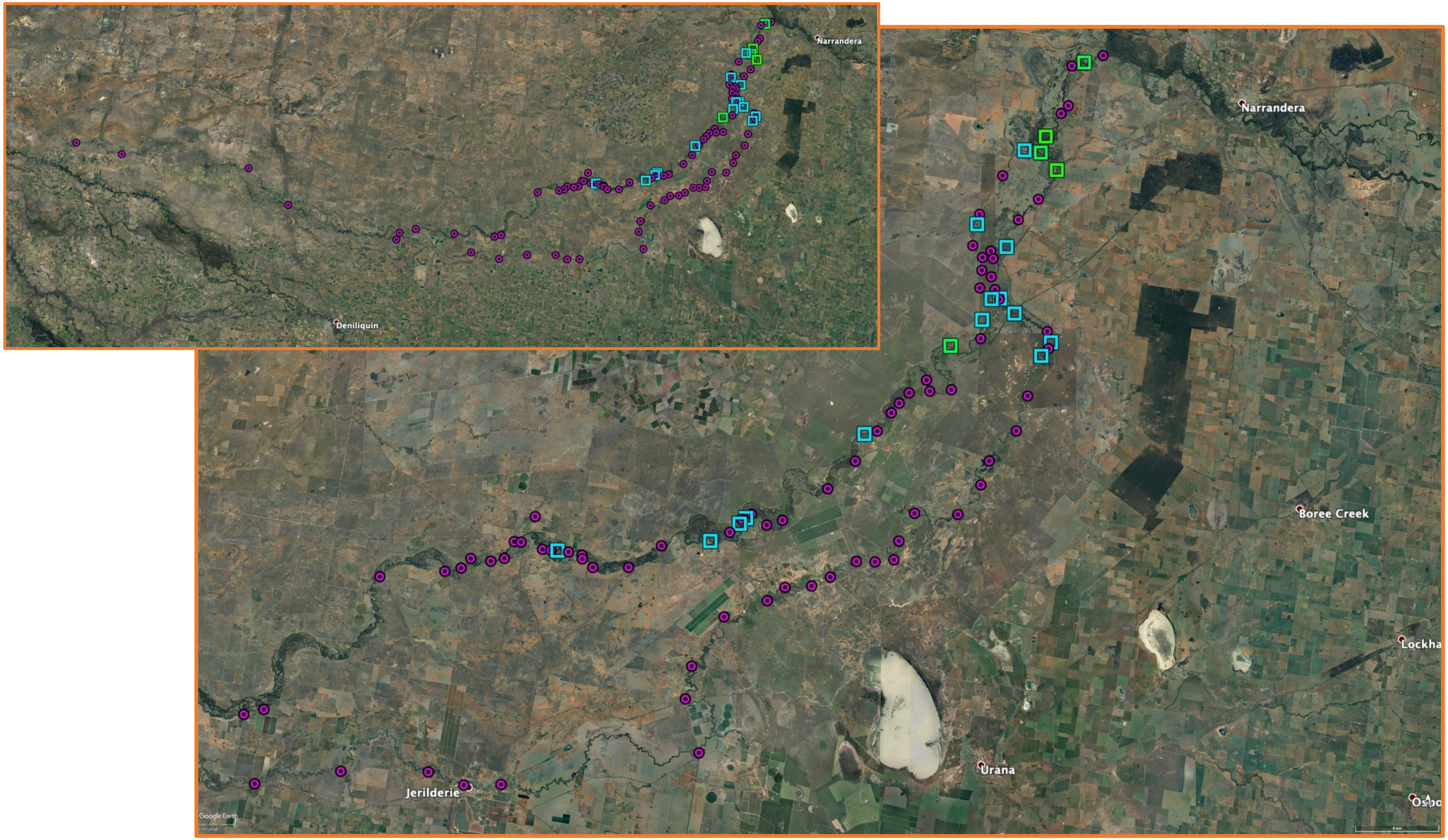


Figure 1. Results of Platypus eDNA Surveys. The larger map shows the extent of the Detected platypus population. Inlay map shows the total survey area. Green squares show sites with two or more assay detections, blue squares show sites with only one. Pink dots show sites where no platypus DNA was detected

DISCUSSION

eDNA Survey

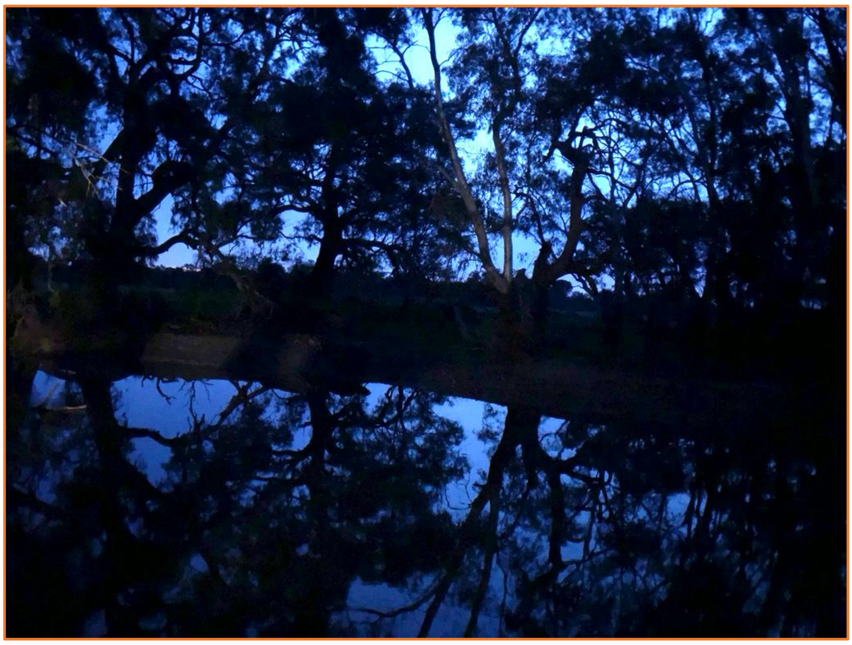
Analysis of the eDNA data shows the presence of a population of platypus in the upper reaches of the Yanco and Colombo creeks between the townships of Morundah and Narrandera, extending up to 100km downstream in the Yanco Creek and tens of kilometres downstream in the Colombo Creek. Results indicate that the density of the population is low, with 18% of sites indicating the presence of platypus. This is considerably lower than upper catchment coastal streams with "healthy" platypus populations (e.g., Yarra Ranges, east Gippsland), where site occupancy is typically >80% (Griffiths et al., 2018; Griffiths et al., 2020).

The distribution of platypus found in this study closely reflects that of other protected and threatened species in the Yanco Creek System. Trout cod, southern Bell frog and Murray crayfish are all confined to the area around Morundah and downstream to the mid Yanco Creek (Sharpe and Stuart, 2015; Sharpe, 2018; Turner et al., 2020). All of these species require permanent, fast flowing water and demand high levels of habitat complexity; characteristics that are particular to the range described. A detailed study to address how habitat complexity and flow regime influence the distribution of threatened and protected species in the system is warranted. This statement re-iterates a recommendation by Cooling and Gippel (2018a) for trout cod.

Platypus numbers in the Murrumbidgee and Murray Rivers are believed to have been significantly historically impacted by targeted hunting for the fur trade in the 19th Century and as bycatch of the inland fishing industry to the end of the 20th Century and illegal netting practices that continue today. The result is a decrease in the numbers of platypus, even though their general geographical distribution remains similar to pre-European colonisation (Scott and Grant, 1997). Recovery in of platypus numbers in the Murray and Murrumbidgee river systems is believed to be slower than elsewhere (Grant, 1993).

It should be noted that detection of platypus eDNA may have been slightly reduced as a result of the high levels of turbidity, especially at sites in the Yanco creek downstream of Coleambally outfall drain DC800 and in the Billabong creek. High turbidity directly reduced the volume of water able to be passed through collection filters and therefore limits the detection capability of the eDNA methods although it is unclear how much of an impact this may have had on the overall results.

Figure 2. Four of the sights with the highest detection of Platypus DNA. Top left: Old Yanko Park, Top right and bottom left - two sights on Somerset park - Somerset Park 1 and Spiller's weir. Bottom right, the sandhill banks at Gorree would provide excellent digging conditions for nesting compared to the heavy clay-based soils that dominate the lower system. All sights have good shallow flow velocities, complex riparian and instream habitat structure, adjacent floodplain systems, high banks with loamy/sandy sections and comparatively clear water for the system.



Picture 3. Evening falls on the high banks of the Yanco creek at Somerset Park, peak time for platypus foraging – Platypus eDNA was detected here at the time this picture was taken.

Community and Landholder Observations

This study demonstrates the potential benefit provided of combining community knowledge with scientific data methodologies such as the emerging eDNA technology. The results show that landholder and community sightings of platypus coincided very strongly with the presence of platypus at sites and within locations, as identified through eDNA analysis, including the equivocal site results. The threshold set for 'Equivocal' detection is an arbitrary set by researchers to avoid false positives over false negatives. In the YCS, the community sightings have effectively reinforced the accuracy of eDNA data suggesting that equivocal results in this study are likely to reflect real results rather than experimental errors. The highly turbid nature of creek water in the lower reaches of all creeks meant that lower volumes of water were able to be passed through filters than is usual in clearer upland streams where platypus are abundant. Detection of positive DNA matches in these lower volumes are potentially more significant than usual. As a result, all positive DNA matches were treated as positives for the current report.

Reported sightings by community members, particularly landholders have a number of attributes that make them helpful sources of data. For instance, landholders are often drawn back to where they have seen a platypus in their creek and so sightings often occur several times at the same site, over a number of years (Otley, 1997). This contrasts to netting and eDNA methodologies which represent single "snapshots" in time. Limitations of community sightings data include the inability to distinguish individuals, so repeated sightings in an area may be of the same different or individuals. Also, observations are typically biased towards population centres or areas of human activity and absences (i.e. no sightings) are rarely reported. While community sightings can be valuable, they should be complemented/verified by systematic surveys. Well-designed survey questions and further exploration of landowner responses can also help to clarify locations, timeframes and uncertainties.

Recollections of timeframes are also somewhat vague with observers uncertain of the exact months or years that observations were made. Several community sightings were described extending back 10-30 years. These included locations in the lower Billabong Creek near Conargo, suggesting that at some time, the population has extended significantly beyond the locations identified in the current study. This is backed up by results from the Atlas of Living Australia that indicate historical records farther downstream in the Yanco Creek and around Jerilderie in the Billabong Creek. When compared to the collective historical records, it appears the current distribution of platypuses in the Yanco Creek system has significantly contracted over the past few decades.

Platypus Conservation in the Murray-Darling Basin

Despite the increasing need for conservation of platypus populations, water resource management mechanisms largely ignore the needs of platypuses in regulated river reaches. The Murray Darling Basin Plan which guides sharing of water resources with the environment is focussed on outcomes for waterbirds and native fish. The Basin Plan and other Commonwealth conservation programs are largely dependent on the listings within the Environment Protection and Biodiversity Conservation (EPBC) Act (1999). Although platypus have been protected since the 19th Century, they are not considered under the EPBC Act 1999.

Recent assessments of historical and survey data have led some researchers to call for a revised conservation status, highlighting an observable decline in the platypus numbers and the distribution of platypus populations (Hawke et al., 2019, 2020; Griffiths et al., 2020). With further declines predicted across their range (Bino et al., 2020), Victoria has recently increased the conservation status to Vulnerable.

Consistent with this is the need to begin incorporating platypus into the regulatory mechanisms that can be utilised to protect populations in the wild. For regulated waterways such as the Murray and Murrumbidgee Rivers (including the YCS) this requires the development of specific environmental water requirements for platypuses and inclusion of those requirements into State and Commonwealth water resource and environmental watering plans. Only then can Commonwealth and State environmental water agencies begin targeting flow allocations for the protection and maintenance of platypus populations.

For the Yanco Creek System, this includes the Murray Darling Basin Plan watering strategies, hydrological models and processes under the Sustainable Diversion Limit adjustment mechanism, the Murrumbidgee Water Sharing Plan and Long-Term Environmental Watering Strategy. Importantly, environmental water requirements for platypus need to find their way into the operational practices of the Murray Darling Basin Authority, Commonwealth Environmental Water Office, the NSW Department of Planning, Infrastructure and Environment Energy and Science and the river operator WaterNSW.

Platypus habitat and Flow Regime

Platypus prefer shallower river or stream reaches with hydraulic diversity (pools less than 3 metres deep with shallow riffle and run areas) and complex benthic habitats (water plants, logs, cobbles) that support benthic invertebrate food resources (Grant, 1995). In lowland systems, access to floodplain habitats and backwaters are also likely to be important (Scott and Grant, 1997). To enable nesting, relatively steep earth banks consolidated by dense riparian vegetation are required (Grant et al., 1992; Serena et al 2001).

In the Yanco Creek System, floodplain areas are frequent and loamy sandhills with relatively intact riparian vegetation are common on riverbanks. These areas are likely to provide suitable sediment structure and form to facilitate burrow construction, particularly given the predominance of black cracking – self mulching clay soils along the creek system (Tom Grant pers comm). In the current study, positive platypus detection and sightings were commonly in or close to sandhills and/or floodplain habitats, particularly those with high creek velocities due to stream confinement. It is recommended that a detailed analysis of habitat variables be undertaken to better understand the essential habitat components for platypus.

Platypus life history depends on reliable surface water availability to support adequate food sources foraging movements and streams with regular and extended cease to flow events are much less likely to support a resident platypus population (Griffiths et al., 2019). Water resource development in the Murray Darling Basin has instead led to artificially stable and high flows (often bankfull during spring-autumn), and water that is cool, turbid and intermittently hypoxic with blue-green algae blooms during drier periods. Some waterways are unnaturally deep, possess poor-quality benthic habitat and food web complexity, making them less suitable as platypus habitat (Scott and Grant, 1997). Water quality impacts that reduce benthic diversity, habitat complexity and invertebrate populations are equally likely to present flow on effects that impact platypus via food web deficiencies. It is believed that platypus distributions in the Murray Darling basin may be restricted by highly turbid water (Scott and Grant, 1997).

Although often considered “artificial”, permanent flows in the YCS may have facilitated the establishment of a suite of threatened native fauna, dependant on the permanent flowing habitats now present in the creek system. The presence of these types of habitats – shallow warm water with permanent but variable flow regime – have disappeared throughout the wider Murray Darling Basin as water resource development created a system dominated by cooler, stable and less variable flow regimes, with unseasonal variability.

These conditions have led to a number of threatened and iconic species establishing populations throughout the Yanco Creeks System. For these species, including platypus, trout cod, southern bell frog and Murray catfish, the protection of this artificial flow regime, is critical for the preservation of these endangered populations (Cooling and Gippel, 2018a and 2018b, Sharpe and Stuart 2015, Sharpe 2018, Turner et al 2020, McNeil and Thompson 2020). Permanent regulated river reaches such as the Yanco Creek System, are likely to become increasingly important refuges for aquatic life in the Murray Darling Basin during drought periods. A scenario likely to intensify under predicted climatic regimes (McNeil et al., 2013). The protection of refuge areas with permanent, shallow flow, complex bank and bed habitat and a diversity of food sources will be central to the long-term resilience of platypus populations.

Local threats and Impacts in the Yanco Creek System

A number of natural resource management issues threaten the habitat quality of the Yanco Creek System and in turn the persistence of local platypus populations. Water efficiency projects are increasingly promoted as benefiting aquatic environments – however, there is little or no follow-up monitoring or assessments of the impacts and benefits of projects. In the Yanco Creek, the Water for Rivers program removed a large volume of water (60GL/y) from the creek system, to return water to the Snowy River and the “environment”. A key outcome of the project was a dramatic reduction in the medium to high level flows through the upper reaches of the creek system. No efforts were made to assess or protect the platypus population and the impacts of drastic flow reduction is unknown.

This impact is exacerbated by water buybacks which have seen further significant volumes removed from the system. In addition, river operators have increasingly turned to irrigation network infrastructure to deliver flows “more efficiently” on paper. Use of escapes, which drain poor quality water from irrigation channels and inject their effluent into the mid and lower reaches of the creek, take more flows away from the upper reaches of the system. It may be coincidence that the platypus population extends downstream to just above the confluence of the DC800 outfall drain from Coleambally irrigation scheme. Highly turbid water observed entering the Yanco Creek at this point could likely decrease the value of habitat downstream, particularly if other water quality impacts are caused via the outfall drain.

Platypus are not a part of monitoring and assessment programs under the Basin Plan or the Commonwealth Environmental Water Office, are not mentioned in the Murrumbidgee Water Resource Plans nor in the mid-Murrumbidgee Long Term Environmental Watering Plan; only the Yanco Creek System Strategic Plan (McNeil & Thompson, 2020) and placards hung on roadside fences, pleading for government attention, make mention of the need to protect the Yanco Creek platypus.

The threats of poor river management continue to mount with a Yanco Sustainable Diversion Limits Adjustment Mechanism project planned to create more efficiencies from a system that has no more to give. Underpinning this is the complete absence of any environmental water requirements or ecological assets in the Yanco Creek Murray Darling Basin Authorities hydrological modelling, ecological equivalence models or business plans. This adds up to very poor representation of the YCS platypus population in the current water resources arena. Only the careful determination of environmental water requirements for platypuses in lowland waterways will enable their inclusion in water resources management practice.

Infrastructure projects that impact on stream banks or waterways should also take into consideration the requirements of platypuses when carrying out risk assessments, Environmental Impact Assessments (EIA) and Reviews of Environmental Factors (REFs). A comprehensive review of factors that must be considered in these assessments, has been published (Grant, 2014) and must be included in all assessments made within the range of the platypus, which is extensive. In the Yanco Creek system, this would include any infrastructure works under the Sustainable Diversion Limits Adjustment Mechanism and the ElectraNet - TransGrid EnergyConnect project.

Environmental Water Requirements

There is not a great deal of information regarding the flow requirements for platypuses, although several recommendations for flow management were set out by Scott and Grant (1997). To ensure suitable habitat for platypus sustainability the authors recommended:

- Extended periods of bankfull flow in late spring and summer should be avoided whenever possible.
- Bank collapse can be minimised by avoiding sudden falls in water level.
- There should also be sufficient calm water so that the platypuses are not continuously swimming against a strong current.
- The flow regime should also be designed to ensure an abundance of invertebrates for food.
- In addition, extreme low flows or dry periods should be avoided due to predation on platypus moving between pools (Keith Bishop pers comm).

Building on this, (Grant and Bishop, 1998) set out to determine specific flow regimes suitable for platypus in coastal streams of NSW. They developed a simple and practical rapid assessment methodology to predict minimum and/or maximum flow requirements in specific water bodies, using field-based measurements made at representative pool and/or riffle transects that indicate potential benthic productivity and the suitability and availability of banks. This focused on a description of instream habitat with the aim of determining benthic productivity, the suitability of the pools and riffles for foraging, resting and daily movements and the availability of suitable sites for burrowing.

- Potential benthic productivity would be assessed by measurements of habitat diversity, total riffle area, total pool area and wetted perimeter.
- The suitability of pool and riffle areas would be assessed by determining the flowrate in terms of velocity and the resulting depth of water over the riffles.
- The availability of suitable sites for burrowing is determined by the distance of earth banks (which are consolidated by roots of vegetation and suitable for burrowing by platypuses), from the water's edge at the various flows and also by the available height of earth banks above the water level.

These characteristics should then be determined over a range of flows, within the predicted flow regime including water extraction and/or release scenarios. It is recommended that the detailed considerations set out in Grant and Bishop (1998) be incorporated into water resource planning, and especially into NSW Long Term Environmental Watering Plans and Water Sharing Plans and the Murray Darling Basin Plan.

The results of the current study suggest that assessments in the Yanco Creek System include:

- Assess importance of sandhills and bank structure as critical nesting sites in the Yanco Creek System including impacts of flow levels on nest viability.
- Consider the role of hydraulic variability, especially rapidly flowing creek sections, in determining platypus distributions.
- Assess the variation in benthic macro-fauna of different hydraulic habitats to determine flow-food relationships and identify food resource limitations to distribution (link to turbidity and structural complexity).
- Consider the role of floodplain inundation and wetland complexity in supporting platypus populations, building resilience and facilitating growth and physical health during high flows (Gust and Handasyde, 1995).
- Assessment of factors set out in Grant (2014) when conducting any EIA, REF or other risk management processes.

Platypus Environmental Water Requirements must be consistent with NSW Long Term Environmental Watering Plans, Water Sharing Plans and ecological, hydrological and hydraulic modelling platforms used to deliver environmental water under the Murray Darling Basin Plan. It is suggested that the development of Platypus EWRs will provide an excellent proxy for hydrological, hydraulic and food web complexity as well as water quality. The provision of flows to support and foster platypus populations will directly support the existing intent and objectives of sustainable water resource management in the Murray Darling Basin.

REFERENCES

Biggs J., Ewald N., Valentini A. et al. (2015). Using eDNA to develop a national citizen science-based monitoring programme for the great crested newt (Triturus cristatus). Biol. Conserv. doi: 10.1016/j.biocon.2014.11.029. [online].

Bino, G. et al. (2019). The platypus: evolutionary history, biology, and an uncertain future. Journal of Mammalogy **100**:308–327. Oxford University Press US.

Bino G., Kingsford R. T. & Wintle B. A. (2020). A stitch in time – Synergistic impacts to platypus metapopulation extinction risk. Biol. Conserv. 242, 108399. [online]. Available from: https://doi.org/10.1016/j.biocon.2019.108399.

Cooling, M.P. and Gippel, C.J. (2018a). Integrated Hydrological Operations Plan for the Billabong, Yanco and Colombo Creeks. Ecological Associates report FL001-2-E prepared for Murray Local Land Services, Albury.

Cooling, M.P. and Gippel, C.J. (2018b). Integrated Hydrological Operations Plan for the Billabong, Yanco and Colombo Creeks - Literature Review and Stakeholder Consultation. Ecological Associates report FL001-1-F prepared for Murray Local Land Services, Albury.

Dowling F. (2018). Along the Billabong Creek. Petaurus Education Group Inc. NSW.

Grant, T. R. (1992). The historical and current distribution of the platypus, Ornithorhynchus anatinus, in Australia. Pp. 232-254 in 'Platypus and echidnas (M. L. Augee, ed.). *The Royal Zoological Society of NSW*, Sydney.

Grant T. R., Grigg G. C., Beard L. A. & Augee M. L. (1992). Movements and burrow use by platypuses, Ornithorhynchus anatinus, in the Thredbo River, New South Wales. In: Platypus and Echidnas (ed M. L. Augee) pp. 263–267 Royal Zoological Society of New South Wales.

Grant T.R. Bishop K.A. (1998). Instream Flow Requirements for The Platypus (Ornithorhynchus anatinus): A Review. *Australian Mammalogy* 20, 267-280.

Grant T.R. (2014). the platypus and the environmental impact assessment process: more cogitations of a consultant. *Consulting Ecology* 33, 50-63.

Grant, T.R., Griffiths, M. and Temple-Smith, P.D. (2004). Breeding in a free-ranging population of platypuses, Ornithorhynchus anatinus, in the upper Shoalhaven River in New South Wales - a 27 year study. Proceedings of the Linnean Society of NSW 125, 227-234.

Grant T. R. & Temple-Smith P. D. (2003). Conservation of the platypus, Ornithorhynchus anatinus: Threats and challenges. *Aquat. Ecosyst. Heal. Manag*. 6 , 5–18.

Griffiths J., Van Rooyen A. & Weeks A. (2016). Platypus distribution and relative abundance in the MacKenzie River and upper Wimmera 2016 (Report to Wimmera CMA). Cesar, Parkville, VIC.

Griffiths J. & Weeks A. (2018). Investigating the current distribution of platypuses, rakali, and blackfish in the upper Wimmera region (Report to Project Platypus). EnviroDNA, Parkville, VIC.

Griffiths J., McColl-Gausden E. F., Connelly F. & Weeks A. (2020). Assessing the impacts of the 2019 / 20 bushfires on platypus populations in south eastern Australia. Cesar Australia, Parkville, VIC.

Griffiths J. & Weeks A. (2011). Temporal patterns in abundance of platypus populations in Melbourne's catchments (Report to Melbourne Water). Cesar, Parkville, VIC.

Griffiths J., van Rooyen A. & Weeks A. (2017). Using eDNA to assess the current distribution of platypuses in the greater Melbourne area (Report to Melbourne Water). Cesar, Parkville, VIC.

Griffiths J., van Rooyen A., Song S. & Weeks A. (2018). Distribution and relative abundance of platypuses in the greater Melbourne area: MWUPP 2013-18. Cesar, Parkville, VIC.

Griffiths, J., McColl-Gaudsen, E. Connolly, F., and Weeks, A. (2020). Assessing the Impacts of the 2019/2020 bushfires on platypus populations in south eastern Australia. Report to the Australian Conservation Foundation.

Gust N. and Handasyde K. (1995). Seasonal variation in the ranging behaviour of the platypus (Ornithorhynchus anatinus) on the Goulburn River, Victoria. *Aust. J. Zoology* 43: 193-208.

Hawke, T., G. Bino, and R. T. Kingsford. (2019). A silent demise: Historical insights into population changes of the iconic platypus (*Ornithorhynchus anatinus*). *Global Ecology and Conservation.*

Hawke, T., Bino, G., Kingsford, R.T., (2020). Platypus: Paucities and peril. A response to: Limitations on the use of historical and database sources to identify changes in distribution and abundance of the platypus, *Global Ecology and Conservation*

Lugg W. H., Griffiths J., van Rooyen A. R., Weeks A. R. & Tingley R. (2018). Optimal survey designs for environmental DNA sampling. Methods Ecol. Evol. 9, 1049–1059.

Lunney D., Grant T. & Matthews A. (2004). Distribution of the platypus in the Bellinger catchment from community knowledge and field survey and its relationship to river disturbance. Proc. Linn. Soc. New South Wales. [online].

McColl-Gausden E. F., Weeks A. R. & Tingley R. (2019). A field ecologist's guide to environmental DNA sampling in freshwater environments. Aust. Zool. doi: 10.7882/az.2019.025.

Mitrovski P. (2008). The distribution of platypus in the Upper Wimmera Catchment (Report to Wimmera Catchment Management Authority). CESAR Consultants, North Melbourne, VIC.

Otley, H. (2001). The use of a community-based survey to determine the distribution of the Platypus Ornithorhynchus anatinus in the Huon River catchment, southern Tasmania. *Australian Zoologist* 31 (4). 632-641.

Rees H. C., Maddison B. C., Middleditch D. J., Patmore J. R. M. & Gough K. C. (2014). REVIEW: The detection of aquatic animal species using environmental DNA – a review of eDNA as a survey tool in ecology. J. Appl. Ecol. 51, 1450–1459. [online].

Scott, A. and Grant, T. (1997). Impacts of water management in the Murray- Darling Basin on the platypus (Ornithorhynchus anatinus) and the water rat (Hydromys chrysogaster). Murray Darling Basin Commission and CRC for Freshwater Ecology. CSIRO Technical Report 23/97 ISBN 0 643 06051 0.

Sharpe, C. and Stuart, I. (2015). The Distribution of Trout cod in Yanco and Colombo Creeks. Final Report for Murray Local Land Services by CPS Enviro and Kingfisher Research, Irymple Victoria.

Sharpe, C. (2018). Trout cod in Yanco Creek; Patterns of spawning, recruitment and population status in 2017/18. Final Report for Murray Local Land Services by CPS Enviro, Irymple Victoria.

Serena M., Worley M., Swinnerton M. & Williams G. A. (2001). Effect of food availability and habitat on the distribution of platypus (Ornithorhynchus anatinus) foraging activity. Aust. J. Zool. 49, 263–277.

Steven, R., Barnes, M, D., Garnett, S. T., Garrard, G., O'Connor, J., Oliver, J. L., Robinson, C, J., Tulloch, A, I, T. and Fuller, R. A. (2019). Aligning citizen science with best practice: Threatened species conservation in Australia. *Conservation Science and Practice* 1(2).

Smart A. S., Tingley R., Weeks A. R., Van Rooyen A. R. & McCarthy M. A. (2015). Environmental DNA sampling is more sensitive than a traditional survey technique for detecting an aquatic invader. Ecol. Appl. 25, 1944–1952.

Thomsen P. F., Kielgast J., Iversen L. L. et al. (2012). Monitoring endangered freshwater biodiversity using environmental DNA. *Mol. Ecol.* **21** , 2565–2573.

Thomsen P. F. & Willerslev E. (2015). Environmental DNA - An emerging tool in conservation for monitoring past and present biodiversity. *Biol. Conserv.* doi: 10.1016/j.biocon.2014.11.019. [online].

Turner, A., Wassens, S. & McNeil, D. (2020). Yanco Creek and tributaries: Intensive frog surveys of creek and farm habitats 2019-20. Final report for Yanco Creek and Tributaries Advisory Council. Institute of Land Water and Society, Charles Sturt University, Albury.

Valentini A., Taberlet P., Miaud C. et al. (2016). Next-generation monitoring of aquatic biodiversity using environmental DNA metabarcoding. Mol. Ecol. 25, 929–942.

Woinarski J. C. Z., Burbidge A. A. & Harrison P. L. (2014). The action plan for Australian mammals 2012. CSIRO Publishing, Collingwood.

Woinarski J. & Burbidge A. A. (2016). Ornithorhynchus anatinus. The IUCN Red List of Threatened Species.

Yamanaka H., Motozawa H., Tsuji S., Miyazawa R. C., Takahara T. & Minamoto T. (2016). On-site filtration of water samples for environmental DNA analysis to avoid DNA degradation during transportation. Ecol. Res. 31, 963–967.